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Impact Analysis of CAP Reform on the Main Agricultural Commodities

Report III

AGMEMOD – Model Description

Author: AGMEMOD Partnership
Editors: Lubica Bartova and Robert M'barek

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■ Foreword

Quantitative models are important tools for analysing the impact of agricultural policies. One of the modelling approaches used to analyse the impact of the Common Agricultural Policy is AGMEMOD (AGricultural MEmber states MODelling), an econometric, dynamic, partial equilibrium, multi-country, multi-market model. AGMEMOD models provide extensive details of the agricultural sector in individual EU Member States and the EU as a whole.

A study was carried out from November 2005 until June 2007 by the AGMEMOD Partnership under the management of the Agricultural Economics Research Institute (LEI, the Netherlands), in cooperation with the European Commission's Joint Research Centre - Institute for Prospective Technological Studies (JRC-IPTS). The aim was to generate projections for the main agricultural commodity markets for each year from 2005 until 2015.

Detailed documentation on the AGMEMOD modelling approach, along with the outcome of the study, is published in five reports in the JRC-IPTS Scientific and Technical Report Series (Box 1) under the heading "Impact analysis of CAP reform on the main agricultural commodities".

Box 1 Impact analysis of CAP reform on the main agricultural commodities

Report I ***AGMEMOD – Summary Report***
This report presents the projections of agricultural commodity markets under the baseline, further CAP reform, enlargement scenarios and exchange rate change sensitivity analyses for the aggregates EU-10, EU-15, EU-25 and EU-27. It summarises the characteristics of the modelling tool used, focusing in particular on the features implemented in this study, and addresses issues that need further attention. (http://www.jrc.es/publications)

Report II ***AGMEMOD – Member States Results***
This report outlines the results of the baseline projections of agricultural commodity markets, further CAP reform scenario impact analyses and exchange rate change sensitivity analyses for individual EU-27 Member States except Malta and Cyprus. For Bulgaria and Romania enlargement and non-enlargement scenarios are analysed. (http://www.jrc.es/publications)

Report III ***AGMEMOD – Model Description***
This report describes the modelling techniques used by the AGMEMOD Partnership, with the emphasis on new commodities modelled and policy modelling approaches. (http://www.jrc.es/publications)

Report IV ***AGMEMOD – GSE Interface Manual***
The Manual gives an overview of the GAMS Simulation Environment (GSE) interface and its application with the AGMEMOD model. (http://www.jrc.es/publications)

Report V ***Commodity Modelling in an Enlarged Europe – November 2006 Workshop Proceedings***
These proceedings consist of presentations and conclusions of a workshop held in November 2006. The presentation of outcomes of the other models such as FAPRI, ESIM, AGLINK and CAPSIM are included in addition to the AGMEMOD approach. (http://www.jrc.es/publications)

We acknowledge the work undertaken by country teams of the AGMEMOD Partnership and by Myrna van Leeuwen, LEI, the Netherlands, the project co-ordinator.

■ Executive summary

In this report the AGMEMOD modelling tool, modelling techniques, scenarios and new features developed and applied in a study carried out by the AGMEMOD Partnership in cooperation with JRC-IPTS are described. AGMEMOD is an econometric, dynamic, partial equilibrium, multi-country, multi-market model and provides extensive details of the agricultural sector in individual EU Member States and the EU as a whole.

The objectives of the study were threefold:

i) To provide market projections for the main European agricultural commodities based on the latest agricultural and trade policy developments and information available;
ii) To assess the impacts of selected scenarios on the main European agricultural commodity markets. In particular, these scenarios concern the introduction of decoupling and new direct payment schemes as well as the enlargement of the EU in 2007;
iii) To apply and improve an agricultural sector model for the enlarged EU, implemented in standard computer software (GAMS and MS Excel), and to make a preliminary version operational and available for the European Commission.

Projections and simulations have been generated for individual EU Member States and the EU at different aggregation levels (EU-10, EU-15, EU-25, EU-27), providing results on supply, demand, trade and prices for the main agricultural commodities (cereals, oilseeds, livestock products and dairy products).

The impact of the following ***scenarios*** was analysed:

- The Baseline scenario for the Member States before the 2004 enlargement and Slovenia models reflects the 2003 CAP reform, which covers the additional milk quotas, a cut in intervention prices and national implementation of the Single Farm Payment Scheme (SFP). For the 2004 enlargement Member States implementation of the Single Area Payment Scheme (SAPS) until 2008 followed by introduction of the Single Farm Payment Scheme from 2009 onwards are assumed. Complementary national direct payments remain in force in the Member States of the 2004 enlargement until 2013;
- The Further CAP Reform scenario, in which all direct payments are decoupled and the rates of compulsory modulation are doubled to 10%, both from 2007 onwards;
- The Enlargement scenario, which examines the consequences of accession to the EU of Bulgaria and Romania.

The AGMEMOD ***modelling system*** applied in this study has been econometrically estimated at individual Member State level. The country models contain the behavioural responses of economic agents to changes in prices, policy instruments and other exogenous variables of agricultural markets. Commodity prices adjust so as to clear all markets considered. For each commodity modelled and in each country, the system generates the main domestic market variables such as production, food and feed demand, prices, trade and stocks. Agricultural income is calculated at sector level. As all policy-relevant agricultural markets are covered, the econometrically modelled country-specific agricultural markets also provide a sound basis for an analysis of the impacts of policy changes.

To ensure that the projections of the modelling system are consistent from an economic and policy perspective, projections have been validated by standard econometric methods and through consultation with national experts. In addition, the study analysed the impact of three alternative paths of the US dollar against the euro exchange rate changes in a form of a sensitivity analysis.

The obtained projections largely accord with the *a priori* expectations. A decline (increase in the value of the €/US dollar exchange rate compared with the baseline assumptions leads to higher (lower) internal EU market prices and consequent adjustments to production, domestic use, imports and exports.

Although results differ across countries, the ***key findings of this* study** regarding the aggregated EU-25 ***baseline projection analyses*** are as follows:

- Despite the decoupling measures of the 2003 CAP reform (also referred to as the Luxembourg Agreement), the EU production in several sectors (wheat, maize) will grow over the period 2005-2015.
- Higher dynamics can be found in the oilseed sector with demand propelling the markets.
- The decoupled payments will induce a further decline in beef and lamb production.
- Pig meat and poultry production are largely unaffected by decoupling.
- The dairy sector is expected to be negatively affected by declining prices, which occur largely as a consequence of the reductions in intervention prices for dairy products, but quotas will still be fulfilled.
- A shift away from butter and skimmed milk powder production can be expected and at the same time growth in the production of cheese is projected.

The ***key findings*** of this study regarding the ***scenario projection analyses*** are as follows:

- The <u>*Further CAP Reform scenario*</u> projections tie in with *a priori* expectations, in that the impact of policy measures assumed in this scenario is very limited due to the fact that many Member States had already chosen to largely decouple direct payments under their implementation of the Luxembourg Agreement at national level.
- The <u>*2007 Enlargement of the EU*</u> with the accession of Romania and Bulgaria is not expected to dramatically change the situation of most key EU agricultural markets. There are increases projected for the production of EU sunflower oil, soft wheat and maize, but accession is projected to have less of an impact on livestock and meat markets.

Although the agricultural markets of the individual countries have different levels of development and the country models are being further developed, the projections provide useful information about general trends of individual Member State agricultural markets.

This report, Report III AGMEMOD - Model Description, summarises methodological issues and describes how a plausible and consistent database is developed as a basis for correctly estimating model parameters, achieving proper simulation results and policy recommendations. The principles of equation specifications and model closure are depicted, followed by an analysis of applied estimations and testing techniques for models. The report describes the projection and simulation procedures of a particular country and EU models and the structure of a particular country and AGMEMOD EU models.
New commodities (rye, oat, triticale) have been modelled and implemented in the AGMEMOD model under the JRC-IPTS study. The commodity models (described in flow charts), the linkages of commodity models in a particular country model and EU models are explained. Special attention is given to the role of prices and closure of models. In addition, the report also discusses further development of AGMEMOD modelling tools.

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Acronyms

AGMEMOD AGricultural MEmber states MODelling
CAP Common Agricultural Policy
CEECs Central and Eastern European Countries
CNDP Complementary National Direct Payments (top-ups)
EU-10 8 EU Member States of the 2004 enlargement, Malta and Cyprus not included
EU-12 10 EU Member States of the 2004 and 2007 enlargements**,** Malta and Cyprus not included
EU-15 15 EU Member States to May 2004
EU-25 23 EU Member States after the 2004 enlargement, Malta and Cyprus not included
EU-27 25 EU Member States after the 2007 enlargement, Malta and Cyprus not included
FAPRI Food and Agricultural Policy Research Institute, USA
GAMS General Algebraic Modelling System
GDP Gross Domestic Product
GSE GAMS Simulation Environment
JRC-IPTS Joint Research Centre - Institute for Prospective Technological Studies (Spain)
MS Member State
OECD Organisation for Economic Co-operation and Development
PSE Producer Support Estimate
SAPS Single Area Payment Scheme
SFP Single Farm Payment
USD U.S. Dollar
WTO World Trade Organisation

1. Introduction

The most common approaches for quantitative assessments of agricultural policy reforms are based on partial equilibrium (PE), computable general equilibrium (CGE) and programming models. A broader variety of models can be found in depicting impacts of the Common Agricultural Policy (CAP), but their use is more focused on production effects and on farms impacts alone rather than on market reactions. Typically these models formulate different production activities which are optimised with respect to a set of production restrictions, prices and costs. Values concerning these variables are usually set exogenously. Instead of values for prices or costs, functions can be implemented in these models so that they will also reflect market processes. However, even with such improvements, the models often tend to be hypersensitive to small changes.

The advantage of CGE models is that they capture the interaction between the agricultural sector and the non-agricultural sectors of the economy and quite frequently the global integration (Van Tongeren and Van Meijl, 2001). However, to limit the complexity of the models and to improve their computational feasibility, agricultural production is often aggregated. Furthermore, inclusion of some agricultural policy measures is sometimes difficult due to this aggregation of agricultural production and inadequate representation of physical resource constraints (Banse and Hagerman, 1996). Tyers and Anderson (1992) note that such aggregation often weakens the interaction and causal linkages between different agricultural production sectors in CGE models. Moreover, it is quite common to model agricultural policy instruments as price wedges.

PE models do not include by definition linkages that allow for the analysis of the impact of developments in the agricultural sector on other sectors of the economy. Otherwise PE models incorporate more details on production and policy instruments (Salvatici et al., 2001). PE models generally describe one sector or a group of closely related products in an economy with a greater level of dis-aggregation than is common in CGE models. Due to the capacity of PE models to incorporate detailed representations of relationships between policy instruments and agricultural commodity supply and demand, these types of models are very suitable to the analysis of the agricultural sector of developed economies. The PE framework also facilitates the extensive coverage of detailed products and countries. Important features of the PE model grouping are their relatively simple economic structure, and interpretable results. This last feature can be advantageous when model results are used by non-economists. A more detailed overview on general and partial equilibrium models and their different features can be found in Van Tongeren and Van Meijl (2001).

One of the study objectives was to apply and further develop a modelling system that captures the dynamics of a large number of agricultural commodity markets, the impact on these markets of a diversity of applied policy instruments as implemented across each EU Member State. For these purposes projections and scenario simulations have been carried out with AGMEMOD model, a PE modelling approach.

The AGMEMOD model was improved in the following way:

- new commodities ‘rye’ and ‘'other grains'’ were specified, estimated and implemented in the country models of significance;
- the decoupled payment system was modelled differentially across the Member States in line with national implementation;
- the EU-10 models were prepared for migration from Excel to GAMS;
- the EU-15 models were combined into an EU-15 model version;

- the EU-10 models were added to the combined EU-15 version, resulting in a EU-25 hybrid model;
- the Bulgarian and Romanian models were added to the EU-25 hybrid model, resulting in a EU-27 hybrid model;
- user-friendly software was implemented in the combined EU-15 model.

The present Report III AGMEMOD - Model Description is comprised as follows. Chapter two summarises the methodological issues. It describes how a plausible and consistent database is developed as a basis for estimating the models correctly and achieving proper simulation results and policy recommendations. The principles of the equation specifications and the model closure are depicted, followed by an examination of the applied estimation and testing techniques for the commodity models. The final part in this chapter looks at the projection and simulation procedures of the country and EU models. The third chapter describes the structure of the country and EU models of AGMEMOD.

The fourth chapter contains a description of new commodity markets in AGMEMOD and how they are modelled. It shows the commodity models (flow charts), the linkages of commodity models in a country model and the EU models. Special attention is given to the role of prices and closures of the models.

Policy scenarios applied in this study are described in the chapter five and software environment of AGMEMOD in chapter six. Finally chapter seven outlines the state of the art of the AGMEMOD modelling tool and discusses further developments.

2. Methodology of AGMEMOD model

This chapter outlines the research techniques used in the AGMEMOD model: the development of country model templates, the selection and acquisition of data, the description of the model's functional forms, the validation procedures, the solving of the model and the generation of projections. Each of these steps is described in the chapter.

The foundation for AGMEMOD model is laid on the country model templates, which assure compatibility of the national models and the commonality of data. The country model templates encapsulate the modelling system used. This system consists of econometric and calibrated models for the main agricultural commodities in the EU Member States. The software embodying the template is also designed so that the resulting country models link together to form a combined one for the EU as a whole.

The model template (Hanrahan, 2001; Riordan, 2002) contains the following issues in respect to the commodity markets in AGMEMOD:

- outline of the role of the commodities in the agricultural sector, its relationship with other commodities and its connection with input markets;
- definition of policy instruments to be explicitly included;
- layout of flow charts to show:
  - the linkages between production, consumption, stock and trade;
  - the influence of economic and policy variables;
  - the linkages with other commodity markets;
- assembly and use of data according to agreed definitions;
- information on the key prices such as:
  - the EU key market;
  - specification of price equation;
  - econometric estimation and projections up to 2015;
- specification of the functional forms of the commodity model;
- labelling of variables (mnemonics).

Partners from EU Member States applied the template to develop their national AGMEMOD model.

2.1. Data base

A plausible and consistent database is necessary to estimate the country models correctly. The criteria for assessing the admissibility of data in the project include:

- reliability and accessibility of the data series and their up-dating;
- additivity of variables: the country level numbers for many variables have to add-up to acceptable totals for the EU as a whole (e.g., the national commodity balance sheets must add-up to that for the EU);
- data consistency across all models for the variables that drive the individual models, (e.g., the currency exchange rates);
- availability of the projections for the macroeconomic variables that drive the models (e.g., GDP, inflation, population growth);
- relevance of the data to the users of the results.

The model's database in AGMEMOD is built up with balance sheets for all commodities, which refer to initial stocks, production, imports, human food consumption, feed use, processing and industrial use, exports and ending stocks. Eurostat data sources - *AgrIS* (Agricultural Information System) and *NewCronos are used* as these meet the above mentioned criteria. Furthermore, these sources have user's relevance as they will tend to be widely used and referenced by policy makers and agricultural interests. The ideal condition would be to use all data from the same database. In practice, however, databases may be incomplete or inconsistent in showing different numbers for the same variables or they may include unclear definitions. Gaps range from the absence of a data point in a series, to the total absence of data for the series in one or more countries. Where there were gaps, comparable data from other sources (FAO, USDA and national sources) are derived, or, as a last resort, interpolations based on statistical techniques or expert judgement are used. Data sources must always be communicated, so that discrepancies can be detected.

Data in Eurostat sources, like in other databases, are subject to frequent revisions. These revisions might not only affect the previous years but also longer periods. As long as these amendments are not taken into account by re-estimations, model results will not reflect the changes in the database. Since the models are not re-estimated in the JRC-IPTS study, one has to keep in mind that deviations, between model projections and actual data, could be caused by data revisions.

The AGMEMOD model uses two types of data, a set for exogenous variables and a set for endogenous variables. The integrity of the model results rests on the use of both data sets.

Exogenous data
Data for exogenous variables are determined outside the model. In the selection of these data series, attention is given to the availability of authoritative projections of their levels to 2015. Exogenous data for macroeconomic variables, policy variables and key prices are consistent across all of the country models in AGMEMOD. Exogenous data sets are now briefly described.

Macroeconomic data
Variables included in this data set are:

- inflation rates per country;
- per capita economic growth per country;
- currency exchange rates (U.S. dollar/euro, national currency/euro);
- population per country;
- world market price per commodity.

Macroeconomic projections are obtained from the Commission services and other internationally recognised sources. They are checked so as to ensure that radically divergent projections, for the development of inflation, currency exchange rates and economic growth across EU Member States, are not used.

Values for the world market price projections are used from the FAPRI modelling system, with the similar to AGMEMOD model structure. This allows for the incorporation of the impact of global supply and demand developments on the EU agricultural markets.

Policy data
Policy data show the variables affected by CAP and GATT-WTO measures and reflect the differences in policies applied across EU member states (Table 2.1). AGMEMOD includes the following policy variables:

- Intervention prices;

- Subsidies on products, including aids/grants for crops and headage premiums;
- Subsidies on production, including those for land set-aside and for cattle premiums;
- Quantitative restrictions, including quotas for milk deliveries and for numbers of animals eligible for headage payments;
- Single Farm Payment (SFP);
- Single Area Payment Schemes (SAPS) for new Member States (the 2004 and 2007 enlargements);
- Ssubsidised export limits and tariff rate quota levels**.**

Table 2.1: CAP policy variables

Market	**Policy variables**
Grains	Set-aside rate Compensation Intervention price Reference yield
Oilseeds	Set-aside rate Compensation Reference yield
Livestock	Suckler cow quota Bull premium Suckler cow premium Beef intervention price Ewe premium Animal density threshold
Dairy	Milk quota (adjusted) Feed subsidy Butter consumption subsidy Butter intervention price SMP intervention price
CAP reform of June 2003 for Member States before 2004 (from 2005) and Member Sates of the 2004 enlargement (from 2007)	Single Farm Payment (SFP)
Policy up to 2007 for Member States of the 2004 enlargement	Single Area Payment Scheme (SAPS)

Key prices

For each modelled commodity, a key price is defined (Table 2.2) as a commodity price at the most important commodity market in the EU. Time series price data for the commodities are used in all country models, particularly for establishing linkages between these system-wide prices and those in each of the countries.

Endogenous data

To the greatest possible extent, partners extract data from Eurostat databases when compiling their commodity supply, use and price datasets. Where necessary, data from national and international agencies are used to supplement the data available from these sources. Each partner checks the commodity datasets assembled so as to ensure that, for all commodity markets and for all sample time period, the following supply and use identity hold exactly:

$$production_t + imports_t + beginning\ stocks_t \equiv domestic\ use_t + exports_t + ending\ stocks_t$$

Where data on the supply and use do not balance, adjustments are made by partners, so as to ensure that the balance held for all commodities and all time periods modelled.

Table 2.2: Commodities and their key markets

Commodity	Key market	Commodity	Key market
Soft wheat	France	Sunflower seed	Rotterdam
Durum wheat	Italy	Sunflower meal	Rotterdam
Barley (feed)	France	Sunflower oil	Rotterdam
Maize (grain)	France		
Rye	Germany	Beef	Germany
Other grains	Germany	Pig meat	Germany
Rapeseed	Hamburg	Lamb meat	Ireland
Rapeseed cake	Hamburg	Broiler	Germany
Rapeseed oil	Netherlands	Butter	Germany
Soybean	Rotterdam	Skimmed milk powder	Netherlands
Soymeal	Rotterdam	Cheese	France
Soybean oil	Netherlands		

Under the 5th Framework Programme project an internally consistent and coherent database of annual time series of supply, use and price data relating to the commodities modelled in AGMEMOD, has already been developed. The sample period covers the years 1970 to 2000 for the EU Member States before the 2004 enlargement. However, this period is restricted to the years 1991 to 2000 for the EU members of the 2004 and 2007 enlargements. The political and economic changes that many of the these countries have undergone in the last ten to fifteen years mean that it is often practical, reasonable and meaningful to constrain the data coverage period to relatively recent years. Additionally, statistics in these countries have only recently come under the aegis of Eurostat, so the lack of common definitions and reporting standards in the compilation of historical data is difficult. This is especially the case for more sophisticated statistical requirements, such as the compilation of food balances and the compilation of the Economic Accounts for Agriculture, both of which form the basis of the data for the AGMEMOD modelling approach (Erjavec and Donnellan, 2005).

2.2. Functional form models

The AGMEMOD country models are econometric, dynamic, multi-product, partial equilibrium commodity models. Their commodity coverage prior to this study comprised: markets for grains (soft and durum wheat, barley and maize), oilseeds (rapeseed, soybeans and sunflower seed), meals and oils, livestock and meat (cattle, beef, pigs, pig meat, poultry, sheep and sheep meat) and milk and dairy products (cheese, butter, whole milk powder and skimmed milk powder). The model description of the general functional forms of AGMEMOD is based on Chantreuil, Hanrahan and Levert (2005).

In the two crop sub-models (grains and oilseeds) land allocation is assumed to be determined in a two-step process. In the first stage, producers are expected to allocate their total land area to the culture groups (i) for grains and oilseeds respectively. Then, in a second stage, the shares of the land areas allocated to grains and oilseeds are allocated to each culture j belonging to the corresponding culture group (i). The total area harvested equations for grains and oilseeds can be written as

$$ah_{i,t} = f\left(p^{j}_{i,t-1}, ah_{i,t-1}, V\right) \quad j = 1,...,n \quad i = 1,...,2 \qquad (1)$$

where $ah_{i,t}$ is the area harvested in year t for culture group i, $p^j_{i,t-1}$ is the real price in year $t-1$ of culture j belonging to the culture group i, and V is a vector of exogenous variables which could have an impact on the area of culture i harvested (such variables include the set aside rate and the rate of arable aid compensation).

The equations used to determine the share of culture k belonging to culture group i ($sh^k_{i,t}$) can be noted as

$$sh^k_{i,t} = f\left(p^j_{i,t-1}, sh^k_{i,t-1}\right) \quad j, k = 1,...,n \tag{2}$$

The yield equations of culture k in culture group i can be presented as

$$r^k_{i,t} = f\left(p^j_{i,t-1}, r^k_{i,t-1}, V\right) \quad j, k = 1,...,n \tag{3}$$

where $r^k_{i,t}$ is the yield per hectare of culture k belonging to the culture group i, and V is a vector of variables, which could have an impact on the yield per hectare of the culture being modelled.

In the specification of the AGMEMOD crops sub-models' supply side income per hectare is not considered in the functional forms. This choice was made in order to distinguish the price and compensation variables as separate effects on the producers' supply decisions.

On the demand side, crush and feed demand and non-feed use per capita are modelled using the following general functional forms

$$Fu^k_{i,t} = f\left(p^j_{i,t}, Z\right) \quad j, k = 1,...,n \tag{4}$$

where $Fu^k_{i,t}$ is the feed demand for culture k belonging to the culture group i and Z is a vector of endogenous variables, which could have an impact on the demand considered (meat production for example).

$$NFu^k_{i,t} = f\left(p^j_{i,t}, NFu^k_{i,t-1}\right) \quad j, k = 1,...,n \tag{5}$$

where $NFu^k_{i,t}$ is the non-feed demand for culture k belonging to the culture group i. Crush demand for oilseed culture k ($CR^k_{i,t}$) is modelled as

$$CR^k_{i,t} = f\left(p^h_{i,t-1}, p^l_{i,t-1}, CR^h_{i,t-1}\right) \quad h, l = 1,...,n \tag{6}$$

where $p^h_{i,t-1}$ is the real price of considered seed oil and $p^l_{i,t-1}$ is the real price of the seed meal produced as a product of the crushing process.

The stock level, exports and imports equations for the grains and oilseed models, in general, have the following functional forms:

$$St_{i,t}^{k} = f\left(PR_{i,t}^{k}, DU_{i,t}^{k}, St_{i,t-1}^{k}\right) \tag{7}$$
$$Ex_{i,t}^{k} = f\left(PR_{i,t}^{k}, DU_{i,t}^{k}, Ex_{i,t-1}^{k}\right) \tag{8}$$
$$Im_{i,t}^{k} = f\left(PR_{i,t}^{k}, DU_{i,t}^{k}, Im_{i,t-1}^{k}\right) \tag{9}$$

where $Im_{i,t}^{k}$, $Ex_{i,t}^{k}$ and $St_{i,t}^{k}$ are respectively the ending stocks, exports and imports for culture k belonging to the culture group i in year t, $PR_{i,t}^{k}$ and $DU_{i,t}^{k}$ are the production and the total domestic use of culture k belonging to the culture group i.

The other commodity markets considered in the crops sub-models are the oil and meal markets. The supplies of these markets are determined by oilseeds crushed and by technical coefficients. For all these markets the specification of equations for exports, imports, stocks, oil per capita consumption, industrial demand for oil and meal domestic use are similar to equations (7), (8), and (9). The estimation of these functional forms, allowed for the determination of harvested areas, yields, feed and non-feed uses, ending stocks, exports and imports for the corresponding commodity markets.

Whereas the structure of individual livestock and meat sub-models varies, its general structure is similar and is presented below. Ending numbers of breeding animals can be written as

$$cct_{i,t} = f\left(cct_{i,t-1} p_{i,t}, V\right) \quad i = 1,\ldots,n \tag{10}$$

where $cct_{i,t}$ is the ending number in year t for the breeding animal type i, $p_{i,t-1}$ is the real price in year $t-1$ of the animal i considered, and V is a vector of exogenous variables which could have an impact on the ending inventory concerned (such variables are the direct payment linked to the animals concerned or specific national policy instruments).

Numbers of animals produced by the breeding herd inventory can be described as

$$spr_{i,t} = f\left(cct_{i,t-1}, ypa_{i,t}\right) \quad i = 1,\ldots,n \tag{11}$$

where $spr_{i,t}$ is the number of animals produced from breeding herd $cct_{i,t}$ in year t and $ypa_{i,t}$ is the exogenous yield per breeding animal concerned.

Within each animal culture i there may be m categories of slaughter j. The number of animals in animal culture i that are slaughtered in slaughter category j can be regarded as

$$ktt_{i,t}^{j} = f\left(cct_{i,t}^{j}, p_{i,t}, z_{i,t}^{j}, V\right) \quad i = 1,\ldots,n \quad j = 1,\ldots,m \tag{12}$$

where $ktt_{i,t}^{j}$ is the number of animals slaughtered in category j of animal culture i in year t, $z_{i,t}^{j}$ is an endogenous variable that represents the share of different categories of animals slaughtered for the animal culture concerned, and V is a vector of exogenous variables.

The average slaughter weight in animal culture i can be noted as

$$slw_{i,t} = f\left(slw_{i,t-1}, z_{i,t}^{j}, p_{i,t}, V\right) \quad i = 1,\ldots,n \quad j = 1,\ldots,m \tag{13}$$

The total meat production from animal culture i is then derived as the product of the average slaughter weight, multiplied by the total slaughter in that culture, which is defined as

$$ktt_{i,t} = \sum_j ktt_{i,t}^j \quad i = 1,...,n \quad j = 1,...,m \tag{14}$$

The ending stocks of animals (breeding and non-breeding) and meat production are derived using identities. The total domestic use of meats is derived as the product of the per capita demand for the meat concerned, multiplied by an exogenous population variable. The per capita consumption of meat can be written as

$$upc_{i,t} = f\left(upc_{i,t-1}, p_{i,t}, p_{k,t}, gdpc_t, V\right) \quad k,i = 1,...,n \quad k \neq i \tag{15}$$

where $upc_{i,t}$ is the per capita consumption of meat i in year t, $gdpc_t$ is the exogenously determined per capita real income and V is a vector of other exogenous variables that affects the per capita meat consumption.

The functional form used to estimate the ending stocks of meats, has the same general form as that used in the estimation of the animal breeding inventories in equation (10). Similarly, the specifications of the trade equations for animals and meats, follow the same general functional form as used in the grain and oilseed models of equations (7) to (9).

Among the AGMEMOD sub-models, the dairy model is arguably the most complicated. A particular feature of the dairy model is its emphasis on the allocation of milk fat and milk protein (rather than just simply milk) to the production of the various dairy commodities modelled. These products are butter, cheese, skimmed milk powder, whole milk powder and ‘other dairy products’. For each dairy commodity modelled, the supply and use is projected as well as the wholesale price.

The AGMEMOD dairy sub-model comprises several components. The first component determines the production, import and export of milk. The second component allocates milk to feed use and to fluid milk consumption. Total milk factory use (manufacturing milk) for further processing into dairy products, is then determined as a balancing item.

The milk yield per cow can be expressed as

$$ypc_t = f\left(ypc_{t-1}, p_t, qua_t, V\right) \tag{16}$$

where ypc_t is the yield per cow in year t, p_t is the real price of milk, qua_t is the exogenous milk quota pertaining to the country concerned, and V is a vector of other exogenous variables that could have an impact on the milk yield per cow. Dairy cow ending numbers can be written as

$$dct_t = f\left(ypc_t, p_t, qua_t, V\right) \tag{17}$$

where dct_t is the ending numbers of dairy cows. The other variables are as defined above. The total milk production is then derived as the product of milk yield per cow and the total ending cow numbers.

As noted earlier, the total milk production is allocated to three uses: feed use (ufe_t), fluid use (ufl_t), and factory use (ufa_t). The feed use of milk can be explained as

$$ufe_t = f\left(ufe_{t-1},\ p_t,\ V\right) \tag{18}$$

with fluid use, is derived as the product of the population and the per capita fluid milk consumption. The per capita fluid milk consumption equation has the same form as that specified for per capita meat consumption in equation (15). The factory use of milk is derived to balance the supply and use of total milk.

As noted earlier, the AGMEMOD model allocates the fat and protein components of raw milk. The amount of fat and protein in the raw milk produced and used in the manufacturing sector, is first calculated. This calculation involves a number of assumptions concerning the fat and protein content of the raw milk and the fat and protein content of the dairy commodities produced with the manufacturing of milk.

Once the available supplies of milk protein and fat have been calculated, the next step is to allocate the protein and fat components. The milk protein allocated to the dairy commodity i can be described as

$$ppc_{i,t} = f\left(ppc_{i,\,t-1},\ p_{i,t}, p_{k,t},\ V\right) \quad i,k = 1,\ldots,n \quad i \neq k \tag{19}$$

where $ppc_{i,t}$ is the allocation of protein to the dairy commodity in question, in year t, $p_{i,t}$ is the price of dairy commodity i, and V are exogenous variables that affect the protein allocation to commodity i. The total protein available is allocated to n dairy commodities. The milk protein allocation equations are estimated for $n-1$ products, with the milk protein allocation to the n^{th} product derived as a balancing residual allocation.

The production of dairy commodities using milk protein is derived as the total milk protein allocation, divided by an exogenous technical protein content conversion factor. Given these production levels, the allocation of milk fat to these products is derived from fixed technical factors. The allocation of milk fat to butter or other dairy products is written as

$$fpc_{i,t} = f\left(fpc_{i,\,t-1},\ p_{i,t}, p_{k,t},\ V\right) \quad i,k = 1,\ldots,n \quad i \neq k \tag{20}$$

where $fpc_{i,\,t}$ is the fat allocation to the dairy commodity i, $p_{i,t}$ is the price of dairy commodity i, and V are exogenous variables that affect the protein allocation to commodity i. Given the allocation of milk fat to other dairy products or to butter, the allocation of the remaining milk fat is derived from the milk fat supply and the milk fat use identity.

To complete the AGMEMOD model , it is necessary to add an equation for each commodity that describes the equilibrium situation at both country and EU level. This condition must imply that the production, plus the beginning stocks, plus the imports equals the domestic use, plus the ending stocks, plus the exports of a commodity. In a closed economy, this supply and use equilibrium condition will be sufficient to determine the equilibrium country market prices endogenously by matching supplies and demands. However, given that the AGMEMOD models do not represent closed economies, the Rest of the World might have important impacts on the economy modelled. To account for such impacts, price linkage equations will be used to capture the relations across Member States on the one hand and on the other hand between the European Union and the Rest of the World. For each commodity, the market of a specific Member State is seen as the key market, while its respective price is considered as the EU key price. In case a commodity's key market cannot be defined, world prices will directly influence country prices.

When the national level market is not considered as the key market in the European Union, the price linkage equations used in the model, can be written as

$$p_{j,t} = f\left(Kp_{j,t}, p_{j,t-1}, ssr_{j,t}, Kssr_{j,t}, V\right) \tag{21}$$

where $p_{j,t}$ is the national price of commodity j in year t, $Kp_{j,t}$ is the key price of commodity j in year t, $ssr_{j,t}$ is the self-sufficiency ratio (domestic use divided by production) for commodity j in the country concerned, $Kssr_{j,t}$ is the self sufficiency rate for the same commodity in the key price market, and V is a vector of exogenous variables which could have an impact on the national price.

When the national price is the key price, the price linkage equations used in the model can be estimated as

$$Kp_{j,t} = f\left(Wp_{j,t}, EIp_{j,t}, Kp_{j,t-1}, Essr_{j,t}, V\right) \tag{22}$$

where Wp_t^j is the corresponding world price, EIp_t^j is the corresponding European intervention price, $Essr_{j,t}$ is the EU self-sufficiency rate for commodity j, and V is a vector of variables which could have an impact on the key price (exchange rates, tariff rate quota levels and subsidised export limits).

2.3. Estimation and validation

With respect to the EU Member States, two different techniques are applied to estimate the parameters of the functional model forms in section 2.2. For members before 2004, the parameters of the specified equations are econometrically estimated, taking account the use of adequate econometric methods. Also, the consistency of the estimation results is regarded with the appropriate theoretical framework and biological constraints. Most of the model equations are individually estimated using the generalized least squares estimation technique. Demand systems are estimated with the seemingly unrelated regression technique, to assure that the estimated parameters are consistent with microeconomic restrictions such as a negative own price elasticity, positive cross price elasticities and a positive income elasticity. The estimated results are validated by standard statistical tests for heteroskedasticity (white heteroskedasticity), autocorrelation (Durbin-Watson) and the goodness of fit. Also, the coincidence of estimation results is compared with, a priori, expectations and economic theory in respect to the magnitude and sign of the estimated parameters. This last mentioned validation test is regarded as superior.

Calibration techniques are applied in cases of short data series, data inconsistencies and structural breaks in policy, to determine the equation parameters for many EU members of the 2004 enlargement (Erjavec and Donnellan, 2005). In general, the econometric approach is used to set the initial values for the regression coefficients. The coincidence of these coefficients, with the economic theory, is verified and compared with results obtained from models of Member States before 2004.

