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iMAP, an integrated Modelling Platform for Agro-economic Commodity and Policy Analysis

New developments and policy support 2012-14

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Abstract

Building, maintaining and applying the integrated Modelling Platform for Agro-economic Commodity and Policy Analysis (iMAP) has been a long-term project (since 2005) at the Joint Research Centre Institute for Prospective Technological Studies (JRC-IPTS), whose aim is to deliver in-house policy support to the European Commission. iMAP is the result of collaboration with and contributions from many former and present IPTS colleagues, as well as from researchers outside IPTS.
The present JRC Technical Report provides an update on published model-related policy impact analysis related to baselines, the Common Agricultural Policy, Resource and energy policies, the bioeconomy, Europe and its neighbours, and Europe's agri-food sector in the global market.

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Building, maintaining and applying the integrated Modelling Platform for Agro-economic Commodity and Policy Analysis (iMAP) has been a long-term project (since 2005) at the Joint Research Centre Institute for Prospective Technological Studies (JRC-IPTS), whose aim is to deliver in-house policy support to the European Commission. iMAP is the result of collaboration with and contributions from many former and present JRC-IPTS colleagues, as well as from researchers outside JRC-IPTS.

The main characteristics and output of iMAP up to the end of 2011 are outlined in the JRC Scientific and Policy report published in 2012. The present JRC Technical Report provides an update on published model-related policy impact analysis.

The editors would like to thank all contributors, in particular their colleagues involved in iMAP at JRC-IPTS over the last 3 years.

Data and market model team: Sergio Araujo, Marco Artavia, Arnaldo Caivano, Pierre Boulanger, Ayca Donmez, Dusan Drabik, Hasan Dudu, Ingo Huck, Thomas Fellmann, Emanuele Ferrari, Alfredo Mainar, Robert M'barek, Ignacio Perez Dominquez, George Philippidis, Ilaria Proietti, Tevecia Ronzon, Guna Salputra, Ana Sanjuán, Fabien Santini, Cornelia Suta, Benjamin Van Doorslaer, and Cristina Vinyes.

Farm model team: Pavel Ciaian, Liesbeth Colen, Maria Espinosa, Sergio Gomez y Paloma, Kamel Louhichi and Angel Perni.

Many subchapters list the names of the researchers who prepared the section. Other (sub)chapters are written or compiled by the editors, although in most cases the scientific work was carried out by other colleagues mentioned in the references.

Within the European Commission, cooperation related to iMAP models takes place in particular with the Directorate General for Agriculture and Rural Development (DG-AGRI), specifically the Head of Unit Pierluigi Londero, Sophie Hélaine and Koen Dillen.

Special thanks are due to Wolfgang Britz from the University Bonn for comments made at an earlier stage of the report.

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1. Introduction to iMAP

1.1 iMAP – model-based research and policy support

The integrated Modelling Platform for Agro-economic Commodity and Policy Analysis (iMAP) was started in 2005 with the idea of building up a platform to host agro-economic modelling tools financed by the European Commission, in particular European Union (EU) Research Framework Programmes. Financed mainly by the Joint Research Centre (JRC) and the Directorate General for Agriculture and Rural Development (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, among those AGLINK-COSIMO, CAPRI and MAGNET (see section 1.4 for an explanation of the models).

The models are used in stand-alone mode or in combination 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.

Science-based policy support first of all requires high-quality and reliable data. iMAP is engaged in long-term activities to consolidate agro-economic data to ensure that they are comparable, using harmonised methodologies. The Institute for Prospective Technological Studies (IPTS) at JRC started to develop concepts for data harmonisation and management along with external partners. The product, DataM, is a database management tool to simplify the daily work of analysts and modellers in agriculture, in order to feed economic models with data, to check data or to analyse results.

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 and public databases should be used whenever possible. In ex ante analysis, a baseline, harmonised between models and accepted by clients, should provide the benchmark for counterfactual analysis.

Following these and other criteria, all the individual components of iMAP are well-established economic models with a long record of application in research and policy support. The 2012 JRC report "An integrated Modelling Platform for Agro-economic Commodity and Policy Analysis (iMAP) — a look back and the way forward" describes the methodology, models and applications in detail.

As outlined in the 2012 JRC report, improvements in iMAP should address policy and research-oriented questions relating to agriculture, food and natural resources and with an economic dimension, in particular:

- assessment of alternative policy options for the Common Agricultural Policy (CAP) in the run-up to 2020 and beyond;
- evaluation of the 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, supply/demand balances and price volatility;
- economic impact analysis of agriculture's contribution to green growth, investigating alternative policy options to adapt to and/or mitigate climate change, to make water use more efficient and, in particular, to estimate indirect land use changes due to new policies;
- determination of how farm structural change, new technologies, and changing consumer behaviour and demographics and other trends impact on the sector and rural regions.

In addition, the 2012 report suggested that further research and investment should also be made to (i) optimise model structures and refine codes to reduce running time, as well as to extend 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 advances in technology, binding constraints for the use of natural resources, etc., have to be carefully evaluated.

The work carried out during 2012–14 followed these lines as closely as possible. The different chapters in the present report describe the studies carried out and the investments made in developing the models to anticipate future research and policy support needs.

1.2 The CAP horizon 2020 and new modelling tasks

One of iMAP's key tasks remains the analysis of the CAP. In 2013 a new agreement on CAP reform was reached, continuing the path of reform started in the early 1990s. However, for the first time, the entire CAP was reviewed all at once and the European Parliament acted as co-legislator with the Council.

The new CAP maintains the two pillars, but increases the links between them, thus offering a more holistic and integrated approach to policy support. Specifically, it introduces a new architecture of direct payments — better targeted, more equitable and greener — an enhanced safety net and strengthened rural development. As a result it is adapted to meet the challenges ahead by being more efficient and contributing to a more competitive and sustainable EU agricultural sector.[1]

A key feature of the reform is 'greening', a new policy instrument of Pillar I with the aim of providing environmental public goods and rewarding farmers for the services they deliver.

Within the context of the iMAP Reference Group, stock-taking discussions took place to evaluate the iMAP models' capacity to implement the full package of the reform and to complete a robust ex ante assessment of the CAP. Under discussion were the PE models CAPRI (including CAPRI–FARM), AGLINK-COSIMO, ESIM and AGMEMOD, the CGE models GLOBE/STAGE and MAGNET (see section 1.4) and the farm-level model IFM-CAP (Individual Farm-based Model for CAP Analysis).

The main issues relevant for the modelling of the CAP are (i) greening, (ii) market measures, (iii) decoupled and coupled direct payments, and (iv) rural development.

Greening implies a high diversity of CAP measures that have an impact on individual farmers and their practices. Thus, impact assessment should strengthen its focus at the farm level. CAPRI-FARM is used to model the impacts of the following measures: permanent grasslands, ecological focus areas and crop diversity. IFM-CAP should be ready to use in 2016. It will capture heterogeneity across farms in terms of policy representation and impacts (i.e. average and distribution among farms). It should run for the whole EU-FADN (Farm Accountancy Data Network) sample to guarantee the greatest representativeness of the European agricultural sector. Sections 4.1 and 4.2 describe the developments.

Market measures relate in particular to the abolition of sugar and milk quotas, which remains an important modelling topic. Sections 4.3 and 4.4 summarise analyses prepared with the models CAPRI and ESIM.

Direct payments are better captured by CGE models, such as STAGE and MAGNET. Further discussions have stressed that CGE models could represent greener payments (e.g. investment in capital and new technology, agronomic constraints and rotations) and that modelling improvements in production functions and the land market are required. The implementation is ongoing.

Rural development, due to its regional and economy-wide orientation, can be targeted by the models RegCgeEU+ and RuralEcMod.

A key element of the CAP analysis and policy assessments is the **market outlook** and the reference scenario and its related uncertainties, as provided by the AGLINK-COSIMO model. Advances are discussed in Chapter 3.

1.3 Looking towards 2030 and its pressing challenges: climate change, food security and the bioeconomy

Agriculture increasingly sits at the junction of many different policies, thus requiring a three-dimensional (economic, social, environmental) assessment. Issues of climate change, natural resource depletion, population growth and environmental degradation, to name but a few, are posing challenging questions for policy-makers. As a significant political and economic player on the world stage, the EU has taken a proactive role in areas relating to reductions in greenhouse gas (GHG) emissions, food security, renewable energy usage and the greening of its agricultural policy.

The future energy and climate change policy framework for the period post 2020 is currently being reviewed by the European Commission. With respect to the agricultural sector, the challenge for the EU is to position agriculture to further contribute to achieving reductions in GHG emissions, while at the same time ensuring that the competitiveness of EU agriculture is not excessively compromised and that it remains capable of contributing to meeting growing global food demand. Identifying the best options to tackle the challenge requires a comprehensive impact assessment of a wide range of possible policy, technological and management measures.

1 See http://ec.europa.eu/agriculture/policy-perspectives/policy-briefs/05_en.pdf

In 2012 the European Commission released a policy strategy paper[2] for a sustainable model of growth that could reconcile the goals of continued wealth generation and employment with sustainable resource usage. To this end, the term 'bioeconomy' was coined which, 'encompasses the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy'. From this definition, one is led to understand that bio-based output not only includes more obvious examples such as agricultural and food output, but can also be extended to embrace any additional value-added activities that employ organic matter of biological origin (i.e. non-fossil) that is available on a renewable basis (e.g. plants and wood and their residues, animal and municipal wastes, fibres, etc.). The EU's Bioeconomy Strategy is an attempt to stimulate research and development activities that can identify and enhance our knowledge of bioeconomic markets and develop forward-looking policy recommendations to meet the aforementioned, sometimes conflicting, challenges.[3]

Towards these new questions at stake, different analysis and model developments have been undertaken to anticipate needs concerning the period after 2020.

Chapters 5 (Resource and energy policies), 6 (The bioeconomy), 7 (Europe and its neighbours) and 8 (Europe in the global market) present several examples of related iMAP studies.

1.4 Brief summary of modelling tools and studies

The analysis of the different topics mentioned above requires a variety of approaches and adaptation of the modelling tools in iMAP. Here, the tools and main applications published as policy and scientific reports are summarised.

Partial equilibrium (PE) models depict the behavioural interactions of one or more economic sectors, while 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, with no feedback of these impacts from other sectors. The PE models in iMAP focus on the agricultural sector. Increasingly, they also include other selected sectors (vegetable oil processing, dairying, 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 and CAPRI, although other models (such as AGMEMOD or ESIM) or tools are used to complement or address questions that cannot be treated with these models.

AGLINK-COSIMO

AGLINK-COSIMO is a recursive dynamic, PE, supply–demand model of world agriculture, developed by the Organisation for Economic Co-operation and Development (OECD) Secretariat in close cooperation with member countries and certain non-member economies.

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 has been developed on the basis of existing country models and thus the model specification reflects the views of the participating countries.

- Burrell, A. and Nii-Naate, Z. (2013) Partial stochastic analysis with the European Commission's version of the AGLINK-COSIMO model. JRC76019 http://publications.jrc.ec.europa.eu/repository/handle/111111111/28678

- OECD-FAO Agricultural Outlook 2014–2023 http://www.oecd.org/site/oecd-faoagriculturaloutlook/

- Hélaine, S., M'barek, R. and Gay, H. (2013) Impacts of the EU biofuel policy on agricultural markets and land use. JRC83936 http://publications.jrc.ec.europa.eu/repository/handle/111111111/15287

CAPRI (Common Agricultural Policy Regional Impact Analysis)

The CAPRI modelling system is a global agro-economic model, which iteratively links a supply module, focusing on the EU, Norway, Turkey and Western Balkans, with a global multi-commodity market module. It consists of specific databases, a methodology, its software implementation and the researchers involved in their development, maintenance and applications. Specific modules ensure that the data used in CAPRI are mutually compatible and complete in time and space. They cover about 50 agricultural primary and processed products for the EU, from the regional level to the global scale, including input and output coefficients. The CAPRI modelling system allows for the economic and environmental analysis of different policy scenarios regarding the reform of the CAP and its successive reforms. It is able to perform a regional-level analysis of specific Common Market Organisations (e.g. sugar, dairies), trade in agricultural goods with the rest of the world (e.g. World Trade Organization (WTO) proposals) and different subsidy schemes in Europe (e.g. partial decoupling of agricultural subsidies). The model was initiated in 1999 and is currently considered a key model for the Commission in terms of reporting on agricultural and agri-environmental policies at the regional level. It has been continuously used by DG-AGRI, DG-ENV (Directorate General for the Environment), DG-CLIMA (Directorate General for

2 European Commission (2012). Innovating for Sustainable Growth: a bioeconomy for Europe" COM (2012)60; http://ec.europa.eu/research/bioeconomy/pdf/official-strategy_en.pdf.

3 Indeed, encouraging biomass usage for energy may adversely affect carbon sequestration and therefore GHG emission limits. Similarly, implementing a strategy for responsible sustainable growth may impose limits on employment generation in the aftermath of the economic crisis.

Climate Action), Eurostat and the JRC (IPTS and IES (Institute for the Environment and Sustainability)) over the last 5 years.

- Burrell, A., Himics, M., Van Doorslaer, B., Ciaian, P., Morales, C. and Shrestha S. (2014) EU sugar policy: a sweet transition after 2015? http://publications.jrc.ec.europa.eu/repository/handle/111111111/30674

- Blanco, M., Adenäuer, M., Shrestha, S. and Becker, A. (2013) Methodology to assess EU biofuel policies: the CAPRI approach. http://publications.jrc.ec.europa.eu/repository/handle/111111111/28408

- Ciscar, JC. (editor). (2014) Climate impacts in Europe. The JRC PESETA II project. http://ftp.jrc.es/EURdoc/JRC87011.pdf

- Witzke, H.-P., Ciaian, P. and Delince, J. (2014) CAPRI Long-term climate change scenario analysis: the AgMIP approach. http://publications.jrc.ec.europa.eu/repository/handle/111111111/30335

- Blanco, M., Van Doorslaer, B., Britz, W. and Witzke, P. (2012) Exploring the feasibility of integrating water issues into the CAPRI model. http://publications.jrc.ec.europa.eu/repository/handle/111111111/29621

AGMEMOD (AGricultural MEmber states MODelling)

AGMEMOD is an econometric, PE, recursive dynamic, multi-country, multi-market modelling system (at the national level and different aggregation levels). The model provides extensive details of agricultural markets and agricultural policy.

Projections for supply, demand, trade and prices in all countries and at all levels are provided for the following agricultural commodities: soft wheat, durum wheat, barley, maize, rye, other grains; rapeseed, sunflower seed, soybeans, vegetables oils and meals; milk, butter, skimmed milk powder, cheese, whole milk powder; beef and veal, pork, poultry, sheep and goats. Sub-models are interlinked.

There are individual models for all the EU Member States (with the exception of Malta and Cyprus), the candidate countries Former Yugoslav Republic of Macedonia and Turkey, and Russia and Ukraine. Model extension to Commonwealth of Independent States (CIS) and African countries is under development.

- van Leeuwen, M. et al. (2012) The agri-food sector in Ukraine: current situation and market outlook until 2025. Extension of the AGMEMOD model towards Ukraine. http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=5459

- Salputra, G. et al. (2013) The agri-food sector in Russia: current situation and market outlook until 2025. Extension of the AGMEMOD model towards Russia. http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=6019

ESIM (European Simulation Model)

ESIM is a recursive dynamic PE model of agricultural production, consumption of agricultural products and some first-stage processing activities. ESIM represents the agricultural sector of the EU Member States, Turkey, the USA, the rest of the world and the world market overall. It covers 41 products and 29 regions. World market prices are endogenous and trade is modelled as net trade.

Computable general equilibrium (CGE) models are a system of non-linear 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 they depicts the production, consumption, intra-sectoral input and trade of all economies for one country, a region or even all countries worldwide. The main CGE models used are MAGNET and GLOBE, complemented by a regional CGE (RegCgeEU+).

MAGNET (Modular Applied GeNeral Equilibrium Tool)

The MAGNET model is a global general equilibrium model. A distinguishing feature is its modular set-up. This allows tailoring of the model structure to the research question at hand. MAGNET is based on the LEITAP model, which has been used extensively in policy analyses. MAGNET offers more flexibility in model aggregation (definition of regions and sectors) and more options for changing the model's structure.

The MAGNET system has the standard GTAP model at its core, with all extensions added in a modular fashion. The modules are focused on different improvements on the agricultural and environmental sector. Some MAGNET modules are: CAP representation, Land supply, Fully flexible production structures, Production quotas, Bilateral tariff rate quotas, and Biofuels Directive, to name a few.

The main aim of MAGNET is to offer a global applied GCE modelling framework that can be easily tailored to specific research questions. It greatly facilitates the aggregation process, and offers an improved modular model structure. This flexibility allows researchers to adjust the complexity of a model to the questions at hand as well as to their own level of understanding of global CGE models.

- Smeets, E., Vinyes Pinto, C., Tabeau, A., Van Meijl, H., Corjan, B. and Prins, A.G. (2014) Evaluating the macroeconomic impacts of bio-based applications in the EU. http://publications.jrc.ec.europa.eu/repository/handle/111111111/32850

- Boulanger, P. and Philippidis, G. (2014) Modelling the Common Agricultural Policy with the Modular Agricultural GeNeral Equilibrium Tool (MAGNET). Effects of the 2014-2020 CAP financial agreement on welfare, trade, factor and product markets.

http://publications.jrc.ec.europa.eu/repository/handle/JRC85874

- Boulanger, P., Ferrari, E., Michalek, J. and Vinyes, C. (2013) Analysis of the impact of Croatia's accession to the EU on the agri-food sectors. A focus on trade and agricultural policies. http://publications.jrc.ec.europa.eu/repository/handle/111111111/29072

GLOBE

GLOBE is a suite of global/multi-region CGE models calibrated using data from the Global Trade Analysis Project (GTAP) database. While these models use the GTAP database, they include a series of behavioural assumptions different from those of the GTAP model and use a transformation of the standard GTAP Social Accounting Matrix (SAM). GLOBE is a 'standard' global CGE model that is been calibrated using data derived from the GTAP database. The model is a direct descendant of an early United States Department of Agriculture (USDA) model. The model also owes a lot to the development of the SAM approach to national accounting and the SAM approach to modelling. The underlying approach to multi-region modelling for this CGE model is the construction of a series of single-country CGE models that are linked through their trading relationships.

There are currently a number of variants of the GLOBE model: GLOBE_EN (energy model), GLOBE_MIG (migration model), GLOBE_IMP (imperfect competition), GLOBE_DYN (recursive dynamic) and other less formal variants developed as parts of various research activities. In addition, STAGE is a suite of single-country CGE models that requires a country-specific CGE model for its calibration.

RegCgeEU+

RegCgeEU+ is a Walrasian general equilibrium model. The model is designed to work interactively with the CAPRI model. It can be used as a stand alone. There is one independent model for each Member State and Turkey, disaggregated to Nomenclature of Territorial Units for Statistics (NUTS 2) administrative regions, covering all economic activities broken down into 11 sectors: agriculture, forestry, other primary production, food processing, other manufacturing, energy products, construction, trade and transport, hotels and restaurants, education, and other services.

2. Databases and data management

Meeting the data requirements in terms of quality and reliability for science-based policy support has been one of the main challenges of the iMAP project. Harmonised, complete and consistent data series are necessary to ensure the quality of research modelling that will support decision-makers. To this end, since 2010 JRC-IPTS has been developing a data management tool, called DataM. The tool is used to ease the daily work of analysts and modellers in agriculture. It gathers data from the main databases on agriculture and allows easy access to, and exploration, visualisation and reporting of, the data.

Following the European Commission commitments made at the G8 open data conference, the JRC is supporting the sharing of agricultural data by offering the DataM tool to the member states of the African Development Bank (AfDB). As part of the collaboration between JRC and AfDB, in 2013 and 2014 DataM was installed at AfDB premises in Tunis and other African countries. This initiative is also included in the recommendations of the Food and Agriculture Organization of the United Nations (FAO)-led African Commission on Agricultural Statistics (AFCAS). More information about this tool can be found in Hélaine et al. (2013).

2.1 DataM – a tool for flexible management, extension and integration of (model) databases

DataM has been developed at JRC to ease the daily work of analysts and modellers in agriculture. It gathers data from the main databases on agriculture and trade, and allows easy access to, and exploration, visualisation and reporting of, the data.

Using one interface, users can rapidly access the main agricultural, trade and macroeconomic databases (as provided by Eurostat, FAOSTAT, USDA, OECD, GTAP), 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 of exporting data. The main advantage of DataM is the data comparability among datasets on different topics. In 2014, the overall accessibility of DataM was extended through a web-based version, which is currently available to the public at http://www.datamweb.com/.

