



Rapport nr. 116

Assessment of the GTAP Modelling Framework for Policy Analysis from a European Perspective

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Statens Jordbrugs- og Fiskeriøkonomiske Institut

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Foreword

On the 10-11, February 2000, the Danish Institute of Agricultural and Fisheries Economics hosted a workshop in Copenhagen financially supported by the European Commission under the FAIR-6 and Inco programmes¹. The workshop and the written contributions are to be viewed in the context of a larger European concerted action project involving researchers from a large number of European Countries - all given the task of assessing the usefulness of the Global Trade Analysis Project (GTAP) framework from a European perspective. In total 40 researchers and policymakers participated in the Copenhagen Workshop².

This publication contains five papers presented at the workshop together with the written contribution of each of the invited discussants. All the papers present assessments of different aspects of the GTAP modelling framework.

The first paper is a review paper by Tongeren et al. assessing **the present state of applied modelling** in the area of international trade in agriculture and related resource and environmental modelling. The models evaluated fulfil the criteria that they are multi-region and multi-commodity in nature, are relevant for current EU policy issues, have relevance for agriculture and natural resource based activities and are applied equilibrium models. Even though there are 18 models that fulfil these criteria no single model seems to suit all purposes. Each of the models has its own merits, given the goals addressed and the issues treated with the model. The paper also contains an extensive appendix systematically summarising the models reviewed and therefore, it provides the reader with a rather quick overview focusing on essential characteristics of the models, such as the way they model trade, the goals, key applications, policy representation, and commodity and country coverage, etc.

In his comments on the paper Frohberg stresses that more attention should have been given to the theoretical consistency and functional representation of the models as both of these topics are very important for a deeper understanding and evaluation of the different models and their merits. Moreover, Frohberg draws attention to the problems with the estimation of the parameters of equilibrium models. Usually parameter estimates are taken from studies carried out under quite different economic conditions than the ones that are supposed to be modelled with the equilibrium model and often the estimates are rather old. He also stresses

¹ The content of this report is the sole responsibility of the authors and does not in any way represent the views of the European Commission or its services.

² The list of participants can be found in the back of this volume.

that more focus should be put on economies of scope, as this seems to be quite important in agriculture.

One of the issues discussed during the workshop was the possibility and the importance of modelling endogenous institutional or policy changes in models of the type being reviewed. Although there was some understanding of the importance of such changes and issues, there did not seem to be a general acceptance of the benefits of such efforts given the present state of the models under review. Some participants mentioned a few other models not reviewed in the present survey – however, they had not been included, as they did not qualify according to the criteria chosen for the survey. Finally, there was also general agreement as to the importance of supplementing the typical standard CGE models with imperfect competition, the existence of multi-national firms, transaction costs and adding satellite models focusing more upon distributional issues (the argument of policy relevance).

After having surveyed most of the potential models that could be used to analyse international trade issues, especially related to EU and its agricultural and environmental policies, the focus in the rest of this volume is on the GTAP model and database. How useful is this framework when assessing topics as diverse as multilateral trade liberalisations, EU enlargement, EU's common agricultural policy and various environmental issues?

At the workshop Francois gave a **short introduction to the GTAP model and database** to prepare the participants for the following papers and discussions. Following his presentation a number of specific questions were raised. These included a discussion of the overall GTAP set-up, e.g. the importance and role of the Consortium, the importance of publicly available data and models as well as the need for detailed documentation. Among the suggestions was the idea of developing the database even further to allow for analyses of more distributional issues not only among countries but also within a given region (e.g. different types of households).

The following paper by Francois et al. deals with **the application of the GTAP model and database for assessment of multilateral trade issues** with particular emphasis on the important elements of the EU agricultural policies. The starting point for their analysis is the main international trade policy issues that were negotiated during the Uruguay Round. The agricultural trade issues are concerned with market access, export subsidies and domestic support, while the non-agricultural policy issues are centred around industrial tariffs and trade in services. The next step is to assess the usefulness of the GTAP model for analysing these issues and the possibilities of extending the application of the GTAP model. Francois

et al. find that GTAP is a useful tool for analysing WTO-related issues. However, the GTAP framework has some important limitations, as it is still rather stylised in certain aspects, and these need to be remedied to improve its usefulness.

Sarris agrees in his comments on the paper that the analysis of international trade liberalisation issues should preferably be done in applied general equilibrium (AGE) models, as they provide important insights into the consequences of these issues. Sarris praises the highly disaggregated agricultural sector in the AGE models, but he stresses some of the disadvantages, e.g. the standard AGE production structure and the generally missing detailed distributional considerations. Sarris also underlines that the latter turns out to be important when assessing the consequences of policy changes on highly specialized farms versus multi-product ones, and when assessing the differences between different liberalization measures. Furthermore, he addresses the importance of representing policies correctly, the possibility to highlight gains and losses and the derived needs for compensation instead of the simple trade-offs that are often seen during negotiations, and finally the effects of liberalisation on market instability. In conclusion Sarris suggests that more emphasis should be given to smaller and more detailed models that are tailored to the question at hand and make them consistent with the more aggregated macroeconomic AGE models.

Following Sarris' presentation the audience discussed the possibilities for modelling instability and uncertainty in this type of economic models. Naturally, such developments are still at the frontier of research and the discussion clearly reflected that a number of theoretical and methodological problems remain to be solved. The discussion also mirrored that it is very important for economic modellers to be able to represent policy regimes correctly – if they are to be of any use for the next WTO negotiations. Examples are the importance of tariff rate quotas and the amount of 'water' in the tariffs (the difference between the bound and the applied rates).

Nielsen et al. give an assessment of **the usefulness of the GTAP model and database for analysing the enlargement of EU**. They start with an overview of the most important policy issues raised by the enlargement negotiations. Several of these policy issues have been addressed in various GTAP applications and a review of the existing applications are given together with a discussion of potential applications. The paper also identifies some of the shortcomings of the GTAP model and database when used to analyse the economic consequences of the EU enlargement. A schematic overview shows that the existing GTAP applications have covered an extensive area in the analysis of the economic consequences of integrating the Central and Eastern European countries (CEEC) into the European Union. The

strengths of the GTAP modelling framework are undoubtedly the strong focus on the agricultural sector and the Common Agricultural Policy, but at the same time these strengths draw attention to a number of areas in which the current GTAP framework is inadequate.

Besides some more specific comments about the relevance of the issues and scenarios presented in the paper, and an appeal to discuss structural issues and institutional reforms in the transition economies, Johan Swinnen concentrates on two things. First, a reassessment of some of the GTAP modelling assumptions related to the pre-accession policy situation in the transition economies, for example the representation of the protection levels and the institutional driven developments prior to enlargement. Second, a reassessment of the modelling of the factor markets in the transition countries especially the property rights and the functioning of the land market and the mobility of labour. In addition, Swinnen argues that it may be important to integrate financial flows and investment, as both are expected to have a significant macro-economic effect both before and after an enlargement of the European Union.

Following these comments several among the audience discussed the validity of some of Swinnens more critical remarks and analyses. The discussion clearly reflected that structural and institutional reform, changes in productivity as well as changes in agricultural policies will affect the future development of production in the CEEC. The audience also discussed the value of input-output data in the current form, where the data – especially in transition economies – can be somewhat dated. However, there was general agreement that it is important to make a serious attempt also to incorporate institutional features, as this type of model is well suited to analysing structural changes. Nevertheless, the whole development might be progressing too fast in the CEEC's right now for these (as well as other) models to keep up – a matter always to be kept in mind when evaluating model results and derived policy conclusions.

Another important aspect to be able to analyse within the GTAP model framework is the **reforms of the Common Agricultural Policy (CAP)**. Mekki et al. assess in their paper whether the CAP reform issues can be analysed by using the GTAP modelling tool. A brief review of past CAP reforms gives the background for discussing the policy issues and policy instruments of importance for future potential CAP reforms. This is used to identify the policy characteristics that we might be able to model within the GTAP model. Mekki et al. conclude that GTAP is suitable for analysing CAP reform issues both within the context of global trade issues and European agriculture. However, the authors also conclude that it is

necessary to improve the structure of the GTAP model to reflect important structural characteristics of European agriculture.

In her comments to the paper, Rabinowicz argues that a somewhat broader criterion should be used when assessing the usefulness of GTAP for analysing reforms of the CAP, namely, the ‘ability of the GTAP model to generate useful and reliable results on policy-relevant CAP issues that are potentially useful for decision making on the future direction of the CAP’. Moreover, Rabinowicz argues persuasively that environmental and regional related policy issues are relevant, and further, that the strong dependence on supply management is an overlooked although important feature of the CAP. Another point raised by Rabinowicz was that comparisons of empirical results from different models are very important, as it might give us an idea about the merits of the results with respect to generating new and interesting information and because it helps when comparing different models. Finally, Rabinowicz concurs with the authors of the paper that the GTAP model is very useful, but also that it should be used in beneficial tandem with other more specialised models.

Following Rabinowicz’s comments the audience discussed the ability of economic models in general and general equilibrium model in particular to predict the economic implications of changes in economic and agricultural policies and the extent to which such model results are useful for policymakers in suggesting policy changes. Several among the audience stressed that results from such models are no better than the data and the behavioural parameters underlying the model (therefore, special efforts should be devoted to ‘getting the data right’). In addition, some of the participants expressed the view that models should primarily be used for policy evaluations. There were a few critical remarks reflecting some scepticism with respect to GTAP’s ability to evaluate changes in European agricultural policies. Others expressed the view that special tailored models – including a specifically tailored GTAP model – can be useful and can highlight important implication of changes in the European agricultural policies – without pretending that any single model can answer all questions. The general rule still applies ‘one model per problem – our economic models and the data necessarily need to be adjusted to the problem at hand’.

The last paper by Brockmeier et al. assesses the usefulness of GTAP for **the analysis of global or transboundary environmental issues**. The paper starts with an overview of the environmental policy issues in the current policy debate with a focus on environmental related domestic policies and trade related policies. This is followed by a discussion of how environmental issues can actually be modelled in GTAP with the help of some additional assumptions and possibly a supplementary model or modules. Having reviewed the interna-

tional literature, Brockmeier et al. argue that the linkages between environment and trade liberalisation have been somewhat neglected in the past. Nevertheless, the authors find that global general equilibrium models such as GTAP can be improved and extended and thereby contribute to the debate of the linkages between trade and the environment. Among the extensions should be adjustments of the standard model to handle specific environmental problems by incorporating for example indicators of environmental quality, abatement cost and technologies together with a detailed modelling of environmental policies. Such adjustments and extensions would also involve major improvements to the environmental data.

In her comments, Kemfert discusses two important aspects in addressing environmental issues. First, the importance of representing the abatement technologies and costs as well as the utility function correctly in the model (involving both a choice of functional forms and the associated elasticities of substitution). And secondly, getting the data right – not only the general economic and trade structures but also the environmental data such as indicators for environmental quality and damages as well as having regional and sectorally- differentiated abatement technology data. Kemfert urges the authors to look more carefully into the differences in energy intensities across regions, as such differences are crucial in the evaluation of, for example, global climate change policies.

The ensuing debate reflected that there are still significant improvements in front of us on both the theoretical as well as the empirical frontier when addressing, for example, the linkages between trade and environment and the impact of, for example, global climate change policies. Nevertheless, the applied research worldwide has also in this area benefited from the GTAP database and modelling framework and there are certainly in the area of energy and environmental issues prospects for significant contributions from specifically tailored global general equilibrium models, such as the GTAP model and database.

Danish Institute of Agricultural and Fisheries Economics, August 2000.

Søren E. Frandsen and Michael H. J. Stæhr

Review of Agricultural Trade Models: An Assessment of Models with EU Policy Relevance

by Frank van Tongeren³, Hans van Meijl¹, Paul Veenendaal¹, Søren E. Frandsen², Chantal Pohl Nielsen², Michael H.J. Stæhr⁴, Martina Brockmeier³, Dirk Manegold⁵; Joseph Francois⁴, Machiel Rambout⁶, Yves Surry⁷, Risto Vaittinen⁶, Leena Kerkela⁸, Thomas Ratering⁹, Kenneth Thomson¹⁰, Bruno Henry de Frahan⁹, Akka Ait El Mekki¹¹ and Luca Salvatici¹²

1. Introduction

The prospect of a new round of trade negotiations under auspices of the World Trade Organisation, the perspective of enlargement of the European Union and international negotiations on transboundary environmental questions are some important policy issues that the European Union is currently facing. The assessment of likely impacts of policies in these areas is bound to be complex and is often supported by quantitative modeling analysis. This paper provides an assessment of the present state of applied modelling in the area of international trade in agriculture and related resource and environmental modelling. It attempts to support users of models and users of model results in finding the most suited modelling tool for the problem at hand.

The general ‘filter’ for inclusion of models has been that the model should be relevant for current EU policy issues, be multi-commodity and multi-region in nature, has relevance for agriculture and natural resource based activities and be an applied equilibrium model (i.e. not a technical or time series projection model). This has resulted in the following list of 18 models:

³ LEI, The Netherlands.

⁴ SJFI, Denmark.

⁵ FAL, Germany.

⁶ EUR/TI, The Netherlands.

⁷ INRA/Rennes, France.

⁸ HSE, Finland.

⁹ VUZE, Czech Republic.

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World models:

Partial models: AGLINK (OECD), ESIM (USDA, Stanford University USA, University Göttingen), FAO World model (FAO), FAPRI (Iowa State University), GAPsi (FAL Germany), MISS (INRA Rennes), SWOPSIM (USDA/ERS), WATSIM (University Bonn, European Commission, Federal Ministry of Agriculture Germany)

Economy wide models: G-cubed (McKibbin and Wilcoxon, U.S. EPA), GTAP (Purdue University, GTAP consortium), GREEN (OECD), INFORUM (University of Maryland), MEGABARE/GTEM (ABARE Australia), Michigan BDS (University of Michigan), RUNS (OECD), WTO house model (WTO secretariat).

EU agricultural sector models

- SPEL/EU (EUROSTAT, University Bonn), CAPMAT/ECAM(SOW, CPB, LEI)

2. Model features

A summary description of model features is provided in tables 1 to 3. This section highlights the various dimensions along which the models are described. A deeper discussion of the evaluation criteria and an elaborate description of each individual model is provided in Van Tongeren and Van Meijl (1999).

2.1. Conceptual framework: Definition and scope

Representation of national economies: partial versus economy-wide models

Partial models treat international markets for a selected set of traded goods, e.g. agricultural goods. They consider the agricultural system as a closed system without linkages with the rest of the economy. The main area of application of partial equilibrium models is detailed trade policy analysis to specific products.

On the other hand, *economy-wide models* provide a complete representation of national economies, next to a specification of trade relations between economies. There are three broad classes of economy-wide models: macro-econometric models, input-output models and Applied General Equilibrium models (AGE). A full economy-wide specification is obtained when the model is closed with respect to the generation of factor income and expen-

ditures, which requires the explicit specification of factor markets for land, labour and capital.

Regional scope

Multi-region models differ with respect to their regional coverage.¹³ Global trade models attempt a closed accounting of the selected commodity trade flows for the entire world. If the model is economy-wide, the global model also includes a globally closed income accounting system. At the other end of the scale, a model might focus on trade between a selected set of trading partners, without attempting a globally closed accounting. Or it might even single out one group of countries, such as the EU-15, and describe its trade on world markets. A globally closed database does not imply that all regions or countries distinguished are treated with the same amount of detail.

Linked individual country models or parametric differences between regions

There are two broad approaches with respect to the modelling of individual economies within the global economic system. One approach starts by giving a detailed representation of individual economies, taking into account much of the institutional and economic details of the individual countries, and subsequently linking individual country models through trade flows, capital flows and possibly factor mobility between countries. The other route to global modelling starts by assuming the same modelling structure for all individual economies, and representing differences between economies in terms of data and parameters only. This ‘one model fits all’ approach yields a more transparent model structure, at the cost of losing country detail.

2.2. Specification and modeling issues

Dynamic versus comparative static specifications

Dynamic models allow the analysis of lagged transmissions and adjustment processes over time. Alternatively, the comparative static approach studies the differences between equilibria resulting from different assumptions on exogenous data or policy variables without ana-

¹³ In accordance with the international trade literature, ‘regional’ has a supra-national meaning in this paper, and not an intra-national (provinces etc.) one. A ‘country’ corresponds to the notion of a nation state. Whenever this report refers to regions, we mean an aggregate of individual countries. Regional aggregations of countries therefore do not necessarily represent a coherent geographical space, for example, a ‘Rest of the World’ region.

lysing the time path between equilibria. Dynamic models can be used to trace the accumulation of stock variables, whereas static models are unable to do this.

Dynamic features can be incorporated in equilibrium models in several ways. The most frequently used approach is to specify a recursive sequence of temporary equilibria. Recursive dynamics do not guarantee time-consistent behaviour, which contrasts with intertemporal equilibrium models.

Modelling of international trade

In classical trade models assume that the goods of one producer perfectly substitute for those of another, i.e. goods are *homogeneous*. If the number of suppliers is sufficiently large, the market will approach the perfect competitive outcome and prices across suppliers will be equalised. Homogeneity and competitiveness also imply that each actor in the market is either an exporter or an importer of the good, but never both, and models that include this assumption describe only inter-industry trade. Since prices are equalised and there is no other distinguishing characteristic of the goods, it makes no difference from which supplier a particular purchase is made. The homogeneity assumption is therefore associated with a ‘pooled’ market approach to trade modelling, where we see only what each actor brings to the market (supply) and what that actor takes from the market (demand). For obvious reasons, the pooled market approach is also known as ‘non-spatial’ modelling.

When product differentiation is possible, goods are called *heterogeneous* (and imperfect substitutes), and different buyers are willing to pay different prices to obtain the same quantity of the good. Hence, independent price movements among suppliers are possible. Another implication of heterogeneity is that each actor in the market may be both a buyer and a seller at the same time if goods are differentiated, and intra-industry trade can be captured.

The most popular way to introduce product differentiation follows Armington (1969) by assuming that imports and domestic goods are imperfect substitutes in demand. An alternative approach is to introduce product differentiation endogenously at the firm level on the supply side (Krugman 1979, 1980, Ethier 1979, 1982). In this approach fixed costs such as R&D or marketing costs are necessary to produce differentiated goods, and profits generated under imperfect competition are necessary to cover fixed costs. The heterogeneity assumption is associated with a bilateral (intra-industry) specification of trade, which keeps track of who trades with whom and allows for modelling of bilateral trade policy instruments.

Representation of policies

An adequate representation of policy instruments is essential in applied trade models. Tariffs and quantitative restrictions such as quotas are two important types of trade policy instruments. Tariffs can be introduced in a straightforward manner and are most of the time expressed as ad valorem tariff rates. Also specific (per unit) tariffs are then translated into ad valorem rates.

Quotas and other non-tariff measures are more difficult to implement, and there are basically two alternative ways to quantify these for use in applied models (Laird, 1997): the first is a tariff equivalent representation, while the second method specifies quantity restrictions directly as bounds on trade flows. In many situations this latter method is preferable. For example, if a quota is not binding in the benchmark, its tariff equivalent will be equal to zero, while the quota may become binding as the result of a policy simulation. This effect will not be captured when the quota is approximated by a tariff equivalent. Another case is the endogenous generation of quota rents and their distribution.

Next to border protection instruments, other relevant policies frequently need to be represented in models. For example, in relation to the EU's GATT/WTO commitments ceilings on the volume of subsidised exports as well as bounds on the value of export subsidies may be relevant. In relation to the CAP, land set-aside and headage premiums are clearly examples of agricultural policies that do not directly affect border protection, but nevertheless have an impact on trade flows. In the area of (transboundary) environmental policy, tradable emission permits and tradable production quotas have emerged and should be captured appropriately.

Theoretical consistency

Judging the theoretical consistency of models has many facets, and the discussion here is far from exhaustive.¹⁴ At its most basic level, a model's numerical results should be qualitatively in accordance with the theoretical foundations on which the model has been erected. At the level of numerical implementation of the model, theoretical consistency places requirements on the parameters used in functional forms, especially parameters used

¹⁴ It is not a straightforward task to develop a sound set of criteria to judge the theoretical consistency of models. This theme is also closely related to the issue of model validation, which we have not taken up in this paper. There exists a sizable, and rather inconclusive, literature on model validation, see e.g. Van Tongeren (1995) for an overview. In addition the evaluation of theoretical and numerical validity would require much more information on the individual models than is available.

in demand systems and supply equations. These should satisfy essential regularity conditions.

Data and parameters

Data requirements are very demanding for multi-regional models of international trade. The amount of data is determined by the level of disaggregation (countries/regions, activities/commodities) and the theoretical structure (homogeneous/heterogeneous goods, bilateral/pooled markets).

The data need to be mutually consistent. Substantial adjustments to the published data are necessary, especially if trade is related to domestic inter-industry structures. While trade data with broad coverage are now widely available on a comparable basis, this is certainly not true for input-output data and for trade protection information.¹⁵ A coherent and consistent description of national economies in the form of a Social Accounting Matrix (SAM) usually underlies economy-wide models, although the SAM is sometimes only implicitly present in the database.

It is obvious that regular updating of datasets will improve the timeliness and relevance of results. The choice of base year for a modelling dataset has consequences, both for comparative static and dynamic models. The economic conditions that prevail at the point of reference determine the conclusions that can be drawn from alternative simulations.

The parameters used in behavioural equations determine the response to policy changes, and are therefore a very crucial element in each modelling exercise.¹⁶

Two approaches to estimating model parameters can be distinguished: econometric estimation and calibration. Econometric estimation of parameters should ideally be done by simultaneous equation estimation methods that take into account the overall model structure. However given the size of applied trade models, identification problems, lack of data etc.,

¹⁵ A recent joint initiative by USDA/ERS, Agriculture and Agrifood Canada, the European Commission, UNCTAD and FAO develops a new Agricultural Market Access Database (AMAD). Upon completion this will contain tariff-line level data on market access commitment- and implementation of about 50 WTO members. AMAD is expected to become publicly available in 2000. See Wainio et al. (1999).

¹⁶ Key parameters usually are: price- and income elasticities and budget shares in demand systems; substitution elasticities and input cost shares in supply systems; Armington (substitution) elasticities in import demand; if economies of scale are included, parameters that capture the degree of exhaustion of returns to scale (cost-disadvantage ratio).

this is not feasible, and one has to resort to single-equation estimation methods, using either time-series or cross-section data. Most applied trade modelers resort to calibration methods – also called the ‘synthetic approach’- to generate a set of parameters that is consistent with both the benchmark data and the model’s theory. The calibration approach takes initial estimates of elasticities etc. from outside sources and adjusts certain other parameters in the given functional forms to the initial equilibrium dataset. Calibration therefore exploits theoretical restrictions, equilibrium assumptions and assumptions on functional forms to arrive at a point estimate.

3. Model overview

In this section we describe the features of the selected partial-, economy-wide- and EU-agricultural models. We first describe the design choices of prototypical standard multi-region partial models and standard economy-wide models. These standards serve as a point of reference for the individual models described in tables 1 to 3. In this section we give a very brief overview.

A standard partial equilibrium (PE) model has the following characteristics: global coverage, parametric differences between countries, comparative static, homogeneous goods, pooled markets, ad valorem price wedges (trade: tariff equivalents), theoretical consistency not implied by theoretical structure, and factor markets and non-agricultural sectors are exogenous. In general, all the selected models are pretty close to the standard model. They differ from the standard model because they are recursive dynamic (AGLINK, FAO World Model, FAPRI, GAPsi), endogenise land allocation (AGLINK, FAO World Model, WATSIM), model explicitly quantitative policies (AGLINK, ESIM, GAPsi, MISS and WATSIM) or include bilateral trade by using the Armington assumption (SWOPSIM, one application). Besides the design choices the models differ in their product and country coverage, which leads to a rather large differences in focus.

The standard approach economy-wide modeling is a multi-region applied general equilibrium (AGE) model with the following characteristics: global coverage, parametric differences between countries/regions, comparative static, Armington, bilateral trade relations, ad valorem price wedges (trade: tariff equivalents), theoretical consistency implied by model structure, endogenous volumes and prices on all markets, including factor markets. This standard multi-regional AGE model is a firmly established workhorse in international trade analysis. While retaining most of the standard assumptions, certain special features are introduced into some models to capture specific issues, such as developing country agricul-

ture (RUNS) or aspects of the Common Agricultural Policy (some GTAP applications). Recursive dynamic variations of the standard model are now commonplace in global climate change research (GREEN, MEGABARE). Imperfect competition versions have gained ground in trade liberalisation of manufactures, and are likely to be used in the assessment trade liberalisation in services (WTO, BDS, GTAP). The most recent development is the intertemporal modelling of macroeconomic interactions between financial markets and real sectors (G-cubed). The size of the data collection effort for global models has in the past forced modellers to be rather economical as regards the regional and sectoral disaggregation. Two collaborative efforts to reduce this entry barrier exist to date: INFORUM and GTAP. The GTAP database is specifically tailored to the needs of general equilibrium modellers, and this has certainly contributed to its wider usage, also by non-GTAP modelling teams.

With regard to EU agricultural models we studied a partial equilibrium (SPEL) and a general equilibrium model (CAPMAT) which are both recursive dynamic.

4. Assessment of models

Nine out of the 18 surveyed models are partial models, according to Table 4. Partial models are in principle able to provide much product detail, and their main area of application is detailed trade policy analysis to specific products, which represent only a small portion of the economy. If agricultural trade policies do not lead to noticeable price shifts in other sectors, PE results will not differ significantly from AGE results. In industrial countries, with small agricultural GDP shares, the direct linkages of agriculture with other sectors is typically not very strong at the level of aggregation that AGE models tend to employ. An exception may be indirect linkages that run through markets for natural resources, especially land. In contrast, in Central and East European Countries (CEECs) with their relatively high share of agriculture in GDP, significant second-round effects are to be expected from policies that pave the ground towards the EU enlargement process, and AGE models provide the only coherent way to analyse these.

In industrialised countries and the European Union, there do exist strong linkages, however, with sectors that are closely related to agriculture, either because they deliver key inputs such as fertilisers, herbicides, agricultural machinery, or because they process primary agricultural products, such as beef processing and dairy industries. Highlighting such interdependencies within the agricultural complex is one area where partial equilibrium models can potentially be very successfully used, and some of the recent partial models have taken

up this challenge (WATSIM, ESIM). This aspect is also gaining importance in the presence of dramatically increasing trade shares of processed food products. Most of the partial equilibrium models surveyed here do not fully exploit this potential advantage because they have a focus on trade in primary agricultural commodities. As a result, there has been a tendency to use AGE models to highlight the forward and backward linkages within food supply chains, as well as to incorporate trade in differentiated food products.

The majority of the models has a global coverage, only three of them treat a regional subset of economies. One of those is a partial agricultural models (SPEL), one is economy-wide (INFORUM) and one is an EU-agricultural model with an economy-wide closure (CAPMAT/ECAM). Within the group of models that closes their accounting with respect to world trade, there are differences in regional emphasis. FAPRI focuses on the US, ESIM on Eastern Europe, MISS focuses on US-EU interactions, GAPsi emphasises the EU. A clear regional bias is less obvious in the economy-wide models with a global coverage. All of them include at least the major trading regions (US, EU, Asia Pacific).

The commodity coverage of partial models puts more emphasis and detail on agricultural commodities. Most AGE models include only 1-3 agricultural sectors, with the exception of RUNS and GTAP. The recent version of the GTAP database has an amount of agricultural detail that is comparable to partial agricultural models.

Only one of the models, INFORUM, features linked individual country models, while all others favour representation of differences between economies via differences in parameters. While in principle, individual country models can capture more regional economic and institutional detail, there are clear difficulties with this approach in terms of consistency and maintenance. Indeed, the linked country models approach seems to be less sustainable, and their contribution to global trade analysis has been rather limited. (The IIASA Basic Linked System, Parikh et. al 1988; The project LINK, Klein and Su, 1979)

Comparative static modelling has certainly not gone out of fashion, although ten models favour a recursive dynamic approach which permits them to generate time paths of variables and lagged adjustment patterns. Forward looking time consistent behaviour is only introduced into one model, G-cubed, which does not have a specific agricultural focus, but concentrates more on macroeconomic phenomena. Explicit introduction of time is certainly appealing to policy users of models, since this relates the model outcomes to concrete time periods. Comparative static models have reacted to this demand by generating projections without explicit modelling of the dynamics. While this procedure has some appeal, it is also

TABLE 4: Basic modelling design choices

	Partial Models	Economy wide models	EU-Agricultural models	Total
Scope of representation				
National economies:				
- Partial	8	0	1	9
- General	0	8	1	9
Regional scope:				
- Global coverage	8	7	0	15
- Non-global coverage	0	1	2	3
Regional unit of analysis:				
- Linked country models	0	1	0	1
- Parametric differences	8	7	2?	17
Dynamics:				
- Static	4	3	0	7
- Recursive dynamic	4	4	2	10
- Forward looking	0	1	0	1
Modelling of trade:				
- Homogeneous	8	0	2	10
- Armington	0	5	0	5
- Monopolistic competit.	0	2	0	2
- Other	0	1	0	1
Treatment of quantitative policies:				
- Tariff/price equivalents				
- Explicit treatment	3	5	0	8
	5	3	2	10
Data:				
Public data availability?				
- Yes	3	5	1	9
- No	5	3	1	9
Parameters:				
- Estimated	2	0	2	4
- Calibrated	6	8	0	14

Note: The table refers only to standard versions of models.

not free of criticism, and some caution should be exercised. Partial models have to make assumptions on the development of a large number exogenous variables to produce a projected future dataset. In fact, the largest part of the projected future does not derive from the model, but from outside assumptions. Since the partial model itself does not provide a consistency check, it is questionable whether these assumptions are always consistent among each other. Projections with static general equilibrium models provide a consistency check, but these models rely on an extremely small number of assumptions for their projections. This implies that a large part of the step between two time periods is ‘explained’ by residual factors such as TFP growth rates which accumulate much of deviations not included in the original model. Finally, the features of the ‘baseline’ in all dynamic models as well as in

projections are critical for the interpretation of policy results which are obtained relative to the constructed baseline scenario.

It is striking to note that all partial equilibrium models and the EU-agricultural models treat international trade in homogeneous products, while AGE models deal with trade in differentiated products by default. As already mentioned above, the volume of trade in processed food products is increasing relative to trade volumes in primary commodities. Since processed food can be considered to be of a more differentiated nature than primary products, it is highly relevant to come to grips with trade in differentiated products. By excluding intra-industry trade, and limiting the analysis to net trade, partial models capture the degree to which countries are interwoven only imperfectly. These models also run the risk of predicting the empirically contestable phenomenon of extreme specialisation. Net trade in homogeneous goods also makes it impossible to incorporate bilateral trade policies. While the standard treatment of trade in differentiated products follows the Armington specification, two AGE models (BDS, WTO) incorporate firm-level product differentiation and economies of scale by default, and the standard GTAP model has been amended in that direction. These models focus on manufacturing and services, where these phenomena are perhaps more relevant than in agriculture. However, in food processing industries economies of scale and imperfect competition aspects are certainly relevant as well. A related issue is Foreign Direct Investment (FDI) by internationally operating processing and retailing firms. This is as yet untreated in the applied models surveyed, but requires the recognition of economies of scale at the plant level as well as at the firm level (Markusen, 1984, Markusen and Venables, 1998). It must be recognised, though, that hitherto the empirical basis for these industrial organisation issues is rather weak.

Ten models attempt to capture explicitly quantitative trade restrictions and CAP-type policies, while eight of the models resort to a tariff-equivalent representation. Policies are typically formulated at the commodity level or tariff-line level. It is at this level that policy makers need information, and partial models are in principle able to get down to the required level of detail, including specific institutional arrangements. Partial models, with their focus on selected sectors, are in principle able to give a more precise representation of policies, such as quantitative restrictions. However, our survey of partial model reveals that some partial models under-utilise that potential and resort to a tariff-equivalent representation of policies. Specialised models of the EU agricultural sector (CAPMAT/ECAM and SPEL-EU) are a notable exception as regards the representation of EU agricultural policies, and the treatment of budgetary implications. However their treatment of international trade is rather limited.

The inventory of models shows that some datasets are used by different models. Usually, modellers adjust the raw data to suit their specific needs, and consequently some duplication of efforts occurs. Nine modelling teams choose to make their dataset publicly available, either free of charge or at cost. This practice, which is increasingly observed within the modelling community, is considered a very useful step as it allows others to build on existing (and time consuming) work and it increases the transparency of modelling results. Sharing of databases has in the past been hampered by well known public good problems, which provide insufficient incentives for individual teams to contribute to database development. The INFORUM network provides an early example of an institutional set-up that facilitates sharing of data. INFORUM contributors submit (input-output) data in a form that matches their particular country model, and does therefore not require major adjustments to a common standard. In contrast, the GTAP framework enforces uniform standards on regional data and trade data. In addition, GTAP is supported by a strong group of institutional stakeholders which puts high requirements on the quality, timeliness and documentation of the data.

It turns out that 15 of the models surveyed here rely on calibration methods, and take their initial parameter estimates from the same published sources that sometimes date back a considerable time. Current models are dominated by ‘theory’ over ‘observations’. Econometric estimation of key behavioural parameters in applied models is certainly an underdeveloped area, although there are some initiatives to estimate partial models in consistency with micro-economic theory (ESIM, FAPRI, CAPMAT/ECAM). Recent developments in entropy estimation methods may help to alleviate some of the technical problems that one encounters in estimating large scale AGE models with limited data (see Golan et al. , 1996).

Although not apparent from our earlier discussions, documentation of models is generally weak and scattered, with some notable exceptions (BDS, G-cubed, GTAP). Especially agency based models do not stand out by clarity of documentation. Modellers that are rooted in academia face stronger incentives to submit their work to peer reviews, which increases transparency. An important related aspect is the accessibility of models and data to outside users, who do not belong to the organisations or bodies which have (initially) financed or sponsored the development of these models. While nine models offer the possibility to obtain their datasets, the models themselves are often proprietary. However, some of the models which are presented in this report can be considered as ‘public goods’ (conditional on certain costs and guarantees) which can be used by or made available to interested organisations or persons. Thus, the SWOPSIM model developed by the Economic Research Service (ERS) of USDA has been made available to numerous academics who worked on

the impact of agricultural trade liberalisation. The OECD AGLINK model is presently used by government services of OECD member countries. A part of the INFORUM models and modelling tools are in the public domain. At the present time, GTAP represents the most far reaching attempt to public availability, and has now several hundred users in the academic community as well as in research agencies all over the world.

