An integrated model platform for the economic assessment of agricultural policies in the European Union

Eine integrierte Plattform für die modellgestützte ökonomische Analyse von Agrarpolitiken auf europäischer Ebene

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Abstract

A number of economic models have been applied to analyse the Common Agricultural Policy. The partial equilibrium models CAPRI, ESIM, AGLINK, AGMEMOD and CAPSIM and the general equilibrium models GLOBE and GTAP are currently integrated in a modelling platform for Agro-Economic Policy Analysis in the premises of the Joint Research Centre in Seville in close collaboration with Directorate-General for Agriculture and Rural Development. Each of the models included has a specific focus, enlarging the capacity for complex policy analysis within this platform. This can be done by comparing the results of different models or by linking them, where several methodological options are available. This paper gives some insights on current applications in the field of model integration for agricultural policy analysis.

Key words

European Commission; Common Agricultural Policy; economic models; quantitative analysis

Zusammenfassung

Verschiedene ökonomische Modelle werden bei der Analyse der Gemeinsamen Agrarpolitik angewendet. Gegenwärtig werden die partiellen Gleichgewichtsmodelle CAPRI, ESIM, AGLINK, AGMEMOD und CAPSIM sowie die allgemeinen Gleichgewichtsmodelle GLOBE und GTAP in einer Modellplattform für die agrarökonomische Politikanalyse am Joint Research Centre in Sevilla in enger Zusammenarbeit mit dem Generaldirektorat Landwirtschaft und ländliche Entwicklung integriert. Jedes einzelne Modell hat einen spezifischen Schwerpunkt und vergrößert somit die Fähigkeit der Plattform zur Analyse komplexer Politikverhalte. Eine Möglichkeit besteht im Vergleich der Modellergebnisse und eine weitere in der Verknüpfung von unterschiedlichen Modellen, hierbei bestehen verschiedenste Optionen. Dieser Artikel gibt einen Einblick in gegenwärtige Anwendungen von Modellverknüpfung in der agrarpolitischen Analyse.

Schlüsselwörter

Europäische Kommission; Gemeinsame Agrarpolitik; ökonomische Modelle; quantitative Analyse

1. Introduction

Economic models constitute a simplified representation of economic reality, showing the interrelationships between selected economic variables and are used to analyse the impacts of policy changes. Since the 1970s, these models have been widely applied in the analysis of the agricultural sector, with a particular focus on its specific characteristics as provider of food, rural economy and environmental effects. The most common approaches for quantitative assessments of agricultural policy reforms are based on partial equilibrium (PE) and general equilibrium (GE) programming models. The advantage of GE models is that they capture the interaction between the agricultural sector and the non-agricultural sectors of the economy and quite frequently the global integration (VAN TONGEREN et al., 2001). PE models incorporate more details on production and policy instruments then GE models (SALVATICI et al., 2001) but do not comprise a full representation of the economy.

The general structure of PE models comprises technical, accounting and/or behavioural equations which rely on observed data and projections for exogenous factors. Agricultural sector modelling is often based on PE models which only focus on specific agricultural sectors without explicitly treating the interrelationships with other sectors. Although the contribution of agriculture to the economy in terms of Gross Domestic Product (GDP) and employment is declining, there is a growing need for modelling tools able to analyse the recent developments of the Common Agricultural Policy (CAP) and the European Union (EU) enlargement and to provide a well-founded basis for policy decision making. Agro-economic models are able to deliver indicators which can be monitored through replication in both time (e.g. dynamic and comparative-static models) and space (e.g. regional models, farm management models, etc.).

At national level, several countries have some tradition of using agricultural economic models in their national research institutes. For example, the Dutch Agricultural Economics Research Institute has used the GTAP[1] (LIPS, 2004) and AGMEMOD[2] models (VAN LEEUWEN and TABEAU, 2005) to analyse the mid-term review of the 'Agenda 2000 CAP reform'. The German Research Institute for Agriculture uses the RAUMIS[3] model to analyse the effects of the CAP on German agriculture on an ongoing basis (FAL, 2003; FAL, 2004).