Figure 1: DataM desktop and web application view

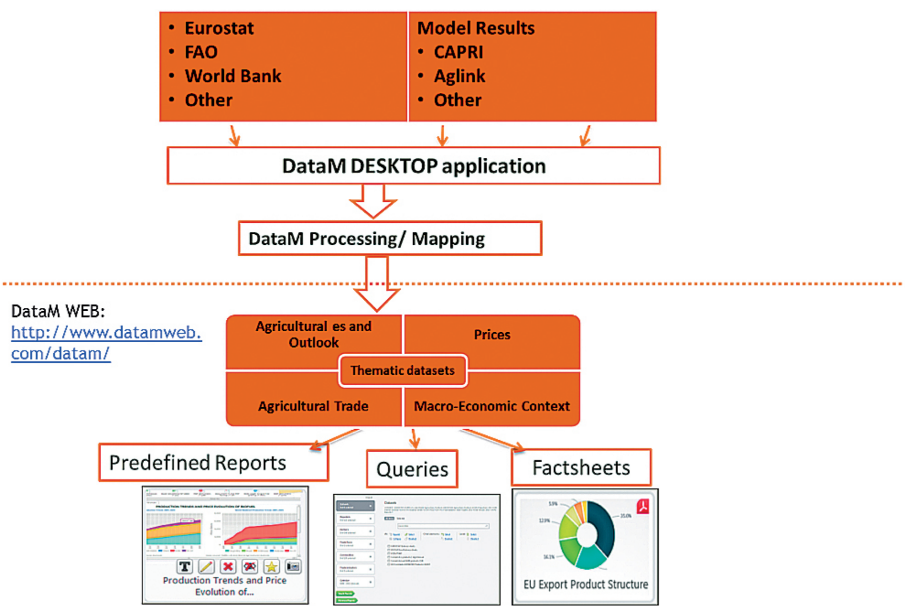


Figure 1 illustrates the link between the two versions of DataM. The web and desktop tools are not identical. Rather, the web application is the dissemination tool of the work the IPTS researchers are conducting using the desktop version. This work involves the creation of thematic datasets by putting together data from different sources on a specific topic. Furthermore, the DataM web version will be used for the dissemination of information and data by the Bioeconomy Observatory and dissemination of the results of the FP7 project on food security.

As part of the Bioeconomy Observatory, DataM offers the potential to store relevant, but different, databases within the same tool and extract for the public only selected indicators for the bioeconomy. Consequently, DataM's contribution to the Bioeconomy Information System and Observatory (BISO) project consists of providing access to different existing datasets collected from both publicly available sources, such as Eurostat and FAOSTAT, and non-public and/or ad hoc data and that can be used by researchers, policy-makers and the general public to monitor bioeconomy figures in Europe. The public will have access via the web version to several thematic datasets on this subject.

In the past year, the user community expanded from internal users within JRC to users in other Commission services (DG-AGRI, DG-ESTAT (Eurostat), DG-DEVCO (Directorate General for Development and Cooperation), etc.). As mentioned before, the tool has also been adopted by AfDB and several of its member countries, within the framework of a collaboration agreement between JRC and this international organisation. Given the new expansion in the user community, DataM will also expand by including new databases to help researchers and policy-makers tackle new research questions.

The DataM web version is also a powerful tool for visualising data on a specific topic via predefined reports, queries or factsheets. Predefined reports are dynamic reports already created containing graphs and/or tables that will enable the user to browse the data on a specific issue by country/commodity/year. Queries are ad hoc visualisations of the data in the thematic datasets. Factsheets are static reports containing both graphics and information on a specific issue and will be available for download in PDF format.

Further reading:

- Hélaine, S., Himics, M., M'barek, R. and Caivano, A. (2013) DataM – Data on Agriculture, Trade and Models: a tool for flexible management, extension and integration of (model) databases.
  http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=6339

2.2 AgroSAM for EU Member States

Section prepared by George Philippidis

An important obstacle to using a SAM-based analysis for analysing the agriculture and, in general, bioeconomy-related sectors, is the high degree of sector aggregation typically found in the national accounts data. As the main data source for constructing the SAM accounts, EU Member State Supply- and Use-Tables (SUT) traditionally represent bioeconomic activities as broad aggregates (i.e. agriculture, food processing, forestry, fishing, wood, pulp) or even subsume those activities within their parent industries (e.g. chemical sector, wearing apparel, energy). Consequently, this severely limits the scope of any study attempting to perform a detailed analysis of the bioeconomy, whether it is SAM based (multipliers) or employing a CGE framework.

As a (partial) response, a set of EU-27 SAMs, dubbed the 'AgroSAMs', was developed by JRC and benchmarked to the year 2000 (Müller et al., 2009)[4]. This data is the only EU-wide SAM-based dataset of its type; another important characteristic is the potential analytical insight resulting from the unparalleled level of sector disaggregation in the bio-based agricultural and food sectors (28 and 11 accounts, respectively).

The construction of the AgroSAMs involved three main steps (Müller et al., 2009): consolidating macroeconomic indicators for the EU-27; combining Eurostat datasets into a set of SAMs with aggregated agricultural and food industry accounts; and, finally, the disaggregation of agri-food accounts based on the database from the PE agro-economic simulation model CAPRI.

With the exception of the agriculture and food accounts, AgroSAM follows the same sectoral concordance as the Eurostat SUTs. Thus, of the 97 activity/commodity accounts, 29 cover primary agriculture, one the agricultural services sector, seven primary sectors (forestry, fishing and different mining activities), 12 food processing, 20 (non-food) manufacturing and construction, and 29 services sectors. In addition, the AgroSAM contains two production factors (capital and labour), trade and transport margins, several tax accounts (taxes and subsidies on production and consumption, Value Added Tax (VAT), import tariffs, direct taxes)[5]. Finally, there is a single account for each of private household, corporate activities, central government, investments–savings and the rest of the world.

4 In the latest two versions of the GTAP database (versions 7 and 8), this dataset has been employed to populate the I-O tables of the EU-27 Member Countries in the GTAP database.

5 The direct tax accounts include 'Property income', 'Current taxes on income and wealth', 'Social contributions and benefits', 'Other current transfers' and 'Adjustment for the change in net equity of households in pension funds reserves'.

Although AgroSAM provides a detailed disaggregation of agriculture and food-related bioeconomic activities, the benchmark year of 2000 was no longer considered to be relevant for meaningful policy analysis. Consequently, it was deemed necessary to perform an update prior to carrying out any subsequent multiplier analysis. The update year 2007 was chosen based on the availability of Eurostat SUT information for all of the EU-27 Member States.

As an initial step, all non agro-food rows and columns in AgroSAM rely on external data from the 2007 EU-27 SUT tables to overwrite existing cell entries regarding the structure of industry costs, commodity supplies, exports, imports, household corporation and government final demands, gross fixed capital formation, stock changes, margins, and net taxes on production and products. In a second step, the resulting AgroSAM was input into a modified version of the SAMBAL program for square matrices[6]. In the current study, the SAMBAL program is further modified with additional equations to (i) target agricultural and food columns to 2007, (ii) maintain 2007 Eurostat SUT non-agro-food account row and column target totals as close as possible, and (iii) preserve the economic structure of the SAM (e.g. equal gross domestic product (GDP) values by income and expenditure; gross capital formation equals changes in stocks plus gross fixed capital formation).

To achieve this, exogenous multiplier variables in each equation are swapped with target variables. Furthermore, the update procedure also incorporates a set of behavioural equations for certain flow values with a view to maintaining, as much as possible, the structural integrity of the SAM, thereby avoiding large fluctuations in cell values when the balancing procedure is carried out. For example, taxes, subsidies and margins are assumed to change proportionally with the transactions upon which they are levied. Moreover, given the difficulty of finding institutional data for all of the EU-27 members, a homogeneous approach is proposed whereby such changes are assumed a constant share of GDP.

For the agricultural industry accounts, given the lack of alternatives, the technical coefficients in the existing AgroSAM were employed subject to 2007 target data for value-added, intermediate and total costs taken from Eurostat's 'Economic accounts for agriculture'. This data source was also employed to implement subsidies on production and products for the 28 agricultural accounts. Target values for agricultural and food exports and imports in 2007 were calculated employing the COMEXT database (Eurostat, 2014a), whereby concordance was ensured between the agricultural and food sectors in the AgroSAM and the Eurostat HS2–HS4 sectors, supplemented by HS6 concordance where necessary. Macro data for 2007 on aggregate demand by components are also taken from Eurostat (2014a).

Further reading:

- Müller, M., Perez-Dominguez, I., Gay, SH. (2009). Construction of Social Accounting Matrices for the EU27 with a Disaggregated Agricultural Sector (AgroSAM). JRC Scientific and technical Reports, JRC 53558. http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=2679
- Philippidis, G., Sanjuán, A., Ferrari, E. and M'barek, R. Structural patterns of the bioeconomy in the EU Member States – a SAM approach. http://publications.jrc.ec.europa.eu/repository/handle/111111111/32584

2.3 SAM at the regional level (NUTS 2)

Section prepared by Emanuele Ferrari and Hassan Dudu

Agricultural policies in the EU increasingly affect not only the agricultural sector but also other economic branches. Pillar II of the CAP also explicitly targets non-agricultural sectors. The indirect effects of these policies might be as important as the direct ones, especially as regards factor markets such as labour. In addition, 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 PE agricultural model is not enough to account for the effects of the EU agricultural policies. The development of regionalised CGE models and the linkages with existing regionalised agricultural PE models is a fundamental step for agricultural economists. The greatest challenge to build a regional CGE model for all EU-27 NUTS 2 regions is the database construction. The main steps needed to construct such a database, known as IOTNUTS 2, are depicted below.

Addressing regional heterogeneity requires multi-sector data on a sub-national scale. Such datasets are usually not sufficiently detailed, if available, which has given rise to numerous non-survey methods to generate regional Input-Output tables (IOTs) based on combinations of regional indicators and national datasets. At the national level, some attempts to construct consistent regionalised tables have been pursued mainly by national statistical offices (NSOs) following survey-based methods (i.e. Finland) or national research institutes following non survey-based methods and linking them to multi-sectoral regionalised national models. To the best of our knowledge, a complete set of SAMs for all the EU NUTS 2 does not yet exist and this work overcomes this deficiency in the literature.

6 For more details see Horridge M, 2003. SAMBAL - a GEMPACK program to balance square SAMs, Technical paper 48, submitted October 2003. Available in: http://www.copsmodels.com/archivep.htm

In the following, the steps are described to build a SAM at the NUTS 2[7] level, called SAMNUTS 2. First, an inventory of regional datasets was conducted for the EU-27 using national and regional databases from Eurostat and the significant information available from the datasets of Member States NSOs. Following standard non-survey procedures, the data were then combined to populate the regional SAMs. Survey-based regional tables NSOs were used to test the reliability of the techniques adopted in this process to combine national and regional datasets. This test shows that, for the majority of economic sectors, non-survey methods generate reliable substitutes for otherwise collected indicators. These matrices were then balanced following a modified Stone–Byron method.

A SAM-based dataset allows the characteristics of CGE analyses to be exploited by capturing the effect 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 such as reforestation programmes, the promotion of investment in agro-tourism or environmental services, or support for the production of renewable energy by farming enterprises, and all the policies related to the so-called Pillar II 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 CGE models and PE models such as CAPRI, which already covers all the EU NUTS 2 regions.

Further reading:

- Mueller, M. and Ferrari, E. Social Accounting Matrices and satellite accounts for EU27 on NUTS2 level (SAMNUTS2). http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=5939
- Mueller, M. and Ferrari, E. An inventory of datasets for the compilation of regional Social Accounting Matrices for the EU. Publication prepared for the 14th Annual Conference on Global Economic Analysis, Venice, Italy (16-18 June 2011) (https://www.gtap.agecon.purdue.edu/resources/download/5380.pdf)

7 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 socioeconomic analyses of the regions. The regional classification follows this hierarchy: NUTS 1 (major socioeconomic regions), NUTS 2 (basic regions for the application of regional policies), and NUTS 3 (small regions for specific diagnoses). The current NUTS classification lists 97 regions at NUTS 1, 271 regions at NUTS 2 and 1 303 regions at NUTS 3 level (http://epp.eurostat.ec.europa.eu/portal/page/portal/nuts_nomenclature/introduction).

2.4 EU domestic support database

Section prepared by Pierre Boulanger and George Philippidis

The GTAP database is the main data source used for global applied trade analysis, especially with CGE models. The last version publicly available (v8) contains complete bilateral trade information, transport and protection linkages for 134 regions (2007 reference year). The representation of agricultural domestic support payments originate from the OECD producer support estimate (PSE). The method used to incorporate PSE elements into the GTAP database has been standardised so that the same approach has been used in all the OECD countries/regions plus some non-OECD countries (the EU is classified as one region). The European Commission JRC-IPTS in Seville has joined the contributing team of the EU's domestic support, and presented potential input at the GTAP board meeting in Dakar (June 2014).

Previous research at JRC-IPTS (Boulanger and Philippidis, 2014) revealed that when compared with official European Commission data from the CAP, GTAP database version 8, based exclusively on the PSE, was incomplete, particularly in its representation of CAP-based rural development payments, or so-called Pillar II payments (in contrast to Pillar I payments, which include CAP market measures and direct payments). More specifically, official data developed by DG-AGRI, known as the Clearance of Account Trail System (CATS), were employed to cross-check the GTAP database. The CATS database presents a full set of accounts across all CAP payments made to the recipients of the European Agricultural Guarantee Fund (EAGF) and the European Agricultural Fund for Rural Development (EAFRD). These data are provided by the Member States to the European Commission on an annual basis for the purposes of carrying out clearance of the accounts, monitoring developments and providing forecasts in the agricultural sector.

The engagement of JRC-IPTS in the GTAP team contributing to the EU's domestic support has opened up the opportunity to use the CATS database when compiling EU domestic support payments by Member State, which are subsequently calibrated into the GTAP database. In December 2014, JRC-IPTS submitted the dataset to GTAP in order that it could be included in the next GTAP database (v9). To maintain consistency, EU domestic support will follow the approach adopted in the previous releases. The difference is in Pillar I support for which CATS data are used (in previous GTAP releases, Pillar I support was not based on PSE but on EAGF financial reports). Altogether these payments amount to EUR 66 530 million (i.e. Pillar I from CATS, Pillar II and national expenditures from PSE). Minor improvements in the allocation of support have been made in this release.

For the year 2011, employing OECD data reveals total CAP and nationally sourced expenditures of EUR 66 788 million, whereas taking Pillar I and Pillar II payments from the CATS data, the corresponding total amounts to EUR 79 373 million. As illustrations of the differences in PSE and CATS datasets, payments to semi-subsistence farms (rural development measure No 141) amount to EUR 81 million in the PSE database versus EUR 137 million in the CATS database, and payments to investment/modernisation in agricultural holdings (rural development measure No 121) amount to EUR 3 435 million in the PSE database versus EUR 4 297 million in the CATS database.

JRC-IPTS prepared two sets of the EU domestic support database for the year 2011. On the one hand, the one to be included in the next GTAP database relies on the traditional approach. On the other hand, the alternative approach uses CATS data not only for Pillar I payments but also for Pillar II payments. In both datasets purely national payments remain from the PSE. These national payments do not figure as part of the CAP budget framework, but rather reflect individual Member State decisions, e.g. on fiscal policy (fuel tax rebates), insurance or irrigation subsidies. In 2011, these national payments totalled EUR 9.5 billion.

Further work will discuss an original allocation of EU agricultural domestic support within the GTAP database, which combines the strengths of the PSE and CATS databases. It will compare the current approach adopted in the GTAP database (v9) with an alternative one in order to make the representation of the CAP expenditures more transparent and comprehensive. It will show that a new allocation includes more domestic support payments than the previous method employed, in which 'only' PSE payments were calibrated into the database. Such a move for accounting for EU domestic support could lead to data discrepancies with other non-EU countries and/or regions in the GTAP database. Ultimately, it would expand the coverage of agricultural domestic support to include some payments currently defined as general services support estimate (GSSE) payments by the OECD, whose definition and content was revised in 2014.

Further reading:

- Boulanger, P. and Philippidis, G. Modelling the Common Agricultural Policy with the Modular Agricultural GeNeral Equilibrium Tool (MAGNET). Effects of the 2014-2020 CAP financial agreement on welfare, trade, factor and product markets. http://publications.jrc.ec.europa.eu/repository/handle/JRC85874

2.5 Calculation of ad valorem equivalents of non-tariff measures

Section prepared by Ana Isabel Sanjuán and George Philippidis

The year 2013 marked the formal opening of trade negotiations between the world's two largest trading partners – the EU and the United States. As an input to the policy-making process, impact assessments typically rely on respected databases (e.g. GTAP) to identify 'winners' and 'losers' under different trade integration scenarios. Unfortunately, such data are not equipped with price-compatible bilateral estimates of sectorial non-tariff measures (NTMs), which, given their pervasiveness, renders ex ante analyses as rather shallow.

Over the last decade, the use of gravity models has received recognition as one such tool for understanding the 'part-worth' of NTM measures on trade restrictiveness. In the literature, a handful of econometric-based studies contain EU and US NTM price-equivalent estimates, although (with one exception), each sector's trade cost is an aggregate over trade with all partners, while when bilateral NTMs are considered, ad valorem equivalents (AVEs) are sectorally aggregated.

In seeking to bridge the gap between econometric estimation and deterministic modelling, a further aim of this study is to present a methodological framework to extend the GTAP database to incorporate NTMs.

This study employs an indirect quantity gravity approach with panel data to provide AVEs of bilateral NTMs on EU–US trade for 18 agri-food sectors. Further refinements are incorporated to deal with the existence of zero values, while additional pairwise *t*-tests statistically compare the mean trade cost estimates of US and EU trade costs on a sector-by-sector basis. Moreover, a bootstrapping procedure is employed to generate confidence intervals in order to assess the reliability of each bilateral AVE point estimate.

Further qualitative and quantitative comparisons are conducted to rigorously assess the veracity of the results. Encouragingly, the results reveal that the NTM AVEs for agricultural and food aggregates in the current study are of a similar magnitude to those reported in other studies. Notwithstanding, on a sector-by-sector basis the predictive capacity of the model is more exposed when making comparisons with intra-EU estimates and contextualising by recourse to relevant policy documents and expert opinion. In some sectors, the results appear credible (i.e. cattle meat, pig/poultry meat, fruit and vegetables, cereals). Elsewhere, the general magnitudes appear to be plausible, although it is debatable whether the EU or the US NTM AVE should be more restrictive (i.e. dairy products, processed rice and sugar). Finally, there are some sectors in which the model performs less well, either because of the counterintuitive result that the intra-EU estimate is higher than the EU NTM imposed on US trade (i.e. oilseeds, live cattle) or because the magnitude of the estimates appears to be well above expectations (e.g. plant-based fibres).

Further work could be focused on improving the sector specificity of each gravity equation to better capture observed trade trends by sector, thereby improving the model's predictive capacity. Notwithstanding, what is clear is that in the 'cornerstone' sectors of (inter alia) meat, dairy products, cereals and vegetables and fruit, substantial trade-led gains could be realised if, under the auspices of the Transatlantic Trade and Investment Partnership, both partners can arrive at a set of common terms of reference for the harmonisation of behind-the-border measures.

The same methodological approach, although applied to a reduced database, is employed in assessing NTM AVE between the EU and Croatia. These estimates were then used in the final study on Croatia's accession and an article was published in *Post-Communist Economies*.

Further reading:

- Sanjuán-López A.I., Philippidis G. and Resano H. Pulling back the curtain on 'behind the border' trade costs: the case of EU-US agri-food trade. *Economic Modelling* (submitted). A draft report is available upon request.

3. Baselines – market outlook – for the medium- and long-term horizon

3.1 A 10-year baseline for the EU

Section prepared by Sergio Rene Araujo, Thomas Fellmann, Ignacio Perez Dominquez and Fabien Santini

The European Commission publishes annually an outlook on the medium-term (10 years ahead) developments in agricultural markets and income in the EU. This outlook (or 'baseline') is elaborated on the basis of specific policy and macroeconomic assumptions and presents a coherent set of market and sector income prospects. It cannot be considered as a forecast, but is rather a description of what may happen under the above-mentioned assumptions. The construction of the outlook involves collaboration between DG-AGRI and JRC-IPTS, and the outlook projections should help to improve understanding of the markets and their dynamics and also to identify key issues for market and policy developments. Furthermore, the outlook serves as a benchmark for assessing the medium-term impact of future market and policy issues.

The core model used for the outlook projections is the European Commission's version of AGLINK-COSIMO, a recursive dynamic PE model giving a detailed representation of world agriculture and policy, described in section 3.1.2. The data used to construct the outlook is based on the latest available market and policy information.

Constructing the baseline follows the three steps described in Figure 2.