Building an applied trade model is costly exercise, which tends to require several man-years of dedicated work on database construction, theory formulation, parameter estimation and computer implementation. In addition, the size of the investment implies that the basic design choices are to a large extent irreversible. Once a particular route has been chosen, the switching cost may become prohibitive. Some developments point towards a further reduction in entry costs to this type of work: (a) convergence towards standards in model building, where new models can build on established blueprints. (b) A major, and seldom fully appreciated, part of model building is devoted to database construction. GTAP has pioneered institutional innovations that lower the costs associated with database construction and database maintenance considerably. (c) The availability of powerful general purpose software packages renders it obsolete to develop own software to solve large scale models numerically. Additional advantages of using packages like GAMS, GEMPACK or GAUSS is the transferability, reproducibility (and therefore cross-checking) of models and ease of maintenance. Early partial equilibrium models have been implemented in spreadsheets, which was top technology at the time. Except for small scale models, and models for pedagogic purposes, spreadsheet models do not have much to commend them. They are inherently difficult to maintain and are very error-prone.

The degree to which models will contribute to new policy questions depends critically on their degree of adaptability. How capable are existing applied models to respond to newly arising policy questions? At a first glance, there are several issues on the current agricultural trade policy agenda that do not seem to fit well within existing trade modelling frameworks:

- ‘consumer concerns’ which are put forward as arguments to restrict imports of allegedly unsafe food products (e.g. hormone treated beef, genetically modified organisms).
- conservation of landscape as an argument to restrict imports from low-cost producers.
- environmental concerns, which lead to production restrictions and ‘green trade’ issues.

Unfortunately, we do not have the benefit of hindsight. It is conceivable, however, that existing models will be adapted for use in the above policy areas. This encompasses at least two issues. First, how existing models can be adapted in terms of policy representations,

and second, how the outcome variables that they provide can be translated into variables that arise on the policy agenda. With some creativity, the policy issues can be translated into preference and technology shifts, which interact with conventional import restrictions and production restrictions. A main contribution from existing models is likely to be a structuring of the discussion and initial quantification, rather than detailed numerical assessment.

5. Concluding remarks

There is, obviously, no model that suits all purposes. Each model has its own merits, given the goals addressed by it and the issues treated with the model. This paper, and the longer Van Tongeren and Van Meijl (1999) report, try to guide potential users in making their choice for an appropriate tool. For this purpose we have identified relevant design choices and a set of dimensions to classify and assess applied trade models.

Ten years ago, the OECD and the World Bank convened a symposium that assessed the ‘state-of the-art’ in agricultural trade modelling at that time, see Goldin and Knudsen (1990). The field has changed over the past decade, but to some extent the comments made at this symposium can be echoed today. Probably the most important innovations have not been theoretical, nor have they been technological. The most significant changes have been of an institutional nature, albeit supported by recent computer and communications technologies. Ten years ago, models, data and software were almost exclusively proprietary. Today, it has become more common to exchange computer code and to share databases. This tendency can be expected to be continued in the future. The ‘open source’ concept that spurred rapid innovations in some parts of the software industry may very well be the direction towards which the global trade modelling community is heading.

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Table 2: Model summary of partial equilibrium models of trade in agricultural products

	Description	modelling of trade	Goals	key applications
Standard model	<i>static partial equilibrium model, global coverage, no factor markets included</i>	<i>Homogeneous good + pooled markets</i>		
AGLINK OECD	Recursive dynamic model Includes land allocation	Standard	To assist the OECD Secretariat in its annual medium term outlook. Conduct quantitative analysis agricultural policies on principal agricultural markets	Annual OECD medium term agricultural outlook.
ESIM USDA, Stanford, Goettingen	Standard model, land market included, special emphasis to Eastern Europe	Standard	Enlargement studies	EU enlargement
FAO World Model FAO	Recursive dynamic model Includes land allocation	Standard	Medium- and/or long- term projection model. Simulating impacts of policy changes.	To contribute to the outlook of FAO on agricultural commodity markets, Uruguay Round
FAPRI Iowa State University	Econometric recursive dynamic model, with a special emphasis on the US	Standard	Compound modelling system for: Policy analysis; Short-, medium and long term projections (1-10 years), annual baseline	Quantitative evaluations of (inter) national agricultural policies that affect US and world agriculture, Farm legislation reform through Uruguay Round negotiations
GAPsi FALC	Recursive dynamic model	Standard	EU agricultural policy analysis	CAP reform, Agenda 2000; planned: EU enlargement, WTO
MISS INRA	Standard model, four regions	Standard	Analysis of agricultural policy changes in EU and US	Trade liberalisation in GATT framework and CAP reform in game theoretic setting, focussing on EU-US relations
SWOPSIM USDA/ERS	Standard model	Standard: base model Armington: one application	Simulation of effects of changes in agricultural support policies on production, consumption and trade	multilateral trade liberalisation (GATT Uruguay round), agricultural policy reforms in US and EU
WATSIM University of Bonn	Standard model	Standard	Three target periods with different aims: Short-term shock analysis (not yet available), Medium-term projections and policy analysis, Long-term projections and analysis of various shift factors.	1) Baseline for years 2005, 2010, 2015 and 2020 2) Analysis of different shift factors including income in Asia, productivity in Transition Countries, 3) Trade liberalisation

Table 1, continued

	Policy Representation	Number of regions (r) or countries (c)	global coverage? (y/n)	Number of sectors/ products	number of farm (f) or processed (p) products	Software	data availability
Standard model	Price wedges						
AGLINK	Quantity restrictions modelled explicitly	11 (c) + 2 (r) EU: 1 (r)	Y	19	6 (f) + 13 (p)	SIMPC	y
ESIM	Quantity restrictions modelled explicitly	7 (c) + 2 (r) EU: 1(r)	Y	27	17 (f) + 10 (p)	Spreadsheet (Supercalc 5.5 or Excel)	no
FAO World Model	Standard	147(c) + 1 (r) EU: 15 (c)	Y	13	6 (f) + 7 (p)	FORTTRAN	n
FAPRI	Standard	29 (c+r) EU: 1	Y	24	24 (f)	SAS-AREMOS, LOTUS 123	n
GAPsi	Quantity restrictions modelled explicitly	13 (c) + 4 (r) EU: 13 (c)+ 1 (r)	Y	13	13 (f)	GAMS, Excel (output)	n
MISS	Quantity restrictions modelled explicitly	1 (c) + 3 (r) EU: 1(r)	N	10 (final) + 10 (inputs)	10 (f) + 4 (non agri-inputs)	Home made software (Language C)	y
SWOPSIM	Standard	36 (r) EU: 2 (c) + 2 (r)	Y	22	22 (f)	Spreadsheet (Supercalc 3 or 5)	yes
WATSIM	Quantity restrictions modelled explicitly	4 (c) + 10 (r) EU: 1(r)	Y	29	14 (f) + 15 (p)	FORTTRAN, GAMS	y

Table 3: Summary of economy-wide models

	Description	Modelling of trade	Goals	Key applications
Standard model	Applied General Equilibrium model, multi-sector, comparative static, constant returns to scale in production, perfect competition on all markets, global coverage	Armington, bilateral flows		
G-cubed McKibbin and Wilcoxon	Intertemporal applied general equilibrium and macroeconomic model.	Standard	Contribute to the policy debate on environmental policy and international trade, with a focus on global warming policies.	Economy-wide impacts of greenhouse policies, financial crisis in Asia, global predictions and outlook of the world economy, Uruguay Round
GTAP GTAP consortium/ Purdue University	Standard (default version) Recursive dynamic and imperfect competition versions available.	Standard Monopolistic competition versions available	Trade policy analysis, especially multilateral liberalisation. Agricultural policies.	GATT Uruguay Round, technological changes, environmental policies; EU enlargement, CAP reform
GREEN OECD	recursive dynamic	Standard, except crude oil (homogeneous)	Asses the economic impact of imposing limits on carbon emissions	Kyoto protocol assessment
INFORUM INFORUM project/University of Maryland	Linked system of dynamic national macroeconomic models with inter-industry Input-Output linkages.	Price and income sensitive econometrically estimated import and export equations	Annual forecasts and policy analysis at national and internationally linked levels.	Early work on NAFTA, national US studies (LIFT), Austrian integration in EU
MEGABARE and GTEM, ABARE	recursive dynamic endogenous population growth, technology bundles in electricity and iron&steel	Standard	Policy scenario analysis primarily in climate change but also in global agricultural trade reform and trade in strategic commodities (e.g. coal).	Climate change policy and the economic impact of the Kyoto Protocol, WTO and the agricultural trade liberalisation
Michigan BDS Model University of Michigan	scale economies and monopolistic competition in manufacturing industries,	Monopolistic competition	To analyse microeconomic effects of trade liberalisation policies	Regional trade agreements (NAFTA, extension of EU with Eastern European countries), Uruguay round, liberalisation in services
RUNS OECD	recursive dynamic	Agriculture: homogeneous goods & pooled markets Manufactures: standard	Analysis of Agricultural policies	GATT Uruguay round, agricultural trade liberalisation
The WTO housemodel	Standard and imperfect competition versions	Standard and firm level product differentiation	To analyse global trade analysis issues such as the upcoming WTO Round	Multi-region CGE analysis of the results of the Uruguay Round

Table 3: continued

	Policy representation	Number of regions (r) or countries (c)	Global coverage (y/n)	Number of sectors	Number of farm (f) or processed (p) products	Software	Public data availability
Standard model	Ad valorem Price wedges		Global			General purpose package	Yes
G-cubed	Standard	4 (c) + 4 (r) EU: part of 'other OECD'	Y	12	1 (f) + 1 (p)	Gauss	N
GTAP	Standard in default version Volume and value restrictions (quota etc) available	27 (c) + 12(r) + RoW EU: 5 (c) + 1(r)	Y	50	12 (f) + 8 (p)	GEMPACK and GAMS versions available	Y, at cost
GREEN	Standard quota, tradable emission permits	5 (c) + 7 (r) EU: 1 (r)	Y	9	1 (f)	C	N
INFORUM	Standard macro-economic policy instruments, taxes and transfers	13 (c)	N	Varies by country: min. 33, max. 100	Varies by country	G	Y partly, free
MEGABARE/ GTEM	Standard Tradable emission permits	27 (c) + 12(r) + RoW EU: 3 (c) + 1(r)	Y	50	12 (f) + 8 (p)	GEMPACK	Partly, Y, See GTAP Energy parts: N
Michigan BDS model	Standard	34 (c) + RoW EU: 12 (c)	Y	29	2 (f)	GEMPACK	Y
RUNS	Standard	13 (c) + 9 (r) EU: 1 (r)	Y	20	11 (f) + 4 (p)	Fortran	N
WTO housemodel	Standard And import quota	5 (c) + 7 (r) + ROW EU: 1 (r)	Y	19	3 (f) + 1 (p)	GAMS/MPSGE	Y

Table 4: Summary EU-agricultural models

	Description	modelling of trade	Goals	key applications			
SPEL-EU University of Bonn	Recursive dynamic partial applied equilibrium model of agricultural production in EU-15	Homogenous goods + pooled markets	Short and medium-term forecasts and policy simulations of the effects of agricultural policy decisions	Particularly, CAP/Agenda 2000			
CAPMAT/ECAM SOW-VU, CPB, LEI	Recursive dynamic applied general equilibrium model and a simulation and accounting tool of agricultural production in EU-15	Homogenous goods + pooled markets	EU agriculture policy analyses	CAP reform (partial liberalisation), agricultural proposals in "Agenda 2000"			
	Policy Representation	number of regions (r) or countries (c)	global coverage? (y/n)	Number of sectors/ products	number of farm (f) or processed (p) products	Software	data availability
SPELL/EU	Price wedges and quota	13 (c) + 1 (r) EU: 13 (c) + 1 (r)	n	5-6 DIGIT/NACE	114 (f)	Home made software	Y, cost
CAPMAT/ECAM	Price wedges and quota, explicit bounds on volumes and values	13 (c) + 1 (r) EU: 13(c) + 1 (r)	n	30	20 (f), 7(p)	SAT in GAMS, ECAM home made software (FORTRAN)	n

Klaus Frohberg

The paper is a summary of an extensive review of partial and general equilibrium models. Almost all of those included in the survey were developed for analysing issues of international trade. With the exception of perhaps one or two, the review covers all the analytical tools currently in use for analysing the impacts of agricultural policies at the national and international level. A few of the models do not emphasise a certain sector of the economy like agriculture and the food industry but stress all industries of the economy equally. Only one of the models is designed to analyse policies affecting climate change. Altogether, 18 models were examined. Perhaps by chance, the same number of researchers was involved in the review.

The paper provides a synopsis of these models. A more detailed description can be found in the Annex which is written by the person(s) who surveyed the corresponding model. According to the authors, one of the models included in the review is not in use anymore. The justification for still being discussed is that its 'results are even now likely to be referenced to date'. Some doubts may be raised whether that is going to happen since the model was used last about 8 years ago prior to the completion of the McSharry reform of the EU's Common Agricultural Policy and the Uruguay Round. In the meantime quite substantial changes took place in many economies. The transition countries opened their economies to the rest of the world and made a considerable stride towards being integrated into the international division of labour. But also in the less developed countries many structural adjustments took place.

A survey of such a large number of rather sophisticated models is bound to be sketchy. Its strength is the information on what modelling tools are currently available and how do they compare. This requires that all relevant models are included in the study. In addition to those covered there exist some other agricultural policy analysis tools the results of which currently receive considerable attention. One is the IFRI-IMPACT model. In my view, it would have been worth for inclusion in the survey. Another interesting approach, the one applied by FAO for long-term projections, i.e. over the next 20 years on supply and demand developments, is not mentioned at all. The procedure followed by this organisation is unique in various ways. It is not a strictly formal model which is applied. Rather, the wisdom of the many country experts employed by FAO also is reflected in the results. In addi-

tion, the approach pays little if any attention to price movements. It emphasises technical developments and changes in income and preferences. A third distinguished feature is that first demand is projected and then it is determined how these consumption requirements can be met by production.

The paper consists of mainly two parts. In section 2 methodological issues are discussed in general. A large number of basic characteristics of the models are covered. The authors include the conceptual framework, specification and modelling issues as well as data requirements. Not all of these points are covered in full depth. Some very interesting characteristics are left out entirely. This is regrettable since choosing the correct methodology is very important. On the other hand, the paper is already rather lengthy. But this is unavoidable given the large number of models covered. The second part of the paper contains the model description. In section 3 the most important ingredients of the models are reported. Some critical comments are provided in section 4. The reader should not be afraid because of the number of pages since both the writing style and the content make the paper worthwhile to be read entirely. The Annex to the paper offers additional insights.

The part on conceptual aspects of section 2 includes considerations all modellers have to decide on. What is the scope of the analysis? Is an equilibrium model required? Shall it be partial or economy-wide. Which effects if any shall the model depict outside the boundaries of the country analysed? An issue which could have been addressed also in this section is the level of commodity breakdown. This is a significant choice to be made. On which basis is it to be done?

The discussion on specification and modelling issues covers such important aspects like handling of time. Most of the models included are either static or recursively dynamic. Only one is forward looking searching for the steady state growth path. This reveals that many difficulties exist in modelling forward looking behaviour. Issues like how to account for intra-industry trade, scale economies, policy representation are covered. The discussion is short with regard to two aspects; theoretical consistency and functional representation.

The theoretical underpinnings is briefly dealt with. Given that partial equilibrium models often lack theoretical considerations this topic could have been given considerably more considerations. In building a model one always has to make the decision on how rigorously theoretical consistency to be enforced. Modelling is believed to be easier if some of the theoretical conditions are not maintained; like the one ensuring the correct curvature. That is the major reason for many partial equilibrium models to be theoretical inconsistent. Often

only homogeneity is imposed. Some modellers also consider symmetry as important and maintain it. But what does one gain from an approach which enforces only a subset of all conditions necessary following microeconomic theory? Curvature often is not part of this set. It is not to be overlooked that all these three conditions and the fourth one, monotonicity, are a direct result of rational behaviour of the economic agent. They are realistic and not artificial. Only one of the partial equilibrium models included in the review, the MISS model maintains all restrictions with regard to optimal behaviour of the economic agents it represents¹⁷. All other seven fail in this respect. This itself is an indication of how these modellers assess the importance of representing microeconomic theory in their analytical tools. It should be noticed that it is common practice to design general equilibrium models to be theoretical consistent.

The functional representation and structure of the models could have been dealt with in more detail. Though further insights are provided in the Annex to the paper, which is highly recommended for reading, there is no assessment of the models in this respect. For the less informed reader it is very difficult to distinguish the models based on the algebraic functions used. There are often maintained hypotheses hidden in these functions which cannot easily be detected by those not familiar with the model. For example, in depicting production technologies a rather restrictive functional form such as the CES is frequently used in general equilibrium models. This function restricts substitution possibilities among the independent variables rather strongly. It contains the maintained hypothesis that substitutability among any pair of distinct variables is alike. Due to this single constant elasticity of substitution it does not have the flexibility needed to reflect adequately second-order effects if three or more independent variables are included in the analysis. To make the reader aware of such impediments would have been very valuable.

In a recent paper Perroni and Rutherford (1995) argue that in applied general equilibrium models it is very important to have theoretical properties to hold globally and that a modified version of the CES, the Nonseparable Nested CES, is best suited from this point of view among a class of widely used specifications. Using functions which lack this property may lead, it is said, to numerical instability for the solution algorithm. However, they also stress the information available for calibrating a general equilibrium model is typical 'local'. Therefore, they prefer to have second-order curvature conditions to remain constant over

¹⁷Even this is not certain because it is said in the more detailed description provided in section 1.6 of the Annex that elasticities are adjusted for 'more theoretical consistency'. This suggests the interpretation that also this model does not adhere to all theoretical conditions.

the entire domain of the variables. This is difficult to be seen from an economic point of view. Unfortunately, the authors also do not provide any justification for this requirement.

The CES specification is also often applied for differentiating between imported and domestically produced goods as well as between the various origins of imports. This is the case for both partial as well as general equilibrium models and also in quite a number of the models reviewed in the study. This procedure is the well-known Armington approach. It is mirrored in modelling exports by using the CET function. The problem arises due the assumption that regardless from which countries the imports originate any two pairs of imported (exported) goods have the same substitution elasticity and this figure is constant no matter how large the share of a product. Clearly, the knowledge base of how much different these substitution elasticities are in reality is also very shallow. Besides limiting substitution possibilities the CES and the CET function also imply a homothetic structure. Used for differentiating trade this implies that the import (export) shares are invariant to the total amount of imports (exports). However, one should not be too restrictive in using a functional form and allow for differences in substitution elasticities. Both characteristics are rejected in empirical studies (Ito et al., 1990, Yang and Koo, 1993). It is shown that the Armington model seems to underestimate price responsiveness of imports.

Among the partial equilibrium models reviewed almost all of them use the double-logarithmic linear function. Problems arise with this algebraic form due its lack of theoretical consistency. Only after imposing severe and rather unrealistic restrictions on the parameters, which are elasticities, can the theoretical conditions be shown to hold. As mentioned above, it is quite questionable whether elasticities remain constant over the domain of independent variables. Those who prefer this function argue that it is parsimonious and easy to estimate because elasticities are independent of the unit of measurement.

Given the observed preference by partial-equilibrium modellers for using the double-log function partial models are disadvantaged in comparison to general equilibrium ones because of their lack of theoretical consistency. The latter are always designed to meet these conditions. However, other functional forms can be employed in partial equilibrium models as well and obviously without any problem in adhering to the regular conditions. Though many algebraic forms do not have the capabilities to maintain these conditions over a certain domain of the independent variables.

Fuss et al. (1978) list the following criteria for selecting a functional form; parsimony in parameters, ease of interpretation, computational ease, interpolative and extrapolative robustness. In an article published some years after, Lau (1986) puts emphasis on slightly different ones; theoretical consistency, domain of applicability, flexibility, computational facility and factual conformity. Though Fuss et al. do not explicitly mention flexibility as being an important criteria by discussing various effects a function should be able to capture they always implicitly refer to this characteristic. In their view, in production analysis these effects include considerations of output level, scale economies, distribution shares, own price elasticity and substitution elasticities. A function which is flexible of the second-order has the capability of depicting these effects. Flexibility means the ability of the algebraic functional form to approximate arbitrary but theoretically consistent behaviour through the appropriate choice of the parameters (Lau, 1986). The degree of flexibility required depends on the purpose at hand. Most often second-order flexibility is asked for. This means that the algebraic values of the function can be determined in a way as to make it fit any value of the function itself as well as its first and second derivatives. In terms of a profit function, this means the level of profit, the output and input demand values as well as the own and cross-price elasticities can be depicted. The Cobb-Douglas is flexible only of the first-order; i.e. it is incapable of attaining arbitrary second-order (substitution) effects. This holds also for the CES in the case of three goods and more. In the two-good case, this function is also second-order flexible.

The double-logarithmic linear function is flexible of the second-order type but has problems in meeting the regularity conditions. Though not as severe as this function other algebraic forms have the same problem. As shown by Lau (1986) it is impossible to find a function of the class which is linear-in-parameters that holds both theoretical consistency and flexibility over the entire domain of the independent variables. In other words, ensuring flexibility globally makes it impossible to have theoretical consistency hold also globally and vice versa. A compromise is necessary. Many authors suggest that these properties are required to hold only in the neighbourhood of the observed data since any realistic policy analysis focuses on instruments nearby those having been observed in the more recent past.

Flexible functional forms of the second-order type, which meet regularity at least over a certain region, can be calibrated with relatively little effort and no more information required than a set of elasticities and, of course, the quantities of output and/or derived inputs. The only condition is that, after imposing the regularity conditions, the functions do not have more parameters free for calibration than there are independent second-order effects (elasticities) as well as first-order effects (quantities of inputs and/or outputs). One can use

as calibration procedure an algorithm which seeks to fit the parameters of the functions as to minimise the deviation from the elasticities implicit in the model and those a-priori determined (Frohberg and Winter, 1999).

This leads to another issue which is of high importance and far too little stressed in the paper; i.e. parameter estimation. Nowadays, it is almost completely out of fashion among builders of equilibrium models to estimate the parameters from what ever data are available. Rather, the values are borrowed from other models. For the partial equilibrium models, the one most often quoted in this respect is SWOPSIM. This analytical tool is not only widely used by other agricultural economists it also is the origin for the empirical content of many other partial equilibrium models. It is interesting to check from where the developers of this model got the empirical information. Such an undertaken reveals quite some embarrassing insights. The parameters of SWOPSIM are estimates obtained from single commodity studies carried out in the earlier eighties. In other words, price responses obtained from studies undertaken about 20 years ago for quite some different type of analysis are still the basis for many investigations done today. Two of the eight partial equilibrium models employ estimated parameters. The general equilibrium models usually also contain parameters which are calibrated based on predetermined elasticities.

Barnett et al. (1990) suggest another approach for parameter estimation and strict conditions for choosing the appropriate functional forms. In terms of selection of functions, they recommend forms which are able to incorporate as much flexibility as can be supported by the empirical information and to maintain all theoretical conditions over the regions relevant for the investigation. They have developed a new function, called 'Asymptotically Ideal Model'. Regarding the estimation procedure, they recommend to employ the Bayesian procedure for seminonparametrical estimation.

The authors of the review paper briefly mention economies of scale and its impact on gains from trade. A related issue not addressed at all in the paper is economies of scope. For agriculture, this also bears quite some relevance. On the other hand, the availability of new technologies in primary production processes considerably increases the size of an operation where the optimal scale is reached. This aspect gets perhaps too little attention in many of the models. Even more important is scale economies in the food processing and distribution industry. The concentration in the number of companies this industry currently goes through provides sufficient evidence of this fact. Problems in modelling these structural changes do not arise because of unsolved methodological issues rather they have their roots in the lack of adequate data availability. Large, including multi-national companies are not

interested in providing insights in their operations by offering statistics. Nevertheless, scale economies remains an important issue which should be addressed in any model investigating the impact of agricultural and food policies.

Closely related to this topic is incomplete competition. Most models, whether they are of the partial or general equilibrium type, assume perfect market structure. On the other hand, we find that product differentiation becomes a strategic behaviour pursued more and more by processing firms. Hence, market structure is to get more attention for analysing international trade in agricultural and food products. However, most of the models do not incorporate any aspects beyond primary production. This neglect is unfortunate since agriculture capture a rather small share of the value added in the entire food chain. In highly developed countries, this share is considerably below 20 %. Hence, many of the models depict the technologies and preferences only up to farm gate levels.

Other relations influencing more and more responses of producers and consumers to changes in policies are institutions. With the exception of policy instruments they are completely ignored in all models. It seems there is urgent need to open the models for these structures. If one considers that in developed economies institutions reach more than 60 % of total GDP it is difficult to justify this omission (Furubotn and Richter, 1998, p. 51). The models currently in use become more and more those of the reduced-form type. Production technologies become less and less crucial in determining supply while institutions gain in importance.

In summarising, the authors of the paper shall be recommended for their efforts in taking up the challenge of offering this survey to a large audience. It is hoped that it receives the broad attention it deserves. If this comment contains additional remarks then it is only because of making the reader aware of additional issues which are of relevance beyond those covered in the review. It is always easy for someone to 'criticise', especially if the person often has been 'on the other side' among the authors.

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Assessment of the Usefulness of GTAP for Analysing Multilateral Trade Liberalisation

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1. Introduction

This paper is concerned with the application of the GTAP model and database for assessment of multilateral trade issues, with particular emphasis on the important elements in relation to EU agricultural policies. The starting point for assessing new trade issues is the trade policy landscape left in place by the Uruguay Round (UR). One of the most important aspects of the UR was a decision to continue the process of reform and liberalization through further negotiations. These were to be initiated at the end of 1999. However, with the collapse of the WTO Ministerial in Seattle, the future is now less clear (or rather has been revealed to be less clear than was thought). The so-called Millennium Round (MR) foundered on a number of issues. The protests outside the meeting halls in Seattle were broad, focused on environment, labour standards, developing country concerns, and a myriad of anti-globalization positions. Within the meetings, however, the greatest stumbling blocks were developing country opposition to any trade liberalization, and EU-US intransigence on agricultural policy. The EU response to outside pressure on agricultural prior to Seattle was to throw everything tangentially related to trade out onto the table, effectively confusing the issue links between agriculture and other core trade policy issues. Regardless of the resolution of developing country concerns, agricultural policy concerns (and especially EU concerns in this regard) have a very real potential to prevent the launch of new trade negotiations.

In the next section we deal with the relevant policy issues that were negotiated in the UR and that will need to be negotiated in the next multilateral round. In section 3 we discuss the usefulness of GTAP for assessing these policy issues, by first giving a short overview of how policy measures are currently modeled in GTAP. Next, we focus on the "modelability" of the different policy issues within GTAP. The final section concludes and describes 3 potential future applications.

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2. Policy issues

As this paper falls within a larger project focused on agriculture, we focus on EU agricultural policies. Hence, the Uruguay Round Agreement on Agriculture and its implications are discussed at some length. At the same time, it is important to recall that the URAA, though a crucial element of the negotiations, was not negotiated in isolation. On the contrary, the extensive and complicated negotiations were a process of balancing all the different preferences of the WTO-member countries. In addition, the implications of the Uruguay Round for other non-agricultural sectors will also have an important impact on world agricultural trade and the overall outcome of UR implementation. As mentioned by Francois (1999), different sectors are both directly linked to agriculture, as with the link between chemicals and agriculture through the production of fertilizers and pesticides, and also indirectly through their competition for resources in capital and labour markets. This means that when the UR and its implications are studied by focusing on only part of the UR, these direct and indirect links might be underestimated, resulting in biased results.²⁰

In the remainder of this section, the URAA and the potential developments for a new multilateral round are first discussed. Next, as they are part of the larger picture, the policy issues related to manufactures trade, services and trade preferences are also examined.

2.1 The URAA and developments for the next round²¹

The Uruguay Round Agreement on Agriculture (URAA) established a new regime for agricultural trade under the headings of market access, export competition and domestic support.

Market access

Market accessibility was to be made more transparent by converting non-tariff import barriers to tariffs. This process is referred to as 'tariffication'. Under tariffication, new and existing tariffs were to be bound and reduced on average by 36 per cent over a 6-year implementation period. Unfortunately, the process of tariffication was complicated by loose interpretation of the relevant guidelines. As a result, OECD countries exhibited a tendency to grossly

²⁰ For example, Goldin and van der Mensbrugge (1996) found, using the Rural-Urban-North-South (RUNS) model with special focus on the agricultural reforms, negative real income effects for Africa mainly caused by higher food prices. However, in other more comprehensive studies (e.g. Francois et al, 1996) the overall outcome was more positive.

²¹ This section draws heavily from Josling and Tangemann (1999).

overstate actual levels of protection, to ensure that they could avoid any real liberalization in those sectors. This process was called dirty tariffication. As a result of dirty tariffication (and combined with the possibility of uneven tariff cuts), the extent of liberalization is especially limited in highly protected 'sensitive' products. As a result the most protected commodities, such as sugar and dairy products, were liberalized the least.

To ensure that dirty tariffication during the UR did not actually lead to "trade liberalization" wherein we actually realized less trade instead of more, the URAA embedded the tariff components of market access commitments into a parallel set of commitments on current access and minimum access. Current access commitments, made in quantity terms, were portrayed to those outside agriculture negotiating circles (i.e. the public) as ensuring that there would not be an erosion in effective market access as a result of the URAA. At the same time, some liberalization was to be guaranteed through minimum access commitments, set at 5 percent of 1986-88 consumption levels. The combination of the two leads directly to quantitative commitments (and quantitative restrictions) on market access. These are managed through tariff-rate quotas.

Tariff-rate quotas are, in effect, a two-tiered tariff system. Up to the quota level, a relatively low tariff is charged. Above this level, a high (and often prohibitive) tariff is charged. Depending on the level of these tariffs and the level of trade, substantial rents can be tied to in-quota imports. The quota levels themselves are determined by current and minimum access commitments.

In theory, while current access commitments could be allocated on a bilateral basis, minimum access commitments should have been allocated on an MFN (i.e. non-discriminatory or most-favored nation) basis. In practice, there is typically no distinction between the two regimes in national tariff schedules. Up to the total access (current and minimum) quota levels, we tend to find a within-quota tariff in national tariff schedules, with imports above this access level, or outside the quota, typically assessed a higher tariff. In cases where the out of quota rate is prohibitive but the quota is largely filled, we in effect have a strict quota system for food imports. The sharing of the relevant quota rents is determined by how the quotas are allocated, and by the in-quota tariff rates. Where the out-of-quota rates are not prohibitive, the two-tiered tariff structure still creates quota rents and all of the political economy considerations associated with rent seeking (and well known from our experience with the Multi-Fibre Arrangement). In yet other cases, the in-quota tariff rate is so high that exports are below the quota levels (i.e. market access has eroded since the end of the UR), and the in-quota tariff rate is the binding constraint. In contrast to the regime for textiles

and clothing, wherein trade restrictions were largely a North-South issue, in agriculture TRQs have been employed by both developed and developing countries. Hence, the implied quota rent transfers are potentially a drain on incomes in both developed and developing food importers.

An important reason why quotas are unfilled in this new regime is the way quotas are allocated. While access commitments were supposed to be MFN based, silent deals were sometimes struck wherein quota allocations were awarded to key suppliers during bilateral negotiations. (Tangermann 1998). As a result, in practice these quotas often are purely bilateral. In addition, the bilateral nature of these quotas has been reinforced by liberal interpretation of the rules. For example, in the case of the EU, there has been an explicit assertion that expanded access for Central and East Europeans under the Associate Agreements will be counted against overall access commitments. On net, we now have a system where protection of politically sensitive agricultural products is often bilateral, and involves quota rents. For other products, we have seen a move toward a price-based system, though one sometimes characterized by very high tariff bindings.

Export competition

In the case of export promotion (i.e. export supports), the changes in the rules were less strong, though the direct trade effects may be more significant. Export subsidies were to be reduced both in terms of expenditure and of volume. The allowed expenditure was to fall by 36 per cent, and the volume by 21 per cent. Although the definition of export subsidies contained in the URAA is fairly rigorous, the definitions of commodities are not. Countries declared commodity aggregates instead of individual tariff lines, which allowed them more flexibility with regard to export supports. For example, the EU included some 40 products as coarse grain. Although the export subsidy commitments have been cited as one of the most important achievements of the round, it should be noted that trade in many products will continue to be heavily distorted at the end of the implementation period.

Domestic support

In theory, transfers to producers through domestic support programs were also limited and had to be reduced by 20 per cent. The domestic support level is measured by an Aggregate Measurement of Support (AMS) defined within the URAA. In practice, the definition of the AMS means that the constraint on any particular commodity is slight. In addition, it was agreed that measures with a minimal impact on trade could be used freely. These 'green

box' measures include government services such as research, disease control, infrastructure, and food security. They also include payments made directly to farmers that do not stimulate production, such as certain forms of direct income support, assistance to help farmers restructure agriculture, and direct payments under environmental and regional assistance programmes. Finally, the USA and the EU also agreed during the negotiations on a 'blue box' category of policies, which, although production neutral, are coupled with supply reduction instruments.

Though countries committed to cut their market price support in the URAA, they have actually engaged in a game of shifting the support (at least partly) into the forms that are allowed in "green" and "blue" categories. A good example of this is CAP reforms where measures affecting market prices have been transformed into animal and land premiums that are fixed to given number of animals or fixed amount of land. Another is the recent pattern of annual "emergency assistance" payments, in the range of \$9 billion per year, made to U.S. farmers as income support.

