

# How to deal with the challenges of linking a large number of individual national models: the case of the AGMEMOD Partnership

## Welches sind die Herausforderungen bei der Verknüpfung einer großen Anzahl von nationalen Modellen: Das Beispiel der AGMEMOD Partnerschaft

Petra Salamon; Johann Heinrich von Thünen-Institut (vTI), Braunschweig, Germany

Frédéric Chantreuil; INRA, Rennes, France

Trevor Donnellan; Rural Economy Research Centre Teagasc, Ireland

Emil Erjavec; University of Ljubljana (LJUB) Domzale, Slovenia

Roberto Esposti; Università Politecnica delle Marche, Ancona (UNIVPM), Italy

Kevin Hanrahan; Rural Economy Research Centre Teagasc, Ireland

Myrna van Leeuwen, Foppe Bouma and Wietse Dol; LEI, The Hague, Netherlands

Guna Salputra; Latvian State Institute of Agrarian Economics (LSIAE) Riga, Latvia

### Abstract

The AGMEMOD Partnership seeks to capture the inherent existing heterogeneity of agricultural systems by linking together individual EU Member State models, an aggregated EU model and several accession countries into one single model, while still maintaining analytical consistency. Although this approach facilitates the comparison of the impact of a policy change across different Member States, it generates challenges in practical implementation, ranging from significant communication and administration requirements, to aggregation and consistency issues. This contribution provides insights into the different challenges posed to the scientists and discusses the key issues for maintenance and further development of such a complex system. Specific attention is paid to technical devices and tools as well as to the design of institutional settings to achieve consistency.

### Key words

linking models; policy analysis; partial equilibrium modelling; Common Agricultural Policy (CAP)

### Zusammenfassung

Ziel der AGMEMOD Partnerschaft ist es, die Heterogenität der europäischen Landwirtschaft über die Verknüpfung der individuellen Ländermodelle für die verschiedenen EU-Mitgliedsstaaten in einem kombinierten EU-Modell abzubilden. Dieser Ansatz erlaubt einen Vergleich der Auswirkungen von Politikmaßnahmen zwischen EU-Ländern, bringt aber gleichzeitig eine Reihe von Herausforderungen in der praktischen Umsetzung mit sich. Diese reichen vom hohen Kommunikation- und Managementbedarf bis zu Fragen der Aggregation und Konsistenz. Der Beitrag erlaubt Einblicke und diskutiert auch Schlüsselfragen der Erhaltung und Weiterentwicklung eines komplexen Modellsystems, wobei auch technische Möglichkeiten und die Ausgestaltung der institutionellen Rahmenbedingungen berücksichtigt werden.

### Schlüsselwörter

Modellverknüpfung; Politikanalyse; partielles Gleichgewichtsmodell; Gemeinsame Agrarpolitik (GAP)

### 1. Introduction

Applying a bottom-up approach, the integrated AGMEMOD<sup>1</sup> model links national partial equilibrium (PE) models for each Member State (MS), possible Accession countries, and important neighbouring countries into a combined model. This model is aimed at capturing the heterogeneity of European agriculture across EU Member States (MS), while enabling, at the same time, simulations of the Common Agricultural Policy (CAP) and national agricultural policies in a consistent and harmonised way for the whole EU. In the process multidisciplinary teams in each of these countries were involved in building and verifying their own country models which were established on agreed rules for data, model design and underlying assumptions. Based on this concept, projections for each commodity, in each year out to a ten year time horizon, for each country, and for the EU are conducted which, in turn, are serving also as counterfactual baselines for an impact analysis of policy changes (BARTOVA und M'BAREK, 2008).

However, in the course of establishing the modelling system, the geographical scope and in turn the policies applied have made extensions of the AGMEMOD modelling systems inevitable. The original AGMEMOD Project (Project No. QLRT-2001-02853) involved institutes in all MS of the EU-15 group, except Luxembourg.<sup>2</sup> In advance of the EU

<sup>1</sup> AGMEMOD stands for "Agri-food projections for the EU member states". AGMEMOD has been funded under the European Commission 5<sup>th</sup> and 6<sup>th</sup> Framework Programme (FP6), by contributions from the partners' institutes throughout the EU and through associated projects for the Institute for Prospective and Technological Studies (IPTS), part of the European Commission's Joint Research Centre.