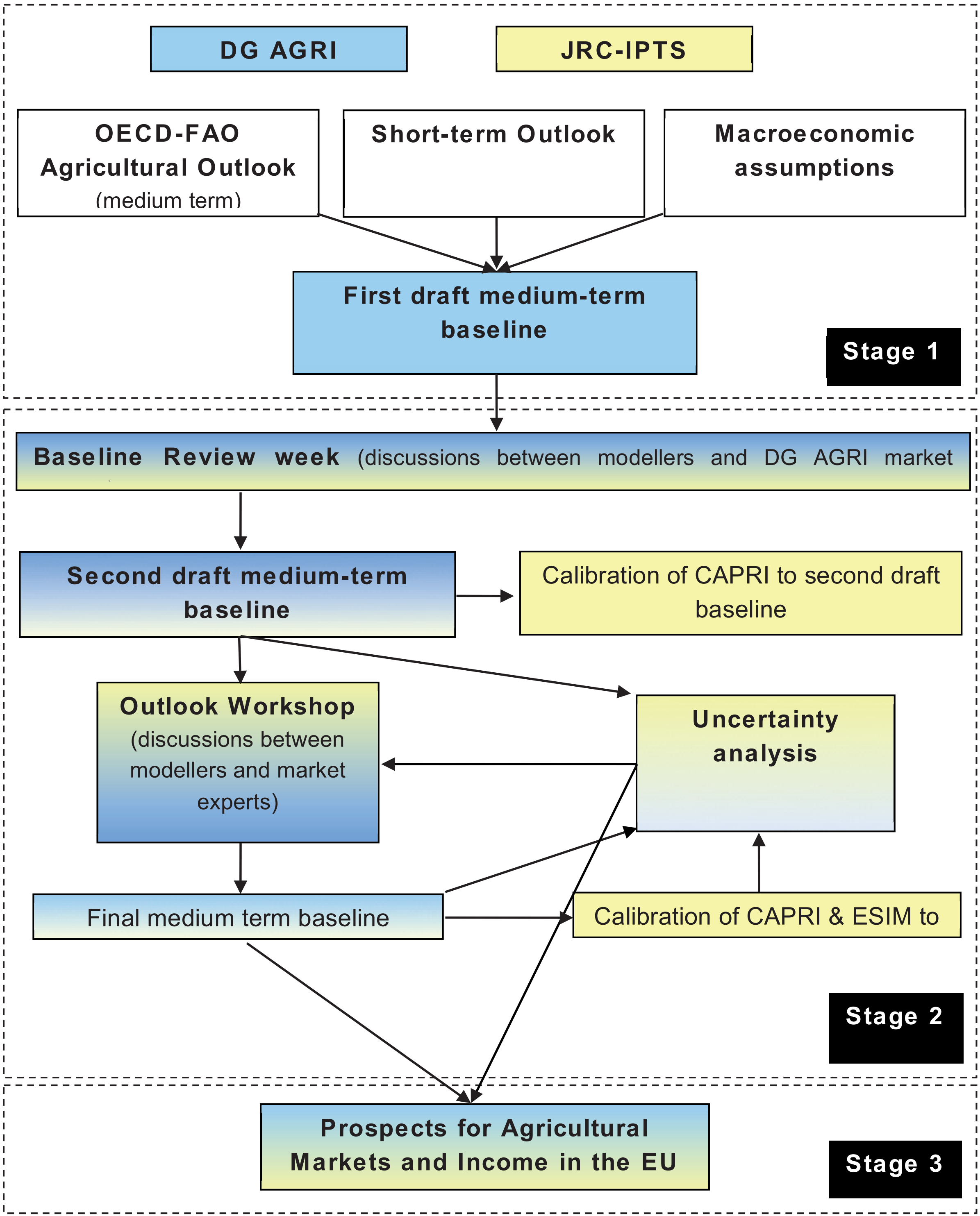
The starting point is the latest available version of the AGLINK-COSIMO model, which was used for the OECD-FAO Agricultural Outlook published in June every year. The EU module of AGLINK-COSIMO is adjusted according to the latest EU short-term outlook (DG-AGRI 6- to 18-month forecasts of EU markets focusing on arable crops, meat, milk and dairy products). Furthermore, the latest available macroeconomic projections (GDP index and deflator, exchange rates, consumer price indices, population and world oil price) are taken from a consistent source (IHS Global Insight) for the main countries at stake (26 currently), as well as the EU up to the last year of the projection (*N* + 10), with data for the near future (2 years) provided by the Directorate for Economic and Financial Affairs (DG-ECFIN).

The second stage starts with an in-depth discussion of the first baseline results between modelling and market experts from DG-AGRI and JRC-IPTS during a 'baseline week' in September/October. After further adjustments, the preliminary baseline is presented in October at the 'Commodity Market Development in Europe – Outlook' workshop, organised by JRC-IPTS and DG-AGRI. In order to identify and quantify the potential variability of the market projections, the results of additional scenarios with alternative assumptions are also presented during the workshop. The proceedings of the workshop are available online from JRC.

Lastly, suggestions and comments made during the workshop are taken into account to improve the final version of the outlook, which is then published by DG-AGRI in the annual report 'Prospects for Agricultural Markets and Income in the EU' in December. This is the basis of the EU's contribution to the next OECD-FAO Agricultural Outlook.

Along with AGLINK-COSIMO, other PE models are used in the elaboration of the prospects for agricultural markets and income in the EU, namely CAPRI and ESIM. By calibrating these two models to AGLINK-COSIMO, they benefit from the review and validation process already done. Calibration to a common baseline is a prerequisite for doing scenario analysis with various models simultaneously. A consensus on the underlying baseline keeps the focus of the discussion on the differences in scenario results rather than on the differences in the baselines themselves. Thus, it is important to calibrate as precisely as possible to those variables that characterise the commodity markets. Those variables include net trade position, relative prices (domestic market prices versus world market price, market price versus institutional prices), fill rates of tariff rate quotas, active/non-active policy instruments (e.g. export subsidies), and the relative size of market balance items (e.g. domestic use, production). An exact calibration is, however, not feasible, because of differences in the model structure or definitions of commodities (products) between the models.

Figure 2: The process of constructing the baseline



Source : IMAP modelling team (2011)

Concerning CAPRI, the calibration is therefore a careful succession of steps and checks on the nomenclature and mapping, policy assumptions and their impact, macroeconomic assumptions, etc. The procedure is described in Himics et al. (2014).

Concerning ESIM, a similar calibration procedure is anticipated and can be summarised in two main steps:

- The first step of the calibration is to generate, for the projection period (starting in 2008), ESIM-consistent target market balances (at individual Member State level) that are in accordance with percentage developments obtained in the European Commission baseline at aggregate (EU-15 (Member States that joined before 2004) and EU-N13 (Member States that joined after 2004)) level.

- The second step consists of shifting the behavioural curves at Member State level (yields, human demand, feed demand and processing demand) so that the model reproduces the target market balances from step 1. In this step the values of the calibration parameters are defined. The procedure is flexible enough to operate for only some of the market elements (partial calibration) or for a majority or all of them (full calibration).

Further reading:

- iMAP Modelling 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. http://publications.jrc.ec.europa.eu/repository/handle/111111111/27073
- Fellmann, T. and Santini, F. Commodity market development in Europe – outlook. Proceedings of the October 2013 Workshop. http://publications.jrc.ec.europa.eu/repository/handle/111111111/31503
- Fellmann, T. and Hélaine, S. Commodity market development in Europe – outlook. Proceedings of the October 2012 Workshop. http://publications.jrc.ec.europa.eu/repository/handle/111111111/27527
- European Commission. Prospects for agricultural markets and income in the EU 2013–2023. http://ec.europa.eu/agriculture/markets-and-prices/medium-term-outlook/2013/fullrep_en.pdf
- European Commission. Prospects for agricultural markets and income in the EU 2014–2024. http://ec.europa.eu/agriculture/markets-and-prices/medium-term-outlook/2014/fullrep_en.pdf
- Himics, M., Artavia, M. and Hélaine, S. Calibrating the CAPRI and ESIM models to the mid-term commodity market outlook of the European Commission. https://ec.europa.eu/jrc/en/publication/calibrating-capri-and-esim-models

3.2 Uncertainty analysis (for medium-term baselines)

Section prepared by Sergio Rene Araujo, Ignacio Perez Dominguez and Fabien Santini

As a complement to the baseline, uncertainty analysis (partial stochastic analysis) can also be undertaken. Stochastic analysis gives an indication of the range of possible outcomes around the baseline, given the variability observed in previous years for key agricultural and macroeconomic drivers. Partial stochastic analysis aims to identify such key risks and uncertainties most likely to affect the projection. It involves performing multiple simulations with different values of these variables and studying their impact on selected variables such as prices, production or trade. It also allows the policy-maker to select specific sources of uncertainty and quantify the probable range of market variation that derives from these identifiable sources of uncertainty.

Major sources of systematic uncertainty in agricultural markets (i.e. macroeconomic conditions and yields) are treated stochastically, and their effects are analysed. The analysis is partial only in that it does not capture all the sources of variability that have affected agricultural markets in the past. For example, uncertainty related to animal diseases is not captured. The selection of which variables to treat stochastically aims to cover the major sources of uncertainty for agricultural markets while keeping the analysis simple enough to be able to identify the main ones in each market. In total, currently,[8] 40 country-specific macroeconomic variables and 78 country- and commodity-specific yields are treated as uncertain in the partial stochastic runs, as shown in Tables 1–3.

Countries and regions are denoted as follows: (AUS) Australia; (BRA) Brazil; (CAN) Canada; (EU) European Union; (IND) India; (JPN) Japan; (NZ) New Zealand; (US) United States; (WLD) World

Abbreviations:

Countries: (EU-15) EU Member States that joined before 2004; (EU-N13) EU Member States that joined after 2004; (KAZ) Kazakhstan; (UKR) Ukraine; (RUS) Russia; (ARG) Argentina; (BRA) Brazil; (PRY) Paraguay; (URY) Uruguay; (CAN) Canada; (MEX) Mexico; (US) United States; (IDN) Indonesia; (MYS) Malaysia; (THA) Thailand; (VNM) Vietnam; (AUS) Australia; (CHN) China; (IND) India; (NZ) New Zealand

Commodities: (WTS) soft wheat; (WTD) durum wheat; (CG) coarse grains; (BA) barley; (MA) maize; (OT) oats; (RY) rye; (OC) other cereals; (OS) oilseeds; (RP) rapeseed; (SB) soybeans; (SF) sunflower seeds; (RI) rice; (PL) palm oil; (SBE) sugar beet; (SCA) sugar cane; (MK) milk

The stochastic analysis methodology can be summarised in four steps: (i) for the drivers that are treated stochastically, historical deviations around their trends or their expected values are estimated using past data; (ii) from these deviations, the stochastic behaviour of the drivers is formalised: (iii) 600 sets of future alternative values for these drivers, based on their stochastic behaviour, are generated; and (iv) the AGLINK-COSIMO model is run for

8 For the purpose of the present report, the last partial stochastic analysis carried out by JRC-IPTS is used as an example (OECD-FAO World Agricultural Outlook 2014).

9 Exports.

each alternative set of values of the drivers. These steps are further explained below.

The uncertainty coming from macroeconomic conditions and crop yields may be analysed jointly and separately, as shown in the table below.

Notes (A): Atlantic region; (P) Pacific region: AGLINK-COSIMO distinguishes two world markets for these meats (Atlantic, Pacific); (SMP) skimmed milk powder; (WMP) whole milk powder; (w) white sugar; (r) raw sugar

Further reading:

- Burrell, A. and Nii-Naate, Z. Partial stochastic analysis with the European Commission's version of the AGLINK-COSIMO model. (2013) http://publications.jrc.ec.europa.eu/repository/handle/111111111/28678
- OECD-FAO Agricultural Outlook 2014–2023. http://www.oecd.org/site/oecd-faoagriculturaloutlook/

Table 1: Macroeconomic variables treated as uncertain and the calculated coefficient of variation of the one-year-ahead forecast errors (%)

	AUS	BRA	CAN	CHN	EU	IND	JPN	NZ	RUS	US	WLD	Total
Consumer price index (CPI)	2.2	7.2	1.6	6.6	1.8	9.7	1.3	2.6	7.2	1		10
Gross domestic product (GDP) deflator	2.6	4.6	2.2	9.1	1.1	6.9	2.1	1.7	10	2		10
Gross domestic product (GDP)	1.3	3.5	2.4	4.3	2.8	3.8	4.2	3	8.1	2		10
Exchange rate (national currency/USD)	13	21	8	4.4	12	10	9.3	15	13.5			9
Crude oil price											26.1	1
Total	4	4	4	4	4	4	4	4	4	3	1	40

Source: OECD-FAO World Agricultural Outlook

Table 2: Commodity yields treated as uncertain and the calculated coefficient of variation (%)

	EU		EURASIA			SOUTH A.				NORTH A.			SOUTH E. ASIA				OTHERS				TOTAL
	EU-15	EU-N13	KAZ	UKR	RUS	ARG	BRA	PRY	URY	CAN	MEX	US	IND	MYS	THA	VNM	AUS	CHN	IND	NZD	
Wheat																					
WT S	4.3	10.0	26.5	26.8	12.0	14.6	14.7	21.8	25.8	11.2	5.4	6.2					33.9	3.1	4.1		15
WT D	9.6	16.5																			2
Coarse grains																					
CG				13.5				14.3	10.9												3
BA	4.3	8.0				16.7				11.0							30.0				5
MA	5.8	23.6				10.7	7.6			7.7	4.4	7.2						3.2			8
OT	4.6	9.5								8.0											3
RY	10.3	10.6																			2
OC	5.3	9.1																			2
Oilseeds																					
OS			33.0	12.4				18.3													3
RP	6.3	11.6								11.0							29.0				4
SB	9.8					15.7	7.5			17.4		5.6									5
SF	6.6	14.1			15.5	10.6															4
Others																					
RI	3.5											3.5			2.9	1.7		1.5	4.7		6
PL													6.3	6.1							2
SBE	4.7	5.3			19.2							6.3						8.3			5
SCA						7.7	3.0					5.7			11.4		8.7	7.4	5.4		7
MK																	2.7			4.5	2
Total per contry	12	10	2	3	3	6	4	3	2	6	2	6	1	1	2	1	5	5	3	1	78
Total per region	22		8			15				14			5				14				78

Source: OECD-FAO World Agricultural Outlook

Table 3: Impact in 2023 of macroeconomic and yield uncertainties on world production, consumption and trade of agricultural commodities, CV_{2023} (%)

CV_{2023} (%)	Production			Consumption			Trade[9]			Prices		
	Yield	Macro	Macro + yield	Yield	Macro	Macro + yield	Yield	Macro	Macro + yield	Yield	Macro	Macro + yield
Arable crops												
Wheat	1.8	0.8	2.0	0.6	0.7	1.0	2.6	1.6	3.0	6.4	9.8	11.9
Coarse grains	1.5	1.3	2.0	0.7	1.1	1.3	3.6	2.5	4.2	5.9	10.5	12.2
Rice	0.8	0.7	1.1	0.3	0.6	0.7	2.0	1.2	2.2	4.6	5.8	7.0
Oilseeds	2.3	1.7	2.9	1.4	1.6	2.2	3.1	3.1	4.3	11.4	11.8	16.5
Protein meals	1.2	1.5	2.0	1.1	1.5	1.9	1.1	2.5	2.7	6.6	13.5	15.7
Vegetable oil	1.5	2.1	2.7	1.5	2.1	2.6	2.9	3.4	4.5	7.7	10.8	12.6
Meat												
Beef	0.2	2.1	2.1	0.2	2.1	2.1	0.3	2.7	2.8	2.2 (A)	14.8 (A)	14.8 (A)
										2.2 (P)	13.6 (P)	13.5 (P)
Pork	0.2	4.1	4.2	0.2	4.1	4.2	0.7	5.6	5.7	2.2 (A)	14.8 (A)	14.8 (A)
										2.2 (P)	13.6 (P)	13.5 (P)
Poultry	0.4	2.0	2.1	0.4	2.0	2.1	0.7	3.0	3.1	2.5	9.4	9.7
Sheep	0.3	2.0	2.1	0.3	2.0	2.1	0.3	2.6	2.6	1.2	9.8	9.6
Dairy												
Milk	0.1	1.9	1.9									
Butter	0.2	2.4	2.3	0.2	2.4	2.3	0.8	2.8	3.0	2.9	10.5	10.6
Cheese	0.1	0.9	0.9	0.1	0.9	0.9	0.7	2.5	2.6	2.0	10.0	10.0
SMP	0.3	0.6	0.6	0.3	0.6	0.7	0.5	1.0	1.1	2.0	9.6	9.7
WMP	0.2	1.8	1.8	0.2	1.8	1.8	1.0	3.8	4.0	2.0	10.6	10.5
Sugar	0.7	1.6	1.8	0.3	1.2	1.2	1.3	4.5	4.8	2.1 (w)	11.7 (w)	12.1 (w)
										1.8 (r)	11.10 (r)	11.3 (r)
Biofuels												
Ethanol	2.6	5.8	6.3	2.6	5.8	6.4	6.2	9.1	11.7	4.8	15.7	15.9
Biodiesel	0.7	5.1	5.2	0.7	5.1	5.2	7.4	22.3	24.2	1.8	15.9	15.7

Source: OECD-FAO World Agricultural Outlook

3.3 Challenges for long-term baselines

Food security-, natural resources- and climate change-related questions focusing on a longer time horizon (2050+) are gaining importance. To assess the requirements for and challenges entailed in the simulation of long-term issues in the agri-food sector, JRC-IPTS carried out the project 'Methodological requirements of a modelling tool for simulation of long-term (2050) effects of policies affecting the agricultural and food sectors', involving experts for different methodologies. The report shows how the inherent large uncertainties related to the long-term (e.g. the development of oil prices) challenge the standard modelling tools for policy analysis. PE and CGE models are covered, and dynamic stochastic general equilibrium (DSGE) and optimal control theory (OCT) approaches are taken into account, evaluated and discussed.

As a kind of checklist, the report Tonini et al. (2013) provides the main findings of the expert meetings regarding the specific major methodological issues for long-term analyses:

Choice between a PE or CGE approach. The recommendation is to use both. The direction of communication, as well as the degree of formal linkage between the two modelling approaches (from PE to CGE or from CGE to PE), will depend on the questions to be addressed. For example, a PE model can generate expert engineering information that can be fed into a CGE model. Similarly, CGE results can be transferred to a PE model to obtain more disaggregated results in terms of products and regions. Owing to their cross-sectoral consistency, CGE models are better than PE models for addressing biofuels, climate change and factor markets, as well as global analysis with a focus on developing countries. These aspects seem particularly relevant when taking a long-term perspective.

Representation of demand and supply based on sound micro- and macroeconomic foundations. Most of the currently available multi-commodity, multi-region models focusing on agriculture represent consumer demand, supply and feed demand decisions in a theory-consistent way. However, more effort should be invested in better representing exogenous shifts. The largest sources of uncertainties in the future are expected to be more on the supply side (e.g. exogenous yield growth resulting from the introduction of new plant metabolisms). Therefore, a modelling structure that is able to interact flexibly with biophysical models (crop models, forestry models, ruminant models and nature conservation) is likely to be better equipped for representing exogenous shifts. The introduction and use of flexible functional forms and of micro-, macro- and physical constraints are deemed essential for capturing dynamic adjustments and for coping with the sources of uncertainty embedded in long-term projections.

Specification of production costs and representation of competition between economic actors. It is considered that these elements are better addressed in a CGE framework. Therefore, use of a CGE is recommended when production costs or competition demand explicit treatment. No unambiguous conclusions could be drawn on the relevance of the treatment of imperfect competition and contingency markets when addressing long-term projections, although for most experts they seemed to be an issue of secondary importance.

Intersectoral and regional factor mobility. CGEs are considered to be better equipped than PEs to address this, owing to their endogenous representation of factor markets and their scope for tackling imperfect mobility. The introduction of a global balance on land use is one source of improvement, as well as the introduction of dynamics to cope with labour mobility and international capital flows. Water supply seems to be currently absent or at most only partly captured in existing multi-commodity multi-regional (MCMR) models with a focus on agriculture. This aspect seems to be linked to the representation of structural change in global agriculture.

Representation of trade partners, agricultural and trade policies and major trade developments. The experts point out that, for the EU, a disaggregated trade representation (at least to country level) may become useful for linking models for different purposes. The 'stickiness' in Armington-type representations of bilateral trade should be improved by selecting long-term trade elasticities, if the aim is to keep a bilateral trade representation in the long term. However, if some simplification needs to be imposed in order to accommodate other complexities arising from long-term projections, it seems that this could be done in the area of trade representation. Moreover, major trade developments seem to be difficult to anticipate and predict 40 years from now.

Structural change in global agriculture. CGE models explicitly represent upstream and downstream sectors and are therefore probably better equipped than PE models to capture and depict changes at different levels in the supply chain. However, as with PE models, CGE models rely on the assumption of an average representative economic agent. DSGEs can also provide a detailed representation of different economic agents such as government and the banking sector.

Incorporation of dynamics. The experts' advice is to begin very simple by focusing on representing demand and supply drivers for the long term, relying on flexible behavioural functional forms able to capture major changing patterns in consumption and technology through the relevant parameters and elasticities. Regarding the choice between fully dynamic and recursive dynamic, the expert recommendation is to use neither if the focus is *only* on the long-term equilibrium. Nevertheless, a formal treatment of dynamics is necessary when we want to trace out the path of the economy between now and the long term.

On the question of whether to use a deterministic or a stochastic approach, the majority of experts consulted recommend deterministic, supplemented with common-sense, tabular presentations to highlight critical aspects of uncertainty.