Potential issues in a new round of agriculture negotiations

One positive contribution of the URAA is a framework for future negotiations. New agricultural negotiations may usefully start from the new disciplines agreed in the UR and improve them by strengthening the rules and making further reductions. Because it is difficult to predict all the issues that would actually be negotiated, in this section we will briefly discuss the relevant issues that are most likely to be on the agenda. These will then be mapped to modelling issues.

In the area of market access, tariff reduction will remain an important topic. A major issue here is whether countries will be willing to offer significant concessions on a few 'sensitive' products, which they were able to avoid in the last round. Another important topic is the future of the tariff rate quota system. The negotiations will probably focus on developing a more uniform system for the administration for the TRQs, or at least eliminating some obvious absurdities in current procedures for allocating licenses under TRQs.

On export subsidies some additional reduction on expenditure and quantity levels if a possibility. In addition, further improvements can be made in defining export subsidies as precisely as possible. The agenda for domestic support is likely to focus on an additional round of reductions of subsidies falling within the AMS, and the measures to be included in the so-called 'blue' and 'green' boxes. It may also be that the role of blue box payments is

questioned in the new negotiations. The U.S. has already transformed its direct payments into a form that qualifies it as green support. Apart from some insignificant agricultural products like Norway and Iceland, the EU is now the only trading region where blue support still plays a major role in agricultural policy (USDA, 1998). Of course, movement in this area will also be tied to restructuring of the CAP. Another possible upcoming issue is targeting of domestic support to individual commodities. Under current practice, domestic support has been calculated as an aggregate measure. This was deliberate, as it gave major players (especially the EU) room to hide support for individual sectors behind these aggregate measures. Since the EU has sizably redirected subsidies towards the blue box, this has created room to increase domestic amber support in individual products (see Swinbank, 1999, Table 1). One possible way to actually target this type of support is to seek product-specific commitments within the aggregate targets.

Other issues

Several other issues of interest for world agricultural trade have been introduced in the UR Agreements, or might otherwise be placed on the next agenda. These include Sanitary and Phytosanitary (SPS) measures, technical barriers to trade (TBT), and the admissibility of genetically modified organisms (GMOs). All of these featured in one way or another in the Seattle protests. They will most likely remain on the political radar of agriculture ministries. They are also particularly hard to quantify, as in practice they can provide cover for both political and legitimate reasons for taking action against agricultural imports. Some of these issues may be reducible to alternative technologies for export goods. (Hormone vs. non-hormone based livestock production, for example). However, they do not generically lend themselves to standardized modelling methods as featured in GTAP.

2.2 Non-agricultural policy issues

Industrial tariffs

Another important feature of the policy landscape left by the UR agreements is tariff bindings on industrial goods. Tariff negotiations in the Uruguay Round were not actually about applied tariff rates, but rather tariff "bindings." Tariff bindings are commitments not to raise tariffs above a certain level. In the case of OECD industrial tariffs, there is a close correspondence between applied and bound rates. This is not the case for developing countries. In particular, for developing countries, the industrial tariff landscape features bound

rates often well above applied rates. For the poorest developing countries, tariffs are often completely unbound.

Under the UR, the share of developing country imports of industrial products subject to tariff bindings rose from 13 to 61 per cent (Blackhurst et al 1996). This rise was mainly due to commitments by Latin American countries to apply ceiling bindings on 100 per cent of tariff lines, and commitments made by Asian developing economies. Some of the Latin American bindings pre-date the end of the UR. Chile was the only developing country that offered to bind 100 per cent of its tariff lines in the context of the Tokyo Round, while Costa Rica, El Salvador, Mexico and Venezuela bound 100 per cent of tariff lines upon accession to GATT during the period 1986-91. Among Asian developing economies, Indonesia bound more than 90 per cent of tariff lines during the UR. India, the Republic of Korea, Malaysia, Philippines, Singapore and Thailand bound between 60 and 89 per cent. Sri Lanka and Zimbabwe bound less than 15 percent. The result of this process is presented in Table 1. The table presents an aggregate picture of national tariff commitments, applied rates, and the implications of a hypothetical tariff binding cut of 25 percent.

What is important for the next Round is the current level of ceiling bindings vis-à-vis applied rates and the limited scope of bindings coverage. Even where they are bound, applied industrial tariffs are often far below bound rates. Taken together with unbound tariffs, this means that developing countries will, collectively, be able to reduce ceiling bindings (or introduce them for the first time) while having to make only modest (and in many cases no) changes at all to applied rates in a future trade round. For most developing countries in the table, a 25 percent reduction in average bound rates would imply a zero reduction in average applied rates. (Francois 1999). Hence, for industrial tariffs, the relevant scenarios for the next round are likely to involve little or no reduction in most developing country applied tariffs. This will be true whether or not developing countries take an active part in industrial tariff negotiations. There are important exceptions in developing Asia (like Malaysia and Indonesia). These are however exceptions rather than the rule. As in previous rounds, there is a good chance that only OECD countries will reduce industrial tariffs as part of any upcoming industrial tariff negotiations.

For the GTAP community, the challenge is to ensure access to a set of post-UR tariff vectors that is mapped to the GTAP model sectors. This is because GTAP is generally benchmarked to a recent year, including recent tariff levels. Yet, substantial changes in tariffs may still be realised, due to UR commitments, between the benchmark year and the end of UR implementation in 2005.

TABLE 1.

Industrial tariff rates and bindings

	percent of GATT imports			mean industrial tariffs		Percent applied rate cut implied from an average reduction in bound rates of 25% ^{1/}
	bound	bound above applied rates	unbound or bound above applied rates	current applied rates	bound rates	
Argentina	100.0	99.9	99.9	14.1	33.5	0.0
Australia	96.9	31.7	34.8	4.4	12.1	0.0
Brazil	100.0	91.0	91.0	18.3	27.7	0.0
Canada	99.8	45.7	45.9	3.2	4.3	0.0
Chile	100.0	99.7	99.7	10.9	24.9	0.0
Colombia	100.0	97.7	97.7	10.5	35.2	0.0
El Salvador	97.1	96.0	98.9	3.8	31.7	0.0
European Union	100.0	17.7	17.7	3.5	4.5	3.6
Hungary	93.6	3.3	9.7	9.8	6.1	53.3
India	69.3	14.8	45.5	29.5	34.2	13.1
Indonesia	92.3	86.6	94.3	14.9	36.9	0.0
Japan	95.9	0.1	4.2	1.5	1.5	25.0
Korea	89.8	3.4	13.6	7.8	16.4	0.0
Malaysia	79.3	31.0	51.7	9.4	8.9	29.0
Mexico	100.0	98.4	98.4	12.0	33.3	0.0
New Zealand	100.0	46.5	46.5	4.0	11.9	0.0
Norway	100.0	36.5	36.5	2.4	2.6	18.8
Peru	100.0	98.5	98.5	12.5	29.4	0.0
Phillipines	67.4	15.5	48.1	9.1	21.3	0.0
Poland	92.8	44.6	51.8	14.2	8.5	55.1
Singapore	36.5	11.7	75.2	2.7	6.9	0.0
Sri Lanka	9.2	1.4	92.2	19.8	17.9	0.0
Thailand	67.4	8.9	41.5	43.7	27.3	53.1
Tunisia	67.9	41.5	73.6	23.5	38.4	0.0
Turkey	49.3	0.0	50.7	5.7	16.3	0.0
United States	100.0	14.0	14.0	2.7	3.5	2.8
Uruguay	100.0	96.3	96.3	10.7	27.9	0.0
Venezuela	100.0	90.3	90.3	10.9	31.3	0.0
Zimbabwe	13.6	3.9	90.3	20.5	23.6	0.0

Notes: ^{1/} If more than seventy five percent of trade is unbound or bound above applied rates, the cut is assumed to be zero. This affects Sri Lanka and Zimbabwe. All other values are based on comparison of adjusted bound rate to applied rate.

source: Finger, Ingco, and Reincke; and World Bank *World Development Indicators*.

Trade in services

Under the General Agreement on Trade in Services (the GATS), services trade is classified in four modes of supply

- cross border supply
- consumption abroad
- commercial presence
- presence of natural person.

From the outset, service negotiations in the UR were "qualitative." They have not targeted numeric measures, but rather commitments in the cross-border movement of consumers and providers and the establishment of foreign providers, as detailed above. As a result, efforts to quantify market access in service sectors (a basic requirement if we want to then quantify liberalization) have been problematic at best. The standard approach (an example is Hoekman 1995) has been to produce inventory measures.

Service representation within GTAP is important for two reasons for agriculture modelling. The first is that, in future negotiations, progress in agriculture is likely to be linked to progress in services. The second reason is that there are strong linkages between the service sector and production and trade in manufacturing and industry. (See Anderson 1999 and Francois and Reinert 1996).

GTAP does not handle service sector issues well as currently constructed. The theoretical structure does not represent services trade, the policy data does not include services, and the level of aggregation is inappropriate. These issues will be discussed in the next section.

Developing country preferences

A concern in past rounds, and certainly one for the next round, is the extent to which trade preference erosion harms developing countries. In the case of the EU, this involves the Lomé Convention, which is the main tool of development policy, focusing on the former colonies of European countries. Related to this are recent conflicts (like the EU banana regime) that have focused on trade preferences.

The European Union has several trade agreements or proposed agreements with developing countries. To some extent, these agreements are a continuation of pre-EU colonial trading arrangements. They include agreements with the Mediterranean countries, Mercosur, South Africa, Eastern and Central European Countries and the African, Caribbean and Pacific countries (ACP, Lomé Convention). Regional co-operation and integration support has been a cornerstone of EU development policy, in addition to direct assistance, training and funds provided for stabilisation.

A common principle within the GATT for organising trade between developed and developing countries is the Generalised System of Preferences (GSP). Under GSP, preferential tariff treatment is granted on a non-reciprocal and non-discriminatory basis by most developed countries to exports from developing countries. Specific products are allowed to enter importing markets with most-favoured-nation (MFN) duties reduced or

importing markets with most-favoured-nation (MFN) duties reduced or eliminated. In practice, most sensitive agricultural products are exempted from these programs. In other cases, the system works to discriminate against some developing countries in favour of others. (Witness the banana regime for example). For the European GTAP community, what is important is the representation of EU regional and developing country preferences within the GTAP database. The most important of these is the Lomé Convention. The Lomé Convention has been the primary framework for the EU's external relations covering trade and development aid between the EU and 70 countries in Africa, the Caribbean and the Pacific (ACP). The negotiations for renewal of the expiring convention are proceeding and the coherence between WTO rules and EU's development policy is one of the guidelines in negotiating the new agreement. These guidelines apply to trade preferences, where duty-free access to European market is guaranteed for manufactured products from ACP countries. The agricultural products are treated in the Common Agricultural Policy of the European Union except for quotas in market access for certain sensitive products, such as beef and sugar.²²

3. URAA Assessments with GTAP

Having provided a brief outline of WTO-related policy issues, in this section we turn to the use of GTAP in assessing these issues. For CGE modelers, the workings of the URAA pose a number of challenges. As noted above, there are several institutional features that are important for understanding and representing the URAA, and any future negotiations in this area. These features include:

- Green/amber/blue box
- Tariff-rate quotas
- Export subsidy limitations
- Various quantity commitments
- Ceiling vs. applied rates

²² In renegotiating the Lomé Convention, there is a possibility for European Union to apply its GSP to the ACP countries. One problem arising in this option is the group of countries that are not included in the Least Developed Countries (classification by United Nations), to which GSP applies. In particular, these ACP non-LDC countries would lose in their commercial positions with EU. In general, the tariff levels in GSP are lower compared to developed countries, but higher than in the Lomé Convention. Of course, one can view the problem in the obverse. At the moment, some of the poorest developing countries, because of their particular colonial legacy, are discriminated against in favor of high-income developing countries under the current regime.

We focus first on GTAP applications related to the Uruguay Round. None of these really consider all or most of the explicit features of the URAA outlined below. We then turn to briefly to new research. Finally, we will focus in the next section on necessary extensions to GTAP.

While GTAP did feature prominently in the CGE work on the Uruguay Round, only a handful of GTAP studies placed any real emphasis on EU interests in UR implementation. These studies included Francois et al (1996,1997), Hertel et al (1996), and Harrison et al (1997). This literature, for the most part, treated agriculture as a mixture of import and export price-instruments (i.e. import and export subsidies and taxes). In one of their papers, Francois et al (1996) do introduce notional quantity commitments under the URAA. However, no one really focused on the mix of price and quantity commitments that emerged under the URAA. This is understandable. The research community did not really grasp the meaning of the emerging agriculture architecture until well after the Round (and related assessments) had been completed.

More recent applications has been more realistic, focused more on the actual workings of the URAA. These papers are however experimental, and are not generally available as GTAP extensions. They include Elbehri et al (1999), who are working on examination of the implications of TRQs for GTAP-type policy assessment. They also include important data work, like that by Abbott and Morse (1999) on the application of TRQs by developing countries.

4. GTAP Issues

4.1 Policy measures in the basic GTAP database

Before we turn to the use of GTAP for upcoming WTO-related issues, we present a brief review of how all policy measures are currently represented in the core GTAP database. Policy measures are presented as ad-valorem price wedges and they are subdivided into border measures and producer subsidies. Border measures are defined as differences between domestic and world market prices and domestic measures as differences between supplier and market prices.

The tariff data used in the protection data base draw on the original country submissions to the GATT for the UR. Bilateral tariffs at the GTAP level of aggregation were constructed by aggregating applied tariff rates from the tariff lines to the GTAP sectors using bilateral import value weights. This aggregation from different tariff lines can cause a problem when

assessing trade liberalisation scenarios. Current practice in most applications involves applying liberalisation scenarios to aggregated tariffs. However, it is much preferable also to aggregate the detailed tariff reductions as outlined above.

The GTAP estimates of producer subsidies and border measures for agricultural commodities are based on producer subsidy equivalent (PSE) calculations done at the OECD for the year 1995. Several types of policy measures are included in the OECD PSE calculations: market price support, levies on output, budgetary payments paid directly to producers, reduction in input cost, general services, programs funded at the local or regional level and other indirect support. Market price support is an indicator of the annual monetary value of the transfer from consumers and taxpayers to the agricultural producers in the form of price gaps between domestic market prices and border prices of agricultural commodities. These price gaps are caused by the policy measures, which include tariffs, import quotas, administered prices, or trade licensing arrangements. In GTAP database calculations, the market price support component of the PSE determines the border measure i.e., the power of the import tariff equivalent, and power of the export subsidy equivalent. The total gross PSE less the market support component determines the producer subsidy. Unfortunately this measure of producer subsidy does not exactly correspond with the AMS as specified in the URAA.

4.2 Extending the Application of GTAP

A representative basic set of URAA related GTAP modelling issues is presented in Table 2. The table emphasizes several points. First, with regard to the AMS, GTAP does not explicitly incorporate data or theoretical mechanisms linking domestic support to AMS restrictions. Furthermore, because the GTAP protection data are inferred from PSEs and CSEs, they do not actually reflect real payments comparable to those included in the AMS. Representation of the AMS will therefore require satellite accounts of actual subsidy payments, their relationship to AMS constraints, and the underlying policies that lead to the (endogenous) support payments. Because the AMS is very flexible, it may be impossible to do more than produce, as output, indicators of when AMS restrictions may be violated.

Another important issue on which the GTAP framework currently provides no support is TRQs. At a basic level, detailed data-work is ongoing at the OECD (coordinated through USDA) on product-specific policy regimes. However, at this stage data simply are not available for detailed assessments involving TRQs and the related scope for tariff and quota concessions in future negotiations. On a technical level, the operation of TRQs involves a

TABLE 2. Issues Regarding Modelling of Agriculture under the WTO

	Policy issues	Existing GTAP applications	If YES: How can they be improved? If NO: How can GTAP be applied? ... and other remarks.
1.	Interaction between the AMS restrictions and subsidy levels.	No	Sectoral subsidy payments need to be linked to aggregate restrictions. However, given the degrees of freedom available to meet AMS restrictions, analysis would need to be limited to noting if AMS levels are violated or not. This requires reporting on support payments in the model and linking them to AMS levels.
2.	Tariff-Rate Quotas.	Yes and No	Research in this area is new. The technical problem of modelling TRQs has been at least partially solved, both in GEMPACK and GAMS. The real limitation is lack of comprehensive data for the task of generic inclusion in GTAP.
3.	URAA Export Subsidy Limitations.	Yes	URAA restrictions on export subsidies have been modelled, albeit in a crude fashion. Progress could include linking endogenous subsidy levels to actual policies (like price support programs), with UR commitments entered as constraints. This would capture interaction between current and future subsidy commitments and the GE effects of other commitments.
4.	URAA Quantity Commitments	Yes	The work done on URAA quantity commitments in general equilibrium has been highly stylised. It would be helped if satellite accounts were developed linking actual quantities for the GTAP base year to commitment levels. This is related to the data requirements for TRQs.
5.	Ceiling vs. Applied Rates in Agriculture	No	This is basically a data problem. Satellite accounts are needed linking base year protection in the GTAP database to bound rates. This requires inputs from the WTO Integrated Database and from the schedules maintained by the WTO Agriculture Division (perhaps through USDA). This also requires working with data from national tariff schedules rather than PSE-based import protection estimates. This is closely related to the data problems for points 2 and 4.
6.	Technical barriers, health concerns, etc.	No	GTAP is not suitable for product specific technical protection assessments (Except perhaps for retaliation assessments under dispute settlement.)

mix of slack and binding constraints. In GEMPACK, the basic technology involves Bach and Pearson's (1996) work on implementing quotas in GEMPACK. Given the nature of the constraints, other platforms might be better suitable for this set of questions. For example, GAMS/MPSGE is explicitly designed for slack-complimentarity problems of this type.

However, software platforms are irrelevant as long as data on the regimes is unavailable. For this reason, other ongoing GTAP-based work (see Anderson et al 1999b) still is based on price based measures, which in turn is derived from OECD and USDA data on PSE and CSE equivalents. What is needed here is basic database and theoretical extensions.

One issue that did receive attention in the GTAP literature on the URAA is export subsidy commitments. This reflects the fact that GTAP does include notional data on export supports. However, even here there are problems. The current approach to agriculture protection in GTAP involves inferring border measures from observed price differences. Hence, the import and export measures are a reduced form, reflecting a number of different policies. To model export subsidy commitments in the WTO, actual subsidy levels must be integrated into the database. (Note that this was done for earlier generations of the GTAP database). This is necessary, as future commitments will be made with regard to actual support levels. Related to this, there is also a need to integrate links between the level of export and domestic support and import protection to underlying policy measures (like income or overall price support).

Yet another problem is the modelling of quantity commitments made in the URAA (and any future agreements). This is linked to the modelling of TRQs, as quantity commitments are often relevant in those markets where TRQs are operational. One important question is the extent to which commitments on a quantity level are inconsistent with observed import levels, and hence with applied rates. Under the URAA, governments made overlapping commitments on quantities and tariffs. If imports fall below pre-UR levels, this implies that applied rates, though below bound rates, actually violate UR commitments on a quantity basis. At a minimum, quantity commitments should operate as constraints in conjunction with other policy instruments. To operationalise this aspect of the WTO Agriculture Agreement within GTAP, satellite accounts are needed linking actual base period quantities to commitment levels.

Finally, in agriculture there is also the problem of ceiling versus bound rates. Of course, all of these (quantity commitments, ceiling and bound rates) come together in the operation of TRQs. Beyond TRQs, there is the more basic question of whether commitments to reduce bound tariffs will have any impact in markets where dirty tariffication led to bound rates well above applied rates. There is also the fact that, given commitments under the AMS, tariff bindings, minimum and current access quotas, and export subsidies, any of these bindings may kick in and act as the limiting constraint, depending on the levels of the other commitments and the interaction with policies in other sectors. Because of the emphasis on

non-price instruments, it would make sense to extend GTAP to allow, in a stylized way, for all of these instruments to be treated as endogenous (subject to bound constraints), and determined by an underlying policy objective like price or income supports.

Table 3 presents a broader set of issues. These are not exclusive to agriculture, but are important if agriculture is to be modelled in the context of other WTO commitments made in other sectors. The first of these is the generic issue of tariff overhang. This is a significant problem, in that ignoring it can lead to overestimation of liberalization in developing countries. Dealing with it requires data inputs from the WTO's Integrated Database. These data on bound and applied rates need to be matched to GTAP model sectors. There is an aggregation problem here, in that the relevance of bindings will be uneven across tariff line within one of the GTAP sectors. Ideally, the best way to deal with this would be to work with the WTO, UNCTAD, or World Bank to ensure that tariff offers, in future negotiations, can be aggregated on a real-time basis to GTAP sector, following line-by-line assessments of bindings, offers, and applied rates. More realistically, at a minimum satellite accounts are needed relating applied rates in GTAP to data on binding levels and coverage.

Two other issues listed in the table, services liberalization and trade preferences, are also largely data issues. In the case of services, further disaggregation is needed. This is forthcoming with GTAP version 5. Also needed is a set of satellite accounts linking GTAP service sectors to FDI flows and stocks in services (in keeping with the GATS commitment types listed above). In terms of trade preferences, the key issue is either explicit inclusion of current preferential tariffs in the GTAP database, or a set of satellite accounts relating GTAP protection to preferential rates. Some problems can only be addressed by expansion of the GTAP database itself. Most of the ACP countries are included in groups of countries in GTAP database. There are three African Regions that comprise only ACP countries: these regions are South African Customs Union (SAF), Rest of South Africa (RSA) and Rest of Sub-Saharan Africa (RSS). So it is possible to study the effects of Post-Lomé negotiations at least for some of the regions. From an EU perspective, one major task in studying the Lomé options would be to connect and make the EU GSP-system compatible with the GTAP data. This can be done by calculating and aggregating the GSP tariffs from the UNCTAD's TRAINS (Trade Analysis and Information System) database.

The final issue in the table is the relationship of regional initiatives (including EU enlargement, and the extension of the CAP to new members) to WTO commitments. There are important questions related to the operation of WTO commitments (like those in agriculture

TABLE 3 Other WTO Modelling Issues in GTAP

	Policy issues	Existing GTAP applications	If YES: How can they be improved? If NO: How can GTAP be applied? ... and other remarks.
1.	Tariff Binding Overhang.	No	This is basically a data problem. Satellite accounts are needed linking base year protection in the GTAP database to bound rates. For industrial tariffs, this requires inputs from the WTO Integrated Database (perhaps through UNCTAD or the World Bank).
2.	Services Trade Liberalization	Yes	Helpful extensions in this area would include development of a satellite accounts on services trade barriers, and analytical work on the representation of GATS commitments with a general equilibrium system.
3.	Trade Preferences	No	With the exception of the EU-EFTA, NAFTA, and Australia-New Zealand, GTAP does not include regional preference schemes or GSP schemes. What is needed is research to develop satellite accounts that include preferential tariff rates, mapped to the affected trade flows. This will also pose analytical problems related to the aggregation of regions and sectors, some of which get preferences and some of which do not.
4.	Relationship of regional integration schemes (EU enlargement, Free Trade Area of the Americas, etc. to WTO Commitments) to WTO commitments	Yes	While GTAP has been used to assess regional integration schemes, emphasis is not usually placed on implications for WTO bindings. Questions include: <ul style="list-style-type: none"> ▪ Does export of CAP to Candidate Countries violate WTO commitments? ▪ Do regional integration schemes lead to less market access for outsiders? If so, what tariff concessions are needed to offset this?

discussed above) on the structure of EU enlargement. Because the candidate countries have their own commitments in the WTO as well, any move toward integration will raise questions vis-a-vis third countries. Of course, the applied literature on enlargement deals explicitly with this issue. However, until the representation of WTO commitments reflects the actual agreements, the WTO lurks in the background but does not really enter as a binding constraint in assessments of enlargement. We know that how we represent CAP instruments in the GTAP data and model can affect GTAP results (see Nielsen 1999). It seems

reasonable to expect that a correct representation of WTO-related constraints in agriculture would also affect the results, compared to current work.

5. Conclusions and recommendations

This study has been concerned with the usefulness of GTAP for WTO-related agricultural policy issues. We can summarize as follows:

- GTAP is a useful tool: WTO agriculture negotiations usually take place in the context of multi-sector negotiations, involving all WTO Members and many sectors. For this reason, a general equilibrium approach makes sense. The GTAP model has demonstrated its usefulness for such WTO-related issues.
- GTAP has important limitations: The coverage of actual agricultural policy in GTAP is stylized at best.

Given the potential value of GTAP for applied general equilibrium work, there are areas where additional research would greatly improve its usefulness. For agriculture, these include both database improvements and analytical enhancements.

Recommended database improvements:

- Satellite accounts linking quantities by GTAP sector to WTO quantity commitments.
- A decoupling of actual payments from notional support payments in the database, combined with satellite accounts linking actual domestic and export support payments to WTO commitments.
- Satellite accounts linking GTAP protection to bound tariff rates.
- Satellite accounts providing information on national TRQ schemes.
- Satellite accounts with information on preferential tariff rates.

Analytical enhancements:

- Development of a standard GTAP module for TRQs
- Development of a standard module for endogenizing agriculture policy commitments, given WTO commitments as constraints. An example would be a "CAP" module that allowed endogenizing (with constraints) subsidies and border measures, given other objectives (like income maintenance, or price or output support).

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Comments on the paper Assessment of the Usefulness of GTAP for Analysing Multilateral Trade Liberalization”

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There is no doubt that applied general equilibrium (AGE) models have provided important insights into the consequences of trade liberalization in general and agricultural trade liberalization in particular. The great advantage of incorporating income effects and intersectoral factor flows, which are the main differences from partial equilibrium models, into analyses of trade policy changes can make considerable difference in these assessments. For instance changes in world prices of agricultural commodities due to the Uruguay Round are considerably different when estimated using partial equilibrium multicommodity models and AGE models (Sharma, Konandreas and Greenfield, 1996). In fact not only are there differences in the orders of magnitude of the estimated changes, but also there are differences in the direction of changes, and the relative price changes. These differences can be attributed to model structure, differences in assumed elasticities, the fact that different types of models incorporate different types of policy instruments, differences in benchmark data on initial tariffs or tariff equivalents, dissimilar aggregation of products among models, and different base periods for simulations (Sharma et. al, 1996).

The types of AGE models that have been utilized in assessments of the Agricultural Agreement of the Uruguay Round (examples are the OECD RUNS model, the model of Harrison, Rutherford and Tarr, the ones by Hertel and associates, the one by Francois and associates, etc.), share several common features. First they all include considerable detail for agricultural products. Although each separate agricultural sector is still in aggregated form, encompassing several individual products, the detailed specification of agriculture is much beyond what is normally done in more general economy wide AGE models. Second, they still maintain the standard AGE production structure, with each subsector having its own production function. This precludes much competition and substitution for sector specific factors like land. Third, they generally exclude detailed distributional considerations, except perhaps for a rural-urban division. This, however, prevents the consideration of issues such as part time farming and multiple sources of incomes for most agricultural households. These limitations are well known. The advantage, nevertheless, from using a general

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equilibrium framework include the possibility of simulating intersectoral factor flows (mainly labor and capital), and the possibility to incorporate and estimate income effects. The GTAP work has provided a framework of data collection and organization that has made the estimation and use of AGE models relatively easy.

The issue dealt in the interesting paper of Francois, Rombout, Vaithinen, and Kerkela has to do with the usefulness of the GTAP framework in the New (as yet not started) Round of Multilateral Trade Negotiations in Agriculture. They correctly first analyze the types of issues that have arisen in the Uruguay Round and the likely issues to arise in the New one. They correctly point out that several issues likely to be important in the New Round have not been treated before in the GTAP based AGE modeling work, and need data related as well as methodological and analytical improvements for their incorporation in the GTAP framework.

The major breakthrough of the Uruguay Round Agreement on Agriculture (Agreement of Agriculture) was that for the first time the protective effects of agricultural policies were quantified via a small number of summary indicators, and a base for liberalization was provided. Tariff equivalents, export subsidies, and domestic support were the main types of summary measures utilized. The contracting parties to the Agreement negotiated on market access, export subsidy limitations, and domestic support limitations. Other issues that were dealt with were technical ones like sanitary and phytosanitary measures, and the New Round is likely to include several more such issues, like genetically modified products, but these are much more difficult if not impossible to quantify in a general equilibrium framework.

The major question that must be asked at the outset is what type of information is likely to be useful for the new Round of trade negotiations, as far as agriculture is concerned, and what type of analytical models can provide this information. While the general public and the economics profession may be interested in overall welfare measures, these have never had much sway in influencing the adoption of specific protective policies. It is suggested here that the major type of information that is useful in trade negotiations is of a distributional nature. In other words, negotiators and governments are more interested in knowing the consequences of any immediate or medium term liberalization on specific income groups like farmers, workers, etc., as well as the public budget. This can be revealed, and is consistent, with the fact that while the overall consequences on the major agricultural trading economies (on magnitudes like GDP, etc.) from agricultural trade liberalization are generally positive and substantial, and the GTAP or other AGE model predictions of

changes in sectoral or subsectoral magnitudes from liberalization attest to this, the negotiations invariably produce much less liberalization than what is needed to produce the positive results. There is generally strong resistance to liberalization by several highly protective countries, and this is, of course, because the costs and benefits are not evenly distributed in the economy.

In this context one may wish to consider issues like the vulnerability of agricultural producers to trade liberalization. Table 1 presents some relevant numbers computed from Farm Accountancy Network (FADN) data on commercial EU farmers in 1987. It can be seen from the table that while there are considerable size and gross output differences among the average commercial farmers in the various EU countries, there are much smaller differences in labor input per farm. Given that generally the commercial farms of the "rich" EU countries of the North are larger, this suggests that commercial farmers of the North EU countries use technology that is more purchased intermediate input and capital intensive. The implication, as seen from the table, is that the Farm Family Income (FFI) as a share of gross farm output is widely different among EU countries. What is most interesting and suggestive is that this share is much lower in the richer and high income countries in EU, than in the poorer countries. For instance, in Denmark, the FFI as a share of total gross farm output is only 6.1 percent. This implies that a one percent drop in prices of the final output of farm products produced by Danish commercial farmers will have a negative impact on FFI of about 16.5% !. The same price decline will have a negative impact of FFI in Germany of 5.9%, and in France of 4.8%. It is thus no wonder that there is such resistance in EU commercial farm circles of the rich countries about trade liberalization. Small declines in average output prices without any compensation will most likely lead to very large farm family income declines, and hence a likely abandonment of farming. This perhaps also explains the insistence of EU farm policy makers of combining any price declines with compensatory payments.

Another issue of relevance here is the degree of specialization of farms. The consequences of trade liberalization are much larger on specialized farms than on multiproduct ones. In the EU and the US it seems that the large commercial farms are highly specialized, making them all the more vulnerable to trade liberalization. The consequences for modeling are that the models ought to give more consideration to the consequences of policy changes on farms and farm households, while the current models are much more focused on market outcomes.

A second issue of relevance to WTO negotiations and AGE modeling is the aggregation of policy measures. If one considers the protective regime for one agricultural commodity, it consists of four independent measures, neglecting domestic direct support and the difference between bound and applied tariff rates. These are market access commitments, in quota tariffs, out of quota tariffs, and quantitative limits on export subsidies. A given degree of domestic protection can be obtained by combining the above instruments. In the new Round, given that protection in agriculture is classified in these forms, the issue will not be only how much to reduce overall agricultural protection, but also of rearrangements within the various protective measures. For instance, one may envision that a given degree of liberalization can be achieved in several ways, such as by reduction of the in-quota tariff, reduction of the out-of-quota tariff, or increase in the TRQ without tariff changes. The difference between these combinations is largely distributional, and it is this that must be addressed in any applied trade model.

A third issue of importance in trade negotiations is compensation. Negotiations in multilateral trade liberalization discussions normally are conducted in terms of tradeoffs. These tradeoffs are not usually computed by reference to impacts on producers, consumers or the economy, but via simple formulas of the type: a 10% tariff reduction on some trade of US\$ 100 million is equivalent to a 20% tariff reduction on other items of trade of US\$ 50 million, or more explicitly that the net benefit in both cases is US\$ 10 million. Such implicit computations approximate the standard surplus measures derived from textbook excess demand curves. It is thus important to have reasonable estimates of such welfare changes in order to estimate the likely compensations required to achieve trade liberalization in various areas.

A fourth aspect that must be considered in relevant trade modeling is the impact of agricultural trade liberalization on input and processing industries. Given the high input intensity of most western farm production, protection implies considerable profits for input industries, such as fertilizers, chemicals, etc. Agricultural trade liberalization, consequently implies substantial losses. Such losses and potential gains to processing industries from raw material declines must be considered in AGE trade liberalization models.

A fifth issue that until now has not been treated in AGE trade liberalization models is market instability. In many EU countries, efforts to isolate domestic markets from international ones have led to specialization, and hence to larger aversion to instability. Trade liberalization will imply much more price transmission from international to domestic markets. This might have severe consequences for farmers that have conditioned their production struc-

tures and financial exposure on the basis of low price transmission. Different trade measures imply different degrees of instability, and this makes the issue even more important.

Many of the issues identified above are too detailed to be dealt with AGE models. Hence, in order to examine them, one needs more detailed modules and most fruitful analytical developments can be obtained by building detailed models that cater to issues specific to trade liberalization. Given the difficulty of doing this in the context of AGEs, the most fruitful way to proceed analytically, besides the enhancement of the existing GTAP data bases, is to build submodels or modules for specific issues, and make them consistent in some way with the more aggregated macroeconomic AGE models.