<sup>2</sup> The Swedish Institute for Food and Agriculture was an original member of the AGMEMOD Partnership, but left the project in 2004. As no replacing institution in Sweden could be

enlargements in 2004 and 2007, the AGMEMOD Partnership was expanded in 2002 to include research institutes from all new EU MS, except for Cyprus and Malta. In addition, the Partnership is in the process of being extended to cover also Russia, Ukraine, Croatia, Macedonia and Turkey.

This growth in regional coverage added by increased product coverage and required policy instruments has raised new or intensified existing challenges in different areas which can be grouped into the categories of communication and management, technical handling, and the methodological issues. In the area of communication and management, due to the increased number of institutions involved, the communication between the groups intensified, and the meetings themselves took on the appearance of seminars rather than meetings. Institutions involved comprise universities as well as governmental research institutes with diverging research interests. Provision of motivation to the varying national teams was required, ensuring that their property rights were respected and, in particular raising sufficient funds to support such a large group. Another important issue was to align the time schedules for conducting short-term policy impact analysis on the one hand and longer term research projects on the other hand, and distributing responsibility across the different national teams involved. In the area of technological and methodological handling, the ultimate goal has been to solve the integrated individual models in a combined version and this provides challenges for the harmonisation and consistency of data, mnemonics and the definition of variables and policy implementation. The reviewing of the MS models and their projected outcomes, internally and externally, under various scenarios became an important issue for the AGMEMOD Partnership as it was necessary to ensure individual countries' interests. A further issue was the technical combination of country models into an model which could be solved for the EU.

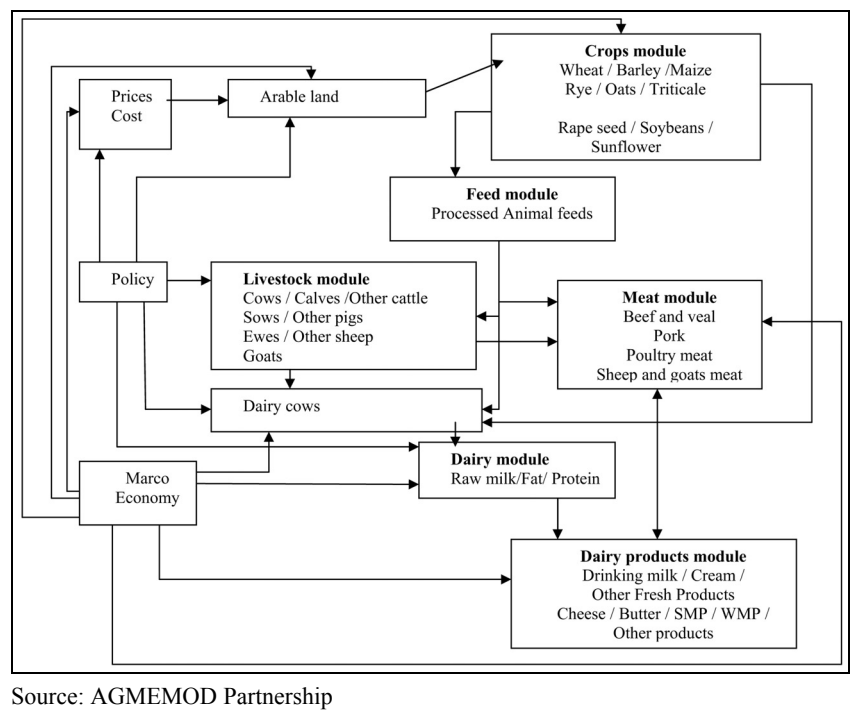
To overcome, or at least to address, these challenges meant that new milestones had to be set, in addition to the research interests in the ongoing projects of the Partnership. The following text provides some insights into how these objectives were at least partly achieved. The text is structured to give a short introduction into the projection and simulation AGMEMOD tool. Then the institutional, technological, and methodological issues are considered. In the end some general conclusions are drawn from the experiences in linking individual country models.