Incorporation of variable and time-dependent parameters. Regarding the scope for allowing for variable returns to scale, non-homothetic functions, time-dependent autonomous adjustments and new substitution possibilities, the experts highlighted that these aspects are partly set when selecting flexible functional forms and introducing consistency constraints.

Use of forecasting errors and checks for forecasting stability. It was emphasised that validation is important and necessary. However, the expert recommendation is to perform validations, especially sensitivity analyses, because the use of forecasting errors and checking for forecast stability do not seem to match the nature and purpose of equilibrium projection models.

'New' methodologies and theories (DSGE and OCT). DSGEs are attractive when intertemporal decisions and the stochastic dimensions become relevant. The applicability and the advantages of DSGE models compared with CGE models are evident, especially for the short term. However, the superiority of DSGE for long-term analysis is far from being an established fact.

In general, the decision about which methodology to use should be driven by the purpose of the long-term projections. During the discussions, it emerged that most sources of uncertainty are on the supply side and this is likely to be particularly important in the developing world. A global perspective seems indispensable when addressing long-term projections, and European policy advising organisations will need to cope with the requirement of having reliable quantitative information from developing countries.

Further reading:

- Tonini, A., Michalek, J., Fellmann, T., M'barek, R., Delincé, J. and Philippidis, G. (eds). (2013) Simulating long-term effects of policies in the agri-food sector: requirements, challenges and recommendations. http://publications.jrc.ec.europa.eu/repository/handle/111111111/30034

4. Common Agricultural Policy

4.1 Modelling farm-level impacts of the CAP with IFM-CAP

Section prepared by: Kamel Louhichi, Pavel Ciaian, Maria Espinosa, Liesbeth Colen, Angel Perni and Sergio Gomez y Paloma

Over the last two decades, the CAP has shown a gradual move from market intervention instruments (e.g. price support) towards farm-specific implementation and targeting of measures. This was evident following the introduction of the Single Payment Scheme (SPS) in 2005, which enhanced support for environmental protection, animal welfare and rural development. The 2013 CAP reform goes further in this direction by introducing a mandatory component to direct payments, the so-called 'greening', with the aim of supporting agricultural practices beneficial to the climate and the environment. The uptake and economic effects of such farm-specific measures differ significantly between farm depending, among others, on their size, specialisation, resource endowment, location, and sociodemographic characteristics. Most of the currently available models are implemented at the aggregate level (regions, countries, groups of countries), and are not fully able to capture the impacts of these new policy measures at the disaggregated micro-level. This can be handled only by models that work at the farm level and are able to improve the quality of policy assessment over existing aggregate models and assess distributional effects over the EU farm population.

In this context, JRC-IPTS-AGRILIFE started developing a farm-level simulation model, named IFM-CAP (Individual Farm Model for Common Agricultural Policy Analysis), for ex ante assessment of the medium-term adaptation of individual farmers to policy and market changes. The main aims of this model are to model farm-specific policies, to capture farm heterogeneity in terms of both policy representation and impacts and to assess policy effects on farm structural change. The typical questions that we attempt to answer with IFM-CAP are the following: How does farm income change with policy reforms? Which share of farms is negatively affected? Where are these farms located? What is their production specialisation? Are small farms more affected? What is the impact on extensive producers? How many full-time and part-time jobs are potentially affected by the negative impact of the scenario?

The IFM-CAP is a static positive mathematical programming model, which builds on the EU-FADN data. It consists of solving, at given prices and subsidies, a general maximisation problem in terms of input choice and land decisions, subject to a set of constraints representing production technology and policy restrictions. In order to reach the best representativeness and to capture the full heterogeneity of the EU farm population, the whole FADN farm-constant sample between 2007 and 2009 (around 60 500 farms) is individually considered in the model. The rationale for using a model based on individual farms instead of farm types is that the latter is subject to aggregation bias, reduces farm heterogeneity considerably, and cannot model a number of CAP policies for which eligibility depends on detailed farm characteristics and location. Moreover, farm-type models can represent only average effects for the set of pre-determined farm types, while an individual farm-level model provides the distribution of effects over the farm population and allows for the ex post representation of results according to any criterion, depending on the specific policy question asked.

The IFM-CAP model starts with a first prototype that is still under development and evaluation. First results are expected in 2015 by assessing the economic impacts of CAP greening on relevant EU farming systems. Table 4 summarises the main specification of this prototype of IFM-CAP.

Table 4: Structure of the first prototype of the EU farm model

Model name	Individual Farm Model for Common Agricultural Policy Analysis (IFM-CAP)
Institution responsible for development and maintenance	IPTS (in-house model development and maintenance) and DG-AGRI (Directorate L, user feedback)
Type of model	Individual farm model running for the whole FADN sample (and therefore all the EU regions and sectors), except farms with less than 3 years observation during the base-year period.
Methodology	Static, deterministic and non-linear programming model
Model calibration	Calibrated for an average of years (3 years) using positive mathematical programming (PMP)
Objective function	Farm income maximisation: (Revenues – accounting costs + Pillar I subsidies – PMP term)
Revenues	Production value by activity: Price × Yield × Activity level (hectare or head)
Accounting costs	Operating costs per unit of each production activity
Subsidies	First pillar policies: coupling and decoupling (SPS)
Constraints	
Land constraint	Sum of area by activity equal to or less than total farm land endowment defined by type of use (arable, grassland, etc.)
Labour, capital	Captured by PMP terms
Policy constraints	Set-aside, quotas, greening, capping, modulation, regional ceiling for premiums, etc.
Livestock	Animal demography and livestock constraint balancing feed demand and feed supply
Other considerations	
Price, yield and subsidies	Exogenous variables
Input costs by activity	Estimated using DG-AGRI input allocation module using the proportion of activity output value in total output
Total farm land endowment	Fixed at base-year level
Structural change	No
Market interaction	No input and output market interactions
Technological progress	Yes, using an exogenous yield trend
Changes in management practices	Yes, using a simplified approach
Public goods and external factors	No
Time horizon	Based on results from AGLINK/CAPRI baseline work
Potential scenarios	CAP Pillar I (i.e. greening), price change, input cost change
Model results	
Type of model results	Production, land use, land allocation among activities within the farm, extensification/intensification level, farm income, variable costs, Pillar I subsidies, distribution of income and CAP benefit among farmers for each scenario (base-year, baseline and policy scenarios)
Farm level	Single farm units
Farm group aggregation	By farm typology, farm size or other relevant dimension [using weights obtained from FADN[10]]
Regional aggregation	FADN regions, NUTS, Member States, EU
Data needs and other considerations	
FADN data	Constant-sample single observations (2007, 2008, 2009)
Programming language	General Algebraic Modelling System (GAMS)

Further reading:

- Louhichi K., Ciaian P., Espinosa M., Colen L., Perni A. and Gomez y Paloma, S. (2015) An EU-wide Individual Farm Model for Common Agricultural Policy Analysis (IFM-CAP). JRC Science and Policy Report (forthcoming).

10 These farm weights are adjusted in the prototype, taking into consideration the fact that a constant sample is used in the model.

4.2 Income distributional effects of direct payment harmonisation

Section prepared by Pavel Ciaian, Sergio Gomez y Paloma, Maria Espinosa, Kamel Louhichi

In this study, CAPRI.Farm Type was employed to simulate the potential impacts of more equitable direct payment schemes, considered under the CAP reform, on the redistribution of decoupled payments, land rents and farm income. The study considered three scenarios. The first scenario (NUTS 1) assumes uniform per-hectare payments at the NUTS 1 level. The second scenario (MS-CONV) equalises the per-hectare rates within each Member State (MS) and partially harmonises the SPS across Member States in line with the 2011 Commission proposal. The third scenario simulates a uniform per-hectare payment at the EU level.

Given that the decoupled payments are based on the reference period support level paid under Agenda 2000, the value of the payments in the pre-reform period largely reflects the productivity of the regions and their specialisations. Regions and farms with high historical yields and higher animal stocking densities have higher payment rates, particularly for the historical and hybrid SPS models. The implementation of a uniform flat-rate at the NUTS 1/ Member State level, particularly the EU-wide flat rate, tends to decrease support in more productive regions and increase it in marginal regions. The scenario analysis has shown that there are strongly heterogeneous income impacts from the introduction of the flat rate among farm types. Strongly affected categories include large farms and dairying, mixed crops and livestock, general field and mixed cropping, olives, cereals and oilseeds, and permanent crops. Small farms tend to lose less support than large farms following the introduction of the flat rate in the old Member States, whereas in the new Member States, small farms gain more than large ones.

The results indicate that land rental prices are likely to decrease in the old Member States and be little changed in the new Member States following the introduction of a more harmonised SPS scheme. Given the implementation characteristics of the SPS, the flat rate tends to induce an overall reduction in land rents in regions where payments drop (mainly in the old Member States), whereas the rents change to a lesser extent in regions where payments increase (mainly in the new Member States). This result is due to the asymmetric redistribution of payments across the Member States. The cut in payments is concentrated in the old Member States, so rents drop in these countries. On the other hand, an increase in payments in the new Member States stimulates the land market to a lesser extent. This is because the additional land used beyond the entitlement bounds does not (fully or partially) benefit from SPS with entitlement constraints, implying a smaller impact of SPS on land markets and hence on land rents. This effect is reinforced by the reduced possibility of acquiring additional entitlements on the entitlement market owing to their limited supply from farms losing payments, as their number is small in new Member States, particularly if payments are fully harmonised across the EU.

Following these rental price effects, the results imply that the impacts of the flat rate on landowners' and farmers' incomes differ regionally and are driven mainly by the rental price changes and the SPS payment redistribution effects. Landowners in more productive regions (e.g. old Member States) where higher direct payments are currently granted tend to lose income with the introduction of the flat-rate system because of reduced land rents, whereas the landowners' rental income in less productive regions (e.g. new Member States) is largely unaffected by the flat-rate system, at least in the short to medium term. At the same time, farmers in more productive regions (e.g. old Member States) lose directly from payment redistribution but gain indirectly from lower land rental costs. Hence, although the flat-rate system redistributes payments away from more productive regions, the farmers' direct losses are partially offset by lower land rental costs. Farmers in less productive regions (e.g. new Member States) gain mainly because of the direct payment redistribution effect, while rental costs are less affected.

Further reading:

- Gocht, A., Britz, W., Ciaian, P. and Gomez y Paloma, S. (2013). "Farm Type Effects of an EU-wide Direct Payment Harmonisation," *Journal of Agricultural Economics*, 64(1): 1-32 http://onlinelibrary.wiley.com/doi/10.1111/1477-9552.12005/abstract

4.3 Sugar quota abolition

Requested by DG-AGRI, this report compares the production, market and trade outcomes of two alternative EU agricultural policy scenarios, namely the expiry of EU sugar quotas in 2015/16 and the extension of the current sugar quota scheme. All other EU policy measures pertaining to the sugar sector, and to agriculture more generally, are assumed to be the same in both scenarios. The year of comparison is 2020. The CAPRI model was used for the simulations. Information available to the authors up to the end of 2012 was included in this study, as this was the end date of the scenario analyses and editing of the report.

The report begins with a description of sugar beet and sugar production within the EU, and outlines the policies applied in the sugar sector within the CAP. This is followed by a description of the workings of the EU market for sugar.

A theoretical model is used to summarise the main functional relationships in the EU sugar market and related markets, and the EU's trade in sugar. From this model, a number of theory-based predictions about the impacts of quota expiry are derived. There is then a brief overview of the CAPRI model and the way it has been used in this study.

In the presentation of the simulation results, the outcomes that occur when quotas expire are presented in the form of differences from the hypothetical scenario according to which the quota scheme is extended until at least 2020. The main findings concerning these differential outcomes at EU level are given in the second column of Table 5, headed 'Impacts of quota expiry (standard scenario)'. These impacts are all in line with those predicted and explained by the theoretical model.

Isoglucose quotas will expire along with sugar quotas, and there is much speculation about the extent of potential competitive substitution between the two sweeteners, which has until now been constrained by the quota arrangements. Sensitivity analysis was performed to obtain greater insight into this issue. Two additional quota expiry scenarios were run, in which isoglucose was assumed to take a 10% and a 20% share of the sweetener market at the expense of sugar, compared with less than 5% in the standard scenario.

The third column of the above table describes how an increasing share of isoglucose in the sweetener market modifies the result of the standard no-quota scenario. A downward arrow means that the impact in the standard scenario is reduced while keeping its sign, whereas an upward arrow signifies that the impact is enhanced while its sign is maintained. A downward arrow followed by '→ reversal' means that the impact is reduced in magnitude to such an extent that, by the time a 20% market share for isoglucose is reached – or before – the sign of the impact is reversed.

Table 5: Summary of the simulation results.

Impact on	Impacts of quota expiry (standard scenario)	Modification of the standard result when isoglucose takes an increasing share in the EU sweetener market[a]
EU production of sugar beet and sugar	Increase (ca. 4%)	↓
EU production of cereals	Marginal increase (< 0.1%)	↓
EU ethanol production	Marginal increase (< 0.1%), lower share of sugar as feedstock (-3 percentage points)	↑
EU sugar imports from high-cost countries	Strong decrease (-43%)	↑
EU sugar imports from low-cost countries	Marginal decrease (-4%)	↑
EU sugar exports	Decrease (-15%)	↓ → reversal
EU consumption of sugar	Marginal increase (< 1%)	↓ → reversal
EU sugar price (relative to the in-quota price)	Significant decline (-15-16%)	↑
EU welfare	Marginal increase (< 0.1%)	↑
EU beet sector income[b]	Strong decline (-17%)	↑

[a]For an interpretation of the symbols in this column, see the text below.

[b]The impact on individual beet growers' total income is smaller, as even the most specialised enterprises grow sugar beet on no more than 30 % of their agricultural areas

In addition, the report presents simulated impacts at Member State, and sub-Member State, levels. The main findings in the standard no-quota scenario are:

- Impacts at Member State level are not uniform; all Member States except Greece and the Netherlands increase sugar beet production, although beet revenue per hectare falls in all Member States except Romania, where it is unchanged.

- The size of the revenue fall (in absolute magnitude) is inversely related to the extent to which total sugar production (including sugar for industrial use) exceeds the sugar quota in the with-quota scenario.

- The average fall in revenue per hectare across the EU-27 is –5.8%.

- At the NUTS 2 level, impacts on production and income vary considerably across the EU and within some of the larger Member States. Moreover, some regions with strong production increases nevertheless experience substantial income declines.

The consequences at Member State and sub-Member State level become more negative as an increasing market share for isoglucose is assumed.

The plausibility of the results, in particular regarding the regional distribution of isoglucose production and demand, would be enhanced if CAPRI were extended by adding an empirically supported depiction of the isoglucose sector and its interactions with the EU sugar market.

The study does not quantify the impacts on non-EU countries in terms of welfare changes or changes in export revenues. When interpreting the very small welfare increases calculated for the EU, it should be borne in mind that other non-reported negative welfare changes are triggered outside the EU, and that these changes might impact quite considerably on particular non-EU countries or economic groups (producers and refiners), whereas consumers are likely to gain.

Further reading:

- Burrell, A., Himics, M., Van Doorslaer, B., Ciaian, P., Morales, C. and Shrestha, S. (2014) EU sugar policy: a sweet transition after 2015? http://ftp.jrc.es/EURdoc/JRC76619.pdf

4.4 Milk quota abolition at Member State level

When the EU milk quota system is abolished, the milk and dairy sector is likely to expand in the most competitive countries, while contracting elsewhere. Nevertheless, the development of production at Member State level is uncertain, because milk markets have been constrained by quotas for many years in the EU.

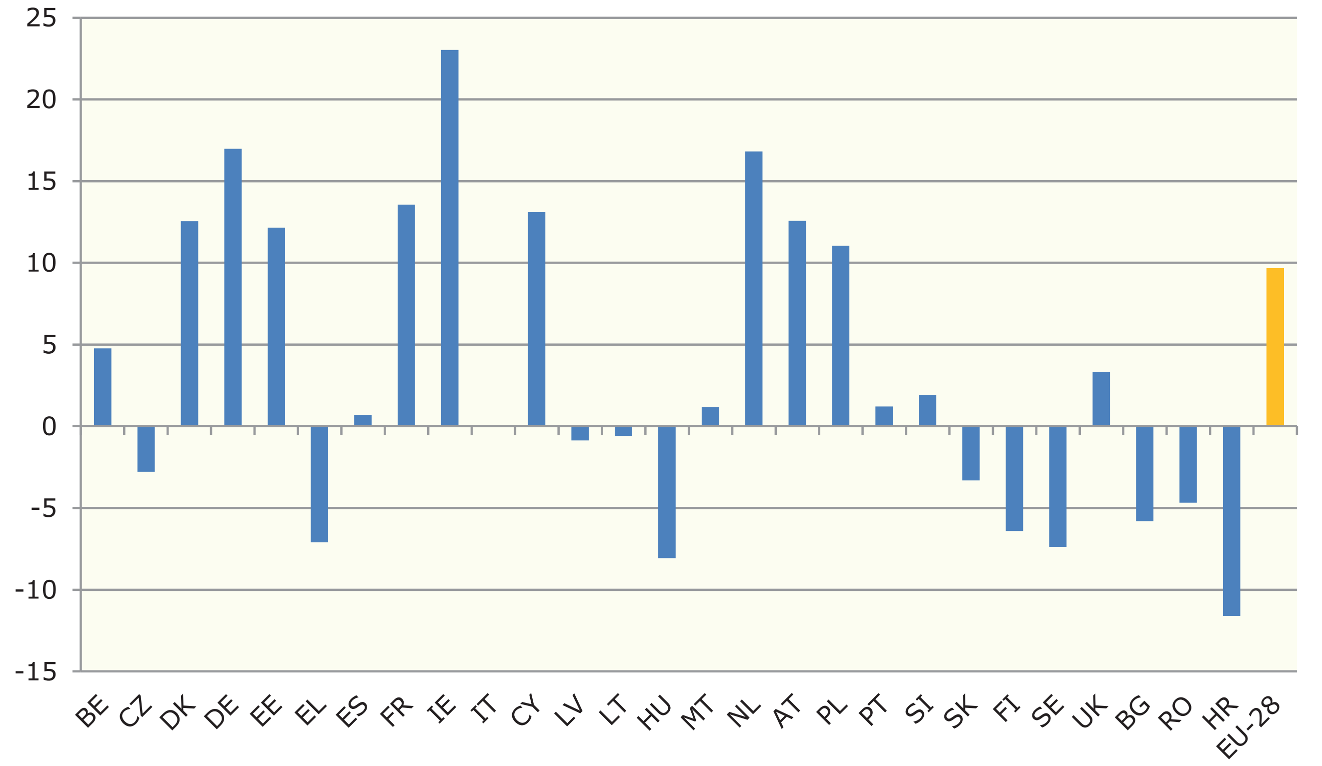
In order to project the change in milk marketable production in 2023 compared with 2012, JRC-IPTS has used the ESIM model. This modelling exercise accounts for farmers' reaction to price developments, milk margins, observed trends in milk deliveries during the phasing out of the quota system, environmental constraints and information available on the recent investments in the dairy sector.

By 2023, milk marketable production is projected to increase by more than 20% in Ireland, more than 15% in Germany and the Netherlands, and more than 10% in Denmark, France, Austria, Estonia, Cyprus and Poland. The projected increase in Belgium and the United Kingdom is below 5%. In contrast, production could decrease in Greece, Finland, Sweden, the Czech Republic, Slovakia, Hungary, Bulgaria, Romania and Croatia. Relatively stable production is projected in Italy, Spain, Portugal, Latvia, Lithuania and Slovenia (Figure 3).

Further reading:

- Evolution of the market situation for milk and milk products. Commission staff working document: accompanying the document Report from the Commission to the European Parliament and the Council, Development of the dairy market situation and the operation of the 'Milk Package' provisions (swd-2014-187_en). http://ec.europa.eu/agriculture/milk/milk-package/swd-2014-187_en.pdf

Figure 3: Change (%) in milk deliveries in 2023 compared with 2012



Source: ESIM results

4.5 CAP budget

Section prepared by Pierre Boulanger and George Philippidis

This research work presents the methodological development of MAGNET (see section 1.4), a global CGE model, for representing the CAP. Using original data on EU domestic support, it examines some likely macroeconomic effects of the expected CAP budget over the period 2014–2020.

