



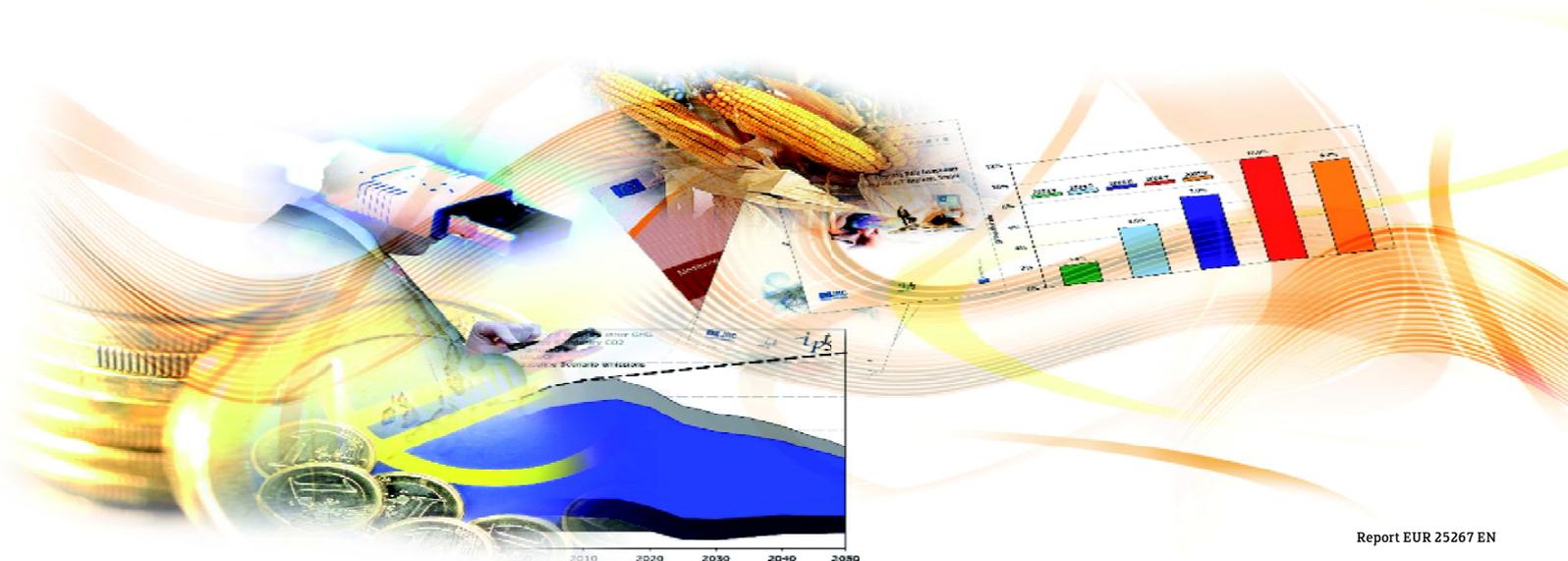
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An integrated Modelling Platform for Agro-economic Commodity and Policy Analysis (iMAP) - a look back and the way forward

Robert M'barek, Wolfgang Britz, Alison Burrell, Jacques Delincé

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- a look back and the way forward

(Editors)

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Building, maintaining and applying an integrated Modelling Platform for Agro-economic Commodity and Policy Analysis (iMAP), whose aim is to deliver in-house policy support to the European Commission, has been a long-term project at the JRC-IPTS since 2005.

iMAP is the result of the collaboration and contribution from many former and present IPTS colleagues as well from researchers outside IPTS, and was formally created in 2006.

It started with an idea from Per Sørup (Head of the SAFH/AGRILIFE unit until February 2009), who early in 2005 entrusted Robert M'barek with the task of building up capacity in agro-economic modelling at IPTS. At the beginning, those involved in the iMAP agro-economic modelling group included former colleagues Stephan Hubertus Gay (now at DG AGRI), Peter Wobst (now at FAO), and Ignacio Pérez Domínguez (now at OECD), Marc Mueller (now at University of Bonn). Monique Libeau-Dulos (IPTS) made an important contribution to the institutional set-up of iMAP.

Later Axel Tonini (now at LEI), Lubica Bartova (seconded from Nitra University), Federica Santuccio (now freelance), Alison Burrell (now freelance researcher), Maria Blanco Fonseca (from Universidad Politecnica Madrid), Thomas Fellmann (now at Universidad Pablo de Olavide de Sevilla), Aikaterini Kavallari (now at LEI), Martin Henseler (now at vTI) and Isabelle Piot-Lepetit (seconded from INRA) joined the team.

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Acronyms

AAFC	Agriculture and Agri-Food Canada
CAP	Common Agricultural Policy
CGE	Computable General Equilibrium
DG AGRI	Directorate General for Agriculture and Rural Development
DG ENV	Directorate General for the Environment
DG Estat	Eurostat
EAAE	European Association of Agricultural Economists
EC	European Commission
EU	European Union
FAO	Food and Agricultural Organization
GMO	Genetically Modified Organism
GSE	Gams Simulation Environment
ILUC	Indirect Land Use Change
iMAP	integrated Modelling Platform for Agro-economic commodity and Policy analysis
iMAP-RG	iMAP Reference Group
IOT	Input Output Tables
JRC-IPSC	Joint Research Centre-Institute for the Protection and Security of the Citizen
JRC-IPTS	Joint Research Centre-Institute for Prospective Technological Studies
JRC-IES	Joint Research Centre-Institute for Environment and Sustainability
LFA	Less Favoured Areas
LEI	Landbouw-Economisch Instituut (Agricultural Economics Institute)
LUCC	Land Use Cover Change
MS	Member State
NUTS	Nomenclature of Territorial Units for Statistics
OECD	Organization for Economic Co-operation and Development
PE	Partial Equilibrium
PRIMES	Energy system model
RD	Rural Development
SAM	Social Accounting Matrix
SFP	Single Farm Payment
SMP	Skimmed milk powder
vTI	Johan Heinrich von Thünen-Institut
WMP	Whole milk powder
WTO	World Trade Organization

■ Executive Summary

This report describes the rationale and performance of the integrated Modelling Platform for Agro-economic Commodity and Policy Analysis (iMAP), hosted by the European Commission's Joint Research Centre, Institute for Prospective Technological Studies (JRC IPTS) in Seville.

Concept of iMAP

The concept of iMAP started early 2005 with the idea of building up a platform to host agro-economic modelling tools financed by the European Commission, in particular the EU Research Framework Programmes. Largely with financing from the Agriculture and Rural Development Directorate General (DG AGRI), it has developed into a policy support-oriented platform that disposes of a number of Partial Equilibrium (PE) and Computable General Equilibrium (CGE) models.

These models are used in stand-alone mode or in combination, so as to address a broad range of topics linked to the economic assessment of agricultural and rural development policies, as well as those concerning related topics such as trade, energy, environment, and climate change.

To serve the policy decision-making process, several requirements have to be met. iMAP has to provide results and recommendations in a timely manner and satisfy high standards of scientific quality and transparency. Close links with the current policy agenda have to be maintained. Furthermore, harmonised, public databases should be used whenever possible. In ex ante analysis, a future baseline, harmonised between models and accepted by clients, should provide the benchmark for counterfactual analysis.

Following these and other criteria, all individual components of iMAP are well-established economic models with a long record of applications in research and policy support.

Modelling tools in iMAP

Partial equilibrium (PE) models portray the behavioural interactions within one or more economic sectors, whilst treating outcomes in other sectors as exogenous and hence unaffected by changes in the sector(s) depicted. PE models are used to investigate the impact of changes on those sectors most immediately relevant to a problem with no feedback of these impacts from other sectors. The PE models in iMAP focus on the agricultural sector. Increasingly, they also comprise other selected sectors (vegetable oil processing, dairies, biofuel processing, feed concentrate industry) with strong ties to primary agriculture or to the wider economy (e.g. competition for land). The core PE models of iMAP are AGLINK-COSIMO, CAPRI and ESIM, although other models or tools are used to complement or address questions that cannot be treated with these models.

AGLINK-COSIMO is a recursive-dynamic, partial equilibrium, market model of world agriculture, built by merging OECD's AGLINK and FAO's COSIMO models. Within iMAP and under the lead of DG AGRI, the model is mainly used to provide the EU agricultural outlook published in the last quarter of each year, which is also fed into the OECD-FAO outlook. The JRC-IPTS team is in charge of the analysis of the uncertainties underlying the baseline projections, running for example partial stochastic simulations.

CAPRI (Common Agricultural Regionalised Impact Analysis) is a global, spatial, partial equilibrium model, specifically designed to analyse CAP measures and trade policies for agricultural products based on a fully consistent data set over different regional scales (global, EU, Member State, NUTS2 regions, farm types). CAPRI is designed to analyse a wide range of policies and topics related to the agricultural sector, including agri-environmental interactions.

ESIM (European Simulation Model) is a comparative static, partial equilibrium, net-trade multi-country model of the agricultural sector. It covers supply and demand for agricultural products, with a detailed specification of cross-commodity relationships, and some first-stage processing activities.

AGMEMOD (AGricultural MEmber states MODelling) is a dynamic, multi-country, multi-market, partial equilibrium modelling system. It is composed of econometrically estimated, country-specific, economic models of agricultural commodity markets and can provide significant detail on the main agricultural sectors in each EU Member State and EU candidate countries.

Computable general equilibrium (CGE) models are systems of nonlinear simultaneous equations representing the constrained optimising behaviour of all agents within the economy as producers, consumers, factor suppliers, exporters, importers, taxpayers, savers, investors, or government. This means that it depicts the production, consumption, intra-sectoral input and trade of all sectors for one country, a region or even all countries worldwide. The main CGE models used are GTAP, GLOBE, MAGNET, soon to be complemented by a regional CGE (RegEU27).

GTAP (Global Trade Analysis Project) is a global network of researchers and policy makers conducting quantitative analysis of international policy issues. GTAP has developed a CGE model known as the GTAP model together with a database that is also used by a number of other CGE models. The standard GTAP Model is a static multi-region, multi-sector, CGE model, with perfect competition and constant returns to scale. Bilateral trade is handled via the Armington assumption.

GLOBE is a Social Accounting Matrix (SAM)-based global CGE model that is calibrated with data from the GTAP database. The GLOBE model, written in the GAMS programming language, permits a great flexibility of general and specific closure rules.

MAGNET (Modular Applied GeNeral Equilibrium Tool) is a global CGE model, adopting a modular approach, whereby the standard GTAP-based core can be augmented with modules such as land supply, land allocation or biofuel modules depending on the purpose of the study. For iMAP the detailed focus on agricultural policy is particularly useful.

REgEU27 is a layer of national CGE models, each regionalized to NUTS2 regions, developed in the FP7 CAPRI-RD project with a focus on CAP Pillar 2 and Rural Development indicators. It currently covers

270 NUTS2 regions for all EU Member States and 12 sectors. The model can be used in stand-alone mode or integrated into CAPRI based on sequential iteration.

Databases and data management

Science-based policy support requires high-quality and reliable data. iMAP is engaged in long-term activities to consolidate agro-economic data so as to ensure that they are comparable, using harmonized methodology.

IPTS has started to develop concepts for data harmonisation and management together with external partners (PROGNOZ software company). The product, DataM, is a database management tool designed to simplify the daily data work of analysts and modellers in agriculture, either to feed economic models with data, to check data or to analyse results.

The main strength of the tool are the linkages between the nomenclatures of the different databases (“mappings”), meaning that users can retrieve all the available data from different sources related to a particular item more quickly without specific knowledge of the nomenclature used by the different data providers.

iMAP at work

A selection of applications of iMAP tools carried out at the IPTS or in cooperation with other model teams is provided according to different topics.

A benchmark for ex ante impact assessment: regular provision of a medium-term outlook for EU agriculture

The “Prospects for Agricultural Markets and Income in the EU” (hereafter known as the “outlook”) is a key annual publication of DG AGRI, which contains medium-term baseline projections. The agricultural baseline projections are constructed jointly by DG AGRI and JRC-IPTS using mainly the AGLINK-COSIMO model. The outlook projections serve as a benchmark for ex ante policy simulations. They provide the context for analysing medium-term market and policy issues, and are not intended to provide short-term forecast of market developments or to address short-term market issues. The CAPRI and ESIM models are calibrated to this baseline, in order to provide the same underlying vision and consistent set of assumptions in subsequent policy simulations.

Baseline projections depict rather smooth market developments, while in reality markets tend to move along a more volatile path as observed in the past and particularly over recent years. An uncertainty analysis is carried out to assess and quantify how alternative assumptions about the main drivers of demand and supply, the general macroeconomic setting, and prospects for biofuel markets could influence the projected agricultural market developments.

iMAP models in stand alone mode: Assessment of agricultural market and farm income impacts

A main objective of iMAP is to support DG AGRI with model-based policy assessments.

An example of a comprehensive analysis of EU agriculture in the context of global and regional trade is the impact assessment of a potential EU-Mercosur Free Trade Agreement performed with

the GLOBE and CAPRI models (JRC Reference Report 2011). Another example is the simulation of a comprehensive free trade agreement between the EU and Ukraine using the AGLINK-COSIMO model, which has resulted in several articles (2011).

The assessment of domestic policies carried out by iMAP models has dealt mainly with the reform of the CAP. An assessment of the EU's milk quota reform and in particular the potential impact of the abolition of the milk quota was a key topic during 2008 and 2009. In a series of studies in close cooperation with international modelling teams the PE models CAPRI, CAPSIM and AGMEMOD were used, focussing on different aspects of the dairy reform. In the context of the impact assessment for the legal proposals for the CAP after 2013, different contributions were delivered, among those the analysis of the proposal to remove the sugar quota from 2015 with the ESIM model. The results are published in the annex of the impact assessment by DG AGRI (2011).

Studies of the possible impacts of EU enlargement have focused in particular on the Western Balkans and Turkey. Studies on Western Balkan countries accession scenarios were published in 2009 (CAPSIM, a PE model which is not anymore used) and on Turkey in 2011 (AGMEMOD).

iMAP as part of JRC-wide policy support

iMAP models have also played a strong role in integrating several JRC activities that span the various different JRC research priorities (agriculture, energy, environment, climate change and development) and have acted as a link between the natural sciences (bio-physical modelling) and economic analysis.

The IPTS study of EU biofuel policy used the three iMAP partial equilibrium agro-economic models, namely AGLINK-COSIMO, ESIM and CAPRI, according to their relative strengths. The report demonstrates how the use of several models provides a rich, composite picture that could not be achieved with just one model. The study was entirely carried out at IPTS, involving the iMAP teams of all three models mentioned. In the preparation phase of these simulations, a dialogue with the model developers took place, in order to acquire full knowledge about how the biofuel sector is specified in each model. The impacts identified include higher EU production of ethanol and biodiesel, and of the crops used to produce them, as well as more imports of both biofuels. AGLINK-COSIMO estimates an extra 5.2 million hectares used for cereals, oilseeds and sugar crops globally as a result of EU biofuel targets for 2020. The study was made a reference document; results were a main input for the ILUC land allocation and finally published as a JRC reference report (2010).

The objective of the JRC-wide project "Evaluation of the livestock sector's contribution to the EU greenhouse gas emissions" was to provide an estimate of the net emissions of GHGs and ammonia from the livestock sector in the EU-27 according to animal species, animal products and livestock systems. The CAPRI model was adapted in cooperation with other research institutions so as to account for product-based GHG emissions from EU livestock production using the life cycle assessment concept. With respect to mitigation policy scenarios, results show that the emission reduction effects per EU Member State in each scenario are quite different from the EU-27 average, depending on the production levels and agricultural activities. The analysis also reveals that a unilateral GHG emission reduction in the EU would provoke an emission increase in the rest of the world. The report was published in 2010.

iMAP under review

As part of the iMAP strategy, a Reference Group was formed, composed of well-known and experienced external experts in agricultural sector modelling, some of them the original developers of iMAP models. The Reference Group provides independent advice and feedback concerning the maintenance, development and use of the main modelling tools currently available in iMAP. Alongside iMAP staff and in close co-operation with DG AGRI it also regularly reviews agricultural market and policy developments from the perspective of their quantitative impact to ensure an appropriate future strategy for iMAP.

This has created an open discussion forum on issues such as database harmonisation, market outlook and the calibration of models to a deterministic baseline, software implementation and capacity-building. Discussions on how to model specific policy instruments have given insights into the comparative advantages of each of the iMAP models, and have highlighted the role of the policy analyst and of the modeller in making the right choices and meeting the demand of the policy makers. Not least, these meetings have given DG AGRI the opportunity to explain upcoming analytical needs, thereby allowing the model developers to prepare their tools accordingly.

Among the current strengths of iMAP identified by the Reference Group are the close interaction between DG AGRI, IPTS modellers and experts beyond the context of a specific study project. This has helped significantly to improve the understanding of what the iMAP models are and which research questions they can address.

The Reference Group considered that the deepening and extension of this interactive procedure also offered an important opportunity for the future, e.g. for increasing collaboration on integrated modelling approaches. Also the limitation imposed by the high staff turnover at IPTS and the danger that resources would be over-allocated to short-term ad hoc policy support were pointed out.

Visions and challenges

The agricultural and food-related policy issues to be assessed, as well as the economic, social and environmental settings, have changed over time. Just as methodologies, software, hardware etc. are further developed over the course of time, so are - or should be - the tools used and competences needed within iMAP.

The policy priorities for the new financial framework of the European Commission and the future CAP are not a straightforward continuation of business as usual. The financial and economic crisis and the increasing importance of emerging countries, as well as global challenges such as climate change, have led to a reshaping of priorities.

These new directions translate into new requirements for models in their spatial and temporal dimensions, sectors and actors, scenarios and interpretation. The globalised world with new economic powers, changing production and consumption patterns, and volatile markets linked to each other, needs models dealing with structural breaks, stagnating economic outlooks and complex new policies.

iMAP has neither the ambition nor the capacity to adapt its models in order to deal with all potential questions arising. Instead, iMAP will focus on improvements needed to address policy and research-oriented questions relating to agriculture, food, and natural resources with an economic dimension, in particular:

- Assessment of alternative policy options of the CAP towards 2020 and beyond;
- Evaluation of international competitiveness of the European agro-food sector in an uncertain and volatile economic environment with ongoing multi- and bilateral trade liberalisation;
- Short-, medium- and long-term assessment of food security, mainly supply/demand balances and price volatility;
- Economic impact analysis of agriculture's contribution to green growth, investigating alternative policy options to adapt and/or mitigate climate change, to make water use more efficient and in particular to estimate indirect land use changes due to new policies;
- How farm structural change, new technologies, changing consumer behaviour, demographics and other trends impact on the sector and rural regions.

Science-based policy support requires high quality, reliable and up-to-date data. So, iMAP will have to devote more effort to validating and checking the input (including parameters, coefficients etc.) and output of models.

Further research and investment will be also made to i) optimise model structures and refine codes to reduce running time, as well as to extending sensitivity analyses; ii) focus on the most important policy developments according to the strengths of the individual models (reminder: no model can serve all purposes); and consequently iii) reinforce the connections between models when this can be beneficial for answering the policy or research question at stake. Moreover, different approaches for long-term outlooks (10 to 40 years and beyond), capturing changes in existing consumption patterns, specific advancements in technology, binding constraints for the use of natural resources, etc. will be carefully evaluated.

In addition to its role in supporting policy, iMAP will contribute to making model results and harmonised data sources publicly available, thus increasing transparency and facilitating their scientific review. Keeping close links to the core development teams in academia remains very important. It should allow the maintenance and further development of the quantitative tools, while keeping the scientific benchmark high.

At JRC level, iMAP has pioneered the development of modelling platforms, has inspired to set up a modelling task force and serves as an example of a productive policy-JRC-academia triangle. The incorporation of related activities within JRC into iMAP is an imminent step.

To further develop its added value as a truly European exercise delivering high quality research and policy support, iMAP has to take up the challenges of integration with other research methodologies, collaboration and transparency.

■ 1 Introduction

Quantitative analysis of agricultural and rural development policies, as well as those concerning related topics such as trade, energy, environment and climate change, make an important contribution to the policy-making process in these areas, as is acknowledged in the EU's Impact Assessment guidelines of the EU¹. Economic simulation models depict the interrelationships between selected economic variables and, as such, provide a simplified but clearly structured and quantified representation of economic reality that can be used *ex ante* to analyse the impacts of policy changes. Such models are widely applied in the analysis of the agricultural sector as provider of food, feed, fibre and now, increasingly, energy, but also of its role in the rural economy and of the environmental effects linked to agricultural production. *Ex post* analysis of policies typically demands an evidence-based assessment, and therefore stylised simulation models like those described in this document are less commonly used.

The Institute for Prospective Technological Studies (JRC IPTS) in Seville, which is part of the European Commission's Joint Research Centre, provides in particular the Agriculture and Rural Development Directorate General (DG AGRI) with impact analyses of agricultural and related policies and collaborates on market projections. When appropriate, this work may be done in close co-operation with other JRC institutes and research institutions.

In order to streamline and enhance the agricultural policy support role played by JRC IPTS, an Integrated Modelling Platform for Agro-economic Commodity and Policy Analysis, known as iMAP, has been set up with the aim of:

- Implementing quantitative tools for agricultural commodity market and policy analysis.
- Developing and validating a single database for agricultural market models.
- Ensuring the development, maintenance, validation and policy relevant application of the selected quantitative tools.

The concept of iMAP started with the idea of building up a platform to host agro-economic tools financed by the Commission, in particular the EU research framework programmes. Largely with financing from DG AGRI, it has developed into a policy support-oriented platform that disposes of a number of tools.

iMAP was created in order to utilise selected Partial Equilibrium (PE) and Computable General Equilibrium (CGE) models, in stand-alone mode or in combination, so as to address a broad range of topics linked to the economic assessment of the CAP, thereby providing a scientific basis for policy decision-making. It also faces the challenge of finding recurrent funding in order to maintain and update tools and related human capital so that they can be deployed on demand while ensuring high standards.

This report begins with a general overview of the modelling platform (chapter 1) and the tools it hosts (chapter 2). It then summarises recent applications of iMAP (chapter 3). Chapter 4 discusses aspects of the implementation and performance of iMAP, including the main areas of agro-economic activity covered by the core models. In chapter 5, the strategic orientation of iMAP for the future is briefly discussed and the role of the iMAP Reference Group is described. The last chapter outlines key issues for the future strategic orientation of iMAP.

1 http://ec.europa.eu/governance/impact/index_en.htm

■ 2 Concept of iMAP, an Integrated Modelling Platform for Agro-economic Commodity and Policy Analysis

Chapter prepared by Robert M'barek, Wolfgang Britz, Alison Burrell, Jacques Delincé

2.1 Challenges of a modelling platform

A modelling platform serving the decision-making process for policy has to meet several requirements.

First of all, it has to provide results and recommendations in a **timely** manner, with high scientific **quality** and **transparency**. Close links with the current policy agenda have to be maintained.

Secondly, harmonised and public **databases** should be used whenever possible (e.g. EUROSTAT or FAOSTAT data), since traceability of data is one of the main obstacles in this discipline. In ex ante analysis, a future **baseline**, harmonised between tools and accepted by clients, should provide the benchmark for counterfactual analysis,

Thirdly, the **models** used should whenever possible satisfy the following criteria:

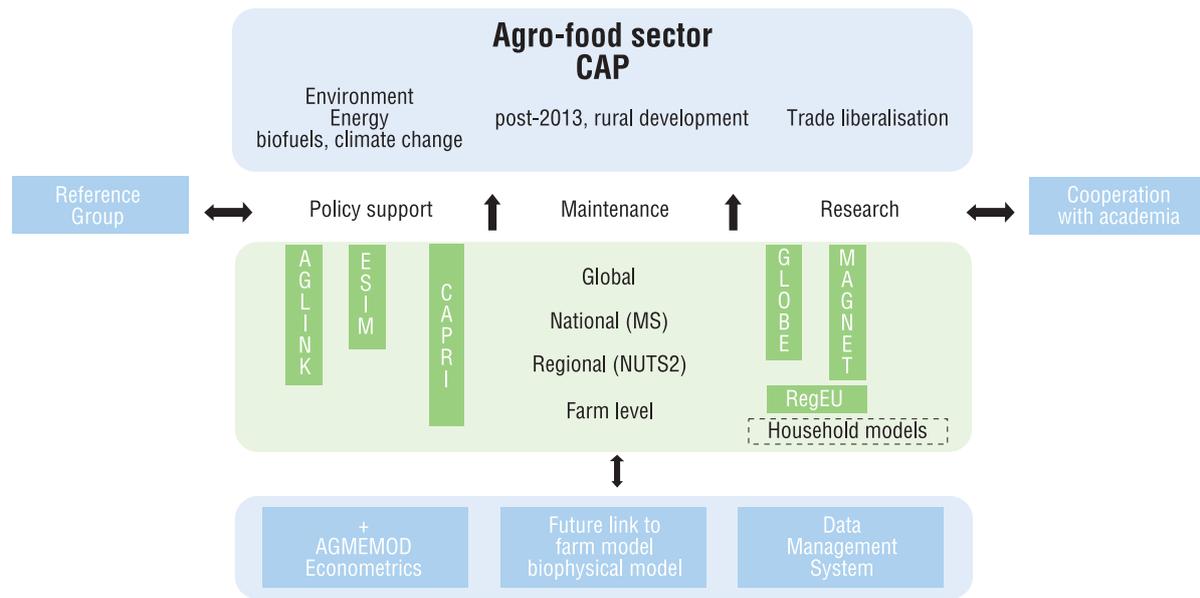
1. They should be backed up by a record of policy-relevant, and if possible peer-reviewed, applications so as to increase the acceptability of their results by policy makers and the wider public.
2. They should be well documented in order to allow a precise understanding of each model's specification. In addition, their similarities, differences and performance characteristics should be documented so that their comparative advantages for specific applications can be well understood by users.
3. They should be regularly and independently peer-reviewed with respect to their behavioural assumptions, overall model structure and their coverage of all relevant policy instruments.
4. A team of experienced analysts who are familiar with the tools should be available to keep the tools up-to-date, in close interaction with model developers.
5. They should support combined or parallel application with other models and allow for integration of common data and ex-ante baselines that permit the comparison of results in order to assess the relevance of alternative model assumptions and the range of uncertainty regarding simulated impacts
6. Their graphical user-interfaces should be flexible in supporting the appropriate utilisation of models and their outputs by different user types (e.g. "viewers", "users" or "developers")
7. Models should incorporate state-of-the-art quality assurance, e.g. by employing coding standards and versioning control.