## 2. Principle modelling approach

The AGMEMOD model is an econometric, dynamic, multi-product partial equilibrium (PE) model. Based on a set of

found, the French partner INRA has inherited the task of managing the Swedish model, so far.

**Figure 1. Linkages between sub-models in the AGMEMOD national country models**



commodity specific model templates, country specific models have been developed to reflect the details of agriculture at MS level, and at the same time to allow for their combination in an EU model. The various domestic commodity markets are linked together by substitution or complementary parameters on the supply or demand side. The basic linkages covered in the model are represented in figure 1. Interactions between the crops and livestock sub-models are captured via the derived demand for calves and feed. The supply and utilisation balance is ensured via a closure variable. The choice of the balance closure variable may differ between one commodity sub-model and another and between one country and another. In general, sub-models capture production, imports, exports, human and feed consumption, stocks and price relationships. These sub-models also cover a detailed set of agricultural policy instruments in each MS.

To complete the building of the AGMEMOD sub-models' tool for each of the commodities, it is necessary to add an equation that describes the equilibrium for each commodity market at the EU level. This condition implies that production plus beginning stocks plus imports, will be equal to domestic use plus ending stocks plus exports, which, in a closed economy, is sufficient to determine the equilibrium country market prices endogenously. Given that the EU does not represent a closed economy, the Rest of the World can have important impacts on the economy modelled. To account for such impacts, price linkage equations are used, to represent the inter-relationship between EU MS, and between the EU and the Rest of the World.

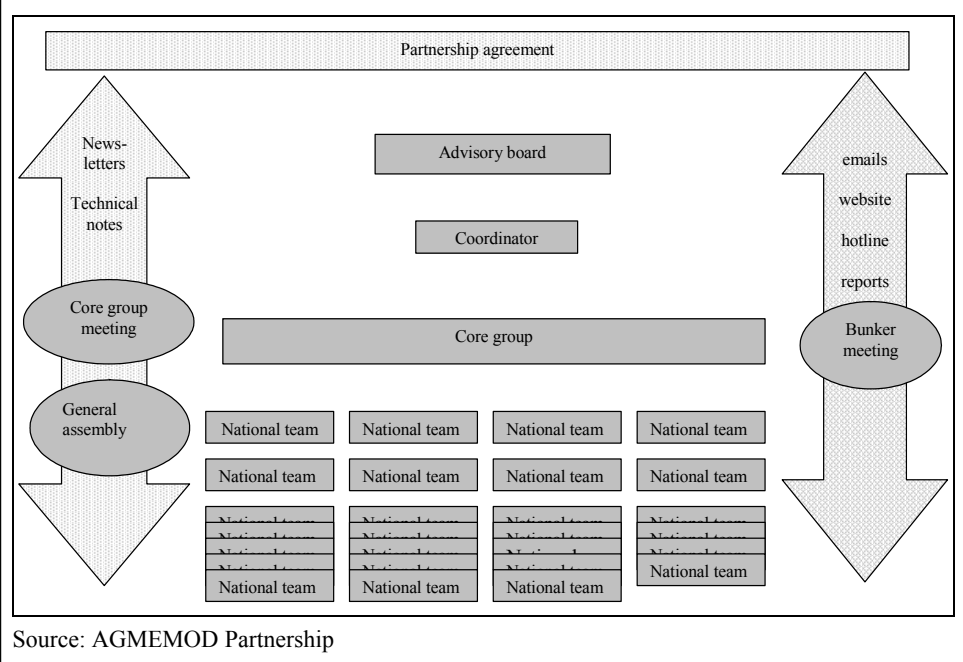
For each commodity market and for each country, the functional representation that is actually used in the model can vary. These deviations from the template are due to the requirement that the country level model should capture distinct market features at MS level. Where data limitations exist, the final functional forms are adjusted in response to

the statistical and economic validation of the models. It should be noted that all the country models are under continuous revision. More details concerning the AGMEMOD modelling can be found in CHANTREUIL et al. (2005a), CHANTREUIL et al. (2005b), CHANTREUIL et al. (2008), ERJAVEC et al. (2006), ESPOSTI and LOBIANCO (2005), IVANOVA et al. (2007), RIORDAN (2004), VAN LEEUWEN and TABEAU (2005).