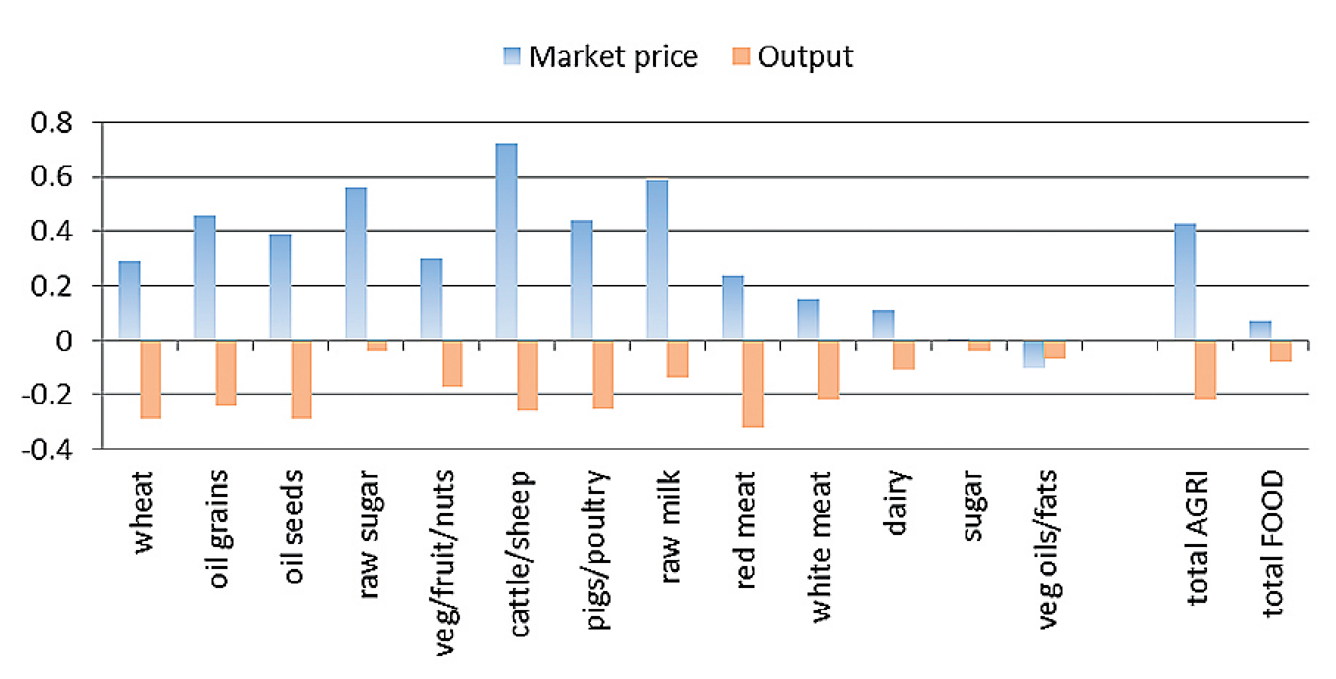
A baseline is implemented over two time periods (2007–2013 and 2013–2020), which coincide with Multiannual Financial Frameworks and Croatia's accession to the EU. The baseline consists of an array of macro-projections and anticipated trade policy shocks and CAP policy shocks. In addition, the baseline includes detailed Pillars I and II expenditure shocks based on the 2011 financial year's real expenditure (not ceiling limits) changes to specific Member State EU agricultural sectors under the CAP Health Check reforms. The numerous Pillar II initiatives are aggregated to five categories employed within the MAGNET model (i.e. investment in human capital, investment in physical capital, agri-environmental payments, support to areas that are handicapped in terms of natural resources, and wider rural development schemes). Given the co-financed nature of Pillar II support, additional nationally funded Pillar II expenditure shocks are also implemented in the first period based on data from the in-house database developed by DG-AGRI, known as CATS.

In addition to baseline shocks, a CAP budget scenario is explored in the second period. Both exogenous Pillar I and II expenditure reductions and exogenous CAP expenditure proportional reductions in the EU budget are implemented assuming that non-agricultural spending concepts remain unchanged. Budget cuts reflect the political agreement reached on 27June 2013, with 13% and 18% cuts in Pillar I and Pillar II expenditures, respectively, in comparison with the 2020 baseline. These cuts in constant price were approved by the European Parliament on 19 November 2013 and the European Council on 2 December 2013.

The MAGNET model is enhanced by the inclusion of additional variables into the CAP budget module to link specific EU payment shocks (i.e. Pillar I-coupled, agri-monetary transfers, other EAGF payments, additional direct transfers) for all tax wedges to the modified CAP budget expenditure accounts. The MAGNET model is also extended to capture the 'own resources' component to the CAP budget, complete with the UK rebate and associated correction mechanisms for Germany, the Netherlands, Austria, Sweden and Denmark.

One main finding is that the cuts in the CAP budget have relatively limited impacts on non-EU countries, or indeed EU agricultural output (see Figure 4). To a large extent, this is to be expected owing to the modelling representation of the decoupled payments. In the literature, there are a number of possible channels *coupling* farmers' production decisions to *decoupled* payments. Owing to the degree of empirical uncertainty regarding the appropriate 'coupling factor', this analysis contemplates only production-neutral behaviour. Consequently, the main production effects arise

Figure 4: Market price and output effects in 2020, % changes



Source: MAGNET results

from changes in Pillar II expenditures and their associated productivity effects in EU Member States.

As a further observation, the complex system of intra-community transfers via the budget mechanism implies that policy-induced changes to CAP support have, at the margin, real income and trade balance implications. Notwithstanding, as is the case in all empirical studies, a number of caveats should be observed, e.g. potential taxpayer savings (losses) from CAP budget reductions could be reallocated within national economies or other EU policies such as R&D, elasticity between Pillar II expenditure changes and productivity changes would require additional research, or there may be a potential reverse 'crowding out effect' from the withdrawal of EU Pillar II investments.

Further reading:

- Boulanger, P. and Philippidis, G. (2014) Modelling the Common Agricultural Policy with the Modular Agricultural GeNeral Equilibrium Tool (MAGNET). Effects of the 2014-2020 CAP financial agreement on welfare, trade, factor and product markets. http://publications.jrc.ec.europa.eu/repository/handle/JRC85874

5. Resource and energy policies

5.1 Assessment of EU biofuel mandates

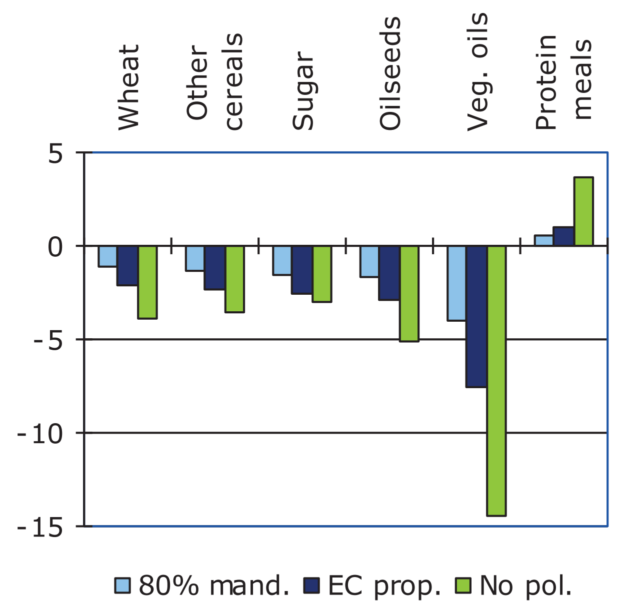
The EU's Renewable Energy Directive (RED) sets an overall target of 20% of the EU's energy use to come from renewable sources by 2020. As part of this target, at least 10% of total transport fuel consumption is to come from biofuels. The EU Member States were required to report their expectations and plans on how to meet these targets in National Renewable Energy Action Plans (NREAPs) by 30 June 2010, including the technology mix and the proposed trajectory to reach them.

Nevertheless, the development of the biofuel market is highly uncertain, especially in the EU. In this report, different scenarios are analysed that could occur in the years to come. First, a situation in which Member States would not reach the 10% target by 2020, but only 8%, is simulated. Second, the European Commission's proposal is analysed. Finally, a complete removal of the biofuel policy in the EU is simulated. All scenarios are compared with a situation without any change in policy and with the fulfilment of the 10% target. The simulations are run with the AGLINK-COSIMO model and provide the impact for the period 2012–2022 on land use, biofuel production and feedstock prices for wheat, maize, sugar and vegetable oils in the EU and world markets.

If food-based biofuels in the EU were limited to 5%, world prices would remain up to 3% below the baseline, except for vegetable oils for which the would be about 7%. Under this 5% threshold, land use for potential biofuel feedstocks (cereals, oilseeds, sugar crops and palm oil) would be reduced compared with the baseline of 2.7 million hectares worldwide (the world arable land area is 1 396 million ha – FAO data for 2011).

The impact of a no-biofuel EU policy scenario on world prices might be particularly significant for vegetable oils (almost a 15% decrease), but other feedstock prices (wheat, maize and sugar) would be at most 5% below the base. About 6 million hectares less (0.7% of the world's arable land dedicated to cereals, oilseeds, sugar crops and palm oil in 2020) would be harvested than is now (Figure 5).

Figure 5: Change in feedstock world prices in comparison with a base in 2020 (%)



Source: Hélaine, S., M'barek, R. and Gay, H. (2013)

Further reading:

- Hélaine, S., M'barek, R. and Gay, H. (2013) Impacts of the EU biofuel policy on agricultural markets and land use. ftp://ftp.jrc.es/pub/EURdoc/JRC83936.pdf

Whereas the AGLINK-COSIMO model focuses on the EU as one block, the spatial agricultural sector model CAPRI, with a high regional disaggregation (NUTS 2), has been extended to include a behavioural market representation for biofuels and biofuel feedstocks. From the methodological point of view, the main enhancement of the model – compared with earlier versions of CAPRI – is the endogenous representation of biofuel markets (ethanol and biodiesel), meaning that biofuel supply and feedstock demand react flexibly to biofuel and feedstock prices and at the same time biofuel demand and bilateral trade flows react flexibly to biofuel and fossil fuel prices. This required an extension of the CAPRI database to include the necessary variables. This extension was based on many sources (the PRIMES and AGLINK-COSIMO models, as well as Eurostat, F.O. Licht and national sources).

The estimation of the biofuel module relies on microeconomic theory and information derived from existing modelling approaches. The OECD-FAO agricultural sector model AGLINK-COSIMO (OECD, 2007, 2008) is used to derive biofuel demand functions. The European energy sector model PRIMES (E3Mlab, 2011) is used to approximate total fuel demand functions.

The biofuel baseline, or reference scenario, is created based on statistical trend estimations and external expert knowledge. Baseline results presented in this report are for illustration purposes only, as the biofuel baseline is fully integrated into the CAPRI model and, therefore, updated yearly.

In this way, the biofuel module extends the advantageous features of the core CAPRI system (particularly its capability to analyse market effects at a very detailed spatial and agricultural product level), with a detailed representation of global biofuel markets, covering first- and second-generation production technologies, biofuel by-products, bilateral biofuel trade and a link to global fuel markets.

CAPRI is now able to jointly assess biofuel and agricultural policies, including policy instruments defined at the Member State level. The CAPRI biofuel module allows a detailed analysis of most relevant biofuel support instruments such as consumer tax exemptions or quota obligations at the EU Member State and international level. In addition, the model permits the analysis of scenarios regarding biofuel trade policies and the availability of second-generation technologies.

While most economic modelling systems analyse the impacts of biofuel policy developments on agricultural commodity markets and land use at aggregate spatial levels, the current study widens the analysis to consider regional effects within the EU as well as environmental impacts.

Further reading:

- Blanco, M., Adenäuer, M., Shrestha, S. and Becker, A. (2013) Methodology to assess EU Biofuel Policies: The CAPRI Approach. http://ftp.jrc.es/EURdoc/JRC80037.pdf

5.2 Assessment of GHG emission reduction policies

Section prepared by Thomas Fellmann, Ignacio Perez Dominquez and Guna Salputra

The European Commission started to reflect on a new policy framework on climate and energy for 2030. Identifying the best options for agriculture to contribute to future GHG emission reductions in the EU requires a comprehensive analysis of a wide range of possible policies and technological and management measures. In this context the CAPRI model has been further improved with respect to GHG emission accounting and especially regarding the endogenous implementation of technological mitigation options. In this research we present the methodology of the new model features and highlight the importance of including endogenous technological GHG emission mitigation options in the model analysis.

Results of illustrative emission mitigation scenarios show that different assumptions on the availability and uptake of technologies alter the scenario outcome significantly.

The modelled mitigation policy shows important impacts on agricultural production in the EU-27, especially for cattle and fodder production. Total agricultural income is projected to increase at EU level by 6.7% in the scenarios with the availability of technological mitigation options, but important regional differences exist, and a few regions may have negative income impacts. The increase in income is mainly the result of the higher producer prices, which can offset the loss in production and increasing costs in more than 90% of the EU regions (which leads to increases in agricultural income). In this context, it is important to note that the higher producer prices are reached under a specific set of assumptions, especially with respect to the EU border protection mechanisms and levels in place in 2030. Consumers, on the contrary, will have to pay a higher price for food, especially for meat and dairy products (up to 22%). It also has to be kept in mind that it is likely that some farmers might have to leave the sector in the event that they are not able to cope with the GHG mitigation obligations. Obviously, only farmers remaining in the sector would benefit from the projected increase in total agricultural income.

The results indicate clearly that the negative impact on agricultural production and trade can be reduced to roughly one-third when mitigation options are available to farmers. There is quite some uncertainty over whether by 2030 more or fewer mitigation options than are used in our scenarios will be technically available to and effectively implemented by farmers. As our analysis shows, different assumptions about the availability and uptake of technologies may alter the outcome significantly. This is a strong signal for enhanced research and development in the area of technological mitigation options, as well as policies that promote their diffusion.

Further reading:

- Felmann, T. (ed.) An economic assessment of GHG mitigation policy options for EU agriculture (EcAMPA). Authors: Van Doorslaer, B., Witzke, P., Huck, I., Weiss, F., Fellmann, T., Salputra, G., Jansson, T., Drabik, D. and Leip, A. (2015) https://ec.europa.eu/jrc/sites/default/files/jrc90788_ecampa_final.pdf

- Witzke, P., Van Doorslaer, B., Huck, I., Salputra, G., Fellmann, T., Drabik, D., Weiss, F., and Leip, A. Assessing the importance of technological non-CO2 GHG emission mitigation options in EU agriculture with the CAPRI model. (2014) http://ageconsearch.umn.edu/handle/182676

5.3 The climate change challenge

Climate change has been identified as one of the policy- and research-oriented questions with an economic dimension, where iMAP would focus on improving the models (see iMAP report 2012, p. 74). In particular, the CAPRI model, with its highly disaggregated spatial dimension in Europe and its linkages to biophysical models, is well suited for such research questions.

Towards 2020

In the context of the JRC PESETA II (Projection of Economic impacts of climate change in Sectors of the European Union based on bottom-up Analysis) project, the CAPRI model has been applied, contributing to analysing in an integrated way the potential impacts of climate change in Europe. The PESETA project has involved the coordination of 12 different teams within JRC (from both IPTS and IES), with more than 40 scientists involved from a wide range of disciplines, from river flood modelling to economics. It responds to a need to provide quantitative modelling support to the European Commission services regarding the impacts of climate change in Europe.

On the adaptation implications in agriculture (2020), the results have shown that climate change is expected to increase EU average crop yields by 2020, although variation between regions, crop types, and climate scenarios is considerable. Under the reference variant 1 and variant 2 versions of the A1B scenario of the Special Report on Emissions Scenarios (SRES), yield changes per crop of between –70% and +90% are expected at NUTS 2 level, although variation is lower at the EU level (between –37% and +20%).

Economic analysis suggests a change of between –0.3% and +8% in EU agricultural income, but with a large regional variation. Small positive impacts are observed in total welfare (up to 0.2%). However, it is important to note that this analysis does not take into account the impacts of climate change on yields outside the EU, which have some influence on agricultural production in the EU.

Further reading:

- The results of this study have also been published in the *Review of Agricultural and Applied Economics* (RAAE 2013;16(2)) and discussed in the well-known blog 'CAPreform' (http://capreform.eu/eu-agriculture-impacts-of-climate-change/).
- Climate Impacts in Europe. The JRC PESETA II project 2014. http://ftp.jrc.es/EURdoc/JRC87011.pdf
- Shrestha, S., Ciaian, P., Himics, M. and Van Doorslaer, B. Impacts of climate change on EU agriculture. Review of Agricultural and Applied Economics 2013;16(2). http://roaae.org/issue/review-of-agricultural-and-applied-economics-raae-vol-16-no-2/
- European Commission. Assessing Agriculture Vulnerabilities for the design of Effective Measures for Adaption to Climate Change (AVEMAC). (2012) http://ec.europa.eu/agriculture/external-studies/2012/avemac/full-text_en.pdf

Towards 2050

The CAPRI model has also been used in initial trials in extending the time horizon towards 2050. This has been pursued in the context of the Agricultural Model Intercomparison and Improvement Project (AgMIP), a major international effort linking the climate, crop and economic modelling communities with cutting-edge information technology to produce improved crop and economic models and the next generation of climate impact projections for the agricultural sector.

The CAPRI modelling framework was employed to investigate the medium- and long-term impacts of climate changes on global agriculture following the AgMIP approach.

A reference scenario is compiled that serves as a counterfactual situation in terms of climate change. This scenario reflects economic assumptions defined under Shared Socioeconomic Pathway (SSP) 2. We simulate one alternative reference scenario, four climate change scenarios and one biofuel scenario, all available from the AgMIP project. All scenarios are run for 2030 and 2050.

The results indicate that globally there will be both winners and losers, with some regions benefiting from agricultural production adjustment as a result of climate change while most regions suffer losses in production and consumption. In general, there are relatively moderate effects on the global aggregate. For example, the global agricultural production, consumption and land use for agriculture aggregate change is approximately between –4% and 2% in 2030/2050 relative to a reference situation with no climate change. Prices respond more strongly to reduced agricultural supply owing to climate change, between 6% and 13%. However, there is a stronger impact at the regional level and for different agricultural commodities. The regional impacts of climate change may increase by a factor greater than 5 or more relative to the aggregate global impacts. As may be expected, the climate change effects would be stronger in 2050 than in 2030.

Further reading:

- Witzke, H.-P., Ciaian, P. and Delincé, J. (2014) CAPRI long-term climate change scenario analysis: the AgMIP approach. http://publications.jrc.ec.europa.eu/repository/handle/111111111/30335

5.4 Carbon Preservation and Sequestration in Agricultural Soils (CAPRESE)

Section prepared by Maria Espinosa and Guna Salputra

CAPRESE is a JRC inter-institutional project from two JRC Institutes (the Institute for Environment and Sustainability (IES) and the Institute for Prospective Technological Studies (IPTS))[11] aiming to analyse the potential impact of land management practices (such as conversion from arable land to grassland, crop land management, agro-forestry) in preserving and increasing the stock of organic carbon in agricultural soils in the EU. CAPRI-FT was applied in this project to simulate the economic effects of a scenario that considered an expansion in the area of grassland of 5% relative to its baseline level in 2020.

According to the simulation results, expanding grassland by 5% increases the total EU-27[12] utilised agricultural area by 0.4% and decreases the arable area by 1.7% relative to the baseline level.

Production of most agricultural commodities declines as a result of converting of arable land to grassland. Only beef and sheep meat production increases slightly, while raw milk production remains unchanged. However, the magnitude of the changes in production is relatively small: less than 1% of the baseline level. The less productive arable land is converted to grassland, leading to higher average crop yields, which partially offsets the overall reduction in production. The average yield of products derived from grazing livestock (e.g. beef, sheep and goat meat and milk) declines as the additional grassland is used in extensive cultivation.

Lower crop production levels are reflected in higher prices for most field crops (especially cereals). The opposite applies to livestock products such as beef and sheep meat, the prices of which slightly decrease (less than 1%).

The overall agricultural income increases by 0.61% in the EU-N12 and decreases by –0.23% in the EU-15. Farms specialising in cereal and oilseed production experience the highest increase in income (1.2%), while farms specialising in cereal-based livestock production face a decrease in income of –2.6% compared with the baseline. There is no significant effect on agricultural income per hectare at the EU level (a decrease of 0.06% compared with the baseline). However, there is greater heterogeneity observed at NUTS 2 level and between Member States.

Using CAPRI-FT simulation results, the compensation that farms need to be paid in order to increase grassland by 5% has been calculated. This compensation represents the payment level that would motivate farmers to voluntarily increase grassland area by 5%. The calculated compensation is EUR 104.92/ton CO_2, which is 23 times higher than the average price of the EU allowance of EUR 4.43/ton CO_2. Considering that the change to grassland has to be maintained for a period of 5 years (e.g. in the agri-environment scheme) and that the compensation payment is paid only once, the value of the CO_2 sequestered in the soil is EUR 20.98/ton CO_2, which is equal to the average value in 2008 (EUR 22.06/ton CO_2). Note that there are other co-benefits of grassland expansion not included in these simulated values related to the provision of public goods such as biodiversity, which may generate additional benefits for society.

Further reading:

- Abad Vinas, R., Angilieri, V., Arwyn, J., Bampa, F., Bertaglia, M., Blujdea, V., Ceglar, A., Espinosa, M., Gomez y Paloma, S. Grassi, G., Hiederer, R., Leip, A., Loudjani, P., Lugato, E., Montanarella, L., Niemeyer, S., Salpultra, G. and Van Doorslaer, B., (2013). Carbon Preservation and Sequestration in Agricultural Soils (CAPRESE): Options and implications for agricultural production (forthcoming; EUR number: 26516).