Next, baseline projections for the national agricultural sectors are generated based on agreed projections for macro variables, policy variables and key prices. In addition to the standard econometric specification tests, two other validation procedures are applied when analysing the entire model response in the stand-alone mode. First, predictions ‘within-sample’ for the years 1996-2000, test the prediction quality of the entire model and its dynamic properties. As the true values of all exogenous variables for this period is known, model predictions are compared with their actual observations. The Mean Absolute Percentage Error coefficient is applied as a prediction quality measure, while the Mean Percentage Error provides an overall picture of the projection error. Second, country experts validate the model results. Econometric work is needed here by partners, to achieve better solid projections on the country level. Some model equations are re-estimated to incorporate, a priori, the restriction on their values as provided by experts and to minimize the in-sample prediction error.

2.4. Solving the EU model

In order to bring together the country models into the EU combined model, it is necessary to convert some variables that are exogenous, at individual country level, into endogenous variables. These variables refer to the self-sufficiency rates and prices for key markets. Neither the AGMEMOD country models nor the EU combined model represent closed economies. Hence, they use key price equations to link country level models and to reflect the Rest of the World impacts on European agricultural sectors. For example, the French key price of soft wheat is exogenous in the stand-alone Irish country model. In the EU combined model, however, the Irish soft wheat price will be modelled as a function of the French key price of soft wheat. In addition, the French key price of soft wheat is endogenously determined as a function of the world market price for wheat, the EU soft wheat intervention price and the EU self-sufficiency rate for wheat.

When solving the EU combined model, just as in the individual country level models, all commodity markets modelled must close to ensure that the supply and use identity for all commodities and all time periods exactly hold. This general condition concerns all versions (EU-15 and EU-25, EU27 levels) of the combined model.

$$spr_{t\,i} + smt_{t\,i} + cct_{t-1\,i} \equiv udc_{t\,i} + uxt_{t\,i} + cct_{t\,i} \quad \forall\, t; \quad \forall i = 1,\ldots,n \tag{23}$$

where $spr_{t\,i}$ represents the production, $smt_{t\,i}$ the total import, $cct_{t\,i}$ the ending stock, $udc_{t\,i}$ the total domestic use and $uxt_{t\,i}$ the total export.

In order to ensure this model closure in the EU combined model, it is necessary to choose a closure variable. Within the country level models, the distinction between intra and extra EU imports and exports is not maintained. Nevertheless, for all $i = 1,\ldots,n$ country models the following identities implicitly hold

$$smt_{t\,i} = EUsmt_{t\,i} + ROWsmt_{t\,i} \tag{24}$$

$$uxt_{t\,i} = EUuxt_{t\,i} + ROWuxt_{t\,i} \tag{25}$$

Because

$$\sum_{i=1}^{n} EUuxt_{t\,i} \equiv \sum_{i=1}^{n} EUsmt_{t\,i} \;\; \forall\, t \tag{26}$$

The sum of all n countries supply and use identities

$$\sum_{i=1}^{n} \left[spr_{t\,i} + smt_{t\,i} + cct_{t-1\,i} - udc_{t\,i} - uxt_{t\,i} - cct_{t\,i} \right] \equiv 0 \tag{27}$$

can be re-expressed as equation (28)

$$\sum_{i=1}^{n} spr_{t\,i} + \sum_{i=1}^{n} cct_{t-1\,i} - \sum_{i=1}^{n} udc_{t\,i} - \sum_{i=1}^{n} cct_{t\,i} + \sum_{i=1}^{n} EUsmt_{t\,i} + \sum_{i=1}^{n} ROWsmt_{t\,i} + \sum_{i=1}^{n} EUuxt_{t\,i} + \sum_{i=1}^{n} ROWuxt_{t\,i} \equiv 0$$

which is equivalent to

$$\sum_{i=1}^{n} \left[spr_{t\,i} + cct_{t-1\,i} - udc_{t\,i} - cct_{t\,i} \right] + ROWsmt_{t\,EUt} - ROWuxt_{t\,EU} = 0 \tag{29}$$

which is equivalent to

$$spr_{t\,EU} + cct_{t-1\,EU\,i} - udc_{t\,EU} - cct_{t\,EU} - NETuxt_{t\,EU} \quad = 0 \tag{30}$$

where

$$\sum_{i=1}^{n} ROWsmt_{t\,i} = ROWsmt_{t\,EU} \text{ and } \sum_{i=1}^{n} ROWuxt_{t\,i} = ROWuxt_{t\,EU} \tag{31}$$

Thus, the European net export variable is used as closure at the European level to ensure that, supply and use identity always hold.

$$NETuxt_{t\,EU} = ROWuxt_{t\,EU} - ROWsmt_{t\,EU} \tag{32}$$

Based on the set of equations in this section, this model allows for projections and simulations at both the EU-15 and the Member State levels, assuming that world prices are exogenous. On the longer term, EU-25 and EU27 combined versions will be developed according to the same approach.

2.5. Projection generation

The AGMEMOD baseline projections are conditioned on the assumed developments in macroeconomic variables, international agricultural market prices and agricultural and trade policy variables. The model provides results under the assumptions of normal weather and stable national and international agreements. The macroeconomic variables are set on the basis of available projections and analysed under these assumptions. Their outlooks come from external sources like Eurostat, DG Economics and Finance or national institutes. World market price projections are linked to the FAPRI projections. Policy assumptions include the current and future developments of instruments under the CAP and GATT-WTO, which reflect the differences in policies applied across EU member states. In this study, the AGMEMOD models of the Member States before the 2004 enlargement are solved as components of the EU-15 model. The models of Member States of the 2004 and 2007 enlargements are run in the stand-alone mode. While EU key prices - necessary to derive the national prices – are endogenously generated in the EU-15 combined framework, these remain exogenously in the stand-alone models. The theoretical basis for the last approach is the assumption that international prices are independent of the individual country markets (the 'small country' assumption).

3. Model structures

This chapter emphasizes the various structures within the AGMEMOD system. Section 3.1 presents the general structure of the commodity models on the country level, whereas section 3.2 is devoted to the overall country and the EU structure of the tool.

3.1. Overview on country model structure

Equilibrium on the national commodity markets is attained under the condition that production, plus beginning stocks, plus imports is equal to domestic use, plus ending stocks, plus exports. As there is no guarantee that variables computed with the econometric model will automatically satisfy the supply and demand equilibrium condition, a closure variable is chosen to ensure this identity. Hence, for each commodity market there is one endogenous variable, generally the export or import variable, which is determined through a supply and demand identity and which closes the model. Figure 3.1 presents the *general* country and EU combined model structure in AGMEMOD. The inner box expresses the supply and utilisation models for individual commodities per country. The model produces estimates of supply and demand components for grains, oilseeds, livestock and meat products, milk and dairy products.

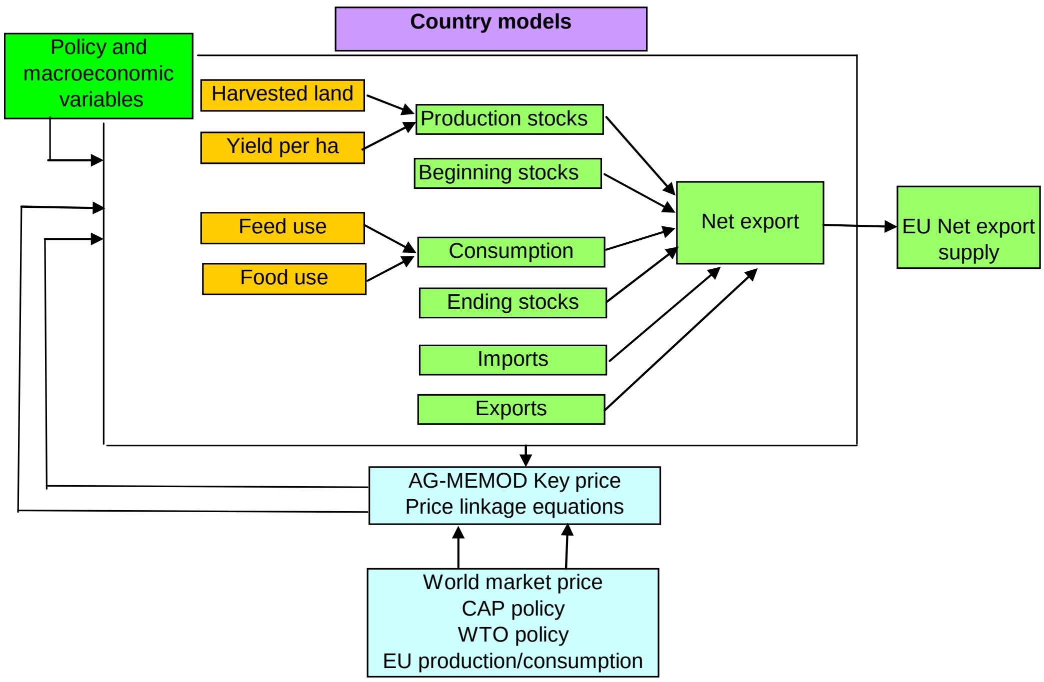

Figure 3.1: Country and EU model structure in AGMEMOD

Member States before the 2004 enlargement

For each individual country and its commodity markets, an operational dynamic multi-market partial equilibrium model is available: *Austria, Belgium (including Luxembourg), Denmark, Finland, France, Germany, Greece (including Cyprus), Ireland, Italy, the Netherlands, Portugal, Spain, Sweden* and *the United Kingdom.* All these models are largely econometrically estimated and are validated by experts from their respective countries. More explicit information on the specific country modelling is to be found in the papers (Riordan 2005; Erjavec and Donnellan 2005; Chantreuil, Hanrahan and Levert 2005; Van Leeuwen and Tabeau 2005; Von Ledebur, Salamon and Weber 2005; Niemi, Jansik, Kettunen and Lehtonen 2005; Esposti and Bianco 2005; Gracia and Casado 2005). In general, all important agricultural markets are presented in these models by laying out supply, import, export, human and feed consumption, stocks and prices. These models also cover a detailed set of agricultural policy instruments in each country.

However, the implementation of the SFP and the new decoupling systems agreed in the CAP reform of 2003 require some further developments. Partially, this is done within this study together with an investigation on how Member States introduce the decoupling rates of the commodities in their country. The modelling approach takes into account that the SFP value for farmers depends on historical entitlements, regional schemes, gradual implementation and the different degrees to which premiums remain linked to production (see Chapter 5).

Most individual EU-15 models can be solved as stand-alone versions within a GAMS environment and thus allow for the generation of projections and scenario simulation results. It is assumed that prices and self-sufficiency rates of commodities in the key countries are exogenously determined in these stand-alone versions.

Member States of the 2004 and 2007 EU enlargements
National static recursive multi-market partial equilibrium models for the following Member States of the 2004[1] and 2007 EU enlargement are available: *the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, the Slovak Republic, Slovenia, Bulgaria and Romania.* These country models contain market models for *crops, livestock products* and *dairy products* and are calibrated and validated by experts from their country. Thus, these modelling tools allow for the generation of medium term projection of agricultural commodity supply, use and prices. The modelling of the introduced CAP instruments and the impact of the CAP reform will still require further research. This study enables the majority of country models of Member States of the 2004 and 2007 enlargements, to be solved as stand-alone versions in GAMS, in addition to their MS Excel or Eviews versions. Variables linked to other Member States are kept endogenous.

The models of Member States before 2004 are integrated into a EU-15 model. This EU-15 combined model, allows for the generation of market projections and alternative scenario simulations for the EU-15 as a whole and the individual Member States. This organization of the EU-15 combined model also allows for the analysis of agricultural policy changes for a given subset of Member States (or commodities) modelled, while considering the rest of the EU-15 (or commodities) as exogenous.

The EU model calculates aggregated supply and utilisation balances for all the commodities of the Member States, and determines the EU net-export supply and prices. The country models are linked to the EU model by price transmission equations and trade flows.

Combined versions of the EU-25 and EU27 models will be developed in the longer term. The market projections and scenario simulations for the EU-25 and EU27 in this study are conducted in the following way. The stand-alone versions of the 2004 enlargement Member States models are added to the EU-15 combined model, resulting into a so called EU-25 hybrid model. Further, the addition of the stand-alone Bulgaria and Romania models to the EU-25 hybrid model is considered as the EU27 hybrid model. The endogenous EU key prices calculated with the EU-15 combined model are used as exogenous EU key prices to run the stand-alone models of Member States of the 2004 and 2007 enlargements. Therefore, the key prices in the EU-25 and EU27 hybrid models must be regarded as a hybrid type too.

[1] Malta (contributes 0.01% to GDP of EU-25) is not considered. However, this will not influence the results for EU as a whole. The agricultural production of Cyprus (0.1% of GDP in EU-25) is covered by the Greek country model.

Characteristics of country models
Table 3.1 presents the technical characteristics of the AGMEMOD country models applied in this study, while Table 3.2 summarizes the output diversity of these models.

Table 3.1: Technical characteristics of country models in AGMEMOD

Country	Model type	Data period	Parameter estimation	Software
Member States	Dynamic recursive, multi-product, partial equilibrium	1973-2000	Largely econometric (validated)	GAMS
Member States of the 2004 enlargement	Static recursive, multi-product, partial equilibrium	1991-2000	Calibrated (validated)	GAMS, Excel Eviews (Hungary)
Member States of the 2007 enlargement (Bulgaria, Romania)	Static recursive, multi-product, partial equilibrium	1991-2000	Calibrated (validated)	GAMS, Excel

Table 3.2: Output characteristics of country models in AGMEMOD

Country	Projection period	Policy instruments	Commodity markets	Key price (exogenous)
Member States	2005-2015	Old CAP (Agenda 2000); SFP not included	Soft/durum wheat, barley, maize; oils/ oilseeds; livestock/ meat; milk/dairy	EU-15 key price depends on: world market price, WTO and CAP instruments, EU-15 production/consumption
Member States of the 2004 enlargement	2005-2015	Until 2004: SAPS 2004-2007: old CAP (Agenda 2000); SFP not included	Soft and durum wheat, barley, maize; oils/ oilseeds; livestock/ meat; milk/dairy	Until 2004: world market price used as key price; From 2004: EU-15 key price used
Member States of the 2007 enlargement (Bulgaria, Romania)	2005-2015	SAPS	*Bulgaria*: soft/ durum wheat, barley, maize; oils/ oilseeds; livestock/ meat; milk/dairy *Romania*: barley, soft wheat, maize, cattle/beef, milk	Until 2004: world market price used as key price; From 2004: EU-15 key price used

3.2. Commodity models

The AGMEMOD model version in this study contains sub-models for the following commodities:

- *crops:* soft wheat, durum wheat, barley, maize, rapeseed, soybeans, sunflower seed;
- *livestock and meat:* cattle, beef, pigs, pork, poultry, sheep, sheep meat;
- *milk and dairy products*: milk, cheese, butter, whole milk powder, skimmed milk powder.

The sub-commodity models are linked with each other (Figure 3.2). For example, the beef production model is linked with the dairy models via the cow slaughtering and the calf production from the dairy herd. Crop models are linked with the livestock models by means of livestock production cost indices that are functions of the prices of grains, oilseeds and meals. The various livestock models are linked primary through their demand side specifications. The meat demand per capita, is determined by the real prices of the meat in question and those of other meats, all of which are assumed to be substitutes.

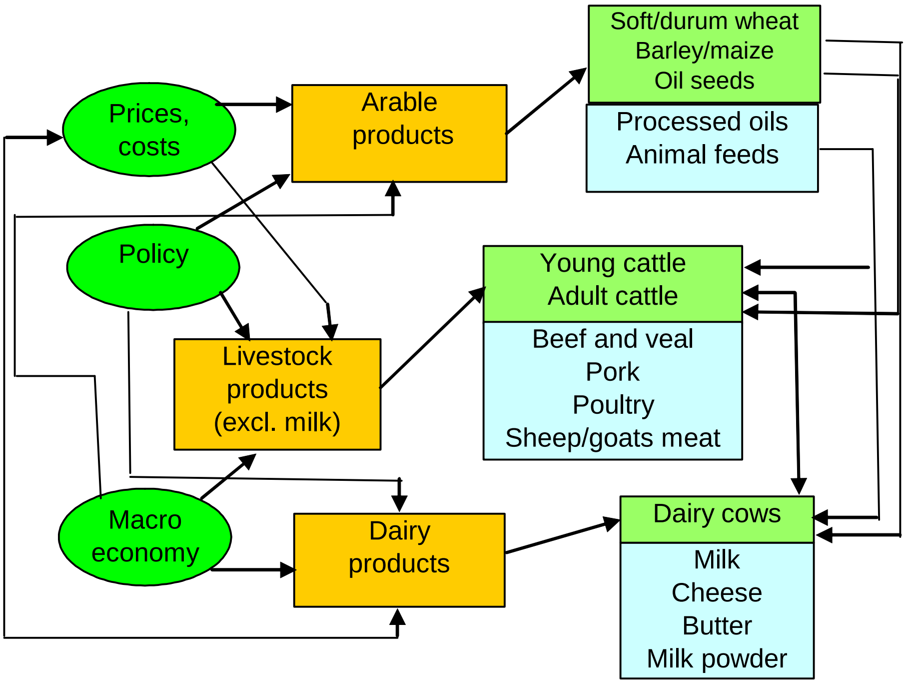

Figure 3.2: Linkages between commodity markets in AGMEMOD

The models' functional forms described in section 2.2 already noticed the similar market structures across commodities and Member States. The entire model structure for each commodity can also be captured by flow charts, showing the relations between production, consumption, stocks, imports and exports. As examples Figures 3.3 – 3.7 present the flow charts for livestock and meat commodities and for milk and dairy commodities in AGMEMOD.

Cattle and beef

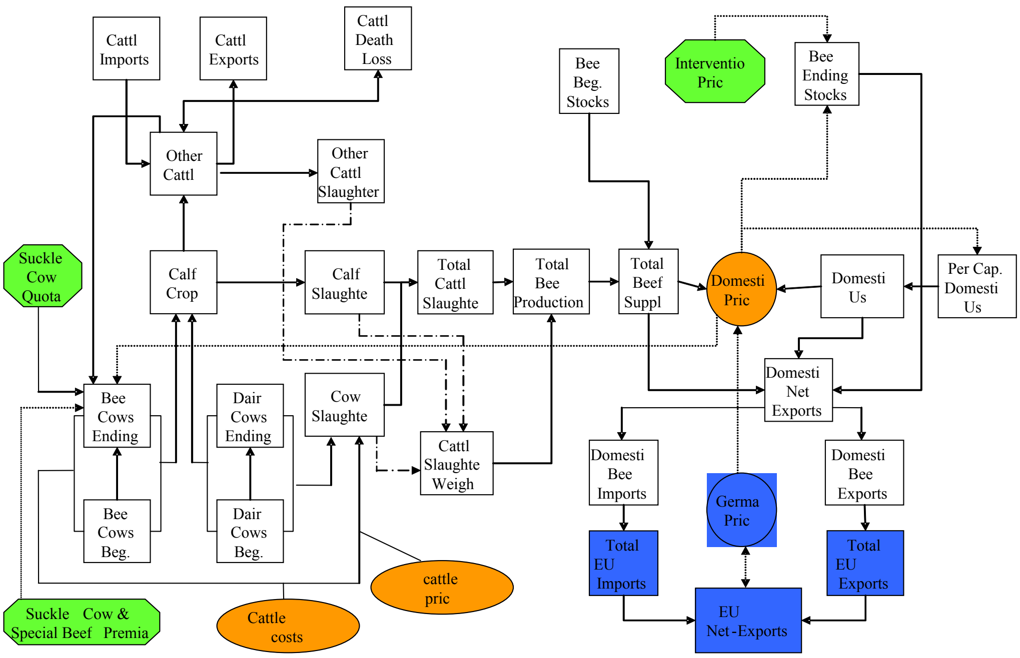

Figure 3.3: Cattle and beef model in AGMEMOD

Pigs and pig meat

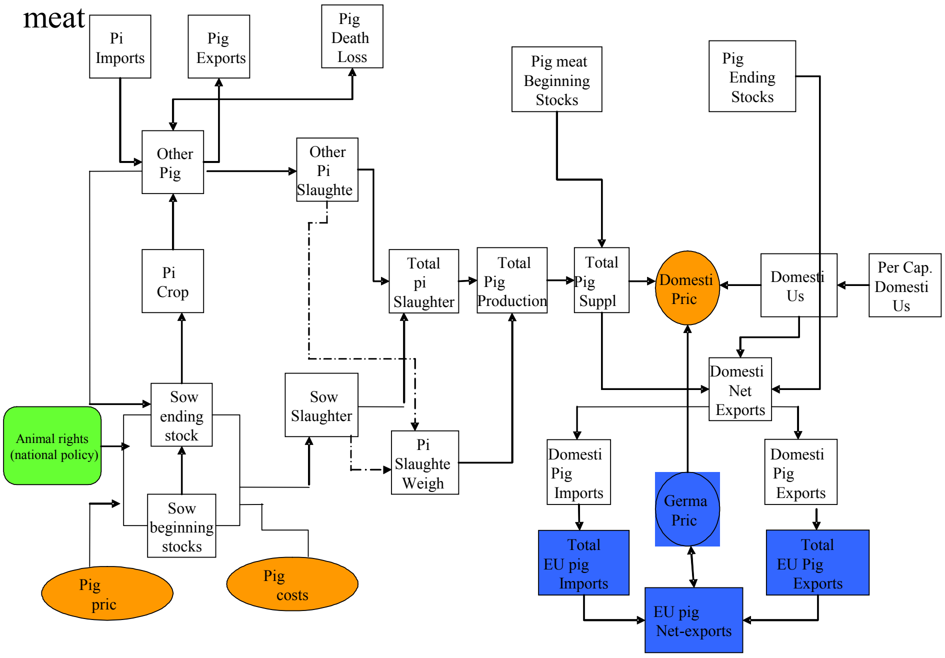

Figure 3.4: Pigs and pig meat model in AGMEMOD

Sheep and sheep meat

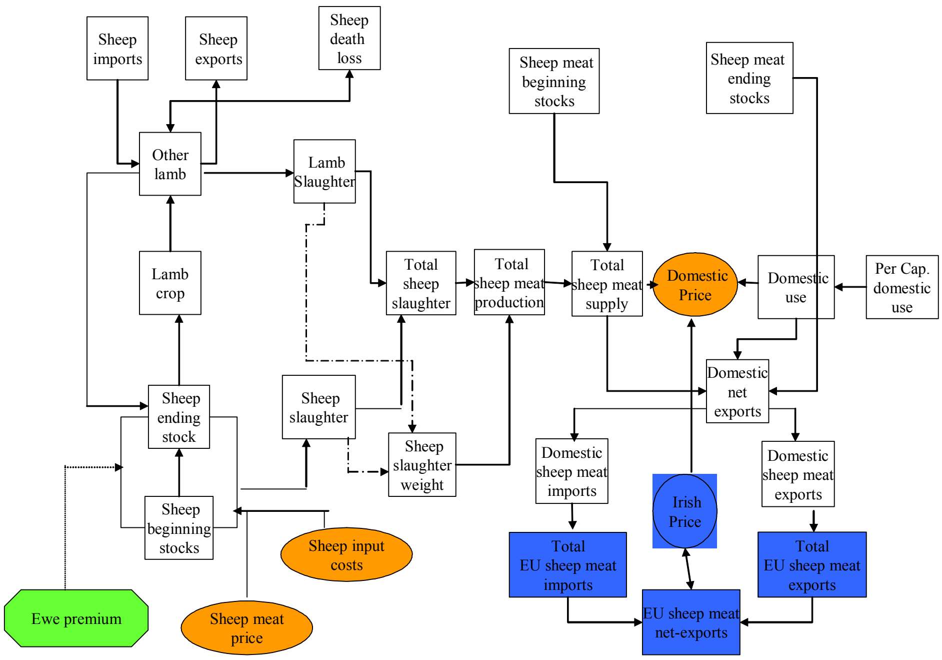

Figure 3.5: Sheep and sheep meat model in AGMEMOD

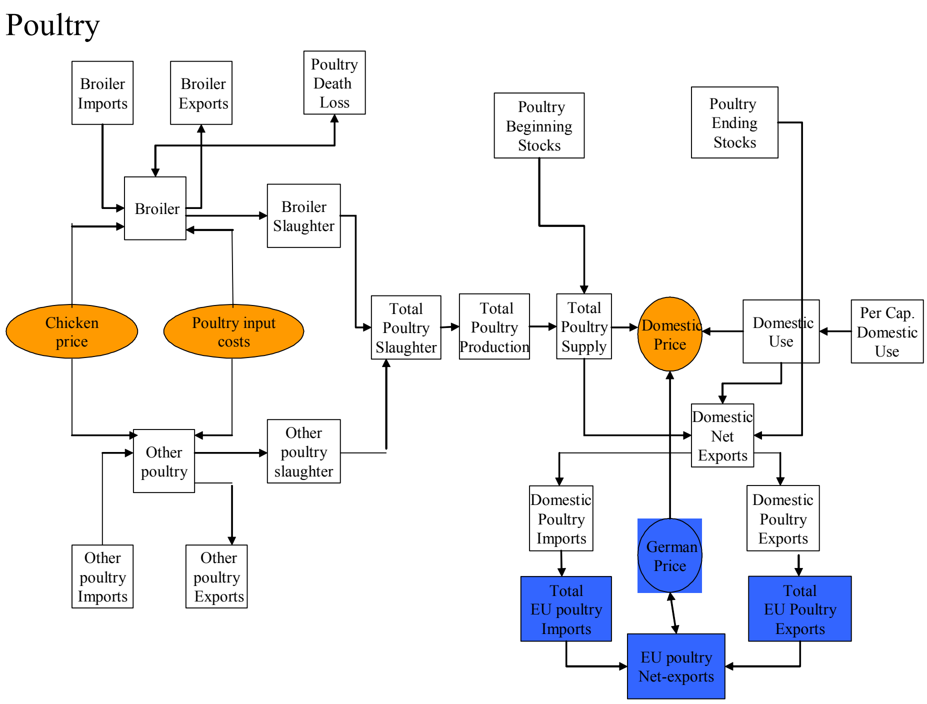

Figure 3.6: Poultry model in AGMEMOD

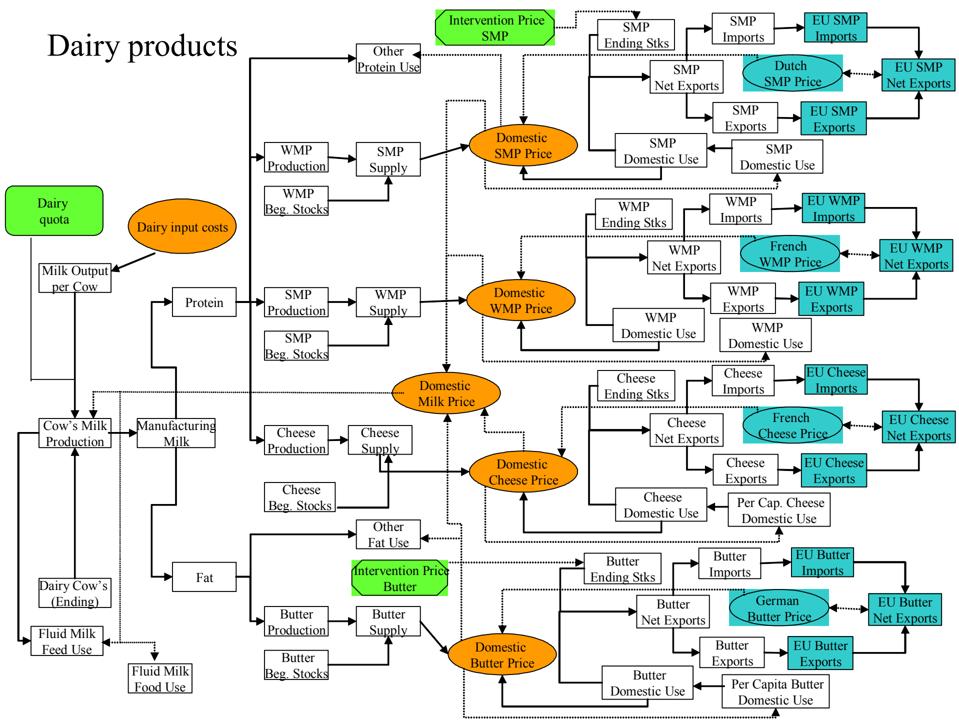

Figure 3.7: Dairy products model in AGMEMOD

3.3. EU-15 model

This section presents the development of the EU-15 model as a combination of models of the Member States, before the 2004 enlargement. Firstly, attention is paid to the conceptual structures that must be followed to solve the EU-15 combined model. Two manners are applied: one when a commodity is modelled in every country and another when a commodity is modelled only in some. Secondly, the developed file structure of the combined EU-15 model is described.

The EU-15 model is a combination of fourteen country models (Belgium and Luxembourg are taken together) in which the price equations and the closure rule play important roles. Each country model consists of sub-models for crops, livestock and meat, milk and dairy products. The sub-commodity models are linked with each other. For example, the beef production model is linked with the dairy models via the cow slaughtering and the calf production from the dairy herd. The crop models are linked with the livestock models by means of livestock production cost indices that are functions of the prices of grains, oilseeds and meals. The various livestock models are linked, primarily, through their demand specifications. Meat demand per capita is determined by the real prices of the meat in question and by those of other meats, all of which are assumed to be substitutes.

As already noticed, there are two different ways of combining a commodity in the EU-15 model: one when a commodity is modelled in every country (such as beef and milk) and another when a commodity is modelled only in some (such as rye and 'other grains'). Figure 3.8 captures the EU-15 model structure of both types of commodities.

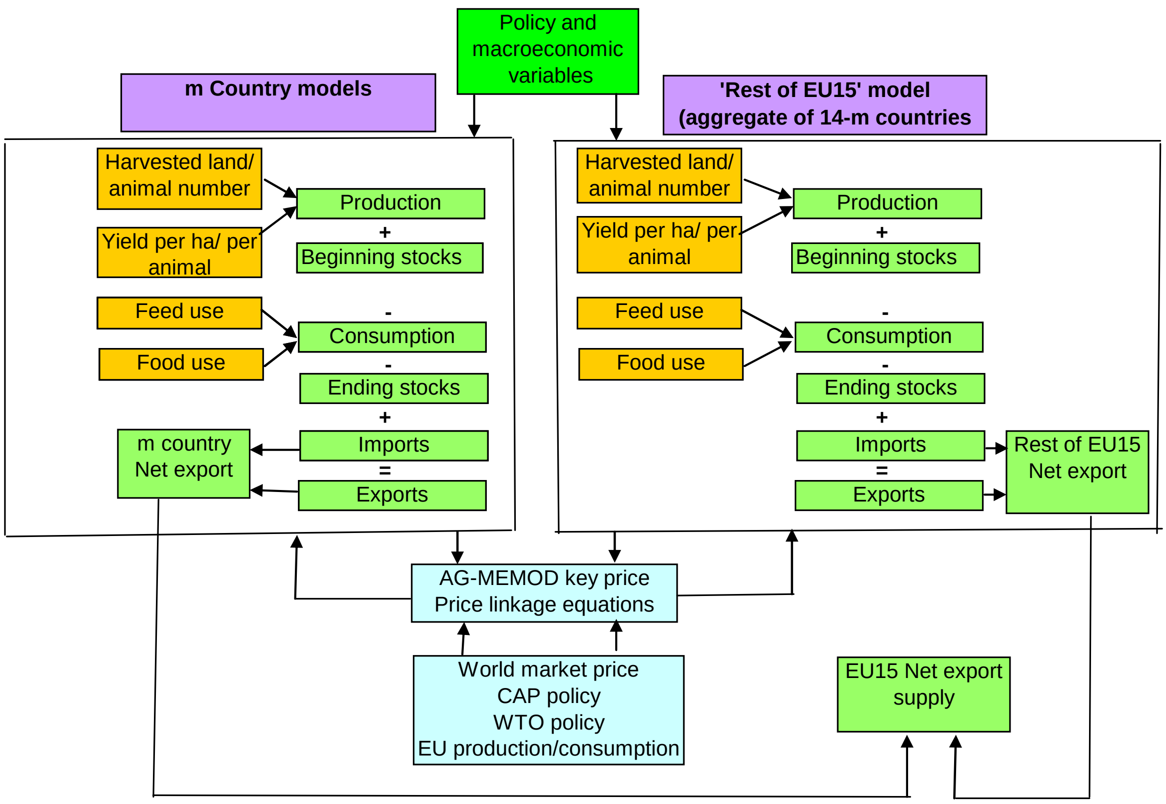

Figure 3.8: EU-15 model commodity structure in AGMEMOD

If a commodity is modelled in m countries (with m < 14), then the complementary 'Rest of

EU-15' model, which is an aggregate of the remaining (14 - m) EU-15 countries, is built for such a commodity. In this case, the EU-15 combined model of such a commodity is a linkage of the m-country models and the 'Rest of EU-15' model. On the aggregate EU-15 level, the system is similarly solved as a commodity modelled on country level. On the other hand, if a commodity is modelled in all countries (with m = 14), then the complementary 'Rest of EU-15' model needs not to be built, for that particular commodity.

For all countries, the projections for all commodities and for each year deliver values of production, stocks, (non-)feed consumption, imports and exports. These supply and use variables per country also provide the information needed to close the EU-15 model, namely the net export supply *NETuxt*. For each year, each commodity and each country, the net export supply (export minus import) equals the production, plus beginning stocks, minus domestic use, minus ending stocks.

$$NETuxt_{t,i,j} = spr_{t,i,j} + cct_{t-1,i,j} - udc_{t,i,j} - cct_{t,i,j} \tag{33}$$

Where t is the time index, $i = 1,...,14$ denotes the country index and $j = 1,...,n$ denotes the commodity index.