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TABLE 1. Indices of Vulnerability to Price Declines of Commercial Farms in EUR12 in 1987

	Average Size of Farms	AWU/ Farm	Gross Farm Output per Farm	Gross Farm Income/ Gross Output	FFI/ Gross Farm Output	Land & Perm. Crop Capital/Far m	Other Fixed Capital/Far m	Liabilities /Total Assets	Liabilities /Gross Farm Income
	(1) ESU	(2)	(3) 000 ecu	(4) Percent	(5) Percent	(6) 000 ecu	(7) 000 ecu	(8) Percent	(9) Percent
EUR12	21.5	1.6	39.5	48.8	25.7	73.3	47.0	15.3	118.8
Belgium	43.2	1.7	84.1	48.3	33.0	50.3	79.7	25.9	104.2
Denmark	37.2	1.1	82.2	38.0	6.1	47.7	171.5	44.3	375.8
Germany*	33.6	1.7	72.1	42.4	17.0	112.1	89.6	23.0	184.5
Greece	7.9	1.3	11.9	70.5	51.5	39.7	9.2	4.5	28.3
Spain	9.4	1.3	19.7	51.6	34.3	45.2	14.2	1.4	10.6
France	32.4	1.6	56.3	46.7	20.8	55.2	64.1	29.2	183.7
Ireland	14.5	1.3	27.7	44.2	25.5	109.1	32.6	5.9	79.8
Italy	14.5	1.6	25.7	60.0	44.3	79.2	30.3	1.5	13.7
Luxembourg	34.6	1.7	75.5	48.7	28.0	70.6	125.1	17.0	120.2
Netherlands	70.9	1.9	146.1	42.5	19.9	196.7	171.8	33.4	234.8
Portugal	8.4	2.1	13.2	51.2	29.2	34.3	11.6	3.9	31.5
UK	77.7	2.5	118.8	45.1	13.7	213.6	171.3	13.5	112.6

* Former West Germany

Source. Sarris (1997)

Glossary. ESU-European Size Unit (1100 ECU of Gross Margin), AWU-Annual (Full Time) Work Unit, FFI- Farm Family Income

Assessment of the Usefulness of GTAP for Analysing the EU Enlargement

by Chantal Pohl Nielsen¹, Michael H. J. Stæhr¹, Søren E. Frandsen¹, Hans G. Jensen²⁴, Tomas Ratinger²⁵ and Kenneth J. Thomson²⁶.

1. Introduction

The eastward enlargement of the European Union has become an important part of the political and economic ideas for the further evolution of the European Union. Some of the main concerns are the economic impacts of enlarging the EU with the at the moment less economic strong countries. However, these potential EU member-countries have a great potential for economic growth and development, the latter especially if they are admitted to the large European market. The objective of this paper is to assess whether the GTAP modelling tool could be usefully applied in analysing the EU enlargement issues.

To achieve this objective, the policy issues and policy instruments that are of prime importance for the EU enlargement and its economic consequences are identified in Section 2 together with the policy characteristics that at least in principle are modellable. First of all, it is important to contemplate the type of Common Agricultural Policy that will be offered to the Central and Eastern European Countries involved in the enlargement process. In addition, it is essential to identify the potential pre-accession options and requirements together with the assistance provided by the EU, as these can have important implications for the enlargement process. Finally, international trade agreements either in the form of already established agreements like the Uruguay Round and in the form of future agreements like the results of the upcoming Millennium Round under WTO could have an impact on the implementation of the enlargement process.

The purpose of Section 3 is twofold as it both outlines the previous applications of the GTAP-model to the analysis of the EU enlargement issues, and in addition, identifies potential applications of the GTAP-model to enlargement issues that have not yet been touched upon or issues which could benefit from some further analysis. Section 4 collects the bits and pieces from the previous sections for the future directions of the applicability of the

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GTAP model to the EU enlargement issues, while the final section concludes the paper and provides some recommendations.

2 Policy issues

The process of enlarging the European Union (EU) eastward has begun to take form. As of 31 March 1998, formal enlargement talks have commenced with five of the most developed Central and Eastern European Countries (CEECs) as well as with Cyprus. The group of CEEC front-runners comprises Poland, Hungary, the Czech Republic, Slovenia and Estonia. The remaining five associated countries – Romania, Bulgaria, Lithuania, Latvia and Slovakia – must achieve further progress in economic and political reform before embarking upon concrete accession talks with the EU.

Enlargement to the east will eventually bring these ten small economies - which are substantially poorer and less developed than the current EU members - into a regional grouping that is characterised by relatively deep economic and monetary integration. This integration poses a substantial challenge for the economies of both the acceding countries and the present members, as well as for the policy formulation that is to establish the grounds upon which accession is to take place. As with earlier enlargements of the Union, agriculture is taking a central place in the discussion of both the expected economic impact of enlargement as well as the necessary adjustments of EU policies.

Both internal and external forces have been pressures for further reform of the Common Agricultural Policy (CAP), and the eastward enlargement of the Union is clearly one of the most important external reform imperatives. Questions of when and how to integrate the future members into the CAP rank highly on the agenda. An issue of great concern is the potential budgetary implications of extending the CAP to the new members. Furthermore, most of the CEECs have signed the Uruguay Round Agreement on Agriculture and thus the future configuration of the CAP must be consistent with these commitments and must also be seen in connection with the upcoming WTO negotiations. Finally, there is an ongoing discussion of whether agricultural policy should take on other forms that address broader issues such as environmental protection and rural development.

2.1 Which forms of the CAP will be offered to the CEECs?

The ease with which the CEECs are integrated into the European Union will depend on how and to what extent the CAP is reformed prior to enlargement. There may be a continuation

of the Agenda 2000 reforms or a more radical reform to ensure competitiveness of EU agriculture on world markets. Clearly, the latter option would – from a purely economic point of view and disregarding distributional and possible environmental issues - yield the greatest economy-wide benefits in the sense that resource allocation would be more efficient and consumers would benefit from lower food prices. Furthermore, integration of the CEECs would be facilitated and costs to the entrants reduced.

Once the CEECs have attained formal EU membership, there are several suggestions as to how the CAP should be extended to the new members. Grant (1997), for example, identifies four broad options. The first is a two-tier agricultural policy in which Eastern European agricultural products are kept at a lower price level. The second option involves a long period of transition to higher prices. The third option is the imposition of quantitative production controls on new members, and the final option is full admittance to the CAP without any transition period or particular restrictions. Clearly, each of these options has its caveats. According to the CEECs a different agricultural policy may seem politically unacceptable, as the ‘common’ aspect of the policy would be breached. Furthermore, both a two-tier CAP and a long transition period would violate the notion of the Single Market and in that case cross-border controls would have to remain in place, at least for some time.

Previous enlargements have typically been characterised by long transition arrangements with regard to the CAP. With the most recent accession of Sweden, Austria and Finland, however, prices were required to adjust to CAP prices immediately, the argument of the European Commission being that the entrants were joining the European Union and not the European Community. Thus, the principles of the borderless Union had to be adhered to. This leads Tangermann (1995 p.280) to suggest that “it is probably better to get used to the idea that eastward enlargement cannot and will not involve a transitional period for the agricultural markets. Upon accession, agricultural prices in the new member countries in Central Europe will therefore probably have to be adjusted fully to those prevailing at that time in the European Union.”

Advocates of gradual price alignment argue that immediate adoption of high CAP prices will put substantial pressures on consumers and the food processing industries in the short run. Moreover, they argue that Eastern European exporters need time to adjust production and regulatory systems to the sanitary and phytosanitary standards and requirements of the European Union as well as obtain marketing expertise. Those who fear that the immediate adoption of high CAP prices will lead to a substantial increase in the agricultural production surplus also support gradual price adjustment. This fear is intimately connected with the

question of increased pressure on the EU budget. An immediate price hike would dramatically increase the budgetary burden of the CAP as well as jeopardise the commitments made in the GATT Uruguay Round Agreement. In the opinion of Grant (1997), immediate price alignment would require the abolishment of the compensation payments since these would be too expensive to extend to the new members – at least in their current form. On the other hand, adjustment in production techniques and input use to higher product prices will take time, and therefore some argue that the output response is not likely to be markedly different with immediate price alignment as compared with gradual adjustment (European Economy 1997).

Immediate CEEC price alignment to the EU levels has the advantage of avoiding complicated border arrangements that would be necessary during a transition period, as was the case with the Mediterranean accession. Furthermore, gradual adoption of the CAP may entail the risk of postponing necessary restructuring in CEEC agriculture. The sector may suffer from the fact that new investment activities would be concentrated in sectors that gain direct access to the EU market and benefit immediately from EU policies. European Economy (1997) argues that while immediate alignment to high CAP prices may be feasible for some of the CEECs, the adverse consequences may be immense for the less developed countries. These countries' agricultural sectors need time to restructure and become competitive, and incomes need to reach levels that are capable of accommodating higher food prices. The problem of a long adjustment period, however, is that the costs of not being included in the common policy are borne for a longer period.

The option of imposing quantitative controls meets opposition because this would amount to reintroducing controls in economies that are on a forward-looking liberalisation and decentralisation path. Subjecting major agricultural commodities to strict production controls to avoid surpluses would seem like a single market because CEEC farmers would receive the same prices as their West European counterparts. However, supply controls would prevent effective competition between farmers and risk freezing the production structure in a pre-mature phase. Both effects are detrimental to the long-term development of the agricultural sector.

Much discussion centres on the extension of the CAP instruments to the new members. Disregarding the budgetary implications, some would argue that the CEECs are not even entitled to the present payments since these were introduced as compensation for expected income loss due to the price reductions introduced by the 1992 CAP reform and the Agenda 2000 decisions. For one thing, compensatory payments will - unless they are completely

decoupled from production - increase the price of agricultural land, with implications for the structural development of farms and the rural sector in general. Furthermore, due to the particular problems about land ownership in the CEECs as a result of the former systems of large cooperatives, the distribution effects may end up being rather arbitrary. Finally, it seems that other targeted instruments would serve agricultural and rural development in the CEECs better than compensatory payments. "Structural measures seem more appropriate to create the conditions for improving the economy in a sustainable fashion and to shorten the time it will take for the economy to catch up with the EU" (European Economy 1996 p. 16).

If the intention is to continue compensatory disbursements to farmers in the incumbent member states but not to the entrants, their basic form would have to change. Payment forms would have to be designed so that competition between farmers in the enlarged Union is not distorted. The most important criteria would be to completely decouple payments from actual production levels. From then on, the disbursements may take the form of payments linked to social or environmental objectives, and these may not logically lie in the realms of agricultural policy. However, in the context of past and future WTO negotiations, the links with agricultural policy *per se* will remain strong.

Some have contemplated the idea of simply excluding agriculture from the accession agreement. This is problematic for several reasons: the principle of the single market would be breached, other members may be tempted to adopt their own agricultural policies, and it would delay the removal of borders between member states. Furthermore, agriculture is such an important part of the East European economies in terms of employment and income generation that such a strategy would meet strong opposition on part of the acceding members. Nevertheless, Josling (1998) argues that the CEECs may in fact benefit from such an agreement because they would not be obliged to introduce distortions in their agricultural markets. Thus, they would be free to develop competitive industries directed toward exports to the states of the former Soviet Union, Asia, and North and South America.

In addition to the CAP expenses, the other major part of the EU budget is the Structural Funds. Support from the EU Structural Funds has the intention of promoting economic and social cohesion within the current Union and as such has a role resembling development aid. An ongoing discussion regarding the enlargement process has centred on access of the acceding members to these funds. If one imagines that the CEECs are initially granted only very limited structural fund support, it might be argued that this would lead to slower growth in these countries and emphasize their less-than-full-member status. On the other hand, a number of Asian economies have experienced rapid growth without much direct

foreign aid and therefore it is uncertain whether exclusion from the structural funds (or at least a lack of special treatment) will be particularly harmful to the CEECs. The outcome depends essentially on the success of these countries in attracting investment activities to build up their infrastructure and in modernising their administration. Structural spending may nevertheless be an important means of reducing excessive intra-EU migration by improving future economic prospects in the CEECs.

2.2 Pre-accession options and requirements for the CEECs

At the outset of the political and economic turnabout of Eastern Europe in 1989/90, agricultural policies were initially liberalised. This led to sharply increasing food prices with resulting declines in real income and demand. This also meant an increase in the prices of raw materials used in agricultural food production, which along with general input price rises, worsened the domestic terms of trade for agricultural food producers. Furthermore, the purchasing power of export markets in the former Soviet Union declined and the agricultural markets of the EU remained largely closed.

This liberalisation impetus was soon reversed to an increasingly more protective stance and some see this as a reaction to the fact that the prospect of eventual EU membership came closer. Agricultural policies resembling the CAP market interventions have been introduced, and domestic agricultural prices have to some extent been screened from external price fluctuations. Consequently, domestic agricultural prices in the CEECs generally exceed world market prices. Nevertheless, with the exception of Slovenia, support to farmers in these countries is still modest in comparison with that of the European Union (Hertel et al. 1997).

It is reasonable to assume that the pre-accession agricultural policy strategies chosen by the CEECs depend on which form of the CAP they expect to face upon accession. Should the European Commission choose to put the CAP on a longer-term track of complete liberalisation, the best strategy for the CEECs would of course be to keep prices and protection levels low. Short of complete liberalisation prior to enlargement, clear signals as to where the CAP is heading will give the coming members the possibility of optimally adjusting their economic policies to the future situation.

If the CEECs seek to raise agricultural prices rapidly in anticipation of a CAP with high prices, this could prove to be costly both in financial and economic terms. If the final outcome itself (i.e. a highly distorted agricultural sector) is undesirable, Josling (1998) sug-

gests that postponing these costs may not be a bad idea. On the other hand, raising agricultural prices prior to accession will shorten a potential post-accession transition period if post-accession CAP prices are high. In any case, it is difficult to determine the optimal price structure, and so keeping CEEC prices below those of the EU and refraining from overstimulating sectors whose profitability depends on EU membership may be a reasonable 'play it safe' strategy.

Bauer (1998) questions the widespread notion that the Central and Eastern European countries will benefit from joining the European Union. It is argued that the rigid entry requirements and the limited assistance the Union seems ready to provide will entail costs that may well exceed the benefits, understood in a narrow sense. Clearly, access to the Single Market will expand the scope of economic opportunities for these countries, yet EU membership is coupled with the adoption of the entire set of EU regulations, i.e. the *acquis communautaire*. Although it is true that harmonisation of domestic policies and market regulations will entail costs for these countries, it must be stressed that persistence of such differences will add to the real costs of trade and hence act as a barrier to EU-CEEC trade. Therefore, in order to capture the full benefits of economic integration, such harmonisation should take place, albeit perhaps over a lengthy transition period. Indeed, the Association Agreements are being used to help the CEECs plan their adoption of the *acquis* and the process of transposing the Community's legal rules into national law.

2.3 Pre-accession assistance and trade concessions

The EU assists the associated CEECs through the PHARE program, where funding is made available for projects in a large number of areas: "privatisation, agricultural reform, administrative and institutional reform, the reform of the social welfare system, education, health care, infrastructure, the environment, and nuclear safety" (Bauer 1998 p. 13). The instruments of the program are the procurement of expertise in these areas and investment promotion. The EU acts as a 'broker' by establishing contacts between donors and the receiving countries. A very limited amount of funds is provided through this program, however. Bauer (1998) estimates that average annual assistance via the PHARE program to the CEECs and via the analogous TACIS program for the New Independent States has made up less than one tenth of the size of the Structural Funds.

The EU has begun to open up its markets to CEEC exporters through the Association Agreements (also known as the Europe Agreements), of which the first were signed in December 1991. One of the objectives of these agreements is the achievement of free CEEC-

EU trade in industrial products by 2002. The trade liberalisation process is asymmetric in the sense that the present EU members are dismantling their trade barriers vis-à-vis the CEECs faster than the other way around. The CEECs started their dismantling in 1997. Since the average level of protection (i.e. the average of the low agricultural and the high non-agricultural protection) in the CEECs is higher than that of the EU, this will prove to be a relatively more difficult task.

However, the intention of promoting growth in CEEC exports to the European Union has not been entirely successful – especially regarding trade in agricultural products. The design and content of the Association Agreements have been criticised for being part of the reason for this outcome. In particular, many of the agricultural subsectors in which the CEECs have a substantial export potential are regarded as ‘sensitive’ for certain incumbents and are therefore excluded from the agreements. Although import tariffs have been reduced for several products, this applies only to limited quantities of CEEC exports, some of which are regulated by quotas. Additionally, a general safeguard clause ensures that the trade liberalisation path can be evaded if EU producers are ‘severely threatened’ by competing CEEC exports. Furthermore, Hertel et al. (1997) assert that the complexity characterising EU administrative procedures prevents the CEECs from being able to fully utilise the quotas for agricultural food exports. So instead of encouraging CEEC agricultural food exports to the EU, the result has been an overwhelming net export surplus for the EU.

The Association Agreements have furthermore been criticised for being bilateral arrangements rather than part of an overall multilateral trade liberalisation framework (Preston 1997). The term used by Baldwin (1994) is ‘hub and spoke’ bilateralism, and this seems to encourage trade with the EU at the expense of trade among the CEECs themselves. Despite attempts to address this issue (e.g. the creation of the Central European Free Trade Area (CEFTA) and the Baltic Free Trade Area), trade with the EU clearly dominates.

Apart from these criticised aspects of the Association Agreements, there are a number of domestic events and characteristics which have exacerbated this outcome. Domestic reasons include real exchange rate appreciation, limited production expansions due to adverse natural conditions as well as economic adjustment problems, inferior product quality and insufficient sanitary standards, an underdeveloped food processing industry and exporting inexperience. Furthermore, in the cases of Bulgaria and Romania, agricultural policies are aimed at protecting the consumer rather than supporting the producer, thereby hindering exports by quotas, tariffs and outright bans (Frohberg et al. 1998).

2.4 International trade agreements and EU enlargement

The Uruguay Round Agreement on Agriculture of 1994 addressed the issues of improved access for imports, enhanced export competition and limits to domestic support. Thus, the Agreement has important implications for the future development of the CAP and hence the support and protection to be expected by the future CEEC members of the EU. The Agreement on agriculture is important because it increasingly subjects the sector to a degree of market discipline and puts future agricultural policy changes in a permanent if not over-tight straightjacket. A major step in the direction of liberalising agricultural trade has been taken by imposing the tariffs-only rule, by banning the introduction of new export subsidies and by classifying domestic policies into acceptable and unacceptable trade distorting measures. In the newly started Millennium Round, the liberalisation process will continue and this is particularly true since the agreed tariff reductions have in fact not amounted to much in terms of market access. This is due to the practice of 'dirty tariffication' by the OECD countries with regard to agricultural products. Baseperiod tariff equivalents of agricultural protection were high and/or over-estimated in several countries (including the EU), which meant that significant cuts could be agreed upon without having any effective impact on current policies. Nevertheless, tariffication in its own right is a substantial achievement because it makes trade policy transparent and it provides a much clearer base upon which further liberalisation can be achieved.

If accession implies that the CEECs become eligible for the same export subsidies as the incumbent members, the EU may attempt to negotiate an increase in the allowable values of export subsidies and the volumes of exports that receive export subsidies. Other WTO negotiators will probably argue that the CEEC farmers have not benefited from export subsidies during the baseperiod (from which the Uruguay Round schedules were derived) and thus contend that there is no reason to harm other exporters by threatening world markets with surplus exports created by the adoption of the CAP by the CEECs.

In general, border protection against imports of agricultural food products is lower in the CEECs than in the EU. Thus, as was the case with the Iberian accession, it may be expected that protection levels in the CEECs rise as they join the Union. However, this would probably conflict with WTO provisions, which stipulate that tariffs are not allowed to rise following the creation of a regional trading arrangement. Several of the CEECs have joined the WTO and have thus committed themselves to these rules. Yet there seems to be a severe lack of clarity regarding WTO stipulations dealing with regional arrangements. Article XXIV asserts that a customs union or a free-trade area should facilitate trade between the involved countries and not raise trade barriers against third countries. Yet according to Na-

garajan (1998) there seems to be ample room for different interpretations of this latter requirement in relation to ‘applied’ versus ‘bound’ tariff rates, and this may lead to moves in a direction contrary to the spirit of continued multilateral liberalisation.

The use of tariff rate quotas has created a new wave of governmental interference with agricultural trade through licensing procedures. The USDA (1997) judges that the system of tariff rate quotas combined with the Europe Agreements will provide the CEECs with considerable access to the EU market. The effect of the tariff quotas and the high above-quota tariffs will be undermined if quotas are increased, however, which may indeed be an outcome of the expected WTO Millennium Round negotiations.

3. Existing and potential applications using the GTAP model

Several of the policy issues discussed above have been addressed in various GTAP applications, whilst others have not. Furthermore, the topics that have been dealt with have been tackled in very different ways. Some studies are based on rather simple assumptions without having made major changes to the basic GTAP framework, whilst others opt for a more detailed analysis requiring adjustments of both the model and the associated database. Moreover, the individual applications have very different focal points and therefore what may be seen as a weakness of one application is often the strength of another. The following will discuss the ways in which the existing GTAP applications have tackled the various policy issues and identify both strengths and shortcomings hereof. In the process, further topics that could be addressed using the GTAP model – perhaps linked to other models – are identified.

3.1 CEEC adoption of the Common Agricultural Policy

The existing GTAP applications differ with respect to the assumptions made about the extension of the CAP to the new member states and the different degrees of CAP reform and policy liberalisation. Jensen et al. (2000), Frandsen et al. (2000), and Herok and Lotze (1998) all assume that the CEECs will fully adopt the current CAP on the same premises as the present members. Liapis and Tsigas (1998) assume that border protection and output subsidisation/taxation of the two regions are harmonised, but that the production limiting policies (land set-aside and quotas) are not extended to the CEECs. Hertel et al. (1997) and Swaminathan et al. (1998) go a step further and assume that not even the EU production subsidies are extended to the new members because many of these payments are given as compensation for previous reforms. Instead, it is assumed that integration leaves current

output subsidies in the CEECs unaltered. None of the studies which assume that the CEECs retain their present levels of output subsidisation consider the added costs of having to uphold cross-border controls with such a solution.

Most of these studies do not explicitly address the specific instruments of the CAP, i.e. the compensatory payments (hectare and livestock premiums), set-aside restrictions, base area restrictions and production quotas (milk and sugar). Exceptions are the studies of Jensen et al. (2000) and Frandsen et al. (2000). They give particular attention to the modelling of the CAP instruments, the 1992 CAP reform and the, at the time of writing, Agenda 2000 proposal. The system of market intervention and guaranteed prices is represented by appropriate setting of the border protection rates under the argument that the long-run mechanism of support works through border protection rather than through storage policies.

The manner in which the CAP instruments are represented in the GTAP database and model is expected to have implications for the results. Nielsen (1999) performs a comparative study of the impact on results of operating with a detailed and a stylised representation of the CAP in a GTAP set-up. The main finding is that this difference does indeed have a substantial effect on the production, trade and welfare results of the EU enlargement scenario.

In the GTAP database, all direct support to agriculture is based on the OECD Producer Subsidy Equivalent (PSE) measure and is represented as output subsidies. Yet the CAP compensatory payments, which constitute a substantial share of total direct subsidies, are not directly linked to production. Crop payments are related to a specified base area and a measure of average yield, whilst livestock payments depend upon the number of suckler cows and breeding ewes. Therefore, in the studies of Jensen et al. (2000) and Frandsen et al. (2000), hectare and livestock premiums are represented in the data base as input subsidies (to land and capital) whilst the initial output subsidy measures are adjusted accordingly so as to provide a more accurate measure of direct support. In terms of the integration scenario, this means that the CAP support to CEEC agriculture is represented as a mix of output, land and capital subsidies rather than exclusively in the form of output subsidies.

A policy issue that has not been addressed by the existing GTAP applications is the option of completely decoupling agricultural support from production. It may be argued that this is the only form of support that will be viable in the long term in light of both internal and external pressure for a reduction of the production and trade distorting forms of current support and protection of agriculture in the EU. This could be done in the GTAP framework by moving agricultural output and input related support into the realms of direct income sup-

port as a transfer to agricultural households. However, the current GTAP database does not include any direct income tax data. Therefore, it would be desirable to incorporate additional tax information and specify relevant revenue constraints. This task would be most meaningful if all the 15 EU countries and the individual CEECs were split out in the database. Such details would also allow for an analysis of intra-EU transfers, which will be discussed below. A complete split of the individual CEECs would furthermore enable an analysis of the consequences of only some of the countries being able to join the Union. A relevant study would be to analyse the economic consequences for those countries that must initiate further reforms and await further economic development before EU membership is a reality.

3.2 Pre-accession development assumptions in base line projections

A few of the existing GTAP applications perform baseline scenarios, which provide projections of the economies to a given year against which enlargement effects can be compared (e.g. Jensen et al. 2000, Frandsen et al. 2000, and Herok and Lotze 1998). The assumptions made about the development of the economies prior to enlargement will of course affect the consequent impact of the enlargement scenario.

None of the base lines take explicit account of the Association Agreements on the argument that the effectiveness of these trade concessions is severely limited – especially for agricultural products. It has also been argued that administrative barriers have severely reduced the effective value of several of these preferences. Nevertheless, explicit modelling of these agreements would improve the quality of the model simulations. The Association Agreements could be included in a baseline projection using the GTAP modelling framework by explicitly accounting for the provided trade concessions. The time-asymmetric nature of the dismantling of the EU-CEEC trade barriers, however, would be most elegantly addressed in a dynamic framework. Furthermore, trade concessions are but one element of the Association Agreements, and addressing the other aspects, generally aimed at providing an appropriate framework for the applicant countries' gradual integration into the Community, could be difficult in the GTAP framework. The pre-accession assistance provided through the PHARE programme is not explicitly addressed in any of the existing applications either. The more or less implicit assumption behind this neglect is that the PHARE programme accelerates GDP growth in general and is therefore captured by growth rate projections.

The baseline projections do, however, typically capture the overall increase in trade between the EU and the CEECs. Another way of taking account of potential pre-accession

developments is that of Frandsen et al. (2000) and Jensen et al. (2000), in which free trade between the CEECs is assumed as a form of preparation for accession. Some authors assume that agriculture in the CEECs will catch up somewhat in terms of productivity, in part because closer ties to Western Europe are expected to facilitate the transfer of know-how and technology. Such expectations can be modelled as a shock to total factor productivity specifically in agriculture and may be supplemented by assumptions about productivity developments in other sectors.

3.3 Uruguay Round

Nearly all the existing GTAP applications related to EU enlargement focus on the implications of the Uruguay Round Agreement (URA) and update the GTAP protection data with the required tariff cuts. The Agreement entails both quantitative and value based export subsidy requirements, however, and Jensen et al. (2000) assess exactly which of these restrictions is expected to become binding for European agriculture, and implement these at an aggregated commodity level. When modelling the Uruguay Round Agreement, attention must also be drawn to the 'dirty tariffication' practice that has characterised the setting of rates for agricultural products. While most studies simply assume that the post-Uruguay Round rates will be fulfilled, Hertel et al. (1997) address the issue of dirty tariffication by substituting the post-UR rates in agriculture with more recent data for the EU and the CEECs.

None of the existing applications address the issue of whether the URA commitments will be breached (either by the CEECs or the current EU) in the process of enlarging the Union. All the studies assume that the CEECs will be allowed to adjust to the prevailing EU level of border protection. Although several presumptions may be made about whether and how the EU commitments will be adjusted to accommodate the enlargement, in-depth analysis in this field must await clarification of the uncertainty regarding the interpretation of the existing stipulations. Another issue concerning the compatibility of the eastward enlargement with the commitments made in the Uruguay Round agreement relates to the tariff rate quotas and whether they will be expanded for the EU as a whole. The next question is then whether and how non-EU countries are to be compensated in some way for the lost market access. Intimately connected to the issue of tariff quotas is to whom the quota rents accrue.

3.4 Budgetary implications of enlargement

Most of the GTAP applications attempt to calculate the budgetary implications of enlargement based on the results of model runs in which a specific budget equation, a 'Brussels' fiscal entity, or the specific CAP instruments, are explicitly included. Jensen et al. (2000) and Frandsen et al. (2000) introduce CAP-related transfers from the EU-15 to the CEECs based on the common financing principle. Transfers to the new members include compensatory payments to land and livestock, export subsidies, and output subsidies net of tariff revenue from CEEC imports and a GDP contribution from the CEECs.

Hertel et al. (1997) and Swaminathan et al. (1998) model the budget by incorporating a fiscal entity – 'Brussels' – from which disbursements are made to member states to cover export and output subsidies for products covered by the CAP. 'Brussels' collects revenue from two sources: (1) 90% of food and non-food import tariff revenue collected by member states and (2) a percentage of GDP – common to all members - that is determined endogenously so that the 'Brussels' budget balances. 'Brussels' disbursements cover the agricultural output and export subsidies as determined by the domestic/world price wedge based on PSE measures.

Liapis and Tsigas (1998) also introduce a budget component in their model and determine the budget expenditures required to finance the CAP under their policy assumptions. A tax rate on income adjusts to balance the budget. Herok and Lotze (1998) combine external data and estimates with model simulation results. There is a wide spread in the results: from ECU 0.2b in Swaminathan et al. (1998), ECU 13.9b in Jensen et al. (2000) to USD 16.1b in Liapis and Tsigas (1998). Part of the difference lies in an assumption of a less-than-full adoption of the CAP in the former study. Yet the large differences between the results of the studies also seem to stem from differences in the modelling of the CAP instruments and the financing thereof as well as the size of the applied trade elasticities and other assumptions.

The other major budgetary issue in relation to enlargement is the new member states' access to the EU structural funds. None of the existing GTAP applications explicitly adapt the model to include the structural funds, but Hertel et al. (1997) calculate how much structural aid to the CEECs would be feasible if welfare in the EU-15 were to remain unaltered. Explicit modelling of the possible access of the new member countries to the EU structural funds seems rather intricate, however. First of all, the extent of this access is still uncertain. At present all ten applicant countries would 'qualify' for the assistance, and this may put excessive pressure on the amount of resources available for the incumbent EU members.

Secondly, explicit modelling is complicated further by the particular way by which these funds are made available, i.e. the co-financing requirement. This might require linking structural fund disbursements to national government budgets or to private investments, depending on the type of activity in question. Given the inadequacy of public finance data available for the GTAP database at the moment, additional country specific data would be desirable. A more detailed tax database would enable analyses of:

- the implications of harmonising tax structures in the enlarged EU;
- the implications for national government budgets of the CAP and structural policy;
- how fiscal policy may be adjusted to enable continued support of the agricultural sector;
- the impact of different forms of support, etc.

There is a keen interest in investigating the consequences for income distribution of changes in public policies. When studying the national economic implications of EU budgetary transfers, it would be particularly useful to have the regional household split up into at least two sub-households so as to enable analysis of distributional issues. A start could be to split the regional household into a rural and an urban household. This distinction is particularly important when analysing the CEECs' integration into the EU since a relatively large share of the labour force is employed in agriculture. Households could also be distinguished in terms of income levels. A second-best solution to such a detailed income distribution analysis is to perform *ex post* calculations of the resulting welfare changes for different household groups. This will provide reliable results to the extent that the implied changes in income distribution have only marginal effects on aggregate commodity demand (Hertel 1998).

3.5 Land, labour and migration issues

Land is the most distinctive feature of agriculture. It is an important tool in the Common Agricultural Policy, and the returns to land are an important determinant of the income and hence welfare of agricultural households (to the extent that they are landowners). Naturally, different qualities and locations of land yield different productivity levels for a particular product. Ideally, such differences should be taken into account when assessing the supply response to enlargement. This would enable some interesting analyses of the regional effects within the individual member states of extending the CAP to the CEECs. The most elegant method would be to distinguish between land types and uses and in this way obtain a differential land rent on different types of land if these are imperfectly substitutable in the production of a certain crop. Hertel (1998) asserts that simpler methods can also capture the

effect of different types and uses of land, yet none of the existing GTAP applications attempt to address this issue. This would either require extensions of the GTAP model itself, links to a national CGE model with such detail or use of e.g. the FARM model of the USDA (Darwin et al. 1995), which is an extension of the GTAP model. The FARM model includes heterogeneous land endowments, water as a primary input in the crops, livestock and service sectors, and crop production as a multi-output sector. Moreover, the GTAP framework restricts land use to the primary agricultural sectors. It may be interesting to be able to capture land use in other sectors as well.

The standard assumption in GTAP is that the economy-wide level of labour supply in each country is constant, but that labour is mobile between sectors within each country. This allows the analysis to capture the effect that integration may have on the sectoral composition of employment as a result of cross-sectoral supply and demand interactions. However, nothing can be said about the impact of integration on the aggregate level of employment and unemployment in the different countries. Labour absorption and unemployment issues are also important in terms of a rural-urban distinction in both the CEECs and the EU. This is particularly relevant in light of the discussions concerning the multifunctional nature of agriculture and the recognition that rural areas encompass several other forms of economic activity than just agriculture. Such an analysis would require detailed data on the rural-urban location of economic activity, and the representation of this link by (im)perfect domestic factor mobility between rural and urban sectors.

Yet another underinvestigated issue concerns international migration. Labour flows across international borders are not explicitly modelled in GTAP. The question is whether East-West migration will increase due to fewer restrictions on labour mobility. On the other hand, potential migration that would occur in the absence of integration may be dampened due to rising incomes and improved future economic prospects in the CEECs. Implementation in the GTAP model would require a description of the behaviour underlying international migration flows and a corresponding representation in the database and set of parameters.

3.6 Dynamics

Since the GTAP modelling framework is designed for long-run, comparative-static policy simulations, many issues related to transition periods cannot be explicitly addressed. This is a particularly important issue for the CEECs since they have a lot of catching up to do in terms of adjusting prices, let alone modernising and adjusting the production apparatus and

the regulatory systems. Analysis of such effects would require a dynamic framework. This would also enable the analysis of alternative accession scenarios, not just once-and-for-all jumps to certain levels of protection and support, but rather a gradual adjustment process.

Welfare effects calculated in static models, such as GTAP, can take account of the effects of increased allocative efficiency, terms of trade effects and inter-regional transfers. Potential dynamic effects of integration such as capital stock accumulation and higher productivity growth cannot be assessed, however. By creating a more stable economic and political environment, membership of the Union may well see a sharp rise in the level of investment in the CEECs. Baldwin et al. (1997) and Francois (1998), for example, pay special attention to the issue of whether integration will lower the risk premium that investors in the CEECs face.