- Espinosa, M., Salputra, G., Van Doorslaer, B. and Gomez y Paloma, S. (2013). CArbon PREservation and SEquestration in agricultural soils (CAPRESE soils): Options and implications for agricultural production. Report of Task 5b: Assessment of the economic impacts of mitigation measures with the CAPRI-FT model. (JRC internal report (JRC88288)).

5.5 The feasibility of water pricing in agro-economic models

Although many modelling projects have integrated food and water considerations at the farm or river basin level, very few agro-economic models can jointly assess water and food policies at the global level. The present report explores the feasibility of integrating water considerations into the CAPRI model.

First, a literature review of modelling approaches integrating food and water issues was conducted. Because of their capacity to assess the impacts of water and food policies at the global level, three agro-economic models (IMPACT, WATERSIM and GLOBIOM) have been analysed in detail. These models handle water supply and demand issues quite differently. GLOBIOM is very flexible in terms of incorporating crop–water relationships, but focuses on agricultural water and uses a rough proxy to account for competition between agricultural and non-agricultural water use. In contrast,

11 Seven actions are involved in the project: SOIL, AGRI-ENV, AGRI4CAST, GEO-CAP and BIOCLIM from IES, together with AGRILIFE-SUSTAG and AGRITRADE from IPTS.

12 Croatia was not considered in the analysis, because at the time the simulations were done it was not included in the CAPRI modelling system.

IMPACT and WATERSIM have less flexibility to model crop–water links; however, as these models integrate a global food model and a global water model, they encompass constraints on water availability at the river basin level, inter-regional water flows and competition between agricultural and non-agricultural water use. In addition, biophysical and hydrological models estimating agricultural water use have also been studied, in particular the global hydrological model WATERGAP and the LISFLOOD model.

Second, the potential of CAPRI for modelling water was assessed. Thanks to the programming approach of its supply module, CAPRI shows considerable potential to integrate environmental indicators as well as to enter new resource constraints (land potentially irrigated, irrigation water) and input–output relationships. At least in theory, the activity-based approach of the regional programming model in CAPRI allows differentiation between rainfed and irrigated activities.

In practice, however, CAPRI is a complex model build upon a large and consistent database, with data series dating from the early 1980s. As no distinction is made in the CAPRI database between rainfed and irrigated crops, building an irrigation module implies a considerable amount of data work. Furthermore, data on irrigation water use and crop–water relationships are mostly unavailable in official datasets or available only at non-administrative spatial scales, adding difficulties to their integration in agro-economic models. Regarding sectoral water use, although a consistent scheme to collect data exists at EU level, the published datasets are often incomplete. The suggested approach to include water in the CAPRI model involves creating an irrigation module and a water use module. The development of the CAPRI water module will enable it to provide a scientific assessment of agricultural water use within the EU and to analyse agricultural pressures on water resources.

The feasibility of the approach was tested in a pilot case study including two NUTS 2 regions (Andalucía in Spain and Midi-Pyrenées in France), their choice being mainly motivated by data availability. Preliminary results are presented, highlighting the inter-relations between water and agricultural developments in Europe.

It is anticipated that the CAPRI water module will be further developed to account for competition between agricultural and non-agricultural water use. This implies building a water use sub-module to compute water use balances.

Further reading:

- Blanco, M., Van Doorslaer, B., Britz, W. and Witzke, P. (2012) Exploring the feasibility of integrating water issues into the CAPRI model. http://ftp.jrc.es/EURdoc/JRC77058.pdf

6. The bioeconomy

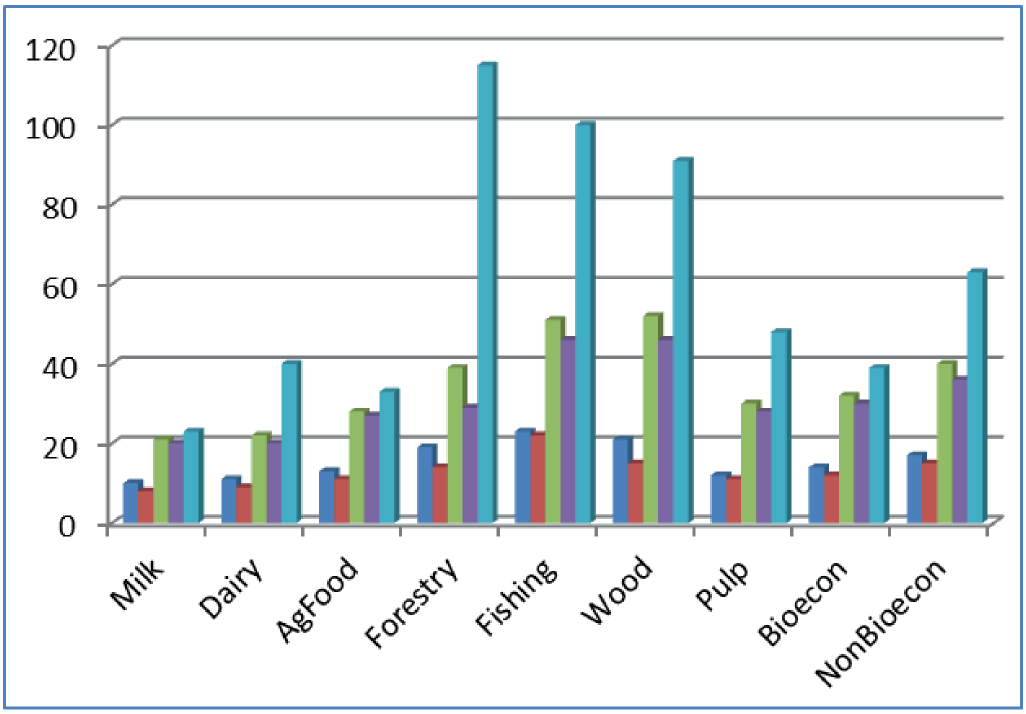
6.1 Structural patterns of the bioeconomy in the EU Member States – a SAM approach

Section prepared by George Philippidis, Ana I. Sanjuán, Emanuele Ferrari and Robert M'barek

The concept of the 'bioeconomy' is gathering momentum in EU policy circles as a sustainable model of growth that reconciles the goals of continued wealth generation and employment with bio-based sustainable resource use. Unfortunately, an economy-wide quantitative assessment covering the full diversity of this sector has been, hitherto, constrained by relatively poor data availability for disaggregated bio-based activities. This research takes a first step in addressing this issue by employing SAMs for each EU-27 Member State encompassing a highly disaggregated treatment of traditional bio-based agricultural and food sectors, in addition to identifiable bioeconomic activities from the national accounts data. Employing backward-linkage (BL), forward-linkage (FL) and employment multipliers, the aim is to profile and assess comparative structural patterns across both bioeconomic sectors and EU Member States. The results indicate six clusters of EU Member States with homogeneous bioeconomy structures. Within-cluster statistical tests reveal a high tendency towards 'backward orientation' or demand-driven wealth generation, while intercluster statistical comparisons across each bio-based sector show only a moderate degree of heterogeneous BL wealth generation and, with the exception of only two sectors, a uniformly homogeneous degree of FL wealth generation.

Employment multipliers are defined as the number of new jobs generated per million euros of additional output value. Calculations are presented for raw milk and dairy products forestry, fishing, wood, pulp and the aggregate sectors 'agri-food' and 'bioeconomy'. In Figure 6, a summary of these numbers for alternative aggregations of Member States is presented.

Figure 6: Employment generation (number of new jobs per million euros of additional output value) for EU Member States' alternative aggregations



For the EU-27, the employment multiplier analysis suggests the creation of 14 new posts for every million euros of additional bioeconomic output value. In comparison, the corresponding EU-27 average for non-bioeconomy sectors reveals a slightly higher level of job creation (17 jobs/ million euros). This finding is broadly robust across all EU-27 Member States (except for the Czech Republic, Luxembourg and Slovakia), while in the 2007 Balkan accession Member States (EU-2), non-bioeconomy job creation is notably higher.

Interestingly, the results suggest that the forestry, fishing and wood sectors are relatively strong bioeconomy drivers of job creation, and the latter two sectors in particular compare favourably across all EU regions in relation to the non-bioeconomy averages.

Further reading:

- Philippidis, G., Sanjuán, A., Ferrari, E. and M'barek, R. Structural patterns of the bioeconomy in the EU Member States – a SAM approach. (2014) http://publications.jrc.ec.europa.eu/repository/handle/111111111/32584 and Spanish Journal of Agricultural Research 2014;12(4):913-926. DOI: 10.5424/sjar/2014124-6192

6.2 Evaluating the macroeconomic impacts of bio-based applications in the EU – a CGE analysis

Section prepared by Cristina Vinyes

In 2012, the European Commission launched the Bioeconomy Strategy and Action Plan. Both have the objective of establishing a resource-efficient and competitive society that reconciles food security with the sustainable use of renewable resources. The focus of the Action Plan is on (1) investing in research, innovation and skills; (2) reinforcing policy interaction and stakeholder engagement; and (3) enhancing markets and competitiveness in the bioeconomy.

To promote and monitor the development of the EU bioeconomy, the European Commission launched the Systems Analysis Tools Framework for the EU Biobased Economy Strategy project (SAT-BBE), with the purpose of designing an analysis tool useful for monitoring the evolution and impacts of the bioeconomy. Second, the European Commission started the Bioeconomy Information System Observatory (BISO) project with the objective of setting up a Bioeconomy Observatory. That observatory must bring together relevant data sets and information sources, and use various models and tools to provide a coherent basis for establishing baselines, monitoring and scenario modelling for the bioeconomy.

This report contributes to the Bioeconomy Strategy and Action Plan and to the projects above, as it aims to evaluate the macroeconomic impacts of bio-based applications in the EU. The macroeconomic effects of bio-based applications studied in this report are determined not only by the production costs but also by the many indirect economic effects of these bio-based applications. Most of the indirect economic effects are caused by the interlinkages of the economy's sectors, mostly through the use of production factors (labour and capital) and intermediate inputs for bio-based production and through changes in prices, production, consumption and trade. Such effects can be evaluated only with economic models, such as MAGNET, which is the global recursive dynamic CGE model used in this study.

Four bio-based applications are considered in MAGNET, namely biofuel (second generation), biochemicals, bioelectricity and biogas (synthetic natural gas). This is done assuming that 1 EJ lignocellulose biomass is converted into fuel, chemicals, electricity and gas and that the final product replaces an equal amount of conventional (e.g. fossil energy) product (on an energy basis). Two methods are used to calculate the net GDP effect, as can be seen in Table 7 below. First, the expected change in production value is calculated based on the conversion efficiency and costs of bio-based and conventional applications. These results are generated without using a CGE model; instead, it can be considered to be a PE model. The second method calculates the net GDP effect using a CGE model such as MAGNET.

Figure 7: The impact of biomass applications on GDP (billion US$)

	PE Net GPD Effect	CGE Net GPD effect MAGNET	Multiplier effect
1 Fuel	3.0	5.1	1.7
2 Chemicals	10.6	6.0	0.6
3 Electricity	-2.5	-3.0	1.2
4 Gas	-4.5	-5.1	1.1

Source: Authors' own and MAGNET calculations

The results show that the production of second-generation biofuel and biochemcials are the only competitive sectors compared with their conventional counterparts in the year 2030 for the EU, based on the assumed efficiency of conversion technology, costs of conversion, biomass price and oil price. In the case of the fuel sectors, it represents a net GDP effect of USD 5.1 billion, which is 1.7 times the net GDP effect when calculated from a PE perspective (taking into account only the difference in production costs between conventional and bio-based applications and no indirect economic effects). The factor of 1.7 can be considered the multiplier effect when using a global CGE model such as MAGNET.

A substantial part of the multiplier effect of biofuel production can be explained by the increase in wages, as the production of biomass is relatively labour intensive. In total, around 26% of the costs of producing, transporting and converting biomass are labour costs, and almost all labour is used for the production and pre-treatment of the biomass. A shift from conventional to bio-based production increases the direct use of labour. The resulting increase in wages is transmitted to other sectors in the economy and increases production and consumption. Another important contributor to the multiplier effect is the lower oil and fuel price as a result of the substitution of oil-based fuel production with bio-based fuel production, which in turn benefits the entire economy.

These effects are greater in the case of the scenario with higher oil prices, as a higher oil price means that the impact of biofuel production has a greater impact on the fuel price. The opposite effect occurs in the case of the lower oil price scenario, but it still makes biofuels competitive.

The same mechanisms described above apply to the macroeconomic impacts of the production of chemicals, electricity and gas. The production of chemicals results in the highest net GDP effect of the four bio-based applications considered, around USD 6 billion, making it very competitive with its conventional counterpart. The GDP calculated from the change in value of production costs is, however, USD 10.6 billion, resulting in a lower multiplier effect than that of the biofuel sector (0.6); this is mainly the result of the reduced competitiveness of the services and the other industry sectors that compete for labour with the chemical industry. This effect reduces the volume of labour and the production volume in these sectors (i.e. services and other industries); moreover, imports also increase to maintain the level of consumption of services and other industry sectors, which results in a negative trade balance effect.

Lastly, bioelectricity and biogas are shown to be not competitive with their conventional counterparts and therefore their prices rise and their employment, production, consumption and exports fall, making it clear that, given the assumptions used in the analysis of biomass applications, biomass would be better used in the production of second-generation biofuels or biochemical industries. The multiplier effect of the biogas and bioelectricity applications are slightly lower compared with that of the biofuel sector, but still higher than one.

Further reading:

- Smeets, E., Vinyes Pinto, C., Tabeau, A., Van Meijl, H., Corjan, B. and Prins, A.G. (2014) Evaluating the macroeconomic impacts of bio-based applications in the EU. http://publications.jrc.ec.europa.eu/repository/handle/111111111/32850

6.3 Food waste and food waste reduction in the CGE framework

Section prepared by Hasan Dudu

Food waste is increasingly recognised as an important factor threatening not only food security but also several dimensions of the sustainability of the food system. Furthermore, it is also linked to several environmental issues such as landfill and gas emissions relevant to climate change. The most recent estimates by FAO indicate that almost 30% of global food production is wasted, while the proportion of food wasted in food production varies between 10% and 37% among EU Member States. Based on these concerns, a clear societal strategy to reduce avoidable food waste seems inevitable and the European Commission set the target of halving food waste throughout the EU by 2020 as part of the strategy to make Europe more resource efficient. However, these strategies are not costless.

From an economic point of view, rational agents only waste food when the benefits of disposal exceed the effort involved in (or costs) of avoiding it. Therefore, policy instruments are necessary to shift incentives towards encouraging less food waste than that found under current market conditions. Both external environmental factors and ethical concerns ('don't starve the poor through the excessive consumption of food by the rich') that touch upon the distribution of resources and income may, generally, require policies that intervene with competitive markets. Correctly designed policy instruments can lead to different and possibly better allocation of resources throughout the economy. Thus, analysis of the probable impact of these policies on the whole economy is essential for the design of socially acceptable and sustainable policies.

We employ a modified version of the RegCgeEU+ model for this purpose. RegCgeEU+ is a comparative static CGE model that consists of 250 NUTS 2 regions in the EU at Member State level using the regional SAMs and with the base year 2005. The model consists of 11 production activities producing 11 commodities for a single type of representative household in each region using labour, capital, land and intermediate inputs. Migration within Member States, the endogenous employment rate and capital stock, the differentiation between regional, national and imported intermediate input use are among the novel properties of the model. We ran our simulations for the Netherlands, where food waste is highest among the Member States and further time use data is readily available.

We simulate three scenarios in which households, farmers and food producers are forced to reduce their raw and processed food inputs by using more production factors, i.e. labour, land and capital (see table). The 'free lunch' (FL) scenario makes the rather unrealistic assumption that the current proportion of food waste can be avoided without any costs. In the 'Tit for tat' (TfT) scenario, we calculate the change in primary factor costs to offset the cost savings and update the primary cost proportions accordingly. Lastly, in the 'Costly lunch' (CL) scenario the increase in primary factor use is twice as high as the cost saving from reduced intermediate input use at benchmark prices.

Scenario results suggest that the lower the cost of food waste reduction, the more the economy benefits from it. Therefore, an important aim of policies targeted at reducing food waste is reducing its costs, economy wide. The trade-off between the time spent on food production and the reduction in food waste turns out to be a crucial component of these costs. Identification and quantification of this trade-off is crucial to be able to address them properly. Once identified, policies to reduce this trade-off, such as encouraging technological improvements that simultaneously save food and the time spent on food preparation in the household and in the food processing industry, turn out to be crucial.

Further reading:

- Britz, W., Dudu, H. and Ferrari, E. Economy-wide impacts of food waste reduction: a general equilibrium approach. Proceedings of the 2014 International Congress of the European Association of Agricultural Economists, 26–29 August 2014, Ljubljana, Slovenia. doi: 10.13140/2.1.4299.5206. Available online: http://goo.gl/1Fu0JQ

Table 6: Summary of the simulation results

	Consumer price			Demand			Producer price			Production		
	FL	TfT	CL	FL	TfT	CL	FL	TfT	CL	FL	TfT	CL
Agriculture	–2.0	–0.9	0.1	2.8	1.0	–0.5	–2.3	–0.8	0.5	3.5	–3.7	–8.9
Forestry	–0.8	–0.4	–0.2	0.7	0.2	–0.2	–0.2	–0.6	–0.8	0.4	0.0	–0.3
Oth. pri. prod.	–1.4	–0.5	0.1	3.1	0.9	–0.6	–1.3	–0.6	–0.2	–0.7	0.0	0.5
Food proc.	–6.2	–0.5	4.0	5.3	0.5	–2.7	–6.3	–0.1	4.9	6.5	–7.7	–16.8
Other manu.	–1.2	–0.4	0.1	1.5	0.4	–0.4	–1.3	–0.5	0.0	–0.7	–0.1	0.4
Energy prod.	–1.0	–0.5	–0.3	1.6	0.5	–0.2	–1.3	–0.6	–0.1	0.4	–0.2	–0.7
Construction	–0.5	–0.3	–0.2	1.3	0.4	–0.2	–0.6	–0.4	–0.3	1.0	0.3	–0.2
Trade & trans.	–0.5	–0.4	–0.4	1.1	0.4	–0.1	–0.9	–0.5	–0.2	0.1	0.0	–0.1
Hotel & rest.	–2.1	–0.3	1.1	2.3	0.3	–1.1	–2.5	–0.3	1.5	2.0	0.1	–1.4
Education	–0.4	–0.3	–0.3	0.2	0.0	–0.2	–0.5	–0.4	–0.3	0.1	–0.1	–0.2
Other serv.	–0.5	–0.4	–0.3	0.8	0.2	–0.2	–0.7	–0.4	–0.3	0.4	0.0	–0.3
Cooking	–0.3	1.2	2.7	1.4	–0.7	–2.6	–0.3	1.2	2.7	1.4	–0.7	–2.6
Leisure	0.9	0.2	–0.4	0.5	0.1	–0.2	0.9	0.2	–0.4	0.5	0.1	–0.2

Source: RegCgeEU+ results

7 Europe and its neighbours

7.1 Enlargement policy: the case of Croatia

Section prepared by Pierre Boulanger, Emanuele Ferrari and Cristina Vinyes

Croatia joined the EU on 1 July 2013. This report assesses the likely effects of this accession on the agricultural and food sectors and analyses its impact on the EU and Croatia and their main trading partners, such as the Western Balkans and the Mercosur countries (Argentina, Brazil, Paraguay, Uruguay and Venezuela). It considers both the harmonisation of Croatia's trade instruments with those applied in the EU, and the adoption of the CAP. The analysis is carried out using MAGNET, a global recursive dynamic CGE model.

The results show that Croatia slightly benefits from its accession to the EU with an increase in both GDP and jobs. The impact on the EU-27's GDP is insignificant, while in terms of jobs it is slightly positive for the agri-food sectors.

The considerable discrepancies in the pattern of protection in the agri-food sectors applied in Croatia and the EU-27 prior to Croatia's EU accession, combined with the differently structured tariffs for exports from Croatia and the EU-27, suggest a significant potential for trade effects. The total exports of Croatian agricultural products increase by 7.4% and those of food products decrease by 2%.

By adopting European trade and agricultural policy, Croatia will face some changes in its production structure. At constant prices, agricultural production benefits (increasing by 1.1%), whereas food production contracts (decreasing by 5.5%). This result sheds some light on the limitations on the competitiveness of the Croatian food-processing industry.

Croatia will experience considerable effects on prices. As a result, the value of production at real prices will decrease in both the agricultural and the food-processing sectors. The sectors most affected in terms of value are vegetables and fruits, pork and poultry meat, beverages and tobacco, and wheat and other cereals. The sugar sector is especially affected, with a sharp decrease in production *volume*, on the one hand, but an increase in production *value* in real prices, on the other hand.

The scope of this report is to model both European trade and agricultural policies. It is worth mentioning that other EU policies such as structural or cohesion policies, and additional gains resulting from accession such as a less risky investment environment or a more efficient regulatory framework, are not modelled. Thus, the outcomes of Croatia's accession presented in this report are not exhaustive and may underestimate the benefits of such an accession.