Hence, for all commodities the sum of the net export supply per country provides the total EU-15 net export supply *NETEUuxt*.

$$NETEUuxt_{t,j} = \sum_{i=1}^{14} NETuxt_{t,i,j} \tag{34}$$

When solving the EU-15 combined model, just as in the individual country level models, all commodity markets modelled must close, to ensure that supply and use identity for all commodities and all time periods exactly hold. To ensure this model closure in the EU-15 combined model, it is necessary to choose a closure variable. Within the country level models, the distinction between intra and extra EU imports and exports is not maintained. Nevertheless, for all fourteen country models, the following identities implicitly hold:

$$smt_{t,i,j} = EUsmt_{t,i,j} + ROWsmt_{t,i,j} \tag{35}$$

$$uxt_{t,i,j} = EUuxt_{t,i,j} + ROWuxt_{t,i,j} \tag{36}$$

where $EUsmt_{t,i,j}$ and $EUuxt_{t,i,j}$ are EU-15 intra imports and intra exports respectively, and $ROWsmt_{t,i,j}$ and $ROWuxt_{t,i,j}$ are EU-15 imports from the rest of the world and exports to the rest of the world respectively. Summing net exports in the fourteen countries (equation (33)) and using equations (35) and (36):

$$NETEUuxt_{t,j} = \sum_{i=1}^{n} uxt_{t,i,j} - \sum_{i=1}^{n} smt_{t-1,i,j} = \sum_{i=1}^{n} EUuxt_{t,i,j} + \sum_{i=1}^{n} ROWuxt_{t,i,j} - \sum_{i=1}^{n} EUsmt_{t,i,j} - \sum_{i=1}^{n} ROWsmt_{t,i,j} \tag{37}$$

Per definition, it follows that

$$\sum_{i=1}^{n} EUuxt_{t,i,j} \equiv \sum_{i=1}^{n} EUsmt_{t,i,j} \ \forall\ t \tag{38}$$

Therefore,

$$NETEUuxt_{t,j} = ROWEUuxt_{t,j} - ROWEUsmt_{t,j} \tag{39}$$

where

$\sum_{i=1}^{n} ROWsmt_{t,i,j} = ROWEUsmt_{t,j}$ notes the EU-15 imports from the rest of the world

$\sum_{i=1}^{n} ROWuxt_{t,i,j} = ROWEUuxt_{t,j}$ notes the EU-15 exports to the rest of the world

Hence, the variable that determines the EU-15 net exports to the rest of the world, closes the supply and utilisation balances at European level and ensures that the supply and use identity always hold.

Figure 3.9 presents the developed file structure of the EU-15 combined model. It covers fourteen country models, indicated by country XY to country ZZ.

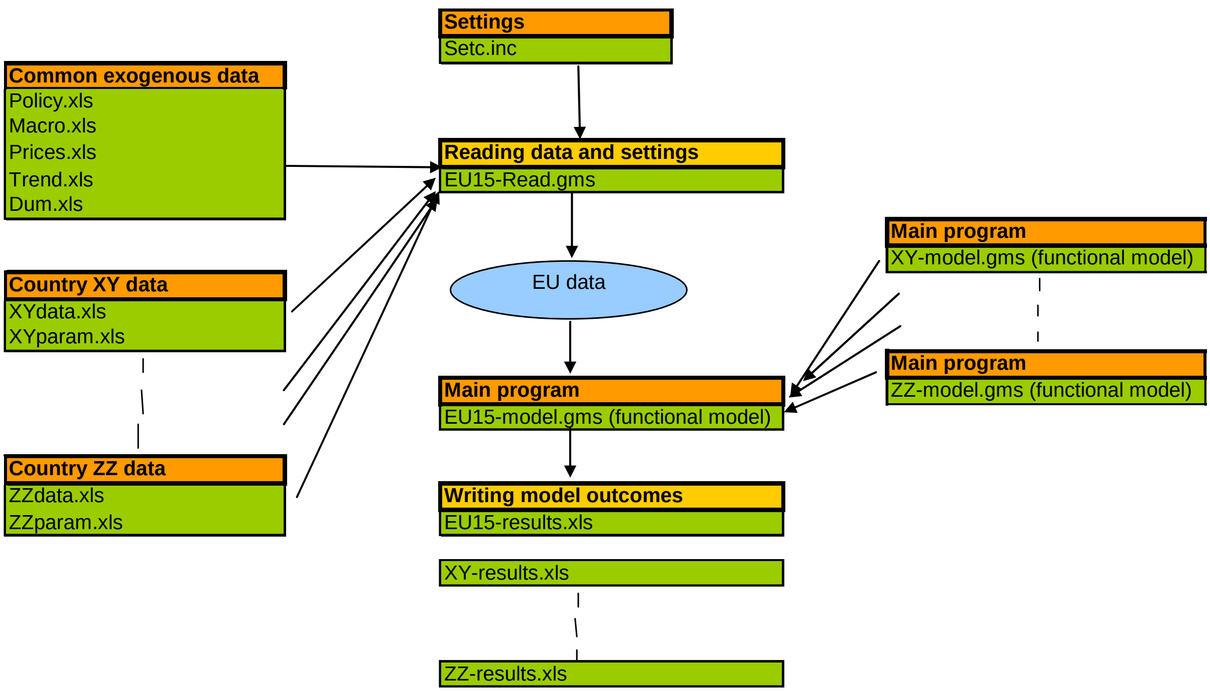

Figure 3.9: File structure of the EU-15 model

The procedure applied to solving and simulating this EU-15 model, follows that of the individual country models in GAMS. Firstly, all common exogenous data, the specific country XY to country ZZ data and sets, are read into GAMS to create a complete EU dataset used to solve the EU combined model. Secondly, these EU data files are combined with the fourteen estimated country models XY through ZZ expressed in GAMS code. If the GAMS solver finds feasible solutions for all markets, in all time periods and for all countries, the results are exported to fourteen country level Excel files. These result files capture the projections of agricultural activity levels (areas harvested, livestock numbers), supply and use balances (production, domestic use, imports, exports and ending stocks) and prices on the country level. Also, a EU-15-result Excel file with the EU-15 agricultural activity levels (areas harvested, livestock numbers), the EU-15 supply and use balances (production, domestic use, net exports and ending stocks) and the EU-15 market clearing prices are produced.

3.4. EU-25 and EU27 models

The models of Member States of the 2004 enlargement are solved in this study as stand-alone (mostly GAMS) versions and then are added to the EU-15 combined model. Hence, the result is regarded as the so called EU-25 hybrid model. A hybrid model, is a combination of one integrated EU model of Member States before the 2004 enlargement (with endogenous key price formation) and eight stand-alone Member State models (with exogenous key prices).

Also, the Bulgarian and Romanian models were solved as stand-alone versions and then aggregated to the EU-25 hybrid model. This provided the so called EU27 hybrid model.

Figure 3.10 presents the conceptual framework to generate the link between the EU-15 model and the eight Member States of the 2004 enlargement models (Cyprus and Malta are not incorporated), whereas Figure 3. 11 shows the linkage of the EU-25 model with the Bulgarian and Romanian models.

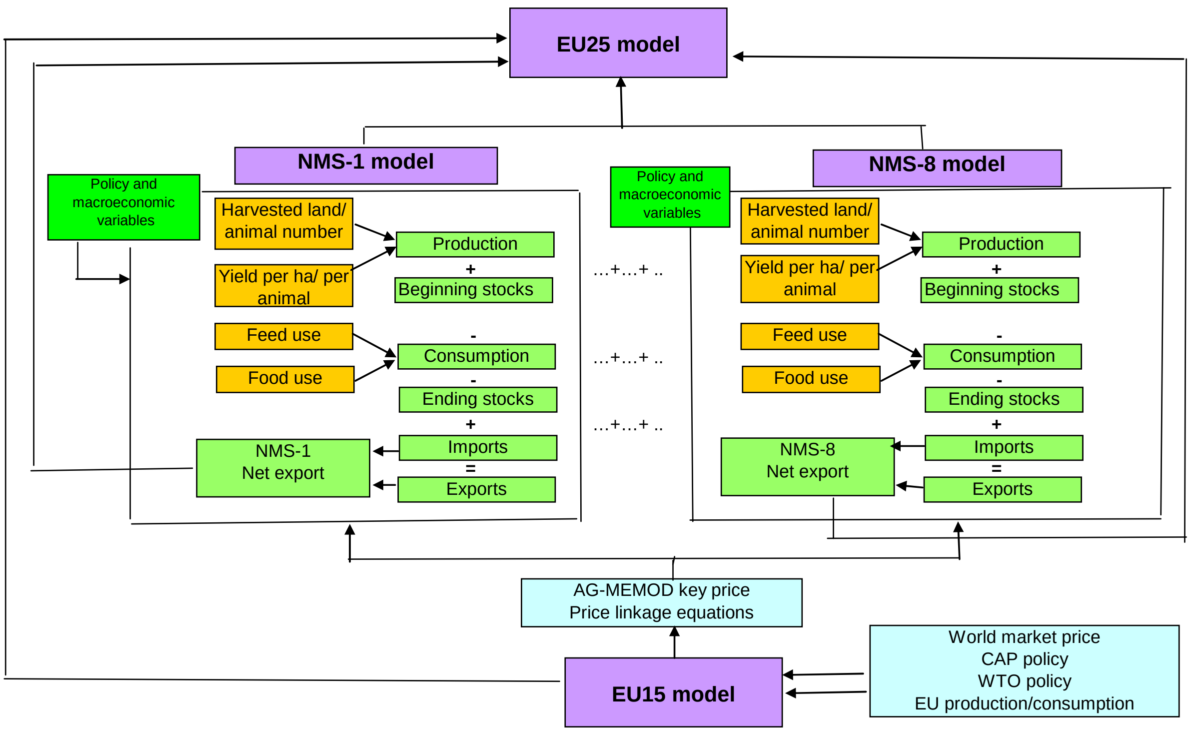

Figure 3.10: EU-25 hybrid model structure in AGMEMOD

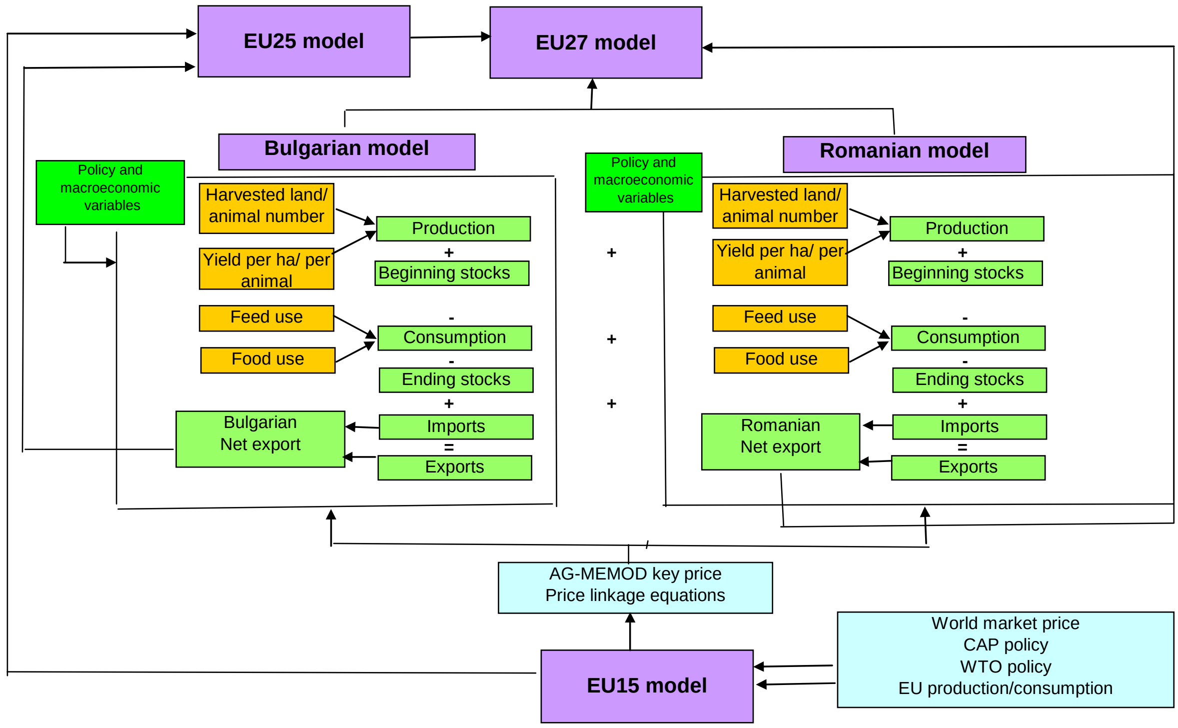

Figure 3.11: EU27 hybrid model structure in AGMEMOD

The endogenous EU key prices calculated with the EU-15 combined model are used as exogenous EU key prices to run the stand-alone Member State of the 2004 and 2007 enlargement models.
The results capture projections of agricultural activity levels (areas harvested, livestock numbers), supply and use balances (production, domestic use, imports, exports and ending stocks) and prices up to 2015 on the EU-25 and EU27 levels.

3.5. Validation

For development and solving of the AGMEMOD model, on different levels of aggregation, Chantreuil and Levert (2003) indicated four main phases. The first one, concerns the data collection for all commodities considered in the study. The second one, is the development of econometric and calibrated country models. The third phase, deals with the implementation of a dynamic country model, for each country in GAMS code, that runs alone. Here, the objective is to generate projections and simulations for an individual country, assuming that variables, relative to other countries, remain exogenous. In the fourth and final phase, the country models must be linked and aggregated to form the EU model versions as mentioned in the previous sections. The target of this last step is to develop a suitable tool allowing projections and simulations at European and Member State levels.

A country model is considered as complete and convenient to be combined with other validated country models, after the following four stage review process:

1) consistency and coherence of data;
2) consistency of estimation results;
3) in-sample behaviour of the country model implemented in GAMS;
4) consistency of baseline projections to 2015.

Consistency and coherence of data

As part of the data collection task, each national modelling team:

- reviews the country data to ensure that the supply and use identity holds for all commodity markets considered;
- establishes a consistent set of exogenous variables;
- uses a common mnemonic convention, to ensure that all country models use the same exchange rates, the same policy variables, the same world prices with the same units, etc..

Consistency of estimation results

The GOLD model manual is used as a template to build the econometric and calibrated country models and to include the new commodities rye and 'other grains' under this study. Partners have certain freedom in adding some changes to account for country particularities and in choosing different types of functional forms. The review process contains the following issues:

- the sign and value of estimated parameters;
- inclusion of the crucial variables for the modelled commodities such as political instruments and important economic variables;
- inclusion of a closure variable for the modelled commodities.

In-sample behaviour of the country model implemented in GAMS

This part of the review process may be very time consuming. It could require a frequent re-estimation of some functional forms or it could lead to the adoption and the estimation of new functional forms. A simple procedure can initially consist in running the country model market by market and then gradually combining all markets together, switching some exogenous variables into endogenous variables. A suitable and easy to handle tool has been developed in order to check the in-sample behaviour of a given country model. The comparison of the results obtained, with real data, helped to clarify adverse effects such as negative variables.

Consistency of baseline projections to 2015

An aim of this study is to provide reliable baseline projections from 2005 up to 2015 for the main agricultural commodities on both EU and country levels. Validation is not only based on statistical tests and in-sample analysis, but also on the review of country experts who are familiar with the specific features of the agricultural sector in their country.

4. New commodities in AGMEMOD: rye, oat and triticale

The EU is one of the world's major cereal producers. The most important cereal crop produced in the EU is wheat but, the group of coarse grain is of an almost identical production volume. Since the original AGMEMOD models does not include all important coarse grains for EU, the new commodity sub-models for rye and 'other grains' are built under this study.

The group of coarse grains consists of maize, barley, sorghum, rye, oats, triticale, and other minor cereals. Barley is the dominant component in the group of coarse grain in the EU, mostly used for animal feed and as a main ingredient in the brewing of beer. But its dominance in the EU is weakening. From 1991 to 2004, its relative share of coarse grain fell from 55% to 40% (Figure 4.1). In absolute terms, barley production has declined in the same period by -23% (Figure 4.2).

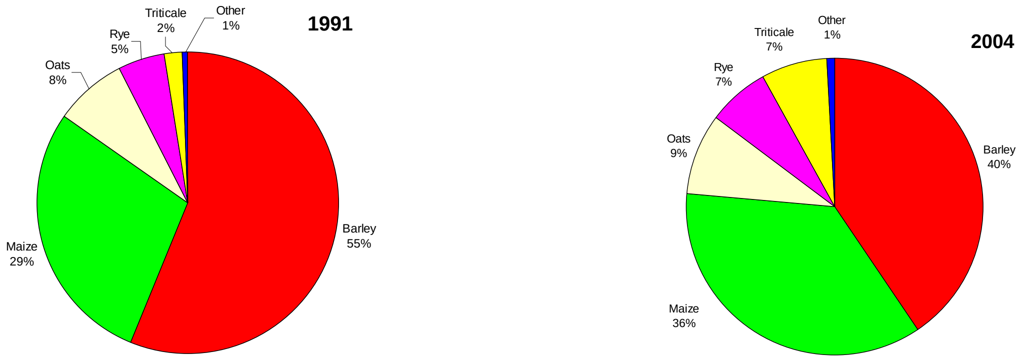

Figure 4.1: Comparison of EU coarse grain production between 1991 and 2004
Source: EUROSTAT data, 2006. Own calculations

At the same time, maize gained importance not only in relative but also in absolute terms (Figure 4.1, Figure 4.2). Its relative share of coarse grain production rose from 1991 to 2004 by 7% and by 30% in absolute terms.

A positive development can be observed with triticale, too. Its production was expanded by 138% over the last 15 years and its overall production share increased by 5%. While it is very similar in its production requirements to rye, it seems obvious that the increase in triticale must have gone at the expense of rye production. Thus, it is important to notice that while rye production has declined in absolute terms, the production of triticale has considerably increased.

The production of oats has maintained at relatively stable levels and the share of overall coarse grain production remained at around 9% during the last 15 years. Production share of other cereals, which comprise sorghum, millet, buckwheat and canary seed, have also remained constant at 1% over the same period.

Total coarse grain production in the EU, in the marketing year 2005/06 reached 134.4 million tonnes, which is down by 12% from 2004/05 due to drought and unfavourable weather conditions in parts of Europe. Barley accounted for 53.1 million tonnes, followed by maize with 49.7 million tonnes. In the group of minor cereals, oats production leads with 12 million tonnes, then triticale with 10.4 million tonnes and finally rye with approximately 8 million tonnes (EUROSTAT, 2006).

4.1. Production of rye

In the 1970s and 1980s, the EU faced the problem of overproduction of several agricultural products. A number of policies attempted to increase consumption of the EU in these products such as school milk, to include special operations for subsidizing consumption of butter and to offer free distribution of products for charity, but failed. Most of the significant measures on demand included costly subsidization of surplus disposal, such as export subsidies, food aid to third countries and subsidies for the incorporation of milk powder into feedstuffs for animals.

The need for changes in the Common Agricultural Policy (CAP) became more binding in the 1980s, as a result of the high budgetary cost and the imbalance between supply and demand. By 1992, a more fundamental reform could no longer be delayed. The main pressure came from budgetary expenses, which were seen as permanently growing because of the increasing unbalance between supply and demand. The cereal sector raised particular problems, as a result of the high prices of EU wheat and corn leading the feedstuff industry to look for cheaper substitutes. Pig and poultry producers, especially those in Northern Europe located close to the main ports with access to cheap imports, were using marginal quantities of EU grains but increasing quantities of cereal substitutes such as cassava or corn gluten feed, a by-product of the US isoglucose and ethanol industry. The situation was such that taxpayers had to subsidise exports of products that were so expensive that they could not find an outlet in the EU market, while consumers imported substitutes (Bureau, 2003). Public stocks were accummulated using intervention purchases and amounted to 25 million tonnes of grains in 1991, against 10 millions in 1988.

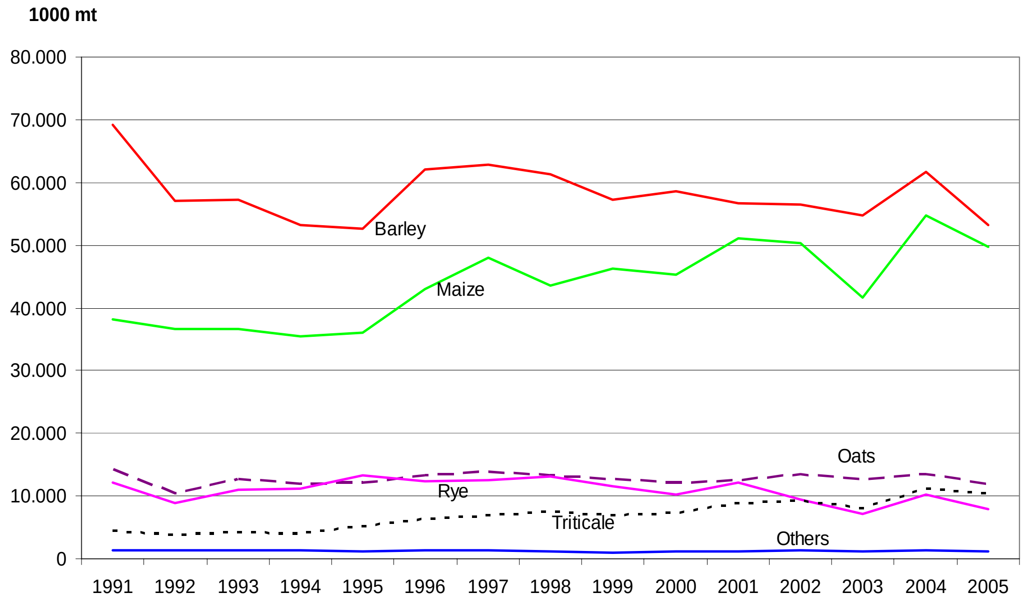

Figure 4.2: Development of coarse grain production in the EU-25

Source: EUROSTAT data, 2006. Own calculations

The 1992 CAP reform also known as the McSharry reform, took place during the Uruguay Round of multilateral trade negotiations. The McSharry reform partially replaced the market price support as the main CAP instrument with a direct income support scheme. It introduced a uniform intervention price for the most important cereals which included wheat, barley, maize, rye, sorghum, and durum wheat. It became effective for the first time in the marketing year 1993/94. The central aspect of the reform was a cut in support price for grains by 35% over three years. The purpose was to make EU cereals more attractive to the animal feed industry. Area based payments on acreage devoted to cereals, oilseeds and protein crops were designed to compensate for the price decrease. Beyond a certain farm size, these payments were conditional to setting aside a portion of their arable land. In practice, this was set annually between 5% and 15%, depending on world market. Farmers received payments for the land set aside and the land on which they were allowed to grow non-food (i.e. mainly energy) crops (Bureau, 2003; CAP Monitor, 2005).

While these measures aimed to reduce intervention stocks, direct payments kept providing significant incentive to extra production. Each member state specified a number of grain growing regions and determined an average annual yield for a period prior to 1990. Direct payments were attributed on a per tonne basis, the reference production level being determined on the basis of the acreage devoted to arable crops and this reference (regional) yield, but remained coupled to the acreage in production.

By the end of the 1990s, official accession talks with Eastern European countries reached a point, where it became clear that the CAP needed adjustments to account for the future enlargement of the EU. The Agenda 2000 agreement, reached at the Berlin European Council in 1999, was created to shape the CAP until 2006. A further reduction of 15% in intervention price for cereals took place in two steps, partially offset by a 17% increase in direct aid. Oilseed arrangements were aligned in three steps, with the existing arrangements for cereals. Mandatory set aside was maintained with a rate set to 10% for arable crops. An extra premium of 9.5 €/tonne of a reference yield was provided for protein crops (Bureau, 2003).

Table 4.1: Cereal intervention stocks in the EU and Germany (1000 mt)

	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05
EU total															
All Cereals	18871	26383	32.660	17993	6392	2722	2345	14522	17982	8799	6901	8087	7468	3707	16546
Softwheat	8595	10943	14704	6480	1901	460	495	2605	6581	3132	764	520	1322	199	9501
Durum wheat	1529	4168	3388	1152	340	85	0	0	0	0	0	0	0	0	0
Rye	3162	3552	2444	2545	1149	794	1045	2734	3718	3280	3839	5105	5132	3358	2307
Barley	5585	7418	8414	6526	3001	1383	792	8187	7436	2344	2284	2425	971	150	1575
Maize	0	301	3561	1130	0	0	13	933	106	37	6	32	27	0	3159
Sorghum	0	0	150	160	0	0	0	62	51	6	10	4	17	0	4
Germany															
All Cereals	9033	11523	12985	8030	4416	2424	2043	6339	8483	5460	4860	6718	5588	3411	6475
Softwheat	3655	4735	6153	2269	1193	446	491	548	283	222	199	54	213	33	3461
Durum wheat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rye	2660	3178	2358	2305	850	786	993	2464	3619	3211	3821	5090	5124	3333	2307
Barley	2719	3572	4246	3243	2373	1192	553	3249	4524	2007	837	1554	233	45	698
Maize	0	38	228	214	0	0	6	79	57	20	3	20	19	0	10
Sorghum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: BMELF/BMVEL/BMELV, Statistischer Monatsbericht, various issues

These policy adjustments did not prevent that by the end of the 1990s, public intervention stocks of rye started to grow again (Table 4.1). Rye is only traded in the world market in small amounts and prices tend to be the lowest of all cereals. This situation did not help to ease the situation of the German rye intervention stocks given rye could just simply not be sold in the world market. The Agenda 2000 agreement set the intervention price for rye at 101.31 €/tonne, the same as for wheat and barley. However, market prices for rye have been below this level, which means that the EU had to subsidize this commodity in order to export it. Given Polish rye production is of similar volume compared to German production, the European Commission feared that with the accession of Poland to the EU, the intervention stocks of rye could build up further. Therefore, it was decided in the Mid-Term Review (MTR) of the Agenda 2000 impact, that intervention of rye had to be abolished. This decision became effective on 01.08.2004. Farmers, giving up the production of rye, could switch to the production of commodities other than cereals, such as grassland, without any type of decrease in their decoupled payments (CAP Monitor, 2005).

The intervention price for other cereals (wheat, barley, maize, sorghum, and durum wheat) has been maintained. The basic amount for arable crops remains 63€/tonne. The existing seasonal correction for intervention price ("monthly increments") was reduced by 50%. To cushion the adverse effects of the necessary restructuring, after the abolishment of rye intervention, the following transitional measure applied. For Member States where the rye production was higher than 5% of its total cereal production and 50% of the EU's total rye production, 90% of the modulation money remains in the country. At least 10% of this money has to be spent in rye producing regions.

In the EU-25, production of rye accounted for 7.9 million tonnes in 2005 and due to policy changes, this figure dropped from a maximum of 12 million tonnes in 2001 (Table 4.2). This is about 3% of total grain production in the EU (5% in 2001). The biggest rye producer, within the EU, is Poland with a share of 46% or 3.6 million tonnes (Figure 4.3) followed by Germany with 36% or 2.9 million tonnes. The remaining production of 1.4 million tonnes in 2005 is divided as follows: the Czech Republic (2.4%), Austria (2.2%), France (1.9%), Denmark (1.7%), Spain (1.7%) and others.

Table 4.2: Area of production (1000 ha), yield (100 kg/ha) and production of rye (1000 mt) in the EU-25

Area of production	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Poland	2407	2157	2286	2436	2452	2415	2298	2291	2242	2130	2068	1632	1544	1620	1473
Germany	720	625	671	733	872	820	855	946	757	853	846	738	543	635	565
Rest of EU	1058	1055	1166	988	971	932	946	959	736	758	713	625	586	571	509
EU-25	**4184**	**3837**	**4123**	**4158**	**4295**	**4168**	**4099**	**4196**	**3736**	**3741**	**3627**	**2994**	**2673**	**2825**	**2546**
Yield															
Poland	25,5	18,7	22,5	21,8	25,6	23,4	23,1	24,7	23,1	18,8	24,4	24,7	21,7	27,8	24,0
Germany	46,8	39,5	45,1	47,8	52,5	52,1	54,3	51,0	57,8	49,3	61,3	50,4	42,9	61,3	51,0
EU-25	**:**	**:**	**:**	**:**	**:**	**29,5**	**30,3**	**31,2**	**30,7**	**27,6**	**33,5**	**31,6**	**:**	**36,3**	**30,8**
Production															
Poland	6136	4025	5152	5300	6288	5653	5300	5664	5181	4003	5050	4037	3344	4503	3604
Germany	3369	2473	3031	3502	4573	4274	4645	4829	4376	4208	5184	3717	2330	3888	2880
Rest of EU	2647	2459	2853	2320	2355	2350	2490	2589	1913	2099	1904	1709	1477	1844	1445
EU-25	**12153**	**8957**	**11035**	**11122**	**13215**	**12276**	**12435**	**13082**	**11470**	**10310**	**12137**	**9463**	**7151**	**10236**	**7929**

Source: EUROSTAT data, 2006. Own calculations

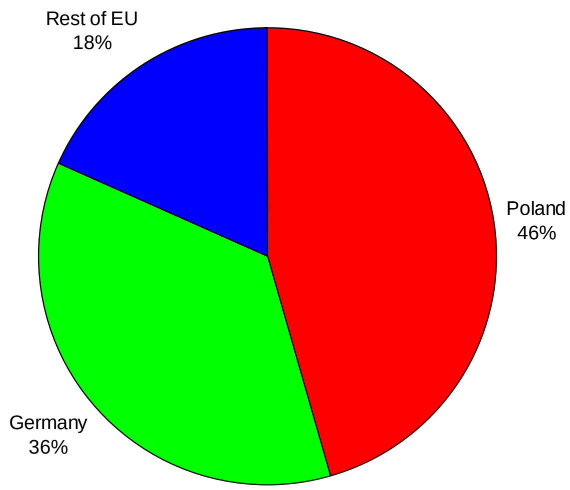

Figure 4.3: EU-25 rye production share for 2005
Source: EUROSTAT data, 2006. Own calculations

Rye is the second largest crop in Poland. Poland produced an average of 4.8 million tonnes of rye, per crop year from 1991 to 2005 (Table 4.2). The average yield is 2.3 tonnes per hectare, which is about one-third the yield Germany can achieve. Rye growing areas have been fairly constant in the 1990s ranging from 2.0 to 2.5 million hectares but declining by almost 25% since 2000. Polish yields increased slightly, but not significantly over the 1990s, and although

production has been relatively stable during these years, it continued with the 1960s long term decreasing trend from 2000 onwards (Table 4.3).
Historically, Poland's production of rye has been much higher. During the 1960s rye accounted for one-half of all grain production, but today it accounts for less than one-fifth of the grain harvest. During the sixties and early seventies, rye production fluctuated between 7 and 8 million tonnes before falling to 6 million during the late seventies. Output again peaked in the mid-eighties but has been falling ever since then. At its high point in 1984, 9.5 million tonnes were collected at harvest. For 2004/05, Poland has produced 26.9 million tonnes of grains and only 3.6 million tonnes of rye. It is due to this smaller than usual rye production and the fact, that 90% of all consumed bread in Poland contains rye flour, that prices for rye in Poland have risen as high as prices for bread wheat.

Table 4.3: Balance sheet of rye in Poland (in 1000 mt)

	1999/00	**2000/01**	**2001/02**	**2002/03**	**2003/04**	**2004/05**
Beginning stocks	587	609	521	583	366	122
Production	5181	4003	4864	3831	3172	4281
Imports	271	391	26	61	37	7
Total supply	6039	5003	5411	4475	3575	4410
Use	**5429**	**4478**	**4828**	**4098**	**3452**	**3734**
Feed	3100	2289	2553	1952	1470	1582
Seed	437	411	330	296	310	295
Food	1230	1230	1228	1226	1197	1202
Industry	392	324	400	440	350	480
Losses	270	224	317	184	125	175
Exports	1	4	0	11	1	203
Ending stocks	**609**	**521**	**583**	**366**	**122**	**473**
Self-sufficiency	95	89	101	93	92	115
Per capita consumption (kg/head)	31,8	31,8	31,9	32,1	31,3	:

Source: EUROSTAT data, 2006. Own calculations

The bulk of Polish agriculture lies in the lowlands of the North European Plain. This area is a poorly drained region, comprised of sandy or clay soils suited more for tolerant rye plants than for the more demanding wheat varieties. The large central region receives the least amount of moisture, just 400 to 600 millimetres of annual precipitation. Another problem for the Polish farmer is that the heaviest precipitations occur during the summer months of June, July and August when winter grains do not require much moisture and at a time when rain can impede harvest activities. If new cropping patterns become more lucrative, it is on the vast, low-lying lands in north and central Poland that most of the changes will take place.

4.2. Production of oats

Production of oats in the EU is much more widely distributed than the production of rye or triticale. Traditionally, it used to be a crop of high value in the northern parts of Europe, while crops like wheat and barley were predominantly grown in the southern parts. This is still reflected in today's growing pattern. Poland is the biggest producer in the EU with a share of 41% or 5 million tonnes in 2005 (Figure 4.4, Table 4.4.). Finland is next, with a share of 10% of the total production, closely followed by Germany with 9%. Other countries with significant volumes are Sweden (7%), France (7%), Spain (5%), and the United Kingdom (5%).

A long term trend of declining oats area and production, which stretched back to the era of working horses, appeared to have been broken in the early 1990s. Increasing demand for oats, for recreational horses and for milling, for human consumption, promised improved price prospects. This, together with the promotion of oats as a break crop, caused a temporary reversal in this trend. But with the unfavourable prices of oats over the last few seasons, output, has again, over the last three years declined.

Declining EU oats production has resulted in a tighter supply situation in 2005/06. Prices have risen and are above those for other coarse grains. The UK harvested the smallest area on record and imports were needed to increase to meet milling and possibly other demands. This tighter EU supply situation, has resulted in prices rising by 5.00 to 10.00 €/tonnes, depending on location, compare to previous year price level (HGCA, 2005).