Modelling results rely on specific methodologies and fairly strong assumptions, ranging from well-behaved functional forms and specific algorithms for data consistency, to specific price transmission equations, which should be given their full weight in the interpretation and policy analysis. Thus, modelling systems need to be more transparent and accessible to the end users. At European Commission (EC) level, resources for the development of modelling tools and quantitative analysis have continued to be allocated through research programmes and specific contracts. In 2003, a com-

[1] GTAP model web site: https://www.gtap.agecon.purdue.edu/models/default.asp

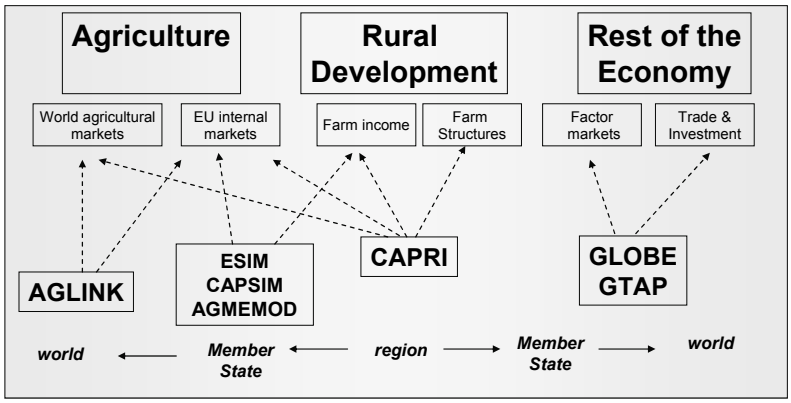
[2] AGMEMOD model web site: http://www.tnet.teagasc.ie/agmemod/themodels2020.htm

[3] RAUMIS model web site: http://www.agp.uni-bonn.de/agpo/rsrch/raumis_e.htm

parative study focusing on the analysis of the initial proposals for the mid-term review of the CAP was prepared by various modelling teams across the EU (EC, 2003). Moreover, the Directorate-General for Agriculture and Rural Development (DG-AGRI) publishes on a yearly basis several outlook reports addressing the most likely developments of agricultural markets, income and rural development indicators in a medium- to long-term horizon (EC, 2007a and 2007b).

The next section gives an overview on integrated agro-economic modelling activities for policy analysis.

Figure 1. Backbone of an agro-economic modelling platform



Source: own illustration

2. Integrated modelling platform for agro-economic policy analysis

2.1 Backbone of an agro-economic modelling platform

'No model can serve all purposes'. With this statement, VAN TONGEREN et al. (2001) give an overview of the most significant models used for agricultural economic analysis and classify them following specific criteria: *scope of representation, regional scope, regional unit of analysis, dynamics, trade representation, treatment of quantitative policies, availability of data and parameter estimation*. Following this methodological classification, a sub-sample of well-established models was selected in order to shape the construction of an Integrated Modelling Platform for Agro-economic Policy Analysis (iMAP) in the premises of the Joint Research Centre in Seville (JRC -IPTS) in close collaboration with DG AGRI (see figure 1). It is interesting to see, that from the models reviewed by VAN TONGEREN et al. (2001) several are still widely used: AGLINK, ESIM, GTAP and WATSIM, the latter currently embedded in CAPRI. The modelling platform covers a broad range of topics, from overall economic analysis to a more focused analysis of the agricultural sector by employing PE and GE models. In the following section the main model features are presented.