### 3. Institutional challenges

Originally coordinated by the Teagasc Research Institute in Ireland, the AGMEMOD Partnership comprised university institutes, governmental agencies with expertises ranging from econometrics, model building via market analysis to impact analysis, overall displaying quite a range of focus in their respective research activities.<sup>3</sup> The extension to the Partnership in 2002 was to gain knowledge and expertise concerning the accession countries.<sup>4</sup> Although this broad scope of knowledge served as an advantage in general, it also provided some disadvantages when it came to special tasks such as the evaluation of modelling results for a great variety of agricultural commodities. In intervals of about 6 months, the AGMEMOD Partnership regularly met in General Assemblies (GA) to discuss the progress of work, achievement of milestones and potential problems, with the original work based on templates deriving from the FAPRI GOLD-model. To support the coordinator the teams functioning as work package leaders formed a Core Group (CG) preparing detailed schedules for the actual forthcoming tasks of the work packages. Additionally, an AGMEMOD

**Figure 2. Institutional set-up of the AGMEMOD Partnership**



Consortium Agreement was set-up to govern rights and obligations among the participating groups.

Based on those experiences, the organisation of the AGMEMOD Partnership<sup>5</sup> was amended at the start of the FP6 project.<sup>6</sup> The number of GAs was reduced and emphasis shifted from more general issues to the discussion of country modelling structures and results. In between each GA one or more meetings of the CG take place, to discuss urgent scientific questions, and also to prepare the next GA. In addition to the work-packages, the CG focuses on the various commodities represented in the AGMEMOD model, modelling approaches, shortcomings and possible improvements, but it also looks at technical and project management issues (see figure 2). As a further element, so-called bunker meetings have been established. They serve as pure business meetings, during which, subgroups of the AGMEMOD Partnership work on distinct modelling problems to be handled by an intensive joint working effort, typically over the period of one week. To enlarge the available expertise on which the AGMEMOD Partnership can draw, an advisory board was established, to which important institutions or supporting scientists are assigned.

Short-term impact analysis for the Institute for Prospective Technological Studies (IPTS) led to a further gradual reshaping of the Partnership's organisation. While the coordination for the current FP6 project is being provided by INRA, the task of managing short to medium-term projects within the Partnership became the responsibility of LEI

<sup>3</sup> The original institutions involved have been Teagasc, Ireland; Institut fuer Wirtschaft, Politik und Recht, Austria; Catholic University of Louvain, Belgium; Danish Institute of Agricultural and Fisheries Economics, Denmark; MTT Food Research Finland; Institut National de la Recherche Agronomique, France; Bundesforschungsanstalt fuer Landwirtschaft, Germany; University of Athens, Greece; Università degli Studi di Ancona, Italy; Universidade Nova De Lisboa, Portugal; Agricultural Economics Research Institute, the Netherlands; Agrofood Research Service, Spain; Agricultural and Food Economics Department at Queen's University of Belfast, United Kingdom, some of the institutions have changed name and/or structure in between.

<sup>4</sup> Institute of Agricultural Economics, Bulgaria; Research Institute of Agricultural Economics, Czech Republic; Department of Economy, Estonian Research Institute of Agriculture, Estonia; Budapest University of Economic Sciences and Public Administration, Hungary; Latvian State Institute of Agrarian Economics, Latvia; Warsaw School of Economics, Poland; Institute of Agricultural Economics, Romania; Slovak Agricultural University, Slovakia; University of Ljubljana, Slovenia.

<sup>5</sup> The AGMEMOD Partnership was again enlarged by additional partners respective subcontractors Lithuanian Institute of Agrarian Economics (LAEI) Vilnius, Lithuania; Ss. Cyril and Methodius University (Subcontractor of LJUB), Macedonia; University of Zagreb (Subcontractor of LJUB), Croatia; Analytical Centre AGRI-FOOD ECONOMICS (AFE) (Subcontractor of LSAIE), Russia; Institute for Agribusiness & Rural Development (IARD) (subcontractor of LSAIE), Ukraine.