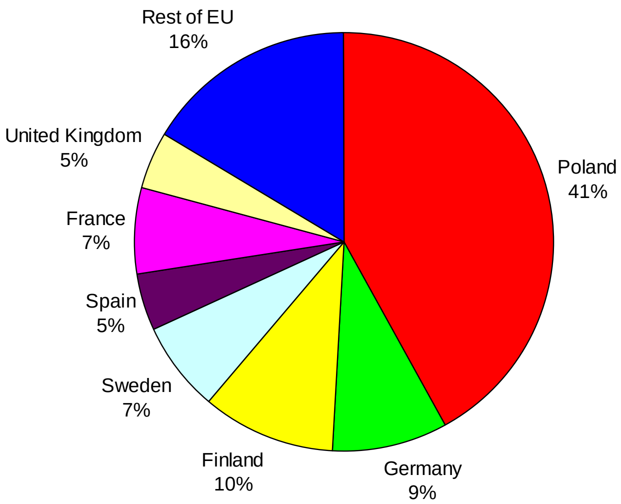

Figure 4.4: EU-25 oats production share 2005
Source: EUROSTAT data, 2006. Own calculations

Table 4.4: Area of production (1000 ha), yield (100 kg/ha) and production of oats (1000 mt) in the EU-25

Area of production	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Poland	1916	1927	1897	1927	1961	1888	2055	2019	1956	2043	1936	1899	1916	1910	1907
Germany	438	411	407	444	354	348	359	302	309	266	260	259	295	252	238
Finland	352	345	343	342	340	384	380	387	416	411	434	463	438	342	362
Sweden	404	408	347	366	305	318	345	338	339	323	298	314	303	245	218
Spain	325	314	315	347	367	391	400	413	434	442	468	468	512	507	480
France	241	227	231	216	197	191	187	187	164	158	170	208	196	188	174
United Kingdom	107	106	95	111	115	99	102	100	94	111	115	129	126	112	95
Rest of EU	816	748	712	735	658	703	770	715	739	697	698	690	711	752	726
EU-25	**4599**	**4488**	**4347**	**4488**	**4297**	**4322**	**4599**	**4463**	**4451**	**4451**	**4379**	**4429**	**4495**	**4309**	**4200**
Yield															
Poland	29,0	19,9	24,7	22,2	27,2	27,0	27,9	28,4	27,4	20,3	26,7	26,9	24,1	29,0	26,0
Germany	48,8	36,9	47,7	42,2	45,2	52,5	50,3	48,0	49,5	45,5	48,8	43,3	45,4	51,5	45,4
Finland	33,6	29,7	35,9	34,3	33,2	33,6	33,6	25,8	24,5	35,3	30,4	33,7	30,4	30,6	33,9
Sweden	40,3	22,2	40,2	29,8	33,3	41,9	40,1	35,9	33,9	39,1	35,2	40,6	39,6	40,8	38,8
Spain	12,4	10,0	13,7	11,9	6,3	17,0	13,0	17,8	12,5	22,2	15,0	19,5	17,9	21,2	11,4
France	41,3	41,6	41,6	41,3	40,4	44,2	42,1	46,2	43,9	43,5	40,2	49,6	39,4	46,5	45,1
United Kingdom	50,0	48,8	52,1	55,0	55,0	61,0	57,5	59,1	58,5	58,8	54,9	59,6	60,6	64,3	58,0
EU-25	**:**	**:**	**:**	**:**	**:**	**:**	**:**	**30,0**	**28,4**	**27,1**	**28,6**	**30,5**	**28,2**	**31,9**	**:**
Production															
Poland	5557	3842	4693	4269	5339	5102	5735	5734	5361	4154	5179	5116	4618	5530	5041
Germany	2139	1518	1941	1873	1599	1826	1806	1450	1529	1212	1270	1122	1338	1299	1080
Finland	1182	1027	1232	1174	1127	1292	1279	999	1021	1450	1320	1556	1330	1047	1228
Sweden	1626	907	1395	1091	1014	1332	1384	1215	1148	1261	1049	1274	1200	1000	835
Spain	404	313	431	414	231	664	521	737	544	983	701	912	914	1073	546
France	993	947	959	893	796	846	787	864	722	686	683	1031	774	874	785
United Kingdom	537	519	494	613	631	602	588	593	550	653	631	771	762	720	551
Rest of EU	1896	1328	1585	1718	1502	1726	1783	1794	1762	1678	1685	1705	1750	2040	1954
EU-25	**14334**	**10401**	**12730**	**12043**	**12240**	**13390**	**13882**	**13386**	**12636**	**12077**	**12518**	**13488**	**12687**	**13584**	**12020**

Source: EUROSTAT data, 2006. Own calculations

The US is the only non-EU importer of oats. Canadian oats are imported mainly for milling into the US upper mid-west. Scandinavian oats are imported into eastern seaboard and Gulf coast markets. While these markets have somewhat different requirements, quality seems to be more important than price to buyers.

As mentioned before, prices of oats have been strong in recent years on the US market which was particularly true for milling and special equine feed markets. The North American market has tended to be masked from the EU by increased shipping costs. While export restitutions were still needed to allow Scandinavian oats to compete in US markets, the level of these subsidies was not much greater than the recent increase in ocean freight costs (HGCA, 2005).

4.3. Production of triticale

The production area of triticale in the EU was 2.6 million ha in 2005, an increase of 4% compared with 2004 and 17.3% compared with the average for the last five years. Poland, Germany and France account for 78.6% of the area under triticale in the EU (*Figure 4.5*). Production was 10.3 million tonnes, i.e. 7.3% less than in 2004 but 15.6% above the average for the last five years. It is interesting to note that since 2002, Poland has become the biggest producer of triticale in the EU, producing 3.7 million tonnes in 2005, compared with 2.7 million tonnes in Germany and 1.8 million tonnes in France (Eurostat, 2006).

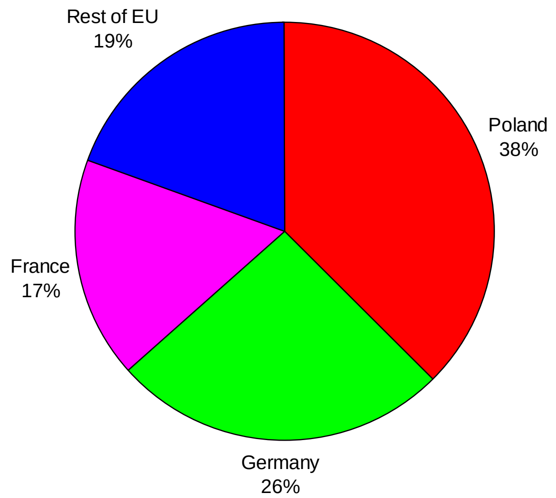

Figure 4.5: EU-25 triticale production share 2005
Source: EUROSTAT data, 2006. Own calculations

The production of triticale in the EU increased by more than 138% between 1991 and 2005 (Table 4.5) while the area of production has more than doubled (116%). Since intervention of rye was abolished in 2004 the possibility of triticale replacing the production of rye, in the medium to long-term, remains an interesting issue.

Table 4.5: Area of production (1000 ha), yield (100 kg/ha) and production of triticale (1000 mt) in the EU-25

Area of production	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Poland	731	659	657	586	616	697	630	635	660	695	838	944	986	1058	1193
Germany	130	175	219	208	289	364	438	469	386	499	533	560	500	507	482
France	161	176	163	175	185	206	218	237	241	244	241	271	290	328	329
Rest of EU	153	181	211	239	273	345	394	400	365	406	449	458	503	559	537
EU-25	**1175**	**1192**	**1250**	**1208**	**1364**	**1612**	**1680**	**1740**	**1653**	**1845**	**2062**	**2233**	**2278**	**2451**	**2544**
Yields															
Poland	33,5	25,9	28,8	27,8	33,2	30,6	29,2	32,4	31,8	27,3	32,2	32,3	28,5	35,2	31,4
Germany	55,1	50,7	52,5	54,1	56,9	58,4	59,9	60,1	61,4	56,1	64,1	54,7	49,6	64,8	55,7
France	45,1	47,3	46,7	46,3	45,9	51,3	47,9	52,7	50,5	51,7	46,6	55,1	44,2	55,9	54,2
EU-25	**:**	**:**	**:**	**:**	**:**	**:**	**:**	**:**	**:**	**:**	**42,6**	**41,0**	**35,5**	**45,3**	**:**
Production															
Poland	2449	1711	1895	1631	2048	2130	1841	2058	2097	1901	2698	3048	2812	3723	3903
Germany	717	890	1147	1125	1643	2128	2621	2814	2374	2800	3419	3068	2480	3290	2686
France	724	835	762	809	850	1054	1043	1248	1216	1262	1122	1491	1282	1831	1783
Rest of EU	479	419	375	413	710	1084	1348	1390	1212	1450	1549	1561	1507	2270	2027
EU-25	**4368**	**3855**	**4178**	**3978**	**5252**	**6396**	**6852**	**7511**	**6899**	**7412**	**8788**	**9168**	**8081**	**11113**	**10399**

Source: EUROSTAT data, 2006. Own calculations

4.4. German market of rye, oat and triticale

Market of rye

The CAP helped to maintain Germany's level of rye production over time while consumption decreased (Table 4.6). With the MTR, the picture changed as the intervention of rye was abolished. Before that, Germany produced some 2 million tonnes of surplus rye annually, that was either stored in intervention facilities or exported, with subsidies, to third-countries such as South Korea, Japan, and China. Rye is mostly used as feeding stuff, but in these three countries it is also used for breadstuffs.

Table 4.6: Balance sheet for rye in Germany (in 1000 mt)

	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04
Beginning stocks	1817	3136	3661	2682	2727	2105	1259	1495	2887	4045	3644	4254	5533	5466
Production	4045	3370	2473	3031	3430	4474	4274	4623	4817	4291	4208	5172	3700	2303
Imports	43	33	42	104	105	50	52	63	56	47	38	33	91	38
Total supply	5905	6539	6176	5817	6262	6629	5585	6181	7760	8383	7890	9459	9324	7807
Use	**2485**	**2275**	**2035**	**2452**	**2654**	**2953**	**3021**	**2852**	**2812**	**2240**	**2410**	**2727**	**2643**	**2306**
Feed	1083	1005	715	1158	1393	1660	1740	1566	1567	1038	1255	1564	1563	1240
Seed	95	90	81	87	97	113	107	112	98	112	110	96	55	65
Food	1149	1027	1106	1071	1020	1018	1017	1013	987	948	920	924	910	919
Industry	54	54	55	47	47	45	46	42	38	31	17	16	17	12
Losses	104	99	78	89	97	117	111	119	122	111	108	127	98	70
Exports	284	603	1459	638	1503	2417	1069	442	903	2499	1226	1199	1215	1900
Ending stocks	**3136**	**3661**	**2682**	**2727**	**2105**	**1259**	**1495**	**2887**	**4045**	**3644**	**4254**	**5533**	**5466**	**3601**
Intervention	2660	3178	2358	2305	850	786	993	2464	3619	3211	3821	5090	5124	3333

Source: BMVEL/BMELV, BLE, ZMP

Although rye is inferior in many ways to the predominant cereal crops such as wheat, rice, and maize, it remains the third most important crop in Germany. Planting rye has significant advantages over other crops. It is considerably more winter hardy than wheat, and produces economical yields on poor sandy soils where no other useful crops can grow. It is grown in many areas that have no other alternative. This is particularly the case in parts of eastern Germany. It is also a good rotational crop because of its ability to compete effectively with weeds. Rye used as livestock feed, has a low feed value compared to other feed grains and is mixed only in small proportions in feed. On occasion, the international market price of rye, generally below milling wheat prices, makes it an attractive feed grain despite its low feed value.

Between 1973 and 1993, the production of rye was about 3 million tonnes in the EU-15, given gross margins were quite small compared to other cereals and rye was only cultivated in areas unsuitable for most other cereals due to climatic reasons. The German re-unification led to an increase in production, as rye was more common in the eastern parts of Germany. However, with the introduction of a uniform intervention price during the Reform of 1992 and its implementation starting in the marketing year of 1993/94, the situation changed towards a dramatic production increase. The coupled increase in intervention stocks and the perspective of additional quantities, eligible for intervention from Polish producers, induced a further policy change which implied the elimination of rye intervention from 2004. After that, the price and the production of rye declined again.

Germany produced 2.9 million tonnes of rye in 2005 (Table 4.6). This is 26% down from the previous year and largely due to the fact that rye intervention was abolished in August 2004. Area of production was also reduced, but not as much as total production (11%). Average yield dropped from 6.1 t/ha to 5.1 t/ha which could have been influenced by weather conditions. But the drop in production could also indicate that farmers could not produce as intensely as before, to reduce their rye production costs. On fertile soils, the alternatives for rye farmers would include crops such as wheat, barley, oats, rapeseed, and sugar beet. However, as most German farmers producing rye are located in areas with less fertile soils, they cold opt for the production of potatoes and/or triticale, but due to the special features of rye in some areas, there are no choices at all and these areas could become fallows.

Figure 4.6 displays the development of the German rye prices between 1999 and 2005. It is interesting to note the drop in prices in August 2004, when the intervention for rye was abolished. Since 2005 prices have remained at historical low levels, but have started to rise to levels of 2002 in December 2005. Given supply is only sufficient to meet demand and is particularly tight for bread quality rye in South-western parts of Germany, prices start to reflect this situation. Some mills are starting to think of contracting farming for rye from 2007 onwards. Current gaps in supply of rye could be filled out of public intervention stocks, but these stocks might be emptied within the next two to three years if farmers maintain the current low production levels.

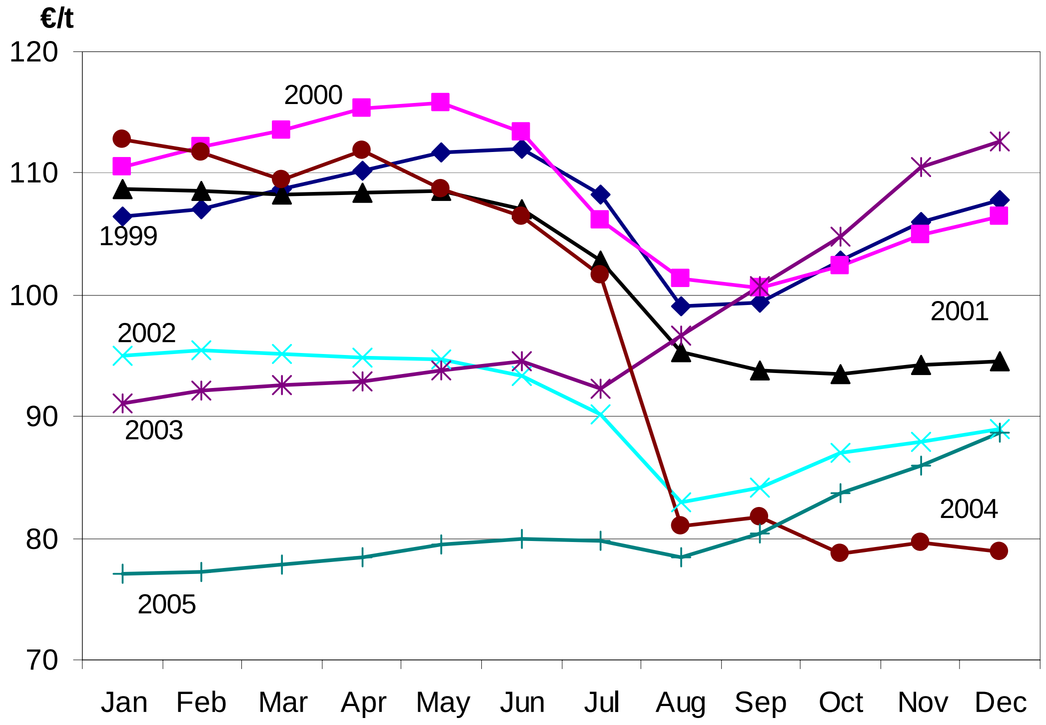

Figure 4.6: Rye prices in Germany 1999 to 2005 (€/tonnes)

Source: Stat. Bundesamt, Pendelliste, various years.

Market of oats

Production of oats in Germany has declined from 2.4 million tonnes in 1990/91 to 1.3 million tonnes in 2004/05 (Table 4.7). This is a drop of 45%. The fall in production is mainly attributed to the fading importance in the use of animal feed. Although the amount of oats used for human consumption has increased by 64% over the last 15 years, it could not outweigh the effect of the shrinking feed use. German oats self-sufficiency has been stable around 100% since 1990/91.

Table 4.7: Balance sheet for oats in Germany (1000 mt)

	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05
Beginning stocks	446	411	371	231	389	335	246	342	356	241	237	220	241	217	222
Production	2360	2139	1518	1941	1855	1580	1826	1783	1427	1508	1202	1249	1107	1297	1284
Imports	45	57	106	75	48	89	60	59	70	87	108	104	147	114	165
Total supply	2851	2607	1995	2247	2292	2004	2132	2184	1853	1836	1547	1573	1495	1628	1671
Use	**2379**	**2167**	**1721**	**1788**	**1826**	**1706**	**1733**	**1687**	**1480**	**1500**	**1254**	**1243**	**1192**	**1321**	**1314**
Feed	2082	1876	1450	1506	1539	1436	1452	1418	1213	1225	1008	984	923	1018	954
Seed	67	66	62	61	67	53	52	54	46	40	39	33	42	36	34
Food	178	177	174	177	178	180	187	174	187	199	178	195	199	234	292
Industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Losses	52	48	35	44	42	37	42	41	34	36	29	31	28	33	34
Exports	61	69	43	70	131	52	57	141	132	99	73	89	86	85	104
Ending stocks	**411**	**371**	**231**	**389**	**335**	**246**	**342**	**356**	**241**	**237**	**220**	**241**	**217**	**222**	**253**
Self-sufficiency	99	99	88	109	102	93	105	106	96	101	96	100	93	98	98
Per capita consumption (kg/head)	2,2	2,2	2,2	2,2	2,2	2,2	2,3	2,1	2,3	2,4	2,2	2,4	2,4	2,8	:

Source: EUROSTAT data, 2006. Own calculations

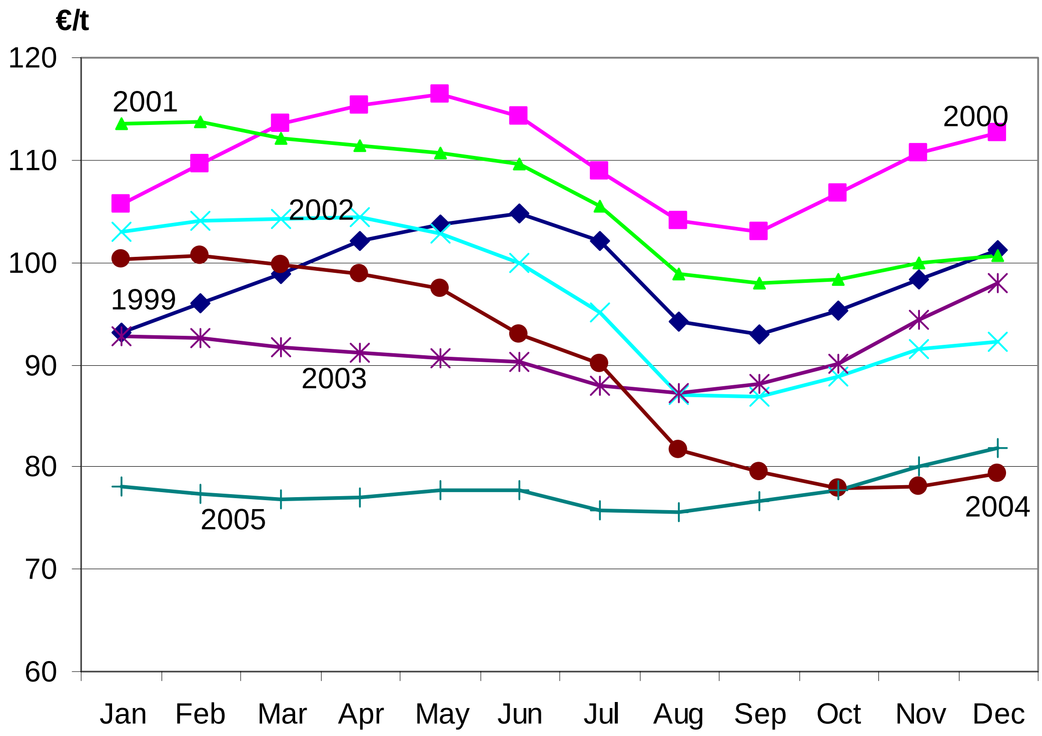

Figure 4.7: Development of feed oats prices in Germany 1999 to 2005 (€/tonne)

Source: Stat. Bundesamt, Pendelliste, various years.

Market of triticale

Triticale has gained importance as a feed component over the years. Its usage as a fodder grain has increased by an impressive 660% from 1990/91 to 2004/05 in Germany (Table 4.8). At the same time, human consumption does not play any significant role in utilization of this cereal. This may be attributed to the fact, that it is not widely known by the public or that its qualities for baking may still not be satisfactory. As it is not included in the intervention system, this crop is subject to existing market forces (Figure 4.8).

Table 4.8: Balance sheet for triticale in Germany (1000 mt)

	1990/91	**1991/92**	**1992/93**	**1993/94**	**1994/95**	**1995/96**	**1996/97**	**1997/98**	**1998/99**	**1999/00**	**2000/01**	**2001/02**	**2002/03**	**2003/04**	**2004/05**
Beginning stocks	9	22	63	62	85	81	97	212	259	233	170	292	326	266	201
Production	389	716	890	1147	1108	1615	2128	2567	2729	2317	2800	3395	3050	2449	3245
Imports	2	1	3	3	3	7	12	13	18	12	10	5	4	0	0
Total supply	400	739	956	1212	1196	1703	2237	2792	3006	2562	2980	3692	3380	2715	3446
Use	**378**	**685**	**894**	**1124**	**1114**	**1577**	**1980**	**2301**	**2576**	**2282**	**2625**	**3100**	**2870**	**2418**	**2782**
Feed	345	633	841	1057	1058	1474	1855	2155	2438	2140	2469	2911	2701	2270	2622
Seed	26	37	35	44	33	46	58	70	62	80	86	90	75	72	72
Food	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Industry	0	0	0	0	0	24	24	24	20	16	14	31	33	27	23
Losses	7	15	18	23	23	33	43	52	56	46	56	68	61	49	65
Exports	0	1	0	3	1	29	45	232	197	110	63	266	244	96	320
Ending stocks	**22**	**63**	**62**	**85**	**81**	**97**	**212**	**259**	**233**	**170**	**292**	**326**	**266**	**201**	**344**
Self-sufficiency	103	105	100	102	99	102	107	112	106	102	107	110	106	101	117
Per capita consumption (kg/head)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	:

Source: EUROSTAT data, 2006. Own calculations

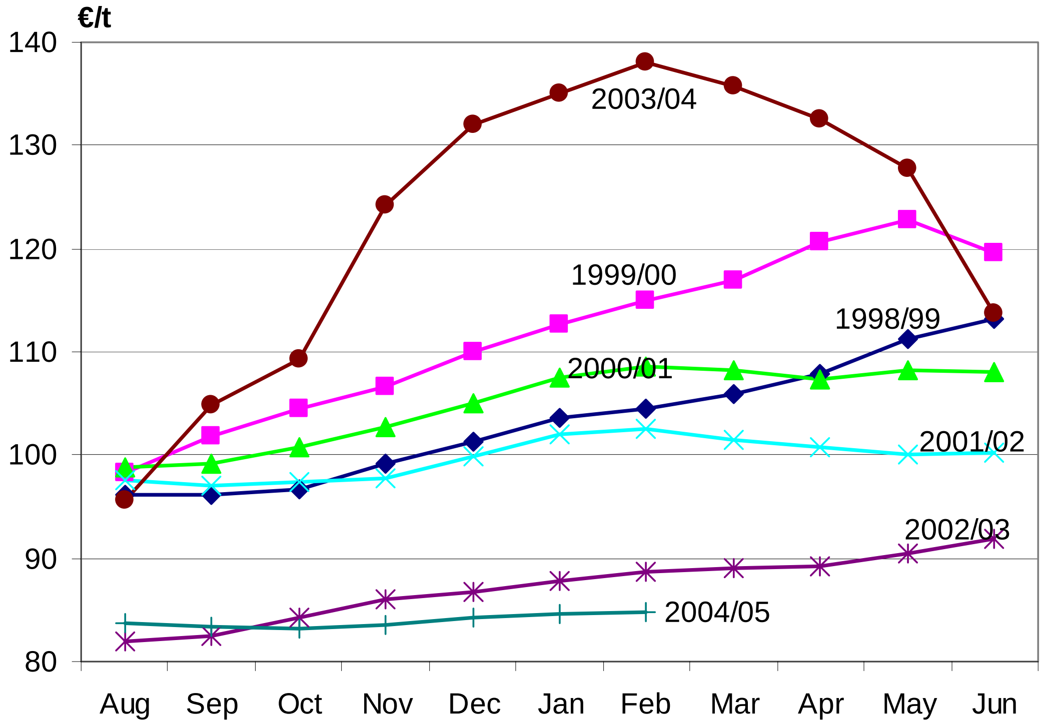

Figure 4.8: Development of triticale prices in Germany 1998/99 to 2004/05 (€/tonne)
Source: ZMP data, 2005

4.5. New AGMEMOD commodity markets and policy description

The commodity coverage for grains originally consisted of soft wheat, durum wheat, barley, and maize. The grain sub-model in AGMEMOD for this study, is extended with two new crops, 'rye' and 'other grains', in which 'other grains' covers the remaining subcultures 'triticale', 'oats and others'.

Figure 2.1 shows the production of these new commodities in the EU-15 (up to 2000) and the EU-25 (from 2000). Planting rye has significant advantages over other crops. It is more winter hardy than wheat and produces economical yields on poor sandy soils, where no other crop can grow and is less influenced by drought than other crops. In some countries like Germany, rye is partly sold as bread cereal, but when used as livestock feed, it has a low feed value compared to other feed grains and is mixed only in small proportions.

Since the unification of the intervention prices in the cereal sector in the mid-1990s, rye production in the European Union exceeds the demand and it is purchased by the Commission in intervention stocks. From 2000, the decline of intervention prices has caused a drop in rye production (see Figure 4.9). On fertile soils, the alternatives for rye include wheat, barley, oats, rapeseed and sugar beet crops. However, rye is mostly planted on less fertile soils. Potatoes and triticale are possible alternatives but due to the special features of rye, in some of these less fertile soil areas, there are really no alternatives at all and these areas could become fallows.

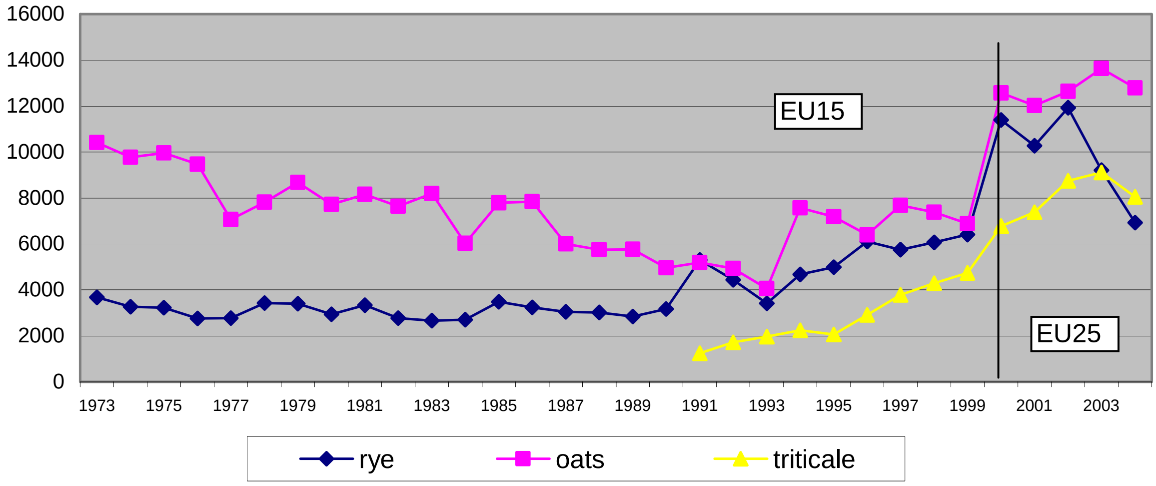

Figure 4.9: Rye, oats and triticale in the EU (1,000 ton)

Figure 4.10 shows the significant position of Germany and Poland in the EU-25 production of rye, oats and triticale, whereas the remainder of the production is scattered over the other Member States. When the production of a particular commodity is concentrated in very few countries, the following strategy is applied:

- the commodity is implemented in the country models when production of this commodity is of significance (Germany and Poland for rye and 'other grains'), whereas others can take the option of implementing it;
- the demand and supply of rye and 'other grains' are modelled as an aggregate, for the remaining countries;
- the demand and supply variables for rye in the country models where this commodity production is of significance, and the demand and supply variables of 'other grains' in the rest of the EU provide the commodity information on the EU-25 level.

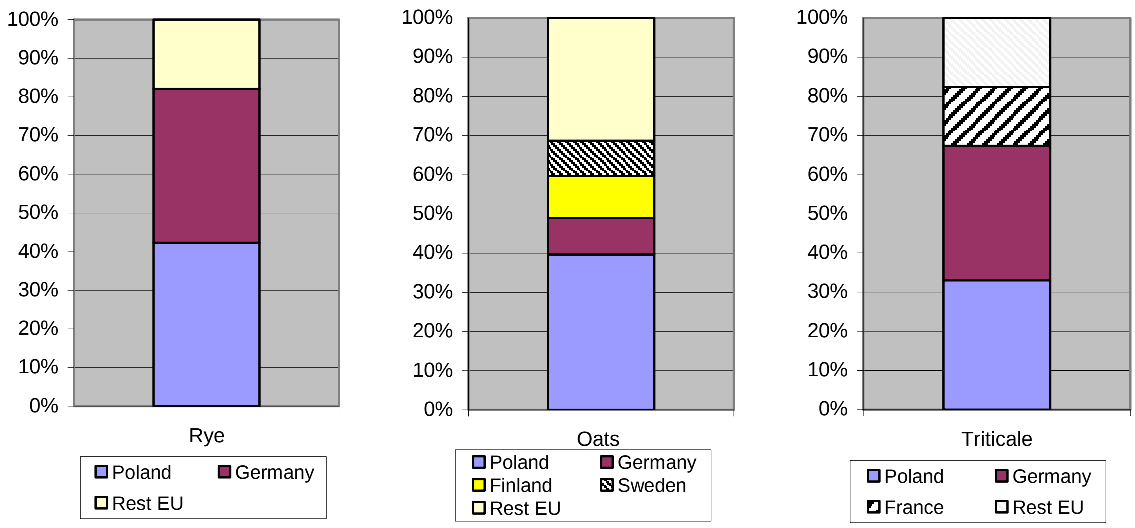

Figure 4.10: Share of EU-25 rye, oats and triticale production in most important EU countries, 2004

Oats and triticale are not included in the intervention regime but covered by the premium schemes. Intervention and direct payments have already been mentioned as the policy instruments influencing rye production. The AGMEMOD approach takes account the following policy issues:

- intervention price for rye;
- unified intervention since 1993/94 (in total -34% compared to intervention price of feed cereals);
- 15% reduction of intervention price under Agenda 2000;
- abolishing of rye intervention from 2004 onwards, due to high intervention stocks, the high self sufficiency rate and expected high production in Poland;
- introduction of direct payments for rye and also 'other grains' in 1993/94 to compensate for the reduced intervention price;
- increase of compensatory area payments for cereals under Agenda 2000, if participating in the set-aside scheme;
- from January 2005, compensatory area payments for cereals and other arable crops replaced by Single Farm Payments based on aid receipts of the period 2000-2002;
- no intervention regime for oats and triticale.

During the analysed period there was only a very limited international trade in rye and other cereals. The model takes account of the WTO export commitments and the tariff rate quotas, with a minimum access of 21,000 tonnes for oats, at a reduced rate, and an additional preferential 10,000 tonnes at zero rate.

Flow charts for land allocation, rye and 'other grains'
AGMEMOD determines the land allocation of the three crop sub-models (grains, oilseeds, root crops) in a two step process. In the first stage, producers allocate their land area to grains, oilseeds and root crops respectively. Then in a second stage, the shares of the land areas which have been allocated to grains, oilseeds and root crops are distributed to a certain culture belonging to that particular crop group. In contrast to the previous model version, the crop-group ‘grains’ were extended with the cultures ‘rye’ and ‘other grains’. The land allocation sub-model is adjusted in the models of countries with significant rye production (see Figure 4.11). The total grain area harvested is modelled as a function of the adjusted expected average return for the

various grains, the cereal set-aside rate and compensation payments. The real expected gross return variable is a function of the moving average of the past real market prices and a trend productivity growth (trend yield). Compensation payments are assumed to have a smaller effect on total grain area than, the expected market return since, producers participating, voluntarily, in the set-aside scheme can receive compensation payments without planting crops. The set-aside rate has a negative effect on the area harvested since it diminishes the area available for crops. This impact is, however, significantly smaller than those of the expected real gross return variables.

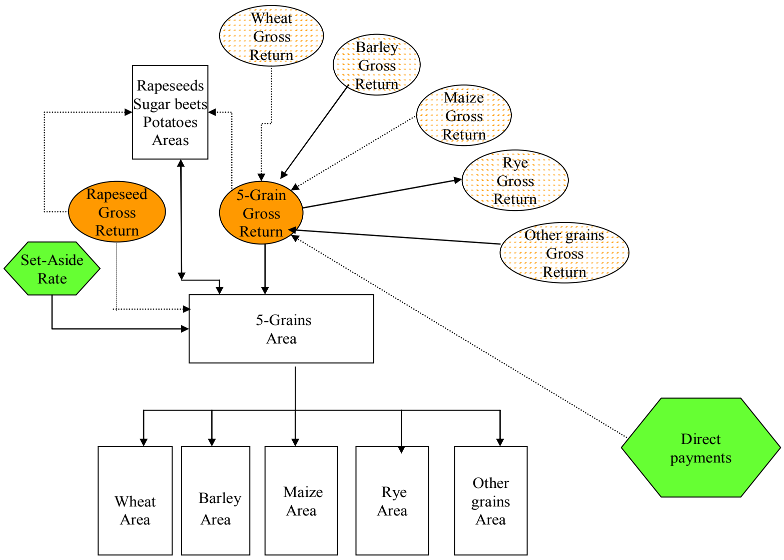

Figure 4.11: Area allocation of grains

The allocation of the total grain area to wheat, barley, maize, rye and 'other grains' is adjusted, in comparison, to the previous AGMEMOD version. Figure 4.12 and Figure 4.13 present the flow charts for rye and 'other grains'. The total grain area is allocated to these specific commodities, by estimating the different shares of the cultures in the total grain area. The share allocation is determined by comparison of the expected real gross returns for the five types. Compensation payments will not have direct impact on the area shares, as these are the same for all grains.