2.2 Model Features

The *Common Agricultural Regionalised Impact Analysis model (CAPRI)* is a spatial economic model that makes use of mathematical programming tools to analyse the economic effects of the Common Agricultural Policy and its successive reforms. As such, it simulates an open economy where price interactions between the EU and other regions of the world are taken into account endogenously. The CAPRI supply model mainly follows the economic accounting principles, defined in the Economic Accounts for Agriculture (EUROSTAT) and makes use of conventional mathematical programming tools to maximise regional agricultural income under different constraints (economic, agronomic or biophysical). The demand model consists of a system of equations where trade is modelled based on the Armington assumption of product differentiation.[4] This allows trade flows between the EU and its most relevant trade partners to be represented bilaterally (BRITZ, 2005).[5] CAPRI follows a scenario-driven approach, with three scenarios forming the backbone of this analysis: (a) the baseline or reference scenario, where the model is calibrated with information coming from a trend estimator, other models (AGLINK and ESIM) and expert knowledge; (b) the ex post scenario, where the calibrated model replicates the base year data found in the database; and (c) the policy scenario, where a specific policy shock is simulated. Several studies have been carried out using this approach (BRITZ et al., 2003; PÉREZ DOMÍNGUEZ and WIECK, 2006; EC, 2007a and 2007b).[6]

The *Common Agricultural Policy Simulation Model (CAPSIM)* is a straightforward, partial equilibrium modelling tool with behavioural functions for activity levels, input demand, consumer demand and processing (WITZKE and ZINTL, 2005). CAPSIM was designed for policy-related analysis of the CAP and therefore covers the whole of the European agriculture. Thus, it is in line with the economic principles of the Economic Accounts for Agriculture (EAA), as is CAPRI, with which it shares the CoCo database (CoCo stands for "Complete and Consistent"). CAPSIM entails a high level of dis-aggregation, both in the list of activities/products and in policy coverage.

The *European Simulation Model (ESIM)* is a recursive, dynamic, partial-equilibrium, multi-country model covering agricultural production, consumption of agricultural products, and some first-stage processing activities, with lagged price responses on the supply side. ESIM was initially developed by the Economic Research Service (ERS) of the United States Department of Agriculture (USDA) (JOSLING

[4] Here the WATSIM model was integrated into the CAPRI framework.

[5] Further information on CAPRI is available at: http://www.agp.uni-bonn.de/agpo/rsrch/capri/capri_e.htm.

[6] The CAPRI model was first employed in the European Commission in 2004, in Directorate G (Economics and Evaluation) of DG-AGRI. Since then, various other DGs have shown an interest in becoming more involved. In 2006, CAPRI was introduced at JRC-IPTS and is currently being used to support the annual prospective studies of agricultural markets carried out by DG-AGRI (baseline construction), as well as the analysis of farm structures. In the near future, its scope for analysis is due to be extended to cover greenhouse gas inventories, contribute to the construction of databases for general equilibrium models and allow links to other economic models (energy and general equilibrium models).

et al., 1998). The current version of ESIM, based on GAMS (BANSE et al., 2004) covers 37 products/activities plus voluntary set-aside areas and 29 regions: namely, the individual EU-15 Member States, the New Member States, the candidate for EU accession (Turkey), USA and the rest of the world (BALKHAUSEN and BANSE, 2006). World market prices are endogenous. ESIM makes use of a wide range of policy instruments, including specific and *ad valorem* tariffs, tariff quotas, intervention and threshold prices, export subsidies, product subsidies, direct payments for keeping land in agricultural use, production quotas and both voluntary and compulsory set-aside. The analyses mainly focus on the effects of enlargement to the East and on the impacts of CAP and World Trade Organisation (WTO) reform on agricultural markets and budgetary expenditures. ESIM is one of the models installed in DG-AGRI and used to derive the Agricultural Outlook (EC, 2007a).

The *AGLINK model* is a recursive-dynamic, partial equilibrium, supply-demand model of world agriculture, developed by the Organisation for Economic Co-operation and Development (OECD) Secretariat, in close co-operation with member countries and certain Non-Member Economies (OECD, 2006) as well as with the Food and Agricultural Organisation of the United Nations (FAO). It covers annual supply, demand and prices for the principal agricultural commodities produced, consumed and traded in each of the countries represented in the model. The overall design of the model focuses, in particular, on the potential influence of agricultural and trade policies on agricultural markets in the medium term.