Finally, the functioning of a modelling platform also depends on a stable and long-term institutional framework.

2.2 iMAP

The integrated Modelling Platform for Agro-economic Commodity and Policy Analysis (iMAP) was created at IPTS in 2006 to facilitate the use of selected Partial Equilibrium (PE) and Computable General Equilibrium (CGE) models, either in

Figure 2.1. Backbone of iMAP



Source: M'barek, R. (2009)³ adapted.

stand-alone mode or in combination.² The models were chosen in order to address a broad range of relevant topics linked to the economic assessment of the CAP and thereby to provide a scientific basis for policy decision making (see **Figure 2-1**). Its creation was also motivated by the fact that tools with the potential to support policy making were being abandoned, not updated or not maintained by their developers or original owners, rendering it impossible to activate them quickly to perform relevant policy analysis.

All individual components of iMAP are well-established economic models with a long record of applications in research and policy support.

The core PE models of iMAP are AGLINK, CAPRI and ESIM, although other models or tools are used to complement or address questions that cannot be treated with these models. The main

CGE models used are GTAP and GLOBE, to be complemented in the future by MAGNET and a regional CGE (EUReg27). The next chapter gives a detailed description of these tools.

Maintaining a **suite of models** allows iMAP to select the model(s) most suitable for a particular request for policy analysis. Full access and knowledge about the tools in iMAP and the underlying modelling approaches enables iMAP staff to provide tailor-made, scientifically sound and timely analysis, specifically to DG AGRI.

In addition, iMAP facilitates and supports the analysis of a given policy question with different tools, leading to the comparison of results in order to substantiate the findings and to assess the range of uncertainties. Moreover, different tools can complement each other by providing outputs not available from the application of a single tool. This process provides additional feedback regarding the future development of models.

A particular role of iMAP is hence the combined use of several models – including pairings with those currently outside iMAP -

2 Pérez Domínguez, I, SH Gay and M'barek, R. 2009. An integrated model platform for the economic assessment of agricultural policies in the European Union. *Agrarwirtschaft: Zeitschrift für Betriebswirtschaft, Marktforschung und Agrarpolitik*, 57 (8), 379-385.
 3 R. M'barek, (2008) Overview of current state of iMAP and work performed in 2009, Strategic meeting of the iMAP Reference Group, Seville, 17-19 March.

and interdisciplinary analyses. Moreover, the increasing complexity of the aims, instruments and impacts of interest of the CAP and other policies relating to agriculture has required a more integrated application of quantitative tools, not only economic ones. The on-going work at JRC-IPTS on databases (see section 3.3) and a common baseline is an important milestone in this respect.

Finally, iMAP seeks a structure in which different quantitative tools can be combined for use in joint exercises, after going through certain validation filters, and can be maintained and updated through collaboration with the core model developers.

As part of the iMAP strategy, a technical **Reference Group** was formed, composed of well-known and experienced external experts in agricultural sector modelling, some of them the original developers of iMAP models. This Reference Group provides independent advice and assessment concerning the maintenance, development and use of the main modelling tools currently available in iMAP. With iMAP staff and in close co-operation with DG AGRI, it also regularly reviews agricultural market and policy developments from a quantitative policy impact perspective to ensure an appropriate future strategy of iMAP.

The regular dialogue among IPTS modellers, the Reference Group and DG AGRI has built a relationship of trust between the parties involved and has increased mutual understanding of needs and interests as well as the institutional settings involved. This dialogue facilitates i) delivery of economic impact assessments of high quality, matching clients' needs, ii) development of synergies between policy-relevant work (typically of limited scientific innovation) but also a high scientific profile (visible from peer-reviewed publications), iii) stronger ties between IPTS and a number of universities and research institutions and iv) deeper understanding among external modellers of requirements in policy-relevant

applications, such as establishing an appropriate, consolidated *ex ante* baseline, employing common assumptions on the development of macro-economic variables and other drivers, and ensuring a shared view on how policy instruments affect agriculture. Not least, it gives DG AGRI the opportunity to highlight upcoming analytical needs, which allows the model developers to prepare their tools accordingly.

2.3 Matching models and policy questions

The choice of the appropriate tool(s) to analyse policy questions is often crucial for the quality, depth, breadth and relevance of the decision-making support delivered, as well as its timing, although this choice is inevitably restricted to the range of tools available to an organisation.

The nature of a given policy question determines *which* model characteristics are crucial for obtaining policy-relevant information. These dimensions include the regional scope (global, EU-wide, national or regional) and scale, the treatment of time (dynamic or static), partial or general equilibrium, the commodity coverage, the detail in which farm management and farm characteristics are covered, which policies should be represented in detail and the ability to link results to other policy fields and to deliver outputs of specific interest.

The *geographic dimension* of the models requires a thorough review in relation to the needs of each policy question, since wider coverage and higher resolution can be resource-consuming. For a major player like the EU, models covering international agricultural markets have to be in the iMAP tool box, and, given the importance of bilateral trade agreements, a careful evaluation of the choice and probable co-existence between spatial and non-spatial market models must be made.

The EU is characterised by great heterogeneity of farm characteristics, natural

conditions, market structures and the macro-economic environment, while national policies are far from being uniform. There is, therefore, also a need for country-level analysis requiring a spatially disaggregated model. Additionally, the sub-national dimension is of crucial importance when analysing the links between agriculture and the environment in Europe. For this, ideally a model that is spatially disaggregated over agro-climatic zones using a small grid-size and that can provide additional information on environmental indicators is needed. Recent reforms of the CAP have also increased the importance of the farm-type dimension (farm size and specialisation).

The choice between a *dynamic* or a *static* specification has important implications for analysing medium-term market developments. Dynamic models have the advantage of describing adjustment processes over time in response to changes in the market and policy environment, but are more complex in structure.

Many policy-relevant model applications in agriculture are ex ante assessments that require a future benchmark as the comparison point for counterfactual analysis, conventionally named the baseline. AGLINK-COSIMO regularly produces global baseline projections that provide EU12 and EU15 aggregates. These projections result from the consultation process between the OECD directorate and OECD members, including DG AGRI. In a second phase, the ESIM and CAPRI models incorporate that baseline and break it down so as to project the future development for individual EU Member States, NUTS 2 regions and individual farm types, while at the same adding further detail and aspects not covered by the AGLINK-COSIMO baseline, e.g. regarding additional commodities or input use.

The choice between a *partial* and a *general equilibrium* model depends very much on the importance of the sector being analysed relative to the general economy, and the degree of the inter-linkages between that sector and the rest of

the economy. Although agriculture represents a small and shrinking part of the economy in the EU, it has strong links to other sectors, especially in rural regions, which necessitate the use of a general equilibrium model approach for specific policy questions.

There is also growing interest in developing *linkages* between agro-economic models, on the one hand, and bio-physical or other types of models, on the other, in order to capture the effects on the environment, land and water use, energy production and so on.

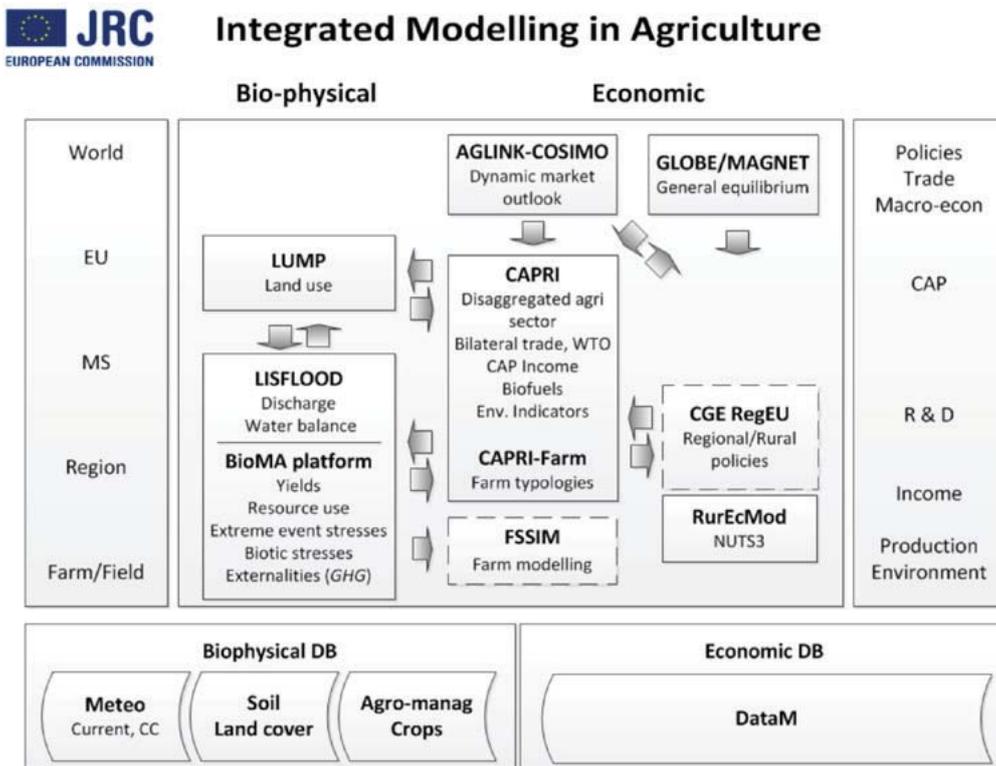
2.4 Communication between models

Within the same model family (e.g. CGE or PE), models with different spatial scales or policy representation can be linked to capture global effects and depict for instance regional impacts in detail. Good examples of PE model linkage are transmissions from global market models to farm-level models. CAPRI provides an example of incorporating a consistent feedback between the global market scale and farm type models inside EU regions based on sequential calibration.

The connection of a CGE and a PE model through price changes can enrich the agricultural policy analysis, through the interaction of different sectors of the economy in a CGE model.

The combined application of economic and biophysical models opens a wide range of possibilities to analyse the impact of policies on environment and land use. They can be unidirectional, providing economic models of estimates of yield and yield variability, and of resource use (e.g. irrigation water used to allow the yield estimated) or bidirectional receiving in addition as inputs constraints in agro-management to explore systems, in this case focusing and optimising iteratively specific systems. CAPRI has made steps in that direction by incorporating in a consistent way a module to

Figure 2.2. Integrated Modelling in Agriculture at JRC



Source: JRC modelling task force on agriculture, 2011.

downscale major results (such as crop areas and yields, stocking densities and fertilizer application rates) from the regional to the 1x1 km resolutions in order to reach the scale on which many bio-physical components operate.

The figure 2.2 gives an overview of recent efforts of the JRC in the area of agriculture, in particular the interfaces of iMAP models with the BioMA (Biophysical Model Applications) software platform.

■ 3 Tools in iMAP: Short overviews, the role of iMAP and an integrated view on tools

This chapter briefly portrays the different tools used in iMAP and features examples of the work on databases within iMAP.

3.1 Partial equilibrium models

Partial equilibrium (PE) models depict the behavioural interactions of one or more economic sectors, whilst treating outcomes in other sectors as exogenous and hence unaffected by changes in the sector(s) depicted. They are used to investigate the impact of changes on those sectors most immediately relevant to a problem. There is no feedback of these impacts from other sectors, although the changes analysed might originate in other sectors. The PE models in iMAP focus on the agricultural sector (production and use of primary agricultural commodities, including their use as intermediate inputs to agriculture itself). Increasingly, they also comprise other selected sectors (vegetable oil processing, dairies, biofuel processing, feed concentrate industry) with strong ties to primary agriculture or to the wider economy (e.g. competition for land based on land supply curves).

The general structure of PE models comprises technical, accounting and/or behavioural equations, which rely on observed data, technical knowledge about the agricultural sector and projections of exogenous factors. Typically, PE models measure outputs and inputs in physical units (metric tons, hectares, heads etc.), and not, as in CGEs, as dimensionless quantity indices. Not only does this allow technical relationships to be incorporated, but also policy instruments like production quotas, premium schemes or specific tariffs can be modelled in a way that is close to the corresponding legal text. This facilitates both the interaction with market experts and linkages to bio-physical tools, as well as the calculation of environmental indicators.

Although the contribution of agriculture to the economy in terms of GDP and employment is declining, there is a growing need for modelling tools that can analyse the recent developments of the CAP and the EU enlargement and to provide a well-founded basis for policy decision making.

PE models typically draw on databases and apply modelling approaches that depict the agricultural sector in rich detail, e.g. regarding product and activity disaggregation and interaction or policy representation, and can have a high spatial resolution, all of which are more difficult to implement in CGE models. These tools are often maintained and applied by groups with specific knowledge of agricultural markets and policies. Compared to CGE models, PE models are far less uniform regarding, inter alia, data sources, methodology, scope and scale and IT implementation. This is a major explanation of why several PE models are hosted by iMAP.

3.1.1 AGLINK-COSIMO

Section prepared by Stephan Hubertus Gay, Sophie H elaine, Aikaterini Kavallari, Olexandr Nekhay, Zebedee Nii-Naate

AGLINK-COSIMO⁴ is a recursive-dynamic, partial equilibrium, supply demand model of world agriculture, built by merging OECD's AGLINK and FAO's COSIMO models. The model covers annual supply, demand and prices for the main agricultural commodities produced, consumed and traded in each of the regions it covers. AGLINK was developed by the OECD Secretariat in close co-operation with member countries and certain non member

⁴ The results of any analysis based on the use of the AGLINK-COSIMO model by parties outside the OECD are outside the responsibility of the OECD Secretariat. Conclusions derived by third-party users of AGLINK-COSIMO should not be attributed to the OECD or its member governments.

economies. The country modules often emerged from existing country models and thus the model specification reflects the views of the participating countries. Collaborative discussions between the OECD Secretariat and the Commodities and Trade Division of the FAO (Food and Agricultural Organisation), starting in 2004, resulted in a more detailed representation of developing countries and regions by linking the FAO's COSIMO (COMmodity Simulation MOdel) with AGLINK into a new combined modelling system AGLINK-COSIMO.

In its current version, AGLINK-COSIMO identifies 52 countries and regions, and covers all major temperate zone agricultural commodities as well as rice and vegetable oil. Sugar and sweeteners as well as biofuels (ethanol and biodiesel) are fully integrated into the model.

The twelve AGLINK country modules (the EU is modelled as two blocks, EU-15 and EU-12) fully reflect specific market structures and national policies. With this structure, care can be given to properly reflecting specific market structures and national policies. These modules are first calibrated on initial baseline projections, derived from annual questionnaires to the respective country. The COSIMO initial projections are a combination of views of the FAO market analysts and model driven projections, as no questionnaires are distributed to COSIMO countries.

Second, the country modules are combined to form the full AGLINK-COSIMO model. The model is then solved and adjusted where needed to generate a baseline consisting of projections of all the variables - commodities, prices and trade flows - treated as endogenous in the model. Individual country models can be solved in stand-alone mode by treating developments on the world market (in particular, the formation of world market prices) as exogenous.

The model is used mainly to derive the OECD-FAO agricultural outlook, which is also the starting point for the annual medium-term outlook on the European agricultural

markets prepared and published by DG AGRI in collaboration with IPTS. It is also used by Agriculture and Agri-Food Canada to produce their international outlook every year, which is published along with a detailed national outlook.

The latest OECD-FAO agricultural outlook can be found under <http://www.agri-outlook.org/> and the latest DG AGRI prospects are to be found under http://ec.europa.eu/agriculture/publi/caprep/prospects2011/index_en.htm.

The documentation can be found in:

- OECD (Organisation for Economic Co-operation and Development) (2006): Documentation of the AGLINK Model. Working Party on Agricultural Policies and Markets, AGR-CA-APM(2006)16/FINAL. Directorate for Food, Agriculture and Fisheries, Committee for Agriculture, OECD, Paris.

In 2011, a major revision of the AGLINK-COSIMO model was undertaken in order to rationalise the model and improve the efficiency of its use. In addition, the validation procedure was enhanced.

In the framework of the revision, a template was developed consisting of a standardised set of equation systems valid for the standard parts of the model. Nevertheless, country-specific elements can always be added to reflect market and policy specificities better. For example, direct payments based on output or area follow the template as they are standard policies. On the contrary, certain trade-related policies remain specific to individual commodities and markets (e.g. tariff rate quotas, quantitative export restrictions, special safeguard mechanisms).

The market closure of country modules can be modelled in two ways: either the net trade is the net flow that clears the domestic market, or exports, imports and domestic market-clearing prices are introduced. A change to the latter market-clearing system was promoted in

the new model version. In addition, consumer prices were introduced in the AGLINK part of the model with explicit transmission equations from producer prices (they were already included in the COSIMO modules). The crop production index was modified and the commodity coverage was extended. Common mnemonics between AGLINK and COSIMO modules were enforced. Finally, agricultural and trade policies, as well as the time series and the elasticities, were reviewed and updated.

JRC-IPTS, together with DG AGRI, has a central role in the use, maintenance and development of the EU module of the AGLINK-COSIMO model. The European Commission is a major contributor to the OECD-FAO agricultural outlook.

Within iMAP, the model is mainly used to provide the EU agricultural outlook published in the last quarter of each year. In addition, it is fed into the OECD-FAO outlook. For this purpose, the European Commission annually provides the OECD with the updated EU projections and model. To produce this baseline annually, JRC-IPTS works in close cooperation with DG AGRI, participating in particular in the meltdown week in September when a preliminary version of the projections is elaborated (see section 4.1.1 below). In addition, the JRC-IPTS team is in charge of the analysis of the uncertainties underlying the baseline projections (see section 4.1.2.). The uncertainty analysis consists of measuring the sensitivity of the projections to the uncertainty characterising the exogenous assumptions that underlie various alternative scenarios. In conducting the sensitivity analysis other models included in the iMap platform may be used in addition to the DG AGRI updated and augmented AGLINK-COSIMO model.

In 2011, JRC-IPTS developed the possibility to run partial stochastic simulations of the AGLINK-COSIMO results. This method is currently used to assess the degree of sensitivity of the EU baseline

projections to the macro-economy and weather fluctuations. JRC-IPTS was also deeply involved in the review of the EU module in the framework of the whole model revision that was finalised in 2011. In addition, the team regularly participates in the improvements of the EU module according to priorities set by DG AGRI.

The AGLINK-COSIMO model was used in 2010 in an IPTS study to assess the impact of the EU directive on renewable energies on the biofuel prices, commodity balances and trade in the EU and in the rest of the world. Similar scenarios will be run in 2012, using the latest version of the DG AGRI updated and augmented AGLINK-COSIMO model, as a contribution to the work of the JRC biofuel task force.

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3.1.2 CAPRI

Section prepared by Wolfgang Britz, Mihály Himics

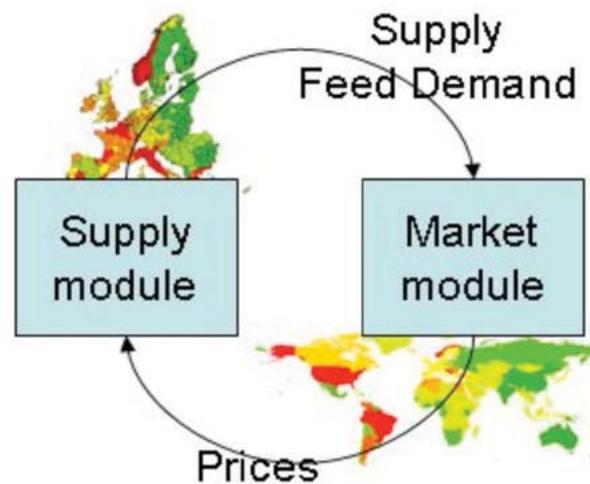
The *Common Agricultural Regionalised Impact Analysis model (CAPRI)*⁵ is a global, spatial, partial equilibrium (PE) model with a focus on Europe specifically designed to analyse CAP measures and trade policies for agricultural products (Britz and Witzke, 2008). Its roots date back to an EU framework project 1996-1999. Since then, it has been expanded, improved and detail added in a range of projects financed from different, mainly EU Commission sources, while continuously being applied to policy relevant questions related to EU and global agriculture.

CAPRI consists of two modules, the highly detailed and disaggregated supply module for Europe and the global market module, which are linked by sequential calibration such that production, demand, trade and prices can be simulated simultaneously and interactively from global to regional and farm-type scale (Britz, 2008).

CAPRI was designed to analyse a wide range of policies and topics related to the agricultural sector, including agri-environmental interactions.

⁵ <http://www.capri-model.org/>

■ Figure 3.1. Concept of the CAPRI model



Source: <http://www.capri-model.org/dokuwiki/images/concept.jpg>.

The databases underlying CAPRI draw as far as possible on well-documented, official and harmonised data sources, especially data from EUROSTAT, FAOSTAT, OECD and extractions from the Farm Accounting Data Network (FADN). The basic idea of the CAPRI database for EU Agriculture is an 'Activity-Based Table of Accounts', where activity levels (measured in hectares, livestock head etc) are linked to sectoral input use and output generation in physical terms via technical coefficients, and to values from the sectoral economic accounts via unit value prices. The connection between the individual activities and markets are the activity levels. The CAPRI database also covers matching market balances and consumer prices, including main secondary agricultural products, at national level. The approach thus shows some similarity to a Social Account Matrix and ensures a fully consistent data set over different regional scales (global, EU, Member State, NUTS2 regions, farm types).

The agricultural supply module consists of non-linear programming models for EU27, the Western Balkans, Norway and Turkey, which depict farming decisions in detail at the NUTS 2 level or at the level of farm types (EU 25, Gocht and Britz, 2011) (cropping and livestock activities, feed mix, fertilizer applications,

yields, farm income, nutrient balances, GHG emissions, farm policy instruments etc.). The mathematical programming approach offers a high degree of flexibility in capturing important interactions between production activities and with the environment as well as in modelling CAP and national policy measures. Currently, about 60 different support schemes are modelled, including measures from the second pillar of the CAP. The programming models comprise low- and high-intensive variants for most crop and livestock activities while a non-linear cost function captures the effects of capital and labour on the farm program. The parameters of the cost function are either econometrically estimated from regional panel data (Jansson and Heckelej, 2011) or calibrated against exogenous elasticities. A land supply function captures competition between farming and other economic activities in land markets. Arable and grass lands are assumed to be only partial substitutes. The regional supply models cover all farming activities with respect to output generation and input use according to the breakdown used in the Economic Accounts for Agriculture and all types of agricultural land use.

The market module is a static, deterministic, partial, spatial model with global coverage, depicting about 50 commodities (primary and secondary

agricultural products) and breaking the world down into 60 countries or country blocks, grouped into 30 trade blocks (see Appendix Table A.4) Its spatial specification allows bilateral trade flows and policies between trade blocks in the model to be modelled.

Within each trade block, including EU15, EU10 as well as Bulgaria and Romania, the current version assumes perfect markets (for both primary and secondary products) so that prices for all countries move together within a market block. The parameters of the second-order flexible behavioural functions for supply, feed demand, of major processing industries and final demand are based on elasticities taken from other studies and modelling systems, and calibrated to projected quantities and prices in the simulation year, while observing required theoretical properties from micro-economics.

Major outputs of the market module include bilateral trade flows, market balances and producer and consumer prices for the agricultural commodities and world country aggregates as well as costs of trade and market related policy measures.

Final demand is based on the Generalised Leontief functional form, which is derived from indirect utility functions of consumer prices and per capita income. Regarding traded products, the model uses a two-stage Armington system: the higher level determines the composition of total demand from imports and domestic sales as a function of the relation between the domestic offer price and the average import price. The lower stage determines the import shares from different origins. The substitution elasticity on the top level stage is smaller than for the second one, i.e. consumers are less flexible in substituting between domestic and imported goods than between imported goods of different origins. For most products, the substitution elasticities are 8 for the upper level and 10 for the lower level⁶. This latter elasticity is rather high compared to

other models, motivated by the higher uniformity of the more disaggregated product groups in CAPRI compared to, for example, CGE models.

CAPRI models both erga omnes and bilateral TRQs⁷. To deal with the discontinuity in the applied tariff caused by the TRQ, a sigmoid function is used, which effectively smoothes the 'kinks' that occur at the two points of discontinuity. CAPRI can handle both ad valorem and specific tariffs, both for MFN tariffs and in-quota tariff for TRQs, and depicts applied rates for the EU's entry price system. Equally, EU export subsidies and market interventions are endogenously depicted where applicable.

Apart from the rich detail on the supply side of the model, CAPRI's strengths are that it simulates results for the EU at sub-member state (NUTS2)⁸ or farm-type group level, whilst at the same time being able to model consistently global world agricultural trade, with the EU's most important trade partners separately identified and bilateral trade flows between them and the EU accounted for. It also comprises a consistent welfare analysis, a detailed analysis of the CAP budget including co-financing and features major environmental indicators. The detailed calculation of GHG inventories at the regional, national and EU scale according to IPCC standards (Pérez Domínguez et al., 2009) and a unique approach to deriving nitrogen balances (Leip et al., 2011) are worth specific mention. A downscaling module (Leip et al., 2008) allows major results (crop shares and yields, stocking densities, fertilizer application rates) to be distributed at the level 1x1 km cell clusters, which facilitates the linkage to biophysical models. CAPRI thus clearly comprises features of an integrated impact assessment tool for agriculture, reaching beyond the core focus

⁶ For dairy products and meat, both elasticities are considerably lower. For meat, they are 4 (upper) and 8 (lower).

⁷ CAPRI assumes that countries fill bilateral TRQs first, then attempt to profit from erga omnes TRQs, which are filled by countries in declining order of price-competitiveness.

⁸ It should be noted that CAPRI calculates agricultural producer prices at member state level, so a particular 'EU producer price' is an average of these prices.

of iMAP, providing a hub for interdisciplinary applications e.g. in conjunction with other JRC institutes.