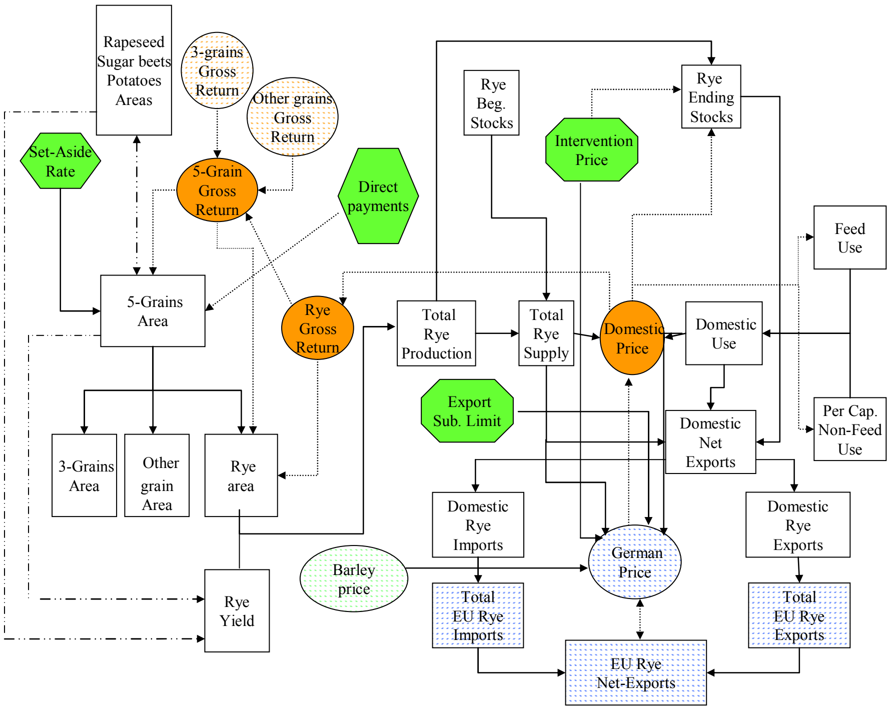

Figure 4.12: Rye sub-model in AGMEMOD

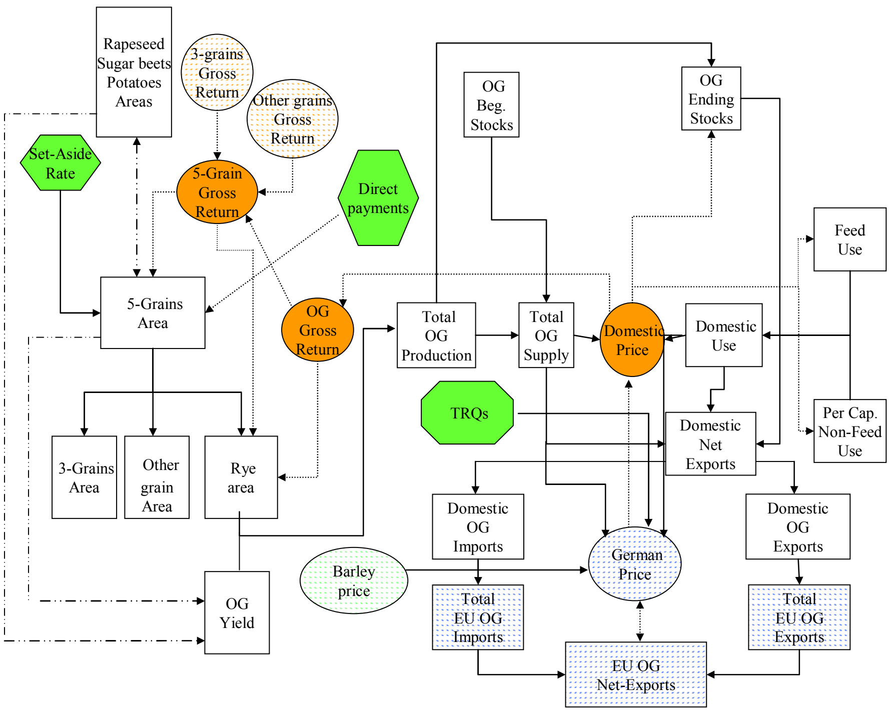

Figure 4.13: 'Other grains' sub-model in AGMEMOD

Key market and key price specification

For each commodity in AGMEMOD, the market of a specific Member State is seen as the key market, while its respective price is considered as the EU key price. Germany, as the most important producer of rye and 'other grains' in the Member States before the 2004 enlargement[2], delivers the key prices of these commodities. The German rye price is specified by the domestic price for barley, the intervention price for rye and the trade instruments as well as by the supply

[2] Although Poland's production of rye is higher than Germany's, the German market is selected as the key market. This is to avoid estimation problems arising from the accession process.

and demand situation. The German "other grains" price is determined by the domestic price, by the supply and demand situation and by the trade instruments.

Database and mnemonics

The model's database in AGMEMOD is built up with balance sheets for all commodities. Reflected balance items are stocks, production, imports, exports, ending stocks as well as domestic usage, which is partly differentiated into human food consumption, feed use, processing and industrial use. The same data set for rye (RY) and 'other grains' (OG) were assembled by all country teams from the Eurostat sources *AgrIS* (Agricultural Information System) and *NewCronos*.

Specification of functional forms

There are five grains modelled in the JRC-IPTS version of AGMEMOD namely wheat, barley, maize, rye and 'other grains'. Although the specifications of each of the grain sub-models are quite similar, they are adjusted according to several model specifications. Among others, an example is the allocation of land to the various grain types.

4.6. Model implementation of new commodities in the AGMEMOD model

The method of including two new markets in the existing German AGMEMOD model is now described. The markets in question are those for rye and 'other grains', which comprise oats and triticale. As can be seen in Figure 4.14, there is a high correlation degree between the price of barley and the prices of rye and oats (proxy for the aggregate ‘other grain’). The existing price relations of the barley sub-model could easily be adjusted for use in projections of the new implemented markets.

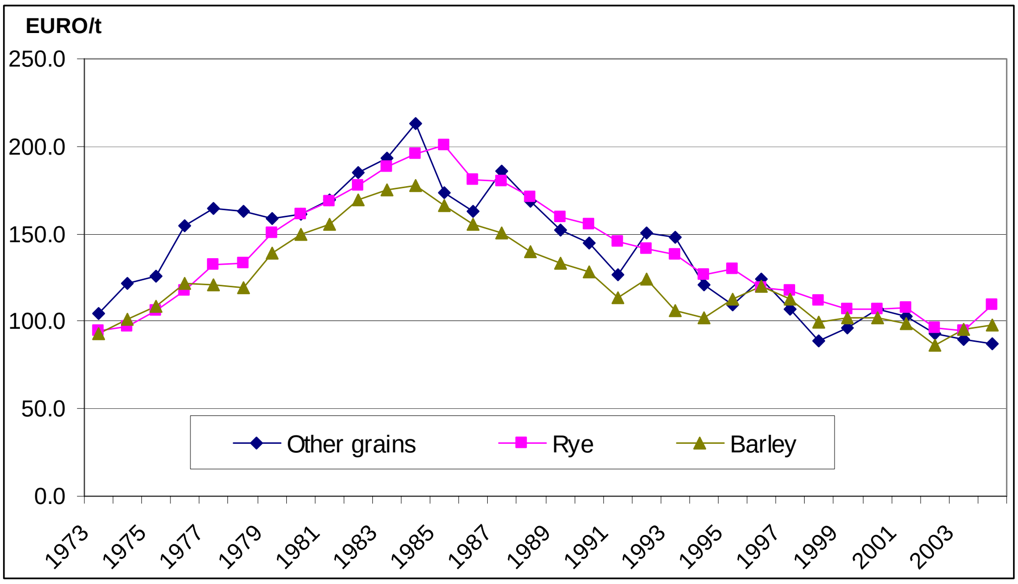

Figure 4.14: German producer prices for barley, rye and 'other grains' (oats)
Source: Eurostat (2006)

In the conventional crop sub-models, implemented in the AGMEMOD system, land allocation is modelled as a two-stage decision in which producers first decide how much area is needed to cultivate cereals and oilseeds. Secondly, these total cereal and oilseed areas are allocated to specific commodities according to the country characteristics. For the new crops, a similar approach is proposed with some simplifications, as there is no sufficient time to estimate the area share equations econometrically. Therefore, an approximate area share equation, based on the barley market model, is adjusted to the two new products. This means that the parameters used to determine the area shares of the new products are ‘synthetic’ and there is no real substitution among the areas devoted to the two new products and the other cereals and oilseeds formerly presented in the model. Even with this isolation of the supply side of the new markets from the remaining crop sectors, the modelling approach performs quite well. Hence, the hypothetical area share of the new products will refer to the 3grain area already used in the model.

To determine production, we use the standard approach:

Production = yield * area

The yields of the new products are determined by equations, based on trend yields of the grains and oilseed areas, as used in the existent product models:

RYAHADE = f(RYYTDE; G3AHADE+O3AHADE)
OGAHADE = f(OGYTDE; G3AHADE+O3AHADE)

Provisionally, the parameters of the barley market are used and adjusted if necessary.

The demand side is composed of different types of consumption. The feed use of the two new products is explained by the feed demand index, the prices of rye and soft wheat as in the case of barley and a level dummy that accounts for the reunification structural brake:

RYUFEDE = RYFINDE, RYPFMDE, WSPFMDE, L90
OGUFEDE = OGFINDE, OGPFMDE, WSPFMDE, L90

The feed indexes are adjusted for the new products, following the standard implementation in the crop models of the AGMEMOD model.

Human consumption (food use) is determined as the product of per capita consumption, multiplied by the population. The per capita consumption is a function of the real own price, a year dummy 1990 and the overall trend:

RYUPCDE = f(RYPFMDE/GDPDDE, D90, TREND70)
OGUPCDE = f(OGPFMDE/GDPDDE, D90, TREND70)

Stocks of rye and 'other grains' are explained by the production, the real own product price and the respective feed index:

RYCCTDE = f(RYSPRDE, RYPFMDE/GDPDDE, RYFINDE)
OGCCTDE = f(OGSPRDE, OGPFMDE/GDPDDE, OGFINDE)

The trade equations are again in line with the structure of the barley sub-model. While imports are determined by an equation, exports are determined by a closing identity to ensure market clearance. Imports are, as in the case of barley, explained as a function of the feed use product, the production level and some year dummies:

RYSMTDE = f(RYUFEDE, RYSPRDE, dummies)
OGSMTDE = f(OGUFEDE, OGSPRDE, dummies)

And the exports are calculated, as follows:

RYUXTDE = RYSPRDE + RYSMTDE + RYCCTDE(-1) - RYUDCDE - RYCCTDE
OGUXTDE = OGSPRDE + OGSMTDE + OGCCTDE(-1) - OGUDCDE - OGCCTDE
The price equations are differently implemented. Due to the correlation observed between the

German price of barley and of oats (other grains), a price transmission equation is estimated allowing the determination of this price. Therefore, the price for "other grains" in the German model is, in fact, indirectly linked to the French barley price where the key market of the composite model is defined:

OGPFHDE = f(BAPFHDE)

For rye, the price transmission equation takes into account the former intervention prices that apply for rye:

RYPFHDE = f(BAPFHDE, RYPIN/EXREDE)

This implementation is a first approach and additional econometric work can be carried out to improve the results, particularly after the abolition of the intervention price for rye. One next step, will certainly be the explicit linkage of these two markets on the supply side (area allocation).

Table 4.9: New product model mnemonics description

RYYTDE	Rye trend yield
G3AHADE	Tree grain area harvested
O3AHADE	Tree oilseed area harvested
RYFINDE	Rye feed demand index
RYPFMDE	price of rye (per tonne)
RYPFHDE	price of rye (per 100kg)
WSPFMDE	Price of soft wheat
L90	Dummy for level change after the German reunification
RYPFMDE/GDPDDE,	Real rye price (price per GDP deflator)
D90,	Dummy for the year 1990 (discontinuity in the time series)
TREND70	Trend beginning in 1970
RYSPRDE	Rye production
RYSMTDE	Rye imports
RYUXTDE	Rye exports
RYCCTDE(-1)	Rye beginning stocks
RYUDCDE	Rye total domestic use
RYCCTDE	Rye ending stocks
RYPIN	Rye intervention price (in ECU or euro)
EXREDE	Exchange rate EUR/DM
BAPFHDE	Barley price (100kg)

Note: RY=rye, OG='other grains'. The above listed mnemonics apply to Germany (DE)

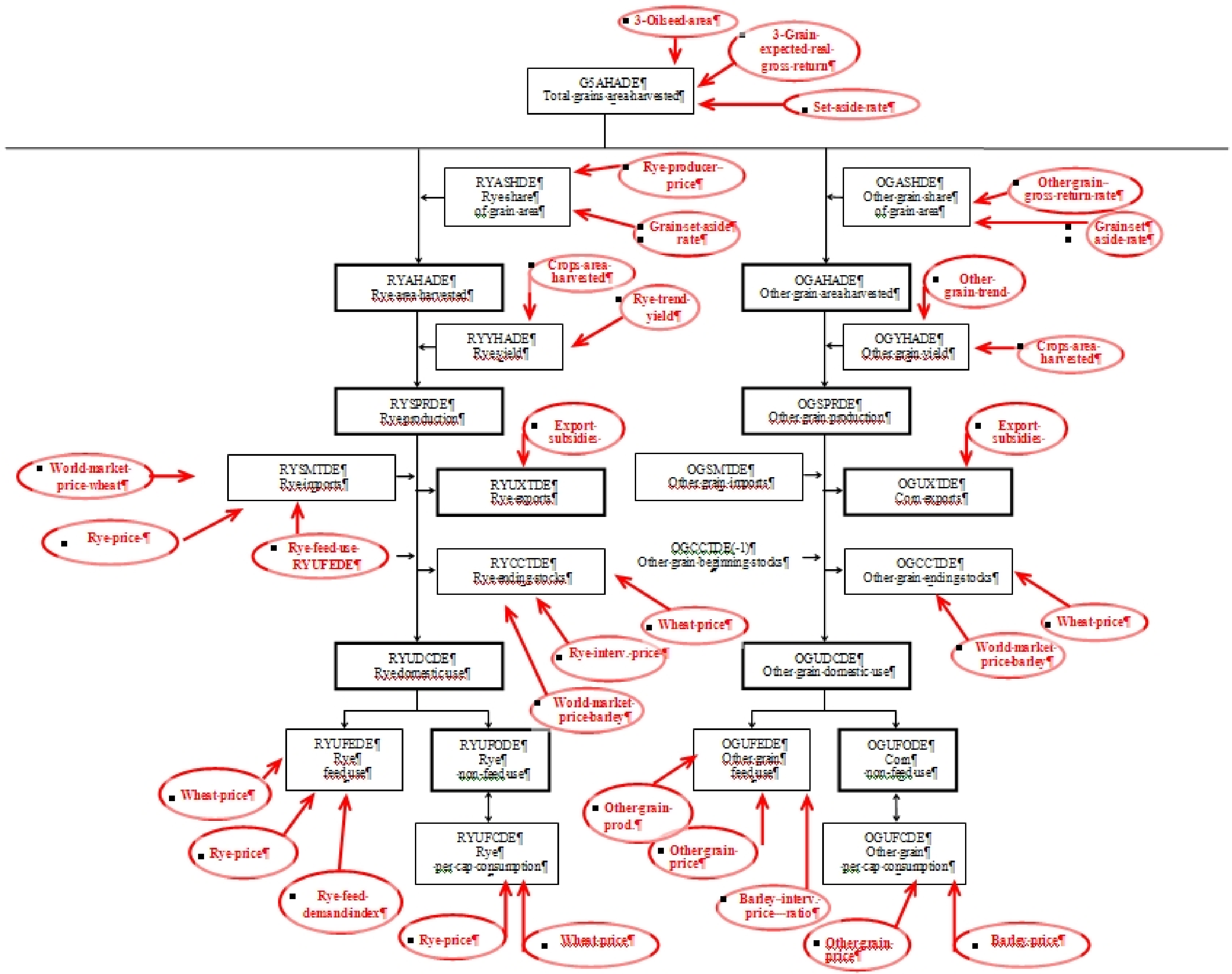

Figure 4.15: The grain sub-model

5. Scenarios

Scenarios of specific changes in policies and other exogenous conditions are formulated in consultation with the Commission services and other parties. These are based on the 2005-2006 policies and their expected development.

Under the Luxembourg Agreement there was a wide range of options for implementing the CAP in the Member States. From January 2005, the majority of the agricultural subsidies, previously linked to production, are combined into the SFP scheme. The value of the SFP to individual farmers depends on the Member State concerned and is based on historical entitlements, regional schemes and the different degrees to which premiums remain linked to production. This information, a priori, sets the conditions for the baseline projections up to 2015. Three sets of scenarios are termed “Further CAP reform” (FCR), “Exchange Rate Change” (ERC) and “EU Accession”.

5.1. Baseline scenario

The baseline projections with the AGMEMOD modelling system are based on the stand-alone country models. Output consists of supply balance sheets and market prices for the following agricultural commodities:

- soft wheat, durum wheat, barley, maize, rye, 'other grains';
- rapeseed, sunflower seed, soybeans, vegetable oils and meals;
- milk, butter, skimmed milk powder, cheese, whole milk powder;
- beef and veal, pork, poultry, sheep and goat meat.

The baseline is in line with the implementation of the Luxembourg Reform of June 2003 as follows:

- for the EU-15 and Slovenia, the individual choices in respect to:
    - the coupled measures, per commodity, in respect to the SFP Reform opportunities;
    - the use of regional/historical schemes for SFP calculations;
    - the introduction of the CAP Reform in 2005, 2006 or 2007;

- for the EU-10 except Slovenia, the policy reflects:
    - SAPS for the period 2004-2008;
    - the regional scheme for SFP calculations from 2009;
    - initial values for decouple multipliers;
    - no coupled measures.

In addition to these basic principles of the agricultural policy, the settings of the baseline scenario are determined by assumptions on trade agreements, world market prices and macro- economic developments. The AGMEMOD country models take into account the following assumptions:

- market access and subsidised exports approved within the Uruguay Round Agreement on agriculture (URAA);
- up to 2015, world market prices depend on FAPRI baseline projections;
- up to 2015, the $/€ exchange rate remains constant on 1.15;
- population growth per country depends on projections of Commission services (DG ECOFIN) and other internationally recognised sources (OECD Outlook);

- inflation rates and per capita economic growth per country, depend on projections of Commission services (DG ECOFIN) and other internationally recognised sources (OECD Outlook).

The 2003 CAP reform introduced the decoupling of direct payments from production, and the Single Payment Scheme (SPS). Introduction of this reform was not immediate. Implementation in the EU-15 is staggered over the period 2005 to 2007 depending on the Member States concerned. The implementation of the Luxembourg Agreement, across the Member States of the EU, is reflected in the AGMEMOD country level models.

Table 5.1 summarises the Baseline Assumptions for the key macroeconomic aggregates for the EU-15, EU-10 and EU-25 groups of Member States. Report II AGMEMOD – Member States Results, contains full details of the macroeconomic assumptions for each AGMEMOD country model. The exchange rate between the euro and the US dollar is a key macroeconomic factor, since it influences the euro value of the exogenous world prices used in the AGMEMOD model.

Table 5.1: Baseline Macroeconomic Assumptions

EU15	Unit	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Population	index (2000=1)	1.00	1.02	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.05	1.05	1.05
GDP	index (2000=1)	1.00	1.07	1.09	1.12	1.15	1.16	1.18	1.20	1.22	1.24	1.27	1.29
GDP per capita	index (2000=1)	1.00	1.05	1.06	1.09	1.11	1.12	1.13	1.15	1.16	1.19	1.21	1.23
Inflation	index (2000=1)	1.00	1.09	1.11	1.13	1.14	1.16	1.18	1.20	1.22	1.25	1.27	1.29

EU10	Unit	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Population	index (2000=1)	1.00	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.98
GDP	index (2000=1)	1.00	1.18	1.22	1.30	1.39	1.41	1.45	1.51	1.57	1.64	1.71	1.78
GDP per capita	index (2000=1)	1.00	1.19	1.23	1.32	1.41	1.43	1.47	1.53	1.60	1.67	1.75	1.82
Inflation	index (2000=1)	1.00	1.19	1.22	1.27	1.31	1.35	1.38	1.42	1.46	1.50	1.54	1.57

EU25	Unit	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Population	index (2000=1)	1.00	1.02	1.02	1.02	1.03	1.03	1.03	1.03	1.03	1.04	1.04	1.04
GDP	index (2000=1)	1.00	1.08	1.09	1.13	1.16	1.17	1.19	1.21	1.23	1.26	1.29	1.31
GDP per capita	index (2000=1)	1.00	1.06	1.07	1.10	1.13	1.14	1.15	1.17	1.19	1.22	1.24	1.27
Inflation	index (2000=1)	1.00	1.09	1.11	1.14	1.16	1.18	1.20	1.22	1.24	1.27	1.29	1.32

Source: AGMEMOD country models (2006)

Details of the assumptions concerning the future evolution of Member States population, economic growth (GDP growth) and inflation, are provided in each of the country sub-sections of the Report II AGMEMOD – Member States Results.

For the euro zone countries, the Baseline projections concerning evolution of the EUR/US dollar exchange rate is illustrated in Figure 5.1. Since AGMEMOD does not have capacity in this area, this exchange rate projection is sourced from internationally recognised macroeconomic forecasters. For non-euro zone countries, exchange rates between national currencies and the euro are given in the country sub subsections of the Report II AGMEMOD – Member States Results. The exchange rates between these national currencies and the US dollar, derive from their exchange rate with the euro and the Baseline EUR/US dollar exchange rate, so that projected exchange rates are consistent, without any possibilities for a triangular arbitrage.

The world agricultural commodity price projections exogenous to the AGMEMOD model have, in general, been taken from the *FAPRI 2006 US and World Agricultural Outlook.* The world livestock and grain prices are market prices from the US. Dairy commodity prices, oilseed, oilseed meal and oil prices are generally northern European prices. These world price projections are used under both the AGMEMOD Baseline and scenario simulations. Table 5.2 and Table 5.3 set out the Baseline projections of world agricultural commodity prices used in AGMEMOD.

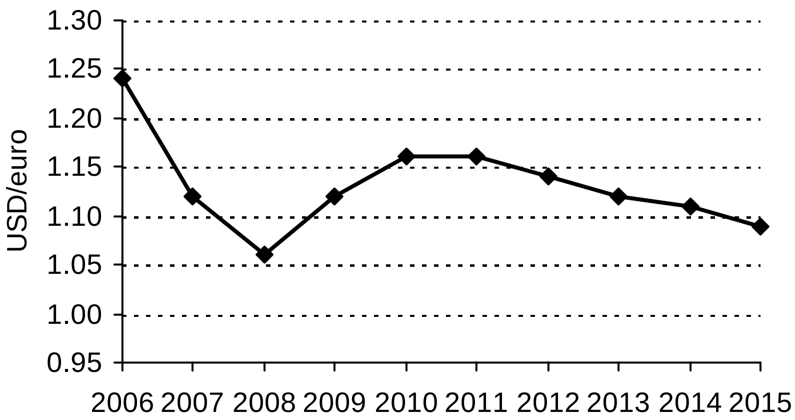

Figure 5.1: Baseline Exchange Rate
Source: FAPRI 2006 US and World Agricultural Outlook

Table 5.2: World Crop Price Projections used in the Baseline and Scenario Projections

Crops	Unit	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Wheat, U.S. Gulf	US$/tonne	161	157	162	164	168	171	173	175	176	177	178
Barley, U.S. Portland	US$/tonne	94	106	107	110	113	117	121	124	127	131	134
Maize, U.S. Gulf	US$/tonne	90	98	104	109	112	115	116	116	117	117	117
Rapeseed	US$/tonne	265	266	273	275	273	272	272	270	268	266	264
Rapeseed Cake	US$/tonne	120	123	125	125	126	126	126	127	136	135	134
Rapeseed Oil	US$/tonne	700	679	704	722	726	737	745	747	754	762	767
Soybean	US$/tonne	247	238	247	254	255	256	259	259	258	257	255
Soyameal	US$/tonne	197	185	190	191	189	189	190	188	186	183	180
Soybean Oil	US$/tonne	555	524	558	582	594	606	619	629	639	650	663
Sunflower seed	US$/tonne	282	290	303	306	306	306	306	306	303	299	296
Sunflower Meal	US$/tonne	113	118	123	122	121	121	120	119	116	113	110
Sunflower oil	US$/tonne	637	638	657	660	663	667	672	676	679	682	686

Source: FAPRI 2006 US and World Agricultural Outlook

Table 5.3: World Meat and Dairy Product Price Projections used in the Baseline and Scenario Projections

Livestock and Dairy	Unit	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Steers, Nebraska	US$/100kg	192	185	180	175	169	164	159	156	157	160	163
Hogs, U.S. 51-52% lean	US$/100kg	110	96	88	91	100	109	105	99	103	106	109
Broilers, U.S. 12-city	US$/100kg	156	144	138	136	135	135	135	136	136	137	137
SMP, FOB N. Europe	US$/100kg	220	198	204	210	213	213	215	215	216	216	216
WMP, FOB N. Europe	US$/100kg	229	207	213	223	225	224	228	230	232	234	234
Cheese, FOB N. Europe	US$/100kg	306	269	275	284	285	286	291	295	298	300	302
Butter, FOB N. Europe	US$/100kg	200	175	180	185	185	186	189	192	195	197	199

Source: FAPRI 2006 US and World Agricultural Outlook

For all simulations (Baseline and policy change scenarios) the world agricultural commodity price projections are assumed to be unchanged (in US dollars) from the Baseline levels. This reflects the current structure of the AGMEMOD model, where developments on EU markets are not assumed to have any impact on world price levels. This “small country” assumption is a feature of the AGMEMOD model, which is being revised as part of the research programme of another project.

Developments of world market prices are also presented in Figure 5. 2.

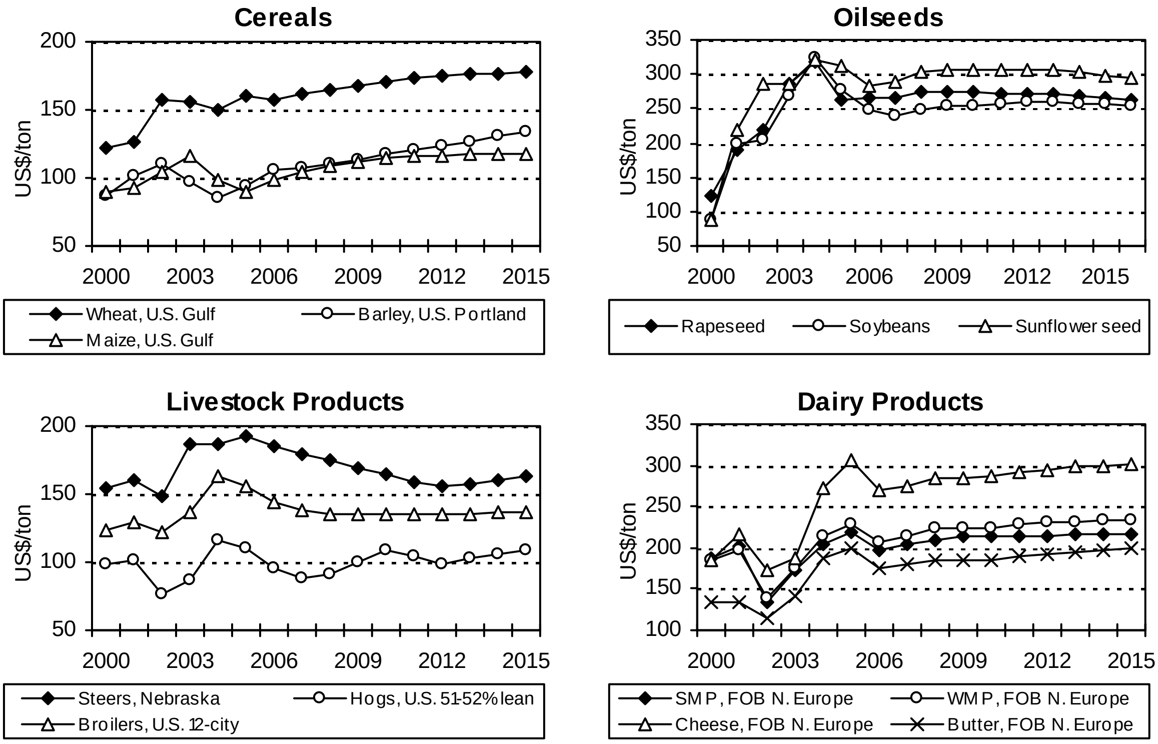

Figure 5.2: World market prices used in Baseline and Scenario Projections
Source: FAPRI 2006 US and World Agricultural Outlook

The purpose of the baseline scenario is to present a yardstick against which to measure the effect of policy changes that may be implemented.

5.2. 'Further CAP reform' Scenario

The following sections outline the motivation for the scenario analysis, assumptions and implementation in the country models.

Description and assumptions

The CAP as applied across the EU, following the reform of 2003, saw the decoupling of direct payments from production and the introduction of the Single Payment Scheme (SPS), sometimes referred to as the Single Farm Payment (SFP) scheme. The Member States of the 2004 enlargement (EU-10), with the exception of Slovenia (and Malta), were not supposed to adopt the SPS before 2007. Over the intervening period, the remaing eight Member States, will continue to operate the Single Area Payment Scheme (SAPS). On adoption of the SPS, these Member States will be allowed to "recouple" some direct payments to production, as is currently allowed in the EU-15 Member States and in Slovenia.

Under the further CAP reform scenario, the coupled direct payments modelled are:

- o in terms of the Luxembourg Agreement allowing continuation of certain coupled direct payments;
- o coupled complementary national direct payments allowed in Member States of the 2004 enlargement. These payments are modelled as decoupled from 2007 onwards.

In parallel with the decoupling of the remaining coupled direct payments, under the further CAP reform scenario, rates of compulsory modulation are doubled to 10% from 2007 onwards. The existing franchise of 5,000 Euro, under which the modulation

provisions do not apply, is considered.
The modulation provisions and cross compliance criteria are not applicable to EU Member States of the 2004 enlargement until the end of the transition period in 2013. At this time, the direct supports to agricultural income in these Member States will be increased to levels of other EU Member States. Thus, the modulation element of the CAP reform scenario will not apply in the 2004 enlargement Member States until 2013.

The different farm income support payment systems of the new CAP, such as the SPS and SAPS in EU-15 Member States, Slovenia and the remaining EU Member States respectively, have to be distinguished and reflected in the scenario analysed.

Further CAP reform in the Member States before the 2004 enlargement and Slovenia
The further CAP reform scenario examine the consequences of (1) requiring all Member States, from 2007 onwards, to fully decouple direct payments currently linked to agricultural production and (2) doubling the percentage compulsory modulation provisions of the Luxembourg Agreement.

Member States, when introducing the SFP, may preserve certain proportions of the Agenda 2000 direct payments coupled to agricultural production. These allowed coupled direct payments and the possibility of Member States to delay implementation of the SFP until 2007 introduced a considerable degree of diversity across the EU-15 and Slovenia. Under the CAP reform scenario, the implementation of the Luxembourg Agreement at national level is homogenised, so that from 2007 onwards, all direct payments in all EU Member States are decoupled from production.

In tandem with the introduction of the decoupled SFP, the Luxembourg Agreement also introduced the compulsory modulation of the SFP received by farmers, where the value of the SFP exceeded a threshold of 5,000 Euro. The rates of “compulsory modulation” are set out in the Luxembourg Agreement. These modulated funds were to be used to support CAP Pillar 2 measures.

With the accession of Bulgaria and Romania to the EU, and the full implementation of the CAP in these two countries, there was concern that the current EU budget for agriculture could not be sufficient within the terms of the financial disciplines, agreed for in the CAP. Thus, as part of the CAP reform scenario, the rates of compulsory modulation are doubled. The application of the increased compulsory modulation provision of the scenario, analysed in Slovenia, is deferred to until 2013. At this time the transition process will be completed and the direct aid to farmers in Member States of the 2004 Enlargement will be increased to the levels of the EU-15.

AGMEMOD Report II - Member States Results (AGMEMOD, 2008) describes how “decouple” direct payments, under the Luxembourg Agreement, have been applied by EU-15. There is a significant difference in how Member States have decoupled direct payments from production. Ireland, for example, has decoupled all of the historic Agenda 2000 direct payments, while France has decoupled direct payments from production to the minimum permited under the Luxembourg Agreement. This information gives an indication of how we can expect important changes in agricultural commodity prices, supply and use in the analysed scenario.

Further CAP reform in Member States of the 2004 enlargement except Slovenia
According to this scenario, the Single Area Payment Scheme (SAPS), rather than the Single Payment Scheme (SPS), will be maintained until at least 2007 in Member States of the 2004 enlargement (EU-10), except in Slovenia. EU-10 can adopt the SPS in 2007, and must switch to the SPS from the SAPS by 2009. All SAPS subsidies are applied on a hectare basis and are fully decoupled from production. Increases in SAPS payments (and subsequent SPS payments when introduced) will continue until equivalence is established with decoupled direct payments in EU-15 in 2013.

Over the transition period, during which EU-10 direct payments will reach levels of the EU-15, EU-10 may provide coupled direct payments financed from national budgets: the so-called complementary national direct payments. When the EU-10 countries leave the SAPS, they are obliged to adopt the regionalised version of the SPS. Under the Luxembourg Agreement, Member States may however, on adoption of the SPS, also introduce EU financed coupled direct payments, similar to those in EU-15. In the scenario analysis, it is assumed that the SPS is adopted in 2009 and that the SAPS prevails until 2008 in all EU-10 except in Slovenia and Malta.

Under the CAP, applied in the EU-10, the decoupled SAPS payments and coupled nationally financed direct payments would be expected to have different impacts on agricultural production. These different types of direct payments and their expected impact on agricultural production, are accounted for in the country level AGMEMOD models, see Report II AGMEMOD – Member States Results.

From 2007 onwards, under the further CAP reform scenario, all coupled direct payments and CNDP will be fully decoupled from production. This means that Member States will no longer be able to couple direct payments to production when switching from the SAPS to the SPS.