<sup>6</sup> 'Agricultural Member States Modelling for the EU and Eastern European Countries (AGMEMOD 2020)'

who also bear the burden of combining the country models (AGMEMOD PARTNERSHIP with BARTOVA und M'BAREK, 2008a; AGMEMOD PARTNERSHIP with BARTOVA und M'BAREK, 2008b; AGMEMOD PARTNERSHIP with BARTOVA und M'BAREK, 2008c; AGMEMOD PARTNERSHIP, 2008d; BARTOVA and M'BAREK, 2008). While these short term projects were being undertaken it became obvious that a communication bottleneck had emerged among the AGMEMOD partners. Therefore several measures were taken to counteract any delays in the communication and implementation process:

- Templates for all commodity modules represented in the model were provided by the Core Group including an example of the actual modelling undertaken in one country;
- At short, but irregular intervals, model up-dates were provided on the Partnership website;
- Other communication tools comprise a regular newsletter – to keep partners fully informed of on-going activities, deadlines, problems and solutions –, technical reports, a hotline to support partners in case of technical modelling problems, as well as conventional email exchange;
- Country models and their outcome are periodically evaluated internally and externally, and results are communicated;
- Short-term projects are conducted by subgroups to accelerate the generation of outcomes.

#### 4. Technical challenges

In the initial stages, the Partnership decided to replace the existing EXCEL country models with GAMS models to overcome PC memory problems at that time. Model revisions, an integral part of the model review and evaluation process, led to the need to constantly disassemble and recombine country models, with all associated problems and difficulties. In the process, guidelines on desired model-building practices were formulated and later have been integrated into a tool to be used by project partners:

- Models should be reproducible to meet scientific standards;
- Other researchers should also be able to handle the models;
- Models are required to be flexible to meet the needs of different projects;
- Models should be reviewed by experts in order to enhance their overall quality; and
- Models should be easily amended and connected to other models.

Over time, the model system was integrated into GSE, a professional user interface, which makes GAMS models more accessible and gives greater insight into the relationship between input and output, provides an integrated version control tool, as well as a scenario analyser to compare, print and depict model input and outcomes. There was no requirement to rebuild the AGMEMOD model from scratch as the EU-15 MS models had already been available in GAMS code (GAMS-IDE), however, a step-wise restructuring of the technical program code was inevitable. Having been converted into GAMS tree (Gtree) which can be considered an alternative to GAMS-IDE (DOL, 2006), this model version was then prepared for a user-friendly GSE

tool. Ultimately, this version was restructured to overcome such issues as computer memory constraints caused by about 60,000 product-activity combinations per country and year, solving simultaneously all years and all countries, diverging start year for projections between country models due to data availability and inappropriate or inconsistent use of GAMS across country models

To reduce computer memory requirements product and activity sets, during processing endogenous variables were combined into one, which are merged or separated into or from one set by a transfer-tool called *Agmmod2gams* (figure 3), accompanied by intensive consistency checks on data. At present not only the data, but also model equations are converted from EXCEL or even directly from the econometric estimation into GAMS code overcoming deficiencies in the former GAMS code as controls have been established e.g. on:

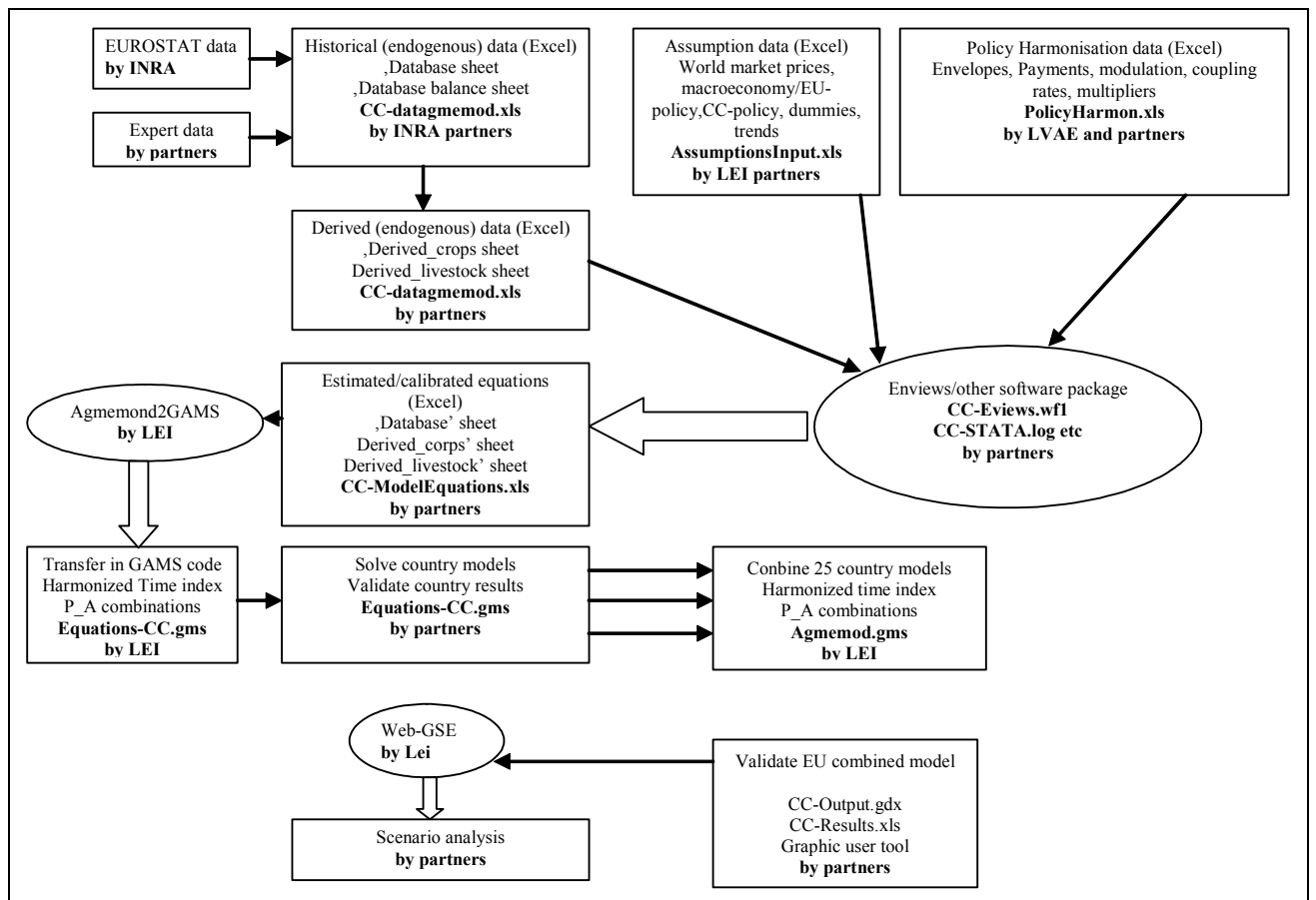
- The existence of a full set of equations per country;
- The declaration of variables as being both exogenous and endogenous;
- The availability of equations to represent a country's declared endogenous variables;
- The accidental usage of equations to represent variable otherwise declared exogenous;

At present, mnemonics can be easily changed or added. Additionally, the *Agmmod2Gams* application facilitates model understanding for new team members as well as for external users.

#### 5. Data and aggregation challenges

Data requirements for the AGMEMOD modelling approach are generally high, as time series for the parameter estimation purpose are requested to cover not only the supply side of agriculture but also different types of usages as well as processing. Each country model is based on an aligned database of annual time series, covering, in principle, a period from 1973 to the latest available year, which, depending, ranges from 2002 up to 2006. The AGMEMOD model's database is composed in part of balance sheets for all commodities, generally detailing opening stocks, production, imports, human food consumption, feed use, processing and industrial use, exports, and ending stocks, at the level of primary agricultural commodities and, often, also their first processing level (CHANTREUIL and LEVERT, 2007). Where possible the AGMEMOD Partnership uses Eurostat sources such as *AgrIS* (Agricultural Information System) and *NewCronos*. An additional dataset captures the evolution of CAP policy instruments, like direct payment instruments and support. Another dataset covers macroeconomic variables like population, inflation, per capita economic growth, and currency exchange rates with their exogenous projections mostly obtained from the national statistical services in the MS or internationally recognised macroeconomic forecasters. Values for the world market price projections are obtained from the *FAPRI* modelling system. However, several issues are associated with this data:

Although, ideally, all data would be drawn from the same database, in practice, however, these may be incomplete or inconsistent or reflect some errors. Where there are such

**Figure 3. Technical Relation between model parts and tools**

Source: AGMEMOD Partnership

gaps or errors, the recommendation is to derive comparable data from different sources.