CAPRI is maintained by a network of European research institutions, including JRC-IPTS and JRC-IES, and is regularly updated. The unique combination of a high level of detail in depicting the CAP and European agriculture, coverage of economic and environmental indicators, full European and global coverage and the active network has led to many different projects and applications. The complexity and richness in detail of the system comes however at the price of high maintenance costs. It also typically requires a longer time before newcomers can successfully apply the system in policy analysis. The large code base of CAPRI, programmed in GAMS and organised as far as possible in a modular fashion, is hosted on a software versioning system to support development, maintenance and application in a distributed network. CAPRI features its own Graphical User Interface in Java, which steers the different working steps (database updates, baseline construction, model calibration, scenario definition, model simulations) and allows the results of each step to be displayed in tables, maps and graphs. These visual tools can also be deployed as a web application.

A thorough documentation of CAPRI and a user manual can be found along with much complementary information on the CAPRI web page (www.capri-model.org).

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The role of JRC-IPTS with respect to CAPRI

JRC-IPTS plays a triple role in the CAPRI network: first, as an active member, currently being mainly responsible for the provision of the baseline and acting as a major policy-science hub towards DG AGRI; second, as a partner in different projects; and third, as an institution outsourcing and supervising projects.

The provision of the baseline is a yearly process in which the CAPRI-team at JRC-IPTS works in close cooperation with the AGLINK team and DG AGRI. It mainly consists in recalibrating the CAPRI baseline to the new DG AGRI baseline

taking into account the modifications and updates of the models and streamlining the data used.

An example of policy support is the Reference Report for DG AGRI on a potential EU-Mercosur FTA Agreement, published in November 2011. This report analyses the possible impacts of a free trade agreement under different scenarios (EU proposal and Mercosur request), with or without a DDA agreement.

Currently, JRC-IPTS is a partner in the FP VII projects CAPRI-RD (http://www.ilr1.uni-bonn.de/agpo/rsrch/capri-rd/capri_rd_e.htm) and SOLID (Sustainable Organic and Low-Input Dairying; www.solidairy.eu), and a participant in other projects dealing with climate change.

JRC-IPTS has commissioned a range of studies contributing to the development of CAPRI and/or led to policy relevant applications. These are specifically a study on the milk market reform (see e.g. Witzke et al. 2009, Kempen et al. 2011), a project to develop a bio-fuel module for CAPRI (Blanco Fonseca et al., 2010) and a larger project involving several JRC institutes on the environmental impacts of EU livestock which significantly improved GHG accounting into CAPRI, inter alia providing global GHG estimates in simulations (Leip et al. 2011). Recently, a study on the feasibility of integrating water use and water markets into CAPRI has started. The SUSTAG action of JRC-IPTS has also contributed to a large extent to the development of a CAPRI farm-type layer (see e.g. Gocht et al. 2011) through several projects, and currently supports the development of a module dealing with structural change.

Latest publications with IPTS participation are

- Gocht, A, Britz, W, Ciaian, P. and Gomez y Paloma S.: *EU-wide Distributional Effects of EU Direct Payments Harmonization analyzed with CAPRI*, Selected Paper for oral presentation at the EAAE 2011 Congress,

August 30 to September 2, 2011 Zurich, Switzerland

- Tukker A, de Koning A, Wolf O, Bausch-Goldbohm S, Verheijden M, Kleijn R, Pérez-Domínguez I and Rueda-Cantuche JM (2011) Environmental Impacts of Changes to Healthier Diets in Europe, *Ecological Economics* 70 (2011) 1776–1788, Elsevier
- Farm level policy scenario analysis, EUR 24787 EN - 2011
- Kempen M, Witzke H, Pérez Domínguez I, Torbjörn J, Sckokai P. Economic and environmental impacts of milk quota reform in Europe. *JOURNAL OF POLICY MODELING* 33 (1); 2011. p. 29-52. JRC60359
- Leip, A, Weiss, F, Wassenaar, T, Pérez Domínguez, I, Fellmann, T, Loudjani, P, Tubiello, F, Grandgirard, D, Monni, S, Biala, K, (2011): Evaluation of the livestock sector's contribution to the EU greenhouse gas emissions (GGELS). European Commission - Joint Research Centre. http://ec.europa.eu/agriculture/analysis/external/livestock-gas/index_en.htm
- Wolf O, Pérez Domínguez I, Rueda Cantuche J, Tukker A, Kleijn R, De Koning A, Bausch-Goldbohm S, Verheijden M. Do healthy diets in Europe matter to the environment A quantitative analysis. *JOURNAL OF POLICY MODELING* 33 (1); 2011. p. 8-28. JRC60224
- Blanco Fonseca M, Burrell A, Gay SH, Henseler M, Kavallari A, M'Barek R, Pérez Domínguez I, Tonini A, authors Burrell A, editor. *Impacts of the EU Biofuel Target on Agricultural Markets and Land Use - A Comparative Modelling Assessment*. EUR 24449 EN. Luxembourg (Luxembourg): Publications Office of the European Union; 2010. JRC58484

- Pérez Domínguez I. and Britz W.: *Greenhouse gas emission trading in European agriculture: a comparison of different policy implementation options in year 2020*. Contributed Paper at the IATRC Public Trade Policy Research and Analysis Symposium “Climate Change in World Agriculture: Mitigation, Adaptation, Trade and Food Security,” June 27 - 29, 2010, Universität Hohenheim, Stuttgart, Germany
- Witzke H, Kempen M, Pérez Domínguez I, Jansson T, Sckokai P, Helming J, Heckeley T, Moro D, Tonini A, Fellmann T, authors Fellmann T, editor. *Regional Economic Analysis of Milk Quota Reform in the EU*. EUR 23961 EN. Luxembourg (Luxembourg): OPOCE; 2009. JRC53116
- Pérez Domínguez I., Britz W. and Holm-Müller K.: *Trading Schemes for Greenhouse Gas Emissions from European Agriculture: A Comparative Analysis based on different Implementation Options*, *Review of Agricultural and Environmental Studies* 90(3), pp.287-308
- Burrell A, Ferrari E., Gonzalez Mellado A., Himics M., Michalek J., Shrestha S., Van Doorslaer B. (authors), Burrell A. (editor): *Potential EU-Mercosur Free Trade Agreement: Impact Analysis*. EUR 25011 EN, Luxembourg (Luxembourg), POCE, 2011, JRC67394

3.1.3 ESIM

Section prepared by Martin Banse, Harald Grethe

The *European Simulation Model (ESIM)* is a comparative static, partial equilibrium, net-trade multi-country model of the agricultural sector (Banse et al., 2010; Grethe et al, 2010). It covers supply and demand for agricultural products, with a detailed specification of cross-commodity relationships, and some first-stage

processing activities. Its geographical coverage is global, although not all countries are individually represented. All EU Member States, as well as accession candidates Turkey, Croatia and the Western Balkan countries, and the USA are modelled as individual countries; all other countries are combined into one aggregate, the ‘rest of the world’ (ROW).

In ESIM, market outcomes are driven by prices, conditional upon a rich specification of relevant EU agricultural policies, including trade policy instruments and direct payments. Since ESIM is mainly designed to simulate the outcomes in agricultural markets in the EU and accession candidates, policies are modelled only for these countries. For the USA and the ROW, production and consumption are assumed to take place at world market prices.

The production of agricultural products for biofuels production (oilseeds/plant oils for biodiesel; wheat, maize and sugar for ethanol) as well as the processing of these products and the production of biofuels have been explicitly included in ESIM since 2006. In addition, market demand for biofuels is modelled, and various biofuel policies are also represented. Thus, ESIM can treat both prices and quantities of biofuels endogenously, and is able to simulate them jointly under alternative sets of assumptions.

In its standard version ESIM is a comparative static model, as no links between the simulation periods exists. All simulation results have to be interpreted as medium- to long-term equilibrium states. A recursive dynamic version with a lagged supply response exists, but has rarely been used. Shifters on the supply as well as the demand sides (e.g. productivity and income growth) are used. Simulations are typically made for a period of up to 15 years beyond the base period, which is currently 2006/07, although ESIM has been used also for a simulation horizon up to 2050 (e.g. Moeller and Grethe, 2010), which requires profound adjustments of the standard parameterisation.

ESIM was developed by the ERS of the USDA in cooperation with Josling and Tangerman. It was first used in 1994. Thereafter, the model was further developed by Tangermann and Münch (1995) as well as Münch (1995). Country coverage of ESIM was expanded in two phases (Münch, 1997, and Münch, 2002). In 2004, the model was updated and extended in terms of base period, product and country coverage, as well as policy formulation. It was also rewritten from SuperCalc into GAMS (General Algebraic Modelling System) software (Banse et al., 2005). Special emphasis has been put on the development of the depiction of the EU sugar market, including endogenous preferential imports and modified EU supply functions, which allow for the simulation of a complete exit of Member States from sugar production (Grethe et al., 2008). ESIM has been used by the European Commission since 2001.

A stochastic version of ESIM was developed in 2008 and used in the analysis of the effects of yield instability on agricultural prices (Artavia et al., 2009, 2010). Furthermore, ESIM has been used in the analysis of climate change scenarios in combination with the vegetation model LPJ (Möller and Grethe, 2010, Möller et al., 2011). In order to analyse distributional effects of the CAP among German farms, an interface with the farm-group model FARMIS has been developed (Deppermann et al., 2010) and applied for distributional analysis (Deppermann et al., 2011). Current work includes the development of an interface with the energy system model TIMES PanEU, which has been developed and is maintained at the University of Stuttgart.

Latest publications with IPTS participation are

- Blanco Fonseca M, Burrell A, Gay SH, Henseler M, Kavallari A, M`Barek R, Pérez Domínguez I, Tonini A, authors Burrell A, editor. Impacts of the EU Biofuel Target on Agricultural Markets and Land Use - A Comparative Modelling Assessment. EUR 24449 EN. Luxembourg (Luxembourg):

Publications Office of the European Union; 2010. JRC58484

- COMMISSION STAFF WORKING PAPER-IMPACT ASSESSMENT Common Agricultural Policy towards 2020 ANNEX 11; http://ec.europa.eu/agriculture/analysis/perspec/cap-2020/impact-assessment/annex11_en.pdf

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- Artavia, M., Deppermann, A., Filler, G., Grethe, H., Häger, A., Kirschke, D., and M. Odening (2010), Ertrags- und Preisinstabilität auf Agrarmärkten in Deutschland und der EU: Betriebswirtschaftliche und agrarpolitische Implikationen. In: Rentenbank (Hrsg.), *Auswirkungen der Finanzkrise und volatiler Märkte auf die Agrarwirtschaft*. Schriftenreihe der Rentenbank Bd. 26, Frankfurt a.M.
- Banse, M., Grethe, H. and S. Nolte (2005), *European Simulation Model (ESIM) in the General Algebraic Modeling System (GAMS): Model Documentation*. Berlin and Göttingen.
- Banse, M., Grethe, H., Deppermann, A. and S. Nolte (2010), *European Simulation Model (ESIM) in the General Algebraic Modelling System (GAMS): Documentation of Model Code*. Hohenheim and Brunswick.
- Deppermann, A., Grethe, H. and F. Offermann (2010), *Farm Level Effects of EU Policy Liberalization: Simulations Based on an EU-Wide Agricultural Sector Model and a Supply Model of the German Agricultural Sector*. Contributed paper at the 114th EAAE Seminar "Structural Change in Agriculture", Berlin, April 2010.

- Deppermann, A., Grethe, H., Offermann, F. (2011): *Distributional effects of the CAP on western German farm incomes and regional farm income disparity*, Contributed paper at the XIIIth EAAE Congress “Change and Uncertainty”, Zurich, Switzerland, August/September 2011.
- Grethe, H., Nolte, S. and M. Banse (2008), *Modelling the Effects of EU Sugar Market Liberalization on Area Allocation, Production and Trade*. In: Bartove, L., Gil, J. M., M’barek, R., Ratinger, T., *Modelling Agricultural and Rural Development Policies, Proceedings of the 107th EAAE Seminar, Selected Papers*. Seville, Spain: 209-222.
- Grethe, H., Banse, M. Deppermann, A. and S. Nolte (2010), *Update of the European Simulation Model (ESIM): Base Year and Baseline. Report 3: Documentation: Update of the base year data, parameter and baseline*. IPTS, European Commission.
- Möller, T. and H. Grethe (2010), *Climate Change and Agriculture in 2050: Assessing Prospects for European Cereal and Oilseed Markets*. Contributed paper at the Agricultural and Applied Economics Association 2010 Annual Meeting, July 25-27, 2010, Denver, Colorado.
- Möller, T., Grethe, H., Waha, K. and C. Müller (2011): *Modeling Climate Change Impacts on European Agriculture: Does the Choice of Climate Models matter?* Poster paper at the XIIIth EAAE Congress “Change and Uncertainty”, Zurich, Switzerland, August/September 2011.

3.1.4 AGMEMOD

Section prepared by Myrna van Leeuwen, Petra Salamon, Martin Banse, Thomas Fellmann, Robert M’barek

AGMEMOD, AGricultural MEmber states MODelling, is a dynamic, multi-country, multi-market, partial equilibrium modelling system, which can provide significant detail on the main agricultural sectors in each EU Member State and EU candidate countries. The model produces results for the EU as a whole. The system has been largely econometrically estimated at the individual Member State level although in some cases, when estimation was either not feasible or meaningful, model parameters have been calibrated. The country models contain the behavioural responses of economic agents to changes in prices, policy instruments and other exogenous variables on the agricultural market. These econometrically estimated, country-specific, economic models of agricultural commodity markets provide a sound basis for analysing the impact of the future accession of current candidate countries. In each model, commodity prices adjust so as to clear all the markets considered, with quantitative baseline estimates of commodity supply and use and prices generated for each year over a 10-year horizon.

To solve the modelling system in prices, the supply and utilisation balances of each product at both the EU and the Member State levels must hold and take into account the international trade and other commitments of the EU. Currently, the model regards the Rest of the World (non-EU region) in a stylised form as the imports and exports of the world market are represented by exogenous world market prices, import tariffs and export subsidies.

The modelling system’s projections are validated by standard econometric methods and through consultation with experts who are familiar with the agricultural market in the regions under study. The estimation and testing procedures within AGMEMOD not only concern single model equations or limited systems of equations, but also the entire multi-market and multi-country model. The testing and validation of the entire model is another key step in achieving a proper simulation model as this stage is especially important in evaluating the

model's internal consistency, dynamic properties and in-sample predictive quality. AGMEMOD is validated by within-sample simulations, ex-post policy evaluations and shock analyses to individual country models and to the combined model. The review process may result in the revision of model structures, parameter estimates and underlying policy assumptions.

The research to date has drawn on the expertise of an extensive network of economists working together across the EU. This growing network has been established over a number of years and has brought together a multi-national expertise that would otherwise be difficult to assemble. The network activities are supplemented by the assistance of national experts in commodity markets in the individual countries, who frequently review the models and projections produced by the national modelling teams (Salamon et al., 2008).

AGMEMOD uses a bottom-up approach. Based on a common country model template, country level models have been developed, reflecting the specific situation of the agricultural sectors in the individual countries. These country-level models are then integrated into an EU-wide model. The approach adopted allows the inherent heterogeneity of agricultural systems existing within the EU to be captured, while simultaneously maintaining analytical consistency across the estimated country models.

The previous version 3.0 of AGMEMOD consisted of the EU Member States (with the exception of Malta) and the candidate countries Croatia and the Former Yugoslav Republic of Macedonia.⁹ The incorporation of Turkey into the modelling system was conducted along the same lines as just described, and this has resulted in the new AGMEMOD version 4.0 model. For version

5.0, the AGMEMOD model has been extended to fully integrate Russia and Ukraine, and both countries' agri-food sectors are now fully presented in AGMEMOD. Version 5.0 also covers Kazakhstan as a new region in AGMEMOD. Furthermore, AGMEMOD version 5.0 also includes an endogenous world price formation which allows analysing the impact of change in supply and demand of countries' covered in AGMEMOD on the world price level.

It should also be mentioned that AGMEMOD is applied in EU Member States, e.g. Finland, Latvia, Slovenia, Germany and the Netherlands, to analyse the medium-term development of their agri-food sectors, see Salputra (2011), Erjavec and Salputra (2011), Salputra and Miglavs (2009), Niemi and Kettunen (2011), Offermann et al. (2010) and Leeuwen et al. (2010).

Latest publications with IPTS participation:

- Fellmann, T., Van Leeuwen M, Salamon P (2011) EU Enlargement to Turkey: potential impacts on agricultural markets and how they are shaped by changes of macroeconomic conditions. Paper presented on the 51st Annual Conference of the GeWiSoLa (German Association of Agricultural Economists). September 28-30. Halle (Germany).
- Van Leeuwen M, Salamon P, Fellmann T, Koç A, Bölük G, Tabeau A, Esposti R, Bonfiglio A, Lobianco A, Hanrahan K, authors Fellmann T, editor. Potential impacts on agricultural commodity markets of an EU enlargement to Turkey. EUR 24772 EN. Luxembourg (Luxembourg): Publications Office of the European Union; 2011. JRC60663
- Fellmann, T., M. van Leeuwen, P. Salamon, A. Koç, A. Tabeau and G. Bölük (2011): The effects on Turkey's agricultural income and markets of a potential accession to the EU. Paper presented at the Eurasia Business and Economic Society Conference, June 1-3, 2011, Istanbul, Turkey

⁹ The AGMEMOD 3.0 version already included models of the cereal and oilseeds markets of Russia and the Ukraine, although these are not EU candidate countries. Both country models, built using AGMEMOD templates, run as separate models in parallel with the EU27 AGMEMOD model.

- Salamon P, Van Leeuwen M, Tabeau A, Koç A, Bölük G, Fellmann T. Potential Impacts of a Turkish EU-membership on Agri-food Markets. *Agriculture and Forestry Research* 60 (4); 2010. p. 193-204. JRC60662
- Bartova L, Fellmann T, M'Barek R, editors. Modelling and Analysis of the European Milk and Dairy Market - Detailed Projection Results. EUR 23833 EN/2. Luxembourg (Luxembourg): OP; 2009. JRC50916
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- Chantreuil F, Donnellan T, Leeuwen M van, Salamon P, Tabeau A, Bartova L (2008) EU dairy quota reform - EU member states" AGMEMOD scenario analysis. In: Mathijs E, Verbeke W (eds) EAAE 2008 Congress "People, Food and Environments: Global Trends and European Strategies": XIIth Congress of the European Association of Agricultural Economists, Ghent, Belgium, August 26-29, 2008
- Salputra, G, Miglavs A (2009). *Eiropas Savienības lauksaimniecības un lauku attīstības politikas sagaidāmās pārmaiņas – perspektīvais novērtējums Latvijai un Baltijas valstīm / Forthcoming modifications of EU Agricultural and Rural Development Policy from Baltic perspective: Final Report for 2009*; LSIAE project contract 200309/ S23 for the Ministry of Agriculture, Riga
- Niemi., J, Kettunen, L (2011). An analysis of the potential CAP changes: A Finnish case study. A paper presented at the Congress of the European Association of Agricultural Economists (EAAE), August 30-September 2, 2011, Zürich, Switzerland.
- Salamon P, Chantreuil F, Donnellan T, Erjavec E, Esposti R, Hanrahan K, Leeuwen M van, Bouma F, Dol W, Salputra G (2008) How to deal with challenges of linking a large number of individual national models: the case of the AGMEMOD partnership. *Agrarwirtschaft* 57(8):373-378
- Salamon P, Chantreuil F, Donnellan T, Erjavec E, Esposito R, Hanrahan K, Leeuwen M van, Salputra G (2008) Linking large numbers of individual national models : the case of the EU member states" AGMEMOD partnership. In: Mathijs E, Verbeke W (eds) EAAE 2008 Congress 'People, Food and Environments: Global Trends and European Strategies' : XIIth Congress of the European Association of Agricultural Economists, Ghent, Belgium, August 26-29, 2008.

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- Erjavec, E, Salputra G (2011). Could the radical changes of direct payments policy destroy agricultural markets in the EU New member states? *Economics of Agriculture/ Ekonomika Poljoprivrede*, Belgrade, Vol. 58: 45-66, YU ISSN 0352-3462
- Ledebur O von, Salamon P, Zimmermann A, Leeuwen M van, Tabeau A, Chantreuil F (2008) Modelling impacts of some European biofuel measures. In: Bartova L, M'barek R, Rättinger T (eds) Modelling agricultural and rural development policies: proceedings; 107th EAAE Seminar, 29th January - 1st February, 2008, Seville. Luxembourg: Office for Official Publications of the European Communities.

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3.2 General equilibrium models

A computable general equilibrium (CGE) model is a system of nonlinear simultaneous equations representing the constrained optimising behaviour of all agents within the economy as producers, consumers, factor suppliers, exporters, importers, taxpayers, savers, investors, or government. This means that it depicts the production, consumption, intra-sectoral input and trade of all economies for one country, a region or even all countries worldwide.

3.2.1 GTAP

Section prepared by Aida Gonzalez Mellado

GTAP (Global Trade Analysis Project)¹⁰ is a global network of researchers and policy makers conducting quantitative analysis of international policy issues. GTAP's goal is to improve the quality of quantitative analysis of global economic issues within an economy-wide framework. Core support and advice for the Project come from a consortium of international and national agencies from around the world. The European Commission is an active member in the GTAP Consortium.

GTAP has developed a CGE (Computable General Equilibrium) model known as the GTAP model together with a database that is also used by a number of other CGE models. The standard GTAP Model is a static multi-region, multi-sector,

computable general equilibrium model, with perfect competition and constant returns to scale. Bilateral trade is handled via the Armington assumption.

The number of regions and sectors depends on the version of the database and the aggregation chosen by the model user for specific simulations. GTAP database 7 contains 57 commodities and 113 countries and regions.

Latest publications with IPTS participation:

- A CGE model analysis of reducing obstacles to trade in Kenya: a focus on the agro-food sector by Gonzalez–Mellado A., and Ferrari E., Published prepared for the 14th Annual Conference on Global Economic Analysis, Venice, Italy (2011) (<https://www.gtap.agecon.purdue.edu/resources/download/5463.pdf>)
- Evaluation of non-tariff measures for African agricultural exports to the EU in a CGE framework by Gonzalez Mellado A, Gay SH, M'barek R and Ferrari E, Publication presented at the 13th Annual Conference on Global Economic Analysis, Penang, Malaysia (2010) (https://www.gtap.agecon.purdue.edu/access_member/resources/res_display.asp?RecordID=3274)
- "Price Shocks, Structural Constraints and Policy Reactions in Tanzania and Malawi. A General Equilibrium Analysis", by Ferrari E., Conforti P., Sarris A., Paper presented at the XLVII SIDEA Convegno di Studi "L'agricoltura oltre le crisi" Campobasso (Italy), (22-25 September 2010) (http://ilo.unimol.it/sidea/images/upload/convegno_2010/paper/conforti%20ferrari%20sarris.pdf)

3.2.2 GLOBE

Section prepared by Scott McDonald, Emanuele Ferrari

GLOBE is a Social Accounting Matrix (SAM)-based global Computable General Equilibrium

¹⁰ <https://www.gtap.agecon.purdue.edu/>

(CGE) model that is calibrated with data from the Global Trade Analysis Project's (GTAP) database¹¹. It incorporates various developments in CGE modelling over the last 25 years; it was initially derived from the USDA ERS model of the late 1980s (Robinson, *et al.*, 1990) and ERS NAFTA Model (Robinson, *et al.*, 1993). It is therefore a close relative of the IFPRI standard model (Lofgren *et al.*, 2002) and the PROVIDE Project model (McDonald, 2003), as well as to the GTAP model (Hertel, 1997). The model is written and solved using General Algebraic Modeling System (GAMS) software.

GLOBE consists of a set of single country CGE models linked by their trading relationships. The price systems are linearly homogeneous, as in all current CGE models, and thus only changes in relative prices matter. Consequently, each region in the model has its own numéraire price, typically the consumer price index (CPI) and a nominal exchange rate, while the model as a whole requires a numéraire, which is an exchange rate index for selected reference regions. One of the distinguishing features of GLOBE is the presence of a “dummy” region, called Globe, which records all the interregional transactions (i.e. trade and transportation margins or remittances) where either the source or the destination is unknown.

The SAM (social accounting matrix) on which GLOBE is based disaggregates each region's economy according to eight main categories of accounts¹². The model can be used with all the possible GTAP database aggregations and is designed to accept extensions to the GTAP database. The behavioural relationships follow standard assumptions for CGE models. Activities maximise profits using technology characterised

by Constant Elasticity of Substitution (CES) production functions over primary inputs and Leontief production functions across intermediate inputs. The households maximise Stone-Geary utility functions, which assumes a linear expenditure system after payment of income tax and after saving a share of post-tax income.

The Armington assumption is used for trade. Domestic output is distributed between the domestic market and exports according to a two-stage Constant Elasticity of Transformation (CET) function. In the first stage, a domestic producer allocates output between the domestic and export markets according to the relative prices for the commodity on the domestic market and the composite export commodity, which is a CET aggregate of the exports to different regions, whereas the distribution of the exports between regions is determined by the relative export prices to those regions. Hence, domestic producers respond to prices in all markets for the product. The elasticities of transformation are commodity- and region-specific. Domestic demand is satisfied by composite commodities that are constructed by means of a three-stage CES function from domestic production sold domestically and composite imports. All commodity and activity taxes are expressed as *ad valorem* tax rates, while income taxes depend on household incomes. The GLOBE model permits a great flexibility of general and specific closure rules, which permits a variety of assumptions about the functioning of the world economy. The modeller has to choose his preferred closure rule for the foreign exchange account, the capital account, the government account and the numéraire. In addition, factor markets may follow different specifications according to the scenarios being modelled and researcher preferences, e.g., combinations of perfect mobility or sector specificity with full employment or unemployment of available resources. All these rules are region-specific.

The current variant of GLOBE used by IPTS includes the provision of bilateral Tariff Rate Quotas (TRQs). TRQs are a widely used

11 For the underlying principles of GLOBE, see de Melo and Robinson (1989) and Devarajan *et al.* (1990); for earlier models that can be described as its antecedents, see Robinson *et al.* (1990, 1993).