AGMEMOD stands for AGricultural MEmber states MODelling, a dynamic, partial, multi-country, multi-market equilibrium system, which provides salient details on the agricultural sector in each EU Member State (EC, 2007c). On the basis of a common country model template, provided by the GOLD model (WESTHOFF, 2001), country level models adjusted for each country were developed to reflect the specific situation of their agriculture and to be subsequently incorporated into a composite EU model. Projections are generated for each year to a 10-year horizon. As all the policy-relevant agricultural markets are covered, the econometrically modelled country-specific agricultural markets also provide a sound basis for analysing the impacts of policy changes.

The GLOBE Computable General Equilibrium model (MCDONALD et al., 2007) is a variant of a Social Accounting Matrix (SAM)-based General Equilibrium (GE) model (PYATT, 1988) calibrated using data derived from the Global Trade Analysis Project (GTAP) database (DIMARANAN, 2006). The standard GTAP model is a multi-region, multi-sector, computable general equilibrium model, with perfect competition and constant returns to scale (HERTEL, 1997). Bilateral trade is handled via the Armington assumption.

A synthetic table with the main technical characteristics of these models: objectives, basic hypothesis and methodology, product and country coverage, data sources, parameter source is included in the annex (see table 1 and table 2).

3. An integrated modelling approach

Whereas partial equilibrium (PE) models like AGMEMOD, CAPRI, AGLINK, ESIM and CAPSIM focus on a very detailed analysis of the CAP and its successive reforms, GE models like GLOBE and GTAP have a less detailed but comprehensive overview of the whole economy. Within iMAP two types of linking approaches have been followed. First of all, a combined use of PE models (one-to-many relationships) and, secondly, a combined use of PE models and GE models (one-to-one relationships).

The *first type of linking approach* concentrates on calibration procedures amongst PE models. From a methodological perspective, we have identified two possibilities of linking models here: (i) by means of econometrically estimated response functions (PÉREZ DOMÍNGUEZ et al., 2008) and (ii) by means of modifying the output of a PE model such as to fit the combined output of other PE models. These approaches have been applied for linking PE models at different levels: (a) linking a technological model to a specific module of an aggregated economic model (e.g. specific representation of dairy or biofuel technologies with an agricultural sector model), (b) linking economic models working at different spatial dimensions (e.g. breakdown of regional results at farming system level), or (c) linking economic models to econometric projections for a different time framework (e.g. long term analysis of greenhouse gas emissions from agriculture). By doing this, additional expert knowledge enters the analysis and increases the performance of a stand-alone model, without forcing the development of a 'one-fits-all model'. Nevertheless, within this type of framework, it is important to be methodologically consistent, so that similar scenario analysis, model variables and parameters are interconnected.

An example of this approach has been followed for the estimation of *regional agricultural market and income indicators* by the CAPRI, ESIM and AGLINK models (see EC, 2007a: 45) in a joint modelling effort within the European Commission. Within this study, the regional developments of the main agricultural markets between 2002 and 2013 (i.e. cereals, oilseeds, dairy and beef) were calibrated[7] in the CAPRI model to the combined projections at Member State level of ESIM for crop activities and AGLINK for animal activities. The main value added, from ESIM and AGLINK, was to incorporate expert knowledge to the study, based on regular surveys[8] and subject to a validation process by market experts at DG-AGRI. In this process ESIM concentrates on crop activities by Member State, whereas AGLINK has a complete coverage of the main agricultural activities on the aggregate level and, thus, serves as the reference for the animal activities. The main value added, from CAPRI, was to perform the breakdown of these results to the regional level and combine them with internal projections on agricultural labour use (MCINERNEY and GARWAY, 2004).

The *second type of linking approach* implies the use of calibration techniques from a more aggregated perspective for connecting GE and PE models. There are two possibilities: (i) firstly, a GE model can be recalibrated at the sectoral level such as to reproduce the output of a PE model

[7] Linear trend estimation subject to constraints (BRITZ, 2005).

[8] ESIM incorporates information from FAPRI surveys.