3.7 Imperfect competition

The standard GTAP model adopts the Armington approach to product differentiation, where products are distinguished according to region of origin. Due to the increasing trade in processed foods and the globalisation of the food industry, however, the relevance of this approach may be questioned. This is because foreign and domestic products are becoming closer substitutes in consumption. Accordingly, the firm as an actor is becoming increasingly important in international food trade and since this type of differentiation of products is endogenous, other modelling methods should be used. This is where the modelling of imperfect competition comes into the picture. Firms may invest in research, development and marketing in order to create a market niche, for example, and thereby enable a mark-up price, while consumers benefit from increased variety.

Modelling imperfect competition in certain sectors concurrently introduces increasing returns to scale in production. Such scale economies may be a consequence of returns from specialisation within firms or at the industry level of intermediate inputs. When removing trade barriers, for example, this then allows the relevant industries to utilise these scale economies and hence welfare gains are expected. Francois (1998) analyses the effects of introducing imperfect competition and scale effects in certain (non-agricultural) sectors in an EU enlargement scenario and finds that the pro-competitive effects have a substantial influence on results. Addressing imperfect competition in the non-agricultural sectors adds important aspects of realism to the enlargement scenarios and one can contemplate adding some of the food processing industries in certain countries to this list. A constraint on the widespread incorporation of such effects in the model lies in the limited access to data rele-

vant for calculating mark-ups, excess profits and economies of scale - not least for the CEECs.

Applying the Armington approach to product differentiation may not be representative of the actual situation in primary agricultural trade for another reason. Certain primary products are mainly traded as bulk commodities and in that sense there may be almost perfect substitution between domestic and foreign products. They may indeed be better represented as homogenous goods rather than heterogeneous.

3.8 Data issues particularly related to the CEECs

A typical criticism of applied general equilibrium models is the lack of empirical validity of parameters, which are very important in determining the outcome of a given scenario. Due to the problems of data availability related to the CEECs, this is clearly an issue to be aware of. In assessing the representativeness of the GTAP data and parameters for the CEECs, it is important that basic issues such as lower product quality, insufficient sanitary and technical standards, underdeveloped food processing industries and exporting inexperience are in some way reflected in the data and/or parameters.

This discussion leads naturally to the question of which benchmark year the model should be calibrated to. This depends, of course, on the availability of detailed data of sufficiently high quality. However, when dealing with issues related to the agricultural sector, which is highly dependent on weather changes, price-inelastic demand and fluctuating world prices, value-added tends to be highly volatile from year to year. Moreover, the choice of a base year for transition economies is particularly difficult because they are - by definition - not in a steady state. The problem is that empirical models such as GTAP link the simulation results to the particular structural characteristics of the economies in a particular year. Yet the process of integration and trade liberalisation is likely to change these structures over time. Therefore, it is particularly important to continuously obtain improved and updated data for these countries. Using time series data to create a representative benchmark equilibrium data set could reduce this problem. Yet however difficult the task may be for a single country CGE database, the task is even more difficult when choosing an appropriate year for a global analysis and hence a global data base.

4 Future directions for GTAP applicability to EU enlargement issues

Tables 1-4 below provide an overview of the relevant policy issues and whether or not they have been addressed by existing GTAP applications. To the extent that the issues have been addressed, comments are attached as to how existing applications can be improved and which extensions may be desirable. For the many policy issues that have not yet been addressed, directions for future work are suggested, supplemented by comments on particular theoretical or empirical challenges. As is evident from the tables, the existing GTAP applications have come a long way in analysing the economic consequences of integrating the Central and Eastern European countries into the European Union. The focus on the agricultural sector and the Common Agricultural Policy highlights a number of strengths of the GTAP modelling framework, and also draws attention to a number of areas in which the current GTAP framework is inadequate.

There are a number of relevant policy questions that can only be addressed if specific developments of and additions to the GTAP database are achieved. Other issues have already been addressed in existing applications, yet data improvements would certainly yield more satisfactory analyses. Closely linked to such database developments is the challenge of properly including these new variables into the GTAP model, giving particular attention to theoretical consistency within the neo-classical model.

One of the most obvious database developments concerns the splitting of the three current GTAP aggregates: the CEECs, the Former Soviet Union and the Rest of the European Union. This would enable several country-focused analyses as well as more detailed analyses of income distribution issues across countries and intra-EU transfers, related to the CAP disbursements in particular. The issue of transfers among EU members would also require an upgrade of the existing tax data. More details regarding the public finances in the individual countries could also prove useful. This would also allow for detailed analyses of the impact and financing of alternative support measures to agriculture such as direct income support. Another area in which database extensions would be relevant is the structural funds. This is also an example of a database extension that would provide a challenging model implication task due to the co-financing requirement, thus creating links between structural fund disbursements on the one hand, and private and government investments on the other. Regarding distribution issues within the individual countries, a split of the regional household into rural and urban households, or more detailed according to income level, will allow for interesting analyses that are currently not possible within the existing framework. Some interest has centred on international migration consequences of EU enlargement, and such analysis would require base migration data as well as model amendments that describe the underlying behaviour.

As discussed above, the existing applications differ substantially with respect to their modelling of the CAP instruments, and one of the identified needs is to split the Producer Subsidy Equivalent (PSE) measure into measures that are in fact output subsidies and those that are in fact input subsidies. Currently, the PSE covers agricultural support measures that are both output and input subsidies. This distinction has important implications for enlargement simulation results. A particular challenge also lies in accurately representing the CAP mechanisms of intervention and guaranteed prices, and stocks. Further improvements of the existing support and protection data would entail obtaining information on applied and bound tariff rates. A particularly difficult issue is also the use of tariff rate quotas and how they can be implemented in the existing model. Most of the existing GTAP applications of the EU enlargement process operate with the standard perfect competition assumption. A clear improvement here would be a more accurate description of certain sectors as being characterised by imperfect competition. Once again, data related to such refinement is particularly difficult to obtain, not least for the CEECs.

As the range of existing GTAP applications and the suggestions for future applications reveal, there are a great number of highly relevant policy issues that can be tackled within the existing static GTAP modelling framework. A few other interesting questions related to EU enlargement can, however, only be dealt with using a dynamic model. This reflects the transition that the CEECs are and will be undergoing and the related adjustment costs. Several analysts expect the CEECs to become more attractive areas of investment as a consequence of the prospect of EU membership, and the consequential expansion of their capital stocks can only be captured in a dynamic framework.

In summary, there are several relevant policy issues pending analysis in the GTAP modelling framework. The GTAP framework is applicable to a number of these issues with more or less extensive amendments and additions to the model and database. Naturally, some improvements and developments are more urgent than others in the sense that they allow for a larger range of policy analyses. With regard to analysing the economic consequences of the EU enlargement, three priority areas have been identified. First of all, there is the obvious need to split the country aggregates of the CEECs, the FSU and the Rest of the EU. Closely related to this is the need to address in more detail the issues of budgetary transfers both among current EU members as well as between the existing and future members. Both these improvements would allow for a more constructive contribution to the policy debate about the income distribution effects of EU enlargement. Finally, it is evident that the nature of the CAP instruments offered to the new members is of key interest and a more adequate representation in both the database and the model is important.

TABLE 1 Forms of the Common Agricultural Policy offered to the CEECs

	Policy issues	Existing GTAP applications	If YES: How can they be improved? If NO: How can GTAP be applied? ... and other remarks.
1.	CEECs adopt the CAP reformed according to the Agenda 2000.	Yes	System of intervention and guaranteed prices plus stocks ought to be modelled.
2.	CEECs adopt a radically reformed CAP.	Yes	Alternative agricultural support, e.g. direct income support. Supplement database with tax data. Specify revenue constraints.
3.	CEECs adopt the lower-support part of a two-tier agricultural policy.	Yes	Explicit financing scheme, intra-EU transfers. Take account of costs incurred by retaining cross-border controls.
4.	CEECs join the CAP with a long transition.	No	Requires a dynamic framework. Take account of costs incurred by retaining cross-border controls.
5.	CEECs adopt the CAP, but restrictions are placed on production quantities.	Yes	Straightforward standard GTAP application.
6.	CEECs adopt most instruments of the CAP, but not the compensatory payments.	Yes	Need to be explicit about which payments are provided as compensations. Should also distinguish between input and output subsidies.
7.	Agriculture is excluded from the accession agreement.	Yes	Alternative agricultural support, e.g. direct income support. Perhaps supplementary tax data. Specify revenue constraints. Cross-border control costs.
8.	Only some of the CEECs join the EU.	No	CEEC aggregate must be split up. The Baltic countries must be split out of the FSU aggregate.
9.	CEECs receive only agricultural support measures that are completely decoupled from production.	No	Convert agricultural output and input related support into direct income support. Supplement database with tax data. Specify revenue constraints.
10.	CEECs receive broad structural support from the EU rather than agricultural support measures.	No	Representation in model and database. Requires supplementary data.
11.	Agricultural policy addresses broader issues, e.g. environmental protection and rural development.	No	Additional data required. Split economic activity into rural and urban.
12.	CAP disbursements to CEECs (and EU-15) are linked to social, environmental or rural development objectives.	No	Requires links to added environmental, social and rural economic data. Split economic activity into rural and urban.

TABLE 2 Pre-accession developments in the CEECs

	Policy issues	Existing GTAP applications	If YES: How can they be improved? If NO: How can GTAP be applied? ... and other remarks.
1.	CEECs adopt 'CAP-like' agricultural policies prior to accession.	No	Requires supplementary data for CEEC agriculture at single country level.
2.	CEECs liberalise agricultural policies prior to accession.	No	Straightforward standard GTAP application.
3.	Assistance from the PHARE programme.	No	Requires supplementary data. Modelling of programme details complex.
4.	Impact of the Association Agreements.	No	Time-asymmetric trade liberalisation process requires dynamic framework. Tariff rate quotas.
5.	Central European Free Trade Area (CEFTA).	Yes	Optimal with single country split of CEEC aggregate.
6.	Baltic Free Trade Area.	No	Need to split the Baltic countries out of the FSU aggregate.
7.	CEEC adjustment to the <i>acquis communautaire</i> .	No	Requires assessment of economy-wide costs and benefits.

TABLE 3 GATT/WTO issues related to the EU enlargement

	Policy issues	Existing GTAP applications	If YES: How can they be improved? If NO: How can GTAP be applied? ... and other remarks.
1.	Required tariff cuts according to the GATT agreement	Yes	Increase attention to applied vs. bound tariff rates. How much 'water' between them?
2.	Which of the quantitative or value-base export subsidy restrictions bind.	Yes	Expand regional coverage on this analysis.
3.	'Dirty tariffication' practice in implementing Uruguay Round agreement on agriculture.	Yes	Update general protection database.
4.	Increased allowable values of export subsidies and volumes of exports that receive export subsidies for enlarged EU.	No	Requires detailed export subsidy data submitted to WTO.
5.	WTO stipulates that tariffs are not permitted to rise due to the creation of a regional trading arrangement.	No	Requires detailed export subsidy data submitted to WTO.
6.	Tariff rate quotas (TRQs) – will they be increased? Compensation for lost market access to non-EU regions? Quota rent accrual.	No	Modelling of TRQs is complex. Correct representation of quota rents and to whom they accrue. What forms of compensation?

TABLE 4 Other policy issues related to the EU enlargement

	Policy issues	Existing GTAP applications	If YES: How can they be improved? If NO: How can GTAP be applied? ... and other remarks.
1.	Budgetary implications of enlargement.	Yes	Relies on correct representation of CAP. Need to investigate intra-EU transfers. Representation of structural funds needed.
2.	CEEC access to the structural funds.	No	Co-financing requirement means linking structural fund disbursements to national government budgets and private investments. Need public finance data.
3.	Intra-EU transfers as a consequence of enlargement.	Yes	More complete analysis requires splitting up individual countries.
4.	Regional effects of adoption of the CAP within individual member states.	No	Split up regional aggregates. Distinguish between types and uses of land. Extension of GTAP such as the FARM model.
5.	Income distribution consequences for CEECs and EU-15.	No	Split regional household into e.g. rural and urban households. Alternatively, split by income levels. Land ownership issues complicated for CEECs.
6.	Labour absorption in rural areas. Multi-functional nature of agriculture.	No	Must distinguish between rural and urban placement of economic activity.
7.	Employment and unemployment effects of enlargement.	No	Endogenize aggregate employment level for each region. Add macroeconomic variables.
8.	International migration.	No	Extend GTAP with description of behaviour underlying international migration flows and data.
9.	CEECs meeting the sanitary and phytosanitary standard requirements of the EU.	No	Explicit account of costs incurred is needed. Possible trade restrictions against goods not meeting standards?
10.	Transition periods for the CEECs. Adjustment costs.	No	Requires dynamic framework.
11.	Investment development in the CEECs.	No	Endogenous capital stocks require dynamic framework.
12.	Pro-competitive effects of integration.	Yes	Data limitations (mark-ups, excess profits and economies of scale) are a constraint, esp. CEECs.

Conclusions and recommendations

A brief summary of the findings of this report includes:

- The GTAP model has demonstrated its applicability for the analysis of the EU enlargement issue. It is built on a solid theoretical general equilibrium foundation, an extensive database containing disaggregated input-output tables and bilateral trade data supplemented with data for the trade barriers
- The GTAP model has been used extensively to analyse the economic consequences of integrating the Central and Eastern European countries into the European Union
- The main focus has been on the agricultural sector and the CAP
- The previous analysis has mainly been done in a static and perfect competition version of the GTAP model with all the deficiencies that this creates.

The following recommendations have been made:

- There is a need for specific developments of and additions to the database: The three current GTAP aggregates, CEECs, FSU and the Rest of EU, need to be split up, and in addition, there is a need for the existing tax data to be updated together with other budgetary transfers
- A more adequate representation of the CAP instruments, especially a split of the PSE measure into input and output measures
- Expand the model to include dynamic effects and imperfect competition in relevant markets both of which might turn out to be very important for the enlargement studies.

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Comments on the paper Assessment of the Usefulness of GTAP for Analysing the EU Enlargement

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This note summarizes a set of comments which are intended to assist in improving the GTAP modeling of effects of the EU eastern enlargement process, and in making the model as useful as possible for the intended consumers of its final products.

I have four major comments on the paper, and some detailed comments. I start with summarizing the major comments.

First, the discussion of the issues and the scenarios need updating. Life goes fast in transition and enlargement, and to make the analysis relevant for policy makers the discussion and the scenarios should reflect the current situation of policies and markets.

Second, the paper lacks a discussion of structural issues and institutional reforms in transition agriculture and its implications for the enlargement process – and for the modeling of it. These are at the heart of CEEC transition and EU enlargement and ignoring them risks making the whole exercise irrelevant.

Third, some of the GTAP assumptions need to be carefully evaluated, especially those on the pre-accession policy situation and on how to model the impact of productivity changes.

Fourth, the modeling of the factor markets in transition countries needs to be reassessed. Furthermore, it seems important to integrate investment and financial flows, which have not only important micro-economic and efficiency effects, but also important macro-economic implications for the adjustments in Central and Eastern European countries (CEECs) and for enlargement.

Before discussing these comments more thoroughly, let me first mention a few additional detailed comments.

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Some specific comments

The title of the paper is misleading as the paper only discusses agricultural issues of the enlargement process.

The paper refers to an enlargement with 10 “small” economies. The ten association countries may be small in terms of output, but certainly not in terms of inputs and asset use. The agricultural land area in the CEEC-10 is equal to almost half (45%) of that of the total EU-15. Moreover, in terms of labour the reference to small economies is completely misplaced. The CEEC-10 have 15% more “farmers” than the EU-15, at least according to their official statistics. Especially Poland and Romania are important: both have around 3.5 million “farmers” compared to 8.2 million in the EU-15.

The discussion on the extension of direct payments to the CEECs misses some key arguments. One is the political issue of having large transfers to “rich” West EU farmers and no direct payments transferred to “poor” East EU farmers. Also, there is some compensation currently (in the pre-accession programmes) and expected in the future under the form of structural aid. The discussion of other EU support underemphasises the role of the structural funds.

The discussion of pre-accession aid covers only PHARE. However the 2000-2006 pre-accession programmes include SAPARD, ISPA, and PHARE. SAPARD in particular is relevant for the agricultural accession discussion.

The discussion of the URAA/WTO does not mention the differences between CEECs in terms of value commitments. For example, some of the countries, such as Poland have their commitments in hard currency, while some others, such as Hungary, are facing tight constraints because their value commitments in local currency have been eroded by inflation.

Updating discussion and scenarios

The discussion on the future CAP needs updating. Furthermore, while it is not yet 100% clear how the CAP will look like at the time of accession, after the Berlin council meeting it is easier to have a reasonable expectation of it than it was a few years ago.

The discussion of CEEC policies should be updated to include some significant policy developments have taken place in recent years. Besides the changes in protection, these also

concerns changes in the policy instruments, such as the introduction of quotas (e.g. Poland for sugar) and direct payments (e.g. Slovenia).

The importance of restructuring and institutional reforms

The paper concludes with reference to the CAP commodity policies that these “policies are of prime importance for enlargement” and that the “immediate adoption of high CAP prices would induce substantial increases in production, ... dramatically increase the budgetary burden of the CAP, as well as jeopardize the commitments in the GATT URAA” (p.3-4).

However, in our concluding chapter of a book published following a three-year FAIR project on agricultural issues of EU enlargement, Stefan Tangermann and I concluded that “*reforms of the CAP, and the resulting price cuts, along with recent developments of national policies in the CEECs, [and exchange rate developments] have greatly reduced the impact that accession to the CAP will have, both on agricultural markets and on the EU budget*”). Furthermore, we argued that “*contrary to what would have been the case in the absence of CAP reform, it now appears that future developments of production in the CEECs will largely be dominated by trends/changes in productivity, rather than by the introduction of the CAP.*” (This general result holds less for those products where production quotas are imposed under the CAP (milk and sugar) and which continue to receive high support.)

Hence, in my opinion the key issues are structural and institutional reform, and these should be the prime focus of analysis and discussion. While these issues go beyond the factor markets, and should include the impact of enterprise restructuring and property rights reform, I will add a few specific comments on some factor markets in the next section commenting on specific GTAP assumptions.

GTAP modelling assumptions

According to the paper two key pre-accession assumptions in GTAP models are: (1) free trade between the CEECs is assumed as a form of preparation for accession and (2) that catch up in productivity in CEECs is modeled as shock in total factor productivity. These assumptions should be carefully assessed.

First, is pre-accession free trade in the CEEC-10 a reasonable or realistic starting assumption? The answer is that it is not very realistic. Price and trade policy in CEECs is characterized by three phases (Hartell and Swinnen, 1998, 2000): high support under Communism

(until 1989); then reduced support with liberalization (1990-1994); and finally increased support with new interventions (since 1995).

For some accession countries (e.g. Slovenia) agricultural protection is close to EU levels, and for some sectors (e.g. sugar) recent PSE levels are higher in virtually all accession countries than in the EU-15. But in general, and especially following the 1998 Russian crisis and the falling of world market prices, agricultural protection and support to farmers has increased significantly in CEECs before accession.

Second, also in terms of changes in output and productivity we see important "phases" in the transition. In an initial phase output (and productivity) falls due to a combination of strongly declining terms of trade and a collapse of the old system of contract enforcement, creating institutional disruptions. After 1994 an increase in output and productivity can be observed in several countries. This growth is primarily productivity-driven (rather than price-driven) (see e.g. Macours and Swinnen, 2000; Mathijs and Swinnen, 2000) and in some sectors heavily influenced by the inflow of foreign direct investment (Gow, Streeter, and Swinnen, 2000).

This has three important implications for the modeling. First, depending on which part of the transition one considers one will end up with very different elasticities. Second, it is not obvious which would be the most appropriate reference period to insert in the model for applying the "productivity shocks". Third, as the impact of various factors (institutional reform, property rights changes, restructuring, price changes, capital inflows, ...) is not constant over the transition period, one needs to be careful which factor to include (and how to model its impact).

Modeling factor markets and inputs in transition countries

There is some discussion on the role of land use in the model, but the paper only talks about differences in location and (physical) quality. In CEECs the main quality factor regarding land use is not location or physical quality, but the property rights and the functioning of the land market. (And there are significant differences between various transition countries in this respect).

Further, the model assumes that labour is mobile. However our empirical studies show that the mobility of labour differs very strongly between countries. Major differences between CEECs in terms of labour productivity changes (from largely positive in Hungary and the

Czech Republic to strongly negative in Romania) can be largely attributed to differences in labour mobility. In fact, one of the major restructuring problems in Poland is the lack of mobility of rural labour, especially those employed on the small-scale family farms which dominate Polish agriculture.

The role of capital inflows -- both public funds and private investments -- is largely ignored. These play a potentially important role, both in terms of their effects on productivity (through stimulating investments and creating private contract enforcement models solving institutional problems) and in terms of their macro-economic effects.

The financial flows include the pre-accession programmes/transfers, the direct/compensation payments (if any), and the internal EU flows from "financial solidarity" principle after enlargement. For example, Banse, Muench, and Tangermann (2000) show that these flows have potentially very important macro-economic effects; this even besides the impact of enlargement-induced private investments.

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Assessment of the Usefulness of GTAP for Analysing Reforms of the Common Agricultural Policy

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1. Introduction

Though the principles of European agricultural policy have remained unchanged since its inception, the EU's Common Agricultural Policy (CAP) has definitely been evolving over time. CAP reform issues are rather recurrent phenomena. The 1992-reform and its adaptations through Agenda 2000 are the prime examples of CAP changes in the past decade. No doubt further reforms will follow. The objective of this report is to assess whether the GTAP modelling tool could be usefully deployed in analysing CAP reform issues.

To achieve this objective, we first identify a) the policy issues and policy instruments that are of prime importance within the context of CAP reforms and b) those policy characteristics that are in principle modellable. A brief review of past CAP reforms provides a background on both the policy issues and the reasons for reform. Against this background, we identify the characteristics of CAP that in principle are modellable. Through a brief review of the recent agricultural economics literature on the topics that are likely to be on the agenda of the upcoming Millennium Round under WTO, we indicate the relevance of mod-ellability of CAP reform issues within this context.

Next, we focus on the modellability of the main current characteristics of the CAP within GTAP and assess the potential usefulness of GTAP in analysing CAP reform issues from different policy perspectives: global trade, European agriculture and rural development. . For each of these, strengths and weaknesses of GTAP are assessed, both intrinsically and with respect to other models.

The final section concludes and provides some recommendations.

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³⁰ LEI, The Netherlands.

2. Policy issues involved

In this section we attempt a) to identify the policy issues and policy instruments that can be considered to be of prime importance within the context of CAP reforms and b) to identify the policy characteristics that are in principle modellable within the broad group of sector and commodity market models that have been reviewed in this project (cf. van Tongeren and van Meijl, 1999).

2.1. Brief review of the CAP

In the Treaty of Rome, which laid the foundation of the EU and came into force on 1 January 1958, the 'special' position of European agriculture was recognised. A Common Agricultural Policy (CAP) was called for and in the aftermath of the 1958 Stresa conference the principles of the CAP were laid down in 1960. These principles are market unity (no internal trade barriers), Community preference (border protection against external suppliers) and common financial responsibility (CAP outlays are funded jointly, partly to be covered by CAP revenues (such as tariff receipts) and for the remainder by budgetary transfers from the member states). These principles still apply today. However, actual policy measures, consisting of market organisation schemes on the one hand and structural measures on the other, have evolved over time. We start with a concise overview of the developments in the former. Later on, we briefly touch on the structural measures.

Market organisation schemes

Initially, in the late 1960s, different market organisation schemes were in force for different agricultural products, such as: a) price guarantees supported both externally (through variable import levies and export refunds at the external border) and internally, by buffer stock agencies ('intervention'), b) price guarantees supported at the external border only, and c) direct producer subsidies ('deficiency payments'). For sugar only a production quota system was put in place with different price guarantees for separate quota segments.

As a result of this policy, and despite the accession of the UK as a major food importer, production increased in excess of the growth of internal demand, imports decreased and exports rose. This put heavy strains on the budget side of the system. Therefore, milk production was brought under a quota system in 1984 and CAP outlays were further constrained through coresponsibility levies, stabilising price adjustment schemes, voluntary set

aside and the spending guideline of 1988, which put a ceiling on the yearly increase of the CAP budget (see e.g. Folmer *et al.* 1995 for details). These measures were not, however, sufficient to alleviate budgetary pressure, and moreover did not sufficiently curb the growth of production and subsidised exports. The increase in the latter was heavily criticised at the negotiating table of the GATT Uruguay Round after 1986.

Therefore, in 1992 a more drastic reform took place that significantly lowered price guarantees, compensating European farmers conditionally for the expected income loss through direct payments per hectare (for cereals, oilseeds and protein crops, COPs for short) or per head (for male cattle and suckler cows). These payments are to some extent decoupled from actual production decisions: the arable premiums are given on a per hectare basis against a regional reference yield and the livestock premiums are given on a headage basis, once or twice per animal depending on the length of the fattening period. This seems to imply that the direct payments are decoupled from yield increases only. However, it is also to be noted that total outlays on these direct payments are upperbounded (nominally); they are guaranteed only up to a maximum eligible reference area or reference herd. Last but not least, the direct payments are not unconditional: 'professional' farmers are obliged to set aside part of the COP area and should not exceed specific livestock density limits per hectare of fodder area nor headage limits per farm. The set aside requirements have now –along with sugar and milk- brought COP production under rather direct control of the European Council.

The 1992 reform, also known as the Mac Sharry reform, paved the way for the Blair House agreement of 1993, which in turn made it possible to conclude the Uruguay Round with an Agreement on Agriculture in 1994. This agreement installed ceilings, decreasing over time, on the admissible volume of subsidised exports and the nominal value of export subsidies on the one hand, and on the import tariffs on the other hand. These ceilings have decreased over the period 1995-2000 by 21% (for subsidised export volumes) and 36% respectively (for export subsidies and – on average - for import tariffs). Moreover, minimum market access had to be given, up to five percent of domestic consumption; this access can be looked at as a source-generic tariff rate quota (TRQ), i.e. as an opportunity to import at a reduced tariff rate up to the import quota. It is to be noted that the minimum market access requirement can also be fulfilled by existing bilateral TRQs ('current market access'). Finally, the agreement stipulates a reduction over time of the Aggregate Measure of Support (AMS) which is essentially the total volume of agricultural production valued against the price wedge of internal and external prices. This ceiling is to decrease by 20%. Note that the AMS does not include the direct CAP payments, which, although not fully decoupled, are permitted ('in the blue box').

The ceilings installed by the Uruguay Round Agreement on Agriculture (URAA) were rather relaxed. However, some have become binding and sooner or later most of the ceilings are likely to become effective constraints. This raises the question when and to what extent these ceilings will drive away the prime characteristic of the CAP, its insulation of domestic price levels from world market price developments. On the import side two tariff arrangements can be distinguished. In accordance with the 1993 Blair House agreement variable tariffs can be applied for cereals and rice up to a given percentage above EU intervention prices, whereas the entry price system for fruits and vegetables also establishes a fixed price floor below which imports cannot occur (cf. IATRC, 1997). For the other agricultural commodities the import tariff ceilings (bound rates) are prohibitive in most cases. Moreover, if some of these turn out not to be prohibitive they can often be made prohibitive by invoking the price-triggered variant of the Special Safety Clause (e.g. sugar, poultry). Therefore, imports either enter the EU under a variable tariff or under a current or minimum market access arrangement (TRQ). In the latter case it is the variable quotient rather than the tariff that plays the buffering role against volatile world market prices. Therefore, the CAP's price insulation policy is still in place almost forty years after its inception. The external supporting mechanism for this policy is still there, though -admittedly- the variable import levies are replaced by variable tariffs and variable rents on the tariff rate quota and the variable export refunds by variable export subsidies. The EU can increase its manoeuvring space under the ceilings by regularly adjusting its guaranteed prices downwards. This is so because the subsidised export volume ceilings can to a large extent be satisfied through a sharpening of CAP production control (a defensive strategy which might be followed for e.g. sugar). On the other hand, more drastic reductions in domestic price guarantees would allow the EU to export its surpluses (almost) unsubsidised (an offensive strategy which seems to apply to wheat).

The latest CAP reform, the agricultural part of Agenda 2000, was amongst other things motivated by the need to find a way out of the problems posed by or to be expected in the near future from the URAA ceilings. Alternatively, it can be seen as an opening bid for the Millennium Round. The European Council endorsed the Agenda 2000 package in its Berlin meeting on 26 March 1999. The package finally agreed upon represented a significantly weakened version of the Commission's original proposals (Swinbank, 1999 and European Commission, 1999a). Essentially, the Agenda 2000 CAP reform is repeating the 1992 CAP reform: lowering price guarantees and raising direct payments to farmers to compensate them (in part) for the income loss. Agenda 2000 both deepens and broadens the principles of the 1992 reform, albeit the broadening, for dairy, is postponed until 2005/2006. Agenda

2000 brings some innovations as well, such as the introduction of slaughter premiums for cattle and dairy cows, the availability of national envelopes for beef and dairy of which the deployment is at the discretion of the Member States, and tighter budget control with separate budget targets for market and rural development policies. Another, major innovation of the Agenda 2000 CAP reform is that existing rural development policies are brought under a single, coherent legal text and that the funding of the majority of these policies is now to come from the Guarantee Section of the European Agricultural Guidance and Guarantee Fund (EAGGF). Thus, these policies are promoted to become the second pillar of the CAP. This brings us to the other component of CAP: its structural measures.

Structural measures

In the early decades of the CAP, its structural policies were relatively modest and affected mainly the production factors land and labour. In the early 1970s they consisted mainly of selective aids to be granted for the modernisation and cessation of farms and for vocational training of farmers (cf. Folmer *et al.* 1995). Later on, special support schemes were put into force for farmers in the so-called less-favoured areas, for farmers in Mediterranean agriculture, and for voluntary set-aside, early retirement, and environmentally friendly ways of farming.

The Agenda 2000 CAP reform emphasises the importance of the EU's new policy for rural development in declaring it to be the second pillar of the CAP. This rural policy seeks to establish a coherent and sustainable framework for the future of rural areas aiming at restoring and enhancing competitiveness and therefore contributing to the maintenance of employment. The rural development policy aims to simplify the existing schemes and implement new schemes for investment aid, setting-up aid for young farmers, support for training and early retirement, allowances to farmers in Less Favoured Areas and to farmers taking agri-environmental measures beyond the usual, support for processing and marketing, for afforestation of agricultural land, and for a range of other measures that promote rural adaptation and development. The Agenda 2000 regulation establishes the framework for rural Community support on the basic principles of multi-functionality, multi-sectoral approach and efficiency. Around 10% of total CAP-outlays is scheduled for allocation to rural development policies and accompanying measures.

The so-called horizontal measures of the CAP take account of environmental and employment issues when granting direct aid to farmers. These measures are known under the headings of cross-compliance and modulation respectively. The cross-compliance measures in-

tend to avoid negative impacts of agricultural practices on the natural environment by allowing subsidies and other favourable conditions to stimulate farmers to apply environmentally sound practices. Landscape protection policies or policies designed to assure a basic environmental quality are also part of other environmental and health policies. Member States may also decide on appropriate penalties for environmental infringements. The agreement on modulation allows Member States to ‘modulate direct payments per farm, within certain limits, in relation to employment on the farm or overall prosperity of the holding’. This means that Member States may establish conditions under which they can reduce the aid granted to farmers who fail to comply with the relevant limits.

2.2. Modellability of current CAP issues

In addition to the market organisation schemes and the structural measures of the CAP, new issues are coming up that require ‘common’ attention, such as the monitoring of food safety, the admissibility of genetically modified organisms (GMOs) in European agriculture or on the internal market, the harmonisation and definition of product standards, the regulation of foods with curative claims, etc. Though conceivably economic model builders might contribute to the debate on these issues, they are not considered in this paper as problem areas that are addressable by the kind of models that are at stake here (cf. the model review of van Tongeren and van Meijl, 1999). Moreover, the issues mentioned are related to the CAP but not in its exclusive domain. Instead, we limit ourselves to an inventory of modellability of the issues arising in the more traditional domains of CAP: its market organisation schemes (including the URAA ceilings) and some of its structural measures.

Market organisation schemes

As the price insulation policy under CAP seems to remain a feasible option under current URAA ceilings and can be considered as one of the prime characteristics of CAP, the issue of price transmission definitely seems to be an issue that should be checked for modellability. Also, as nowadays most main agricultural commodities have been brought under some form of production control, the modellability of direct production quota and set aside requirements seems to be an important issue. The modellability of the rather complicated direct payments systems under CAP is a third issue that should receive attention, both because of its welfare implications and the impacts on supply response and because this is likely to remain a sensitive area under WTO (box content discussions). The set-up of the EU budget (and the 1988 spending guideline) would also qualify as a modellable character-

istic of CAP and -last but not least- the implementation in a modelling system of current URAA ceilings confronting CAP seems highly relevant.

Structural measures

Several structural policy characteristics of the CAP can be identified as modellable. These characteristics are on the one hand in the domain of rural development policy measures (like setting-up aid for young farmers, early retirement grants, compensatory allowances for less-favoured areas and afforestation premiums, support for processing and marketing) and on the other hand comprise the so-called horizontal measures (cross-compliance and modulation).

To illustrate the relevance of modelling CAP reform issues, we briefly review the topics that have been identified in the recent agricultural economics literature as prominent items for the agenda of the WTO Millennium Round. This is not a random choice, however, because, beforehand, a global model seems to be best suited for addressing multilateral policy issues.

2.3. Relevance of CAP issues in relation to the Millennium Round

CAP policy reforms may be captured by incorporating specific changes in a modelling system in a way that allows analysis of the policy scenarios of interest. In this section we focus on issues that are both related to the latest CAP reform and to the issues that are likely to be on the agenda of the next round of agricultural trade negotiations under the auspices of WTO. Alternative policy scenarios may in principle range over all the policy instruments at hand. However, not all instruments are likely to be of equal interest. A brief review of the recent literature in agricultural economics may be helpful in assessing the relevance of modelling specific issues.