12 Outputs, intermediate inputs, factors, households, government, capital, margins (trade costs and transport) and rest-of-the-world.

instrument for agricultural trade. Developed countries use this measure to improve market access for less developed countries or to keep under control the volume of imports of agricultural goods considered as sensitive. Other global CGE models have implemented TRQs using the Mixed-Complementarity-Problem (MCP) approach available for models coded in GAMS; the approach to the modelling of bilateral TRQs follows the approach suggested by van der Mensbrugge (2003).

Different versions of GLOBE are currently available:

1. GLOBE_EN is an energy focused global CGE model calibrated using transaction data in a SAM plus satellite accounts for energy input.
2. GLOBE_MIG is a variant of GLOBE that uses the GTAP_MIG database to calibrate a model that includes labour migration.
3. GLOBE_IMP is a variant of GLOBE that includes mark-up pricing.
4. GLOBE_DYN is a recursive dynamic variant of the GLOBE model where time is incorporated through LOOPS in the experiment file

Latest publications with IPTS participation:

- “Potential EU-Mercosur Free Trade Agreement: Impact Assessment” by Burrell A., Ferrari E., Gonzalez Mellado A., Himics M., Michalek J., Shrestha S., Van Doorslaer B.; EC internal report, forthcoming JRC Technical Report (2011)
- Burrell, A., Ferrari, E., Gonzalez Mellado, A., Michalek, J. (2012). EU market access for agricultural products in the Doha Development Round: A sensitive issue. Paper presented at the 28th IAAE Conference, Foz do Igauçu, Brazil, 18-24 August 2012.

- “Doha Development Agenda in the European Union: impacts on the agricultural sector” by E. Ferrari, J. Michalek, A. Burrell, A. Gonzalez Mellado. Paper presented at the 13th European trade Study Group Annual Conference, Copenhagen (Denmark) 8-10 September.
- “Analysis of the European Food Industry” by M. Banse, E. Kaditi, S. McDonald, S. Robinson, J. Swinnen. Editors: S. H. Gay, R. M'barek, F. Santuccio, JRC Technical Report (2008)
- “Analysing the implication of the EU 20-10-20 targets for world vegetable oil production” by S.H. Gay, M. Mueller and F. Santuccio, The 107th EAAE Seminar “Modelling of Agricultural and Rural Development Policies”, European Association of Agricultural Economics (EAAE) (2008).

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3.2.3 MAGNET

Section prepared by Hans van Meijl

To overcome some limitations of the above mentioned CGE models in CAP analysis, iMAP recently included the Modular Applied GeNeral Equilibrium Tool (MAGNET), developed by LEI-WUR. MAGNET is a global CGE model that covers the whole economy and has been used extensively in agricultural, environmental and trade policy analysis. The MAGNET model played a key role

in the Scenar2020 I & II studies (Nowicki et al., 2006 and 2009a respectively) and the Modulation study (Nowicki et al., 2009b) all of which were commissioned by DG AGRI. Furthermore, it is used for the OECD Environmental Outlook (OECD, 2008 and OECD forthcoming) and the OECD Long-term scenario project. MAGNET builds on the global general equilibrium GTAP model and is the successor of the LEITAP model (Meijl et al., 2006, Banse et al., 2008).

MAGNET adopts a modular approach, whereby the standard GTAP-based core can be augmented with modules depending on the purpose of the study. These include:

- a production module, which allows for more flexible interactions between different types of inputs in agricultural production (i.e. the user may choose totally different nesting structures between sectors and countries);
- a land supply module with endogenous land supply so as to model changes in the total availability of agricultural land;
- a land allocation module, which allows for the specification of sluggishness of different types of land;
- a factor markets module, which allows for modelling of different factor market closures including segmented factor markets;
- a dynamic international investment module allowing for international capital and capital income flows and;
- an enhanced consumption module, which dynamically adjusts income elasticities over time depending on income per capita;
- modules for explicit treatment of agricultural policies, including the CAP budget, production quotas, intervention prices, (de) coupled payments and second pillar policies;

- modules for biofuels (ethanol, biodiesel, by-products), the EU biofuels directive and renewable energy policies to address greenhouse gas and biodiversity issues. Implementation of elements of the bio-based economy is possible including using first and second generation technologies to produce ethanol, biodiesel, pellets, bio-electricity and bio-based-chemicals.

The model permits downscaling of simulation results to NUTS2 regions and allows multi-product sectors (by-products) to be modelled. To assess the long-term impact of drivers and policies on biodiversity and emissions, the MAGNET model is linked to the biophysical IMAGE model of the Dutch Environmental Assessment Agency. Amongst other model developments, it is planned to extend the MAGNET model to include household poverty impacts, population dynamics and to develop nutrition-health linkages.

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- Eickhout, B., H. van Meijl, A. Tabeau and E. Stehfest, The impact of environmental and climate constraints on global food supply. In: Economic Analysis of Land Use in Global Climate Change Policy, ed. T.W. Hertel, S. Rose, and R. Tol. 2009, USA: Routledge.
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- Nowicki, P., H. van Meijl, A. Knierim, M. Banse, J. Helming, O. Margraf, B. Matzdorf, R. Mnatsakanian, M. Reutter, I. Terluin, K. Overmars, D. Verhoog, C. Weeger, H. Westhoek (2006). Scenar 2020 - Scenario study on agriculture and the rural world. Contract No. 30 - CE - 0040087/00-08. European Commission, Directorate-General Agriculture and Rural Development, Brussels. http://ec.europa.eu/agriculture/publi/reports/scenar2020/index_en.htm
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3.2.4 CGERegEU+

Section prepared by Wolfgang Britz and Emanuele Ferrari

CGERegEU+ is a layer of national CGE models, each regionalised to NUTS2 regions, developed in the FP7 CAPRI-RD project with a focus on CAP Pillar 2 and Rural Development indicators. It currently covers 270 NUTS2 regions for all EU Member States and 12 sectors. The regional Social Accounting Matrices for all NUTS2 regions have been developed by IPTS in the framework of the CAPRI-RD project.

CGERegEU+ adopts standard characteristics of comparative-static, single-country CGE models: firms maximize their profits and consumers their utility, a nested Constant Elasticity of Substitution (CES) production function, Leontief intermediate demand and a Linear Expenditure System (LES) demand function. Intermediate demand of each regional industry is differentiated by regional, national and rest-of-world demand to analyse regional multiplier effects, the same holds for final demand, based on the Armington assumption. The model allows for different representations of primary factor markets (capital, labour and land). The labour market plays a fundamental role in the model and can be modelled as fixed wages, wage curve, fixed factor endowments of the industries or fully mobile. In addition, the model contains net-migration functions for population. Different closure rules for the state budget and current account balance are available. The rest of the world is captured only via import supply and export demand functions in the fashion of small open economy models, keeping the door open for a link to a global trade-oriented CGE. A module maps the different measures under Pillar 2 into shocks for the regional CGEs.

The model can be used in stand-alone mode or integrated into CAPRI based on sequential iteration. In the latter case, non-agricultural prices as well as capital and labour use of agriculture are passed to CAPRI, whereas CAPRI updates output, land use and return to capital and labour in the regional CGEs. The stand-alone version is available both in GEMPACK and GAMS; the latter is integrated into CAPRI and shares its user interface including the exploitation tools.

References:

- Törmä H. and Zawalinska, K. Final documentation of the CGERegEU+ model, CAPRI-RD Deliverable 3.3.3, <http://www.ilr1.uni-bonn.de/agpo/rsrch/capri-rd/docs/d3.2.3.pdf>
- Britz W.. RegCgeEU+ in GAMS, documentation including the Graphical User Interface, CAPRI-RD Deliverable 3.2.4. <http://www.ilr1.uni-bonn.de/agpo/rsrch/capri-rd/docs/d3.2.4.pdf>

3.3 Databases and data management

Science-based policy support requires high-quality and reliable data. iMAP is engaged in long-term activities to consolidate agro-economic data so as to ensure that they are comparable, using harmonised methodology.

3.3.1 DataM - a tool for flexible management, extension and integration of (model) databases

Section prepared by Sophie Héline, Mihaly Himics, Robert M'barek, Arnaldo Caivano

Even if models differ with respect to regional and commodity coverage, they nevertheless share a large amount of data (e.g. time series on wheat production in EU Member States). This is why a harmonised database is a basic requirement

when building an integrated modelling platform. In 2007, IPTS started to develop concepts for data harmonisation and management together with external partners.¹³

DataM, a database management tool to simplify the daily data work of analysts and modellers in agriculture, either to feed economic models with data, to check data or to analyse results has been developed since 2010. Using one interface only, users can rapidly access the main agricultural and trade databases as well as the in-house model databases. The tool addresses different needs, ranging from data collection and data checks to advanced reporting with the possibility to export data.

The main strength of the tool are the linkages between the nomenclatures of the different databases (hereafter referred to as “mappings”), meaning that users can retrieve all the available data from different sources related to a particular item more quickly without specific knowledge of the nomenclature used by the different data providers.

Each iMAP model has its own tailor-made database. In addition, a variety of databases, provided by EUROSTAT, FAOSTAT, FAPRI, USDA, OECD, GTAP and other sources, are used. All these databases are stored in different formats and follow specific classification schemes. This diversity creates severe obstacles for flexibly handling the different data sources.

For many studies, specific datasets have to be created, first by comparing the available information in several data sources and then by making a reasonable choice which one to use. Furthermore, if data in a certain database are considered to be reliable, it may be necessary

to incorporate them into not just one but several model databases. Generally, the process of making model databases consistent can be extremely time-consuming, depending on the complexity of the (mis)matches between the nomenclatures. Therefore, a shared database incorporating these mappings can significantly reduce the cost of data updates. In addition, it allows model results to be stored so that they can be retrieved easily when necessary.

To overcome the above-mentioned issues, and based on the long experience of dealing with different datasets, IPTS launched a project to develop a software product that allows flexible management, extension, and integration of existing (model) databases, and facilitates their comparison. At the end of 2009, IPTS started working on the development together with Prognoz Europe. Prognoz offered to customise and further develop its software product called PROGNOZ 5 platform according to the specific needs of iMAP.

The software is named DataM, where M refers to management, which is the central idea and the main purpose of the tool. It is already in use by iMAP and new developments are continuously implemented. In addition, the application will be further developed in 2012 to offer the possibility to visualise the results very easily and rapidly through a web interface.

Easy access to the data

With DataM, most of the databases needed for users' work can be accessed through a single interface. It means that the user does not have to remember the different websites and the different logins for databases under licenses. Furthermore, it is not necessary to know how to retrieve data from the diverse data providers and DataM is user-friendly, therefore data collection is rather intuitive.

The data are kept up-to-date by Prognoz. For model data, automatic data-loaders are used so

¹³ Verhoog, D, M Heiden, P Salamon, W Dol, F Godeschalk, SH Gay (ed.), M Müller (ed.) and F Santuccio (ed.), 2008. Potentials of a Harmonised Database for Agricultural Market Modelling. JRC Scientific and Technical Reports, EUR 23417 EN – 2008. Online: <http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=1639>

Figure 3.2. Screenshot from the DataM tool



that the user can import the model datasets with just a few mouse clicks.

Researchers need additional information about the content and context of the data, e.g. how the data were collected, how they are organised etc. This kind of information, hereafter called meta-information, is stored in DataM together with the raw data so that any questions concerning the data content can be answered immediately without leaving the user interface.

In addition, the tool offers the possibility to work in a multi-user environment; user rights and privileges can be set at database level.

A tool to compare and transform the data

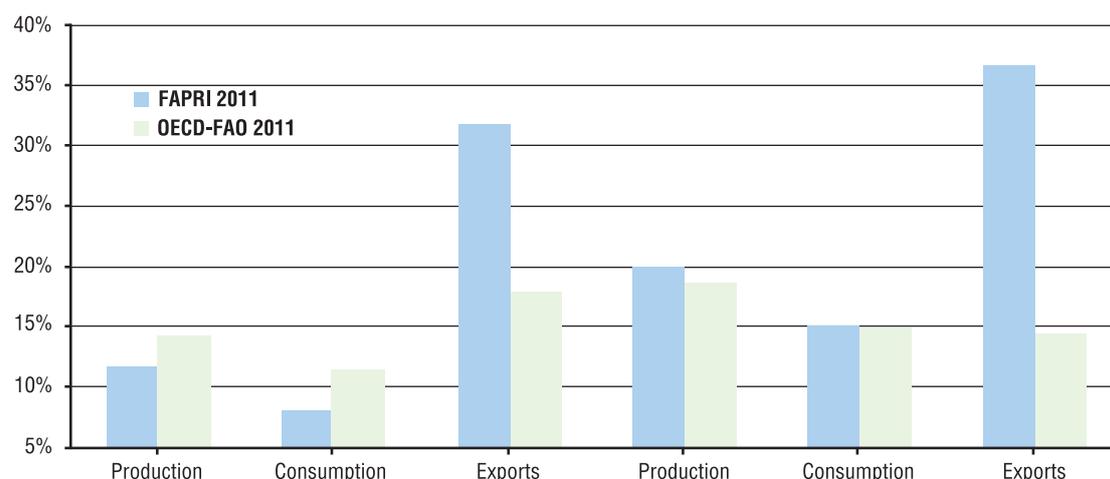
In DataM, databases with different original formats and structures are transformed into time series. Therefore, model data can be consulted without using the models' own specific software

environments such as GAMS or Troll. Certain models do not have an easy data viewer; in this case, DataM can be used as an extension of the models to compare different model runs rapidly.

The classification schemes have been harmonised where possible. As a consequence, users can easily compare results of different models and of other projections using the "workbook", a spreadsheet area. If needed, users can also import datasets into DataM.

The databases of economic models typically comprise data from several sources. The data from different statistical sources are compared and processed (revised, completed etc.) to make them consistent with the model structure (aggregations, ensuring that balances close etc.). DataM supports these working steps. In addition to the access and comparison of data, the tool includes basic statistical methods to complete and transform time-series. Moreover, some of

Figure 3.3. Comparison of world outlook for cereals markets (2020/2010)



the data checks can be automated by defining validation rules.

DataM has a search function that allows a search of the available data on a specific commodity, attribute or country through all the stored databases. If users do not know the original labels or codes in the databases they can launch a search using the common nomenclature (mapping) developed. This common nomenclature is also available in all the modules of the tool. Therefore, users can always switch to this common nomenclature to look more quickly for the data they are interested in.

An example of DataM use can be found in European Commission (2011) "Agricultural commodity markets outlook 2011-2020 – a comparative analysis". (http://ec.europa.eu/agriculture/analysis/tradepol/worldmarkets/outlook/2011_2020_en.pdf)

A flexible tool to analyse and report on the data

The workbook is a spreadsheet area where users can select data easily, consult large amounts of data, rapidly define calculations and check the data graphically. The graphical user interface (GUI) is user-friendly and intuitively accessible.

Defining a report can be more time-consuming but users can design specific tables that are easy to update and to consult with the possibility of changing parameters (years, country, commodity, attributes, and so on).

In both cases, using the tree structure of the databases or the search function, the analyst can select the relevant parts of the datasets, rapidly change the focus or add data from other data sources. Any workbook or report can be saved and exported to Excel and each time they are opened the data is updated automatically.

The choice between the two functions depends on users' way of working. DataM offers great flexibility because after the data are selected, they can be treated entirely, partially or not at all in DataM. That is why the export function is available.

3.3.2 Agricultural Social Accounting Matrices (AgroSAM) for EU27 Member States

Section prepared by Marc Mueller, Emanuele Ferrari

The AgroSAMs were constructed based on Supply and Use Tables (SUT) provided by Eurostat.

The agricultural sector has been comprehensively covered by integrating the database from the partial equilibrium (PE) agro-economic simulation model “Common Agricultural Policy Regionalised Impacts analysis modelling system” (CAPRI) (Britz and Witzke, 2008). These two main datasets have been processed to compile a specific dataset for each Member State covering agricultural and non-agricultural activities and commodities. This database is intended to enhance modellers’ assessment of agricultural policy issues within each EU member state, e.g. the analysis of the impacts of 2013 CAP reforms on agricultural and non-agricultural sectors, with tools typical of the I-O or SAM analysis. This dataset permits a level of analysis that is much more detailed than already existing databases designed for agricultural CGE analysis. For example, the GTAP database, which is by far the most frequently used database for global CGE analysis, distinguishes 12 raw agricultural products and 8 processed food commodities. Currently, the AgroSAM database contains 28 raw agricultural sectors and one processed food sector, and an agricultural service sector, for each member state. All the AgroSAMs contain 98 activities and 97 commodities. The non-agricultural sectors are disaggregated according to the NACE 1 classification.

The AgroSAMs were built by following three main steps. First, consolidated macroeconomic indicators for EU27 were compiled. Second, different datasets from Eurostat were combined into a set of SAMs with aggregated agricultural and food-industry sectors. Third, these sectors were disaggregated based on the CAPRI database. The comparison of the activity accounts built on top of the CAPRI database and the European System of National Accounts (ESA) databases revealed that, despite some relevant differences in coverage and definition, the CAPRI database can be considered a reliable source of information. Particularly, produced and trade quantities of agricultural goods, activity levels, output and input coefficients and basic prices are the most reliable values. Other sources, such as

PRODCOM, are used to complete the database when they are not exhaustive, as in the case of the food industry sectors.

The CAPRI and the ESA databases, both expressed in a SAM structure, have been merged. This step was initially problematic, because ESA data are expressed on a mixture of basic and purchaser’s price while the CAPRI database is measured only at basic prices. The a priori SAM has been populated following a compilation procedure that is fully documented in Mueller et al. (2009).

At the end of each of these three stages, the datasets had to fulfil all the balancing criteria needed by a typical SAM. The method for balancing the datasets draws heavily on the concept of cross entropy estimation (Golan et al., 1994). Structural deviations of agricultural sector and economy-wide data created a need to specify in which cases comparatively large deviations from recorded agricultural data could be tolerated, and in which cases not. For this purpose, cross entropy procedures proved to be extremely useful. The final matrices are balanced through a cross-entropy approach, combined with a multiplicative disturbance term. The balancing process is constrained by the ESA totals and the CAPRI totals.

The integration of the CAPRI database with SUT tables represented the most relevant challenge and achievement of the project. The integration of the CAPRI database into a complete and consolidated set of SAMs for the EU27 raised several challenges. The first challenge came from the level of detail of the CAPRI database, its format and its division between agricultural and food processing activities. CAPRI was too detailed for the scope of the AgroSAM project. Specifically, CAPRI contains data on manure production and use, fertiliser consumption, set-aside, milk quotas which are extremely difficult to transform into a SAM framework. In addition, the CAPRI database does not follow the typical “activity to commodity” structure of SAMs,

whereas the CAPRI database does not take non-agricultural activities into account. This makes it difficult to treat sectors such as wine, meat and milk, which are considered to be processed food in ESA but end-of-pipe agricultural products in the CAPRI database.

- JRC-IPTS (AGRILIFE unit) has contributed the EU I-O Tables to GTAP. In total 27 SAMs have been included in the GTAP database version 7.1. https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=3181
- The underlying methodology is published: “Construction of Social Accounting Matrices for EU27 with a Disaggregated Agricultural Sector (AgroSAM), by M. Mueller, I Pérez Domínguez, SH Gay., JRC 24010 (2010) <http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=2679>
- Using Macro Indicators for Consistent CGE Baseline Construction by E. Ferrari, M. Mueller and A. Gonzalez Mellado, Publication presented at the 13th Annual Conference on Global Economic Analysis, Penang, Malaysia (2010) (<https://www.gtap.agecon.purdue.edu/resources/download/5105.pdf>)
- “Using Macro Indicators for Consistent CGE Baselines”, By E. Ferrari and M. Mueller, AgFoodTrade FP7 Project Working Paper (2010)

3.3.3 Social Accounting Matrices at regional level (NUTS2)

Section prepared by Marc Mueller and Emanuele Ferrari

Agricultural policies in the EU are increasingly affecting not only the agricultural sector but also other economic branches. The longer-term objectives of Pillar 2 of the CAP also involve non-agricultural sectors. The indirect effects of these policies might be as important as the direct ones, especially as regards factor markets like labour. In order to understand and refine the targeting of

agricultural measures better, policy makers are devoting more attention to the regional impacts of these policies. For these reasons, a pure partial-equilibrium agricultural model is not enough to account for the effects of EU agricultural policies. The development of regionalised Computable General Equilibrium models and linking them to existing regionalised agricultural partial equilibrium models is a fundamental step for agricultural economists. The greatest challenge in building a regional general equilibrium model for all EU27 NUTS2 regions is the database construction. The main steps needed to construct such a database, called IOTNUTS2, are described below.

Addressing regional heterogeneity requires multi-sector data on a sub-national scale. Such datasets as are available are usually not sufficiently detailed, which gave rise to numerous non-survey methods to generate regional IOTs based on combinations of regional indicators and national datasets. At national level, some attempts to construct consistent regionalised tables have been pursued, mainly by National Statistical Offices (NSO) following survey-based method (i.e. Finland, OFS) or national research institutes following non-survey-based methods and link them to multi-sectoral regionalised national models. To the best of our knowledge, a complete set of SAMs for all the EU NUTS2 does not yet exist and this work fulfil this deficiency in the literature.

In the following, the steps are described to build a database consisting of Social Accounting Matrices (SAMs) on NUTS2¹⁴ level, called

¹⁴ The Nomenclature of Territorial Units for Statistics (NUTS) classification is a hierarchical system for dividing the economic territory of the EU for the purpose of collection, development and harmonisation of EU regional statistics and socio-economic analyses of the regions. The regional classification follows this hierarchy: NUTS1 (major socio-economic regions), NUTS2 (basic regions for the application of regional policies), and NUTS3 (small regions for specific diagnoses). The current NUTS classification lists 97 regions at NUTS1, 271 regions at NUTS2 and 1303 regions at NUTS3 level. (http://epp.eurostat.ec.europa.eu/portal/page/portal/nuts_nomenclature/introduction)

SAMNUTS2. Firstly, an inventory of regional datasets was conducted for EU27, covering national and regional databases from Eurostat and the information-rich datasets coming from Member States NSOs. Following standard non-survey procedures, the data were then combined to populate the regional SAMs. Survey-based regional tables coming from NSOs were used to test the reliability of the techniques adopted in this work to combine national and regional datasets. This test shows that for the majority of economic sectors, non-survey methods generate reliable substitutes for indicators collected by others means. These matrices were then balanced following a modified Stone-Byron method.

A SAM-based dataset allows the characteristics of Computable General Equilibrium analyses to be exploited by capturing the feedback of agricultural policies on non-agricultural sectors and on the factor markets. In fact, the advantages of both types of modelling - the generality of the CGE and its capacity to take account of all the aspects of an economy, and the “depth” of the PE model and the abundance of detail in the modelling of a single sector - can be exploited in two main ways. First, policies like reforestation programmes, the promotion of investment in agro-tourism or environmental services, or the support for the production of renewable energy by farming enterprises, and all the policies related to the so-called Pillar 2 of the CAP, can be regionally

modelled. Such measures primarily target the agricultural sector, but are likely to influence other economic sectors and aggregate regional income, depending on the regional economic structure and the dominance of agriculture. Moreover, such a regional database facilitates linkages between modified existing regionalised national Computable General Equilibrium (CGE) models and partial equilibrium models like CAPRI, which already covers all the EU NUTS2 regions.

Important references are:

- An Inventory of Datasets for the Compilation of Regional Social Accounting Matrices for the EU by Mueller and Ferrari, Publication prepared for the 14th Annual Conference on Global Economic Analysis, Venice, Italy (2011) (<https://www.gtap.agecon.purdue.edu/resources/download/5380.pdf>)
- “Compilation of datasets needed for regional splitting of the national SAMS”, E. Ferrari, M. Blanco-Fonseca, M. Himics and M. Müller, (2010) CAPRI-RD FP7 Project Deliverable: D2.2.3
- “Procedure for the compilation of regional SAMs based on national SAMs and available regional datasets”, E. Ferrari M. Himics and M. Müller, (2010) CAPRI-RD FP7 Project Deliverable 2.2.4.

■ 4 iMAP at work: a selection of policy relevant applications

In this chapter, a selection of applications of iMAP tools carried out at the IPTS or in cooperation with other model teams is briefly described. The authors of the sections are not necessarily the authors or persons responsible for the studies portrayed.

4.1 A benchmark for ex-ante impact assessment: regular provision of a medium term outlook for EU agriculture

Section prepared by Zebedee Nii-Naate, Pavel Ciaian, Thomas Fellmann, Emanuele Ferrari, Sophie H elaine, Mihaly Himics, Robert M'barek, Olexandr Nekhay, Shailesh Shrestha, Benjamin Van Doorslaer

4.1.1 A common baseline for EU and third country agricultural policy analysis

DG AGRI publishes an annual report called *“Prospects for Agricultural Markets and Income in the EU”* (hereafter known as the “outlook”), which contains medium-term baseline projections. The construction of the agricultural baseline projections involves joint efforts by DG AGRI and JRC-IPTS. The outlook presents a consistent set of market and sector income projections based on specific policy and macroeconomic assumptions. The projections are not intended to be a forecast of what the future will be, but instead is a description of what may happen given a specific set of assumptions and circumstances, which at the time of making the projections were judged plausible. As such, the outlook projections serve as a benchmark for ex ante policy simulations. They provide the context for analysing medium-term market and policy issues, rather than short-term forecasts

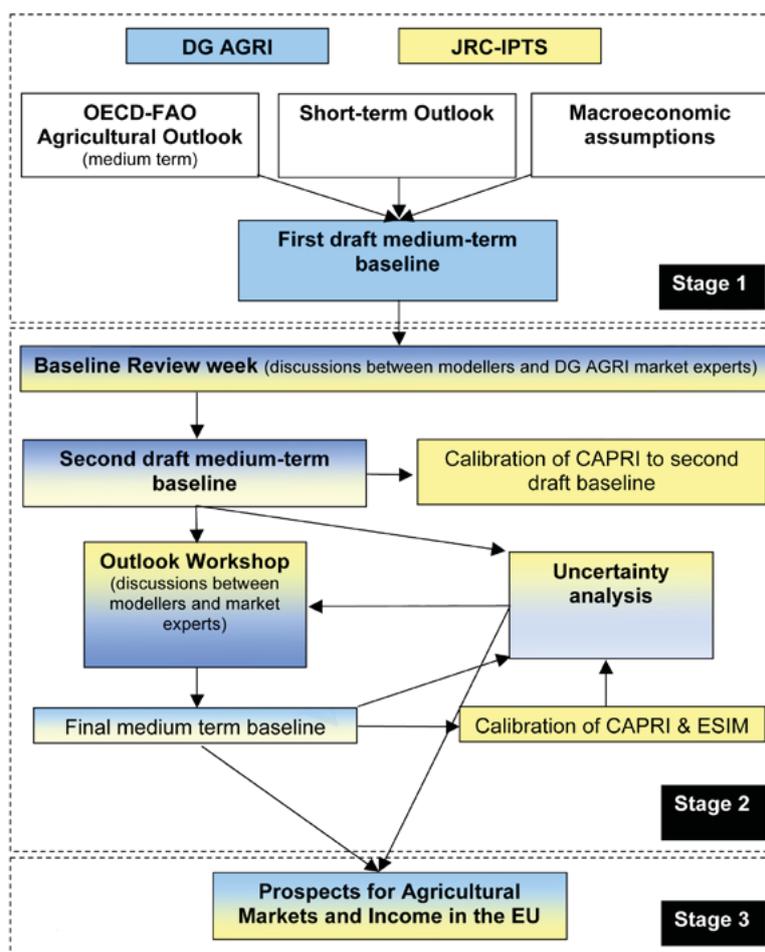
for monitoring market developments and addressing short-term market issues.