Annex 2 to this report, provides information on the agricultural policy implementation in EU-10. The SAPS and CNDP, are converted to synthetic payments per 100Kg of output added to the supply inducing producer price. Elements of the SAPS (and SPS) and CNDP are decoupled from production under the Baseline. Multipliers, similar to those employed in implementing the Luxembourg Agreement in the EU-15 models, are used. These multipliers reduce the supply inducing impact of payments decoupled from production.

Under the CAP reform scenario, all direct payments are fully decoupled and the effective supply inducing impact of the synthetic premiums, detailed in Annex 2 to this report, will be reduced. This indicates how decoupling of all direct payments from production, as envisaged under the CAP reform scenario, can have impacts on the agricultural commodity markets in these countries.

5.3. Implementation of SFP, SAPS and decoupling in country models

Due to the different direct payment models in the EU-15 and in the EU-12, except Slovenia, discussions differ on the method of implementing the CAP reform scenario.

The SFP and SAPS general provisions enabled the EU Member States to opt for exemptions from the rule of decoupling which was widely used by the Member States. Therefore, the Member States' regulations reflect a diverging picture of coupled and partial decoupled payments. More details concerning the countries' decisions are found in the AGMEMOD Report II – Member States Results. In the following section two schemes are set out covering the overall intention of the SFP and the SAPS and, at the same time, allowing a country-specific differentiation.

Method of SFP implementation in EU-15 and Slovenia
The Reform of the CAP agreed on in June 2003 led to a re-distribution of the EU support to farmers. Although direct aid payments exist since 1993, the SFP has been introduced since 2005 and it is paid independently to the type of agricultural production chosen by the farmers. Since the McSharry Reform in 1993, the agricultural support to farmers has been shifted from price support measures to direct payments such as arable land payments, special beef and suckler cow premiums, ewe premium payments, etc. These payments remained in force until the end of 2004 and even continue, to a lesser extent, in some of the Member States under the new SFP 'partial decoupling' provisions. Direct payments are more transparent than the market support and intervention mechanisms, they offer to link income support to the provision of public goods and are classified in the WTO's Green Box. This means that they are exempt from reduction commitments under the WTO rules. The scheme was formally adopted as EU Regulation 1782/2003 and published in Official Journal L 270 of 21 October 2003. The decision was supplemented by a similar reform package, covering 'Mediterranean' products (tobacco, olive oil and cotton) approved on 22 April 2004 as Regulation 864/2004, published in Official Journal L 161 of 30 April 2004.

The main regulations are as follows: The SFP was enacted on 1 January 2005. Aid is payable to all eligible producers independent to the actual production. Nevertheless, receipt of the SFP depends on fulfilment of certain "cross-compliance" environmental conditions. Member states could delay implementing the SFP until 2007. The SFP is based on premiums received by farmers in the period 2000-2002. Maximum ceilings for total aid payments have been implemented for each Member State. Farmers' entitlements are defined by average of CAP receipts during the period of reference and dividing it by the average of hectares, entitled to direct payments. The SFP is only paid if the farmer holds the number of eligible hectares. Slightly different arrangements apply for integration into the SFP regime of direct aid payments to dairy producers implemented in 2004 and paid per tonne of milk quota. The premium is increased in the period 2004-2006, to compensate for the cut in the intervention prices. In principle, dairy payments may remain separate from the SFP until 2007. However, Member States were required to incorporate the dairy premium into the SFP at an earlier date. In this case, the overall entitlements were adjusted upwards in 2005 and 2006 to cover 'coupled' dairy premiums. Entitlements may be transferred with or without land, therefore these do not have to correspond to the same parcel of land to enable payment but only to the SFP-eligible hectares.

With the implementation of the SPS, most direct payments under the CAP have been decoupled from agricultural production, linked to agricultural land, made on condition to farmers engaging in good farming practices and on satisfaction of a cross-compliance criteria. This raises two important points of concern to this study:

- the receipt of the 'production decoupled' direct payments will continue to affect farm level production in a certain extent;
- nationally differentiated implementations of the decoupling provisions of the Luxembourg Agreement have taken place across the EU. Accordingly, EU Member States have been allowed to maintain the link between certain direct payments and agricultural production.

The above concerns motivated the introduction of the SPS in the AGMEMOD model allowing for a supply inducing impact of the decoupled payments, as well as the nationally differentiated implementation of the 2003 CAP reform.

In this study of the AGMEMOD model these concerns are addressed through the introduction of a set of countries, commodities and time specific multipliers, DEC(x,c,t), used to derive synthetic premiums, PREMS(x,c,t), that exogenously affect the level of agricultural production simulated in the AGMEMOD MS models. The following information is assembled for each country:

- Direct payments per hectare or per animal (PREMREF) and the associated entitled hectares and animal numbers (HANREF) for commodity *x* and country *c* in the period of reference 2000/02 (i.e. under the Agenda 2000 CAP);
- National supplements for commodity *x* and country *c*, provided to (new) farmers unable to establish eligibility in the period of reference 2000/02 (i.e. Slovenia);
- Coupling rates (CR) for commodity *x* in country *c* in year *t* up to 2015 (allowing for the differential implementation of the CAP, due to the possibility of retaining certain coupled direct payments);
- Total hectares of agricultural land, including grassland use for animals, coupled to payments (CLA) in country c in the period of reference 2000/02;
- Total hectares of agricultural, horticultural, forage and grassland (TOTLA) in country *c* in the period of reference 2000/02;
- The proportion of the SFP, namely 3% for 2005, 4% for 2006, and then 5% annually, to be deducted from farmers and channelled into a new fund for rural development measures (compulsory modulation). In order not to penalise small farms, the first 5,000 Euro are exempted from modulation taken into account in CMOD (c,t);
- The voluntary financial degression rates in country *c* in year *t* up to 2015, denoted as VMOD (c,t).

Annex 1 details variables of derivations and calculations of the DEC(x,c,t) multipliers and the associated PREMS(x,c,t).

The multiplier DEC(x,c,t) is defined as

*DEC(x,c,t) = CR(x,c,t) + MULT1(x,c,t)*MULT2(c,t)* MULT3(c,t)*

Where *x* is an index over the commodities modelled in the AGMEMOD model, *c* is an index over the countries modelled and *t* is a time index.

CR(x,c,t) are commodity, country and time specific coupling coefficients covering the degree to which a particular Member State has decoupled historic (Agenda 2000) direct payment instruments, applying to the production of product *x* at time *t*.
With full decoupling of a direct payment *CR(x,c,t)* = 0, with partial decoupling where, for example, a MS is allowed to retain 25% of the value of the historic direct payment coupled to production, then *CR(x,c,t)* = 0.25.

MULT1(x,c,t) is a commodity, country and time specific multiplier that reallocates the proportion of the historic direct payment that enter the SPS payment, across all agricultural land. This reflects an assumption, within the current AGMEMOD model, that decoupled direct payments are paid on a flat rate across all agricultural land and not only the land on which direct payment entitlements were established.

Thus *MULT1(x,c,t)* is defined as

$$MULT1(x,c,t) = [1-CR(x,c,t)]*[CLA(c)/TOTLA(c)]$$

where *CR(x,c,t)* is as previously defined, *CLA(c)* is the total land area on which direct payments were established and *TOTLA(c)* is the total agricultural land area in country *c* in the period of reference (2000 to 2002).

Since the area on which direct payment entitlements were established is lower than the total agricultural area of the MS, this ratio will, for all MS, models be less than one. The size of the ratio *CLA(c)/TOTLA(c)* varies considerably across Member States (see Table 5.4, column 2). This heterogeneity reflects the different degrees to which coupled direct payments to flat area payments SPS would lead to in the redistribution of subsidy incomes. In Member States, (such as for example in Ireland, where most agricultural land in the period of reference was associated with coupled direct payments commodity production) the *CLA(c)/TOTLA(c)* ratio will be very close to 1. In MS (such as for example Spain), with more diverse land use patterns, and with agricultural production activities, not associated with the receipt of coupled direct payments, in the period of reference, the ratio will diverge significantly from 1.

The country and time specific multiplier *MULT2(c,t)* covers the impact of the compulsory modulation provisions of the Luxembourg Agreement, whereby all single farm payments over 5,000 Euro are modulated or taxed. The multiplier also allows inclusion of the impact of a MS government implementing the voluntary modulation of the SFP paid to farmers. Thus MULT2 is defined as

$$MULT2 = 1- [CMOD(c,t) + VMOD(c,t)]$$

where *CMOD (c,t)* is the rate of compulsory modulation, under the Luxembourg Agreement, and *VMOD(c,t)* is the rate of voluntary modulation introduced in country *c*.

While the provisions of the Luxembourg Agreement do not allow for any differences in MS's implementation of compulsory modulation or for the proportion of farmers in different MS with SPS payments above the 5,000 Euro threshold, this means that the rate of compulsory modulation used in each MS AGMEMOD model varies after accounting for the proportion of farmers not subject to compulsory modulation.[3] Column 3 of Table 5.4 sets out the reallocation of decoupled payments across the Member States, according to the compulsory and voluntary modulation rates (*MULT2* effect).

The final element of the *DEC(x,c,t)* multiplier is the term *MULT3(x,c,t)*. This term attempts to cover the extent to which decoupled payments received by farmers are not necessarily invested in agriculture or affect agricultural production decisions as fully coupled direct payments.

There are various motivations for inclusion of the term *MULT3(x,c,t)* and range from:

[3] Henke and Storti (2004) present data from a European Council working party document illustrating the wide variation in the proportion of farms subject to compulsory modulation across EU Member States. These data indicate that over 70% of Greek farms will not be subject to compulsory modulation while less than 15% of UK farms fall below the EUR 5,000 threshold.

- the expected decrease in the proportion of land owned by farmers and the concomitant leaking of SFP via land rents to the non-agricultural economy;
- the possibility of farmers of not having to relate some or all of their decoupled payment receipts to their ongoing agricultural production activities.

The rates used in the different stand alone AGMEMOD country models differ across commodities as capital invested in different agricultural systems is not uniform. In general, assets in the production of arable crops are considered more illiquid than those used in animal production systems. An example of this is found typically in crop production, land and machinery given these are less likely to be convertible to other forms of agricultural production, particularly in the short term. The degree of variation in the value of *MULT3(x,c,t)* across different MS is limited. Thus, the major source of heterogeneity in the *DEC(x,c,t)* variables across EU-15 arises from the degree to which MS have chosen to fully decoupled payments(as reflected in the CR(x,c,t) variable), the value of *MULT1(x,c,t)* and *MULT2(x,c,t)*.

For all countries c, for all commodities x, and for all time periods t, $MULT3(x,c,t) \leq 1$.

Columns 4 and 5 of Table 5.4 set out the reallocation of decoupled payments across the Member States, according to a shift of subsidies from highly supported sectors to the general non-agricultural economy (*MULT3* effect).

In calculating the synthetic premiums, *PREMS(x,c,t)*, that are used in the implementation of the 2003 CAP reform in the AGMEMOD model, the historic CAP direct payment rates per animal, per hectare or other unit of production in the year of reference, *PREMREF(x,c)*, are multiplied by the appropriate commodity multiplier DEC(x,c,t).

$$\begin{aligned}
PREMS(x,c,t) &= PREMREF(x,c) * DEC(x,c,t) \\
&= PREMREF(x,c) * \left(CR(x,c,t) + MULT1(x,c,t) * MULT2(c,t) * MULT3(x,c,t)\right) \\
&= PREMREF(x,c) * \begin{pmatrix} CR(x,c,t) + \\ (1 - CR(x,c,t)) * \left[\dfrac{CLA(c)}{TOTLA(c)}\right] * [1 - CMOD(c,t) - VMOD(c,t)] \\ * MULT3(x,c,t) \end{pmatrix}
\end{aligned}$$

If a particular direct payment, under the national level implementation of the Luxembourg Agreement, has remained fully coupled, then this term simplifies to PREMREF(x,c). When the direct payment is fully decoupled, the term simplifies to:

$$PREMS(x,c,t) = PREMREF(x,c) * \left(\left[\frac{CLA(c)}{TOTLA(c)}\right] * [1 - CMOD(c,t) - VMOD(c,t)] * MULT3(x,c,t)\right)$$

The last two columns of
Table 5.4 reflect the historic direct premiums remaining ‘in the minds of the farmers’ when determining their production plans if full decoupling. These so called supply inducing multipliers, refer to crop sectors and livestock sectors respectively. Multiplier rates range from 19% for crops in Belgium (i.e. Belgium farmers will behave as if they

were receiving a premium of 12 €/tonne grains - 0.19*63 €/tonne grains - in 2015) to 57% for livestock sectors in Ireland (i.e. Irish farmers will behave as if they were receiving a premium of 120 €/bull - 0.57*210 €/bull - in 2015).

Table 5.4: Total supply inducing multiplier impacts of decoupled payments in EU-15 and in Slovenia, up to 2015

	Land re-allocation	Modulation in 2015	Exit from crop sectors	Exit from livestock sectors	Multiplier rate[1)] for crops	Multiplier rate[1)] for livestocks
Austria	11%	25%	60%	40%	27%	40%
Belgium	51%	3%	60%	40%	19%	29%
Denmark	18%	4%	60%	40%	31%	47%
Germany	11%	16%	60%	40%	30%	45%
Spain	36%	15%	60%	40%	22%	33%
Finland	30%	2%	60%	40%	27%	41%
France	8%	15%	60%	40%	31%	47%
Greece	8%	14%	60%	40%	32%	48%
Ireland	0%	5%	60%	40%	38%	57%
Italy	43%	15%	60%	40%	19%	29%
The Netherlands	8%	25%	60%	40%	28%	41%
Sweden	0%	15%	60%	40%	34%	51%
Portugal	20%	5%	60%	40%	30%	46%
Slovenia	11%	5%	60%	40%	34%	51%
UK	5%	5%	60%	40%	36%	54%

1) Multiplier rate = (1 - land reallocation rate)*(1 - modulation rate)*(1- exit rate)

Source: own calculations

The ‘quota’ commodity milk falls under the SFP scheme, but needs a somewhat different approach to that for crops and livestock. Dairy payments are paid to each dairy producer per tonne of milk quota since 1999 and they were annually increased over the period 2004-2006 to compensate for intervention price cuts. In the study, this payment is modelled as a lump sum income transfer, only integrated in the agricultural income calculation and not included in the calculation of PREMS variables. However, the value of the lump sum dairy compensation payment is subject to the modulation provisions (compulsory and voluntary) applied to other decoupled payments via the PREMS variables’ calculation. This assumption that the dairy compensation component of the Single Farm Payment has no supply inducing impact, introduces an important difference between the treatment of the decoupled dairy direct payments and other direct payments. Future research will examine alternative means of representing the probable supply inducing impact of the decoupled dairy compensation payments.

Under the Baseline, decoupled direct payments are assumed to have a supply inducing influence on agricultural production. This supply inducing impact is, however, less than that of coupled direct payments. The assumption that decoupled direct payments have some supply inducing impact is based, in part, on the fact that direct payments require some continued involvement as an agricultural producer; satisfaction of good farming practices and other cross compliance criteria. In addition, there are well established theoretical arguments based on the wealth effects of such transfers and the impact of increases in wealth on the production behaviour of risk avers agricultural producers (Hennessy, 1998). Empirical research examining the impact of direct payments on agricultural production behaviour is an active research area. Models such as the AGMEMOD model, are not designed to provide significant insights into such questions, but must reflect the aggregate demand for and supply of agricultural commodities and the probable ongoing incentives that such payments provide European farmers. Other partial equilibrium models of the EU agricultural sector that have analysed the impact of decoupling, such as the FAPRI-Ireland model (Binfield et al., 2003) and the AGLINK model (OECD, 2004), have used similar assumptions as those concerning the ongoing supply inducing impact of production decoupled direct payments.

The scenario analysis examines the elimination of the partial decoupling provisions of the Luxembourg Agreement. Ceteris paribus, it is expected that EU agricultural commodity prices will be somewhat higher compared to the Baseline analysis covering the medium term. Compared to the Baseline levels, it is expected that with full decoupling in all EU Member States, levels of agricultural activity and volume of agricultural production will be lower. Given the model assumptions concerning the supply inducing impact of decoupled direct payments, the effects on EU agricultural commodity market supply balance are not expected to be dramatic. This expectation is reinforced by Report II AGMEMOD – Member States Results which illustrates the degree to which most Member States have already chosen to fully decouple direct payments, under their current national implementation of the 2003 CAP reform.

The CAP reform scenario is analysed using the stand alone country models. This requires projections for commodity key prices to be provided so as to enable the simulation of country level commodity models where for commodity *x,* country *y* is not the key price country (the most important commodty market in the EU) in the AGMEMOD modelling framework. To provide these key price projections the stand alone country models, which are associated with key prices in the AGMEMOD modelling framework, are simulated in combined mode under the CAP reform scenario. The key price projections generated, are provided in the form of MS Excel spreadsheets for use in the simulation of the CAP reform scenario, with stand alone country models, by other project participants. The "key price countries" are France, Germany, Ireland, Italy, and the Netherlands. Commodity prices exogenously determined in the combined AGMEMOD model remain exogenous in the performance of the CAP reform scenario analysis.

Implementation in other EU-12 except in Slovenia
In this study, the single area payment scheme (SAPS) is planned to be maintained for the EU-12 until 2007 and additional direct payments are supposed to be maintained until the end of 2008. The SAPS, which have been mostly decoupled from 2004, are based on the farm area and a flat rate aid payment on national levels (including fruits and vegetables, potatoes, etc.). All subsidies are applied on a hectare basis. For crop production, the assumption on hectare payments could be taken into account. For livestock, a specific mechanism could be adopted as a variation on the basic price mechanism. Calculations are made on the share base, either on the proportion of Gross Agricultural Output represented by the commodity in the year of reference (2001), or over the number of animals and livestock density. Thus, area payments are not endogenous and are calculated outside the model. A 'SAPS per hectare' quotient is derived by dividing the financial budget from the EU (agreed in the accession negotiations) and by the utilised agricultural area.

When an EU-12 country leaves the SAPS, it is obliged to adopt the regionalised version of decoupling within the full EU SFP scheme, but is also permitted to apply partial decoupling. In addition, there were several options for implementing the CAP in the EU-12, designed to ease their transition to a market economy. In particular, decoupled direct payments were gradually phased-in over the first ten years since 2004 from 25% in 2004 and to 100% of the full EU-15' payments in 2013. Cross-compliance criteria were not compulsorily applied in the EU-12 countries, and they had the possibility of topping-up direct payments with national funds.

Direct payments, which are coupled to different degrees under the various specific schemes, will impact the market in different extents. When payments are decoupled, some of the supply inducing effect could be retained. This is taken into account in the AGMEMOD models using multipliers. On the longer term, a uniform approach is applied in respect to policy implementation in the EU-12 models. This approach is based on multiplier rates that are country, commodity and time dependent (as applied to the EU-15). For this study, however, just a few different multiplier levels are used to assess the impact of direct support on production:

- 0.3 for SAPS until 2009, paid per hectare or per animal;
- 0.6 for complementary national direct payments per hectare or per head which are not fully coupled to production;
- 1.0 for the complementary national direct payments per hectare or per head which are fully coupled to production;
- 0.3 for SFP from 2009, paid per hectare or per animal.

Actually, the policies operating before and after accession are handled in the models using the same policy variables. On the longer term, a subsidy per unit value of production is calculated and added to the producer price (or to the expected gross returns) creating a synthetic price construction – described as a 'basic price'. Basic prices reflect changes in nature and value of the support given to agriculture. For the period before accession, the direct payments included in the PSE calculations were used to determine the subsidy values.

Under the FCR scenario, the SAPS is applied for a period following accession for all EU-12 except for Slovenia. The SAPS payments are fully decoupled and are paid on the basis of farm area and a flat rate per hectare in each Member State. CNDP may be paid as coupled or decoupled aid payments.

In the Baseline version of the AGMEMOD EU-12 agricultural sector models, SAPS payments and the nationally financed complementary direct payments (if decoupled), are assumed to have some supply inducing impact on agricultural production, though this impact is less than the impact of coupled payments or prices.

The supply inducing impact of different types of payments is covered by deriving synthetic premiums, added to the producer incentive prices (in euro per 100Kg) in the country models. Thus, the decisions on supply made by producers are a function of market prices and synthetic premiums based on the SAPS and CNDP payments. Different multipliers are used to cover the possibly different supply inducing impact of the SAPS and CNDP payments (if for example the latter are coupled to production).

The synthetic premiums for arable crops associated with the SAPS payments, in euro per 100Kg, denoted as $PREMSAPS_{i,c,t}$ are calculated in the following way:

$$PREMSAPS_{i,c,t} = \left(\frac{SAPS_{c,t}}{TOTLA_{c,REF}}\right) * \left(\frac{AHA_{i,c,REF}}{SPR_{i,c,REF} * 10^5}\right) * MULT4_{i,c,t}$$

Where $SAPS_{c,t}$ is the total projected SAPS expenditure in a new MS c in year t, $TOTLA_{c,REF}$ is the total land area in that particular MS in the base year (2004), $AHA_{i,c,REF}$ is the total area harvested of the i^{th} crop in the MS c in the year of reference, and $SPR_{i,c,REF}$ is the production of the i^{th} crop in the year of reference in the MS concerned. The volume of production (expressed in thousands of tonnes) is scaled up, so as to generate the premium per 100Kg which can be added to the producer incentive prices, expressed per 100kg in the AGMEMOD country models. As in the calculation of the synthetic premiums in the EU-15 country models, country, product and time specific multipliers ($MULT4_{i,c,t}$) are used to account for the supply inducing impact of the synthetic SAPS premiums on agricultural production. As in EU-15 country models, the value of these multipliers are based on the expert judgements of the country modelling teams, for all countries and for all commodities the value of $MULT4_{i,c,t}$ <1.

Table 5.5 sets out the hypothetical EU SAPS premia remaining 'in the minds of the farmers' across new Member State countries (MULT4 effect).

Table 5.5: Total supply inducing multiplier impact of SAPS payments in New Member States up to 2015 (MULT4)

	SAP scheme (2004-08)		SPS scheme (2009-15)	
	Crops	Livestock	Crops	Livestock
Bulgaria	50%	50%	50%	50%
Czech Republic	97%	97%	84%	84%
Estonia	100%	100%	84%	84%
Hungary	60%	10%-60%[a)]	60%	10%-60%[a)]
Latvia	30%	100%	30%	100%
Lithuania	30%	30%	30%	30%
Poland	30%	30%	30%	30%
Romania	50%	50%	50%	50%
Slovak Republic	15%	15%	15%	15%

a) 60% for suckler cows; 10% for cattle

Source: own calculations

Calculations of the SAPS synthetic premiums applying to meat products are obtained in a slightly different way to those for arable crops. The share of total livestock units in the year of reference associated with the i^{th} meat product, multiplied by total grassland area in the year of reference ($PA_{c,REF}$), is used together with the average per hectare SAPS premium and total production of the meat in question, to generate the synthetic SAPS premium per 100Kg of meat.

$$PREMSAPS_{i,c,t} = \left(\frac{SAPS_{c,t}}{TOTLA_{c,REF}}\right) * \left(\frac{\left(\frac{LU_{i,c,REF}}{\sum_j LU_{j,c,REF}}\right) * PA_{c,REF}}{SPR_{i,c,REF} * 10^5}\right) * MULT4_{i,c,t}$$

CNDP are allowed in EU-12 in the transition process, during which farm income support payments in the EU-12 are increased to the levels of the EU-15. These CNDP can be coupled to production or decoupled from production. The method of calculating the per 100Kg synthetic premiums ($PREMCNDP_{i,c,t}$) associated with the CNDP, is the same as that used in the calculation of the premiums associated with SAPS payments except that the multiplier ($MULT5_{i,c,t}$) differs to account for the possibility that the CNDP may be fully coupled to production. The degree to which EU-12 have chosen to introduce coupled and decoupled CNDP, varies by MS and between different commodities within each new MS.

$$PREMCNDP_{i,c,t} = \left(\frac{CNDP_{c,t}}{TOTLA_{c,REF}}\right) * \left(\frac{AHA_{i,c,REF}}{SPR_{i,c,REF} * 10^5}\right) * MULT5_{i,c,t}$$

$$PREMCNDP_{i,c,t} = \left(\frac{CNDP_{c,t}}{TOTLA_{c,REF}}\right) * \left(\frac{\left(\frac{LU_{i,c,REF}}{\sum_j LU_{j,c,REF}}\right) * PA_{c,REF}}{SPR_{i,c,REF} * 10^5}\right) * MULT5_{i,c,t}$$

In the EU-12 models applied in this study, a few different multiplier levels are used in order to assess the impact of direct support on production. *Table 5.6* sets out the hypothetical national CNDP premiums remaining 'in the minds of the farmers' across New Member State countries (MULT5 effect).

Table 5.6: Total supply inducing multiplier impact of CNDP in New Member States, 2015 (MULT5)

	SAP scheme (2004-08)		SPS scheme (2009-15)	
	Crops	Livestock	Crops	Livestock
Bulgaria	50%	50%	50%	50%
Czech Republic	100%	100%	100%	100%
Estonia	100%	100%	84%	84%
Hungary	10%	10%	100%	100%
Latvia	60%-100%[a)]	100%	30%	100%
Lithuania	80%	100%	30%	30%
Poland	60%	60%	60%	60%
Romania	50%	50%	50%	50%
Slovak Republic	15%-50%[b)]	15%-50%[b)]	15%-50%[b)]	15%-50%[b)]

a) 60% for fodder; 100% other crops; b) 15% for decoupled payments; 50% for coupled payments

Source: own calculation

The synthetic premiums (per 100kg) associated with the SAPS and CNDP, are added to the producer incentive prices which drive the supply of the EU-12 agricultural commodity models.

Under the Further CAP Reform scenario, all direct payments (including CNDP) are fully decoupled from production and are incorporated in the SPS (SAPS) payment. For the EU-12 models, this effectively means that the distinction between CNDP and the fully decoupled SAPS and SPS payments disappears, i.e. $MULT5_{i,t} = MULT4_{i,t}$. With the adoption of the SPS under the further CAP reform scenario the possibility of introducing coupled direct payments will no longer exist.

In addition to the decoupling provisions of the scenario, from 2013 all EU-12 will have completed the transition process, under which the value of EU funded agricultural supports will have been increased. From 2013 EU-12 are obliged to introduce the modulation. Thus the multiplier MULT4 will also incorporate the effective rate of compulsory modulation (and it's doubling under the further CAP reform scenario). As in the models for other MS, the applied modulation factor is adjusted to reflect the extent to which farmers, in the MS concerned, on average receive SFP over the 5,000 Euro franchise. This can be expected to vary widely between EU-10, see Henke and Storti (2004).

Ceteris paribus, the full decoupling of direct payments under the Further CAP Reform scenario" can be expected to lower the value of the synthetic premiums added to the producer incentive price. The degree to which this occurs depends on whether EU-12 planned to introduce coupled direct payments on adoption of the SPS and whether their CNDP were coupled or decoupled from production.

As in the analysis of the Further CAP Reform scenario with the EU-15 models when run in stand alone mode, key price projections are necessary to simulate the impact of the Further CAP Reform scenario. The same CAP reform key price projection MS Excel spreadsheet file, provided to those simulating stand alone AGMEMOD country models for the EU-15 is provided to modelling teams from the EU-12.

5.4. USD/EUR exchange rate Scenario

The scenario (sensitivity analysis) involves the impacts of three shocks in the USD/EUR exchange rate on the agricultural commodity markets in the EU. The description, assumptions and motivation for this scenario analysis, as well as its implementation in the country models are outlined in the following sections.

Description and assumptions

The exchange rate between the US dollar and the euro is an important factor in determining the influence of world prices of agricultural commodities on EU agricultural markets and the competitiveness of EU agricultural exports to world markets. Thus, it is important to evaluate, using the AGMEMOD model, the impact of changes to the US dollar against the euro exchange rate that could merge over the 10 year projection period of the AGMEMOD model.

Under the Baseline, the macroeconomic assumptions underlying the AGMEMOD model were described. The Baseline's data on the evolution of the US dollar against the euro exchange rate foresaw an exchange rate of US$ 1.15 per euro from 2007 onwards. In evaluating the impact of changes in this key macroeconomic assumption, three alternative paths of the US dollar against the euro are analysed. Two of these exchange rate projections involve a depreciation of the US dollar against the euro, with the exchange rate moving to rates of 1.3 and 1.4 US dollar per euro in 2007. The third alternative exchange rate projection examined is one under which the euro depreciates against the dollar, with the exchange rate in 2007 to a parity exchange rate of US $ 1 per euro.

Figure 5.3 illustrates the Baseline projection of the US dollar exchange rate against the euro and the three alternative exchange rate paths to be analysed.

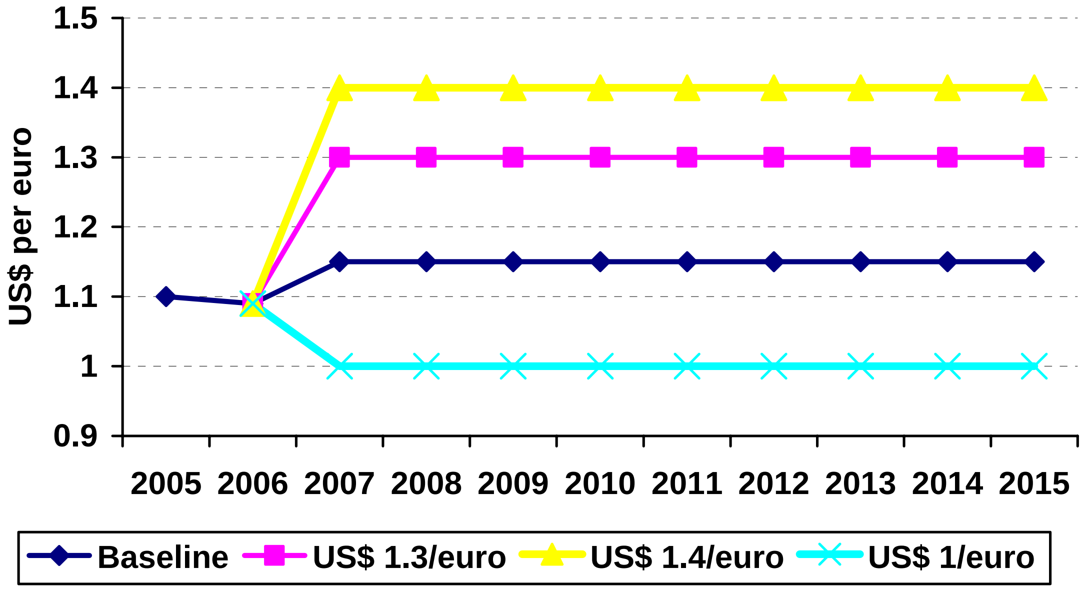

Figure 5.3: US$/euro exchange rate projections

Due to the fact that some countries within the EU have not adopted the euro as their national currency, additional assumptions can be made regarding the evolution of their national currency exchange rates against the US dollar. In each of the scenarios analysed the exchange rate between the relevant national currency and the euro is assumed to be equal to that under the Baseline. This assumption, by construction, implies a path for the national currency's exchange rate against the dollar under each of the three alternative US dollar euro exchange rate scenarios. This is because given *n* exchange rates, only *n-1* exchange rates are independent. Annex 3 of this Report presents the Baseline exchange rates between the euro and the dollar, and between the remaining national currencies of the EU (and accession states) and the US dollar. In Annex 4 the sets of national currency exchange rates against the US dollar that are associated with the different scenarios are presented.

Implementation in country models

The implementation of the exchange rate shock scenario is achieved by modifying the exchange rate used in each stand alone country model, from 2007 onwards and the key price data set that each stand alone country model uses.

The exchange rate between the US dollar and the euro affects prices in the AGMEMOD model in two ways. Firstly a change in the euro dollar exchange rate affects the AGMEMOD model projections through its impact on the key price for a given commodity. Secondly, it affects the projections of the AGMEMOD model through impact on the value in national currency terms of the exogenous dollar world prices. These are prices in the model to which producers respond when the commodity price is exogenous (this is the case for most oilseed and oilseed derived products in the AGMEMOD model).

The impact of a change in the exchange rate between the dollar and the euro on the key price can be seen from the general form of the key price determination equation.

$$Kp_{i,t} = f\left(Wp_{i,t} * EXRD_t, EIp_{i,t}, Kp_{i,t-1}, Essr_{i,t}, V\right)$$

where $Wp_{i,t}$ is the corresponding world price in US dollars, $EXRD_t$ the exchange rate of euro per US dollar, $EIp_{i,t}$ the corresponding EU intervention price in euro, $Essr_{i,t}$ is the EU self-sufficiency rate for commodity *i*, and V is a vector of other exogenous variables that could affect the key price, such as tariff rate quota levels and subsidised export limits.

A changed key price projection for commodity *i* in turn affects the price, that determines supply and demand, for that commodity in countries other than the key price country. This can be seen from the general form of the price linkage equation for non-key price countries

$$p_{i,t} = f\left(Kp_{i,t} * EXRE_t, p_{i,t-1}, ssr_{i,t}, Kssr_{i,t}, V\right)$$

where $p_{i,t}$ is the national price in national currency of commodity *i* in year t, $EXRE_t$ is the exchange rate between national currency and the euro, $Kp_{i,t}$ is the key price of commodity *i* in year t (in euro), $ssr_{i,t}$ is the self sufficiency ratio (domestic use divided by production) for commodity *i* in the country concerned, $Kssr_{i,t}$ is the self sufficiency rate, for the same commodity in the key price market, and V is a vector of exogenous variables which could have an additional impact on the national price. Where the country concerned is not part of the euro zone then, the term $EXRE_t$ will differ from one. For all euro-zone countries modelled, the exchange rate between their national currency (the euro) and the euro is of course set equal to one.

When the price of a given commodity is not endogenously modelled in the AGMEMOD modelling system, the supply and demand relationship in all country models are functions of the exogenously determined world price. This is the case, for example, for oilseeds and oilseed meals.

The projections of these prices and their equivalent values when expressed in euro (or other national currency) are a function of their level in US dollars and the value of the exchange rate used to translate these prices into national currencies. Each stand-alone country model exchange rate between the dollar and the relevant national currency, are adjusted to reflect the assumptions concerning the evolution of the US dollar exchange rate from the period 2007 onwards.

Annex 3 and Annex 4 provide details of the exchange rate assumptions used in the simulation of each country's stand alone AGMEMOD model in the exchange rate shock analysis scenario. These alternative exchange rate projections, together with relevant key prices determined endogenously, are used to produce simulations of their impact on the different stand-alone AGMEMOD country models.