WTO Millennium Round issues

The Uruguay Round established a 'built-in agenda': negotiations on a continuation of the trade liberalisation process were to commence before the end of 1999. These negotiations, dubbed the Millennium Round, will certainly pertain to URAA issues such as improvements in market access and reductions in export subsidies and domestic support. In approaching the negotiations the EU will have in mind to maintain certain existing provisions on which key elements of the CAP are built (such as the blue box, the Peace Clause and the Special Safeguard Provisions), to achieve improvements in market access to third country

markets and to ensure compatibility of rural and environmental policies in agriculture through recognition of its 'multifunctional' role (cf. European Commission, 1999b). Moreover, at the Seattle Conference, November 30 – December 3 1999, which failed to produce an agenda for the Millennium Round, other issues of interest for the agri-food sectors have been proposed for introduction into the agenda as well, such as competition law and standards with respect to production circumstances (especially labour and the environment).

Once agreement on the next WTO agenda will have been reached, many trade issues could be on it. Provisions for market access, domestic support and export competition are expected to be retained (Meilke et al, 1996; Swinbank, 1999). It is likely that the negotiations will be dominated by requests to speed up the liberalisation process. The rate of reduction for the main targets 'may need to be set at least as high as that agreed in the Uruguay Round' (Josling and Tangermann, 1999). However, outcomes of the negotiations will heavily depend upon the domestic political constraints and also on the actual evolution of farm policies, farm incomes and world market prices.

Direct payments have emerged as one of the major policy instruments of the CAP. In Agenda 2000, the EU is attempting to deepen its 1992 CAP reform. Meilke *et al.* (1996) have pointed out that quantitative analysis of trade liberalisation should emphasise the analysis of direct payments programs, encompassing some form of supply control. These direct payments are likely to become a contentious issue in future WTO negotiations. It is also conceivable that, in the years to come, CAP reform will entirely remove domestic support and export subsidies and yet high import tariffs could be retained (Swinbank, 1999). Regardless of the WTO rules, the CAP has been considered by competitors as protectionist and distortive in international export markets.

The impact of environmental support measures on agricultural markets has become an issue of concern too (Rabinowicz, 1999). In general, difficulties arise in assessing the likely trade-distorting effects of agri-environmental measures. Nevertheless, when direct payments as well as export subsidy programs are coupled with friendly environmental agricultural practices, these inevitably imply transfers to agriculture and consequently can be considered as trade-distorting measures.

Improvements in market access

Import tariff reductions will remain an important topic in future agricultural trade negotiations as well as the issue of whether quantitative access commitments should be expanded

or not. Thus, a debate is likely to start about the future role of the tariff rate quotas (TRQs). A negotiable option here might be the trade-off between expansion of quantitative access and the rate of above-quota tariff reduction (Meilke *et al.*, 1996). The negotiations may focus on developing a more uniform system for the administration of the TRQs, or at least on eliminating some drawbacks in current procedures for allocating TRQ licenses (Josling and Tangermann, 1999).

Though implicitly applied tariffs for cereals and rice have been reduced by Agenda 2000 the latest CAP reform does not aim at liberalisation of EU agricultural imports. Josling and Tangermann (1999) report that the EU 'is going to be cool toward any sweeping cuts in tariffs'. The EU might be vulnerable here regarding its abundant use of specific tariff rates, the use of entry prices for fruits and vegetables and the relatively high degree of protection for cereals. Besides these commodities, dairy products and sugar are also likely to receive attention during the next negotiations.

Reductions in export subsidies

On export subsidies, according to Josling and Tangermann (1999), the EU is likely to stress that these will continue to be needed, at least for the next few years to come. Any further tightening of the export subsidy constraints in the next WTO round will consequently be a major challenge to the CAP (Swinbank, 1999). Further reduction of export subsidies may be possible for some commodities such as cereals, and some countries will try to negotiate their complete elimination. On the other hand, agricultural exports are often assisted by export credits and credit guarantees. These two forms of intervention can be viewed as indirect subsidisation schemes and are likely to receive more attention in the future.

Another issue that escaped attention during URAA was the possibility of introducing export levies to prevent domestic prices to increase in line with world market prices. Though this possibility seems to belong naturally to the repertoire of price insulation under CAP, one might argue that prevention of world price transmission is against the spirit of trade liberalisation. The Agenda 2000 regulation mentions explicitly that an export levy (for arable crops) will be applied as a safeguard measure in cases of extreme urgency. This seems to imply that this measure will not be adopted automatically and that – in principle - price guarantees under CAP are to be interpreted as floor prices, that don't prevent domestic prices to rise if world market prices exceed these floors.

Domestic support

The measures to be included in the so-called ‘green’ and ‘blue’ boxes of the URAA will be under debate too. On the one hand, the EU position is that the ‘blue box’ exemptions will remain in place over the next decade. On the other hand, several of its trading partners have declared their hostility to the blue box concept and wish to see it abolished altogether in the next WTO Round (Swinbank, 1999). This may imply that efforts should be made to restructure the direct payments under the CAP in such a way that they meet the criteria of the ‘green box’, which would ensure their continued exclusion from the Aggregate Measurement of Support. Thus, EU direct payments would become more compatible with those of the US FAIR Act.

Another contentious issue is likely to be the size and composition of the ‘green box’. For the EU, the green box represents a possible solution to the conflict between satisfying political constraints of farm income support and complying to WTO provisions. However, it is questionable to what degree the ‘European Model for Agriculture’ may meet the strict criteria laid down for ‘green box’ measures. Swinbank (1999) notes that the EU is well within its permitted ceiling for AMS, and that the AMS is not a meaningful constraint for EU for the immediate future. It is not unlikely, that payments of voluntary and/or mandatory measures aimed at compensating farmers for their contribution to the ‘multifunctionality’ of European agriculture would be allowed even if not totally compatible with current definitions of trade-neutral provisions (Josling and Tangermann, 1999).

3. Potential suitability of GTAP for addressing CAP reform issues

In this section we focus on GTAP as the modelling system that could be adapted and tuned to accommodate the CAP reform issues identified as modellable in the previous section. First, we review existing GTAP applications that have addressed these issues. Next, we attempt to assess the potential suitability of GTAP for the further analysis of CAP reform issues.

3.1. Review of CAP reform issues that have been modelled with GTAP

Market organisation schemes

In GTAP, tax revenues and subsidy expenditures are computed by comparing the value of a given transaction, evaluated at agents' and market prices. In simulations, the market price as well as the agent price will generally change. The ad-valorem producer subsidy equivalent is expressed as $100 * [P_s - P_m] / P_m$, where P_s denotes producer price and P_m the domestic market price.

In the most recent version of the GTAP database, producer subsidies for agricultural commodities are based on PSE calculations done at the OECD for the year 1995. Several types of policy measures are included in the OECD PSE calculations:

- market price support
- levies on output;
- budgetary payments paid directly to producers;
- reduction in input cost (e.g., interest and insurance subsidies; subsidies on the purchase of fertilisers, seeds, feed);
- general services, assistance and support (e.g. measures that in the long term reduce costs but which are not directly receivable by producers such as research, advisory, training, and pest and disease control);
- programs funded at the local or regional level;
- other indirect support (e.g. tax concessions).

It is important to notice that there is no application that simulates the system of intervention and guaranteed prices internally through intervention stocks. Rather price guarantees are modelled as being supported externally through border protection rates. This is because “the main (sustainable) mechanism in the long run is border protection and not storage” (Jensen *et al.*, 1998). Since the market price support component of the PSE determines the border measure (see below), the total gross PSE less the market support component determines the producer subsidy.

Trade policies (tariff and non-tariff barriers)

In the case of imports, border measures raise the domestic market price, P_m , above the world market price, P_w . Price comparisons are expressed as a percentage difference between the domestic market price and the world price; hence, the ad-valorem tariff equivalent is expressed as $100 * [P_m - P_w] / P_w$. These price wedges are caused by policy instruments such as import tariffs or import quotas. In the GTAP database, the market price support component of the PSE determines the ad-valorem tariff equivalent.

In the case of exports, subsidies will raise the domestic market price above the world market price. They can be specified in the same way as tariffs since an export subsidy is merely a negative export tax. Indeed, in the latest version of the data base (version 4), the price comparison approach is carried over to the export side as well. Thus, the observed domestic/world price wedge is applied at the commodity level on both the import and the export side.

The prevention of world price transmission through its system of variable import levies and variable export refunds has for a long time been the most striking characteristic of the CAP. Although the application of variable import tariffs is at odds with tariffication under URAA, it is still formally allowed for cereals and rice because of the 1993 Blair House agreement. As the bound import tariffs generally are prohibitive (and in some cases can actually be made prohibitive by invoking the price-triggered variant of the Special Safety Clause) most agricultural imports enter the EU at a fixed import price level, either because a variable tariff is applied or because the imports are under a regime for current or minimum market access (TRQ). In the latter case it is the variable rent on the import tariff quota that buffers against the volatility of the world market price. Therefore, in general it seems still to be a feasible approach to insulate domestic market prices from world market price developments, provided the bound tariffs are prohibitive and the URAA export ceilings are unbinding. In case the latter tend to become binding, the EU can create space under the ceilings by adjusting its guaranteed prices downwards. This is so because the subsidised export volume ceiling can to a large extent be satisfied through a sharpening of CAP production control. Therefore, price insulation still is viable for most agricultural products. On the other hand, more drastic reductions in domestic price guarantees would allow the EU to export its surpluses unsubsidised as long as the guaranteed price falls short of the world market price. If the EU would refrain from imposing an export levy in case the world market price is above the price guarantee the world market price would be fully transmitted to the internal market. Note that in this case import protection may still be prohibitive.

In GTAP, price insulation can be modelled through a careful respecification of endogenous and exogenous variables (closure swap) that makes domestic market prices and the ratios of the domestic price and the average import price exogenous, and export subsidies and import tariffs endogenous. Under this so-called CAP-closure, domestic market prices for CAP-commodities are kept fixed with respect to e.g. the price index of GDP. Price fixity is supported by variable import tariffs and export subsidies on foreign trade. One may introduce endogenous closure swaps to represent the price floor character of domestic price guaran-

tees. In that case the switch to an export tax is prevented by reverting to a closure swap that makes the domestic price endogenous and the export subsidy zero and exogenous; conversely, price fixity and endogenous export subsidies are again activated endogenously as soon as the domestic price hits the price floor. One important complication arises because of GTAP's assumption of constant returns to scale in production. In this case, supply functions are almost horizontal, implying large and unrealistic supply shifts in case policy makers change administered domestic prices. This can to a large extent be overcome by introducing 'sluggish' or sector-specific production factors, which lead to decreasing returns to scale with respect to the remaining 'mobile' means of production and hence to an upward-sloping supply schedule. In the specific case of binding production quota, fixed domestic prices can be imposed for a price range that supports a positive production quota rent without the need to resort to factor immobilisations.

If price insulation is not imposed, closure swaps can also be used to model a binding import (export) quota. In this instance, the closure must be modified so that the quantity imported (exported) is exogenous and the tax equivalent (export subsidy or import tariff) is endogenous.

In order to deal with the URAA commitments on export subsidies, Blake *et al.* (1998) make the export subsidy rates for agricultural and food-processing goods endogenous, and subsequently reduce expenditure on export subsidies by at least 36% and the volume of subsidised exports by at least 21%. This experiment yields four possibilities for each good:

- the expenditure condition binds, with a greater than 21% fall in export volume;
- the quantity condition binds, with a greater than 36% fall in expenditure;
- one or both conditions are not met, with subsidy payments reduced to zero;
- both commitments are met, with neither being binding.

Alternatively, Bach and Frandsen (1998) undertake a number of preparatory simulations in order to determine the binding constraint between the reduction in the volume of exports and the reduction in the value of export subsidies, as well as between the tariff rate reductions and the minimum import requirements. Once the binding constraints are determined it is straightforward to fix them exogenously.

Since the publication of the seminal paper by Bach and Pearson (1996), it has become relatively easy to model current WTO and bilateral trade commitments for agricultural and food commodities explicitly. Exploitation of their technique of imposing complementary slack-

ness conditions makes it possible to generate regime switches³¹ with respect to all the URAA ceilings endogenously. Thus, Elbehri *et al.* (1999) impose bilateral TRQs in assessing the effects of liberalisation of the sugar market, while Veenendaal (1998), uses four complementary slackness conditions to reflect EU import regimes. These represent

- current market access quota (bilateral TRQs)
- toggle for price equation for imports above current market access quota
- minimum market access quota (source generic TRQs)
- toggle for price equation for imports above minimum market access quota

In principle these would together define 16 different possible import regimes for a given bilateral flow, but due to inequalities in the different import tariffs, only 9 different import regimes for a given bilateral flow are actually reachable. Under the CAP-closure (price insulation) the modelling of these regimes is more difficult but still feasible if one introduces endogenous closure swaps (to identify the adjusting tariff (equivalent) which depends on the import regime).

Decoupled payments

Following the 1992 CAP reform, the share of direct market support in total transfers to the agricultural sector has decreased, while compensation measures and other direct payments have increased. What distinguishes the compensatory payments from production subsidies is the fact that they are not linked directly to production, implying that they are (at least partially) “decoupled”. Since in the GTAP data base decoupling is not recognised and all direct subsidies are represented as output subsidies, it is particularly important to see how this problem has been dealt with in GTAP applications.

In Frandsen *et al.* (1997), Bach and Frandsen (1998), and Jensen *et al.* (1998), the compensatory payments to land are implemented as input subsidies to agricultural land. Therefore, in the initial GTAP data base input subsidies to land (hectare premiums) are added and output subsidies are adjusted³². The implementation of compensatory payments to land is modelled by imposing the total EU budget available for this measure and allowing the hectare premiums to adjust endogenously. This corresponds to the principle underlying the direct payments to COP producers, namely that compensatory payments per hectare will be re-

³¹ A regime switch is said to occur if the variable being zero before the shock becomes nonzero afterwards, forcing the other variable in the complementary pair to become zero instead (Veenendaal, 1998).

³² A similar approach is followed by Herok and Lotze (1998), and Lotze and Herok (1997).

duced proportionally in case the area involved in the applications exceeds the total reference area³³.

The implementation of compensatory payments to livestock reflects the fact that suckler cows and breeding ewes are a part of the production capital used to produce slaughter animals, while male animals and steers are final products sold directly to the slaughter houses. Accordingly, payments to the former were added in the data base as input subsidies, while those to the latter were maintained as output subsidies. In both cases, the implementation is carried out by imposing total EU budgetary expenditure available for premiums and allowing premiums per animal to adjust endogenously (Jensen *et al.*, 1998).

A more extreme approach is followed by Blake *et al.* (1998), since they treat compensation payments as fully decoupled. Consequently, they have no effect on resource allocation and can be treated as a transfer payment from government to the “farm household”³⁴.

Quantitative restrictions in production

a) Inputs (e.g. compulsory set-aside)

Blake *et al.* (1998) assume that land in cereals is specific to the sub-sector, so that set-aside is modelled by a reduction in the volume of land used in the EU cereals sector. Alternatively, Frandsen *et al.* (1997) model the set-aside requirement as a negative productivity shock to agricultural land in the wheat and other grain sectors. This reflects that the allocation of one hectare of land to these sectors has reduced productivity (of say the equivalent of 0.95 hectare), without the need to impose an *ad hoc* assumption such as the factor specificity at the sub-sectoral level.

b) Outputs (e.g. milk and sugar quotas)

The approach followed in the existing GTAP applications (Jensen *et al.*, 1998; Bach and Frandsen, 1998; Nielsen, 1999) is to introduce quota rents into the database as wedges between the value of output at producer prices and the value of output at market prices. Jensen *et al.* (1998), and Nielsen (1999), implement the quotas in the model by making the quantity produced exogenous and letting changes in demand for milk products be reflected in the market price (allowing the quota rent to adjust). On the contrary, Frandsen *et al.* (1997), and

³³ A similar approach is followed by Nielsen (1999).

³⁴ In the GTAP modelling framework there is just a single household in each region that accounts for all private and government consumption and savings. Therefore, Blake *et al.* assume that the compensation payments are paid to sector-specific agricultural factors and will accrue to the farm household.

Bach and Frandsen (1998) represent the EU dairy policy by stabilising the domestic market price letting milk production be endogenous (allowing the quota to adjust), on the ground that “the EU Commission occasionally has shown a willingness to adjust the quota” (Bach and Frandsen, 1998, p.9).

EU budget

The focus of the GTAP model is on elucidating the impact of changes in exogenous conditions on the allocation of resources in the economy and intra-region income distribution aspects are not explicitly treated. For each GTAP region just one regional “household” is distinguished so that the budget constraint of the public sector is only implicit. In particular, the EU budget is absent in the standard model. This is a weakness of the model, since one of the most contentious issues regarding the CAP is its impact on the budget. In order to model this critical aspect, Hertel *et al.* (1997) introduce a new fiscal entity in the model called “Brussels”. This entity makes disbursements to members in order to finance their food and agricultural expenses. GDP-based contributions are used to cover any deficit. Liapis and Tsigas (1998) follow a similar approach, including a budget component in the standard model. They determine the budget expenditures required to finance the CAP in their experiments, and the tax rate on income needed to generate the necessary revenue to balance the budget. In the same vein, Bach and Frandsen (1998), Jensen *et al.* (1998), and Nielsen (1999) introduce an equation that captures the cost of introducing compensatory payments as well as output and export subsidies in CEECs net of the new members’ contribution to the CAP expenses (consisting of tariff revenues from agricultural imports plus 0.65% of GDP).

3.2. Assessment of GTAP’s potential suitability

3.2.1 Data and aggregation issues

Sectoral and commodity disaggregation

Intervention under the CAP varies widely across farm commodities, both in terms of intensity of support and in terms of policy instruments deployed. By aggregating products affected by different policies into one single aggregate, one certainly loses some detail and accuracy in assessing policy responses. In economic model building (as well as in other fields of economic research) there is no escape from the trade-off between the costs incurred by aggregation and the benefits of analysing additional

information in greater detail on distinct types of commodity market interventions. A multi-purpose model such as GTAP needs to provide a relatively balanced treatment of the entire economy. On the contrary, special purpose models focused on the agricultural sector, such as the EU agricultural models reviewed in van Tongeren and van Meijl (1999) have the possibility to be more lopsided in their focus on specific agricultural policy issues. Furthermore, being a global model, GTAP needs to deal explicitly with agricultural trade and related domestic policies, in a variety of countries. As a consequence, multiple data sources must be used, and this makes disaggregation even more difficult. The most recent version of the GTAP database distinguishes 20 farm and food products (providing even greater coverage of agriculture than some current agricultural partial equilibrium models do) and 30 non-food products. However, obtaining this degree of sectoral detail for many different countries necessarily involves some compromises: even with this degree of sectoral detail, the breakdown may not be sufficient for each and every policy issue related to the CAP.

Structural measures and producer heterogeneity

A great deal of variation in farm size as well as production technology can be observed within European agriculture. There are still many small part-time operations in which farming is part and parcel of the household's lifestyle rather than a commercial activity. The possibility of representing these differences seems crucial in order to model the CAP's structural measures, such as, for instance, voluntary participation in structural farm programs. However, as has already been mentioned, the GTAP model does not seem to have any comparative advantage here.

Regional disaggregation (national level)

Global applied general equilibrium analysis is often the most appropriate tool when policy makers are seeking answers to global economic policy questions, such as the impact of multilateral trade liberalisation. Moreover, for many agricultural products the EU is such a big player on the international markets that global modelling is required, not because the policy scenario under consideration is global, but rather because the consequences of domestic reform may be widespread. However, since one of the most contentious issues regarding the CAP is its incidence on member countries, a complete disaggregation of the EU region into

member states would allow one to adequately capture the national impacts of CAP reforms. Currently, work is under way to establish such a breakdown in the next release of the GTAP database. This may make it possible to assess the distribution of benefits and costs of CAP reforms amongst member countries.

Establishing an appropriate benchmark

“The vagaries of weather, long gestation periods, price-inelastic demands, and heavy (but unpredictable) intervention by governments all contribute to greater volatility of agricultural assets, relative to their nonfarm counterpart” (Hertel, 1999, p.12). This volatility can translate directly into variations of key parameters during the calibration process that is common practice in the CGE modelling approach. The risk of significant alterations in the values of the parameters could be reduced through the introduction of new methods of calibration, in which the model is fitted to multiple data points rather than to a single “reference equilibrium” (Hertel, 1999).). There is also the issue of what benchmark should be used to assess the impact of policies that are due to be implemented in a period (or under conditions) different from that (those) described by the database. A common solution is to use a counterfactual benchmark obtained by modification of the original database. However, it is worth noting that the public availability of regular updates of a global economic database such as the GTAP one (presently on its fourth release) decreases the need for this type of adjustments.

Treatment of inputs (e.g. land, water)

There is no way around dealing with land markets if one wishes to appropriately model the agricultural sector. In this respect, GTAP is certainly a big improvement in comparison with models that fail to distinguish land from other capital inputs.

On the other hand, to treat all farmland as homogeneous does not take into account how the capacity of a given piece of land to produce a particular farm product varies with soil type, location and climatic conditions. In GTAP rental rates can differ across uses according to the elasticity of transformation adopted. However, it is conceivable to disaggregate land endowments much further: drawing a distinction between land types and land uses or characterizing land types according to the length of growing season (cf. the approach followed using the USDA FARM model in the applications review by Francois, 1999). Although the

development of a full-blown model of agricultural production by locality and land type could be out of reach for a global model such as GTAP, these extensions are crucial to assess the effects of climate change on agriculture, or the sub-regional implications of policy shocks. Similarly, the availability of sufficient water is indispensable for sustained agricultural production and not explicitly accounted for in GTAP. The use of other important inputs, such as agro-chemicals (inorganic fertilisers and pesticides), is captured implicitly by the input-output structure of GTAP's domestic databases and reflected by intersectoral sales from the chemical industries to agricultural users.

Compatibility of GTAP's EU database with official statistics

In evaluating CAP reform from the European perspective, developments in certain key variables and the trade-offs between them are generally of major importance. Amongst these are: agricultural value added (in total and by subsector), agricultural employment, the EAGGF budget and – to a somewhat lesser extent – consumer food expenditure and welfare. In principle, all these indicators are readily available from GTAP too. However, availability is not the only thing that matters, compatibility of baseline results with official EU statistics is an important issue too, especially for the policy maker. Moreover, discussion on simulation outcomes would greatly benefit if these could be given explicitly in volume terms as well, in stead of in percentage changes with respect to the baseline only. As the volume issue seems to be a minor issue once the baseline is compatible with official EU statistics we focus on compatibility here, in particular of agricultural value added and of EAGGF budget items.

Gross value added of EU agriculture in the GTAP (version 4) database shows good matches with official EU statistics, both in aggregate and for agricultural subsectors (see Table 1).

TABLE 1. Value added in EU agriculture, in total and per sector, 1995

	<i>Official EU statistics</i>	<i>GTAP (version 4)</i>
Gross value added at market prices, agricultural total, in million ECU	110390	110112
Idem, as percentage of agricultural total:		
Wheat	5	5
Coarse grains	4	5
Rice	0	0
Vegetables, fruits, nuts	18	18
Oilseeds	1	1
Sugar CB	3	3
Plant based fibers	1	1
Raw milk	19	18

Bovine cattle, sheep, goats	13	12
Other products (total)	36	36
- other crops		12
- other animal products		24

Sources: EUROSTAT and EU Commission, GTAP database (version 4).

For the EU budget items comparison of the GTAP database with official statistics leads to rather mixed results. In the case of agricultural protection, estimates of producer subsidies and border measures in GTAP are based on the PSE calculations made by the OECD. The PSEs include a much broader range of support than what is actually reported in the EAGGF budget. Therefore, budgetary outlays allocated to the EU budget on the basis of the GTAP 1995 database exceed the EU budget in official EU statistics (see table A1 of Annex A). Furthermore, considerable differences across sectors between official EU and GTAP statistics show up. These are very much in line, however, with Swinbank's (1999) observations with respect to the AMS: official EU-figures for milk support are no doubt too low, whereas those for fruit and vegetables seem rather high. It goes without saying that the compatibility issue requires more thorough investigations. If the sources of incompatibilities are sufficiently clear, one might proceed to incorporate official EU statistics directly in the GTAP database to ensure compatibility, using, amongst other things, the ALTERNAX software program (see Malcolm, 1998).

3.2.2. Model structure

Consumer demand

GTAP employs a Constant Difference Elasticity functional form that solves some of the problems posed by explicitly additive demand systems, such as the CES or the LES. The CDE approach certainly is a useful compromise between fully flexible functional forms and practical limitations to empirical estimation. Recent work in the GTAP consortium makes use of AIDADS functions which are better suited for long run projections involving large changes in income and – as a consequence – in budget shares.

We notice that in GTAP the inventory demand is not modelled, and such demands are purged from the benchmark equilibrium data set, in the process of constructing a representative year data base. Although it is apparent that there are incentives for stockholding – either private or public – in the case of nonperishable crop commodities, in the longer run, the importance of stocks is diminished, since continued stock accumulation or decumulation quickly becomes infeasible. Since GTAP, as well as the majority of CGE models, focuses on deterministic, comparative static analysis for the medium term, it

on deterministic, comparative static analysis for the medium term, it abstracts from commodity stockpiling, assuming that the associated price effects will only be transitory. Such an assumption fits rather well with the present situation of low public stocks in the EU, but it certainly did not apply to the CAP before the 1992 reform. As far as the future is concerned, if the EU decides to use commodity storage in order to abide by the URAA ceilings (e.g. in terms of subsidised exports), it could be appropriate to extend the standard model explicitly by incorporating the stockpiling of commodities into the GTAP framework.

Producer technology

GTAP differs from most CGE-models by allowing input substitution (since version 4.1 of September 1998), reflecting the important role that input substitution plays in the farm and food system. The potential incidence of farm programs is “closely circumscribed by the ability of livestock producers and food processors to substitute among raw agricultural products” (Hertel, 1999, p. 17). Particularly in the EU, (cross) price-responsiveness of feed demand has always been a sensitive issue, since the gains from price support programs for grain-crops have been shared with non-grain producers in the EU and overseas.

Given that several important CAP measures represent interventions in the primary factor markets (e.g. set-aside requirements and compensatory payments programs), it is clear that proper assessment of their impact on variables such as employment and land rents hinges crucially on the specification adopted for farm technology. In this respect, the representation provided by a global model such as GTAP is certainly not comparable with the detailed treatment that can be found in EU dedicated models with an agricultural focus. On the other hand, the representation of the full input-output structure enables assessments of multi-market impacts and back- and forward linkages in the entire supply chain.

Finally, it is worth noting that within GTAP primary factors in each region can be specified as perfectly mobile across productive sectors or as factors that are sluggish. The possibility to model factor mobility assumptions is very important, since these assumptions are crucial in determining the incidence of farm programs. On the other hand, GTAP does not allow for international factor mobility. Given the growing concern about international migration and the potential demand for (non-EU) agricultural labor, this area could represent an interesting extension of the standard model.

International trade

Being a global trade model, GTAP does not face the main criticism raised against most models, namely that they abstract from cross-price effects in export demand. Another feature of the model, absent in many others (even global ones), is that transportation costs are explicitly taken into account. In addition, by using the Armington approach, intra-industry trade is possible. The work on international trade under imperfect competition seems highly relevant for large parts of the farm and food complex, and there are already some extensions of the standard model going in this direction. See van Tongeren and van Meijl (1999) for a discussion of the Armington assumption and alternative modelling approaches to incorporate imperfect competition and trade in differentiated products.

3.2.3. Representation of policy instruments

Market and price policies

These policy instruments can be easily modelled through the introduction of price wedges, but they are also becoming less important as a consequence of CAP reform. On the other hand, aggregate measure of support targets have been part of the Uruguay Round Agreement on Agriculture and could be present again in future agreements. As has been mentioned in the case of quotas, this type of commitments has become relatively easy to model explicitly through the technique of imposing complementary slackness conditions (Bach and Pearson, 1996).

Trade policies

A well-known problem in constructing a trade protection database is that the difference between domestic and world prices is taken as given, and GTAP is no exception. Many other factors, such as quality differences of the traded goods, distort the rates determined in this way.³⁵

To date, the construction of the GTAP database can be considered as the most comprehensive attempt to integrate bilateral protection and trade data into a consistent framework.

Looking ahead, the major challenge is represented by the modelling of present and future trade liberalisation commitments. A global model such as GTAP is able to model bilateral preferential agreements, since tariffs and export subsidies and their ad-valorem equivalents are source (destination) specific. Tariff aggregation problems may complicate assessments

³⁵ For a discussion of some of these issues see Wainio and Gibson (1999) who report on a joint initiative by USDA/ERS, Agriculture and Agrifood Canada, the European Commission, UNCTAD and FAO to develop a comprehensive agricultural market access database (AMAD).

though (see Bureau *et.al.*, 1999 for an analysis of alternative tariff slashing schemes). Other commitments are more difficult to model explicitly, but imposing complementarities in GTAP provides a flexible and easy-to-use tool for modelling policy “fences”. However, models with regime switches are harder to solve than nonlinear equation systems, and introducing complementarities in a multi-regional context may introduce non-monotone relationships and impair this approach to policy modelling (Veenendaal, 1998)).

Decoupled payments and structural measures

If the swing from market support to direct payments continues, the debate on the measurement of the degree of decoupling of alternative systems of direct payments will become more and more important (e.g. Gohin *et al.*, 1999). Since the impact of domestic income support instruments on agricultural production (and trade) mainly depends on production technologies and the extent of factor mobility between sectors, multi-region CGE models should play a role in evaluating the degree of decoupling of present agricultural policies.

Although the representation of compensatory payments in the GTAP database is not satisfactory, several recent GTAP applications deal explicitly with these aspects.

On the other hand, if we consider fully decoupled payment schemes, distributional implications will be more important than allocative ones. ‘Second pillar’ programs supporting rural development and a multifunctional agriculture focus both on producers and households and are implemented at the subnational level. From this perspective, disaggregation of households in the economy seems to be important. Unfortunately, data on factor payments to different household groups are difficult to obtain for many different countries.

Quantitative restrictions

The implementation of quotas in GTAP is not a major problem as long as they are binding. Otherwise, the introduction of a potential constraint would require endogenous changes in policy regimes (as was mentioned in the section about trade commitments). Processing sector impacts, in addition to the changes in returns to farms, must be captured by any model choosing to focus on policies of production control (Hertel, 1999). In this perspective, it should also be recalled that in many cases CAP provides support for farm commodities through the processing sector. This type of indirect approach to supporting the farm sector

can have important implications for policy analysis, and hence for the appropriate structure of the model. Though the treatment of food manufacturing and marketing sectors in GTAP is rather straightforward, we observe that GTAP's version 4 database makes quite a few distinctions between primary and secondary sectors that may be relevant from the point of view of modelling the CAP (e.g. milk and dairy, sugarbeet and sugar, livestock and meats).

EU budget

The introduction in the standard model of a budget component for "Brussels" is a good starting point. Nonetheless, there are no applications yet providing a comprehensive account of the expenditures on agriculture. Structural adjustment funds, for instance, account for a significant share of the agricultural expenditure, but the disbursement of these funds is not modelled. Nor are there applications that incorporate the 1988 spending guideline.

3.3. Summary

Our findings can be summarised as follows (see table 2). The price insulation issue can be modelled using the CAP-closure, either exogenously (see van Tongeren *et al.*, forthcoming) or endogenously (in order to do justice to the price floor character of price guarantees). All other major elements of the CAP's market organisation schemes seem to have been implemented in GTAP in a rather satisfactory way. However, the issue of data compatibility with

TABLE 2. GTAP and CAP reform issues

<i>Issue</i>	<i>Already applied?</i>	<i>If Yes: How can they be improved? If No: How can GTAP be applied?</i>	<i>Benefits to costs</i>
Price insulation by making prices fixed	Yes and No	An application is being prepared imposing the CAP-closure exogenously	++
Price insulation by preventing prices to fall below price guarantees	No	Price fixity can be activated endogenously if price hits the floor and de-activated if export subsidy becomes zero	++
Output quota	Yes	There does not seem to be an application yet with an endogenous quota mechanism	++
Set aside	Yes	Applications do not seem to need improvement	n.a.
Direct acreage and livestock payments	Yes	Applications do not seem to need improvement	n.a.
EAGGF budget items	Yes	Applications do not seem to need improvement; compatibility with EU statistics remains an important issue though	n.a.

Agricultural spending guideline	No	Budget ceilings may be imposed; benefits may be small as ceilings are not likely to become binding	-
Second pillar policies	No	Applications would require household and regional detail	--
URAA export ceilings	Yes	Applications exist by trial and error and by explicit imposition	n.a.
URAA import regimes	No	Import regimes can be specified explicitly using complementarity slackness conditions	++
URAA AMS	No	AMS ceilings may be imposed; there may be benefits if one wants to assess what would happen if the blue box were abolished	++

official EU statistics seems to need further attention. The agricultural spending guideline has not been modelled and the benefits of imposing budget ceilings explicitly may be small since the guideline is not expected to become binding. Second pillar policies have not been addressed at all in GTAP applications. The GTAP model will not be particularly well suited for analysing the CAP's structural measures, unless subnational and household detail is introduced. The cost benefit ratio seems to be rather high here. The URAA ceilings have been imposed on the export side, but the TRQ import regimes have not been widely addressed yet in GTAP applications. As the source code for such applications is readily available the benefits to costs ratio of an application seems to be rather high here. The URAA AMS ceilings have not been imposed yet. If the blue box could be maintained, these ceilings are not likely to become binding. However, it may be worth the effort to impose these ceilings explicitly in order to enable GTAP users to address the amber box issues.

4. Strengths and weaknesses of the GTAP framework for analysing CAP reform issues

In this section we attempt to identify the strengths and weaknesses of the GTAP modelling framework for the analysis of CAP reform policy issues from different points of view. It is perhaps unsurprising that the relative strengths of GTAP seem to be directly related to the coverage required by the subject matter of the analysis. Its strengths as a policy analysis tool are likely to diminish if one moves down from global trade issues via the policy issues that are predominant in the debate about the functioning of the internal market to the policy issues that are of prime importance for the analysis of rural development issues. This can be substantiated as follows.