Figure 4.1 describes the main analytical steps performed during the construction of baseline for agricultural commodity market developments and income.

The baseline construction has three main stages:

1. Stage 1 leads to the first draft medium-term baseline bringing together three elements. First, a consistent and coherent set of medium-term macroeconomic projections is introduced into the latest OECD-FAO Agricultural Outlook. The AGLINK-COSIMO model is used to simulate the most probable medium-term reference scenario for development of individual agricultural commodity markets worldwide and in the EU-27 (including explicit results for the EU-15 and the EU-12), under specific assumptions concerning developments of exogenously determined variables (e.g. macroeconomic projections and recent policy changes). Second, the Short Term Outlook (6-18 month forecasts of EU agricultural market development that are published in September/October, generated by DG AGRI and based on the latest market and price developments and focusing on EU market balances for arable crops, meat, milk and dairy products) is incorporated into the latest OECD-FAO Agricultural Outlook. The short-term outlook involves statistical analysis of the most recent data on arable crops, meat, milk and dairy, which are combined with numerous and wide-ranging qualitative judgments provided by product and commodity market experts at DG AGRI. Finally, the first draft medium-term baseline

Figure 4.1. Overview of the agricultural baseline process



is simulated to generate world market and EU prices, together with EU commodity balance sheets that are consistent with a global market-determined equilibrium.

2. Stage 2 starts with a Baseline Review week and consists of three components:
 - a) The first draft medium-term baseline is reviewed at Baseline Review meetings between market and modelling experts of DG AGRI and JRC-IPTS. Subsequent necessary adjustments are made and a revised baseline is produced. In revising the first draft baseline, the work is broken up into commodity specialisms (arable crops, sugar and biofuels, meat, milk and dairy and agricultural income) of around ten members of DG AGRI and

JRC-IPTS staff. Each group's individual expert adjustments to the balance sheet, policy variables, and elasticities are submitted to the baseline review manager before they are incorporated into the model and simulations are run. This flexible and iterative approach is performed until a preliminary baseline is assembled. At this stage, technical issues (such as the model failing to solve because of model misspecification or extreme values of input data) and expert commodity advice is incorporated into the model and baseline. A key input into the baseline projections is the up-to-date input of commodity market judgements by DG AGRI experts, especially in the short-term projections. The work of the Baseline Review week is then presented

to around 30 product and commodity experts and senior officials for their feedback. The presentations are given by model experts and focus on balance sheet projections and areas where the modellers would benefit from the insights of commodity experts and key areas of uncertainty. The comments received are incorporated into the baseline before it is disseminated. The key output at this stage of the baseline process is the preliminary baseline, which is used as the starting point for the uncertainty assessment of the baseline's assumptions and the calibration¹⁵ process of CAPRI and ESIM models.

- b) The CAPRI and ESIM models are calibrated to DG AGRI's updated AGLINK-COSIMO baseline, with the objective of constructing a baseline scenario for individual EU Member States, and also at more disaggregated (i.e. NUTS2) levels. A further objective is to perform sensitivity and uncertainty analyses on the outlook projections. The calibration process is important because it allows DG AGRI to exploit the richer detail of ESIM's Member State projections and CAPRI's Member State and NUTS2 level data that is missing from the AGLINK-COSIMO model but in a way that all simulations and policy support produced by the three models are based on the same underlying vision and consistent set of assumptions.
- c) The preliminary baseline forms the basis of an outlook workshop, which is jointly organised by DG AGRI and JRC-IPTS, gathering high-level policy makers, modelling and market experts from the EU, third countries, international organisations and stakeholders. The

workshop offers the opportunity to comment on the reliability of the results obtained as well as to discuss how different settings and assumptions regarding macroeconomic factors and other uncertainties may influence the projections of individual commodity markets. The experts are also afforded the opportunity to present and discuss the reasons behind observed and expected market developments, and to draw conclusions about the short- and medium-term perspectives of European agricultural markets in the context of world market developments. In addition, scenario and uncertainty analysis by JRC-IPTS are presented and discussed. Each year, the set of quantitative uncertainties and sensitivities examined varies, depending on the main areas of risk to the baseline using the DG AGRI and JRC-IPTS's suite of partial and general equilibrium models. As part of the validation procedure, suggestions and comments made during the workshop are taken into account in order to improve the baseline projections. The simulated results are then passed for comment to the commodity experts on a bilateral basis. This process is repeated until both the modelling subgroups and the product and commodity experts are satisfied with the baseline projections. The baseline is finalised after several iterations of the uncertainty assessment, calibration processes and feedback from market experts via bilateral exchanges, converge to a consensus position. An innovation that has helped to enhance transparency is the publication of the proceedings of the outlook workshop.

3. Stage 3 consists of publishing the final projections in the DG AGRI's Prospects for Agricultural Markets and Income in the EU. These projections are then used as the

¹⁵ Of the three partial equilibrium models, AGLINK-COSIMO is the only one suitable for generating a baseline.

Commission's initial input into the OECD-FAO agricultural outlook process (see Figure 4.1 for details) at end-December.

The process of creating the baseline implies that the final projections are profoundly enriched and improved by internal and external expert opinion. In producing the baseline and interpreting the uncertainty analyses, there is a very important role for expert judgement.

Further reading:

- Gay S, Kavallari A, Blanco Fonseca M, Burrell A, Fellmann T, Helaine S, Henseler M, Himics M, M`Barek R. Prospects for Agricultural Markets and Income in the EU 2010-2020 . In: Prospects for Agricultural Markets and Income in the EU 2010-2020. Brussels (Belgium): European Commission - DG Agriculture and Rural Development; 2010. p. 53-76. JRC62591 http://ec.europa.eu/agriculture/publi/caprep/prospects2010/fullrep_en.pdf
- European Commission (2011). Prospects for Agricultural Markets and Income in the EU 2011-2022. http://ec.europa.eu/agriculture/publi/caprep/prospects2011/fullrep_en.pdf
- Fellmann, T and S. H elaine (2011). Commodity Market Development in Europe – Outlook. October 2011 Workshop Proceedings, IPTS Scientific and Technical Report: <http://ftp.jrc.es/EURdoc/JRC67918.pdf>
- iMAP modeling team (compiled by Nii-Naate, Z) (2011). Prospects for Agricultural Markets and Income in the EU: Background information on the baseline construction process and uncertainty analysis. IPTS Scientific and Technical Report: <http://ftp.jrc.es/EURdoc/JRC67803.pdf>

4.1.2 Uncertainty analysis of the baseline

The published baseline of the DG AGRI's *Prospects for Agricultural Markets and Income in*

the EU assumes normal weather conditions, steady demand and yield trends and no disruptions caused by factors like animal disease outbreaks or food safety issues. As such, the baseline projections depict rather smooth market developments, while in reality markets tend to move along a more volatile path as observed in the past and particularly over recent years. Part II of the Report addresses a number of uncertainties underlying the baseline projections. The main objective of the uncertainty analysis is to assess and quantify how alternative assumptions about the main drivers of demand and supply, the general macroeconomic setting, and prospects for biofuel markets could influence the projected agricultural market developments. The uncertainty analysis carried out at the JRC-IPTS makes use of different agricultural sector models, namely the DG AGRI updated AGLINK-COSIMO model and other models included in the iMAP platform (CAPRI, ESIM and a general equilibrium model).

In 2010 and 2011, a number of uncertainty analyses were undertaken covering a wide range of topics on the key drivers of uncertainty, some of which are listed below:

- changes in the situation in specific trading partner economies;
- changes in yield growth;
- changes in input costs;
- macroeconomic uncertainties; and
- uncertainty about the crude oil price.

The uncertainty analysis undertaken at the JRC-IPTS aims to describe how much the baseline is affected by changes in model input values via "what if" analysis. It investigates the importance of uncertainty in model inputs as part of the decision-making and modelling process. In 2011, the analysis of uncertainty was extended through the use of partial stochastic simulations. This method was used to assess the degree of sensitivity of the baseline projections to the macro-economy and

weather fluctuations. To run these simulations, 500 sets of correlated macroeconomic variables¹⁶ or arable crop yields¹⁷ were incorporated into the modelling system and a baseline was simulated for each of them. The result was two sets of 500 alternative baseline projections that lie within the boundaries of what might be possible, given past levels of uncertainties. It is important to note that the main reason for running partial stochastic simulations is not to improve the macroeconomic projections or arable crop yield development but to ascertain the degree of uncertainty in the baseline projections due to those uncertainties.

Further reading:

- Nii-Naate, Z and A. Burrell (2012). Stochastic Methodology: DG AGRI's Updated and Augmented AGLINK-COSIMO model (forthcoming).

4.2 iMAP stand alone: Impact of agricultural policies on agricultural markets and farm incomes

The main objective of iMAP is to support DG AGRI with model-based policy assessments. The tools maintained and further developed are used for different types of policy analysis. In the following sub-sections a selection of recent applications is presented aiming at a brief summary of the approach and main results as well as describing the added value of choosing between or combining different models.

4.2.1 EU agriculture and global and regional trade

4.2.1.1 Potential EU-Mercosur free trade agreement

Section prepared by Alison Burrell, Emanuele Ferrari, Aida González Mellado, Mihály Himics, Jerzy Michalek, Shailesh Shrestha, Benjamin Van Doorslaer

Negotiations for a bilateral preferential trade agreement between the EU and Mercosur began in 1999 in the context of the EU-Mercosur Inter-regional Framework Cooperation Agreement (Council Decision 1999/279/EC). The aim of the negotiations was to move towards free trade between the two regions whilst respecting WTO commitments, involving all sectors but also taking account of sensitive areas.

After exchanging initial proposals, and subsequently exploring various sensitive issues, the trade negotiations were suspended in October 2004. In particular, Mercosur found the EU's offer on market access for key agricultural goods to be insufficient, whereas the EU expected greater concessions from Mercosur in sectors like textiles, footwear and vehicles. Although the closing EU and Mercosur positions concerning trade in goods, which provide the inspiration for the scenarios examined in this study, evolved considerably from the opening offers presented in 2001, they were still not close enough to finalise a deal¹⁸.

Following an informal dialogue between the two parties during 2009 and 2010, the Commission recommended a relaunch of the negotiations, which was agreed at the Madrid summit of May 2010. The coverage and level of ambition (all sectors, single undertaking etc) enshrined in the framework for the previous

16 In 2011, the partial stochastic analysis of macroeconomic variables included: EU GDP growth, EU and US GDP deflator, EU Consumer Price Index, Brent crude oil price and the USD-Euro exchange rate.

17 In 2011, the partial stochastic analysis included soft wheat, durum wheat, barley, maize, other cereals, oats, rye, soya bean sunflower, and rapeseed yields in EU-15 and EU-12.

18 Apart from the issues related to goods, there were also disagreements regarding services, investments, government procurement and intellectual property (see Zago de Azevedo and Henz, 2006).

negotiations were to be maintained. In addition, the context was broadened to include issues relating to sustainable development, and provisions for greater cooperation with the Andean Countries (Peru and Colombia) and countries of Central America and the Caribbean are also envisaged.

At the end of 2010, DG AGRI requested IPTS to carry out a socioeconomic impact assessment. The study was conducted entirely in-house, assisted by external experts for some technical and methodological issues.

For this study, simulations were made with two different models of two alternative hypothetical versions of a bilateral free trade agreement between the EU and Mercosur. At the same time, two alternative possible states of the world trade context were envisaged, namely, a state in which there is no Doha Round agreement and hence multilateral trading rules remain as at present, and one in which a Doha Round agreement has been reached and is implemented by the latest in 2020.

The two models used for this analysis are quite different in their philosophy, construction and coverage. GLOBE, a CGE model, is able to simulate the impact on all sectors in all countries and regions modelled. On the other hand, CAPRI, a partial equilibrium model, simulates only the effects generated by and incurred by the agricultural sectors. However, CAPRI is able to look more closely at individual primary and secondary agricultural commodities and offers a more disaggregated spatial perspective within the EU at NUTS2 level. Hence, it adds additional important information to the study of trade policy changes for which agriculture is expected to be one of the sectors that is most affected.

In order to run the simulations, the GTAP data was updated and additional trade data were incorporated (bilateral trade, tariff rates, TRQs). In particular, this implied the development of bilateral TRQs for GLOBE.

To prepare the CAPRI model for this study, trade information was revised and updated, including adjustments to the FAPRI price data. The sugar module was adapted in order to incorporate latest EU policies and trends.

Main results

The simulation results show that the economic losses and the adjustment pressures arising from a bilateral trade agreement between the EU and the countries of Mercosur would, as far as the EU is concerned, fall very heavily on the agricultural sector. The gains to other sectors would be widely diffused and, given the very small magnitude of these gains relative to the EU economy as a whole, would be easily absorbed without imposing an adjustment burden. The aggregate welfare changes for the EU, whether measured across the whole economy or on a partial basis with respect only to the activities agricultural production and food consumption, would be small. However, the trade-off involved in the redistribution of income between agriculture and the rest of the economy is steeper in the scenarios depicting the terms requested by Mercosur than in those involving the terms offered by the EU. The Mercosur request provokes a much greater downward impact on EU agriculture whereas the additional gains elsewhere (to non-agrifood sectors or to consumers in the EU) are relatively smaller.

At NUTS 2 level, the distribution of the production and revenue falls for individual agricultural products in the EU depends both on the pattern of specialisation for the product and the regional competitive advantage in its production. The largest percentage falls in revenue are observed for the EU regions specialising in livestock production. In a few regions, falls in beef production are as much as 9% and the decrease in revenue from beef exceeds 20%.

Main outcome

The preliminary findings were presented to the Member States during a joint DG TRADE &

DG AGRI Committee Meeting (Brussels) in April 2011 and to the INTA Committee of the EP in June 2011. Final results were presented to the same Committee in September 2011. On both occasions, Member State representatives had the opportunity to comment on the results.

The study was published as a JRC Reference report at the end of 2011. Furthermore, the resulting material of the study served as a source for three conference papers.

The study was also the start of some further developments of GLOBE (multilateral TRQs) and of CAPRI (possible introduction of a “trade” layer).

- A. Burrell, E. Ferrari, A. González Mellado, M. Himics, J. Michalek, S. Shrestra, B. Van Doorslaer (authors), A. Burrell (editor), “Potential EU-Mercosur Free Trade Agreement: Impact Assessment”; JRC Reference Report, European Commission, Luxemburg, EUR 25011 EN (2011) <http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=4819>
- E. Ferrari, A. González Mellado, J. Michalek, “Doha Development Agenda in the European Union. Impacts on the agricultural sector”; presented at the 13th Annual Conference of the European Trade Study Group (ETSG) 2011 in Copenhagen (work in progress)
- A. Burrell, E. Ferrari, A. González Mellado, J. Michalek, “EU Market Access for Agricultural Products in the Doha Development Round: A Sensitive Issue”; paper accepted at the 28th Triennial Conference of the International Association of Agricultural Economists (IAAE) in Brazil from August 18 to 24, 2012.

4.2.1.2 Simulations of a comprehensive free trade agreement between the EU and Ukraine

Section prepared by Olexander Nekhay, Thomas Fellmann

The EU and Ukraine are currently negotiating a deep and comprehensive free trade agreement (FTA). Such a FTA can be expected to affect agricultural markets, providing opportunities as well as challenges for both trading partners.

The main objective of the study was to provide a model-based quantitative assessment of the potential impacts of a FTA on agricultural commodity markets and farmers revenues in the EU and Ukraine.

For the quantitative analysis, the AGLINK-COSIMO model was adapted and applied (Section 3.1.1). To simulate a potential FTA between Ukraine and the EU the abolition of import tariffs for 14 main agricultural products (wheat, coarse grains, rice, oilseeds, vegetable oils, protein meals, butter, cheese, skimmed milk powder, whole milk powder, beef and veal, pork, poultry, sheep meat) was assumed. The results of the FTA scenario were compared with the results of a baseline scenario (where import tariffs actually applied are kept in place). The projection period for both scenarios was 2010-2020.

As AGLINK-COSIMO is a net trade model, the destination and origin of the traded commodities are not included. Therefore, several changes to the original model had to be introduced in order to be able to tackle the question addressed:

- The EU and Ukrainian modules were extracted from the AGLINK-COSIMO model. The EU module was derived from the European outlook for agricultural markets while the Ukrainian module was derived from the OECD-FAO agricultural outlook.
- The Ukrainian module was calibrated on the world market prices as given in the European outlook for agricultural markets and updated information on tariffs for the years 2008 onwards (after the Ukrainian accession to WTO) were introduced.

- A third module was created to bridge the EU and Ukrainian modules. In this new module three types of equation were introduced (for all 14 commodities under consideration):
 1. Combined net trade of Ukraine and the EU equals the rest of world net trade, which is kept as exogenous.
 2. Border prices in Ukraine and the EU are equal to the world market prices.
 3. World market prices are exogenous in the trade between the EU and Ukraine.
- For the FTA scenario, import tariffs for 14 commodities in the corresponding databases for Ukraine and the EU were eliminated. In the case of Ukraine oilseeds, export duty that is currently 12%, but foreseen to decrease to 10% in 2012, was considered. Export tariffs on oilseeds have been kept.

Results of the simulation indicate a positive change in producer revenue of € 393 million (+2.6%) in Ukraine and of € 860 million (+0.4%) in the EU. Thus, this FTA entails benefits for the agricultural sectors of both trading partners. However, gains from a FTA are not distributed evenly and vary significantly among commodities. These results are conditional on the assumption that Ukrainian agricultural producers are prepared and able to meet the challenges involved in complying with the quality and sanitary standards of the EU.

The main findings of the study were delivered to DG AGRI. Preliminary results of the study were presented at a market and policy expert workshop in Kiev (Ukraine). Final study results were presented at the EAAE 2011 Congress in Zurich (Switzerland) and at the AEEA 2011 Conference in Madrid (Spain). Furthermore, a paper has been accepted for publication in the *Post-Communist Economies Journal*.

Further reading:

- Nekhay, O., T. Fellmann and S.H. Gay (2011): Potential effects on agricultural markets and revenues of a free trade agreement between Ukraine and the European Union. Paper presented at the VIII Congreso de Economía Agraria, September 14-16, 2011, Madrid, Spain
- Nekhay, O., S.H. Gay and T. Fellmann (2011): A Free Trade Agreement between Ukraine and the European Union: Challenges and Opportunities for Agricultural Markets: Paper presented at the 13th European Association of Agricultural Economists Congress 'Change and Uncertainty. Challenges for Agriculture, Food and Natural Resources', August 30 - September 2, 2011, Zurich, Switzerland
- Nekhay, O., T. Fellmann and S.H. Gay (forthcoming): A Free Trade Agreement between Ukraine and the European Union: Effects on Agricultural Markets and Farmers Revenues. *Post-Communist Economies* 3 (42)

4.2.1.3 GMO import ban

Section prepared by Martin Henseler, Isabelle Piot-Lepetit, Aïda Gonzalez Mellado, Emanuele Ferrari, Sophie H elaine

In recent years, the European feed industry has experienced increasing difficulties with the import of genetically modified (GM) feedstuffs because of the EU's *zero tolerance* policy for non-authorised GM material in feed and the asynchronous approval of GM crops. In this study, the impact of a potential interruption of soybean and soybean meal imports from the major exporting countries (Argentina, Brazil, the US and China) to the EU was analysed.

For this study a CGE, the standard GTAP model, and a PE model "ESIM" were used sequentially. The CGE model was used for simulating the impact on international oilseed

trade and on EU import prices that could result from a simulated trade restriction on oilseeds¹⁹ with main exporting countries. The import price change for soy products evaluated by the CGE model was transferred to the PE model as an import tariff-equivalent barrier. The results of the PE model were then used to analyse the impact on the specific agricultural commodity markets in the EU, especially on the meat and dairy markets.

The modelling and the analysis were carried out in-house in close collaboration with the ESIM modelling team in Hohenheim and with particular support from Martin Banse for the CGE modeling.

Main results

Four scenarios were simulated: 1) an increase in import price without any trade interruption, 2) an interruption of soy imports from the US, 3) an interruption of soy imports from Argentina and the US, 4) the worst-case scenario: an interruption of soy imports from Argentina, Brazil, the US and China. The last one is presented in detail in the report.

In the worst-case scenario, results from the GTAP model indicate that a trade disruption with the US, Argentina, Brazil and China leads to a decrease of 64% in the total value of oilseeds imported into the EU and the oilseed import price increases by 46%. The imports into the EU come from non-restricted countries like the Russian Federation, Asia, Australia, New Zealand and Sub-Saharan Africa and to a lesser extent from Turkey, the Rest of Europe and North Africa. These countries import soybeans and meal from the traditional exporting countries to supply their domestic market while increasing the exports of their domestic soy production to the EU.

As illustrated by the ESIM results, increased crushing of rapeseed and sunflower seed into oilseed meals and vegetable oils outside the EU

allows the substitution of soybean meal and soy oil in the EU. While import prices for rapeseed and sunflower seed meals increase due to the higher EU demand, the import prices for rapeseed and sunflower oils decrease slightly. Sunflower seed meal imports increase and the EU switches from being a net exporter of rapeseed meal to become a net importer.

The higher import price of soy products decreases the feed demand for soybeans and soy meal by 36% and 37% respectively, while the animal feed cost index increases by between 4% and 14% depending on the type of meat. This implies a loss of competitiveness in the EU livestock sector and increased attractiveness of imported meat. The production of meat decreases for sheep, pork and poultry by 1%, 5% and 4% respectively. Thus, the reduced supply of soy products and meat is compensated by increased net imports of other protein meals and meat and by a higher domestic production of fodder. Milk production decreases slightly (-1%) and this results in a reduction of the supply and net exports of some dairy products. Finally, the analysis shows that the impact for the meat and dairy sectors are not as extreme as one could expect.

Main outcome

A report was prepared for DG AGRI and an article has been submitted to *Agricultural Economics*.

This analysis was the first contribution of a CGE model to policy analysis for DG AGRI within iMAP. It was also the first attempt in-house to use a PE and a CGE model with sequential linking. As such, it was a very beneficial experiment for further work.

Reference

- “On the Asynchronous approvals of GM crops: Potential Market Impacts of a Trade Disruption of EU soy Imports” by Henseler M, Piot-Lepetit I, Gonzalez Mellado A, Ferrari E, Helaine S; internal working paper (2011)

¹⁹ In the GTAP model soybeans are not individually represented that is why the aggregate oilseeds is used in this article.

4.2.2 Domestic policy assessment: reform of the CAP

4.2.2.1 Milk quota reform in the EU

Section prepared by Robert M`barek

The assessment of EU's milk quota reform and in particular the potential impact of the abolition of the milk quota was a key topic during 2008 and 2009.

Given the importance and difficulty of the topic, combined with the need to provide very robust results, it was decided to use different PE models, CAPRI, CAPSIM and AGMEMOD, in a series of studies in close cooperation with international modelling teams. The rationale for this choice of models is as follows: AGMEMOD was chosen as it based on econometric estimation for each Member State and therefore includes a high degree of country-specific expert knowledge; CAPRI was used as it provides regional impacts and was combined with a complex study on the estimation of regional milk quotas; and CAPSIM offered at this time very detailed databases and gave insight into price transmission in the context of EU enlargement.

Within the project, a significant amount of work was devoted to a rigorous update of the models and databases.

A key contribution to policy making was the study of the regional impacts of the milk quota abolition, which has been cited in the report from the EC to the European Parliament and the Council "Evolution of the market situation and the consequent conditions for smoothly phasing out the milk quota system"²⁰.

Further reading:

- Tonini A, Perez Dominguez I. Review of Main Methodological Approaches Quantifying the

Economic Effects of the European Milk Quota Scheme. EUR 24016 EN; 2009. JRC53822 <http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=2719>

- Witzke H, Zintl A, Tonini A. The Common Agricultural Policy SIMulation (CAPSIM) Model: Dairy Reform and Western Balkan Countries Accession Scenarios . EUR 23951 EN. European Commission; 2009. JRC50411 <http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=2519>
- Witzke H, Kempen M, Perez Dominguez I, Jansson T, Sckokai P, Helming J, Heckelei T, Moro D, Tonini A, Fellmann T, authors Fellmann T, editor. Regional Economic Analysis of Milk Quota Reform in the EU. EUR 23961 EN. European Commission; 2009. JRC53116 <http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=2520>
- Bartova L, Fellmann T, M`Barek R, editors. Modelling and Analysis of the European Milk and Dairy Market - Detailed Projection Results. EUR 23833 EN/2. European Commission; 2009. JRC50916 <http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=2320>

4.2.2.2 Sugar reform in the EU

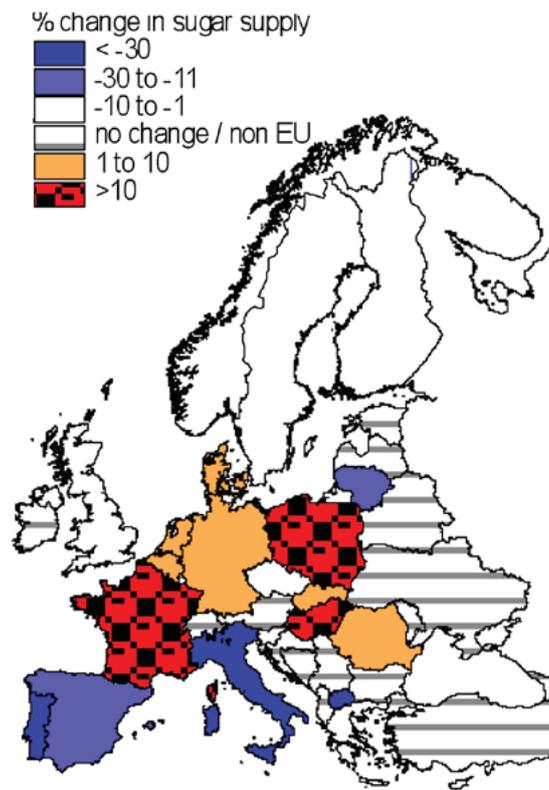
Section prepared by Sophie H elaine, Martin Henseler

In the framework of the reform of the CAP after 2013, it is proposed to remove the sugar quota as from 2015. This proposal gave rise to the need for an assessment of the impact of quota removal on the EU-27 sugar market in terms of production levels and prices.