Table 1. Main characteristics of the CAPRI, CAPSIM and ESIM models

CRITERIA	CAPRI	CAPSIM	ESIM
Acronym	**C**ommon **A**gricultural **P**olicy **R**egional **I**mpact	**C**ommon **A**gricultural **P**olicy **SIM**ulation	**E**uropean **SIM**ulation **M**odel
Model Description	Partial Equilibrium; Comparative Static; Armington Spatial Model; Calibration/ Microeconomic Framework with Technological Relationships; Functional forms flexible and well behaved; Deterministic	Partial Equilibrium; Comparative Static; Net Trade Model; Calibration/Microeconomic Framework with Technological Relationships; Deterministic	Recursive Dynamic Partial Equilibrium Multi-Country Model; Calibrated Iso-elastic Behavioural Functions; Logistic Price Equations; Theoretical Consistency Guaranteed through Homogeneity, Symmetry, and Strict Quasi Convexity/ Concavity
Sub-models	Young Animal Trade Module, Fodder Module, GHG Emission Module	---	---
Input to other Models	With CAPSIM; (share similar database→ resource efficient); With FAOSTAT (database for the market model)	*To CAPRI:* CoCo database	Potential With AGMEMOD for data on Balkan Countries
Input from other Models	ESIM, AGLINK (baseline construction)	*From CAPRI:* Baseline calculation	FAPRI (development of non-European markets)
Links to other Models	DNDC (nitrogen fluxes), GTAP (factor markets), Energy Models (feedstock demand), EDIM (milk quota rent functions)		
Supply Side	Flexible Profit Function/Exogenous Yields/Technological Constraints; Feed Livestock Specification (nutrient balance consistency, theoretical consistency, feed items related to particular animal activities)	Flexible Profit Function/Exogenous Yields/Technological Constraints; Feed Livestock Specification (nutrient balance consistency, theoretical consistency, feed items related to particular animal activities)	Constant Elasticity Modelled Through Lagged Price Responses or Price Expectations; Function of Own and Cross Prices, and Technical Progress
Demand Side	Generalised Leontief	LES or Generalised Leontief	Constant Elasticity; Includes Human Demand, Seed Demand, Processing Demand and Feed Demand; Function of Own and Cross Consumer Prices, Income and Population
Market Clearing	Bilateral Trade Regime (import tariffs and tariff rate quotas can be bilateral) through "Adjusted WTO Limits"	Net Trade Regime Through "Adjusted WTO Limits"	Net Trade Regime
Welfare Measures	Producers, Consumers, Processing Industry, EU Budget	Producers, Consumers, Processing/ Industry and EU Budget	
Forecasts	Through Baseline Mode, inclusion of Expert Information on market developments	Through Reference Run Mode Allows the Possibility to Include Expert Information	Projections Are Made in an Ad Hoc Way Through Shifters (income, population and technology) for the Period 2003-2020
General Product List	Large Disaggregation: ca. 40 marketable agricultural products; 10 non-marketable agricultural products ; 21 processed products;	Large Disaggregation for Dairy; 13 Crops, 8 Animal Products, 12 Processed Products (among which 9 are dairy products), 5 Inputs	Large Disaggregation for Crops; 15 Crops, 6 Animal Products, 12 Processed Products (among which 5 are dairy products), 6 Inputs and Other Products
Regional Coverage	EU-25, Bulgaria, Romania, 7 Western Balkans, and ca. 30 world trade countries/ country aggregates	EU-27 Countries, Croatia, FYROM, (add. Serbia, Kosovo, Montenegro, Bosnia, and Albania) and potentially Turkey	EU-15 Members, EU-10 Members, Bulgaria, Romania, Turkey and the US; Remaining Countries Are Modelled as Rest of the World (potential for expansion to Western Balkans)
Major Policy Instruments	Premiums/activities; Set Aside (obligatory and voluntary); Intervention Prices; Quotas (milk, sugar); Border Measures; WTO Limits; Import tariffs, TRQs; Decoupling (on arable and grassland for hybrid decoupling systems)	Premiums/Activities; Set Aside (obligatory and voluntary); Intervention Prices; Quotas (milk, sugar); Border Measures (tariffs, flexible leavies, export refund, and; WTO limits); Decoupling (As Uniform to All Eligible Land)	Specific and Ad valorem Tariffs, Tariff Rate Quotas, Intervention and Threshold prices, Export Subsidies, Product Subsidies, Direct Payment for Keeping Land in Agricultural Use, Production Quotas, Voluntary and Obligatory Set-Aside
Model Output	Market Balances; Agricultural Production/Income; Processing Industry Income; Consumer Welfare; FEOGA Impacts (Welfare Change); Labour input, per activity; Nitrogen-based Environmental Indicators (GHGs, Ammonia)	Market Balances, Agricultural Production and Income, Changes in Processing Industry Income, Consumer Welfare and European Agricultural Guarantee and Guidance Fund Impacts, Simplified Environmental Indicators	Domestic and World Prices, Production, Consumption, International trade
Data	EUROSTAT Newcronos; FAOSTAT; Other sources	EUROSTAT NewCronos; National Statistical Offices, Agricultural Ministries, FAO, Calculation and Residual Data	DG AGRI, EUROSTAT, FAO, AGRIS, and National Statistical Sources
Exogenous variables and parameters	Macroeconomic variables (GDP growth, inflation rates, population growth); European policy variables	Agricultural Activity Levels, Market Balances, Market Prices, Income, FEOGA Expenditure, Shifters of Behavioural functions (Reference Run Mode), Labour (no feedback into model)	Technical Progress, Population Growth, Income Growth, Inflation, Exchange rates, Administered Pricing Regimes, Quantitative Controls on Production, Trade Barriers