Further reading:

- Boulanger, P., Ferrari, E., Michalek, J. and Vinyes, C. Analysis of the impact of Croatia's accession to the EU on the agri-food sectors. (2013) A focus on trade and agricultural policies. http://publications.jrc.ec.europa.eu/repository/handle/111111111/29072
- Philippidis G., Boulanger P., Ferrari E., Michelak J., Resano H., Sanjuán A.I. and Vinyes C. The costs of EU club membership: agri-food and economy-wide impacts in Croatia. Post-Communist Economies, Volume 27, Issue 1, 2015.

7.2 Economic growth in the Euro-Mediterranean area through trade integration: focus on agriculture and food – the case of Turkey

Section prepared by Hasan Dudu

This study analyses the effects of trade liberalisation, the increase in the world price of basic staple commodities and growth in the productivity of agricultural activities (see Table 9 for details of the scenarios) in Turkey using a dynamic CGE model calibrated to 2008 data. In trade liberalisation scenarios, we simulated unilateral trade liberalisation, elimination of NTMs and an accession scenario. All scenarios were benchmarked against a baseline scenario in which the growth of the economy was calibrated in order to reflect historical averages.

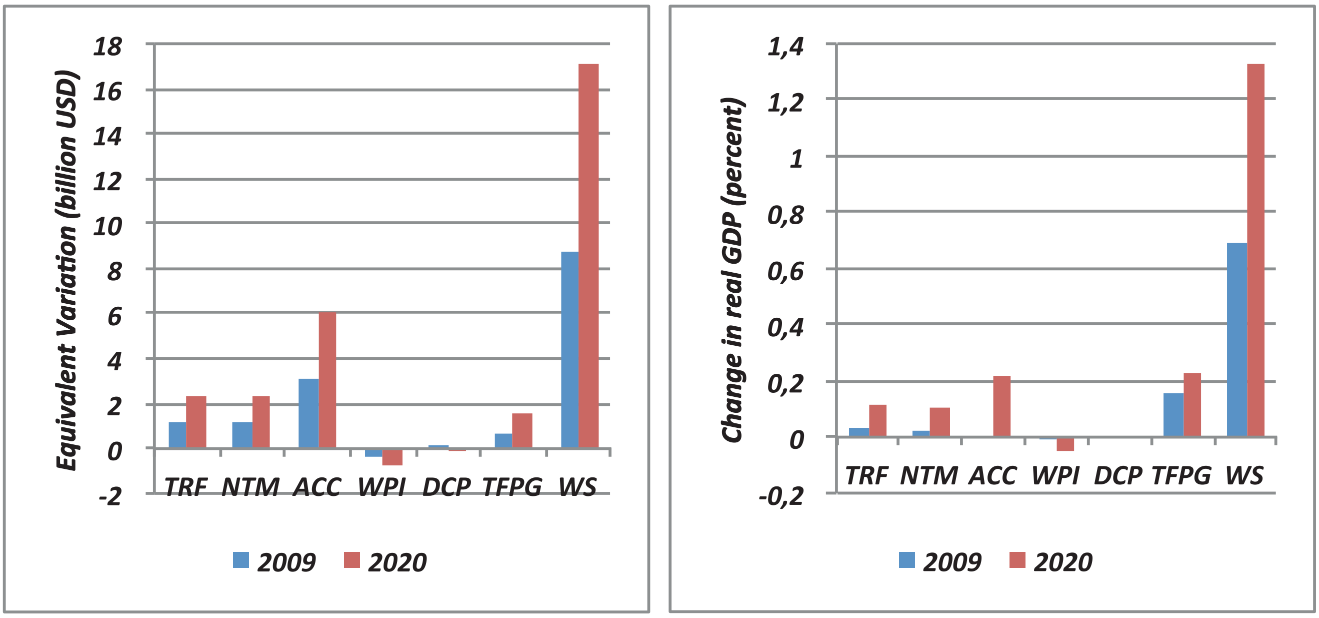
Table 7: Overview of scenarios

	Scenario	Assumptions
Baseline	BASE: Baseline scenario	0.9% population growth 0.8% TFP growth in agricultural activities 1.06% TFP growth in manufacturing activities 0.4% TFP growth in services Natural resource growth equals 25% of growth of capital Capital output ratio is 4.2
Trade liberalisation shocks	TRF: Tariff elimination	BASE + Elimination of related tariffs
	NTM: Non-tariff measure elimination	TRF + Increase in prices of Turkish exports to the EU
	ACC: EU accession	NTM + Tripled agricultural subsidies + Transfers from the EU to Government
Wheat price shocks	WPI: Wheat price increase	World wheat price increases by 3.6% over 2008–2020
	DCP: Domestic consumer protection	WPI + Turkey reduces tariffs imposed on wheat imports by around 6% to keep domestic prices close to the baseline
TFP shocks	TFP: Total factor productivity increase	0.15% extra TFP growth on top of baseline
	DFW: Decreasing food waste	Productivity in agricultural and food-processing industry increased according to FAO (2011)

The results suggest that the change in equivalent variation is not significantly different under the TRF and NTM scenarios but is more than twice higher under the accession scenario, thus reflecting the importance of accession for trade liberalisation in agriculture (Table 10). The effect of the increasing world price of wheat and the reduction of tariffs to stabilise domestic prices is not significant, but the difference between these two scenarios adds up to USD 390 million. The effect of the TFP scenario on consumer welfare is also limited compared with the trade liberalisation and food waste scenarios, which yield the highest welfare gains. The reflection of the welfare gains in terms of GDP is generally small. The impacts are generally absorbed by the substitution mechanisms in trade, consumption and production. The overview of the simulation results suggests that trade liberalisation in agriculture is likely to have a limited overall effect under the current structure of the Turkish economy. Welfare gains are positive but not as high as expected for consumers.

Domestic prices for all agricultural commodities decline proportionally with the size of protection under trade liberalisation, with the exception of sugar beet and vegetables. Imports in all sectors increase. Manufacturing imports increase significantly. In terms of agricultural activities, the highest increase is in wheat, dairy products and other cereals. The increase in imports from the EU-27 causes imports from other trading regions to decline, revealing significant trade diversion. Under accession, the impacts become stronger, as the effects of trade diversion

Figure 8: Change in equivalent variation and GDP under different scenarios



Source: Model results. See Table 7 for the definitions of the scenarios

combine with the effects of increasing domestic production. Changes in exports differ considerably under different trade liberalisation scenarios. The effects are negligible under the TRF scenario. Under the NTM scenario, exports of rice, food, maize and fruits increase significantly. Exports of other field crops also increase significantly under the ACC scenario.

To summarise, under trade liberalisation, imports from EU-27 countries increase significantly, causing domestic prices to decline in the trade liberalisation scenarios. Consequently, production levels of agricultural commodities fall. Since the decline in domestic prices is lower than the tariffs imposed in the other trading regions, prices of agricultural imports from other regions increase. This causes aggregate imports to decline. Therefore, trade liberalisation with the EU has a trade diversion effect, causing imports from other trading regions to decline. Food consumption increases with trade liberalisation. As a result, trade liberalisation increases food security.

Under the WPI scenario, it was observed that decreasing tariffs imposed on wheat by around 6% eliminates the effects of a world price increase on domestic prices and production. The effects of policy response occur mainly via wheat trade. Wheat imports from all regions decline by around 12% under the WPI scenario. After tariff reductions, the change becomes insignificant. The change in exports to the Middle East and North Africa remains significant. Consequently, trade policy can be used to avoid the adverse effects of increasing world basic staple commodity prices. Increasing exports and declining imports can jeopardise food security if world prices increase. This effect is not significant for Turkey. The economy can handle the adverse effects on food security through substitution mechanisms.

The immediate impact of increasing total factor productivity (TFP) is a surge in the production of agricultural commodities. The increase is between 2.5% and 6.3% for crops but varies between 1.8% and 2.4% for livestock-related activities. Expansion in agriculture and services production occurs at the expense of manufacturing production. This is due to the link between agricultural activities and manufacturing through the factor and intermediate input markets. Trade effects are relatively significant under the TFP scenario. Food security improves substantially under the WS scenario. Turkey becomes less dependent on food product imports and contributes significantly to global food safety by exporting more than 8% of its food production. Subsequently, the TFP increase in agricultural production boosts the production of all agricultural commodities, causing their prices to fall and exports to increase. The final magnitude of change is driven by competition for factors, and the ability of activities to substitute intermediate inputs with factors becomes crucial.

Further reading:

- Cakmak, E.H. and Dudu H. Economic growth in the Euro-Med area through trade integration: focus on agriculture and food – the case of Turkey. https://ec.europa.eu/jrc/sites/default/files/euromed_turkey_final3.pdf

7.3 Food security in North Africa

Section prepared by Pierre Boulanger and Robert M'barek

This research work presents some impacts of deeper economic integration between the EU and three North African (NAF) countries, namely Egypt, Morocco and Tunisia. It conducts a quantitative impact assessment of the increase in trade and investment flows using MAGNET. Simulations are viewed within the process of the Euro-Mediterranean integration and are framed by the expected Deep and Comprehensive Free Trade Areas (DCFTAs) developed by the EU. They focus on reciprocal tariff and non-tariff liberalisation between these partners (scenario TL-NTM), and productivity gains promoted by investments, either in the whole economy or in the agricultural supply aiming to reduce losses (waste) in NAF agricultural production, post-harvest handling and storage (scenarios BI and TI respectively). Table 8 below summarises the effects of each scenario on growth, the labour market and food security in the NAF countries and draws three concluding remarks.

First, each scenario has a positive impact on GDP, with higher growth in the NAF countries of about 2.7% (TL-NTM), 3.5% (BI) and 2.3% (TI) on average in 2020. Economic growth is stimulated mostly by a productivity boost, and the effects are more pronounced if productivity gains involve all sectors of the economy. Growth is also boosted by trade liberalisation, which makes the NTMs removal a key issue for further trade integration between the EU and NAF countries. This suggests that the positive impact on economic growth could be intensified by combining policies that aim to foster both productivity and trade flows. In the EU, southern countries experience greater import competition (e.g. vegetable oils and fats), which has a negative impact on domestic production and employment.

Table 8: Trends in the impacts on growth, labour market and food security of different scenarios for NAF countries, 2020

Scenario	Trade liberalisation (TL-NTM)	Broad investment (BI)	Targeted investment: food waste (TI)
GDP	+	++	+
Employment	+	+/–	+/–
(Agriculture)	(+)	(–)	(–)
(Non-agriculture)	(+)	(+)	(+)
Real wages	+	+	+/–
(Agriculture)	(+)	(+)	(–)
(Non-agriculture)	(+)	(+)	(+)
Household consumption of food (per capita)	+	+	+
(Domestic food)	(–)	(+)	(+)
(Imported food)	(++)	(+)	(-)
Household prices	–	+	– –

Note: As the shocks and reference scenario differ, the table shows only trends; magnitudes of effects cannot be compared. The trends refer to the end-point difference in percentage changes in 2020; + indicates an increase and ++ indicates a more pronounced increase; – indicates a decrease in the simulation result; – – indicates a more pronounced decrease; +/– indicates an ambiguous effect
Source: Authors' own compilation based on MAGNET results

Second, the results confirm that, as the economy of NAF countries grows, less labour is demanded by the agricultural sectors and real wages in the agricultural sectors increase. Specific agricultural productivity growth reduces agricultural employment and wages (TI scenarios), which may have negative implications for rural households that are more dependent on primary agricultural sectors. However, positive effects on agricultural employment may emerge if productivity growth is combined with trade liberalisation. The latter aligns with the objectives of the DCFTAs that specifically not only anticipate trade liberalisation but also heighten investment flows to promote growth and efficiency gains.

Third, economic growth leads to more demand for food and thus to higher prices. Increasing agricultural productivity and cutting down losses (waste) in food production and improved storage and handling can be considered as a first step to reducing dependence on and vulnerability to changes in the world market. Indeed, the results show that food security can be reinforced by lowering prices and increasing the food consumption of households in NAF countries. A further disaggregated analysis of agri-food markets and consumption could provide deeper insights in terms of changes in diets and values.

Further reading:

- Boulanger, P. and M'barek, R. (eds) (2013) Economic growth in the Euro-Med area through trade integration: focus on agriculture and food. Regional impact analysis. Authors: Kavallari, A., Rau, M.-L. and Rutten, M. http://publications.jrc.ec.europa.eu/repository/handle/111111111/29857
- Boulanger, P., Kavallari, A., Cardenete, M.A. and Rau, M.-L. (eds) (2013) Economic growth in the Euro-Med area through trade integration: focus on agriculture and food. North Africa case studies – Egypt, Morocco, Tunisia. Authors: Abdallah, M.B., Ait El Mekki, A. and Siam, G. http://ftp.jrc.es/EURdoc/JRC84801.pdf
- Boulanger, P., Kavallari, A., Rau, M.-L. and Rutten, M. Trade openness and investment in North Africa: a CGE application to deep and comprehensive free trade areas (DCFTAs) between the EU and respectively Egypt, Morocco and Tunisia. International Agricultural Trade Research Consortium (IATRC) Symposium, Seville, June 2014. http://ageconsearch.umn.edu//handle/152360

7.4 Russia market outlook

Section prepared by Guna Salputra and Thomas Fellmann

The legal framework of the relationship between the EU and the Russian Federation (Russia) is the EU–Russia Partnership and Co-operation Agreement (PCA) signed in 1994. The PCA contains special provisions regarding the economic relations between the EU and Russia, with one of its main objectives being the promotion of trade and investment, as well as the development of harmonious economic relations between the two parties. Dominated by non-agricultural commodities, Russia has become the EU's third largest trading partner. In turn, the EU is Russia's major trading partner regarding both exports and imports. Russia supplies the EU with large amounts of oil and gas, while the EU exports to Russia are more diversified, covering, in addition to machinery and manufactured goods, food and live animals. Since 2008, the EU and Russia have been negotiating a new agreement that will update and replace the existing PCA and provide a comprehensive framework for bilateral relations. The potential impact of EU restrictive measures adopted in July 2014 regarding Russia's access to EU capital markets as well as the agri-food products ban have not been accounted for or evaluated by the study.

During the period of transition to a market economy, Russia's agricultural output decreased severely throughout the 1990s, especially in the livestock sector. In the 2000s, agricultural production in Russia started to rebound and the country became an important player in world agricultural markets with respect to both exports and imports. In particular, grain output and exports increased considerably and Russia became a major supplier of grain on the world market. Although production in the livestock sector also increased, imports of agro-food products continued to grow during the 2000s, and Russia became one of the largest net importers of agro-food products.

Agricultural support in Russia has been driven by the orientation of policies towards import substitution, stimulating growth in livestock production through border protection and investments to improve agricultural efficiency. Since the beginning of the 2000s, one of the major agricultural policy objectives in Russia has been to stimulate production in the livestock sector. The Russian government therefore supports the livestock sector with subsidies and market interventions. Market price support is mostly enacted by border measures, while input subsidies and output payments are the dominant domestic policy instruments in Russia. Applied domestic measures are mostly input subsidies, including interest rate subsidies, at both federal and regional levels.

The simulations for the outlook were conducted at the beginning of 2012, and therefore Russia's accession to the WTO and the associated commitments are not taken into account. Accordingly, for the baseline projections, the Russian border policy applied to protect Russian agriculture

– which reflects a package of import tariffs, export quota and export taxes – is assumed to be applied unchanged up to 2025.

To generate the projections for the agricultural commodity market developments in Russia until 2025, the AGMEMOD tool (see section 1.4) was used. As a major part of the study, the AGMEMOD model was expanded to include Russia in order to capture the developments in Russian agricultural policy and markets and their impact on agricultural world markets. The Russian model consists of different supply and demand sub-models for those commodities that represent the majority of Russia's agricultural output.

The projection results for the main Russian agricultural markets show that until 2025:

- Prices in Russia for all cereals and oilseeds are projected to remain below their world price levels, as the Russian grain market is assumed to continue to be driven by state purchasing and selling of intervention stocks. Therefore the Russian cereal and oilseed markets will remain partly segregated from world markets. However, owing to increasing internal demand for arable crops, domestic prices are also projected to increase and the differential to diminish.
- The shift from the area planted with cereals to oilseeds will be driven by a stronger demand for oilseeds and less governmental influence on oilseed than on cereal production.
- Although self-sufficiency rates decline in the course of the projection period, Russia is expected to remain self-sufficient for the main cereals, as well as for sunflower seed and rapeseed.
- With the exception of poultry, Russia is projected to remain a net importer of all kinds of meat, despite the import tariffs, tariff quotas and subsidies for animal products applied. Income growth drive and increase in consumption per capita of all meats, with the strongest growth projected to take place in pork consumption.
- In the baseline projections, Russian prices of milk exceed the EU prices, and the same holds true for skimmed milk powder and cheese. However, in the case of butter, Russian prices and EU prices are relatively close. Driven by strong demand based on economic growth, milk and dairy prices increase, especially in the second half of the projection period. Despite the high prices and additional domestic support, milk production is projected to remain insufficient over the projection period owing to the low level of productivity. As a consequence, Russia is projected to remain a net importer of dairy products.

How does the WTO agreement affect our projections for the Russian agricultural outlook? First, the results of a WTO accession scenario conducted with AGMEMOD indicate that the WTO commitments might particularly affect prices in Russia's livestock sector. As Russia will have to lower its market interventions in the livestock sector, this is projected to result in lower production increases in the sector and augmented meat imports (especially pork). Lower livestock production in Russia implies lower domestic demand for feed grains, which is projected to also impede the growth in production of Russia's grain sector; however, grain exports are projected to increase.

Further reading:

- Fellmann, T., Nekhay, O. and M'barek, R. (eds) (2013) The agri-food sector in Russia: current situation and market outlook until 2025. Extension of the AGMEMOD model towards Russia. Authors: Salputra, G., van Leeuwen, M., Salamon, P., Fellmann, T., Banse, M. and von Ledebur, O. http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=6019

7.5 Ukraine market outlook

Section prepared by Guna Salputra and Thomas Fellmann

The EU and Ukraine have developed an increasingly dynamic relationship since 1991, when Ukraine gained independence. Ukraine is a priority partner country within the European Neighbourhood Policy (ENP) and the Eastern Partnership. Negotiations on a new EU–Ukraine Association Agreement were launched in March 2007 and signed in June 2014.

Ukraine has huge agricultural potential owing to its rich natural resources (soil, climate and water) and key geographical position, with access to the Black Sea and the key markets in the EU, the Commonwealth of Independent States (CIS), the Middle East and North Africa. The role of agriculture in the Ukrainian economy is quite remarkable. Although the proportion of agriculture accounting for Ukraine's GDP has decreased considerably since 1991, agriculture still accounted for about 8.2% in 2010. In addition, at 15%, the Ukrainian agricultural sector still contributes significantly to national employment. Agriculture also has a core role in Ukrainian foreign trade, with agri-food exports accounting for about 20% of total Ukrainian exports in 2010.

As part of this study, Ukraine was integrated into the overall AGMEMOD modelling framework. Therefore a detailed dataset and modelling structure for the main Ukrainian agricultural commodities has been developed. The Ukrainian model consists of different supply and demand sub-models for those commodities that represent the majority of the agricultural output in Ukraine.

In general, cereals and oilseeds and their derived products (oils and cakes), sugar beet, potatoes, livestock (cattle, poultry, sheep and goats) and their derived products, and dairy products (raw milk, butter, milk powder and cheese) are represented. For each of these commodities, production as well as supply, demand, trade, stocks and domestic prices have been derived by econometrically estimated or calibrated equations. Furthermore, detailed data sets of agricultural policy instruments such as input subsidies, direct payments, support prices, import tariffs and export duties have been developed for the Ukrainian model.

To ensure that the baseline projections of the Ukrainian AGMEMOD model make economic sense and are coherent from a policy perspective, they have been validated by standard econometric methods and by the Ukrainian partners familiar with agricultural policy and markets in Ukraine. From this perspective, the performance of the Ukrainian commodity market models in determining the baseline projections had primacy in the evaluation of the modelling system's performance.

The market outlook presented is a model-based projection of the future development of the main agricultural commodity markets in Ukraine until the year 2025, with endogenous formation of world market prices. The projections are based on a set of coherent macroeconomic and policy assumptions. Moreover, the projections assume normal weather conditions and steady demand and yield trends (following recent time paths), i.e. no disruptions, caused, for example, by bad weather conditions, are considered.

The projection results for the main Ukrainian agricultural markets show that until 2025:

- Ukrainian cereal prices are projected to follow the broad developments in world market prices, but generally at a level considerably below EU and world market prices. The difference in price levels reflects Ukraine's position as a large exporter of cereals and oilseeds. Total grain and oilseed areas are projected to slightly increase owing to additional production areas being brought into cultivation. Following historical trends, further increases in yield are expected due to the use of higher yielding seed varieties, higher fertiliser input and improved potential for irrigation.

- Concerning oilseeds, in particular, rapeseed and soybean production are projected to increase. The growth in Ukraine's soybean production is a reaction to the fact that Ukraine is currently a protein-deficient country and its domestic demand for soybean meal is expected to grow significantly owing to increases in production in the Ukrainian livestock sector. The increased soybean production is expected to be used mainly in the domestic crushing industry.