The study was performed using the EC version of AGLINK-COSIMO. However, for such reforms with significant impact on the producers and the industry, policy makers need more detailed analysis, which is why the ESIM model was used to provide results for each Member State.

²⁰ http://ec.europa.eu/agriculture/milk/quota-report/com-2010-727_en.pdf COM(2010) 727 final

Figure 4.2. Impact of the quota abolition on sugar supply in 2020 (in comparison to the baseline scenario)



For the purpose of this analysis, the sugar data (quota, production and C-sugar) was updated in the ESIM model (2010 version). A crucial element of the sugar common market organisation is the preferential access to the EU market mainly for the ACPs and the LDCs, and also for other countries within TRQs. The willingness of these countries to export to the EU depends on the difference between the EU price and the world price, plus transport cost. This behaviour has been implicitly taken into account in ESIM when estimating the import demand function by using the results of another model developed by Stephan Nolte of Ghent University, which simulates this decision explicitly for all countries with preferential access over a large range of different world market prices. Therefore, the analysis was carried out in close collaboration with Stephan Nolte. In addition, the Hohenheim team contributed especially to the calibration of the model to the world price development assumed for the analysis.

The results show that if the sugar quota is abolished in 2015/2016, the sugar beet area in 2020 is expected to be higher by 5% than if the quota is maintained. Production in the EU-27 could increase by nearly 7%. Because of the higher supply, the EU price for white sugar would decrease by 12% in nominal terms. Demands for direct human consumption and industrial use (other than biofuel) are almost not affected due to their low price elasticity. The biofuel demand is not higher because in the baseline the biofuel target is already achieved due to a large share of other feedstock (common wheat and corn). While demand is relatively stable and EU production is higher, net imports decrease drastically by 1 Mt.

The changes in production are very different in the Member States (MS) as illustrated in Figure 4.2. Production increases in the MS with the lowest costs of production, which were particularly constrained by the quota, namely in France, Germany, Poland and the

UK. However, in certain competitive MS, the additional output after quota abolition is not so large because these MS are projected to produce a lot of sugar out-of-quota in any case, even if quotas are not abolished; this is the case for the Netherlands, Denmark, Sweden and Belgium. In Greece, production stops, and the production decrease is very large in Italy and Finland, where the production costs are high. In Spain, the production drop is also significant.

The sugar market is one of the most complex markets to depict in models. Therefore, close discussion with the sugar market unit in DG AGRI took place to understand better the functioning of the sugar CMO. In addition, numerous exchanges of intermediate results took place with DG AGRI because the analysis was carried out at the same time as the further development of the EU sugar module of AGLINK-COSIMO and both models could benefit from the ongoing analyses. The level of the price difference between the EU and the world was intensively discussed. It showed that the acceptability of the model results by market experts was conditional on clear explanations of certain highly sensitive issues.

As an outcome of this work, a note was sent to DG AGRI. Furthermore, the results were summarised in a section of the Annex XI to the impact assessment published by DG AGRI the 12 October 2011.

Further reading:

- COMMISSION STAFF WORKING PAPER-IMPACT ASSESSMENT Common Agricultural Policy towards 2020 ANNEX 11; http://ec.europa.eu/agriculture/analysis/perspec/cap-2020/impact-assessment/annex11_en.pdf

4.2.2.3 CAP towards 2020

Section prepared by *Sophie H elaine and Mihaly Himics*

The Common Agricultural Policy (CAP) has undergone fundamental reform over recent

decades. As well as its traditional objectives, EU agriculture is now also required to produce in an environmentally and socially sustainable way, while also improving its competitiveness.

The Commission published the legal proposals for the CAP after 2013 on 12.10.2011. iMAP contributed to the preparation of these important proposals, working together with DG AGRI on the prospects for agricultural markets and other inputs to the Impact Assessment report.

Input for DG AGRI

In the framework of the impact assessment of the CAP towards 2020, many analyses were carried out by DG AGRI Unit L.3 using FADN data. This Unit has developed a static model determining the level of direct payment by farm in 2020 for different scenarios. In order to take into account the market developments foreseen in the baseline up to 2020, price and yield developments were communicated to the FADN Unit. Initially, the AGLINK-COSIMO baseline results were provided for the blocks EU-15 and EU-12. Once calibration was finalised, ESIM results by Member State were also sent.

In the end, DG AGRI used only the developments for EU-15 and EU-12 as it was easier for them to model and available more quickly. In addition, except for milk, the changes in prices in ESIM are similar for the different Member States as the EU average prices are used in the model.

CAPRI analysis

JRC-IPTS and JRC-IES are both involved in the FP7 project "Common Agricultural Policy Regionalised Impact – The Rural Development Dimension (CAPRI-RD)"²¹. Deliverable 6.2 of the

²¹ http://www.ilr1.uni-bonn.de/agpo/rsrch/capri-rd/capri_rd_e.htm. The project aims to investigate the regional effects of CAP Pillar I and II policy options. The standard CAPRI modelling framework has been further developed to meet this goal, featuring for example a modelling layer of regional computable general equilibrium models.

project is a model-based impact assessment of a possible 'greening' of the Common Agricultural Policy. This policy scenario defines a combination of a regional flat-rate system for direct payments with a 15% "corridor" around the EU27 average payment rate. The study is led by University of Bonn with DG AGRI playing a key role in the scenario design. The institutions vTI, LEI and IPTS are also directly involved.

In this modelling exercise, the newly developed farm-type layer of the CAPRI modelling system will be applied as it takes farm heterogeneity across EU into account. The results will include a detailed description of possible CAP redistribution effects across EU regions and farm types. Also the effects on land use, product balances, prices and some relevant environmental indicators will be examined.

The CAP towards 2020 impact assessment shows, on the one hand, the importance of the market models for constructing a baseline to serve as an input for farm-income models and other types of model (e.g. land-use). On the other hand, the limits of the market models become obvious since the main features of the reform are linked to environmental measures, which can only partly be captured by agro-economic models. The linkage of different model types (e.g. economic and land-use) would open up new opportunities for making joint use of the strengths of individual models.

Further reading:

- COMMISSION STAFF WORKING PAPER-IMPACT ASSESSMENT Common Agricultural Policy towards 2020 ANNEX 11; http://ec.europa.eu/agriculture/analysis/perspec/cap-2020/impact-assessment/annex11_en.pdf

4.2.3 Europe and its neighbours

4.2.3.1 Western Balkan Countries Accession Scenarios

Section prepared by Axel Tonini and Robert M'barek

In a study of potential impacts of a further EU enlargement, an early accession scenario for Croatia (in 2010) with accession for the remaining Western Balkan countries (in 2015) was analysed with the Common Agricultural Policy SIMulation (CAPSIM) model. The CAPSIM model was developed by the University of Bonn and was used in the period from 2001 to 2008 at DG ESTAT. In order to run the accession scenarios for Croatia and remaining Western Balkan countries, the price transmission mechanism between Member State prices and EU prices was enhanced as compared to the previous CAPSIM version as described in Witzke and Zintl (2007). The revised price transmission mechanism is particularly relevant for accession scenarios since it reflects differences in composition and in quality of the products considered.

CAPSIM – a particular case

In 2007, DG ESTAT decided to discontinue agro-economic modelling and to focus on data analysis only. The JRC-IPTS was asked to take over the CAPSIM model and to further develop it with funding from the DG ESTAT budget. A series of projects launched in 2007 included two policy applications: the analysis of the milk quota reform (see section 4.2.1.1) and the analysis of a potential Western Balkan accession to the EU. Furthermore, a project to set up a database for agricultural sector modelling extending and improving the data on Western Balkans and Turkey was also launched. The actual modelling work was done by the contractor EuroCARE.

Subsequently, the iMAP portfolio was further developed and the AGLINK, ESIM and CAPRI models became core models. The model developers at University Bonn and EuroCARE Bonn then decided to focus exclusively on CAPRI, due to the infeasibility (given time availability) of maintaining a second, simpler model in addition to CAPRI, despite some synergies between the two models. Therefore, CAPSIM was no longer used as an iMAP support tool. However, the datasets and some methodological features were taken into the core models.

The following Western Balkan accession scenarios were performed: i) accession of Croatia in 2010 and the remaining Western Balkan countries five years later; ii) same as i) but with steering price convergence parameters adjusted in order to allow stronger price convergence; iii) same as i) but with expiry of milk quotas prior to accession.

While CAP features like milk quotas and decoupled payments are introduced in the Western Balkans, accession results in a convergence to EU prices, and in yield-increasing technology transfer. Agricultural income per head is projected to increase by about 30% in the Western Balkans largely due to higher total sectoral income rather than to a decline in agricultural labour, which is estimated fall by about 5%. Welfare effects are also estimated to be positive even though quite heterogeneous. There would be a total welfare gain to the region of €1.3 billion which accrues largely in Serbia (+€0.7 bn).

These expected favourable outcomes are likely to be boosted by accession impacts on services and industry (not modelled) and rural development measures (also not covered). Since the degree of price adjustment is highly uncertain and crucial, sensitivity analyses were used to explore its role.

The project reports were delivered to DG ESTAT as well as to DG AGRI. At the time of the report, enlargement discussions were centred on the agricultural sector, so that the report results did not enter into policy discussions or documents, and it has not been possible to trace any effect of the report on the outcome of the accession negotiations. Apart from the JRC technical report, no additional scientific output was produced from this exercise due to staff leaving and changing priorities in iMAP. Nevertheless, all datasets and the complete model code were made public to permit the rerun of the model.

CAPSIM is a good example of the iMAP approach in reacting to client needs and developments in the “market” of economic models.

Further reading:

- Witzke H, Zintl A, Tonini A. The Common Agricultural Policy SIMulation (CAPSIM) Model: Dairy Reform and Western Balkan Countries Accession Scenarios. EUR 23951 EN. Luxembourg (Luxembourg): European Commission; 2009. JRC50411 <http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=2519>

4.2.3.2 Turkey EU Accession Scenarios

Section prepared by Thomas Fellmann and Robert M'barek

Following the Helsinki European Council of December 1999, Turkey was accepted as a candidate for EU membership and formal accession negotiations with Turkey started in October 2005. Given the importance of Turkey's agricultural sector, Turkish accession to the EU could be expected to affect the agricultural markets in both the EU and, to a much greater extent, in Turkey. To assess the potential impacts of an EU enlargement to Turkey for agricultural commodity markets and income in Turkey and the EU an in-depth model-based study was conducted.

This study attempts to anticipate relevant policy questions, and respond to institutional/scientific demands for iMAP, namely the wish of the Scientific and Technological Research Council of Turkey (TUEBITAK) to include Turkey in the pan-European model network AGMEMOD. In this case, iMAP benefitted from specific credits from the JRC for Enlargement & Integration (<http://ec.europa.eu/dgs/jrc/index.cfm?id=1720>).

To quantify the potential impacts of a Turkish EU accession on agricultural commodity markets and income the AGMEMOD (AGricultural Member States MODelling) model (see section 3.1.4) was used. In order to conduct the analysis, a detailed dataset and modelling structure for the main agricultural commodities in Turkey had to be developed and integrated into the overall AGMEMOD modelling framework. The study

was carried out by members of the AGMEMOD Consortium under the management of the Agricultural Economics Research Institute (LEI, the Netherlands), in cooperation with the JRC-IPTS and the Johann Heinrich von Thünen-Institute (vTI, Germany), the Department of Economics at the Akdeniz University (Turkey), the Alessandro Bartola Association (Ancona, Italy) and the Teagasc-Rural Economy Research Centre (RERC, Ireland).

Results of the Turkish EU-membership simulation show that the impacts on agricultural markets in Turkey are significant, whereas effects on EU markets are rather limited. The main impact on Turkish agriculture is a reduction of producer prices. Agricultural income is expected to be reduced especially for Turkish crop producers, due to the decline in market prices and produced quantities, and also because the coupled Turkish direct payments and the input subsidies will be replaced by lower payments under the CAP. In contrast, accession effects on the Turkish livestock sector are projected to be positive, mainly due to lower feed costs. Furthermore, the demand levels of most commodities are projected to increase due to lower prices, thus Turkish consumers are expected to gain from accession to the EU.

The presentation of preliminary results to a specific workshop in Brussels led to useful feedback and dialogue between the collaborators in the study and DG AGRI, in particular the units dealing with enlargement. In 2011, when official discussions on the inclusion of agriculture in the current customs union between Turkey and the EU started, the material provided in the study contributed to the internal assessment.

The excellent cooperation between IPTS and the contractors resulted in several scientific publications and conference papers.

As in many iMAP modelling projects, and typically very pronounced with the AGMEMOD model, cooperation between teams within and beyond EU borders, a strong training and knowledge transfer component, were features

of this exercise. This manifests an important dimension of a European/international platform for modelling and scientific exchange.

Further reading:

- Van Leeuwen M., P. Salamon, T. Fellmann, A.-. Koç, G. Bölük, A. Tabeau, R. Esposti A. Bonfiglio, A. Lobianco, K. Hanrahan, authors; Fellmann T, (editor) 2011: Potential impacts on agricultural commodity markets of an EU enlargement to Turkey. EUR 24772 EN. Luxembourg (Luxembourg): Publications Office of the European Union. JRC60663 <http://ftp.jrc.es/EURdoc/JRC60663.pdf>
- Salamon, P. M. van Leeuwen, A. Tabeau, A. Koç, G. Bölük and T. Fellmann (2010): Potential impacts of a Turkish EU-membership on agri-food markets. *Agriculture and Forestry Research* 4 (60):193-204
- Fellmann, T., M. van Leeuwen, P. Salamon, A. Koç, A. Tabeau and G. Bölük (2011): The effects on Turkey's agricultural income and markets of a potential accession to the EU. Paper presented at the Eurasia Business and Economic Society Conference, June 1-3, 2011, Istanbul, Turkey
- Fellmann, T., M. van Leeuwen and P. Salamon (2011): EU enlargement to Turkey: Potential impacts on agricultural markets and how they are shaped by changes in macroeconomic conditions. Paper presented at the GEWISOLA 2011 Conference 'Entrepreneurial Agriculture - Meeting Changed Market Demands and Social Requirements', September 28-30, 2011, Halle, Germany
- Fellmann, T., M. van Leeuwen and P. Salamon (forthcoming): EU enlargement in an uncertain macroeconomic environment: How do changes in macroeconomic conditions influence the potential impacts on agricultural markets of a Turkish accession to the EU? *Marmara Journal of European Studies* 1 (20)

4.3 iMAP as part of JRC-wide policy support: Agri-economic impacts of policies targeting horizontal (multi-sectoral) issues

iMAP tools play a strong role in integrating several JRC activities, since they span the different JRC priorities on agriculture, energy, environment, climate change and development and as a link between natural sciences (biophysical modelling) and economic analysis.

4.3.1 The bio-economy aspect: Assessment of EU biofuel targets

Section prepared by Aikaterini Kavallari, Maria Blanco Fonseca, Alison Burrell, Stephan Hubertus Gay, Martin Henseler, Robert M'barek, Ignacio Pérez Domínguez, Axel Tonini

The EU's Renewable Energy Directive sets an overall binding target of 20% for the share of EU energy needs to be sourced from renewables by 2020, with at least 10% of each Member State's transport fuel coming from renewable sources (including biofuels).

The consequent growth in biofuel production is likely to trigger indirect land use changes worldwide. An IPTS project studied the impact of EU biofuel policies on agricultural production, trade and land use within and outside the EU, up to the year 2020, based on the market outlook from 2009. This analysis was requested by DG AGRI in the context of policy support delivered by IPTS.

The IPTS study of EU biofuel policy used the three key iMAP partial equilibrium agro-economic models, namely AGLINK-COSIMO, ESIM and CAPRI, according to their relative strengths. The report demonstrates how the use of several models provides a rich, composite picture that could not be achieved with just one model.

AGLINK-COSIMO presents the most detailed picture of production in non-EU countries and of world trade, includes a rich representation

of policy measures, uses a baseline agreed by OECD member countries, and due to its recursive dynamic properties it is able to take into account adjustment lags and the time path of the changes required to comply with the directive by 2020.

However, CAPRI offers a far richer and more informative picture of land use changes within the EU, and hence greater possibilities for drawing qualitative conclusions about the incidence of internal environmental effects. Moreover, it provides a more detailed picture of the impact on agricultural production technologies and environmentally relevant activities.

Finally, ESIM, in which each EU Member State is separately modelled, EU policies are specified in depth, and total land use (up to an effective limit) is endogenised. The use of this model contributes to a deeper understanding of the underlying responsiveness of the agricultural market outcomes, and helps to support the findings of the other two models.

All three models are able to identify policy impacts on supply and demand, trade flows, domestic and world markets. In addition, they can give a consistent global picture of indirect land use change impacts triggered by price signals transmitted via market interactions.

The study was entirely carried out at IPTS, involving the iMAP teams of all three models mentioned. In the preparation phase of these simulations, a dialogue with the model developers took place, in order to acquire full knowledge about how the biofuel sector is specified in each model.

The impacts identified include higher EU production of ethanol and biodiesel, and of the crops used to produce them, as well as more imports of both biofuels. AGLINK-COSIMO estimates an extra 5.2 million hectares used for cereals, oilseeds and sugar crops globally. One quarter of this extra land use is in the EU (Table 4.1). The most pronounced land use increase outside the EU would occur in South America (Argentina +2.3% and Brazil +1.6%).

Table 4.1. Area of wheat, coarse grains, oilseeds and sugar crops, selected countries, 2008-2020, by scenario and between scenarios

	2008		Change 2020 vs. 2008				Policy impact	
			Counterfactual (CF)		Baseline (BL)		(BL)-(CF), 2020	
	1000 ha	1000 ha	%	1000 ha	%	1000 ha	%	
EU	71639	-6140	-8.6	-4677	-6.5	1462	2.2	
USA	91848	-1082	-1.2	-813	-0.9	269	0.3	
India	78436	3422	4.4	3598	4.6	176	0.2	
China	72408	1027	1.4	1057	1.5	29	0.0	
Russian Federation	52373	535	1.0	701	1.3	166	0.3	
Brazil	46853	13696	29.2	14685	31.3	989	1.6	
Argentina	27077	-2173	-8.0	-1609	-5.9	565	2.3	
Canada	24127	1292	5.4	1422	5.9	130	0.5	
Ukraine	22260	3166	14.2	3377	15.2	211	0.8	
Australia	21820	559	2.6	838	3.8	279	1.2	
Africa	96935	3069	3.2	3316	3.4	247	0.2	
Other Asia	70648	968	1.4	1541	2.2	573	0.8	
Other L. America	14309	1222	8.5	1327	9.3	105	0.7	
The Rest	30578	-555	-1.8	-541	-1.8	14	0.0	
World	721312	19006	2.6	24221	3.4	5214	0.7	

Notes: The baseline scenario assumes that the blending target of 10% for the use of biofuels in transport as given by the Renewable Energy Directive will be met and that tax rebates for biofuel consumption and import duties will be in place by 2020. The counterfactual scenario assumes absence of tax rebates, of the blending target and also absence of any second generation biofuel use by 2020.

Source: AGLINK-COSIMO simulations

However, the global figure does not include any land use implications of the higher vegetable oil production in Indonesia and Malaysia.

Inevitably, the results depend on various underlying assumptions such as future trends in fossil fuel prices, crop yields, population and world GDP. The sensitivity of the simulated scenarios to yield growth assumptions, to the least-cost combination of biofuels use and to crude oil price trends was investigated.

Both the iMAP Reference Group and external experts carried out a thorough peer-review of this study, which led to improvements. A continuous exchange with market experts from DG AGRI and members of the Commission's biofuels steering group also took place throughout the duration of the study (about one year).

Given the sensitivity of the topic and the uncertainty of biofuel developments, the customary impartial and science-based approach of IPTS was particularly welcome and the report was conceptualised as a purely scientific and factual document. The presentation of results strictly followed the logic of the agro-economic tools used and depicted strengths and limits of the approach. Thus, the document fitted very well in the rather tense and political debate as the only economic assessment prepared within Commission.

The report received a lot of recognition:

- The study was made a reference document for the public consultation and was presented at the second stakeholder consultation meeting on 26 October 2010

in Brussels http://ec.europa.eu/energy/renewables/consultations/2010_10_31_iluc_and_biofuels_en.htm

- The AGLINK-COSIMO results were summarised in the “Report from the Commission on indirect land use change related to biofuels and bioliquids”, published 22 Dec 2010 http://ec.europa.eu/energy/renewables/biofuels/land_use_change_en.htm
- Report from the Commission on indirect land use change http://ec.europa.eu/energy/renewables/biofuels/land_use_change_en.htm

This economic assessment was also a main input for the ILUC land allocation report of JRC-IES:

- Hiederer, R. et al: Biofuels, A New Methodology to Estimate GHG Emissions from Indirect Land Use Change; European Commission; EUR 24483 EN; 2010 http://eusoils.jrc.ec.europa.eu/esdb_archive/eusoils_docs/other/EUR24483.pdf

The report was finally published as a JRC Reference Report:

- Blanco Fonseca, M., Burrell, A., Gay, S.H., Henseler M., Kavallari, A., M’barek, R., Pérez Domínguez, I., Tonini, A.,(authors), Burrell, A., (ed.) (2010) Impacts of the EU Biofuel Target on Agricultural Markets and Land Use A Comparative Modelling Assessment, JRC Reference Report, European Commission, Joint Research Centre, EUR 24449 EN; <http://ftp.jrc.es/EURdoc/JRC58484.pdf>

Furthermore, it was presented in several articles and conference contributions:

- Ramos, F., Marelli, L., Blujdea, V., Leip, A., Mulligan, D., Koeble, R., Kavallari, A. and R. M’barek (forthcoming): Biofuels: Modelling the spatial distribution of new cultivated land to estimate greenhouse gas emissions from global land use change. Paper submitted for publication at the Biomass and Bioenergy.
- Burrell, A., Gay, S. H. and A. Kavallari (2012): The Compatibility of EU Biofuel Policies with Global Sustainability and the WTO. *The World Economy*, article first published online 29 February 2012: DOI: 10.1111/j.1467-9701.2011.01430.x
- Kavallari, A., Gay, S. H. and A. Burrell (2010): EU biofuel policies: A closer look at some collateral impacts. Contributed paper at the 14th ICABR Conference, Ravello, 16-18 June.
- Kavallari, A., and S. H. Gay (2010): EU biofuel policies: What are the effects on agricultural markets? Contributed paper at the 18th European Biomass Conference, Lyon, 3-7 May.

This exercise was the first comprehensive agro-economic study to be carried out entirely at the JRC-IPTS but involving the original model developers in the preparation phase, which is also recognised in common publications. In this sense, it provides an excellent example of how iMAP can function through close collaboration between the client, IPTS and external modellers (iMAP Reference Group) in order to deliver policy-relevant economic assessments at a very high standard whilst keeping confidentiality.

Currently, an update of the biofuel policy assessment based on the latest available market outlook for the EU is being prepared.

4.3.2 EU livestock and GHG emissions

Section prepared by Thomas Fellmann

In line with the Budget Review Communication and with the aim of increasing market orientation, the future CAP should become greener, focussing more on climate change and the environment. The role of agricultural production in the context of climate change, and particularly the livestock sector's contribution to greenhouse gas (GHG) emissions, is gaining visibility. With increased visibility, interest in policy options for mitigating agriculture's GHG emissions is also growing. Designing mitigation policies requires a proper emission accounting system and it is imperative to understand the impact of such policies on GHG mitigation, on the one hand, and their cost in terms of agricultural production and trade, on the other hand.

Initial research started in 2009 to develop the existing agro-economic models so as to deal with the crucial questions of climate change mitigation and adaptation. The objective of the project "Evaluation of the livestock sector's contribution to the EU greenhouse gas emissions" (GGELS) was to provide an estimate of the net emissions of GHGs and ammonia (NH₃) from the livestock sector in the EU-27 according to animal species, animal products and livestock systems, following a food chain approach. A further objective within the GGELS project was the assessment of the GHG and NH₃ emission reduction potential of a selected number of policy options. To this end, the possible future evolution of EU agricultural emissions, and including expected macro- and microeconomic changes, was measured by scenario simulation.

The CAPRI model was adapted for the GGELS project so as to account for product-based GHG emissions from EU livestock production using the life cycle assessment (LCA) concept. The LCA approach gives a more complete picture of emissions created by livestock products as it also considers emissions caused by the production

of the inputs used. However, official emission values of the national inventories are not reported based on products but based on activities. Hence, for the assessment of the GHG mitigation policy scenarios, the calculation of agricultural emission inventories in CAPRI is based on agricultural activities, taking into account all emissions during a specific agricultural production activity in the respective NUTS 2 region. The regional supply models in CAPRI capture the links between agricultural production activities in detail as CAPRI incorporates a detailed nutrition flow model per activity and region (including explicit feeding and fertilising activities, i.e. balancing of nutrient needs and availability). With this information, CAPRI calculates GHG emission coefficients endogenously following the IPCC guidelines. As relevant output, emission inventories are calculated for EU Member States, mimicking the reporting on emissions by the EU to the UNFCCC.