CAP reform issues and the Millennium Round

GTAP is by design primarily a tool for global trade analyses and seems to be very well suited to studying the consequences of CAP reform issues within this context. This is so because

- GTAP has global coverage, distinguishes bilateral trade flows, admits intra-industry trade and has sufficient coverage of agricultural and food commodities
- GTAP can be adapted to reflect the URAA ceilings explicitly
- GTAP can also be adapted to reflect the characteristics of CAP that seem most important in this context, namely price insulation, production control (through production quota and set-aside obligations) and the CAP's schemes for compensatory payments. The ability to reflect the latter with sufficient detail will become especially important if one would try to redesign these schemes to make them qualify for whatever box in which they would be allowed in a revised set-up under WTO.

CAP reform issues and market organisation schemes

GTAP can also be deployed to study CAP reform policy impacts on the internal market, especially in the domain of market organisation schemes, because GTAP can be adapted to reflect most of the main characteristics of CAP in this domain. Though GTAP's current database does not distinguish member states separately, this may well be the case in one of its future releases. Yet, it seems that here the specialised EU models focussing on food and agriculture like SPEL and CAPMAT might be at an advantage, as these are both richer and more detailed in their explanation of supply responses and changes in internal demands (cf. van Tongeren and van Meijl, 1999). Moreover, the prime objective of these specialised models is precisely to do impact analyses of CAP reform for European agriculture (see e.g. European Commission, 1998). World market price developments are exogenous in these models though. In evaluating CAP reform from the European (as opposed to the global) perspective, developments in certain key variables and the trade-offs between them are generally of major importance. Amongst these are: agricultural value added (in total and by subsector), agricultural employment, the EAGGF budget and – to a somewhat lesser extent – consumer food expenditure and welfare. In principle, all these indicators are readily available in GTAP too. However, there is no doubt that much more energy has been spent on the databases of the specialised models than on the EU database inside GTAP. Therefore, the quality of GTAP's EU database is likely to fall short in comparison. Yet, a quick scan of agricultural value added and export subsidies by subsector in the GTAP version 4 database shows good matches with official statistics, with some exceptions that need further investigation. However, the database scan has been rather incomplete, and a more thorough investigation of data quality and data compatibility with official statistics seems to be needed. In

order to facilitate communicating model simulation outcomes it seems to be important to ensure that a) the GTAP database is fully compatible with official EU statistics and b) volume developments can be reported explicitly (i.e. in tons rather than in percentage changes with respect to the baseline)

CAP reform issues and structural measures

As it stands now GTAP is unlikely to be a productive tool in studying the consequences of changes in EU structural policies or in assessing the impacts of particular rural development policy options. It simply has not been built for these purposes and lacks the regional and agricultural household detail that seem to be required for this subject matter. Nor are the specialised EU agricultural models in their current state suitable for these purposes. It seems that other dedicated models are needed here, that either describe the complete rural economy in sufficient detail or focus on specific items like agricultural household structure or environmental practices on a rather local scale. In general, it seems that particular rural policy issues should be addressed through a series of detailed case studies, possibly in conjunction with less detailed models, but not by models alone.

Should GTAP be deployed in tandem with other models?

This more or less naturally brings us to the question whether synergies can be obtained in analysing specific CAP reform scenarios with GTAP *in tandem* with other, more specialised models. At first sight this seems indeed the case, as GTAP may provide the specialised models with world market price developments that are consistent with the reform scenario at hand. Conversely, the specialised models may indicate more delicate responses within the internal market than GTAP is able to reveal. This set-up raises interesting research questions that need further study. For instance, compatibility questions need to be addressed both with respect to classifications and with respect to model structure. Another question that seems to be of special interest here is whether it is possible to adapt the structure of GTAP's EU module in such a way that it becomes rather easy to import the responses generated by specialised EU-models. If the answer to this question is affirmative, the deployment of GTAP in tandem with other models might be a fruitful approach.

5. Conclusions and recommendations

The findings of this report can be briefly summarised as follows:

- GTAP is a versatile tool that is adaptable to reflect the main policy issues connected with CAP reform
- a review of GTAP applications reveals that in the domain of market organisation schemes most of the major mechanisms characterising CAP are, at least in principle, modellable; these include CAP price insulation, CAP compensation schemes, CAP supply controls, CAP budget regulations and the URAA ceilings confronting CAP
- a review of the recent agricultural economics literature shows that the modellability of these characteristics of CAP is especially of interest if one considers the topics that are likely to be on the agenda of the Millennium Round under WTO
- therefore GTAP appears to be a tool that is particularly well suited for the analysis of CAP reforms within the context of global trade issues
- similarly, GTAP is also usable for impact analyses of CAP reform issues on European agriculture, especially in the domain of market organisation schemes; in this area specialised EU models may play a complementary role as their usage is likely to yield further insights.
- finally, GTAP is unlikely to contribute precious insights in the CAP domain of structural measures without spatial and household group disaggregation; it seems to be more fruitful to deploy models that have been especially built to address the issues involved here, rather than to attempt to expand GTAP to make it a modelling tool ‘for all questions’.

The following recommendations have been made in this report:

- to critically review GTAP’s model structure in order to adapt it in such a way that its reflection of important structural characteristics of European agriculture is improved
- to critically review and adapt the current GTAP database for EU in order to ensure its compatibility with official European statistics
- to investigate whether synergies are to be expected from the deployment of GTAP *in tandem* with other, more specialised models that focus on EU food and agriculture in analysing CAP reform issues

Annex A. EAGGF budget comparison

TABLE A1 Expenditures and receipts from support and protection data in GTAP (version 4) and official EU statistics (million ECU)

Expenditures						
	EU	GTAP	EU	GTAP	EU	GTAP
	Export subsidy	Export subsidy	Intervention ¹	Intervention ¹	Total ²	Total
Cereals	1093	492	13667	14317	14760	14809
Sugar	1312	1311	519	28	1831	1339
Vegetables, fruits, nuts	204	-18	978	461	1181	443
Vegetable oils	38	0	342	146	380	146
Other crops nec	35	78	1391	4646	1426	764
Plant based fibers	0	0	876	28	876	28
Rice	0	145	50	30	50	174
Dairy	2267	4845	1762	4916	4029	9761
Bovine cattle and meat	1761	1859	4041	6721	5802	8580
Other cattle and meat	319	761	1921	5874	2239	6635
Other food products	611	-86	616	2126	1227	2041
Wine ³	37		821		858	
Total	7676	9387	26982	39293	34658	48680
Receipts						
	EU	GTAP				
Custom duties	10900					
Levies	938					
Import tariffs	11838	9200				
Sugar levies ⁴	1462					

Sources: GTAP (version 4), European Commission

Notes:

- 1) Intervention includes for example set-aside payments, storage costs, area and headage payments.
- 2) Total = export subsidies + intervention
- 3) In GTAP part of much larger beverages sector
- 4) Sugar levies in GTAP included by intervention (expenditures).

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Comments on the paper

Assessment of the Usefulness of GTAP for Analysing Reforms of the Common Agricultural Policy

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Introduction

The authors present an assessment of the usefulness of the GTAP model for analysing reforms of the CAP. A strict interpretation of my role as a commentator should imply of making an assessment of an assessment. Hence I should make a similar analysis and then compare my results with those of the authors. The analysis is based on an in depth examination of the GTAP model itself and a comparison of the GTAP with 17 other models. It is hardly possible for me, especially taking into account the time limitations both for preparation of the paper and for making the comments, to make a similar analysis and compare my conclusion to those of the group involved in making the original assessment. I'm familiar with the GTAP model but I have not done any work with it myself. Hence, my comparative advantage in this audience can hardly be a detailed knowledge of and experience with GTAP modelling. Therefore, I would like to mainly focus on broader modelling issues and highlight some aspects that could be added to the assessment.

Choice of criterion for analysis

The authors choose as a main criterion for their assessment the usefulness of the GTAP model for analyzing reforms of the CAP the modellability of the main current characteristics of the CAP within the GTAP. I would suggest a somewhat broader criterion, namely: ability of the GTAP model to generate useful and reliable results on policy-relevant CAP-issues that are potentially useful for decision making on the future direction of the CAP. The criterion that I'm suggesting is not completely different from the one that has been selected by the authors. On the contrary, modellability of the main current characteristics of the CAP is a necessary precondition for the ability to deliver relevant results. However, I would argue that the criterion that I have suggested also includes ability to generate interesting and new insights, transparency of results, reliability and accessibility of data, openness as well as ability to offer plausible explanations for the outcomes. I will return to a discussion of the components of the proposed criterion at the end of my presentation. My main

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argument for choosing this “amended” criterion is that applied work on policy relevant issues is ultimately motivated by the usefulness of the analyses for making “enlightened” policy decisions. To my mind it is somewhat pointless to conduct applied work on policy issues without considering potential use of the result for decision making. This view may seem naive. Any student of political economy could tell me that this is not the way political decisions on agriculture are made. Decision-makers seldom pay much attention to the prescriptions of the economists. I would, nevertheless, argue that we as economists should always design our analysis as if we expected that the results would be applied.

Identification of relevant policy issues

The objective of the paper is, as stated by the authors, to assess whether the GTAP modelling tool could be usefully deployed in analysing of CAP reform issues. The question that emerges immediately is what issues can be considered as relevant. The authors seem to identify the unfolding WTO negotiations as a primary pressure for change and focus on functioning of internal market, tariffs, market access, export subsidies etc. Structural and environmental policies are mentioned but play a relatively minor role among the identified policy priorities. A question that could be asked is whether this is a correct identification of relevant policy issues. It could be argued that this is the case. Bulk of support that is provided by the CAP for farmers at present is related to market interventions and compensatory payments. Structural and environmental policies seem still to play a very minor role, especially in total spending on the CAP.

However, looking at the present level of spending at the EU level might be misleading as guidance for identification of future policy issues. Pressure for change of the CAP may not only come from the WTO and the process of enlargement. The implication of Kyoto protocol for agriculture and fading legitimacy of the CAP, to take some examples, constitute also relevant factors that may bring about a change of the CAP. Moreover, policy preferences are different among the Member States. To substantiate this point, let us look at the structure of CAP spending on agriculture in Sweden.

Two comments can be made with respect to table 1. Firstly, share of environmental and regional payments is significant (40%). Hence, at least for the Swedish conditions (similar applies to Finland and Austria) modelling such payments is necessary to assure that the results are relevant. Secondly, the table could also be interpreted in terms of revealed political or societal preferences. Apparently, the Swedish society attaches importance to environmental and regional aspects of agriculture. Accordingly, not only should the environmental

TABLE 1. Direct payments to Swedish agriculture 1998, MSEK

Type of support	Share %	Amount
Arable land premia	55	3650
Livestock premia	5	312
Regional support	13	890
- LFA payments		595
- national support to Northern Sweden		293
Environmental payments	27	1797
- open landscape		578
- organic farming		258
- roughage		402
- Biodiversity		314
- other environmental payments		245
Total	100	6649

Source: Yearbook of agricultural statistics, 1999. Statistics Sweden.

and rural payments be included into modelling exercises but such exercises should in general emphasise environmental and regional implications of other policies as well.

Moreover, it could be argued that identification of relevant policy scenarios should not only focus a very narrow perspective but also take into account more radical proposals how the CAP should be reformed. There is no shortage of proposals how this should be done. There is no time or place to review them all here. There is a common denominator, however. Most proposals embrace a reduction/removal of market price supports and an increase of environmental payments and rural support. One such proposal advanced by a group of researchers (including myself) and headed by A. Buckwell and called CARPE (Buckwell et al, 1997) envisaged a common agricultural and rural policy for Europe where environmental and cultural landscape payments and rural development initiatives would constitute major elements of the common budget.

Modelling of supply management

The authors argue that the dominant feature of the CAP still is isolation from the international market. Hence they focus the analysis on this issue. I agree. However, I would argue that an equally important feature of the CAP is the strong dependence on supply management. Let me start with some comments related to this issue. Supply management includes not only quotas that can be modelled in the GTAP but also all kinds of rules, especially technological requirements in different regimes that are not equally easy to model. It can be claimed that in case of the CAP the devil is in the details. As long as those details remain

unchanged no modelling problems arise. This is, however, not always the case. The problems could be avoided if changes of technical specification can be easily translated to “supply shifters” before running the model. Such translation is, however, not always possible without the model. An example can be used to substantiate my point, according to an analysis of the impact of Agenda 2000 on the Swedish agriculture (DS 1998), based on a programming model, the design of technical specifications had a major impact on the expected outcomes for Sweden. This was in particular the case for rules for set aside and recruitment for suckler cows. Hence, when changes in technical details may produce bigger impact on production than changes in prices, one needs a model having such details included.

Modelling of market regulations and direct payments

Assessment of the ability of the GTAP to represent existing market regulations is discussed at some length in the paper. I agree with the analysis of the market regulations with exception of set asides and decoupling. I would like to add some comments on those two issues starting with the latter. Decoupling is a highly relevant policy issue as it very contentious in the WTO and in relation to the enlargement negotiations. To start with, we do not know enough how direct payments affect production. W Meyers observed, during a recent OECD meeting (December 1999) that in spite of supposedly decoupled direct payments, supply of agricultural products from US agriculture was increasing while prices were falling.

Full coupling occurs when the compensation scheme fully restore the price change and full decoupling is the case in which the change in production only corresponds to that under a price change. Estimates for Italy (Moro, Schokai (1998)) indicate a partial rate of decoupling. Degree of decoupling decreases, moreover, as its own price cut increases. This result is intuitively appealing. As long as prices are high, the main impact of payments is probably to sustain a high level of land value. At low prices some land would have gone out of production in the absence of payments.

Accordingly, treating direct payments as decoupled, as was done in one of the GTAP applications quoted in the paper is simply wrong. At present cultivation is required for receiving payments. Moreover, the discussion above indicates that type of conditions that are attached to payments may be crucial for the impact on production. Looking again at analyses for Sweden indicates that the results were quite different depending whether only sowing or sowing and harvesting was required to receive the payments and whether 100 set aside was accepted as agricultural use of the land.

The authors argue that treatment of set-aside in GTAP "do not seem to need an improvement". I believe that this statement needs to be qualified. The underlying analysis does not distinguish between voluntary and compulsory set aside. Compulsory set aside may be modelled in the way that was done in the two applications quoted in the paper. Modelling of voluntary set aside, which may emerge as an interesting option if prices decrease and compensation payments increase may not be possible in the GTAP. Voluntary set-aside seems especially attractive if farmers are allowed to set aside a whole farm and not only a part of it (in the former case farmer may get rid of farm machinery). Another complicated issue, that is difficult to handle in any model, is whether decoupled payments are credible (Rabinowicz 1999). Would farmers really believe in the long term payments with "no strings attached", I would not?

Environmental modelling

I agree with the assessment of the author in relation to modelling of the environmental issues. It is not possible to analyse impact of environmental policies without a fully blown model of agricultural production by locality, type of land, type of activity (conventional vs. organic, extensive vs. intensive). Many of environmental goods respective bads are related to very specific dimensions of agricultural production technologies and location of production, for instance whether the beef meat comes from production of fatted bulls or grazing steers. Biodiversity is strongly related, at least in Sweden, to the number of grazing animals and the type of land that is grazed.

Of course, some environmental problems may be difficult to address even in an activity based, fully regionalised model. The nitrogen pollution is a case in point. This is a classical case of a diffuse, non-source pollution. A connection between on farm use of nitrogen fertilisers and environmental problems elsewhere, for instance in the Bay of Laholm, not far from Copenhagen, is not very strong. Accordingly, such problems are not efficiently remedied by Pigouvian taxes or similar measures but rather but a combination of different measures that may be very farm and location-specific. To identify an appropriate combination of measures a detailed economic/environmental farm level model is needed.

Comparison of results

Very little attention in the paper is paid to the results that have been obtained by the GTAP and the other models that had been included in the study. The comparisons focus on technical features of the models: how certain aspects have been modeled, what and what not has

been included. I would argue that comparison of results is an important part of an assessment. Ideally, one should compare models by confronting them all with the same policy scenario/s in a kind “controlled experiment” and then contrast the resulting figures, conclusions or recommendations.

Conducting such controlled experiments may be difficult, for practical reasons. However, even if this is not possible the results that have been obtained should not be completely disregarded in an evaluation of relative merits of “competing” models. It could be argued that it is hardly meaningful to conduct a detailed comparison of numerical results of different policy scenario that have been produced by different models. I would argue, however, that a cautious, qualitative comparison of the outcomes is possible. The models, as analytical devices are at their best when we obtain insights into complex problems that could not be sorted out otherwise. Results should thus not be obvious and may even be surprising but should make sense after a closer examination. Hence, a question could be asked how successful is GTAP in generating new and interesting insights as compared with other models. To what extent genuinely new information has been generated or are the outcomes of modeling exercises only a matter of putting new figures, orders of magnitude, on what we know already so we could “know it better”.

Accessibility and openness

If modeling exercises are to be able to contribute to the debate on CAP reforms the results must also be accessible and transparent. Modelability of key policies is an important aspect, a necessary but not a sufficient condition. Results must be understandable for the decision-makers. Far too many models are simply black boxes where only those directly involved are able to fully understand what is going on. If we want to affect the decision-makers, as I believe we should, greater transparency and openness is absolutely necessary. The issues of accessibility and openness are, moreover, especially relevant for a supranational policy as the CAP. In this respect, the open architecture of the GTAP compares favorably with several other models.

Reliability of the data or empirical content of the model

It is a trivial observation that reliability of the data is crucial for the reliability of the results. This is especially the case if empirical results matter i.e. when effects of a proposed policy change are known in general and the issue is to establish the order of magnitude or direction or change. The latter may, for instance, be the case when opposing effects are involved and

it is not known in advance which of them will dominate. A highly relevant question that could be asked in such a situation is how trustworthy are the key parameter that are driving the results of the model. Relating this question to the main theme of our discussion, usefulness of the GTAP for analysing reforms of the Common Agricultural Policy, it could be observed that a decision-maker seriously contemplating to use a result of a model as a decision support is entitled to know whether the key policy conclusions/recommendations are highly sensitive to few parameters that in turn dependent on shaky estimates. At the same time we all know that in-data, especially behavioral parameters, are weak spots of most models. The authors discuss this issue with respect to compatibility of GTAP figures with EU official statistics. I would argue that much more analysis and critical scrutiny on this point is needed.

Conclusions

The authors conclude their analysis by stating that strength of GTAP as a policy analysis tool is likely to diminish if one moves from global trade issues via issues related to the functioning of the internal market to the policy issues that are of prime importance for analysis for rural development and I would add environmental implications of the CAP. I agree completely with this assessment. I would also like to add that strength of GTAP lies in analysis of impact of changes in the structure of economic incentives in agriculture (and in agriculture compared with the rest of the economy) as embodied in changes of relative prices etc. Impact of changes in modalities of payments and in other technical regulations that sometimes may overshoot the impact of changes in relative prices are not equally easy to model in this type of approach. This may imply that GTAP is more suited to analyse the present CAP and likely short run changes than that kind of CAP which I believe (or I hope) is likely to emerge in the future. This does not mean, however, that GTAP should be amended to be able to address those new issues. As correctly observed by the authors a universal "one size fits all" model simply does not exist. Instead, the idea of using GTAP in tandem with other specialised models that is advanced by the authors seems very attractive.

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Assessment of the Usefulness of GTAP for Analysing Environmental Issues in a Multi-Region Context

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1. Introduction

Computable General Equilibrium (CGE) models are increasingly utilised to analyse environmental policies in recent years. Particularly the economic assessment of global environmental issues are more and more based on these kind of frameworks. How can this popularity be explained? Global environmental problems are of transborder nature. In addition, the policies and regulations established to cope with most of these environmental problems (e.g. CO₂ tax) affect the whole national economy through intersectoral linkages and repercussions as well as other economies through trade flows. Accordingly, a tool is advantageous that captures linkages between all sectors and agents of the economy and world wide bilateral trade flows. Characteristics like these are indeed inherent in global multi country CGE models, but are they sufficient to enable sophisticated analysis of environmental issues?

Given this background, the paper aims to assess the current application of CGE models and the GTAP model in particular to global environmental issues based on the following structure. Chapter 2 presents a brief overview of currently discussed environmental policy issues which form the environmental modeling potential. This is succeeded by Chapter 3 that explains how the analysis of environmental issues is handled in the standard and extended versions of the GTAP model. Chapter 4 evaluates the ability of GTAP to handle environmental issues.

Before turning to substantive matters, it is however necessary to define the boundaries of the paper. For this purpose, environmental economics and natural resource economics are distinguished. The latter is concerned with the intertemporal allocation of renewable and non-renewable resources, as dealt with in the seminal paper of HOTELLING (1931) and the body of literature following it. This literature on natural resource economics is excluded

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from this paper. To keep the task manageable, this paper focuses on environmental issues that have a global or transboundary nature.

2. Environmental Policy Issues in the Current Policy Debate

Recent years have shown a growing awareness about environmental consequences of production and consumption. In some cases the list of policy instruments discussed to solve these environmental problems is very long and complex (e.g. green house gas emissions). In contrast, there are cases where the public debate is aware of the environmental problem, but constructive policy solutions have not yet been proposed (e.g. loss of biodiversity and gene pools). Therefore the list of environmental issues and policies can only be incomplete.

2.1. Domestic policies related to environmental issues

Human activities might be a dramatic threat to the sustainability of the environment. Advocates of greater environmental protection therefore ask for more stringent measures. Of particular note are domestic policies implemented to internalise negative external effects. Due to their impacts on trade flows, these policies do not only affect the national economy, but also international trade. Prominent representatives are the domestic policies to curb (MAHE, 1997; RUNGE, 1998; WHALLEY, 1999)

- green house gas emissions (e.g. CO₂ tax, tax on energy content, value added tax also in conjunction with reductions of social security contributions) and climate change,
- SO_x emissions and acid rain depositions (e.g. SO₂ tax, emissions trading),
- deforestation and smoke initiated by forest clearing and reduction of carbon sinks,
- economic activities that lead to a loss of biodiversity and gene pools,
- manure, soil erosion and desertification and
- water pollution, especially due to intensive use of fertiliser and pesticides.

Domestic policies to internalise positive external effects can be represented by payments to farmers which are linked to provision of environmental benefits (green box policies). In addition, there are domestic policies creating or enforcing environmental problems. In most cases these are intervention failures which occur when government policy interventions fail to correct for, create and/or further exacerbate market failures. Examples of this kind of domestic policies are typically illustrated by the extensive use of fertiliser due to agricultural protection and particularly subsidies (OECD, 1994).

2.2 Trade, Trade Liberalisation and Environment

Another front page issue in environmental economics is the linkage between trade, trade liberalisation and the environment. Here, the growing body of literature mainly concentrates on four mechanisms, namely the production, scale, structural and regulatory effect of trade (OECD, 1994).

The product effect refers to the fact that trade influences the environment through the international exchange of particular products and goods. On one hand, trade serves as vehicle for diffusion of goods which contribute to environmental protection or constitute alternatives to environmental damaging goods. On the other hand, trade also enables the international movement of goods (e.g. hazardous waste, dangerous chemicals) which directly harm the ecosystem (COLE, RAYNER and BATES, 1997).

Trade also expands the overall level or scale of economic activity and market growth, thereby affecting the environment. A positive scale effect arises, because trade increases the income so that there is more interest in and more funds to spend on environmental protection. Trade also increases the efficiency of international markets which allows resources to be allocated to least cost and highest-return production activities. However, trade may also have a negative scale effect by worsening environmental problems when expansion of global production and consumption activities occurs in the absence of measures to control the possible adverse environmental impacts (FERRANTINO, 1997).

The more indirect structural effect of trade relates to the pattern of production and resource use stemming from trade-related factors. Trade changes the composition of industry and maximises the allocation efficiency among nations. A positive structural effect is given, when the economic activity is allocated in accordance with the environmental capacities and conditions of different countries and the efficient use of resources is promoted. The positive structural effect therefore deals with the question whether or not geographical concentration of harmful effects is a good or a bad thing. Accordingly, trade may also have a negative structural effect, if production and consumption is located in geographical areas that may be unsuited to nature of intensity of the activity (WHALLEY, 1999).

Trade policies are more and more oriented towards lower level of protection. Trade liberalisation promotes freer trade. Does trade liberalisation reduce or increase the product, scale and structural effect of trade? Additionally, it would be interesting to know whether regional or global trade liberalisation has a greater impact on the environment. Related to this issue is the fact, that trade liberalisation also has a regulatory effect which enforces national

policies to be harmonised. Again, it would be interesting to assess how this harmonisation affects the environment.

2.3 Trade Measures as Environmental Policy Instruments

Recent years have witnessed an increasing use of trade-related measures for environmental purpose, including measures taken pursuant to multilateral environmental agreements (MEAs). Use of these measures is based on the exception clause contained in Article XX of the GATT allowing WTO member countries to legitimately place public health and safety and national environmental goals ahead of its general obligation not to raise trade restriction or to apply discriminatory trade measures.

To avoid the misuse of trade measures the WTO has stated that the preferred approach for governments to take in tackling transboundary or global environmental problems is co-operative, multilateral action under an MEA. Examples for multilateral solutions to global environmental problems are the Montreal Protocol and the Kyoto Protocol enforcing the protection of the ozone layer and the global climate. However, the list of dispute settlements of the WTO in relation with the use of trade measure pursuant to MEAs clearly shows that unilateral action in this context does still exist. In this regard, several questions are of importance (OECD, 1994; MAHE, 1997; RUNGE, 1999; WHALLEY, 1999):

- Should it be allowed to use export subsidies for products that are environmental friendly (e.g. pollution control equipment, alternatives to environmental damaging products, goods produced using environmental friendly methods) even though it is to be expected that export subsidies will be severely reduced or banned in the next WTO Round?
- Should import restrictions for products harming the environment be tolerated, if domestic production is subject to environmental policy instruments and/or environmental friendly (e.g. existence value)? How is it possible to avoid an increase of environmental harming production (e.g. carbon leakage) in the case of lax environmental standard abroad? Are trade sanctions (e.g. import ban on dolphin-unfriendly tuna fishing) a useful instrument to enforce environmental concerns?
- How should developing countries be treated regarding environmental issues who fear that their growth and development will slow down significantly if they are subjected to externally trade enforced environmental restraint?

- Are eco-labelling programmes an adequate instrument to pursue environmental protection? Do eco-labelling programmes induce trade effect?

The next section shows how a few of these environmental issues are modeled within the GTAP framework. Thereby special emphasise is given to both modeling and data issues.

3. Modeling Environmental Issues in GTAP

3.1 Trade, Environmental Indicators and Welfare

The standard GTAP model as described in HERTEL (1997) is not tailored to the needs of environmental policy analysis. However, with the help of some additional assumptions and a supplementary model, it is possible to analyse issues that are not directly accommodated by the standard GTAP model.

Of particular relevance in the paper of PERRONI and WIGLE (1997) are environmental externalities, and abatement costs and benefits of an improved environmental quality, which GTAP does not currently incorporate. To mimic these features with the standard GTAP model, the authors firstly assume that the production structure in the GTAP model implicitly represents abatement technology and can be portrayed by the following functional form:

$$Q = f(X, E) \tag{1}$$

where: Q output
 X input
 E emission

In this way, emissions are viewed as an additional input in the production process. If an emission fee is implemented to close the gap between social and private costs and production technology is assumed to be LEONTIEF, then the only way for producers to react to this internalisation is a reduction in output. In this case, the emission fee charged would be the price of these emissions and the cost covering price of the produced good would be a function of input prices and emission fees. If, in contrast, production technology is assumed to be COBB-DOUGLAS, abatement is possible either by reducing output of "dirty" goods and/or by using more inputs to economise on the use of emissions.

Secondly, the authors assume that each consumer in the GTAP model can be represented by the regional household and has a constant elasticity of substitution (CES) utility function defined over the standard utility aggregate plus environmental quality.

$$\tilde{U} = f(U, V) \tag{2}$$

where: \tilde{U} Welfare from consumption, savings and environmental quality
 U Equivalent Variation (as in the standard GTAP model)
 V Environmental quality

Environmental quality is defined as the difference between an initial endowment of environmental quality and the damages from emission. It is also assumed that one unit of pollution degrades the environment by one unit.

$$V = \bar{V} - D \tag{3}$$

where: \bar{V} Endowment of environmental quality
 D Damages

To implement the assumed production structure (equation (1)) and consumption structure (equations (2) and (3)), the authors integrate additional information into the GTAP data base.

- Emission data utilised according to LUCAS, WHEELER and HETTIGE (1992) is represented as damage-weighted emissions in equally toxic pounds per dollar of output for the USA. Under the assumption that the benchmark per unit of output emission is the same for all countries in the data base, the authors apply these rates to all other regions. However, the damages are valued differently in the other included regions. Accordingly, the same amount of emissions causing \$1 of damage in high-income countries, cause 50 cent and 20 cent damages in middle and low income countries (including China), respectively.
- Abatement costs are taken from LOW (1992). They are given as expenditures per dollar of output in US industries and are assumed to be representative of all other regions in the model.
- Endowment of environmental quality is calculated using the assumption that the initial ratio of benchmark damages to endowment environmental quality (D/\bar{V}) is 0.25. Additionally, the elasticity of substitution between goods and environmental quality is assumed to be 0.5.

Furthermore, the authors complement the GTAP model with a special purpose model that is built in GAMS. This GAMS submodel as well as the additional information on emissions, abatement cost and sectoral output of the GTAP data base are used to calculate emission taxes imitated by an increase in the output tax and abatement technologies simulated as a shock to the augmenting technical change parameter of the production function. The resulting model represents a practical method of using an off-the-shelf model to analyse environmental issues.

TSIGAS (1994), GRAY, KRISOFF and TSIGAS (1995) as well as TSIGAS, GRAY and KRISOFF (1996) have extended the work of PERRONI and WIGLE in several respects. First of all, the authors implemented the code of the GAMS submodel into the standard GTAP model, so that the extended version of the GTAP model now has a more uniform appearance. Furthermore, some additional theoretical and empirical features are added to the model. These features include two supplementing environmental aspects in the form of an additional sector

- for land conservation which holds land that is set aside by the agricultural sector. Accordingly, land is allocated between agriculture and the land conservation sector. An ad valorem tax on land is integrated to induce the agricultural sector to use less land and thereby reduce soil erosion. The land tax revenues are distributed to the land conservation sector in form of an output subsidy.
- for pollution cleaning. This sector collects the ad valorem sales tax for the pollution emissions and uses them for cleaning activities. The size of the pollution-cleaning sector therefore depends on its purchasing power given as tax revenues divided by the average cost of providing cleaning services.

Another extension in respect to the work of PERRONI and WIGLE deals with the modeling of environmental quality and welfare measurement. Here, the authors first calculate a so-called net pollution level with the help of the following formula:

$$NP = QPE + QPO - QPC \tag{4}$$

where: NP Net pollution
 QPE Soil erosion
 QPO Other pollution
 QPC Abatement

In a second step, the net pollution is then used to calculate environmental quality analogously to equation (3).

$$V = \bar{V} - NP \quad (3')$$

A lot of additional information is required to implement the extensions of the standard GTAP model described above. To estimate emissions by sectors for all regions of the extended GTAP model, US pollution intensities are extrapolated to other regions. Thereby the GTAP data base is complemented with data for

- soil erosion used as a proxy for sediment runoff which can adversely affect transportation, road and shipping. Soil erosion rates on set aside, and planted acreage for grains and non grain crops, are taken from the US Conservation Reserve Program (OSBORN, 1995).
- pesticide toxic release utilised as a proxy for risks imposed by pesticides on food safety, farm worker and commercial handler safety (e.g. ground water contamination). The active ingredients of herbicides, insecticides and fungicides used in the production of US grains and non-grains are weighted by the consumer component of the environmental impact quotient.
- livestock waste measured by the total nitrogen content of waste from beef cattle, dairy cows, hogs, sheep and chicken layers and broilers for the average animal in the US using data from Soil Conservation Service.
- emissions of the manufacturing sectors, calculated employing data compiled by the World Bank under its Industrial Pollution Projection System for each region.

Additionally, pollution abatement expenditures are integrated into the GTAP data base. Total operating costs of pollution abatement for each US sector are divided by values of production to derive expenditure shares. Abatement expenditures for the other regions in the data base are calculated based on the assumption that the shares are equal in industrial countries and lower in developing countries. Abatement expenditures differ between sectors and are based on the following data sources.

- Land conservation expenditures are taken from the US conservation reserve program.
- Marginal cost of Environmental Protection Agency regulations regarding pesticide use for typical farms in Illinois, Mississippi and Kansas is the basis to calculate abatement expenditures for grain and non-grain producers in the US.
- Abatement expenditures by the livestock sector are based on US regulations for storing and dispersing livestock waste.

This extended version of the GTAP model is used by TSIGAS (1994), GRAY, KRISOFF and TSIGAS (1995) as well as TSIGAS, GRAY and KRISOFF (1996) to assess the harmonisation of trade and environmental policies in the Western hemisphere under different policy options.

3.2 Global Climate Change

Various extensions are added to the GTAP model to analyse policies coping with global climate change. HSU, HUANG and LI (1998) and LI, HSU and HUANG (1999) have modified the GTAP model to assess the global warming mitigation policies proposed by the Taiwanese government. For this purpose, the following extensions are implemented:

- Integration of an exogenous autonomous technical change parameter in the production function of each industry in Taiwan.
- Carbon taxes are transformed into ad valorem taxes for coal, crude oil and natural gases using carbon tax conversion factors (see LI and ROSE, 1995 for more detail).
- A CO₂-constraint for each region according to the Kyoto Protocol is included for all regions. The endogenous carbon tax adjusts so that each country meets its commitments.