5.5. EU Enlargement scenario

The accession of Bulgaria and Romania to the EU is analysed as an EU enlargement scenario. The focus of this scenario is put on the adoption of the CAP (SAPS) by Romania and Bulgaria and its impact on their agricultural sectors. This section describes the assumptions of the scenario analysed, outlines the motivation for this analysis and its implementation in the country models.

Enlargement of EU with Bulgaria and Romania

At the Brussels Summit in 2004 it was agreed that Bulgaria and Romania accede to the EU in January 2007, with the possibility of a year delay if the countries were not ready for accession.

The agricultural chapter of the Bulgarian and Romanian accession agreement determines the CAP as it applies in Bulgaria and Romania following accession. The general conditions for direct payments and other CAP related issues are the same as those agreed in the EU Enlargement in 2004 involving other CEEC countries. Bulgaria and Romania will gradually phase in EU agricultural direct payments between 2007 and 2016. Direct payments start at 25% in 2006, 30% in 2007 and 35% in 2008 of the initial system and increase by 10% steps to reach 100% of the then applicable EU level in 2016.

On accession Bulgaria and Romania adopt the Single Area Payment Scheme (SAPS). The SAPS provides a flat-rate per-hectare payment to farmers paid once per year, irrespective of the crops produced or even whether any crops are produced at all. The only requirement is that the land is maintained in good agricultural and environmental conditions. The SAPS payments per unit (i.e. hectare) paid in Bulgaria and Romania is calculated as in EU-10, by dividing the country total amount of direct payment funds available (negotiated) divided by the total amount of eligible agricultural area. Each farmer with eligible area receives the same per hectare payment.

Within carefully defined limits, all EU-12 (including Bulgaria and Romania) have the option to "top-up" EU funded direct payments with national subsidies. Over the period 2007-2009, Bulgaria and Romania thus have the possibility to top-up EU direct payments to

- Either 55% of EU level in the year 2007, 60% in 2008 and 65% in 2009. From 2010, the acceding countries may top-up EU direct payments by 30 percentage points above the applicable phasing-in level in the relevant year or;
- The total level of direct support the farmer would have been entitled to receive, on a product by product basis, in the new Member State prior to accession like national scheme, increased by 10 percentage points.

Under the accession agreements Bulgaria and Romania are allowed to apply SAPS for up to 3 years after accession, and the EU-25 will preserve the right to extend this for a further period if deemed necessary. However, like for other EU-10, full cross-compliance rules should apply at the end of 3 years regardless of whether SAPS or the SPS is applied from then on.

Individual national models upgraded and migrated to GAMS are used to produce simulation results of their accession to the EU. Therefore the enlargement scenario reflects a situation in which the accession effects of Bulgaria and Romania are demonstrated, in particular the adoption and implementation of SAPS on their agricultural markets over the models' projection period 2007-2015.

The enlargement scenario takes into account the above described gradual rising of direct payment level and the possibility of nationally funded top up CNDP. It is assumed that the 2003 CAP reform which introduced the SPS and which sets out a time-table for the adoption of the SPS by all EU-25 Member States, will not be implemented in Bulgaria and Romania following their accession. Rather in the enlargement scenario it is assumed that their agricultural policy will be determined by SAPS up to 2015, with the possible addition of nationally finances complementary direct payment aids. As in the models of the agricultural sectors of the EU-10, the possible supply inducing impacts of SAPS and CNDP are accounted for in the models for Bulgaria and Romania. Multipliers reflect the likely production impact of the different coupled and decoupled direct payments that can occur in Bulgaria and Romania, according to expert opinion, after EU accession.

Under the enlargement scenario analysed, Bulgarian and Romanian prices, after EU accession, are expected to converge towards EU price levels. A key issue in modelling the impact of enlargement on Bulgarian and Romanian agriculture is how to incorporate the process of price convergence, between agricultural commodity markets in these two countries and in other EU Member States. In performing the accession analysis, the linking producer and consumer prices of Bulgaria and Romania, to those in EU markets follows the same approach adopted in modelling the price convergence process between the EU-15 and the EU-10 countries. In the Bulgarian and Romania stand alone AGMEMOD country models, EU key prices are used in both the pre-accession and post-accession periods. Both, the expected difference between the individual acceding market price and the EU key market price and the rate at which these prices converge are accounted for using dummies.

Counterfactual Non-Enlargement Scenario

The non-enlargement scenario includes a description of the base set of agricultural policy assumptions, macro economic assumptions and those relating to other exogenous factors. In this study, the non-enlargement scenario attempts to simulate the evolution of Bulgarian and Romania agriculture, under agricultural policy regimes in Bulgaria and Romania assumed to have remained unchanged from their pre-accession state.

This non-enlargement scenario provides insights into the evolution of Romanian and Bulgarian agricultural markets over the next decade and can be interpreted as a measure of how the production and trade potentials may have evolved in the absence of the initiatives provided for by the pre-accession and accession processes. This counter-factual scenario enables the estimation of the impact of accession on Romanian and Bulgarian agriculture.

The evaluation of the impact of Bulgarian and Romanian accession on EU-25 agricultural commodity markets requires the incorporation of Romania and Bulgaria in an integrated EU27 version of the AGMEMOD model. Simulation results from the composite EU27 AGMEMOD model will, in the future, be capable of evaluating impact of accession on Bulgarian and Romanian agricultural commodity markets and will also be capable of evaluating the impact of the accession of these countries on agricultural markets else where in the EU.

6. Software environment

In this chapter attention is paid to the structure of the software environment of the country and EU models.

Experience has shown that building models and writing the corresponding software can give rise to considerable problems. If software is developed poorly, numerous problems could emerge and could easily become unreadable for less familiar users. Badly structured and poorly documented software allows very little flexibility and extendibility and can hardly be passed on to other developers.

Normally, models need to be adjusted for each research project in order to answer new research questions. Newer model versions are made or new scenarios are run. In turn, this leads to a continuous alteration of code and it will become unclear what computer models actually do. The consistency between conceptual models and actual computer models may be lost. This classic approach to the model building process in applied research work may cause problems.

In order to fulfil the requirements of the user-interface and to ensure the most efficient and sustainable access to AGMEMOD, GSE interface which stands for GAMS Simulation Environment, has been implemented to the EU-15 combined model and to some of the stand-alone EU-10 models. For stand-alone models, this is only possible where these models could run and solve in GAMS and are consistent with the structure of the EU-15 GAMS models (in respect to their codes for input and output variables).

Philosophy of GSE
Simulation models tend to change very rapidly during their lifetime. Therefore, both, model building scientists and IT-specialists, have thought of demand on modern model building and use, with regards to:

- models should meet customers' requirements and provide the outcomes in time;
- models should be part of corporate knowledge (database experts, economists, ICT people);
- other researchers, apart from the model developers, must be able to use the model for their research project;
- model results should be reliable and their set-up should be clear;
- models should be flexible to meet the requirements of various research projects, with different versions of the models;
- model results should be reproducible;
- peers should review models in order to enhance the overall quality;
- models should be developed to be easily connected to other models.

Most of these requirements are also applicable to development of a tool for projections and simulations, using the AGMEMOD model of the agricultural sector on the EU and Member State levels. GSE can be seen as an attempt to integrate the AGMEMOD model knowledge, by introducing a general concept of building GAMS models and user interfaces. Model knowledge should be specified in a mathematical form and this will lead to:

- more general and extendable model structures;
- higher quality of projections;
- better understanding of the model by peers and colleagues.

The GSE interface was considered as the appropriate tool for making AGMEMOD accessible in the most efficient and sustainable way. One of the main advantages of GSE is that it keeps the original GAMS code of the model intact. The user interface functions are extended separately from development of the model. Thus, project planning become easier the quality of the model can be improved. In this context GSE allows for:

- more transparent (model) links;
- continuity of the AGMEMOD model by providing easier access to and wider use of the model;
- a DataViewer to review and analyse data, including a Geographical Information System;
- a version control tool;
- a scenario analyser to compare, print and depict outcomes;
- a link between AGMEMOD and organisations instead of personal links.

Implementation of GSE to AGMEMOD
Using GSE means that the mathematical formulation of the model must be introduced in GAMS code in the implementation phase of the model building process. There was no need to build the AGMEMOD model from scratch: EU-15 models were already available in GAMS code (GAMS-IDE), whereas the models for EU-12 have been written in GAMS as part of this study. Each country model has been migrated from Excel to GAMS, equation by equation. This means, that the EU-15 model could be seen as a sequence of the complete set of country equations, without considering the adjustment of (parts of) the commodity models into a more generic structure. Over the longer term, however, this is expected to be solved when the EU-25, EU27 combined models are developed.

For AGMEMOD to be more transparent and better accessible, a restructure of the technical program code of the model is needed. A two step procedure has been followed here (see Figure 6.1). First, the model is restructured using the *Gtree* tool, which stands for *GAMS tree* and can be considered as an alternative of the GAMS-IDE (Dol, 2008). The left column of Figure 6.2 shows the break down of AGMEMOD in sub-files for settings, parameter and variable definitions, data reading, model calculations and output savings.

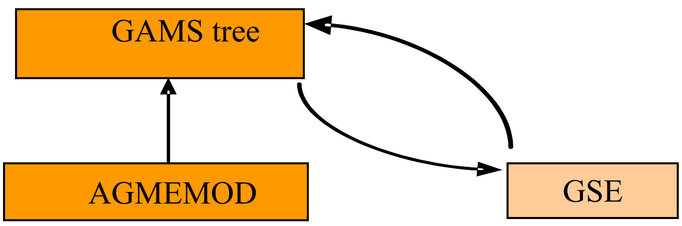

Figure 6.1: GSE concept in relation to AGMEMOD
Secondly, the Gtree version of the model has been prepared to implement it to the user-friendly GSE tool. In practice, this enables the AGMEMOD user to run (several) scenarios, to save their outcomes, to examine scenario inputs and outputs and to examine

the scenario outcomes in a GSE environment. An explanation of the toolbar and the various function buttons can be found in the AGMEMOD – GSE Interface Manual (Dol, 2008).

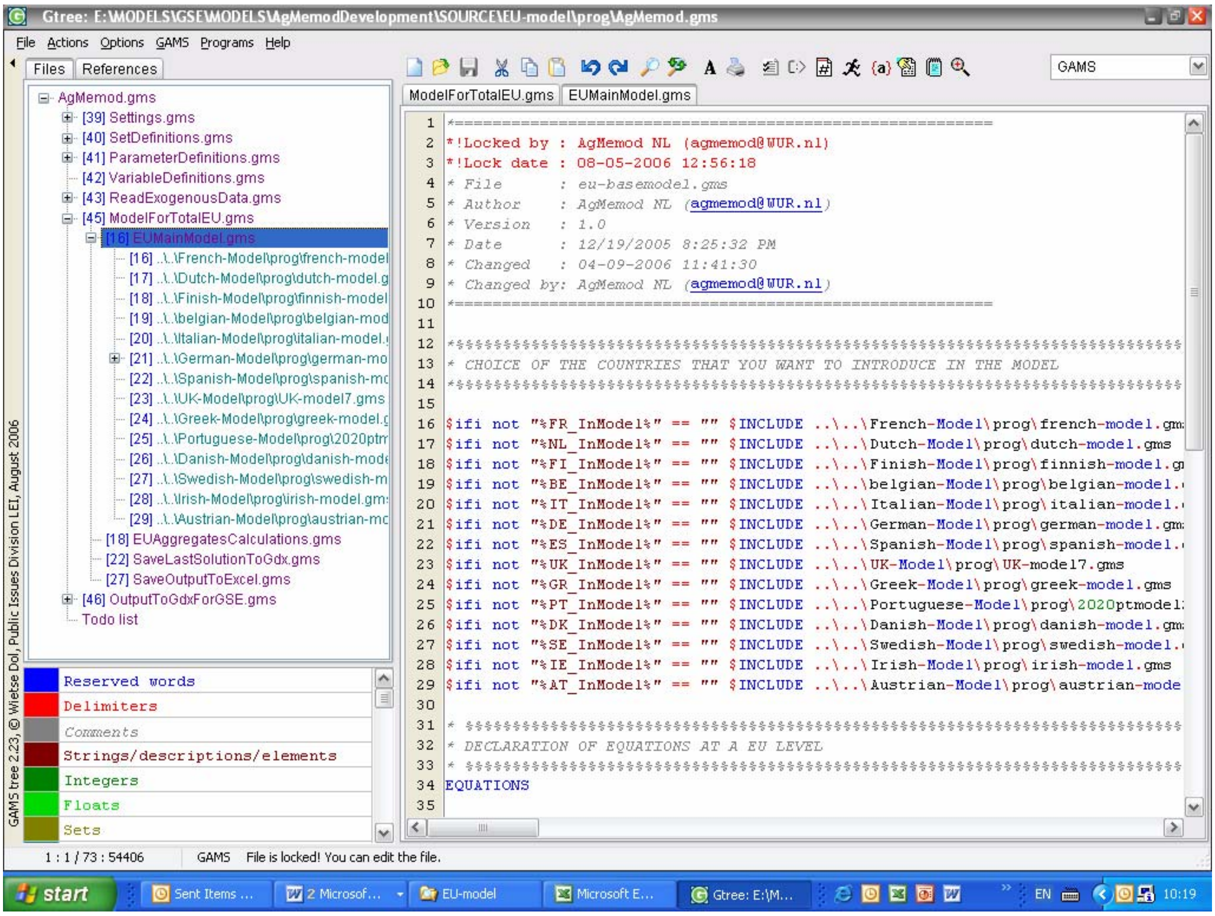

Figure 6.2: Structure of AGMEMOD in the GAMS tree

7. Discussion and conclusions

The objective of the study "Impact analysis of the CAP reform on the main agricultural commodities" was to provide projections and simulations up to 2015 for individual EU Member States, the EU-10, the EU-15, the EU-25 and the EU-27 as a whole, with emphasis on supply, demand, trade and prices for a set of commodities. Impacts of selected scenarios regarding the further decoupling of direct payments, the enlargement of the EU and sensitivity analysis of exchange rate shocks were assessed. To this end, the AGMEMOD modelling approach has been improved, implemented in standard computer software and applied.

This study made a considerable contribution for the improvement of the AGMEMOD model, e.g. implementation of the decoupled payments system, combination of EU-15 country models into an EU-15 version and the provision of market projections for each Member State. Despite the series of new features, the current AGMEMOD tool comes with a number of following caveats, which will need further investigation in the future.

Decoupling
The precise degree to which decoupled direct payments do or do not affect the production decisions of farmers across the EU remains unknown.

The degree to which decoupled direct payments do or do not affect the production decisions of EU farmers, is an active research area. Micro-level research focusing on farms provides more insight into this issue. Future work on the development of the AGMEMOD model (the FP6 project AGMEMOD 2020) will attempt to incorporate these research findings.
In the short term, it might be possible to examine different assumptions regarding the extent of the supply-inducing impact of decoupling using a sensitivity analysis.

EU Small Country Assumption
The AGMEMOD model embodies a small country assumption with respect to the EU.

The small country assumption means that projected developments on EU-25 agricultural commodity markets do not have any impact on world agricultural commodity markets. However, influence of the EU on international prices is still relevant. Thus, the exchange rate sensitivity analysis results underline this limitation in the current model.
The EU-27 hybrid model does not incorporate feedback from the EU-12 models on the EU-15 models. This can only be overcome by a combined EU-27 version integrating all Member State models. The construction of a combined EU-27 model is a future task.
Development of the AGMEMOD model will moderate the small country assumption by altering the way the model closes. This modification will allow AGMEMOD to model and make projections of the impact of the EU on international prices for commodities.

Impact on Agriculture of Biofuel Production
Currently, the model does not address the emerging issue of biofuel production and its potential impact on agriculture in terms of land allocation, crop prices, feed prices and, in turn, livestock production.

This world-wide issue can be incorporated in the model through the interaction considered between AGMEMOD and other modelling systems. More relevant for the AGMEMOD model however, is the potential impact of biofuel production within the EU.

In a short term, this issue can be addressed using a sensitivity analysis. The AGMEMOD model is developed with regards to the biofuel issues under the FP6 AGMEMOD 2020 project.

Enlargement to include Bulgaria and Romania
The potential for the Romanian and Bulgarian agricultural sector growth is relatively high. Therefore, further technological changes, supported by rural development funds, could give a much more dynamic picture than the AGMEMOD country results showed. These changes will probably not take place in the first years following accession in 2007 due to structural and market deficiencies. It should be noted that some of the main agricultural activities in Bulgaria and, to some extent, also in Romania, were not modelled and the impact of these omitted markets on the expanded EU-27 market would, in theory, be stronger. This refers to the vegetable, tobacco and wine markets as well as to other Mediterranean agricultural activities. The model commodity coverage for these countries will be maximised, subject to the availability of data.

In conclusion, achievements of this study contribute to discussions on changes in EU and international agricultural and trade policies and their impact analysis at both EU and Member States level.

8. References

AGMEMOD (2008): Impact Analysis of CAP Reform on the Main Agricultural Commodities. Report II AGMEMOD - Member States Results. AGMEMOD Partnership. JRC – IPTS Scientific and Technical Report. EUR Number: 22940 EN/2, 2008.

Banse, M. and Tangermann S. (1996) Agricultural implications of Hungary's Accession to the EU – Partial versus general equilibrium effects. 50th EAAE Seminar "Economic Transition and the Greening of Policies: New Challenges for Agriculture and Agribusiness in Europe", October 15 -17, 1996. Giessen, Germany (contributed paper in print).

Bureau, J. C. (2003) Enlargement and reform of the EU Common agricultural policy: Impacts on the western hemisphere countries. Background paper. Washington, DC. April 2003. 138 pp.

Chantreuil, F. and F. Levert (2003) What is a complete and convenient country model to be combined, CAPRI, Italy, 4th AGMEMOD meeting.
Online at www.tnet.teagasc.ie/AGMEMOD/modellingag.htm.

Chantreuil, F., K. Hanrahan and F. Levert (2005) The Luxembourg Agreement Reform of the CAP: An analysis using the AGMEMOD composite model. In: 89th EAAE Seminar: 'Modelling agricultural policies: state of the art and new challenges', 3-5 February 2005 - Parma.

Dol, W. (2008): AGMEMOD – GSE Interface Manual. Impact Analysis of CAP Reform on the Main Agricultural Commodities. AGMEMOD Report IV. JRC Scientific and Technical Reports, IPTS, European Commission. EUR 22940 EN/4. 2008

Erjavec, E. and T. Donnellan (2005) Development of the AGMEMOD Country Level Agricultural Policy Analysis Tool in the New Member States of EU. In: 89th EAAE Seminar: 'Modelling agricultural policies: state of the art and new challenges', 3-5 February 2005 - Parma.

Esposti, R. and A. Lobianco (2005) Analysing the Impact of the CAP Reform on the Italian Crop production with the AGMEMOD Model: the Case of Durum Wheat . In: 89th EAAE Seminar: 'Modelling agricultural policies: state of the art and new challenges', 3-5 February 2005 - Parma.

Eurostat (2006) Statistics in focus. Agriculture and fisheries. 3/2006.

Gracia, A. and J.M. Casado (2005) An Assessment of the Luxembourg Agreement on the Spanish Agricultural Sector: an Econometric Model. In: 89th EAAE Seminar: 'Modelling agricultural policies: state of the art and new challenges', 3-5 February 2005 - Parma.

Hanrahan, K. F. (2001) The EU GOLD MODEL 2.1. An introductory manual, Working Paper.

Hennessy, D.A. (1998) The Production Effects of Agricultural Income Support Policies Under Uncertainty. *American Journal of Agricultural Economics* 80(1998):46-57
HGCA (2005) Home Grown Cereals Authority, 2005. Planting Survey June 2005. http://www.hgca.com.

Leeuwen, M. van, and A. Tabeau (2005) Consequences of 2003 CAP Reform for Dutch Agriculture. In: 89th EAAE Seminar: 'Modelling agricultural policies: state of the art and new challenges', 3-5 February 2005 - Parma.

Niemi, J., C. Jansik, L. Kettunen and H. Lehtonen (2005) A Tool to Analyse the Impact of Policy Changes on the Agri-Food Sector of Finland. In: 89th EAAE Seminar: 'Modelling agricultural policies: state of the art and new challenges', 3-5 February 2005 - Parma.

Riordan, Brendan (2002) Guidelines for Model Building in the AGMEMOD Partnership. Working Paper.

Riordan, Brendan (2005) Building Local Knowledge into EU Agri-food Projections: Experiences of a Fifth Framework Co-ordinator. EuroChoices 4(1).

Salvatici, L., G. Anania, F. Arfini, P. Conforti, P. De Muro, P. Londero and P. Sckokai (2001) Recent developments in modelling the CAP: hype or hope? *Agricultural Sector Modelling and Policy Information Systems,* Heckelei T., P. Witzke and W. Henrichsmeyer (eds.). Wissenschaftverlag Vauk, Kiel.

Tongeren, F. van, H. van Meijl and Y. Surry (2001) Global models applied to agricultural and trade policies: A review and assessment. *Agricultural Economic*s, 26:149–172.

Tyers, R. and K. Anderson (1992) *Disarray in World Food Markets. A Quantitative Assessmen*t. Cambridge University Press. Cambridge.

Von Ledebur, E., P. Salamon and G. Weber (2005) Who is Telling the Truth? Synthetic Uniformly Structured or Econometric Country Specific Models – a Model Comparison based on the Luxembourg Agreement. In: 89th EAAE Seminar: 'Modelling agricultural policies: state of the art and new challenges', 3-5 February 2005 - Parma.

Westhoff, P. (2001) *The European Union Grain, Oilseed, Livestock and Dairy (EU GOLD) Model*, FAPRI at the University of Missouri.

9. Annexes

Annex 1: Implementing the Single Payment Scheme in the AGMEMOD model

With the implementation of the SPS most direct payments under the CAP have been decoupled from agricultural production and linked to agricultural land use, good farming practices and satisfaction of cross-compliance criteria.

In the AGMEMOD model, the potential supply inducing impact of the decoupled payments on the production is modelled through a set of country, commodity and time specific multipliers, DEC(x,c,t), that are used to derive synthetic premiums PREMS(x,c,t). Synthetic premiums exogenously affect the level of agricultural production in the country models.

This annex provides details of the derivation and calculation of the DEC(x,c,t) multipliers and the associated PREMS(s,c,t) variables.

As outlined in the paper, multiplier DEC(x,c,t) is defined as

*DEC(x,c,t) = CR(x,c,t) + MULT1(x,c,t)*MULT2(c,t)* MULT3(c,t)*

Where *x* is an index over the commodities modelled in the AGMEMOD model, *c* is an index over the countries modelled and *t* is a time index.

CR(x,c,t) are commodity, country and time specific coupling coefficients expressing the degree to which decoupled historic (Agenda 2000) direct payment instruments on the country level, are applied to the production of product *x* at time *t*.

With full decoupling of a direct payment *CR(x,c,t)* = 0, with partial decoupling where, for example, a Member State is allowed to retain 25% of the value of the historic direct payment coupled to production then *CR(x,c,t)* = 0.25. The AGMEMOD Report II - Member States Results (AGMEMOD, 2008) provides information of the *CR(x,c,t)* coefficients for each EU-15 Member State in the AGMEMOD model.

MULT1(x,c,t) is a commodity, country and time specific multiplier that reallocates the proportion of the historic direct payment entering the SPS payment, across all agricultural land. This reflects an assumption the AGMEMOD model that decoupled direct payments are paid on a flat rate across all agricultural land and not only the land on which the direct payment entitlements were established.

Thus *MULT1(x,c,t)* is defined as

MULT1(x,c,t) = [1-CR(x,c,t)][CLA(c)/TOTLA(c)]*

where *CR(x,c,t)* is as previously defined, *CLA(c)* is the total land area on which direct payments were established and *TOTLA(c)* is the total agricultural land area in country *c* in the period of reference (2000 to 2002). Since the area on which direct payment entitlements were established in all countries is less than the total agricultural area, this ratio for all Member State models is less than one.

The country and time specific multiplier *MULT2(c,t)* expresses the impact of the compulsory modulation provisions of the Luxembourg Agreement. Thus MULT2 is defined as

MULT2 = 1- [CMODE(c,t) + VMOD(c,t)]

where *CMOD (c,t)* is the rate of compulsory modulation under the Luxembourg Agreement and *VMOD(c,t)* is the rate of voluntary modulation introduced in country *c*.

The final element of the *DEC(x,c,t)* multiplier is the term *MULT3(x,c,t)*. This term attempts to cover the extent to which decoupled payments, received by farmers are not to be invested in agriculture or affect agricultural production decisions as do coupled direct payments.

For all countries *c*, for all commodities *x* and for all time period *MULT3(x,c,t)* ≤1.

In calculating the synthetic premiums, *PREMS(x,c,t)*, used in the AGMEMOD model implementation of the 2003 CAP, the historic CAP direct payment rates per animal, per hectare or other unit of production, *PREMREF(x,c)*, are multiplied by the appropriate commodity multiplier DEC(x,c,t).

$$\begin{aligned}
PREMS(x,c,t) &= PREMREF(x,c) * DEC(x,c,t) \\
&= PREMREF(x,c) * \left(CR(x,c,t) + MULT1(x,c,t) * MULT2(c,t) * MULT3(x,c,t)\right) \\
&= PREMREF(x,c) * \begin{pmatrix} CR(x,c,t) + \\ (1 - CR(x,c,t)) * \left[\dfrac{CLA(c)}{TOTLA(c)}\right] * \left[1 - CMOD(c,t) - VMOD(c,t)\right] \\ * MULT3(x,c,t) \end{pmatrix}
\end{aligned}$$

If a particular direct payment under the national implementation level of the Luxembourg Agreement has remained fully coupled then, this term simplifies to PREMREF(x,c). When the direct payment is fully decoupled the term simplifies to

$$PREMS(x,c,t) = PREMREF(x,c) * \left(\left[\frac{CLA(c)}{TOTLA(c)}\right] * \left[1 - CMOD(c,t) - VMOD(c,t)\right] * MULT3(x,c,t)\right)$$

PREMS calculations

Four examples of the calculation of PREMS(x,c,t) are given. These are the calculations of the synthetic premiums associated with the historic suckler cow premium policy variable in the Netherlands and France and the ewe premium in the Netherlands and France. These examples were chosen to illustrate the three cases of fully coupled, fully decoupled and partially decoupled direct payments.

For the Netherlands, the ratio of the areas on which SFP entitlements were established to total agricultural land is approximately 0.92, while the equivalent ratio in France is approximately 0.917.

The rates of compulsory modulation are the same across the EU, however in the simulation of the AGMEMOD model, adjustments have been made to the compulsory modulation rate to account for the varying proportion of farmers in different Member

States that will have their SFP modulated. The compulsory modulation rates for France and the Netherlands are given in Table 9.1. This table also set out the voluntary modulation rates applied in France and the Netherlands.

Table 9.1: Compulsory and Voluntary Modulation Rates in France and the Netherlands

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
France											
CMOD	2.9	3.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
VMOD	0.0	0.0	1.0	2.0	3.0	4.0	5.0	6.0	8.0	9.0	10.0
The Netherlands											
CMOD	1.8	2.4	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
VMOD	2.0	4.0	6.0	8.0	10.0	1.0	140	16.0	18.0	20.0	22.0

Source: AGMEMOD Report II - Member States Results

In France the suckler cow premium under the French implementation of the Luxembourg Agreement remains fully coupled to production, thus the CR(BC,FR,t) = 1. In the Netherlands, by contrast, the suckler cow premium is fully decoupled, thus CR(BC,NL,t) = 0.

Ewe premium in France presents an example of what has been termed as “partial” decoupling, where 50% of the historical direct payment remains coupled to possession of an eligible ewe with the remaining 50% of the value of the ewe premiums transferred to the SFP in the period of reference. Ewe premium is fully decoupled in the Netherlands.

The MULT3(x,c,t) for ewes and beef cows in both France and Belgium are assumed to be the same, declining by 5% per annum from 2006 onwards so that by 2015 approximately 60% of the value of the decoupled part of the suckler cow and ewe premium direct payments enter the supply inducing synthetic premiums.

The reference values of the suckler cow premium and the ewe premium in the period of reference are euro 250 and euro 21 respectively.

Given the above information provided in AGMEMOD Report 2 – Member States Results we can calculate the synthetic premiums, using the DEC(x,c,t) multipliers as follows:

PREMS(BC, NL,2015) = PREMREF(BC)*[CLA(NL)/TOTAL(NL)]*[1-VMOD(NL,2015)-CMOD(NL,2015)]*MULT3(NL,BC,2015)
= 250*(0.92)*(1-0.25)*0.6 =103. 5

PREMS((BC, FR,2015) = PREMREF(BC)*1
= 250

PREMS(EW,NL,2015) = PREMREF(EW)*[CLA(NL)/TOTAL(NL)]*[CMOD(NL,2015)+VMOD(NL,2015)]*MULT3(NL, EW, 2015)
= 21*(0.92)*(1-0.25)*0.6 =8.7

PREMS(EW,FR, 2015) = 21*[0.5 + 0.5*(0.917)*(1-0.149)*0.6]
= 15.4

Annex 2: Baseline policy implementation in the Member States of the 2004 enlargement

Table 9.2: Budgetary support (euro per 100 kg) for main agricultural commodities in the Czech Republic

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Wheat	2.59	2.56	2.76	3.14	3.53	3.92	3.84	3.76	3.67	3.67	3.67	3.67
Barley	3.05	3.01	3.24	3.70	4.15	4.61	4.51	4.41	4.32	4.32	4.32	4.32
Maize	2.47	2.44	2.63	2.99	3.36	3.73	3.65	3.58	3.50	3.50	3.50	3.50
Rye	2.86	2.83	3.04	3.47	3.90	4.32	4.23	4.15	4.06	4.06	4.06	4.06
Other grains	3.55	3.51	3.78	4.31	4.84	5.37	5.26	5.15	5.04	5.04	5.04	5.04
Rapeseed	4.20	4.16	4.47	5.10	5.73	6.35	6.22	6.09	5.96	5.96	5.96	5.96
Sunflowerseed	7.03	6.95	7.47	8.52	9.57	10.62	10.40	10.18	9.96	9.96	9.96	9.96
Soybeans	10.57	10.45	11.24	12.81	14.39	15.97	15.64	15.31	14.98	14.98	14.98	14.98
Milk	0.69	0.83	0.97	1.25	1.52	1.80	2.08	2.35	2.63	2.63	2.63	2.63
Beef	14.98	17.98	20.98	26.97	32.96	38.95	44.95	50.94	56.93	56.93	56.93	56.93
Pig meat	---	---	---	---	---	---	---	---	---	---	---	---
Sheep meat	---	---	---	---	---	---	---	---	---	---	---	---
Poultry	---	---	---	---	---	---	---	---	---	---	---	---

Table 9.3: Budgetary support (euro per 100 kg) for main agricultural commodities in Estonia

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Wheat	1.78	1.94	2.10	2.27	2.27	2.59	2.91	2.91	2.91	2.91	3.24	3.24
Barley	1.93	2.11	2.28	2.46	2.46	2.81	3.16	3.16	3.16	3.16	3.51	3.51
Maize	---	---	---	---	---	---	---	---	---	---	---	---
Rye	2.00	2.18	2.36	2.54	2.54	2.91	3.27	3.27	3.27	3.27	3.63	3.63
Other grains	2.11	2.30	2.49	2.68	2.68	3.07	3.45	3.45	3.45	3.45	3.83	3.83
Rapeseed	3.28	3.58	3.87	4.17	4.17	4.77	5.36	5.36	5.36	5.36	5.96	5.96
Sunflowerseed	---	---	---	---	---	---	---	---	---	---	---	---
Soybeans	---	---	---	---	---	---	---	---	---	---	---	---
Milk	1.62	1.77	1.91	2.06	2.06	2.35	2.65	2.65	2.65	2.65	2.94	2.94
Beef	84.37	92.04	99.71	107.38	107.38	122.72	138.06	138.06	138.06	138.06	153.40	153.40
Pig meat	---	---	---	---	---	---	---	---	---	---	---	---
Sheep meat	---	---	---	---	---	---	---	---	---	---	---	---
Poultry	---	---	---	---	---	---	---	---	---	---	---	---

Table 9.4: Budgetary support (euro per 100 kg) for main agricultural commodities in Hungary

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Wheat	2.50	2.76	3.00	3.38	3.85	4.51	5.00	5.10	5.10	5.10	5.10	5.10
Barley	3.00	3.31	3.60	4.06	4.62	5.40	5.99	6.11	6.11	6.11	6.11	6.11
Maize	1.83	2.02	2.19	2.47	2.81	3.29	3.65	3.73	3.73	3.73	3.73	3.73
Rye	4.64	5.12	5.56	6.28	7.15	8.36	9.27	9.46	9.46	9.46	9.46	9.46
Oats	4.66	5.14	5.58	6.30	7.17	8.39	9.30	9.49	9.49	9.49	9.49	9.49
Other grains	3.41	3.76	4.09	4.61	5.25	6.14	6.81	6.95	6.95	6.95	6.95	6.95
Rapeseed	4.61	5.09	5.53	6.24	7.10	8.31	9.21	9.41	9.41	9.41	9.41	9.41
Sunflowerseed	5.18	5.71	6.21	7.00	7.97	9.33	10.34	10.56	10.56	10.56	10.56	10.56
Soybeans	5.39	5.95	6.47	7.30	8.30	9.72	10.77	11.00	11.00	11.00	11.00	11.00
Milk	1.64	1.81	1.96	2.22	2.52	2.83	3.14	3.20	3.20	3.20	3.20	3.20
Beef	35.61	39.29	42.69	48.17	54.82	64.15	71.12	72.61	72.61	72.61	72.61	72.61
Pig meat	---	---	---	---	---	---	---	---	---	---	---	---
Sheep meat	145.50	160.55	174.44	196.81	224.00	262.13	290.61	296.69	296.69	296.69	296.69	296.69
Poultry	---	---	---	---	---	---	---	---	---	---	---	---

Table 9.5: Budgetary support (euro per 100 kg) for main agricultural commodities in Latvia