The mitigation policy scenarios were all designed to achieve a 20% GHG emission reduction in the year 2020 relative to EU emissions in 2005. The policy scenarios envisaged an Emission Standard (emission standard with a regionally homogeneous cap), an Effort Sharing Agreement for Agriculture (emission standard with regionally differentiated caps according to the EU effort sharing agreement), an Emission Trading Scheme for Agriculture (regionally homogeneous cap, with trade in emission rights at regional and EU-wide level) and an emission tax on livestock (regionally homogeneous taxes per cow, sheep and non-ruminants).

The GGELS project was initiated by an administrative agreement between DG AGRI and the JRC (cooperation between IES, IPSC and IPTS). Within the project, JRC-IES was responsible for the LCA approach, and the JRC-IPTS carried out the assessment of the GHG mitigation policy scenarios in cooperation with the Agricultural Economics Research Institute (LEI, the Netherlands), EuroCARE (Germany), the Swedish

University of Agricultural Sciences (SLU, Sweden) and the von Thünen Institute (vTI, Germany).

The GGELS report provides an in-depth analysis of the livestock sector of the EU, starting from a general overview of the sector, developing a new livestock typology and quantifying its GHG and NH₃ emissions on the basis of the CAPRI modelling system, both ex post for the year 2004 and ex ante according to the latest CAPRI projections for the year 2020. The CAPRI model was thoroughly updated for GGELS to reflect the latest scientific findings and methodologies agreed by the IPCC, and was extended in order to allow a cradle-to-farm-gate calculation. The report is complemented by an overview of the impact of the EU livestock sector on biodiversity, an analysis of the GHG reduction potential using technological measures and an assessment of selected policy mitigation scenarios.

With respect to the mitigation policy scenarios, results show that the emission reduction effects per EU Member State in each scenario are quite different from the EU-27 average, depending on the production level and the composition of the agricultural activities. Extensification effects in agriculture can be observed in all scenarios, with the largest decreases in agricultural activities being projected to take place in beef production activities (e.g. beef production decreases by 15% in the standard scenario). In some scenarios, the projected decrease in production activity leads to higher prices and therefore to higher agricultural income. Results also indicate that a livestock tax in particular would significantly influence milk and beef activities, with strong decreases in herd sizes and income.

The analysis also reveals that a unilateral GHG emission reduction in the EU would provoke an emission increase in the rest of the world. That means that the effective emission reduction commitment in the EU is diminished

due to 'emission leakage', i.e. a shift of emissions from the EU to the rest of the world (e.g. while the EU reduces its emissions by 20% in the livestock tax scenario, emissions in other countries increase by an equivalent 5%). Thus, other countries would increase their agricultural production and trade more in order to meet demand in the EU (mainly higher net imports of feed and animal products in the EU).

A report prepared for DG AGRI underwent a thorough review by members of the advisory board and the steering group (including DG AGRI and DG ENV) of the project. Conference contributions and scientific journal articles are in preparation.

- Leip, A., F. Weiss, T. Wassenaar, I. Pérez Domínguez, T. Fellmann, P. Loudjani, F. Tubiello, D. Grandgirard, S. Monni, K. Biala (2011): Evaluation of the livestock sector's contribution to the EU greenhouse gas emissions (GGELS). European Commission - Joint Research Centre. http://ec.europa.eu/agriculture/analysis/external/livestock-gas/index_en.htm
- Pérez Domínguez, I., T. Fellmann, P. Witzke, T. Jansson, D. Oudendag (Authors) with the collaboration of A. Gocht and D. Verhoog; Editor: T. Fellmann (2012): Agricultural GHG emissions in the EU: an exploratory economic assessment of mitigation policy options. Seville (Spain): European Commission - Joint Research Centre; forthcoming summer 2012.
- Fellmann, T, I Pérez Domínguez and SH Gay, 2011. Political and administrative instruments for the abatement of greenhouse gas emissions from EU agriculture. In: Kuratorium für Technik und Bauwesen in der Landwirtschaft e.V. (KTBL), 2011. *Emissionen der Tierhaltung – Treibhausgase, Umweltbewertung, Stand der Technik*. KTBL-Schrift 491, Darmstadt, 229-243.

■ 5 iMAP under review

Section prepared by Hans van Meijl, Martin Banse, Wolfgang Britz, Pierre Charlebois, Harald Grethe, Thomas Heckeley, Scott McDonald, Pat Westhoff

5.1 The Reference Group

As part of the iMAP strategy, a Reference Group was formed, composed of well-known and experienced external experts in agricultural sector modelling, some of them the original developers of iMAP models. The Reference Group provides independent advice and feedback concerning the maintenance, development and use of the main modelling tools currently available in iMAP. Alongside iMAP staff and in close co-operation with DG AGRI, it also regularly reviews agricultural market and policy developments from the perspective of their quantitative impact to ensure an appropriate future strategy for iMAP.

The objectives of the Reference Group are:

- To provide a discussion forum for analysing the potential development of modelling tools in the context of market dynamics and policy reforms,

- To identify potential improvements in the iMAP tools, as well as model synergies and potential model linkages,
- To evaluate the performance of the iMAP sector modelling work by reviewing the results of relevant policy applications performed by IPTS staff.

Within strategic meetings (taking place twice per year) broader topics of interest to iMAP have been discussed. These have been:

- Demand and requirements for preparing a medium-term market outlook,
- Keys to the success of a modelling platform, discussion of how to intensify the collaboration between European institutions, e.g. DG AGRI or JRC-IPTS with the academic world,
- Modelling of the CAP towards 2020,
- Challenges for modelling agricultural policies in a CGE framework,
- Evaluation of iMAP with a view on its performance and sustainability,

■ Table 5.1. Members of Reference Group

Name	Institution
Hans van Meijl (designated coordinator)	LEI (Dutch Agricultural Economics Institute)- part of Wageningen UR
Martin Banse	vTI – Johann Heinrich von Thünen Institut (German Agricultural Economics Institute)
Wolfgang Britz	EuroCARE / University of Bonn
Pierre Charlebois	AGLINK-COSIMO expert
Harald Grethe	University of Hohenheim
Thomas Heckeley	EuroCARE / University of Bonn
Scott McDonald	OBU – Oxford Brookes University
Pat Westhoff	FAPRI – Food and Agricultural Policy Research Institute, Missouri

- Comparison of iMAP models and identification of comparative advantages.

The Reference Group remains in close contact with IPTS staff and provides hands-on support on technical questions regarding iMAP models in sessions scheduled to take place twice per year, as well as responding to questions and helping to solve operational problems on an ad hoc basis.

5.2 Views on iMAP from the Reference Group

The regular dialogue among IPTS modellers, the Reference Group and DG AGRI has built a relationship of trust between all parties involved and has increased mutual understanding of needs and interests as well as of the different institutional settings.

iMAP and the regular Reference Group meetings are built on the idea that joint efforts are needed to respond to all potential requests and provide high quality policy support. Often the research questions require a collaborative approach and need to be answered by more than one specific model. This need has been recently intensified by the increasing inter-linkages of the agricultural sector with other sectors. Environmental policies for example, such as those aiming to regulate the carbon market, and/or renewable energy policies such as targets for biofuel use in transport, affect agricultural markets and often more than one tool needs to be employed to give an answer to policy makers. To address these needs and to support the policy-making process with relevant outcomes, communication and collaboration are needed between the academic community, the policy makers and public research institutions. iMAP and the Reference Group are set up on this premise and hence are considered to be a unique platform for bringing the policy makers together with the academic community and the public policy support research institutions.

The regular Reference Group meetings within iMAP have given the opportunity to exchange information and views on modelling issues and approaches beyond the content of a specific research project. This has created an open discussion forum on issues such as database harmonisation, market outlook and model calibration to a deterministic baseline, software implementation and capacity-building. Discussions on how to model specific policy instruments have given insights into the comparative advantages of each of the iMAP models and underlined the role of the policy analyst and of the modeller in making the right choices and meeting the demand of the policy makers. Not least, these meetings have given DG AGRI the opportunity to highlight upcoming analytical needs, thereby allowing the model developers to prepare their tools accordingly.

The open discussions within iMAP can provide a good basis for planning the future needs in terms of agro-economic modelling. Understanding and comparing iMAP models has helped to render the “walls” between the models and the modelling approaches more transparent. Given that the agricultural sector is becoming more linked to the rest of the economy and also to environmental concerns, an opportunity for the future within iMAP would be to intensify the discussion on how to build bridges between the models. In this content, linking the iMAP PEs with the iMAP CGEs and also linking iMAP models with biophysical modelling approaches would be worth exploring further.

However, the continuous staff turnover in IPTS and to a lesser extent in DG AGRI creates a problem. On the one hand, newcomers have to catch up with the current status of discussions in iMAP. On the other hand, as well as repeating past discussions for the newcomers, there is a need to deepen the debate and move forward. Nevertheless, it has to be acknowledged that the problems newcomers to IPTS face when jumping into using complex models for policy support would have been higher had it not been for iMAP.

Table 5.2. Reference Group's views on iMAP

<p>Strengths</p> <ul style="list-style-type: none"> • Interaction between DG AGRI, IPTS modellers and experts beyond the context of a specific study project • Mutual trust between policy makers and analysts • Good balance between competition and cooperation of different models and approaches 	<p>Weaknesses</p> <ul style="list-style-type: none"> • Meetings of the Reference Group meetings are overloaded with too many different topics • Abstract discussions at the level of first brainstorming ideas • Limited integration of new staff in IPTS to the current state of discussions
<p>Opportunities</p> <ul style="list-style-type: none"> • Continuous interaction between models and modellers • Increasing collaboration among Reference Group members on integrated modelling approaches • Increasing need for integrated modelling approaches in order to capture the carbon market, land use changes due to GHG emission reduction policies, effects of the overall macroeconomic environment on agriculture 	<p>Threats</p> <ul style="list-style-type: none"> • High staff turnover in IPTS • Allocation of resources for short-term ad hoc policy support at the expense of long-term model development

Finally but equally important, the fact that the demand for agro-economic modelling is determined by short-term ad hoc policy-support questions makes it difficult to formulate a long-term strategy on modelling issues. And yet, in order to deepen the discussions within iMAP and to take decisions on which modelling tools to further develop one needs a long-term perspective.

Table 5.2 summarises the views of the Reference Group on iMAP in a SWOT framework.

To sum up, iMAP is a unique platform bringing together agro-economic model developers with policy makers. The regular Reference Group meetings have proven to be very beneficial for having an open dialogue between academia, IPTS and DG AGRI. This has helped significantly to improve the understanding of what the iMAP models are and which research questions they can address. Opportunities for the future of iMAP are to continue bridging modellers and policy makers and to deepen the collaboration on integrated modelling approaches.

■ 6 Visions and challenges: Strategic outlook for iMAP

Section prepared by Robert M'barek, Jacques Delincé

The topics for integrated economic assessment of policies, as well as the economic, social and environmental settings, have changed over time. Just as methodologies, software, hardware etc. are further developed over the course of time, so are - or should be - the tools used and competences needed within iMAP.

The policy priorities for the new financial framework of the European Commission and the future CAP are not a straightforward continuation of business as usual. The financial and economic crisis and the increasing importance of emerging countries, as well as global challenges such as climate change, have led to a reshaping of priorities.

These new directions translate into new requirements for models in their spatial and temporal dimensions, sectors and actors, scenarios and interpretation. The globalised world with new economic powers, changing production and consumption patterns, and volatile interdependent markets, needs models dealing with structural breaks, gloomy economic outlooks and complex new policies.

The models used in iMAP have certainly incorporated many new methodological and policy developments and benefitted from the rapid evolution of information and communication technology. However, they remain rooted in their original design and might reach their boundaries of adaptation.

This chapter considers potential pathways for moving ahead, whilst remaining aware of the difficulties path dependencies can cause, and also conscious of the achievements and robustness of

the models that have been developed and served their purpose well over decades. We look in particular at the main policy orientations for the future, their implications for data and tools, and for a broader iMAP perspective.

6.1 Policy questions of the future related to iMAP

Agriculture is increasingly more integrated into the macroeconomy and linked to other sectors. Consequently, the agro-economic discipline needs a more holistic approach. There is a broad range of literature on the different aspects of current and future policy challenges related to agriculture. A comprehensive overview is given in the publication "The top 100 questions of importance to the future of global agriculture", subdividing 100 pertinent questions into four overarching sections: i) natural resource inputs; (ii) agronomic practice; (iii) agricultural development; and (iv) markets and consumption.²²

The topic of food security returned to the agendas of all main intergovernmental panels, such as the G20, after the high prices for food turned into real food crisis. A globally sufficient food supply is a major priority for the G20, and also for the European Commission.

Within the CAP, other driving elements are the single farm payment and the move towards a single common market organisation for all agricultural products, shifting the focus from classic market analysis to more income-related questions. However, today's globalised markets

²² <http://bis.gov.uk/assets/bispartners/foresight/docs/food-and-farming/additional-reviews/11-599-wp5-top-100-questions-future-global-agriculture.pdf>

raise even more complex queries. The European Parliament has summarised key questions from a European perspective in its report “What Market Measures in the Future CAP after 2013?”:

“Higher volatility and increasing trends in commodities prices, increasing interdependence with energy markets and the high concentration of processors/retailers on food markets will characterise European agriculture in the future. The final outcome of the WTO Doha Round could add further competitive pressure on some sectors characterised by reduced farms’ margins, which face higher production costs, more demanding environmental regulations and increasing competition from third countries. Improvements in the information channels and access to new technologies will condition the sectors’ capacity to cope with the new challenges. Perhaps the most important issues for European agriculture are increasing world food demand, climate change and scarce water, land and energy resources.”²³

iMAP has neither the ambition nor the capacity to adapt its models in order to deal with all these questions. Instead, iMAP will focus on improvements to address policy and research-oriented questions with an economic dimension, in particular:

- Assessment of alternative policy options of the CAP towards 2020 and beyond;
- Evaluation of international competitiveness of the European agro-food sector in an uncertain and volatile economic environment with ongoing multi- and bilateral trade liberalisation;
- Short-, medium- and long-term assessment of food security, mainly supply/demand balances and price volatility;

- Economic impact analysis of agriculture’s contribution to green growth, investigating alternative policy options to adapt and/or mitigate climate change, to make water use more efficient and in particular to estimate indirect land use changes due to new policies;
- How farm structural change, new technologies, consumer behaviour, demographics and other trends impact on the sector and rural regions.

The tools available in iMAP allow a rapid switch between different topics. Depending on the client’s needs and the priorities defined by the JRC, different orientations are possible, starting with the agricultural sector and leading to an analysis of the whole economy. Thus, apart from the classic topics dealt with within the agro-economic research domain, one of the potential pathways is a focus on the bioeconomy²⁴.

6.2 Improving data and tools

6.2.1 Data challenge and the need for validation

Science-based policy support requires high quality, reliable and up-to-date data. Closely related to this is the imperative of validating/checking the input (including parameters, coefficients etc.) and output of models.

The data challenge has different dimensions.

Firstly, model simulations should ideally always use the most recent data available. Efforts to harmonise (input) databases among models are ongoing, aiming at more efficient (and transparent) procedures. In this context, the data management system DataM, developed together

23 What Market Measures in the Future CAP after 2013?; EP April 2011 <http://www.europarl.europa.eu/studies>

24 European Commission strategy and action plan, “Innovating for Sustainable Growth: a Bioeconomy for Europe”, http://ec.europa.eu/research/bioeconomy/press/press_packages/index_en.htm

with a software company to provide harmonised, complete and consistent data series that can be used for research and modelling (see section 3.3.1) will largely overcome the diversity of datasets, software and nomenclature.

Secondly, new data are needed to represent adequately the evolution of EU and international policies into new areas and instruments in the models. Systematic databases on policy instruments are scarce – a concept such as an improved Producer Support Equivalent (PSE by OECD) applied and adapted to European regions and farm types, available as a time series, could be useful. Also, data on key farm management characteristics (fertiliser rates, irrigation land share and equipment, stable and manure handling systems etc.) are missing. Moreover, data on total income of agricultural households are crucial, e.g. to evaluate the income risk from farming.

The sensitivity of results to different assumptions about key parameters is very important in economic modelling. This suggests the need for investing more time and effort in model validation, as well as systematic sensitivity analyses.

It could also be useful to identify which are the most influential variables in the models. To start with, a systematic collection of available elasticity estimates would be beneficial. Thus, econometric analysis should become an integral part of equilibrium analysis.

Finally, another dimension of the data challenge is that improved data and information systems make markets more transparent and efficient, as intended for instance by the AMIS initiative²⁵.

6.2.2 New model features and design

New developments in policy making require not only new data, but also new features

representing policy in the modelling tools. In the last few years, the iMAP modelling team has been working with other researchers on the development of new methodologies to cope with the new questions arising.

Different methodologies to analyse *price volatility* have been described and applied.²⁶ The importance of *non tariff measures* in trade has been empirically examined and the information incorporated into CGE models.²⁷ The inclusion of *climate change* induced yield variation is touched upon, but adaptation to climate change in particular is not sufficiently worked out.²⁸ In other IPTS research groups, a survey-based analysis of farmer's behaviour is carried out.²⁹

The examples mentioned are rather self-standing methodologies and do not necessarily link to existing global economic models. The challenge is obviously to use the information and additional knowledge in the context of the equilibrium tools in iMAP to the greatest possible extent.

The *uncertainty analysis* by means of stochastic simulations (see section 4.1.2) for the AGLINK-COSIMO model is more advanced. A similar approach is being tested for ESIM, with a feedback loop to the CAPRI model. Routines for more systematic methods are still on the wish list.

Further developments are also needed in the overall design of the models. There is a clear advantage in having a modular structure (see e.g. CAPRI and MAGNET), allowing the modeller to

26 "Methods to Analyse Agricultural Commodity Price Volatility", Springer, 2011; JRC technical report "The point on price volatility (forthcoming 2012).

27 JRC technical report (2011) "The importance of non-tariff measures for African agricultural and food trade to the EU Evidence from selected countries". González Mellado A., Ferrari E., (2011), "A CGE model analysis of reducing obstacles to trade in Kenya: a focus on the agro-food sector", 14th GTAP Annual Conference, Venice, 9-11 June 2011.

28 Different approaches are currently tested for the CAPRI model. For the mitigation of climate change see section 4.3.2. Different approaches are currently tested for the CAPRI model.

29 JRC technical report (2011) "Farm Investment Behaviour under the CAP Reform Process".

25 Agricultural Market Information System <http://www.amis-outlook.org/>.

switch different model features on and off without being obliged to modify the model code at different places. A strict use of hard coding is key.

The platform BioMA (Biophysical Model Applications) developed by the JRC Monitoring Agricultural ResourceS (MARS unit) is a good example of a toolbox where routines are reused without duplication.³⁰ This extensible software platform runs biophysical models on generic spatial units. The guidelines followed during its development aimed at maximizing:

- Extensibility with new modelling solutions
- Ease of customisation in new environments
- Ease of deployment

This means that tools can be linked according to the needs and not vice versa, where needs are re-interpreted based on the options of the model. It still remains to be seen whether this approach is useful and feasible in the economic modelling world too.

In any case, the further development of hard or soft linkages to models from other disciplines, specifically to biophysical models, but also to energy and financial models, requires the creation of “docking stations” and therefore a rethinking of the model design.

In concrete terms, further research and investment will be made to i) optimise model structures and code to reduce running time, as well as for comprehensive sensitivity analysis; ii) focus on the most important policy developments according to the strengths of the individual models (reminder: no model can serve all purposes); and consequently iii) the connection between models if beneficial for answering the policy or research question at stake.

6.2.3 Outlook challenge

A market outlook or projection serves as a benchmark for policy simulations providing the no-change context for analysing medium-term market and policy issues, i.e. 1 to 10 years. However, there is an increasing need to employ economic models for baseline analysis in the long run (10 to 40 years and beyond). The economic tools in iMAP used to prepare a baseline and perform simulations, are originally designed as tools for analysis of medium-term policy effects.

To allow for a long-term outlook, capturing changes in existing consumption patterns, specific advancements in technology, binding constraints for the use of natural resources, etc. different approaches have to be carefully evaluated.

6.3 iMAP as an integrated hub for sound science and transparent policy support

In addition to its role to support policy, iMAP shall contribute to making model results and harmonised data sources publicly available, thus increasing transparency and facilitating their scientific review. It should actively support EU and international initiatives to provide common baselines for different time horizons, data sources, and databases on parameters for example.

iMAP and policy-making

The mission of the Joint Research Centre and therefore also for iMAP is “to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies.”

When scrutinising iMAP in terms of the criteria of scientific quality, objectivity and perceived independence, flexibility in the conduct of the research and the likelihood of

³⁰ <http://mars.jrc.ec.europa.eu/>

EU biofuel policy

In 2009, the European Union adopted mandatory targets to achieve by 2020 through Directive 2009/28/EC on the promotion of the use of energy from renewable sources (the “Renewable Energy Directive”). Various reasons led to a reflection on the targets, also due to indirect land use change.³³ Among other studies, also iMAP delivered a report which was published and quoted in the Report from the Commission on indirect land-use change related to biofuels and bioliquids: “However, the Commission acknowledges that indirect land-use change can have an impact on greenhouse gas emissions savings associated with biofuels, which could reduce their contribution to the policy goals, under certain circumstances in the absence of intervention.”³⁴

iMAP does not interact directly with the decision making in Brussels, but supports the policy making process via the European Commission, providing sound, well reflected and independent analysis. This happened in the case of the biofuel mandate analysis, where the results clearly indicated the consequences of policies – 5.2 Mio ha of additional land due to the mandate (study 2009). The report states: “The simulated effects of EU biofuels policies imply a considerable shock to agricultural commodity markets, but precise magnitudes need to be treated with some caution.”³⁵

the research achieving its target and positively contributing to policy making, some observations can be made.³¹

The use of iMAP output and citation in policy relevant publications is wide-ranging (see in particular chapter 4). This, jointly with the close collaboration and publication with academia, could also be interpreted as an indicator for high scientific quality. Many different topics have been analysed in the last few years, evidencing the flexibility.

At this point, “the million dollar question” has to be posed: how does iMAP relate to objectivity and perceived independence? The box above on EU biofuel policy from chapter 4 illustrates one example of iMAP's role in the decision making process.

iMAP reports are written in an impartial way, indicating all pertinent results of the policy simulations and raising questions regarding potential consequences if relevant for the topic. Agriculture and related policies face immense challenges and iMAP must have the mission to clearly identify and describe the issues at stake.

31 Burrell A, Gay SH, M'barek R, http://www.gewisola.de/files/Schriften_der_GEWISOLA_Bd_46_2011.pdf

A call for transparency

The intense cooperation with academia and other institutions, and the setting up of a Reference Group illustrate the transparent approach of iMAP. Transparency is a sine qua non condition, not only from a scientific point of view, but also for continuing successful policy support.

iMAP tools are to a large extent freely available and in general well documented (see tables in annex 1). To this end, iMAP will continue to promote and improve the availability of data, parameters, model code etc.

The complexity of the models is certainly an entry barrier for many potentially interested users. However, it should be kept in mind that a push-

32 See for example: “However, due to growing global demand for agricultural commodities there is a risk that part of the demand for biofuels will be met through an increase in the amount of land devoted to agriculture worldwide.” <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52010DC0811:EN:HTML:NOT>

33 <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0811:FIN:EN:PDF>

34 See page 53 in “Impacts of the EU Biofuel Target on Agricultural Markets and Land Use A Comparative Modelling Assessment”, JRC Reference Report, European Commission, Joint Research Centre, EUR 24449 EN; <http://ftp.jrc.es/EURdoc/JRC58484.pdf>

button approach opens the door for misuse, and hence could damage the reputation of a model.

Cooperation with academia

Close cooperation with the core development teams in academia remains very important, even if internal (JRC) capacity is growing. It should allow the maintenance and further development of the quantitative tools, while keeping the scientific benchmark high.

A role model for institutional settings

iMAP should also contribute to develop and improve the institutional settings for the larger scientific community around tools, e.g. regarding questions on how to deal with intellectual property rights and how to share fix costs (for database updates, baseline development, code

maintenance, integration of the latest lawbooks, development of training material, maintenance of web sites and further technical infrastructure e.g. for version control).

At JRC level, iMAP has pioneered the development of modelling platforms, has certainly inspired the hierarchy to set up a modelling task force and serves as an example of a productive policy-JRC-academia triangle. The incorporation of related activities within JRC into iMAP is an imminent step.

Added value for agro-economic analysis

To further develop its added value as a truly European exercise delivering high quality research and policy support, iMAP has to take up the challenges of integration, collaboration and transparency.