Source: own presentation

Table 2. Main characteristics of the AGMEMOD, GLOBE and AGLINK models

CRITERIA	AGMEMOD	GLOBE	AGLINK
Acronym	**AG**ricultural **ME**mber States **MOD**elling	-	-
Model Description	Econometric; Partial Equilibrium; Dynamic, Recursive; Multi-country, multi-commodity; Estimation/Calibration/ Microeconomic Framework with Technological Relationships; Deterministic	Comparative static, deterministic, multi-country, multi-sector, SAM-based General Equilibrium Model	Dynamic partial equilibrium, Policy specific model: Collaborative approach
Sub- models	National Models	Variants for specific cases; e.g. GLOBE_EN	Standalone country models; COSIMO (Commodity Simulation Model) of the FAO for non-OECD countries
Model Synergies	FAPRI modelling system (projections of the macro data, world market prices); Future - AGLINK is interested in using the AGMEMOD output		AGLINK is calibrated on forecast derived by member countries, partially based on other models in the case of the EU ESIM
Supply Side	OMS/NMS – econometrically estimated parameters/calibration, Theoretical consistency; Biological constraints are regarded	CES/Leontief technology nest, profit maximizing factor demand	Econometrically estimated parameters/calibration; Elasticities are also derived from literature
Demand Side	OMS/NMS - SUR/calibration	Linear expenditure system	Econometrically estimated parameters/ calibration; Elasticities are also derived from literature
Market Clearing	Net trade	Armington approach to imports, CES transformation between domestic production and exports, bilateral trade between all regions and products	Generally net trade; in the case of reduced tradability by regions; Import / export relationship is derived from the calibration
Welfare Measures		Equivalent variation; indirect compensation by consumption	Not directly derived
Forecasts	Econometric estimates, calibration based on the National Expert knowledge	–	Coefficients derived on past data as well as calibration based on country experts
General Product List	Extensive coverage of detailed products; Sub-models are inter-linked	57 product categories (incl. 12 agricultural and 8 food categories)	7 product categories including about 30 single products; separate modelling of Ethanol and Bio-diesel (2008 version)
Regional Coverage	Individual EU27countries, aggregates EU25, EU27, EU15, EU10	The world is represented by 87 regions, including all individual EU Member States	39 countries plus regional aggregates (EU is modelled as EU27 with disaggregation into EU15 and EU12)
Major Policy Instruments	Intervention prices; Subsidies on products including grants for crops and headage premiums; Subsidies on production , including for land set/aside and for cattle premiums; Quantitative restrictions, including quotas for milk and for numbers of animals eligible for headage payments; SFP; SAPS; Subsidised export limits and TRQ evels	Policies are normally represented as price wedges at different stages, e.g. tariffs, tax rates	Policies are modelled for all major countries based on the collaboration between the OECD and the specific member state; in the case of the EU a detailed representation of the CAP is included: milk quota, area payments, decoupling rates; set aside; head payments; export refunds; tariffs etc.
Model Output	Market Balances; Ag. Production/Income	Balanced SAMs, comparison to base situation for all included variables; several macro-economic indicators and welfare measures	Annual market balances and prices
Data	Eurostat complemented by the National Sources; Internationally consistent, and coherent database	SAMs derived from GTAP 6.0 database	Data base provided by the member countries and in case of COSIMO mainly FAOSTAT data
Exogenous variables and parameters	Macroeconomic variables, Policy variables, World prices (EU price taker), Key prices (in national models)	Closure settings fix variables to allow for a balanced system of equations and variables	Macroeconomic variables and policy variables