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Wheat	1.80	2.48	2.89	3.12	3.26	3.22	3.57	3.57	3.57	3.57	3.57	3.57
Barley	2.11	2.91	3.39	3.66	3.82	3.77	4.19	4.19	4.19	4.19	4.19	4.19
Maize	---	---	---	---	---	---	---	---	---	---	---	---
Rye	2.28	3.14	3.66	3.95	4.13	4.07	4.53	4.53	4.53	4.53	4.53	4.53
Oats	2.41	3.32	3.87	4.18	4.37	4.31	4.78	4.78	4.78	4.78	4.78	4.78
Other grains	1.67	2.30	2.68	2.89	3.02	2.98	3.31	3.31	3.31	3.31	3.31	3.31
Rapeseed	2.83	3.90	4.55	4.91	5.13	5.06	5.62	5.62	5.62	5.62	5.62	5.62
Sunflowerseed	---	---	---	---	---	---	---	---	---	---	---	---
Soybeans	---	---	---	---	---	---	---	---	---	---	---	---
Milk	0.90	1.25	1.45	1.57	1.64	1.56	1.73	1.73	1.73	1.73	1.73	1.73
Beef	17.34	23.91	27.88	30.10	31.44	31.01	34.46	34.46	34.46	34.46	34.46	34.46
Pig meat	---	---	---	---	---	---	---	---	---	---	---	---
Sheep meat	49.28	67.95	79.21	85.53	89.34	88.13	97.92	97.92	97.92	97.92	97.92	97.92
Poultry	---	---	---	---	---	---	---	---	---	---	---	---

Table 9.6: Budgetary support (euro per 100 kg) for main agricultural commodities in Lithuania

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Wheat	1.43	1.62	1.97	2.22	2.62	3.08	3.08	3.08	3.08	3.08	3.08	3.08
Barley	1.95	2.21	2.70	3.04	3.59	4.22	4.22	4.22	4.22	4.22	4.22	4.22
Maize	3.12	3.54	4.32	4.87	5.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75
Rye	2.28	2.59	3.16	3.56	4.21	4.94	4.94	4.94	4.94	4.94	4.94	4.94
Other grains	2.23	2.52	3.08	3.47	4.10	4.81	4.81	4.81	4.81	4.81	4.81	4.81
Rapeseed	2.78	3.15	3.85	4.34	5.12	6.02	6.02	6.02	6.02	6.02	6.02	6.02
Sunflowerseed	---	---	---	---	---	---	---	---	---	---	---	---
Soybeans	---	---	---	---	---	---	---	---	---	---	---	---
Milk	2.21	2.51	3.06	3.45	4.08	4.70	4.70	4.70	4.70	4.70	4.70	4.70
Beef	51.16	58.00	70.75	79.75	94.22	110.65	110.65	110.65	110.65	110.65	110.65	110.65
Pig meat	---	---	---	---	---	---	---	---	---	---	---	---
Sheep meat	47.83	54.21	66.14	74.55	88.07	101.58	101.58	101.58	101.58	101.58	101.58	101.58
Poultry	---	---	---	---	---	---	---	---	---	---	---	---

Table 9.7: Budgetary support (euro per 100 kg) for main agricultural commodities in Poland

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Wheat	2.42	2.87	3.01	3.65	4.15	4.88	5.35	5.30	5.26	5.23	5.23	5.23
Barley	2.94	3.48	3.65	4.44	5.05	5.93	6.50	6.44	6.40	6.36	6.36	6.36
Maize	1.82	2.16	2.26	2.75	3.13	3.67	4.03	3.99	3.96	3.94	3.94	3.94
Rye	3.74	4.44	4.66	5.65	6.43	7.55	8.29	8.21	8.15	8.10	8.10	8.10
Other grains	3.38	4.00	4.20	5.10	5.80	6.81	7.47	7.40	7.35	7.31	7.31	7.31
Rapeseed	3.41	4.04	4.24	5.15	5.86	6.88	7.55	7.48	7.42	7.38	7.38	7.38
Sunflowerseed	---	---	---	---	---	---	---	---	---	---	---	---
Soybeans	---	---	---	---	---	---	---	---	---	---	---	---
Milk	1.85	2.20	2.30	2.80	3.18	3.55	3.89	3.86	3.83	3.81	3.81	3.81
Beef	42.79	50.75	53.20	64.59	73.49	86.29	94.71	93.83	93.14	92.60	92.60	92.60
Pig meat	---	---	---	---	---	---	---	---	---	---	---	---
Sheep meat	141.19	167.46	175.56	213.15	242.51	270.41	296.79	294.02	291.89	290.18	290.18	290.18
Poultry	---	---	---	---	---	---	---	---	---	---	---	---

Table 9.8: Budgetary support (euro per 100 kg) for main agricultural commodities in Slovakia

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Wheat	2.22	1.42	1.78	2.17	2.56	2.95	3.34	3.54	3.73	3.93	3.93	3.93
Barley	2.96	1.89	2.36	2.88	3.40	3.92	4.44	4.70	4.96	5.23	5.23	5.23
Maize	1.81	1.16	1.45	1.77	2.09	2.41	2.73	2.88	3.04	3.21	3.21	3.21
Rye	2.79	1.78	2.22	2.71	3.21	3.70	4.19	4.43	4.68	4.93	4.93	4.93
Other grains	2.09	1.33	1.67	2.03	2.40	2.77	3.14	3.32	3.50	3.69	3.69	3.69
Rapeseed	3.74	2.39	2.99	3.64	4.31	4.96	5.62	5.95	6.28	6.61	6.61	6.61
Sunflowerseed	4.92	3.15	3.92	4.79	5.66	6.53	7.39	7.82	8.26	8.69	8.69	8.69
Soybeans	6.69	4.28	5.34	6.51	7.70	8.87	10.05	10.63	11.23	11.82	11.82	11.82
Milk	0.65	0.83	0.98	1.25	1.56	1.87	2.19	2.50	2.81	3.12	3.12	3.12
Beef	28.14	35.96	42.47	53.96	67.43	80.86	94.29	107.76	121.20	134.67	134.67	134.67
Pig meat	---	---	---	---	---	---	---	---	---	---	---	---
Sheep meat	100.60	128.56	151.86	192.91	241.08	289.11	337.14	385.30	433.33	481.49	481.49	481.49
Poultry	---	---	---	---	---	---	---	---	---	---	---	---

Annex 3: Baseline exchange rate data

Table 9.9: Baseline Exchange Rate Data

		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Baseline Exchange rate Euro vs $												
EU-15	euro/$	0.912	0.917	0.871	0.871	0.871	0.871	0.871	0.871	0.871	0.871	0.871
Baseline Exchange rate vs $												
Belgique/B	BEF/$	36.770	36.974	35.144	35.144	35.144	35.144	35.144	35.144	35.144	35.144	35.144
Danmark	DKK/$	7.131	7.171	6.816	6.816	6.816	6.816	6.816	6.816	6.816	6.816	6.816
Deutschlan	DM/$	1.783	1.793	1.704	1.704	1.704	1.704	1.704	1.704	1.704	1.704	1.704
Ellada	GDR/$	310.594	312.316	296.861	296.861	296.861	296.861	296.861	296.861	296.861	296.861	296.861
Espana	PTS/$	151.661	152.502	144.955	144.955	144.955	144.955	144.955	144.955	144.955	144.955	144.955
France	FF/$	5.979	6.012	5.715	5.715	5.715	5.715	5.715	5.715	5.715	5.715	5.715
Ireland	IEP/$	0.718	0.722	0.686	0.686	0.686	0.686	0.686	0.686	0.686	0.686	0.686
Italia	ITL/$	1764.910	1774.698	1686.878	1686.878	1686.878	1686.878	1686.878	1686.878	1686.878	1686.878	1686.878
Nederland	NLG/$	2.009	2.020	1.920	1.920	1.920	1.920	1.920	1.920	1.920	1.920	1.920
Osterrich	ATS/$	12.543	12.612	11.988	11.988	11.988	11.988	11.988	11.988	11.988	11.988	11.988
Portugal	PTE/$	182.739	183.753	174.660	174.660	174.660	174.660	174.660	174.660	174.660	174.660	174.660
Suomi/Finl	FIM/$	5.420	5.450	5.180	5.180	5.180	5.180	5.180	5.180	5.180	5.180	5.180
Sverige	SEK/$	7.702	7.745	7.362	7.362	7.362	7.362	7.362	7.362	7.362	7.362	7.362
United King	£/$	0.632	0.644	0.614	0.614	0.614	0.614	0.614	0.614	0.614	0.614	0.614
Bulgaria	Lev/$	1.783	1.793	1.704	1.704	1.704	1.704	1.704	1.704	1.704	1.704	1.704
Czech Rep	cz koruna/$	27.146	27.297	25.946	25.946	25.946	25.946	25.946	25.946	25.946	25.946	25.946
Estonia	kroon/$	14.262	14.341	13.631	13.631	13.631	13.631	13.631	13.631	13.631	13.631	13.631
Hungary	forint/$	226.098	227.351	216.101	216.101	216.101	216.101	216.101	216.101	216.101	216.101	216.101
Latvia	lat/$	0.635	0.638	0.607	0.607	0.607	0.607	0.607	0.607	0.607	0.607	0.607
Lithuania	litas/$	3.147	3.165	3.008	3.008	3.008	3.008	3.008	3.008	3.008	3.008	3.008
Poland	zloty/$	3.667	3.687	3.505	3.505	3.505	3.505	3.505	3.505	3.505	3.505	3.505
Romania	lei/$	3.300	3.319	3.155	3.155	3.155	3.155	3.155	3.155	3.155	3.155	3.155
Slovakia	sk koruna/$	35.183	35.378	33.627	33.627	33.627	33.627	33.627	33.627	33.627	33.627	33.627
Slovenia	tolar/$	218.366	219.577	208.712	208.712	208.712	208.712	208.712	208.712	208.712	208.712	208.712

Annex 4: Scenario exchange rate data

Table 9.10: Exchange rate data at US$ 1.3 per euro

		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Exchange rate Euro vs $: US$1.3 per euro												
EU-15	euro/$	0.909	0.885	0.769	0.769	0.769	0.769	0.769	0.769	0.769	0.769	0.769
Implied Exchange rate vs $: At US$ 1.3 per euro												
Belgique/B	BEF/$	36.673	35.699	31.031	31.031	31.031	31.031	31.031	31.031	31.031	31.031	31.031
Danmark	DKK/$	7.112	6.923	6.018	6.018	6.018	6.018	6.018	6.018	6.018	6.018	6.018
Deutschlan	DM/$	1.778	1.731	1.504	1.504	1.504	1.504	1.504	1.504	1.504	1.504	1.504
Ellada	GDR/$	309.773	301.549	262.115	262.115	262.115	262.115	262.115	262.115	262.115	262.115	262.115
Espana	PTS/$	151.260	147.244	127.989	127.989	127.989	127.989	127.989	127.989	127.989	127.989	127.989
France	FF/$	5.963	5.805	5.046	5.046	5.046	5.046	5.046	5.046	5.046	5.046	5.046
Ireland	IEP/$	0.716	0.697	0.606	0.606	0.606	0.606	0.606	0.606	0.606	0.606	0.606
Italia	ITL/$	1760.245	1713.513	1489.438	1489.438	1489.438	1489.438	1489.438	1489.438	1489.438	1489.438	1489.438
Nederland	NLG/$	2.003	1.950	1.695	1.695	1.695	1.695	1.695	1.695	1.695	1.695	1.695
Osterrich	ATS/$	12.509	12.177	10.585	10.585	10.585	10.585	10.585	10.585	10.585	10.585	10.585
Portugal	PTE/$	182.256	177.418	154.217	154.217	154.217	154.217	154.217	154.217	154.217	154.217	154.217
Suomi/Finl	FIM/$	5.405	5.262	4.574	4.574	4.574	4.574	4.574	4.574	4.574	4.574	4.574
Sverige	SEK/$	7.682	7.478	6.500	6.500	6.500	6.500	6.500	6.500	6.500	6.500	6.500
United King	£/$	0.630	0.622	0.542	0.542	0.542	0.542	0.542	0.542	0.542	0.542	0.542
Bulgaria	Lev/$	1.778	1.731	1.504	1.504	1.504	1.504	1.504	1.504	1.504	1.504	1.504
Czech Rep	cz koruna/$	27.075	26.356	22.909	22.909	22.909	22.909	22.909	22.909	22.909	22.909	22.909
Estonia	kroon/$	14.224	13.847	12.036	12.036	12.036	12.036	12.036	12.036	12.036	12.036	12.036
Hungary	forint/$	225.500	219.513	190.808	190.808	190.808	190.808	190.808	190.808	190.808	190.808	190.808
Latvia	lat/$	0.633	0.616	0.536	0.536	0.536	0.536	0.536	0.536	0.536	0.536	0.536
Lithuania	litas/$	3.139	3.056	2.656	2.656	2.656	2.656	2.656	2.656	2.656	2.656	2.656
Poland	zloty/$	3.657	3.560	3.095	3.095	3.095	3.095	3.095	3.095	3.095	3.095	3.095
Romania	lei/$	3.292	3.204	2.785	2.785	2.785	2.785	2.785	2.785	2.785	2.785	2.785
Slovakia	sk koruna/$	35.090	34.158	29.692	29.692	29.692	29.692	29.692	29.692	29.692	29.692	29.692
Slovenia	tolar/$	217.789	212.007	184.283	184.283	184.283	184.283	184.283	184.283	184.283	184.283	184.283

Table 9.11: Exchange rate data at US$ 1.4 per euro

		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Exchange rate Euro vs $: At US$ 1.4 per euro												
EU-15	euro/$	0.909	0.877	0.714	0.714	0.714	0.714	0.714	0.714	0.714	0.714	0.714
Exchange rate vs $: at US$ 1.4 per euro												
Belgique/B	BEF/$	36.673	35.386	28.814	28.814	28.814	28.814	28.814	28.814	28.814	28.814	28.814
Danmark	DKK/$	7.112	6.863	5.588	5.588	5.588	5.588	5.588	5.588	5.588	5.588	5.588
Deutschlan	DM/$	1.778	1.716	1.397	1.397	1.397	1.397	1.397	1.397	1.397	1.397	1.397
Ellada	GDR/$	309.773	298.904	243.393	243.393	243.393	243.393	243.393	243.393	243.393	243.393	243.393
Espana	PTS/$	151.260	145.953	118.847	118.847	118.847	118.847	118.847	118.847	118.847	118.847	118.847
France	FF/$	5.963	5.754	4.685	4.685	4.685	4.685	4.685	4.685	4.685	4.685	4.685
Ireland	IEP/$	0.716	0.691	0.563	0.563	0.563	0.563	0.563	0.563	0.563	0.563	0.563
Italia	ITL/$	1760.245	1698.482	1383.050	1383.050	1383.050	1383.050	1383.050	1383.050	1383.050	1383.050	1383.050
Nederland	NLG/$	2.003	1.933	1.574	1.574	1.574	1.574	1.574	1.574	1.574	1.574	1.574
Osterrich	ATS/$	12.509	12.070	9.829	9.829	9.829	9.829	9.829	9.829	9.829	9.829	9.829
Portugal	PTE/$	182.256	175.861	143.201	143.201	143.201	143.201	143.201	143.201	143.201	143.201	143.201
Suomi/Finl	FIM/$	5.405	5.216	4.247	4.247	4.247	4.247	4.247	4.247	4.247	4.247	4.247
Sverige	SEK/$	7.682	7.412	6.036	6.036	6.036	6.036	6.036	6.036	6.036	6.036	6.036
United King	£/$	0.630	0.616	0.503	0.503	0.503	0.503	0.503	0.503	0.503	0.503	0.503
Bulgaria	Lev/$	1.778	1.716	1.397	1.397	1.397	1.397	1.397	1.397	1.397	1.397	1.397
Czech Rep	cz koruna/$	27.075	26.125	21.273	21.273	21.273	21.273	21.273	21.273	21.273	21.273	21.273
Estonia	kroon/$	14.224	13.725	11.176	11.176	11.176	11.176	11.176	11.176	11.176	11.176	11.176
Hungary	forint/$	225.500	217.588	177.179	177.179	177.179	177.179	177.179	177.179	177.179	177.179	177.179
Latvia	lat/$	0.633	0.611	0.497	0.497	0.497	0.497	0.497	0.497	0.497	0.497	0.497
Lithuania	litas/$	3.139	3.029	2.466	2.466	2.466	2.466	2.466	2.466	2.466	2.466	2.466
Poland	zloty/$	3.657	3.529	2.874	2.874	2.874	2.874	2.874	2.874	2.874	2.874	2.874
Romania	lei/$	3.292	3.176	2.586	2.586	2.586	2.586	2.586	2.586	2.586	2.586	2.586
Slovakia	sk koruna/$	35.090	33.859	27.571	27.571	27.571	27.571	27.571	27.571	27.571	27.571	27.571
Slovenia	tolar/$	217.789	210.147	171.120	171.120	171.120	171.120	171.120	171.120	171.120	171.120	171.120

Table 9.12: Exchange rate data at US$ 1.0 per euro

		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Exchange rate Euro vs $: US$ 1.0 per euro												
EU-15	euro/$	0.909	0.917	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Exchange rate vs $: at US$ 1.0 per euro												
Belgique/B	BEF/$	36.673	37.009	40.340	40.340	40.340	40.340	40.340	40.340	40.340	40.340	40.340
Danmark	DKK/$	7.112	7.177	7.823	7.823	7.823	7.823	7.823	7.823	7.823	7.823	7.823
Deutschlar	DM/$	1.778	1.794	1.956	1.956	1.956	1.956	1.956	1.956	1.956	1.956	1.956
Ellada	GDR/$	309.773	312.615	340.750	340.750	340.750	340.750	340.750	340.750	340.750	340.750	340.750
Espana	PTS/$	151.260	152.648	166.386	166.386	166.386	166.386	166.386	166.386	166.386	166.386	166.386
France	FF/$	5.963	6.018	6.560	6.560	6.560	6.560	6.560	6.560	6.560	6.560	6.560
Ireland	IEP/$	0.716	0.723	0.788	0.788	0.788	0.788	0.788	0.788	0.788	0.788	0.788
Italia	ITL/$	1760.245	1776.394	1936.270	1936.270	1936.270	1936.270	1936.270	1936.270	1936.270	1936.270	1936.270
Nederland	NLG/$	2.003	2.022	2.204	2.204	2.204	2.204	2.204	2.204	2.204	2.204	2.204
Osterrich	ATS/$	12.509	12.624	13.760	13.760	13.760	13.760	13.760	13.760	13.760	13.760	13.760
Portugal	PTE/$	182.256	183.928	200.482	200.482	200.482	200.482	200.482	200.482	200.482	200.482	200.482
Suomi/Finl	FIM/$	5.405	5.455	5.946	5.946	5.946	5.946	5.946	5.946	5.946	5.946	5.946
Sverige	SEK/$	7.682	7.752	8.450	8.450	8.450	8.450	8.450	8.450	8.450	8.450	8.450
United Kin	£/$	0.630	0.644	0.704	0.704	0.704	0.704	0.704	0.704	0.704	0.704	0.704
Bulgaria	Lev/$	1.778	1.794	1.956	1.956	1.956	1.956	1.956	1.956	1.956	1.956	1.956
Czech Rep	cz koruna/	27.075	27.323	29.782	29.782	29.782	29.782	29.782	29.782	29.782	29.782	29.782
Estonia	kroon/$	14.224	14.355	15.647	15.647	15.647	15.647	15.647	15.647	15.647	15.647	15.647
Hungary	forint/$	225.500	227.569	248.050	248.050	248.050	248.050	248.050	248.050	248.050	248.050	248.050
Latvia	lat/$	0.633	0.639	0.696	0.696	0.696	0.696	0.696	0.696	0.696	0.696	0.696
Lithuania	litas/$	3.139	3.168	3.453	3.453	3.453	3.453	3.453	3.453	3.453	3.453	3.453
Poland	zloty/$	3.657	3.691	4.023	4.023	4.023	4.023	4.023	4.023	4.023	4.023	4.023
Romania	lei/$	3.292	3.322	3.621	3.621	3.621	3.621	3.621	3.621	3.621	3.621	3.621
Slovakia	sk koruna/	35.090	35.412	38.599	38.599	38.599	38.599	38.599	38.599	38.599	38.599	38.599
Slovenia	tolar/$	217.789	219.787	239.568	239.568	239.568	239.568	239.568	239.568	239.568	239.568	239.568

Annex 5: Assumptions for Bulgaria and Romania in (Non)-Enlargement scenarios

Macroeconomy

Table 9.13: Macro-economic assumptions for Bulgaria

	Unit	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Real GDP	bil. Euro	522	640	658	677	696	715	733	766	800	836	874	913
Population	million	7.9	7.6	7.5	7.4	7.3	7.3	7.2	7.2	7.2	7.2	7.2	7.2
GDP deflator	1995=1	1.31	1.39	1.40	1.41	1.42	1.44	1.45	1.46	1.47	1.48	1.48	1.49
Real GDP/capita	euro/cap	2125	2180	2204	2225	2253	2250	2277	2332	2390	2445	2508	2567

Table 9.14: Macro-economic assumptions for Romania

	Unit	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Real GDP	bil. Euro	61	78	100	96	100	105	110	116	122	129	137	144
Population	million	22.4	21.6	21.6	21.6	21.5	21.5	21.5	21.5	21.4	21.4	21.4	21.4
GDP deflator	2001=1	1.00	0.93	0.81	0.86	0.83	0.80	0.88	0.91	0.94	0.87	0.92	0.92
Real GDP/capita	euro/cap	2723	3621	4617	4457	4666	4892	5141	5414	5690	6017	6381	6748

Price linkage and price convergence

Table 9.15: Price determination for agricultural products in Bulgaria (prod prices, euro per tonne)

	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Softwheat												
EU key price	109.3	103.7	104.1	103.5	103.5	103.7	104.0	103.9	103.9	103.9	103.8	103.8
BG NES price	94.9	99.0	99.1	98.5	98.3	98.4	98.6	98.5	98.5	98.5	98.5	98.5
BG ES price	94.9	99.2	99.3	98.7	98.6	98.6	98.8	98.8	98.7	98.7	98.7	98.7
Dummies	0	0	0									
Barley												
EU key price	111.5	99.6	99.2	98.2	97.9	97.6	97.4	97.3	97.2	97.2	97.1	97.0
BG NES price	91.4	83.2	82.9	82.2	81.9	81.7	81.5	81.5	81.4	81.4	81.3	81.3
BG ES price												
Dummies	0	0	0									
Maize												
EU key price	120.8	107.4	107.8	107.1	106.9	106.6	106.5	106.3	106.1	105.9	105.6	105.3
BG NES price	104.0	108.7	108.7	107.9	107.2	107.1	107.1	107.0	107.1	107.2	107.2	107.3
BG ES price	104.0	109.3	109.5	108.7	108.1	107.9	107.9	107.9	107.9	107.9	108.0	108.0
Dummies	0	0	0									
Sunflowers												
EU key price	237.9	266.3	267.7	254.3	254.2	254.1	252.0	252.0	252.0	252.0	252.0	252.0
BG NES price	185.8	154.0	144.7	143.2	149.3	146.2	144.0	144.0	144.0	144.0	144.0	144.0
BG ES price	185.8	154.0	144.7	143.2	149.3	146.2	144.0	144.0	144.0	144.0	144.0	144.0
Dummies	0	0	0									
Beef and veal												
EU key price (€/100kg)	298.6	287.0	285.3	281.8	280.3	280.3	281.2	282.8	283.0	283.4	283.6	283.7
BG NES price (€/100kg)	176.0	213.8	220.4	225.0	231.6	237.5	244.2	252.1	259.9	267.7	275.6	283.4
BG ES price (€/100kg)	176.0	220.7	227.3	231.9	238.5	244.4	251.2	259.0	266.8	274.6	292.5	290.3
Dummies	0	0	0									
Pork												
EU key price (€/100kg)	131.7	111.9	105.3	98.5	95.2	101.3	106.9	106.4	105.8	105.2	104.6	104.1
BG NES price (€/100kg)	134.6	119.0	114.3	108.9	105.7	108.4	111.1	110.4	109.5	108.6	107.7	106.8
BG ES price (€/100kg)	134.6	119.3	114.6	109.1	105.9	108.8	111.4	110.7	109.8	108.9	108.0	107.0
Dummies	0	0	0									
Poultry												
EU key price (€/100kg)	152.9	141.4	138.0	135.1	131.9	130.7	129.2	126.8	124.4	122.0	119.5	117.1
BG NES price (€/100kg)	121.8	104.3	101.0	98.4	96.3	94.3	92.6	92.6	92.6	92.6	92.6	92.6
BG ES price (€/100kg)	121.8	102.7	100.2	98.0	96.0	94.4	94.4	94.4	94.4	94.4	94.4	94.4
Dummies	0	0	0									
Sheepmeat												
EU key price (€/100kg)	136.3	154.9	156.9	158.8	160.6	162.8	165.0	167.9	170.3	172.7	174.9	177.0
BG NES price (€/100kg)	142.5	149.8	149.5	149.2	149.0	148.6	148.7	148.6	148.6	148.7	148.9	149.0
BG ES price (€/100kg)	142.5	150.4	150.2	149.9	149.7	149.3	149.5	149.4	149.4	149.5	149.7	149.8
Dummies	0	0	0									
Milk												
EU key price (€/100kg)												
BG NES price (€/100kg)	177.9	182.5	181.5	179.9	175.0	175.5	175.6	175.4	175.1	174.8	174.5	174.2
BG ES price (€/100kg)	177.9	182.9	181.9	180.1	174.3	174.9	175.0	174.8	174.5	174.2	173.9	173.8
Dummies	0	0	0									
Cheese												
EU key price (€/100kg)	474.5	476.4	465.6	453.9	441.3	432.1	425.5	420.8	417.3	414.7	412.8	411.4
BG NES price (€/100kg)	167.0	156.8	157.2	156.9	149.4	150.1	150.3	150.0	149.7	149.3	149.0	148.6
BG ES price (€/100kg)	167.0	157.6	58.2	157.9	150.2	151.0	151.2	151.0	150.6	150.2	149.9	149.6
Dummies	0	0	0									

NES: Non-Enlargement scenario; ES: Enlargement scenario

Table 9.16: Price determination for agricultural products in Romania (prod. prices, euro per tonne)

	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Softwheat												
EU key price	109.3	103.7	104.1	103.5	103.5	103.7	104.0	103.9	103.9	103.9	103.8	103.8
RO NES price	112.0	127.0	123.1	125.0	128.0	130.0	131.0	132.0	133.0	133.0	134.0	134.0
RO ES price	112.0	127.0	123.1	135.0	145.0	143.0	135.0	136.0	136.0	137.0	137.0	138.0
Dummies	0	0	0									
Maize												
EU key price	120.8	107.4	107.8	107.1	106.9	106.6	106.5	106.3	106.1	105.9	105.6	105.3
RO NES price	108.0	123.0	119.0	122.0	125.0	127.0	127.0	128.0	130.0	131.0	131.0	133.0
RO ES price	108.0	123.0	123.0	130.0	131.5	132.0	132.0	134.0	134.0	135.0	135.0	135.0
Dummies	0	0	0									
Sunflowers												
EU key price	237.9	266.3	267.7	254.3	254.2	254.1	252.0	252.0	252.0	252.0	252.0	252.0
RO NES price	213.7	255.5	258.1	260.9	263.0	265.1	267.6	268.0	268.0	265.0	262.0	262.0
RO ES price	214.0	255.0	262.0	266.0	271.0	275.0	277.0	279.0	281.0	283.0	284.0	288.0
Dummies	0	0	0									
Beef and veal												
EU key price (€/100kg)	298.6	287.0	285.3	281.8	280.3	280.3	281.2	282.8	283.0	283.4	283.6	283.7
RO NES price (€/100kg)	214.1	241.0	245.8	250.7	250.0	246.0	248.5	249.5	249.2	249.0	249.1	249.3
RO ES price (€/100kg)	214.1	241.0	245.8	252.6	249.0	246.8	246.5	237.9	238.1	238.3	238.4	238.9
Dummies	0	0	0									
Pork												
EU key price (€/100kg)	131.7	111.9	105.3	98.5	95.2	101.3	106.9	106.4	105.8	105.2	104.6	104.1
RO NES price (€/100kg)	138.0	157.0	158.2	158.5	158.8	159.1	159.2	159.4	159.6	159.7	159.8	160.1
RO ES price (€/100kg)	138.0	157.0	158.2	153.8	153.4	154.4	156.0	156.6	156.7	156.8	157.0	157.0
Dummies	0	0	0									
Poultry												
EU key price (€/100kg)	152.9	141.4	138.0	135.1	131.9	130.7	129.2	126.8	124.4	122.0	119.5	117.1
RO NES price (€/100kg)	105.0	119.7	123.1	123.5	123.7	123.7	123.8	123.9	123.9	123.9	123.8	123.7
RO ES price (€/100kg)	105.0	119.7	123.1	118.0	117.6	114.5	114.2	113.8	113.5	113.2	113.0	112.5
Dummies	0	0	0									

NES: Non-Enlargement scenario; ES: Enlargement scenario

Budgetary support

Table 9.17: Budgetary support for agricultural commodities in Bulgarian model (mio euro)

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Softwheat													
NES – national funds	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
ES - national funds	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
ES - EU funds					59.6	71.2	83.0	95.4	94.6	94.0	93.3	93.7	93.0
Maize													
NES – national funds	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ES - national funds	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ES - EU funds					15.7	18.7	21.9	25.3	25.3	25.2	25.2	23.2	25.2
Sunflower													
NES – national funds	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
ES - national funds	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
ES - EU funds					17.6	23.6	28.8	33.0	33.3	33.7	33.1	33.0	33.0
Cattle													
NES – national funds	196.7	203.2	209.8	216.1	216.1	216.1	216.1	216.1	216.1	216.1	216.1	216.1	216.1
ES - national funds	196.7	203.2	209.8	216.1	216.1	216.1	216.1	216.1	216.1	216.1	216.1	216.1	216.1
ES - EU funds					6.4	16.5	36.7	37.2	38.8	40.4	41.8	43.2	46.5
Ewe													
NES – national funds	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
ES - national funds					5.2	6.2	7.2	8.2	9.0	9.6	10.0	10.9	11.2
ES - EU funds													
Milk cows													
NES – national funds	196.7	203.2	209.8	216.1	216.1	216.1	216.1	216.1	216.1	216.1	216.1	216.1	216.1
ES - national funds	196.7	203.2	209.8	216.1	216.1	216.1	216.1	216.1	216.1	216.1	216.1	216.1	216.1
ES - EU funds					6.4	16.5	36.7	37.2	38.8	40.4	41.8	43.2	46.5
Cattle cows													
NES – national funds	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ES - national funds	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ES - EU funds													
Total NES													
Total ES nat. funds	198.4	204.9	211.4	217.7	217.7	217.7	217.7	217.7	217.7	217.7	217.7	217.7	217.7
Total ES EU funds	197.2	203.7	210.2	216.5	221.7	222.8	223.7	224.8	225.6	226.1	226.6	227.4	227.8

NES: Non-Enlargement scenario; ES: Enlargement scenario

Table 9.18: Budgetary support for agricultural commodities in Romanian model (mio euro)

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Softwheat													
NES – national funds	114.9	148.4	181.1	230.5	222.2	232.2	243.1	255.3	268.6	282.0	298.1	316.0	334.0
ES - national funds	114.9	148.4	182.3	230.5	64.1	67.6	67.6	67.6	67.6	67.6	67.6	67.6	67.6
ES - EU funds	0.0	0.0	0.0	0.0	411.9	435.1	435.1	435.1	435.1	435.1	435.1	435.1	435.1
Barley													
NES – national funds	24.8	32.0	39.1	49.8	48.0	50.1	52.5	55.1	58.0	60.9	64.3	68.2	72.1
ES - national funds	24.8	32.0	39.1	49.8	13.8	14.6	14.6	14.6	14.6	14.6	14.6		
ES - EU funds	0.0	0.0	0.0	0.0	88.9	93.9	93.9	93.9	93.9	93.9	93.9		
Maize													
NES – national funds	158.0	204.1	249.0	317.0	305.6	319.3	334.3	351.1	369.3	387.8	409.9	434.5	459.2
ES - national funds	158.0	204.1	249.0	317.0	88.2	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0
ES - EU funds	0.0	0.0	0.0	0.0	566.4	598.2	598.2	598.2	598.2	598.2	598.2	598.2	598.2
Sunflower													
NES – national funds	50.6	65.4	79.8	101.6	98.0	102.4	107.2	112.5	118.4	124.3	131.4	139.3	147.2
ES - national funds	50.6	65.4	79.8	101.6	28.3	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8
ES - EU funds	0.0	0.0	0.0	0.0	181.6	191.8	191.8	191.8	191.8	191.8	191.8	191.8	191.8
Cattle													
NES – national funds	37.1	68.0	55.6	70.8	68.3	71.4	74.7	78.4	82.5	86.7	91.6	97.1	102.6
ES - national funds	37.1	68.0	55.6	70.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ES - EU funds	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Milk cows													
NES – national funds	36.5	44.0	49.7	63.3	61.0	63.7	66.7	70.0	73.7	77.4	81.8	86.7	91.6
ES - national funds	36.5	44.0	49.7	63.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ES - EU funds	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cattle cows													
NES – national funds													
ES - national funds					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ES - EU funds					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total NES	422.0	561.9	654.3	833.0	803.0	839.1	878.6	922.5	970.5	1019.0	1077.1	1141.7	1206.8
Total ES nat. funds	422.0	561.9	655.5	833.1	194.5	205.1	205.1	205.1	205.1	205.1	205.1	190.5	190.5
Total ES EU funds	0.0	0.0	0.0	0.0	1248.7	1319.0	1319.0	1319.0	1319.0	1319.0	1319.0	1225.1	1225.1

NES: Non-Enlargement scenario; ES: Enlargement scenario

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Abstract

This report is based on the outcome of a study carried out by the AGMEMOD Partnership under the management of the Agricultural Economics Research Institute (LEI, the Netherlands), in cooperation with the Joint Research Centre – Institute for Prospective Technological Studies (JRC-IPTS) to generate yearly projections for the main agricultural commodity markets from 2005 until 2015.

This report describes the modelling techniques used by the AGMEMOD Partnership, with emphasis on new commodities modelled and policy modelling approaches.

Detailed documentation on the AGMEMOD modelling approach, along with the outcome of the study, is published in five reports in the JRC-IPTS Scientific and Technical Report Series under the heading "Impact analysis of Common Agricultural Policy reform on the main agricultural commodities".

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