- Ukrainian beef and poultry prices are projected to remain at a level below their respective EU and world market prices, while the price of pork is projected to develop further above the EU and world market prices.

- Ukrainian beef production is mostly based on dual purpose cattle, with milk being the determining output. Low yields and semi-subsistence farming have affected beef production in the past, but investments are expected to turn this around, and beef production is projected to increase, mainly driven by rising slaughter weights.

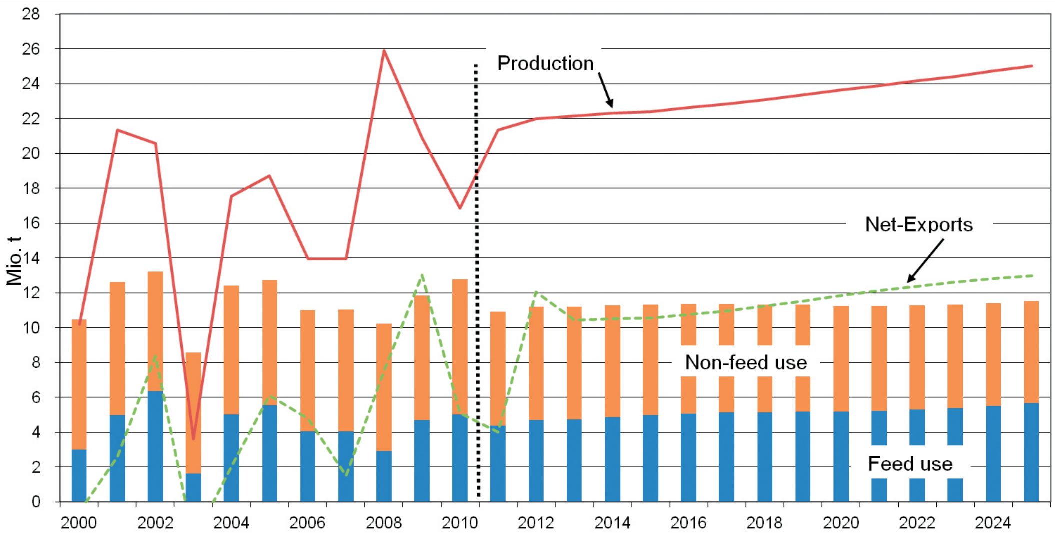
- Although Ukraine's main big pork producers are vertically integrated holdings with higher investment, production and consumption are projected to develop at about the same pace, and therefore Ukraine is expected to remain a net importer of pork over the projection period.

- The poultry market in Ukraine is dominated by vertically integrated production, and, owing to further investment, domestic poultry production is projected to expand further. As increases in production outpace the increases in domestic consumption, Ukraine, will turn into a net exporter during the projection period.

Further reading:

- Fellmann, T., Nekhay, O. and M'barek, R. (eds). (2012) The agri-food sector in Ukraine: current situation and market outlook until 2025. Extension of the AGMEMOD model towards Ukraine, Authors: van Leeuwen, M., Salamon, P., Fellmann, T., Banse, M., von Ledebur, O., Salputra G. and Nekhay, O. http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=5459

Figure 9: Soft wheat baseline outlook for Ukraine until 2025



Source: AGMEMOD results

8. Europe in the global market

8.1 Contribution to the economic impact assessment of policy options to regulate animal cloning for food production with an economic simulation model

Section prepared by Emanuele Ferrari, Pascal Tillie, George Philippidis and Sophie Hélaine

The European Commission conducted an impact assessment process to evaluate different policy options towards the use of cloning techniques in animal reproduction and the incorporation of products derived from cloned animals into the food chain in the EU. In the context of this impact assessment, we simulated the economic impacts of selected policy options that could result in de facto trade disruptions. The study presents a quantification of the likely effects of different policy measures for animal cloning for food production on the international trade and the EU domestic markets, particularly on production and prices.

In the crops and livestock sector, the potential for animal cloning would allow a spread of desired genetic characteristics to be secured, compared with traditional breeding techniques. This translates into increased productivity over time. Most studies available in the literature focus on the dairy sector, as it has considerable commercial potential for cloning. The present study therefore focuses on specific simulations for cattle and milk production and the corresponding downstream sectors, beef and dairy products.

The analysis employed GLOBE, a global CGE model. Different model scenarios were constructed based on combinations of the policy options discussed, such as a ban, or traceability and labelling requirements with associated productivity increases arising from the use of the cloning technique.

The first scenario assumes that all countries will adopt cloning and there are no restrictions on trade. The results show that the impact of cloning on productivity, both inside and outside the EU, is limited. Cloning increases productivity and therefore ameliorates the competitive position of those sectors with access to the technology, leading to a slight increase in domestic production. However, as all countries are assumed to gain from cloning, the trade effects are small.

A further scenario assumes that the EU prohibits the use of cloning but not the imports of derived products, while some of its trade partners use the cloning technique. We assume that the United States, Argentina, Brazil and New Zealand adopt the technology, as they have signed a joint statement on the topic. Under the assumptions of this scenario, there are no trade restrictions and the difference lies in the productivity increase associated with the use of cloning in some countries, although not in the EU. The results show that, in this case, the EU would import marginally more cattle, beef and dairy products, but the effects on prices and domestic production would be negligible, as imports represent only a small part of EU domestic use.

In the next scenario, traceability and labelling are added as a requirement for imports from countries using the cloning technology. This requirement leads to a slight reduction in imports, as the increased costs of the traceability system offset the benefits from the technology. Again the changes are too small to lead to any significant production or price effects in the EU's domestic market.

Finally, the last scenario is built on the assumption that imports of cattle, beef, milk and dairy products from countries using the animal cloning technique come to a halt owing to express prohibitions or a de facto decision by exporters. In this scenario the effects are more pronounced. An initial direct effect is a shift in the sources of imports into the EU. If imports from Brazil, the United States, Argentina and New Zealand are suspended, Canada and Australia would increase their exports to the EU, in response to demand. The substitution effect is, however, not complete. The total reduction in imports would be significant, with a 50% drop in the imports of cattle and beef compared with baseline and a 20% decrease in imports of dairy products. This reduced availability of imports for the EU would lead to an increase in import prices. For cattle and beef, import prices would rise by approximately 10%, while the price increase for dairy products would be much smaller (about 1%).

The reduction in imports under this last scenario would be partly compensated for by increased EU domestic production. Cattle production is expected to grow by about 4%, while the beef sector would grow by slightly more at 6%. These changes are small, as the proportion of imports represents a relatively small part of EU domestic consumption. The value of this expanded domestic production is, however, significant, as it represents about USD 4.28 billion. The expansion in production is accompanied by a slight increase in producer prices. A similar chain of events can be expected in the milk and dairy sector. However, as both the reduction in imports and the proportion of imports in total production are smaller, the effects on domestic production are less pronounced.

The production expansion in the EU due to the de facto ban on meat and dairy imports from some countries has an effect on the upstream sectors. The demand for fodder increases by 4%, leading to a small price increase in other land-based production systems such as cereals and grains.

The changes in production and prices also have a downstream effect. EU consumers will experience a price increase, as domestic production cannot fully compensate for the loss of imports. The price effect is most pronounced in the beef sector where it amounts to about 2%. For cattle, milk and dairy products, the price effects are much smaller, not surpassing 1%. The price of other meat products, mainly poultry and pork, increases marginally through a combination of substitution and price increases in the input markets. All these price effects combined lead to a welfare loss of about USD 1.7 billion in the event of an EU ban on (or a de facto interruption of) imports from countries using the cloning technology.

This work highlighted the need for further specific analysis to understand the impacts in certain niche markets or to investigate the response of individual countries to the EU's requirements for traceability and labelling.

Further reading:

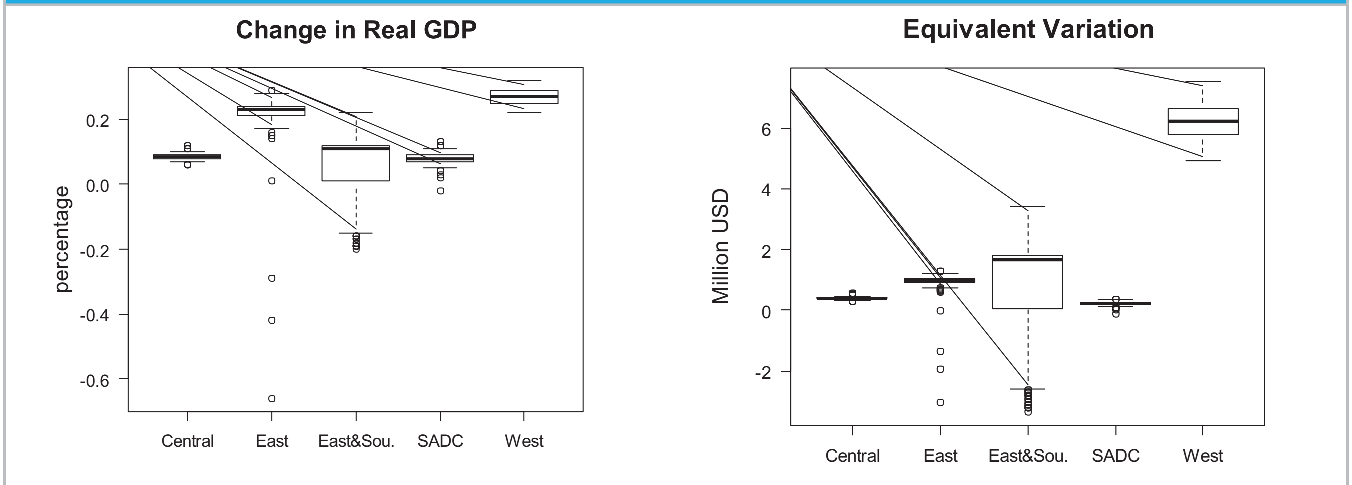
- Dillen, K., Ferrari, E., Tillie, P., Philippidis, G. and Hélaine, S. (2013) Contribution to the impact assessment of policy options to regulate animal cloning for food production with an economic simulation model. http://ftp.jrc.es/EURdoc/JRC79995.pdf

8.2 A potential 'green revolution' in Africa

Section prepared by Hasan Dudu, Cristina Vinyes and Emanuele Ferrari

Sub-Saharan Africa (SSA), largely missed out on the green revolution, and therefore it is thought that the continent is long overdue for an agricultural boom like those that lifted other regions such as Asia. Given this background, in this report a global CGE model is used to analyse the economy-wide effects of a potential 'green revolution' in SSA. Following many studies in the literature, a potential green revolution is modelled as an increase in TFP; on the other hand, the uniqueness of this study lies in the introduction of the observed and desired yield changes (following past observed green revolutions such as in Asia) and in letting the model determine the required TFP change to attain these yield levels. Furthermore, a stochastic yield change is introduced as a shock to the CGE model using a Gaussian quadrature approach. This way, instead of presenting only one point for a probable green revolution, one can analyse the effects of a green revolution under the full spectrum of possible yield changes.

Figure 10: Distribution of changes in real GDP and equivalent variation in African regions



Source: Model results

The results suggest that the median change in GDP varies across the regions; however, the average change is slightly above zero for Central, East and South and Southern African Development Community (SADC) regions, while it is slightly higher than 0.5% for East and West Africa regions, confirming that the West region is also the one gaining the most in terms of GDP due to the yield changes and the fact that this region's distribution is concentrated around the median. In the case of East Africa, the distribution of the difference in GDP change is relatively more dispersed, also spanning negative values, and it is the same for the East and South region. The difference in welfare, represented by the EV between the baseline and the scenario, is relatively small and follows the same pattern as the change in GDP. In this case, it is even clearer that West African consumers gain significantly more than the other regions, with a median difference around USD 6 billion and the distribution of the difference in EV spans only positive values. The second best region in terms of welfare gain is the East and South Africa region, with a higher median than the rest of the regions, but in this case the distribution is significantly more dispersed and includes negative values.

Further reading:

- Dudu, H., Vinyes, C. and Ferrari, E. Potential economic impact of a 'Green Revolution' in Sub-Saharan Africa: a CGE analysis. Paper presented at the 17th Annual GTAP Conference, 18-20 June 2014, Dakar, Senegal. https://www.gtap.agecon.purdue.edu/access_member/resources/res_display.asp?RecordID=4486

8.3 Agricultural commodity price volatility and its macroeconomic determinants

Section prepared by Ayca Donmez and Emiliano Magrini

The research study on price volatility investigates the main drivers of agricultural commodity price volatility using the GARCH-MIDAS model developed by Engle et al. (2013)[13], which allows isolation of the low-frequency component of volatility and takes into consideration potential drivers via mixed data sampling. In the scope of the study, the high-frequency component reflects the daily fluctuations associated with transitory (or short-lived) effects of volatility, and a mean reverting GARCH(1,1) is used to formulate it. The secular or low-frequency component aims to capture slowly varying or highly persistent conditions in the economy and the MIDAS (mixed data sampling) regression is used for modelling it. The GARCH-MIDAS model provides a unified framework for working with data in different time frequencies by assuming that the volatility can be represented as the multiplication of high- and low-frequency components. Different from the previous studies in the literature, this feature enables the construction of a direct linkage between the information coming from the high-frequency data on daily prices and the drivers sampled at lower frequency (monthly in our case) in one single model without the loss of information resulting from aggregation.

Our analysis focuses on the volatility in wheat, maize and soybean prices over the period 1986–2012. A broad list of potential drivers is proposed in order to capture the effect of market fundamentals, common macroeconomic factors, climate and derivative market activity. In the first step, we based our estimations on only realised volatility and we observed that modelling agricultural price volatility as the product of high- and low-frequency components is more efficient than filtering it through a standard GARCH(1,1) model. After combining daily prices for wheat, maize and soybean with monthly drivers over the period 1986–2012, it appears that supply–demand indicators and conventional speculation proxies play an important role in explaining the low-frequency component of volatility, while monetary factors and energy markets play a significant but less important role. In order to address one possible limitation of the model concerning the presence of structural breaks in the unconditional volatility, we test and confirm the presence of a break in coincidence with the recent large price swings. After re-estimating the models taking into consideration a structural break, we observe substantial differences between the full sample and the period following the recent price spikes (2006–2012). When we consider only the period 2006–2012, monetary factors, especially the interest rate, become essential to describe agricultural price fluctuations, also suggesting that the heterogeneity in the effects of the drivers on different crops is decreasing. The activity on the derivative market does not have a crucial role any more. This can be due to the inadequacy of traditional speculation measures in capturing the impact of the non-commercial actors operating through highly sophisticated financial products or simply to the real lack of connection between price volatility and financialisation of the agricultural commodities.

Further reading:

- Donmez, A. and Magrini, E. Agricultural commodity price volatility and its macroeconomic determinants: a GARCH-MIDAS approach. https://ec.europa.eu/jrc/sites/default/files/garchmidas_adem_pubsy_finalversion.pdf

13 Engle, R.F., Ghysels, E. and Sohn, B. (2013). Stock market volatility and macroeconomic fundamentals.
The Review of Economics and Statistics, 95(3): 776–797.

9. Need for integrated assessment: AgriFood2030

Section prepared by Robert M'barek, George Philippidis and Emanuele Ferrari

The preceding chapters have given insights into different areas, from data to baselines and policy analysis, on different spatial and temporary scales.

The bioeconomy, as outlined in Chapter 6, seeks to enable the transition to more resource-responsible production and use of food, fibre and other bio-based products. Such a transition is particularly required for the European agri-food sector, as it faces a number of interlinked challenges in future. Society expects a well-integrated agri-food sector that is based on competitive agricultural and food-processing sectors in the European economy and continues to ensure food security in Europe while also contributing to global food security. However, at the same time, agriculture is increasingly expected to deliver ecosystem services such as maintenance of biodiversity and the cultural landscape or production of renewables beyond food and fibre, while reducing the effect of external environmental factors, respecting animal welfare and contributing to the livelihoods of rural economies.

A scientific analysis of the bioeconomy literature echoes these main objectives/drivers in general [14]:

(1) The main driver discussed is the need to reduce our dependence on fossil fuel resources, as the availability of these resources is uncertain, and it is generally expected to decrease in the near future; even if there are no immediate shortages, the remaining fossil fuel reserves are becoming more difficult to reach. Furthermore, the remaining reserves are often located in geopolitically unstable regions.

(2) There is a need to reduce GHG emissions or our carbon footprint (a need to reduce the negative impacts of the use of fossil fuels).

3) The bioeconomy will create further benefits and boost rural development and stimulate rural economies through increased demand for agricultural or forestry products.

14 Pfau, S.F.; Hagens, J.E.; Dankbaar, B.; Smits, A.J.M. Visions of Sustainability in Bioeconomy Research. Sustainability2014, 6, 1222-1249.

The following drivers named are: (i) secure supply of energy and commodities; (ii) environmental concerns; and (iii) expected economic benefits, as well as increasing demand for commodities, sustainability and food security.

The above list already indicates several conflicts of interest and trade-offs between sectors (e.g. resource competition for food versus material versus energy use), between policies and between regions (e.g. leakage effects). The literature review further points out that land availability and land use competition is described by many as a problem or even the limiting factor for the development of a bioeconomy, and competition with food production is the example most often described[15].

With regard to the issue of policy coherence, the European Commission (EC, 2014) committed itself to an improved biomass policy that would, among other things, allow fair competition between different biomass uses[16].

Developing strategies for the main biomass provider, the agri-food sector, and supporting policies to cope with these challenges, are very dependent on the future context, such as the overall development of the global economy, but also specific aspects that society will focus on.

The AgriFood2030 project, building on initiatives analysing these questions on a global scale such as AgMIP (see chapter 5.3) and the most recent discussions on methodological advances in long-term modelling (see chapter 3.3), draws on a foresight approach for the European agri-food system in which narrative stories describing in a qualitative way coherent future development paths are mapped into quantitative scenarios for (bio)-economic simulation modelling. The specific contribution of the AgriFood2030 project to the global studies is twofold. First, it complements

15 Pfau, S.F.; Hagens, J.E.; Dankbaar, B.; Smits, A.J.M. Visions of Sustainability in Bioeconomy Research. Sustainability2014, 6, 1222-1249.

16 See European Commission COM (2014)15 Final: 'An improved biomass policy will also be necessary to maximise the resource efficient use of biomass in order to deliver robust and verifiable greenhouse gas savings and to allow for fair competition between the various uses of biomass resources in the construction sector, paper and pulp industries and biochemical and energy production. This should also encompass the sustainable use of land, the sustainable management of forests in line with the EU's forest strategy and address indirect land use effects as with biofuels.'

a broader global view provided by these initiatives with a detailed one for Europe, especially with regard to regional detail. Second, it analyses in detail possible sectoral EU policies and initiatives fitting to the narratives.

To provide the necessary sectoral and regional detail, the AgriFood2030 project employs tools from the JRC's iMAP modelling platform, which hosts a set of complementary economic simulation models for the European agri-food sector. In particular, the following models are employed in the AgriFood2030 project, at a later stage and coherently: (1) MAGNET, a Global Trade Analysis Project (GTAP)-based CGE model with modules and modifications geared towards the analysis of food and agriculture; (2) CAPRI, which combines a global multi-commodity model for agriculture and food with non-linear mathematical programming models at farm type scale; and (3) regional CGEs at NUTS 2 level for all EU Member States.

On 26-28 August 2014 in Ljubljana, the 2014 Congress of the European Association of Agricultural Economists (EAAE) took place under the banner 'Agri-Food and Rural Innovations for Healthier Societies'. This congress offered an ideal forum to discuss this work with respected peers in the agricultural economics profession and relevant stakeholders[17].

As a suitable vehicle for showcasing the work, an organised session entitled 'AgriFood2030 – pathways for the European agriculture and food sector towards 2030' was arranged. From a quantitative analytical perspective, the broad outlines and preliminary results were presented, describing different pathways for Europe's agriculture and food sector towards 2030, (i.e. a time horizon in between the established policy framework up to 2020 and the highly uncertain projection periods covering the time span to 2050 or even beyond).

As an introduction to the session, the concept of the AgriFood2030 project was presented, outlining the motivation and relations to initiatives such as AgMIP and the narratives to be analysed. A second presentation focused on key elements of the methodology, especially how narratives are mapped in a consistent way in scenarios for a suite of interlinked economic simulation models. Finally, the last presentation analysed how strategies to avoid food waste at the industry and household level could complement agri-environmental policies to improve efficiency in the agri-food sector while reducing unwanted consequences on food security.

Further reading:

- M'barek, R., Boulanger, P., Britz, W., Fellmann, T., Ferrari, E., Philippidis, G., Van Doorslaer, B., Vinyes, C., Drabik, D., Jansson, T., Leip, A., Salputra, G., Witzke, H.-P. and van Meijl, H. AgriFood2030 – pathways for the European agriculture and food sector towards 2030. Congress of the European Association of Agricultural Economists (EAAE), 26-28 August 2014, Ljubljana, Slovenia. https://www.conftool.pro/eaae2014/index.php?page=browseSessions&abstracts=show&form_session=11&presentations=show

17 https://www.conftool.pro/eaae2014/index.php?page=browseSessions&abstracts=show&form_session=11&presentations=show

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