Source: own presentation

for a specific scenario[9], and (ii) secondly, the PE model database can be restructured such as to fit the data structure of a GE model. The latter option has been selected within the iMAP model chain. It takes place within a so-called "SAM framework"[10], a common denominator for data structuring in GE models providing a complete characterisation of current account transactions of an economy as a circular (flow) system. In the context of a global SAM, the com-

[9] This is a fairly straightforward approach and has been selected within different modelling projects in Europe, such as Scenar2020 (EC, 2006), where the LEITAP model is calibrated to the output from ESIM and CAPRI, and SEAMLESS (http://www.seamless-ip.org), where GTAP should be calibrated to the output from CAPRI.

[10] A SAM is a transactions matrix; hence, each cell in a SAM simply records the values of the transactions between the two agents identified by the row and column accounts. The selling agents are identified by the rows, i.e., the row entries record the incomes received by the identified agent, while the purchasing agents are identified by the columns, i.e., the column entries record the expenditures made by agents.

plete and consistent conditions need to be extended to include transactions between regions; requiring that each import transaction by a region must have an identical counterpart export transaction by another region (MCDONALD et al., 2007).

PE models for agriculture are characterised for a quite good coverage of multi-input multi-output relationships in quantity and value terms. Within this linking approach, this information is reused in order to expand and re-balance the input-output and production sub-matrices embedded in a typical SAM.[11] A GE model, based on this information, would solve a policy simulation experiment in that the column totals, in the SAMs, equal the corresponding row totals. This implies that if a change is introduced in one sector of the economy, other sectors (the PE newly introduced sectors amongst them) would have to react in order to re-establish the general equilibrium.

An example of this approach has been followed for the analysis of an increased demand for biofuels in Europe (GAY et al., 2008). The SAMs, used by the GE model GLOBE, had been extended by an additional bio-diesel sector. The data used in the process have been market balances for vegetable oils and information on bio-diesel production. The former have been collected from Oilworld[12] which uses a PE approach to derive market clearing balances for oilseeds, oils and oilmeals. A similar approach on a broader base is currently applied to derive SAMs for the EU Member States with a disaggregated agricultural sector (MÜLLER and PÉREZ DOMÍNGUEZ, 2008). In this process, market balances for agricultural products derived with CAPRI are incorporated into compiled SAMs based on Eurostat data (European system of accounts, ESA) with one single agricultural sector. The data derived from CAPRI and its database CoCo is used as a prior for the disaggregation of the agricultural sector into 30 sub-sectors. As the data in CoCo/CAPRI is not in a SAM format, additional data work is required to balance the final SAM. The resulting product allows analysing the EU agricultural sector, its implication for factor markets and linkages to other sectors in detail. The importance of the linkages, between the agricultural sector and other sectors, has risen in recent times especially with regard to the energy sector.