If frequent database revisions are not taken into account through re-estimation of the respective equations, the model results will not reflect such changes in the database.

In those cases where the supply and use do not balance, adjustments are to be made so that the balance will hold for all commodities and in all years.

Length of the time series available may vary a lot from the standard for particular countries. Furthermore, national borders for some MS may have changed in the course of time. In advance of and during the EU accession agricultural market regimes may have changed, often combined with a harmonisation of the related statistics.

Owing to all these facts, the aggregation of EU models is not a trivial matter. All these caveats are of relevance in the aggregated data for the EU as a whole or MS subgroups, becoming obvious in the net-trade figure for the EU compiled, so that the net-trade in AGMEMOD may differ from figures published elsewhere. To ease the problem, national teams are requested to check with expert users of national data in their Member State. To interrogate the data further, data for specific variables across different data sources is compared, a process which will improve with the upcoming inclusion of the AGMEMOD database in the METABASE (DOL, 2008; VERHOOG, 2008), which will allow for a comparison against different data sources. However, all these provisions are very time consuming; thus, the implementa-

tion of a tool calibrating AGMEMOD's historical net-trade to an external source may provide a feasible solution.

## 6. Conclusions and future challenges

AGMEMOD has shown that it is possible to establish a country based agricultural market modelling system through linked individual country models managed by national teams. But getting the system up and running is a time consuming task. However, several organisational and technical features helped the process to evolve, although, those 'tools' were more often than not developed through a trial-and-error procedure. In the process of linking those countries models into a model for the EU as a whole, several insights have been gained so far: Communication among the researchers, and the respective sub groupings involved, have increased, while the steering requirements for the project have increased dramatically as the number of linked models involved has increased. Even more, the structure of the Partnership was needed to follow and to adapt to the new challenges. Communication tools had to be reshaped like the function of the core group or newly invented like providing newsletters.

From a modelling perspective it became apparent that extending the model would be facilitated by provision of working templates for countries and commodities, as there is an ongoing requirement to increase the number of countries included and the number of products covered. But it was also found that harmonisation to a certain degree was

inevitable when it came to data and policy implementation, having regard for the commitment that each model's structure should reflect national heterogeneity across Europe.

Also, as the number of groups involved increased, knowledge transfer became a big issue. In this regard, the provision of technical tools proved to be a very important step forward as they guarantee transparency and consistency between model input and output, and between the models themselves on the one hand and on the other hand facilitate knowledge transfer between researchers.

However, model data should not only be handled by consistency checks within their own data base. Crosschecks, to detect inconsistencies in comparison to external data, are an important device. In this context the inclusion of the AGMEMOD dataset in a wider data management system will be helpful in the future.

Beyond the tasks of solving the issues mentioned above, significant challenges lie ahead for the AGMEMOD Partnership. The survival of an extended Partnership requires that the necessary resources are found to finance the continued provision of market knowledge and country expertise for all the country models involved, and this is seen as an integral part of the Partnership. One possibility could be to follow a two-tier approach, with the wider Partnership developing the country models and examining some research questions, while smaller sub groups of partners deal with specific impact analyses. An alternative to this approach would be one where the model and the data are managed and maintained by an outsourced organisation, while the further development and the extension of the country models are handled by researchers. The organisational template used by consortia such as the GTAP-Consortium could be adopted. However, it is clear that both approaches will require financial resources.

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Corresponding author:

**DR. PETRA SALAMON**

Institute of Market Analysis and Trade Policy,  
Johann Heinrich von Thunen-Institute (vTI)  
Bundesallee 50, 38116 Braunschweig  
phone: 05 31-59 65 309, fax: 05 31-59 65 399,  
e-mail: [petra.salamon@vti.bund.de](mailto:petra.salamon@vti.bund.de)