7 Annex 1: Overview of main model features

Table 7.1. Model history: partial equilibrium models

	AGLINK	ESIM	CAPRI	CAPSIM	AGMEMOD
Full name	AGLINK	European Simulation Model	Common Agricultural Policy Regionalised Impact Modelling System	The Common Agricultural Policy Simulation (CAPSIM) Model	Agricultural Member State Modelling
Development	Developed by the OECD Secretariat, beginning in the late 1980s, in close co-operation with member and certain non-member countries.	Started by ERS (USDA), first used in 1994. Further developed by Tangermann, Münch, and later by Banse, Grethe. Used by the European Commission since 2001. In the mid-2000s, updated and extended, re-written in GAMS.	Began as a FAIR3 project in 1997-99, development continued under various EU-funded projects.	Developed from the SPEL/EU Base system and Medium-term forecasting and simulation System dating from early 1980s and 1990s respectively (collaboration between Eurocare, Bonn & Eurostat). CAPSIM began in the late 1990s but after 2009 was no longer used as an iMap support tool..	Network set up in 2001, originally coordinated by B. Riordan (Teagasc, Ireland). Development funded by 5th and 6th Framework Programmes, and contributions from the partners' institutes throughout the EU.
Current institutional base	OECD Secretariat	University of Hohenheim, von Thünen Institute	University of Bonn	Eurocare, Bonn	Coordinated by LEI, The Netherlands
Currently undergoing development at its host institution?	Updated annually, with the cooperation of OECD member governments. on-going model improvements.	No ongoing development programme	Sporadic development within PhD projects, and under EU-funded contracts		Inclusion of more countries (Russia, Ukraine, Kazakhstan, followed by Belorussia, Brazil.
Is it run in-house? How many IPTS staff can use it?	Yes 2 persons	Yes 2 persons	Yes 2 persons		
Used in recent Agrilife studies?	Annual outlook for DG AGRI. Indirect land-use impacts of EU biofuel mandate (2010)	Indirect land-use impacts of EU biofuel policy (2010) Trade disruptions from asynchronous regulatory approvals of new GM crops (2010)	Regional Economic Analysis of Milk Quota Reform in the EU (2009) Indirect land-use impacts of EU biofuel mandate (2010) Potential EU-Mercosur Free Trade Agreement: Impact Assessment (2011)	Dairy Reform and Western Balkan Countries Accession Scenarios (2009)	Impact Analysis of CAP Reform on the Main Agricultural Commodities (2008) Modelling and Analysis of the European Milk and Dairy Market (2009) Impacts on agricultural commodity markets of an EU enlargement to Turkey (2011)
Other model or institutional links	Actively used by some member governments, who contribute to its development. Linked with FAO's COSIMO model. As AGLINK-COSIMO, has global coverage (52 countries and regions)		Integral part of the SEAMLESS modelling system, and the SENSOR project (LEI). Participation in other large-scale projects		AGMEMOD is itself a linked suite of models of EU member and non-member states, according to a common template, each hosted in a national institution of the country concerned.
Reference Group partner	Pierre Dubois (Agriculture & AgriFood, Canada)	Harald Grethe, Martin Banse	Wolfgang Britz, Thomas Heckelei		Member of the AGMEMOD consortium

Table 7.2. Main model features: partial equilibrium models

CRITERION	AGLINK-COSIMO	CAPRI	ESIM	AGMEMOD
Model output				
Market balances and prices	Yes	Market balances: gross production, losses on farm, sales, seed use on market, losses on market, stock changes, imports, exports, human consumption, feed use, biofuel processing, processing to secondaries, other processing; prices (market, producer, consumer), processing margins, cif and fob prices by trading partner, import and export unit values	Net trade market balances	
Agricultural income	No	Based on regional gross value added; can be found for individual activities	No, but can be estimated by farm production value	
Processing industry income	No	Based on normalized quadratic profit function (dairies, other processing)	No	
Consumer welfare	No	Based on equivalent variation from demand system	No	
General summary of product coverage/modelling:				Main products of agricultural and first stage food processing
Cereals	Wheat, coarse grains and rice	Soft wheat, durum wheat, barley, oats, rye & meslin, maize, paddy, other cereals	Yes	
Oilseeds	Oilseeds and oilseeds products	Rape seed, sunflower seed, soybean	Yes	
Animal production	Beef and veal, pork, poultry, sheep meat, eggs, milk	Fresh milk from cows, fresh milk from sheep & goats, beef, pig meat, poultry meat	Yes	
Milk products	Butter, cheese, SMP, WMP, fresh dairy products, whey, casein, others	Butter, SMP, cheese, fresh milk products, cream, concentrated milk, WMP, whey, casein & caseinates	Yes	
Processed products	Meals, veg. oils, meats, dairy, sugar, hfcs, biofuels, molasses	Cakes (rape, sunflower, soya), oils (rape, sunflower, soy, palm oil, olive oil, other vegetable oil), protein rich and energy rich by-products for feed purposes	Yes	
Fruits & vegetables	No	Tomatoes, other vegetables, apples, pears & peaches, citrus, table grapes, table olives, other fruits	Yes	
Pasture	Yes, in some countries	Fodder maize, fodder root crops, other fodder on arable land, intensive & extensive permanent grass land	Yes	
Other	Sugar cane and/or beet in most countries, beans in Mexico and roots and cotton in COSIMO	Textiles, tobacco, olives for oils, vineyards, pulses, potatoes, sugar beet, nurseries, flowers, fallow land, new energy crops, other industrial crops; trade model for young animals		

CRITERION	AGLINK-COSIMO	CAPRI	ESIM	AGMEMOD
Livestock (head)	Yes when the review is over, cattle, hogs, poultry and sheep numbers	12 activities for cattle, pigs for fattening, sows, laying hens, poultry for fattening, sheep & goats for milk, sheep & goats for fattening	No	
Inputs		Mineral fertilizer (N,P,K); organic fertilizer (N,P,K); seed cost, plant protection costs, repair and machinery costs, energy costs etc for each activity		
General summary of country representation:			Yes	
EU	Yes but in 2 parts: the oldest 15 members and the 12 new members	Break down by individual countries in market module, nuts2 / farm types on supply side	Yes	Net trade for EU MS
Candidate and Accession countries	Only Turkey is included	Western Balkans at country level, Turkey at NUTS2	Western Balkans, Turkey	
US	Yes	Yes	Yes	
OECD (rest of)	Norway, Switzerland as major part of "Rest of Europe", Canada, Mexico, Austria & New Zealand, Chile	Canada, Mexico, Australia, New Zealand, Japan, Korea are endogenous while Switzerland and Norway are exogenous		
Other countries	Due to the incorporation of COSIMO in AGLINK-COSIMO, 44 countries or regions including China, Russia, Argentina and Brazil	Russia, Belarus, China, India, Brazil, Argentina, Bolivia, Venezuela, Uruguay, Paraguay, Rest of South and Middle America, Morocco, Tunisia, Algeria, Egypt, Israel, Rest of Mediterranean countries, ACP, other LDC, Rest of World; more detailed breakdown foreseen		
Suitable for market outlook	Yes	Based on an existing market outlook, provides consistent NUTS2 / farm type perspective, closed area balances, young animal flows, closed feeding ratios. Expert judgements can be entered as "priori information" in a Bayesian framework	Already used	Not at EU-level, modeling results are intensively used in several national baselines
Dynamic	Yes	No	Possible (recursive dynamics), but not used	No
Stochastic baseline	Yes	No	Stochastic yields included, but currently no other variables with stochastic terms which would establish a truly stochastic baseline	No

CRITERION	AGLINK-COSIMO	CAPRI	ESIM	AGMEMOD
Sensitivity analysis	Yes	work package in CAPRI-RD project	Not implemented as an automated feature	Contains an option to apply Shock Analysis
Factor markets				
Land	No	Agricultural land supply function, substitution between arable and perm-anent grassland, empirically-based substitution of land between crops	No	
Labour	No	Medium term strategy is linked to regional CGEs	No	
Capital	No		No	
CAP				
Product subsidies	Old crop-specific payments do not appear anymore, but are still used for beef and sheep meat		Yes	
SFP, SAPS (de) coupling factor	The treatment of the SFP varies by commodity. For crops and dairy it is treated as a fully coupled program in E15 and does not appear in E12. For beef it is again treated as a fully coupled program for both E15 and E12. SAPS is absent.	Highly detailed calculation at regional level	Yes, decoupled direct payments are weighted with a “decoupling factor” (which captures the effect on production relative to a product subsidy) and enter the iso-elastic land supply function as part of the incentive prices.	Technically possible but by definition decoupled payments do not affect individual crops. Thus any scenario on decoupled payments will not affect the crop production pattern.
Effect of decoupled payments on supply	Yes, but work in progress	Decoupled direct payments are paid as a subsidy to land; marginal payments drop to zero when entitlements are reached		

CRITERION	AGLINK-COSIMO	CAPRI	ESIM	AGMEMOD
Effect of decoupled payments (DP) on production structure	no	Decoupled payments drive amount of land in agricultural production	Yes, due to different DP per product and different shares of DP in incentive prices, even uniform changes in DP lead to changes in production structure.	No because markets are modelled, not farm types
Quotas (milk, sugar)	yes	Sugar quota regime with differentiation of A,B and C sugar	Yes	
Set aside	The old set aside does not appear anymore	Obligatory & voluntary; distinguishes set-aside used for idling land, grass land and afforestation; regional set-aside rates take small producer shares into account	Yes	
Intervention and threshold prices	Through stock holding or export subsidy in the case of cereals and dairy but nothing for red meats	Behavioural function drive change in intervention stocks at EU level; maximum yearly intervention purchases can be included	Yes	
EU budget	weak	Highly detailed and complete calculation of pillar I budget and selected part of pillar II	Partially	
National policies	no	some specific payment schemes included	Size of direct payments	
Rural development / pillar II measures	no	Work in progress (CAPRI-RD FP7 project, finishing in 2013), will be built on an RD measures database (constructed within this project); first implementation with LFA, AEM and N2K payments operational	No	No
Environmental indicators				
Accounting of greenhouse gases	No	Modelling of detailed national GHG inventories for EU Member States, explicit consideration of IPCC guidelines (latest 2006)	No	
Accounting of nitrogen flows	No	Detailed nitrogen flow model at regional level considering inputs (fertilizer, atmospheric deposition, ...) and outputs (gaseous losses, leaching, ...)	Yes, implemented	
Estimation of marginal abatement costs	No	Costs of reducing 1 additional emission unit, linked to the regional production functions in the model	Yes, implemented	
Ammonia	No		Yes, implemented	

CRITERION	AGLINK-COSIMO	CAPRI	ESIM	AGMEMOD
Life cycle analysis energy use in agriculture	No	Calculation of all direct and indirect use of energy (fossil fuels, gas, electricity) by activity and region	No	
Life cycle analysis GHGs	No	Calculation of GHG and ammonia emissions following an LCA at farm-gate (accounting of emissions in feed vs. non-food activities, raising animals, imports/exports,...)	No	Yes
Environmental policy (incl. biodiversity)			No	
Trade				
Bilateral trade flows	No	yes	Possible with dynamic version	No
Specific and ad-valorem tariffs	Yes, for many countries	yes	Yes	planned: average tariffs over several tariff lines
Export subsidies	Yes, for EU cereals and dairy products and USA dairy but no for EU red meats and India wheat and sugar	Yes, behavioural function depending on relation between EU market prices and administrative prices	No	
Tariff Rate Quotas	Only those with changing binding parameters	bilateral and global; tariffs are endogenous under TRQs	No	planned: average tariffs over several tariff lines
Multi-lateral trade agreement	Yes, the model is better suited for measures applied to all countries	yes		
Bilateral trade agreement	Feasible but not well equipped	Yes		
Non-tariff barrier	Rather well covered for red meats with a segregation of the world markets in 3 parts largely determined by animal disease status but not for the others	not included		planned: average tariffs over several tariff lines

CRITERION	AGLINK-COSIMO	CAPRI	ESIM	AGMEMOD
Price responsiveness				
Price volatility	No, for the very short term but yes, on an annual basis, the effect of increasing margin between farm and retail price is captured, supply and demand elasticities have been recently up-dated Endogenous stock demand function which reduces year-to-year volatility	No, medium term behavioural models are not well suited for analysing price volatility	Yes, stochastic yields lead to price volatility in ESIM. But no endogenous stock holding. As a “shortcut”, supply elasticities for year of stochastic analysis can be calibrated such as to reproduce historical price volatility.	Not yet implemented (but planned)
Price transmission	Yes, between the world and domestic and between farm and retail	Based on Armington model; currently relative margins in EU; work package in CAPRI-RD will improve modelling price transmission inside EU market	No	
Risk aversion	no	only for sugar beet		
Speculation	the speculative motive of stock demand is captured on an annual basis	no	No	
Links to upstream and downstream industry				
Fertilizer industry/ market	Yes for the price through a reduced form equation		No	
Food industry	Only through retail price	Analysis of different diets following recommendations of different institutions (WHO, WCFR), links to an input-output model	No	
Link to other policies				
Macro-economic shocks	Yes	Existing interfaces to change GDP, inflation, exchange rates, crude oil prices	Yes	
Environmental policy (incl. biodiversity)	No		No	
Multifunctional aspects of agriculture (public goods)	No		No	
Diversification	No	Part of Pillar 2 policies to be evaluated in CAPRI-RD projects based on regional CGE	No	
Biofuel policy	Yes, and very detailed for the key players			
- Biofuel products	Yes, both ethanol and biodiesel	Bio-ethanol, bio-diesel	Yes	
- By-products	Yes	Cakes, DDGS	Yes	
- Which biofuel policies	Mandates, blending rates, tax credit, direct subsidies, tariffs		EU mandate, tax policies	
- Other energy markets	No	New energy crops covered	Just crude oil price	
Climate change policy (e.g. Carbon market or taxes)	No	Project “Evaluation of the livestock sector’s contribution to the EU greenhouse gas emissions (GGELS)”	No	

CRITERION	AGLINK-COSIMO	CAPRI	ESIM	AGMEMOD
Agriculture and fisheries	A fish model is waiting to be merged	No	No	
Agriculture and water	Only through assumed yield reduction	Estimated irrigation needs for major cultures available in data base	No	
Animal welfare	No	No	No	
Animal diseases	Market segmentation resulting from FMD status	Costs of insurance scheme had been analysed	No	
Forestry	No	Afforestation on obligatory set-aside is one production activity in supply models	No	
Dietary habits		Analysis of different diets following recommendations of different institutions (WHO, WCFR), links to an input-output model		
Links to other models				
PE models	Can be easily linked to more detailed national models and to the OECD PEM	AGLINK (baseline is harmonized with AGLINK results), ESIM link for baseline generation is still available but not used; milk quota rents from EDIM; FFSIM in SEAMLESS	Optimisation model FARMIS	ESIM; farm-type LP model for Germany: FARMIS and regional agricultural model RAUMIS at vTI; DRAM (regional farm structure model for NL) at LEI
CGE models	Can be done	Link to GTAP in SEAMLESS; recent publication based on linked GTAP-CAPRI, regional CGE layer is being built in CAPRI-RD project - template is RegFin	MAGNET, GTAP	MAGNET, GTAP
link to bio-physical model	Difficult	Environmental indicators on NUTS2 level and even 1x1 km grid cells; link to DNDC model; integration of MITERRA results	No	No
Energy models	Can be done easily through the crude oil price and the biofuel production	PRIMES	Study with University of Stuttgart	No
Land use	Yes, since area harvested is a key available variable	CLUES-S (regional and 1x1 km)	No	No
Validation of data, results, parameters				
Data	AGLINK is validated by member countries and by the OECD	Baseline uses validated AGLINK results and expert knowledge. No validation network to check MS/regional level results, IPTS is currently in charge of baseline validation (using other validated data sources). Special input database: Coco	No	Cross-validated within membership

CRITERION	AGLINK-COSIMO	CAPRI	ESIM	AGMEMOD
Parameters	Validated and sometimes produced by member countries and by an AGLINK consultant (P.Charlebois)	Parameter calibration ensures compliance with micro-economic theory and enforces plausibility bounds	No	Foreseen
Results	Large number of simulations and tests have been and will be performed on each stand-alone AGLINK component and also on the overall AGLINK/COSIMO model	No permanent validation network to check MS/ regional level results; results had been scrutinised in many policy-relevant projects; several projects with focus in baseline work (also long term) where results are discussed with Commission services and national experts	Validation procedure in new tender	Planned: permanent validation network to check ms/ regional level results; national results have been scrutinized in many projects at ms-level

Table 7.3. Model history: general equilibrium models

	GLOBE	GTAP	MAGNET
Full name		Global Trade Analysis Project	Formerly LEITAP
Development	A SAM-based global CGE model using GTAP data, developed during the 1990s from various antecedents	Started in 1990 by Tom Hertel in collaboration with some Australian researchers.	Developed in the late 1990s/ early 2000s, uses the GTAP data base extended to reflect EU agrifood and land use in greater detail
Current institutional base	University of Sheffield, UK	Purdue University, USA	LEI, The Hague
Currently undergoing development at its host institution?	Yes, actively maintained and developed on demand	Actively maintained and developed through world-wide collaboration with GTAP members	Yes, actively maintained and developed on demand for new applications
Is it run in-house? How many IPTS staff can use it?	Yes 3	Yes 3	Taken up in-house late 2011 Potentially 3
Used in recent Agrilife studies?	Potential EU-Mercosur Free Trade Agreement: Impact Assessment (2011)	Trade disruptions from asynchronous regulatory approvals of new GM crops (2010)	Not yet
Other model or institutional links		GTAP is itself a global open-source collaborative network of researchers analysing international policy issues, using common data bases and a core model. Many links and extensions, e.g. GTAP-E (incorporates carbon emissions from fossil fuel combustion), which in turn may be linked to a global data base of agro-ecological zones (to become GTAP-AEZ).	
Reference Group partner		Hans van Meijl	Hans van Meijl

Table 7.4. Main model features: general equilibrium models

CRITERION	GLOBE	GTAP	MAGNET
Model description	Multi-country, multi-sector, SAM-based General Equilibrium Model	Multi-country, multi-sector, SAM-based General Equilibrium Model	Multi-country, multi-sector, SAM-based General Equilibrium Model. MAGNET has a flexible modular structure, which can be adapted to the research question.
Treatment of time	Typically comparative static; but also a dynamic version is available	Typically comparative static; dynamic and recursive-dynamic versions available	Typically comparative static; recursive-dynamic versions available
Typical simulation horizon	Usually a baseline, for example till 2020, 2030 or 2050; flexible in period definitions	Base period depending on the study	Typically a baseline, for example till 2020, 2030 or 2050; flexible in period definitions
Base year	2004 in the latest version	Latest version of the database delivered in base year 2004	Current GTAP base year (2004); may be updated by the model and calibration of some variables to a later year (e.g. 2007, 2010)
Sub-models	GLOBE-EN (energy), GLOBE-MIG (migration), globe-IMP (imperfect competition)	Various sub-models developed by different research teams. E.g. GTAP_Dyn, GTAP_E, GTAP-AEZ. Some can be downloaded from www.gtap.org GTAP_AGR,	The model is ONE system of equations, but some parts (like international capital dynamics, dynamic demand, dynamic factor mobility) can be switched on or off. Includes many of the GTAP sub-models GTAP_AGR, GTAP_Dyn and GTAP_E and a lot of own extensions (Pillar 1 and 2 EU Policy, land supply, biofuels Directive, etc.
Parameter source and treatment	Synthetic, around 70% from GTAP, 30% from other sources	Typically synthetic	GTAP database is the starting point. LEITAP extensions either econometrically based or using “expert knowledge”
Supply side	Two-tiered technology nest (CES/Leontief/CES), profit maximizing factor demand	Three-tiered technology nest (CES/Leontief/CES) technology nest, profit maximizing factor demand	Same tiered technology nest as in GTAP, profit maximizing factor demand. Flexible CES nesting structure, including feed-land, fertilizer-land, energy-capital, crude-oil-biofuel substitution possibilities. Flexibility in the current production function is possible with regard to e.g. dynamics, production structure (nesting structure), labour market, land market).
Demand Side	Linear Expenditure System (LES)	Constant Differences of Elasticities (CDE)	CDE function with dynamic income elasticities depending on PPP corrected GDP per capita. The dynamics of the income elasticities is very flexible; for example able to have a rising income elasticity of cattle meat for very poor countries, decreasing for countries in the middle range and stabilizing at zero elasticities for very rich countries.
Price formation	Prices are determined by supply and demand	Prices determined by supply and demand	Prices determined by supply and demand

CRITERION	GLOBE	GTAP	MAGNET
Numeraire	Flexible; chosen for each region, can be CPI or PPI. World numer aire is the exchange rate index of the reference region (group of richest regions)	Flexible	Flexible
Trade and transportation margins	Explicitly modelled. A new region called GLOBE is introduced to pool differentiated commodities used in trade and transport services	International trade margins based on difference between cif of importing country and fob of exporting country. Fixed margins on domestic transactions	International trade margins based on difference between cif of importing country and fob of exporting country. Fixed margins on domestic transactions
Market clearing	Walras law	Walras law	Walras law
Usual market balance closure rules (RoW, I-S, gov bal)	I-S	I-S	Normally I-S on a worldwide level; closure can be adjusted depending on the question to be analysed
Factor markets	Skilled labour, unskilled labour, (both types of labour subdivided into agricultural and non-agricultural), land, capital, natural resources	Skilled labour, unskilled labour, land, capital, natural resources	Skilled labour, unskilled labour, land, capital, natural resources
Factor market closure rules (full employment vs. unemployment, fixed vs. flexible factor prices)	Can be specified by the user.	Normally full employment, but possibility to have different closures with for example fixed (real) wages	Normally full employment, but possibility to have different closures with for example fixed (real) wages
Land treatment (AEZ, land module...)	Land mobile across agricultural sectors	Land mobile across agricultural sectors	Land supply curve based on information from a biophysical land use model (IMAGE or CLUE); nested CET functions for allocating land supply over sectors; correction for difference between marginal and average land productivity based on biophysical land use model (IMAGE and CLUE). Possibility to exclude certain land types (e.g. forests) from agricultural use, based on information from biophysical model IMAGE (used for analysis of sustainability criteria)
Flexibility in changing closure rules	Closure rules can be changed very easily.	Closure rules can be changed very easily, using swap statements	Closure rules can be changed very easily, using swap statements; standard swapping files available in the DSS simulation system
Institutions (HH, Gov, firms, ROW)	The accounts are: commodities, activities, factors, households, government, capital, rest-of-world	Private households, government household, regional household, firms, regions, global bank, global transport sector.	Private households, government household, regional household, firms, regions, global bank, global transport sector.

CRITERION	GLOBE	GTAP	MAGNET
Government budget – explicitly modelled?	No explicit government budget included in the model.	No explicit government budget included in the model.	No explicit government budget included in the model. An explicit EU agricultural policy budget is included; this idea could be used for all other government budgets, but is not implemented at the moment.
Flexibility in aggregating, disaggregating, adding institutions	In theory, yes	In theory, yes	Flexibility in aggregating ex ante is very high; working on a completely automatic system, based on GTAP database and additional information. Disaggregation relative to GTAP database is possible, but requires extra information. For example, we split out ethanol, biodiesel, animal feed. Aggregation ex post very fast and flexible. Adding institutions means model adjustments that require a lot of work
Trade	Armington Spatial Model (bilateral trade flows, non-perfect substitution)	Armington Especification (bilateral trade flows, non-perfect substitution)	Armington Spatial Model (bilateral trade flows, non-perfect substitution)
Perfect or imperfect competition	Standard perfect competition	Standard perfect competition	Standard perfect competition. We have experimented in the past with imperfect competition, but don't use it at the moment.
Welfare measures	Equivalent variation	Equivalent variation	Equivalent variation
Forecasts	the static version can be calibrated relatively easily	Dynamic model can be calibrated on external forecasts	Both the dynamic and static model versions can be calibrated on external forecasts
Products/ product categories (sectors)	In the last GTAP database release 57 product categories (incl. 12 agricultural and 8 food categories). Single-country models: depend on the SAM construction	In the last GTAP database release 57 product categories (incl. 12 agricultural and 8 food categories). Single-country models: depend on the SAM construction	In the last GTAP database release 57 product categories (incl. 12 agricultural and 8 food categories)
Flexibility in adding new sectors			Flexibility is high, but requires the relevant data.
How are sectors aggregated or disaggregated?	Aggregate FlexAgg		Aggregate FlexAgg and our own aggregation programs for the MAGNET information; disaggregation through SPLITCOM and programs tailor made to create weighting schemes for SPLITCOM; sometimes small programs to adjust the SPLITCOM results afterwards
Regional coverage	In the latest GTAP database release the world is represented by 117 regions, including all individual EU Member States	In the latest GTAP database release the world is represented by 117 regions, including all individual EU Member States	In the latest GTAP database release the world is represented by 117 regions, including all individual EU Member States

CRITERION	GLOBE	GTAP	MAGNET
How do you aggregate or disaggregate regions?	Same as for sectors.		Same as for sectors.
Disaggregation within EU27?	We have all EU27 countries in, and can aggregate these countries in all combinations.		We have all EU27 countries in, and can aggregate these countries in all combinations.
Domestic	Policies are normally represented as price wedges at different stages, e.g. tariffs, tax rates. Different level of policy analysis depending on different models' focus.	Policies are normally represented as price wedges at different stages, e.g. tariffs, tax rates. Different level of policy analysis depending on different models' focus.	Policies are normally represented as price wedges at different stages, e.g. tariffs, tax rates. Different level of policy analysis depending on different models' focus. Explicit EU budget, quotas, etc.
Trade measures	tariffs, TRQ, etc	tariffs	tariffs, TRQ
Model output	Balanced SAMs, comparison to base situation for all included variables; several macro-economic indicators and welfare measures	Balanced SAMs, comparison to base situation for all included variables; several macro-economic indicators and welfare measures	Extremely flexible. It is obvious that SAMs are balanced; comparison to base situation and scenario for all included variables; several macro-economic indicators and welfare measures.
Data	Matrices derived from GTAP 7.0 database, or specific SAMs for single country models	Matrices derived from GTAP 7.0 database, or specific SAMs for single country models	Matrices derived from GTAP 7.0 database, FAO data for land use and land availability, energy data (EIA) for biofuels, etc.
Exogenous variables and parameters	Closure settings fix variables to allow for a balanced system of equations and variables. Elasticities of production, consumption and trade.	Closure settings fix variables to allow for a balanced system of equations and variables. Elasticities of production, consumption and trade.	Closure settings fixed to allow for a balanced system of equations and variables. Elasticities of production, consumption and trade: some are dynamically dependent on other variables; e.g. income elasticities of consumption depend on PPP corrected real GDP per capita

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Title: An integrated Modelling Platform for Agro-economic Commodity and Policy Analysis (iMAP)
- a look back and the way forward

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Abstract

This report describes the rationale and performance of the integrated Modelling Platform for Agro-economic Commodity and Policy Analysis (iMAP), hosted by the European Commission's Joint Research Centre, Institute for Prospective Technological Studies in Seville. iMAP was created in order to provide a scientific basis for policy decision-making addressing a broad range of issues linked to the economic assessment of the Common Agricultural Policy and related topics such as trade, energy, environment, and climate change. The platform contains selected partial equilibrium and general equilibrium models, used in stand-alone mode or in combination.

As the Commission's in-house science service, the Joint Research Centre's mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle.

Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new standards, methods and tools, and sharing and transferring its know-how to the Member States and international community.

Key policy areas include: environment and climate change; energy and transport; agriculture and food security; health and consumer protection; information society and digital agenda; safety and security including nuclear; all supported through a cross-cutting and multi-disciplinary approach.