In addition, the authors model energy substitution of natural gas or nuclear power for coal in power generation by changing the relative energy input coefficients for Taiwan's electric utilities. This extended version of the GTAP model is then recursively shocked from year to year to obtain counter-factual solutions.⁴⁰

In contrast, TRUONG (1999a and 1999b) explicitly models an endogenous CO₂-tax in his enlarged version of the GTAP model which he calls GTAP-E. Additionally, the author has adapted the production structure of the standard GTAP model to account for energy-economy-environment-trade linkages. In so doing, TRUONG pays unique attention to the relationship between capital and energy, which experience has shown are substitutable in the long run, but complementary in the short run. To model this relationship as realistically as possible, he took energy out of the intermediate nest and incorporated it into the value added nest in two steps. Firstly, he separated energy into nests for electricity and non-

⁴⁰There are no more details in the two papers referred to about how the new features are modeled. Also, nothing is said about projection methods, e.g. if shocks to labor, capital, population, etc. are applied to move this extended version of the GTAP model to the target year of 2020 or where the additional data comes from.

electricity. Within the nest of non-electricity inputs, as well as between non-electricity and electricity inputs, some degree of substitution is allowed (see Figure 1 in the appendix). In the second step, the resulting energy composite is then combined with capital to form a capital-energy nest, which in turn is combined with the other factors of production. The critical value of the substitution elasticity between capital and energy (σ_{ce}) is assumed to be positive, indicating that capital and energy are substitutes in this »inner nest«. However, the substitution elasticity between the energy-capital composite and the other factors of production (σ_{va}) in the next higher nest is set at a higher level, so that energy and capital may still be viewed as complements form the outer nest.

Similar changes are implemented in the consumption behaviour of the GTAP model. For the government, the energy-composite and the non-energy composite are separated according to a Cobb-Douglas (CD) functional form, while the private household combines the two composites within a constant difference of elasticity (CDE) functional form.

In order to implement this extended version of the GTAP model, Truong added some additional information to the GTAP data base.

- After changing the production structure, supplementary information on the substitution elasticities in the newly created nests is necessary. Here, the author critically compares the values used in other studies on the same matter (e.g. ABARE, 1996; BURNIAUX, et. all, 1992; BÖHRINGER and PALKE, 1997; BABIKER, MASKUS and RUTHERFORD, 1997; BORGES and GOULDER, 1984) before a decision is made.
- It is necessary to integrate some kind of information about CO₂-emissions into the GTAP data base to establish a CO₂-tax. The relationship between fossil fuel combustion and CO₂-emissions is linear. Unlike ordinary pollutants, CO₂ is one of the natural products of combustion and no abatement technology is available to change the amount of it produced when burning a particular fuel. Accordingly, CO₂-emissions are normally calculated under the assumption that prices are equal to one in the benchmark data set and that values equal physical quantities. In contrast, TRUONG uses a special data set, called GTAP-E4, that is a comprehensive combination of input-output data by region, bilateral trade and protection data and energy prices, quantity and tax data.⁴¹

⁴¹The project was funded by the US Department of Energy (DOE) and jointly carried out by researchers at the GTAP Center, the University of Colorado, Boulder, and the OECD Development Centre. For more information on this project please refer to <http://www.agecon.purdue.edu/gtap/database/energy/index.htm>

This extended version of the GTAP model is used to show the differences between the two data sets of GTAP 4-E and GTAP 4. Both data sets are employed to analyse a 25% reduction in CO₂ emissions using the endogenous CO₂ tax.

Australian Bureau of Agricultural and Resource Economics (ABARE, 1996) also used an endogenous CO₂-tax in their enhanced version of the GTAP model, which represents the broad class of least cost economic instruments that could be used by governments to reduce emissions. Additionally, equations to allow for international emissions trading are implemented in the model, so that the CO₂-tax can also be interpreted as the price of the international emission quota.

For the production structure, a different approach is chosen. The so-called MEGABARE model employs a unique technology bundle (see Figure 2 in the appendix) which firstly differentiates between technology bundle inputs and non-technology bundle inputs. While the latter is quite similar to the standard structure of GTAP, the technology bundle inputs are assumed to be produced according to a constant ratios of elasticities homothetic (CRESH) functional form using output of various technologies (e.g. coal fired, nuclear, gas fired, oil fired, solar, etc.) as inputs. This structure enables the producing sector to respond to relative price changes or restrictions on input use. Technology bundle like these are used in slightly different form in the electricity industry as well as in the energy intensive production of iron and steel.

Moreover, MEGABARE has an intertemporal nature, that permits the growth of variables to be tracked over time. This is necessary because most of the global climate change policies are implemented within a certain time range. The capital stock of MEGABARE grows through investments and the rate of depreciation. Thereby, investments follow a partial adjustment path influenced by the savings patterns of different age groups in each region and the international flow of capital. Labour supply is determined endogenously over time with the help of population dynamics including fertility and mortality rates which depend on income. Also a migratory pattern is imposed exogenously to predict age and gender specific population changes.

MEGABARE is based on version 3 of the GTAP data base. In order to execute this extended version of the GTAP model additional information is needed. The most important ones are described briefly in the following.

- Regional estimates of CO₂ emissions from fossil fuel combustion available for the WORLD RESOURCES INSTITUTE (1996)
- Information on production, exports and prices needed to construct the technology bundles are taken from UNITED NATION (1994) an IEA (1996).
- Elasticities of substitution in the technology bundles are calibrated to resemble the actual observed intermediate usage.
- Birth and mortality rates are derived from econometric analysis based on publications from IEA (1983a and 1983b).
- Information on the demographics mostly comes from United Nations (1992).

HANSLOW, HINCHY, SMALL, FISHER, and GUNASKERA (1994), GRAHAM, HINCHY, FISHER and TULPULÉ (1998) and SCHNEIDER, FAIRHEAD, GRAHAM, and STUART (1998) demonstrate how the model can be used to assess policies curb global climate change.

Recently, MEGABARE has been further extended at ABARE. The successor GTEM is now based on version 4 of the GTAP data base. The production structure has been changed again to allow for interfuel substitution and between fuel and primary factors in the production process of the non-technology bundle.⁴² Thus, the carbon intensity of production can be altered in response to emission constraints by substituting between energy and primary factors or changing energy mix.

Beside the CO₂ emissions from fossil fuel combustion (WORLD RESOURCES INSTITUTE, 1996), GTEM now has an extended coverage of greenhouse gas emissions. The emissions included incorporate sectoral information on CO₂ emissions from other sources than fossil fuels, methane and nitrous oxides.

- National inventory figures reported by individual countries to the United Nation Framework Convention on Climate Change (UNFCCC) are used.
- Most of the information on these emissions compatible with the GTEM regions and sectors are not readily available or of poor quality. ABARE therefore estimated these data using output data from external sources and emission coefficients (emissions per unit of output) for each region.

⁴²GTEM is currently under development, so that the documentation of GTEM is not yet available. The information presented here are therefore of qualitative nature only.

- Emission coefficients are obtained from Intergovernmental Panel on Climate Change (IPCC, 1995), National Greenhouse Gas Inventory Committee (1996 a-e) or estimated by ABARE.

GTEM's application focuses on the Kyoto Protocol. The most comprehensive effort is given by BROWN et al (1999). Several other applications utilising the GTEM model for this purpose can be found on the internet (<http://www.abare.gov.au/pubcat/greenh.htm>).

3.3 Global Climate Change and Agriculture

Global climate change severely affects sectors in the economy which are sensitive to climatic conditions. In particular, agricultural production is fine-tuned to temperature and moisture conditions in terms of cultivation practices and inputs. Furthermore, climate change might also lead to changes in land resources, and thus in the pattern of global economic activity. TSIGAS, FRISVOLD and KUHN (1997) firstly review the literature on this topic, which mostly used partial equilibrium modeling. The authors then assess the impacts of global climate change in their paper employing the standard GTAP model. In so doing, they utilised both general and partial equilibrium closures of the GTAP model.

The authors model climatic change as Hicks-neutral technical change in the crop sector of each region. Essentially this involves a shock to the Hicks-input augmenting technical change parameter (ao_{ir}) in the top nest of the production structure. Accordingly, with this procedure, it is assumed that climate change influences the productivity of all inputs in the same way. Information on how productivity in the agricultural sector changes in the presence of global climate change is taken from ROSENZWEIG and IGLESIA (1994) and REILLY, HOHMANN and KANE (1993), who differentiate between direct and indirect effects of CO₂ on crop production.

This work has been further developed by DARWIN, TSIGAS, LEWANDROWSKI and RANESES (1994, 1995, and 1996) and DARWIN (1999). They used an extended version of the GTAP model in conjunction with a GIS (Geographic Information System), called Future Agricultural Resource Model (FARM). The GIS model links monthly temperature and precipitation with land and water resources in each regions. Using length-of-growing-season data, this information is then utilised to classify land into classes with different potential of productivity. Afterwards GTAP determines how the changes of these production possibilities affect global production, trade and consumption. The enlarged version of the GTAP model is mainly based on the implementation of

- heterogeneous land endowments into the primary factor nest of the production tree. Each region therefore has up to six different types of land classes determined by the length of the growing season. These land classes are employed by all producing sectors in the economy.
- water as a homogenous primary factor in the production process of crops, livestock and service sectors.
- multi output possibilities for the crop production sector differentiating between crops, other grains and non-grains.

To apply this extended version of the GTAP model, it is necessary to supplement the GTAP data base with some additional information consisting of the following components:

- Global climate change scenarios derived from monthly temperature and precipitation estimates generated by the General Circulation Model (GCM) of the Goddard Institute for Space Studies (GISS, HANSEN et al 1988), the Geophysical Fluid Dynamics Laboratory (GFDL, MANABE and WETHERALS, 1987), the United Kingdom Meteorological Office (UKMO, WILSON and MITCHELL, 1987), and the Oregon State University (OSU, SCHLESINGER and ZHAO, 1989).
- Water supply in the regions of the used aggregation taken from WRI (1990).

The FARM model is used to evaluate the global effects of changing water and land resources without taking into account policies that might be implemented to cope with CO₂ emissions.

4. Strength and Weaknesses of GTAP for Assessing Environmental Issues

After surveying the existing GTAP applications this final section tries to identify the strengths and weaknesses of GTAP as tool for environmental analyses. According to this, it seems clear, that the standard GTAP framework can only be used for analyses of environmental issues, if it is adapted or supplemented by some kind sub model. This stands in contrast to analyses of other subject matter, like analyses of the common agricultural policy of the EU or multilateral trade liberalisation, for which the standard GTAP framework is readily available.⁴³ However, Section 3 also shows that GTAP is a versatile and flexible tool that

⁴³The standard GTAP framework can be used as a first step. Sophisticated analyses however needs some adaptation of the GTAP framework as well. For more detail see FRANCOIS, 1999 and VEENENDAAL, 1999.

can in some cases easily be tailored to the needs at hand. As a global model GTAP is advantageously used for global and transboundary environmental problems. Particularly the analysis of global climate witnesses the strength of GTAP in environmental analysis. In contrast, regional or national environmental problems need a lot of changes in the model structure and additional data.

What would be necessary to make GTAP model a true environmental CGE model? Table 1 in the Appendix answers this question by putting together the environmental modeling issues which need to be solve for an optimal environmental GTAP model. On of the most important issues is the integration of environmental quality (e.g. willingness to pay) into the utility function to facilitate a quantitative measure of benefits of environmental policies. However, this is a topic on which environmental economists are already working for a long time, but do not find a satisfying solution. Problems at hand are the relationship between market and non-market goods as well as between environmental quality and environmental damage. Additionally, it would be desirable to econometrically estimate the parameters to establish a more comprehensive utility functional form. However, this is true for most parameters of partial and general equilibrium models. In addition, it would improve environmental analysis using GTAP, if abatement technologies and costs are included in form of a separate sector to permit sophisticated evaluation of costs of environmental policies. Compared to the integration of environmental quality into the utility function, the incorporation of abatement cost and technologies does not seem to be such a big effort. Accordingly, the ratio of benefits to costs is just middle in the first and high in the last case. Table 1 also shows that environmental analysis on the basis of GTAP could be improved, if environmental policies in place or relevant for the issue in question and other related policy instruments are modeled in detail especially to track second best solution. Here, it would be necessary to establish some kind of environmental protection data base. In some cases this is an easy task (e.g. CO₂ tax) whereas in others even the policy instruments is not determined yet. Nevertheless, detailed modeling of all these policies seem to be important and therefore beneficiary issue.

Table 2, 3 and 4 in the appendix use some prominent examples of environmental issues to show a very rough first guess of the corresponding requirements for the data base of the environmental GTAP model. These tables can be summarised as follows. All environmental application need additional »environmental data« to conduct the analysis. Optimally, these information should be available for all sectors and all regions of the GTAP data base. In most cases an additional sector disaggregation of the GTAP data base is necessary to isolate

the sector in question (e.g. fertiliser in the case of water pollution). However, the "experience with the climate change work <of the GTAP team> is likely representative of what will be required for other environmental-related applications of global AGE analysis. In each case, some kind of satellite data base will be needed to capture the physical relationships involved in the degradation of the environment and attempts to mitigate such damage" (Hertel, 1999). Though it is not clear from our current point of view what effort is evolved to put together these satellite data bases, it still seems to be worthwhile to establish such data bases, especially in the case of global environmental problems.

5. Summary

Recent years have shown a growing awareness of the environmental consequences of production and consumption. Beside regional environmental issues, the public debate also concentrates on global or transboundary environmental problems which are assessed in this paper. While some general or theoretical questions in the current policy debate are much alike across global environmental issues, some specific questions arise in the context of global climate change and the linkages between environment and trade liberalisation.

Looking at the applications of the GTAP model on environmental issues, it is obvious that two topics dominate the scene. These are global climate change and environmental quality and welfare measurement. A comparison between the model potentials in Section 2 and application of the GTAP model in section 3 furthermore shows, that the linkages between environment and trade liberalisation are especially neglected and need to be extended in the future. Applications of the GTAP model to environmental issues would be improved if the standard model is tailored to environmental issues by incorporating environmental quality, abatement cost and technologies and a detailed modeling of environmental policies in place and in question.

Additionally, the use of GTAP to analyse environmental issues is characterised by the common problem of missing »environmental data« needed to conduct sophisticated analysis of environmental issues with the GTAP model. This problem may be solved with the help of additional

- submodels producing the necessary information (e.g. the GIS model in FARM).
- single country data which is extrapolated to the other regions of the model (e.g. environmental indicators for the US).

- »environmental data« on a global basis (e.g. global data on greenhouse gas emissions in GTEM; energy volumes in GTAP E-4)

Though the time requirement is different between the alternatives mentioned above, it is clear that the analysis of environmental issues within the framework of CGE makes great demands on additional data. The time consuming task of gathering data might therefore be reduced, if approaches like the GTAP data base in general and GTAP E-4 in particular will be adopted in environmental analysis.

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Appendix

TABLE 1: Environmental modeling issue

Issue	Applica- tion	Further steps need for application or improvement	Ratio of Benefits to Costs
- Include environmental quality into the utility function to enable measurement of benefits of environmental policies	yes	<ul style="list-style-type: none"> - data on environmental quality (e.g. willingness to pay) for all regions of the GTAP data base; <ul style="list-style-type: none"> - evaluate form of utility function, e.g. separability between market and non-market goods, parameters - evaluate relationship between environmental quality and environmental damage (e.g. one unit of emission reduces environmental quality by x unit) 	middle
- Include abatement costs/technologies in the GTAP data base and/or production function	yes	<ul style="list-style-type: none"> - data on abatement for all sectors and regions of the GTAP data base - include a separate sector for abatement technology 	high
- Detailed modeling of environmental policies in place	no	<ul style="list-style-type: none"> - environmental protection data for all sectors and regions of the GTAP data base - implement existing environmental policy instruments into the GTAP model (e.g. policy instruments of the US Clean Air Act) 	middle
- Detailed modeling of environmental policies relevant for the issue in question	yes	<ul style="list-style-type: none"> - environmental policy instruments need to be developed and implemented in the model (e.g. emission quotas, payment schemes for green box policies) - relationship between consumption/production and environmental issue needs to be evaluated, if unclear (e.g. biodiversity and gene pools) 	high
- Detailed modeling of related policy instruments in place	yes	<ul style="list-style-type: none"> - improvements and requirements given in VEENENDAAL (ed.), (1999) for the usefulness of GTAP for analyzing CAP reform policies - improvements and requirements given in FRANCOIS et al (1999) for the usefulness of GTAP for assessing multilateral trade liberalisation 	high

TABLE 2: Domestic policies related to environmental issues with global impacts

Issue	Applica-tion	Further steps need for application or improvement	Ratio of Benefits to Costs
- Green house gas emissions	yes	<ul style="list-style-type: none"> - data set on green house gas emis-sions for all regions and sectors of the GTAP data base - data on energy content of different fuels (tax on energy content also in combination with CO₂ tax) - data on social contribution, wage rates and unemployment for rele-vant regions of the GTAP data base - data on forestry carbon sink for all regions of the GTAP data base - data on elasticity of substitution parameters for all regions and sec-tors of the GTAP data base 	high
- SO _x emissions and acid rain deposition	no	<ul style="list-style-type: none"> - data on SO_x for all regions of the GTAP data base 	middle
- Deforestation, smoke initiated by forest clearing and reduction of carbon sinks	no	<ul style="list-style-type: none"> - data on forest clearing areas for all regions of the GTAP data base - data on forestry carbon sink for all regions of the GTAP data base 	high
- Loss of biodiversity and gene pools	no	<ul style="list-style-type: none"> - data on biodiversity and gene pools for all sectors and regions on the GTAP data base 	low
- Soil erosion and desertification	yes	<ul style="list-style-type: none"> - data on soil erosion and desertifica-tion for all sectors and regions of the GTAP data base 	high
- Manure	yes	<ul style="list-style-type: none"> - data on livestock waste for all re-gions and all sectors of the GTAP data base 	middle
- Water pollution, especially due to intensive use of fertiliser and pesticides	no	<ul style="list-style-type: none"> - data on water quality (analogous to FARM) - data on water pol-lution caused by fertiliser and pesticides use for all regions and sectors of the GTAP data base - disaggregation of the GTAP data base to isolate fertiliser and pesti-cides 	high
- Payment to farmers which are linked to provision of environmental benefits (green box policies)	no	<ul style="list-style-type: none"> - data on relevant environmental problems for all regions and sectors of the GTAP data base - sector disaggregation of the GTAP data base to isolate sectors consid-ered 	high
- Extensive use of fertiliser due to subsidies or agricultural protection	no	<ul style="list-style-type: none"> - disaggregation of the GTAP data base to isolate fertiliser 	high

- Subsidy on gasoline for farmers	no	- disaggregation of the GTAP data base to isolate gasoline	middle
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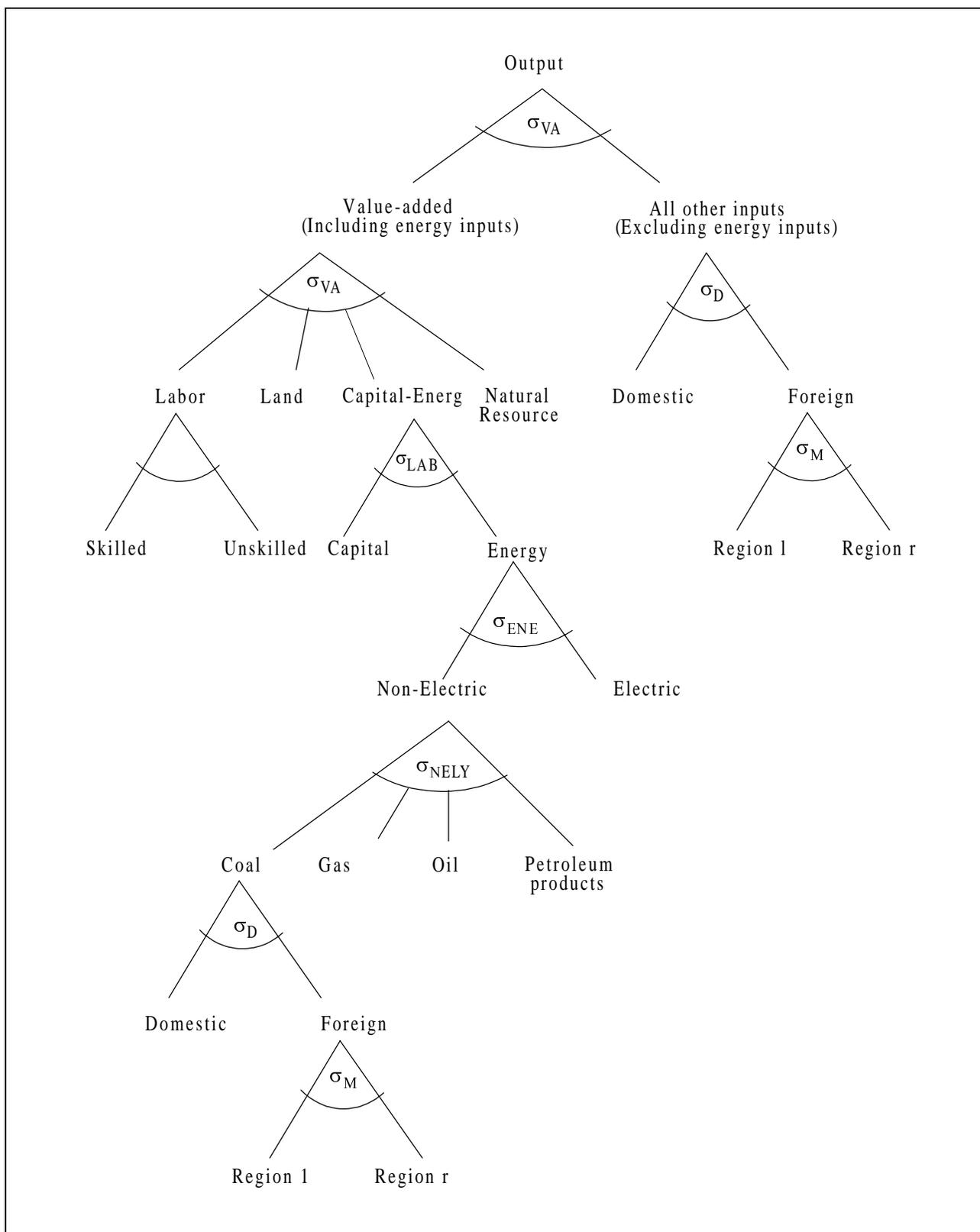
TABLE 3: Trade, Trade Liberalisation and Environment

Issue	Applica-tion	Further steps need for application or improvement	Ratio of Benefits to Costs
<ul style="list-style-type: none"> • How does the product effect of trade (product composition of trade) affect the environment? Trade as vehicle for diffusion of goods which contribute to environmental protection or constitute alternatives to environmental damaging goods or international movement of goods (e.g. hazardous waste, dangerous chemicals) which directly harm the ecosystem 	no	<ul style="list-style-type: none"> - data on relevant environmental problems for all regions and sectors of the GTAP data base - sector disaggregation of the GTAP data base to consider environmental problems in questions (e.g. damaging goods and relevant alternatives; sectors producing hazardous waste or dangerous chemicals need to be separated) 	low
<ul style="list-style-type: none"> • How does the scale effect of trade affect the environment? Linkages between trade, income, environmental quality and protection; Linkage between trade, economic growth, abatement spending and pollution 	no	<ul style="list-style-type: none"> - data on relevant environmental problems for all regions and sectors of the GTAP data base 	high
<ul style="list-style-type: none"> • How does the structural effect of trade affect the environment? Allocation of economic activity in accordance with the environmental capacity (e.g. ability of the environment to cope with pollution) and conditions of different regions 	no	<ul style="list-style-type: none"> - data on relevant environmental problems for all regions and sectors of the GTAP data base - data on environmental capacity for all regions of the GTAP data base 	middle
<ul style="list-style-type: none"> • Does trade liberalisation increase or reduce the product, scale and structural effect of trade? 	no	<ul style="list-style-type: none"> - data on relevant environmental problems for all regions and sectors of the GTAP data base 	high
<ul style="list-style-type: none"> • How does trade liberalisation and the harmonisation of environmental policies (regulatory effect of trade liberalisation) influence the environment? 	yes	<ul style="list-style-type: none"> - data on relevant environmental problems for all regions and sectors of the GTAP data base 	high

TABLE 4: Trade Measures as Environmental Policy Instruments (Green Trade Restrictions)

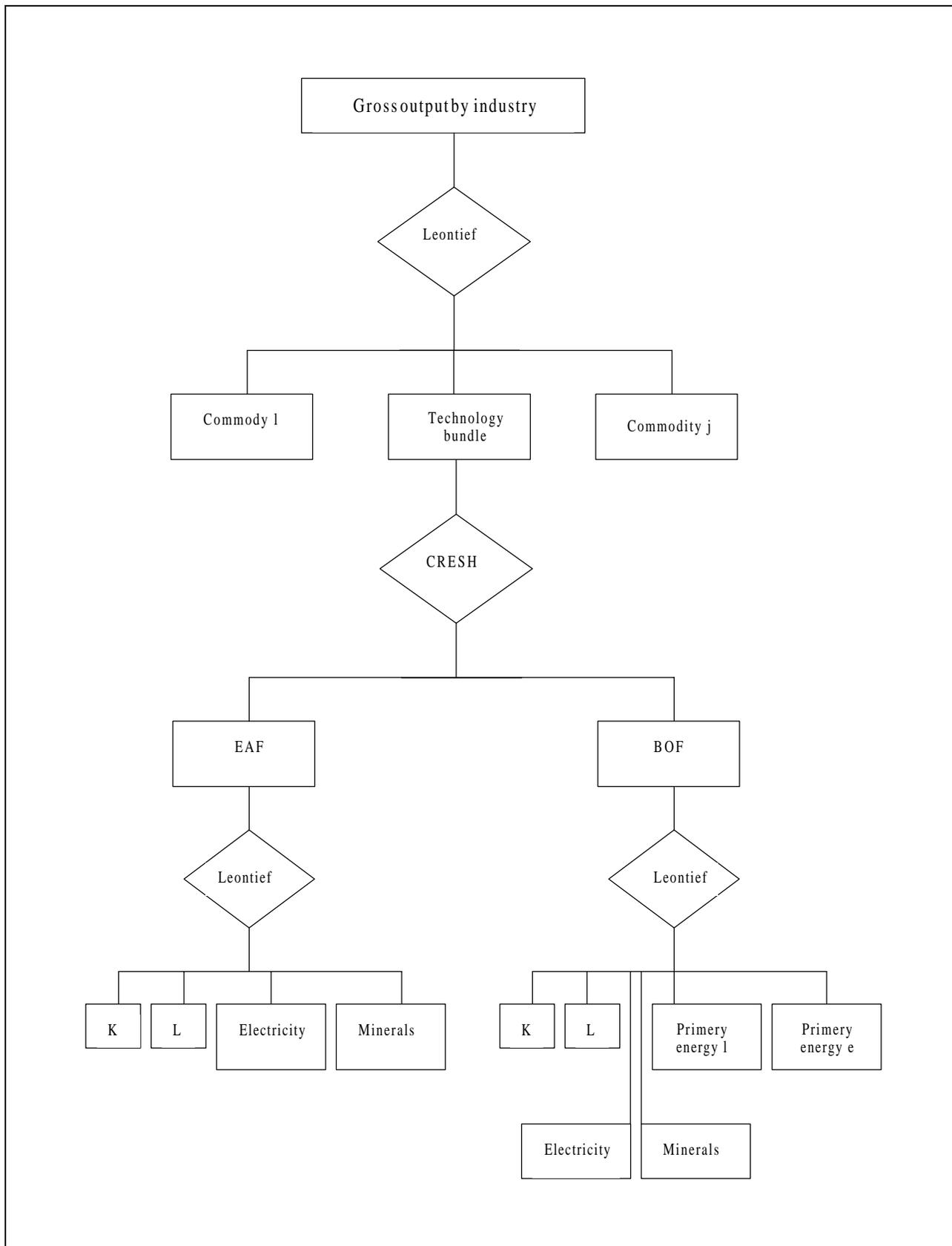
Issue	Applica-tion	Further steps need for application or improvement	Ratio of Benefits to Costs
<ul style="list-style-type: none"> • Multilateral environmental agreements (e.g. Kyoto Protocol) as instrument to enforce environmental protection 	no	<ul style="list-style-type: none"> - data according to »climate change« in table 1 	high
<ul style="list-style-type: none"> • Analysis of export subsidies for products that are environmental friendly (e.g. pollution control equipment, alternatives to environmental damaging goods, goods produced using environmental friendly methods) 	no	<ul style="list-style-type: none"> - data on relevant environmental problems for all regions and sectors of the GTAP data base - sector disaggregation of the GTAP data base to consider environmental damaging goods and relevant alternatives 	high
<ul style="list-style-type: none"> • Analysis of import restrictions including trade sanctions for products harming the environment (e.g. lax environmental standards abroad; carbon leakage), if domestic production is subject of environmental policy instruments and/or environmental friendly (e.g. existence value) and cost intensive (eco-dumping) 	no	<ul style="list-style-type: none"> - data on relevant environmental problems for all regions and sectors of the GTAP data base - sector disaggregation of the GTAP data base to consider the products in question 	high
<ul style="list-style-type: none"> • Analysis of growth and development in the presence of externally trade enforced environmental restrains (particularly developing countries) 	no	<ul style="list-style-type: none"> - data on relevant environmental problems for all regions and sectors of the GTAP data base - sector disaggregation of the GTAP data base to consider the products in question 	high
<ul style="list-style-type: none"> • Analysis of eco labeling on trade 	no	<ul style="list-style-type: none"> - data on relevant environmental problems for all regions and sectors of the GTAP data base - disaggregation of the GTAP data base to isolate products with eco labeling 	high

FIGURE 1: Production structure in GTAP-E



Source: TRUONG (1999), GTAP-E. Incorporating Energy Substitution into GTAP Model. pp. 39-40.

FIGURE 2: Production structure in MEGABARE



Source: HANSLOW et al (1996), Trade and Welfare Effects of Policies to Address Climate Change. pp. 7 and 9.

Comments on the paper

Assessment of the Usefulness of GTAP for Analysing Environmental Issues in a Multi-Region Context

Claudia Kemfert⁴⁴

The paper focuses on the evaluation of computational general equilibrium models used for the investigation of environmental policy assessment based on GTAP data. The authors stress on a consideration of models based on environmental economics and provide an overview of existing modelling approaches currently used for environmental economic studies. The paper elaborates strength and weaknesses of existing approaches and conclude by an strength and weaknesses of existing approaches .

The first part of the paper concentrates on environmental policies and measures, especially on domestic level in order to improve the environmental situation and to curb environmental pollution. Trade plays an important role within the global dimension of the environmental issue, especially negative environmental effects arise due to production trade or by emission leakage effects through production removal or transfer. In order to avoid these negative impacts by trade, international governments have to establish worldwide environmental policies and measures as, for example, export subsidies or import restrictions. This part of the paper provides a good introduction and overview of the objective.

Part three of the paper presents an abstract of modelling approaches in GTAP. Firstly, the authors present a simplified GTAP model based on ideas by Perroni and Wigle (1997) in order to cover the needs for environmental policy investigation. A modified production function is introduced extended by a further input factor, emissions. However, neither a Leontief or a Cobb Douglas production technology seems appropriate to represent the real abatement costs in order to diminish the polluting factor as emissions, nor emissions are directly used for the production of commodities, the input factor energy or a distinction between a polluting and non polluting input factor emerges more suitable. Because of that a CES production function turn out to be essential and the abatement opportunities are given by regional different abatements technologies and the potential to substitute the emitting factor by other non polluting factors like capital and labour, given by the substitution elasticities. Abatement opportunities depend substantially on the abatement technologies which

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cannot be transferred and applied from the US data to other regions. Table 1 in the Appendix of the paper tackles this issue properly regarding the necessity to improve the existing GTAP models by including abatement costs and data and by introducing a separate sector for abatement technology.

Utility of agents is represented more appropriately by a CES utility function covering the significant factor environmental quality defined as the difference between an initial endowment of environmental quality and the damages from emissions. However, it arises the question why elasticity of substitution between goods and environmental quality is assumed to be 0.5. Is this based on literature or estimation of data for different regions? Very beneficial transpire other extensions by Perroni and Wigle to estimate the environmental quality by net pollution and the integration of pollution abatement expenditures to the GTAP data base differing between industrial and developing countries.

The next part of the paper illustrates an overview of the GTAP models currently used in order to investigate the impacts of global climate change. The summary concentrates on two major works by Truong and ABARE. Truong developed the GTAP - E version with very advantageous improvements of the application of different production functions covering assorted kind of substitution opportunities between main input factors. The Australian Bureau of Agricultural and Resource Economics (ABARE) provides by the so called model MEGABARE a very useful tool to represent a production structure including different kind of technologies closing the gap between more bottom up and top down oriented model approaches. The extended version of MEGABARE, GTEM now includes all greenhouse gases which is also a required necessity for all other CGE – GTAP models. However, this described part of the paper presents no comprehensive indication of currently used models for the assessment of climate change implications. International modellers by various kind of institutes are currently using GTAP in order to assess international trade or climate change implications. The Energy Modelling Forum (EMF) is mainly involved in the analysis and evaluation of world economic implications by reaching the Kyoto target and assessment of concrete topics as, for example, impacts on energy intensive sectors and carbon leakage effects. Presently, more and more participants of EMF are using world economic models based on GTAP as, for example, the MRT model by Montgomery or WAGE by Kempfert, see *Kempfert (1999)*. Controversially discussed is continually the GTAP database, as for example, the energy intensities of different sectors in different regions, like in China. It would be supportive to include these aspects within this context.

The last section of this paper confers an assessment of strength and weaknesses of GTAP models used for the evaluation of impacts by environmental policies and measures. The extensions of the currently used models are a first step in order to apply GTAP models also for environmental purposes. As correctly pointed out within this context, the very beneficial extension of existing GTAP models is the incorporation of environmental quality and damages within an utility function. Especially, the implementation of regional and sectoral different abatement technology data and the necessity to include much more data into the GTAP database is specified accurately. The Appendix provides a comprehensive overview of further steps and improvements of models and data in order to assess domestic and international environmental policies and measures.

To sum up, the paper presents a sufficient overview how environmental aspects can be included within the GTAP context and what kind of approaches and solutions are already found by different authors. These approaches are not evaluated but specified and described. The models used for the evaluation of the impacts by global climate change policies and measures are not documented comprehensively, and data problems, as for example regarding the energy intensities in different regions (developing countries) discussed within the *Energy Modelling Forum* (EMF 18), are neglected. It is recommendable to include these aspects by presenting a comprehensive outline of all policy relevant topics in this context and by referring to discussion groups.

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