4. Critical assessment from a user's perspective

When moving from basic methodological research to applied policy economics, the need for a robust analytical tool cannot be over-stressed. Firstly, stand-alone models have to be well documented, so that a high degree of transparency is ensured. Secondly, harmonised and public databases have to be used whenever possible, since traceability of data is one of the main obstacles in this discipline. Thirdly, graphic user interfaces should be available, to allow the proper utilization of models by different types of users. And last but not least, the sensitivity of the models to different policy alternatives has to be tested and understood, thereby increasing users' confidence in the modelling system itself.

Having access to different modelling approaches enables agricultural economists to support policy makers with a tailor-made analysis. It also makes it possible to compare the results of the different models in order to substantiate the findings. In this process, comparison provides feedback on the different models which can be used for the benefit of their future development. Additionally, it is important to highlight the fact that policymakers need quantitative tools that are adapted to their daily work. This is why close links with the current policy agenda should be maintained (e.g. short- to medium-term analysis). Modelling systems should be adaptable enough to include policy issues currently under discussion, for example, the subsidisation of bioenergy crops, prevention of nitrate leaching, reform of sensitive common market organisations or the liberalisation of trade in agricultural commodities.

The main strength of iMAP is its "restricted" interdisciplinarity, "restricted" in the sense that the focus is placed on the economic analysis of the European agricultural policy.[13] The increasing complexity of analysing the successive reforms of the CAP, however, requires the use of quantitative tools in a more integrated way, which is the aim of this modelling platform.[14] The second strength relates to its individual components, relying on well-known economic models with a long record of applications in the research and policy-making fields. Additionally, the methodological consistency of the approaches selected for model linking has to be mentioned as a third strength, all subject to scientific external review. Last but not least, the structure of this modelling platform is flexible, in the sense that it allows combining different quantitative tools, after going through certain validation filters, and can be maintained and updated through collaboration with the model core developers.

It is, however, necessary to mention here several challenges for iMAP. Firstly, the main drawback of any integrated model chain lies in the model links themselves, i.e. how well information is transmitted from one model to the other. This issue has not yet been well covered in the literature and remains the main point of criticism. Secondly, from a methodological perspective we can differentiate between "hard" and "soft" model links (see PÉREZ DOMÍNGUEZ et al., 2008: 12, for a typical example). Here, no clear distinction has been made up to now. On the one side, "hard" linking implies the quasi-integration of two model components in one tool, which might hamper the transparency of the analysis and the computing. On the other side, "soft" linking might weaken the overall performance of the model chain (see first caveat). An additional drawback relates to

[11] This approach is documented in MÜLLER and PÉREZ DOMÍNGUEZ (2008).

[12] For further details about Oilworld, please refer to http://www.oilworld.biz.

[13] In the SEAMLESS (http://www.seamless-ip.org) and SENSOR (http://www.sensor-ip.org) model families, interdisciplinarity is widened out, so that, for example, biophysical models or non-agricultural sector models are considered.

[14] On the one hand, PE models capture, in detail, links between agricultural production activities and allow, based on the differentiated lists of production activities, inputs and outputs to define environmental effects of agriculture in response to changes in the policy or market environment. On the other hand, GE models are able to overcome the limitations of PE models on the domestic availability of factors and international relationships.

the scientific validity of the economic models selected. Sensitivity analysis is very important in this area, in order to see how much model results depend on exogenous assumptions or how reactive they are to changes in policy variables.[15] In this sense the iMAP modelling platform shall contribute to make models and databases publicly available, thus increasing transparency and facilitating their scientific review. Close links to the different modelling teams should enhance synergies and allow maintenance and further developing of these quantitative tools.

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The views expressed are purely those of the authors and may not in any circumstances be regarded as stating an official position of the European Commission.

[15] It is important to say that the performance of validity tests in economic models has been difficult due to their large non-linearities and important computing time. This might improve with the use of grid-solving algorithms (already available for GAMS models) or work within grid networks.

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