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Modeling agricultural trade liberalization and its implications for the European Union

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Abstract

The paper reviews the models used in the past 10 years or so to analyze the expected effects of liberalizing agricultural trade with specific reference to the implications for agriculture and agricultural policies in the European Union. Its main aim is to provide the reader with an overview of models which have been used to assess, first, during the Uruguay Round, the implications of alternative hypothetical trade liberalization scenarios, then, the Agreement itself, and, more recently, the implications of further steps in liberalizing agricultural markets as a result of the on-going WTO negotiations. The conclusion is that the efforts to model agricultural trade and trade policies, taken as a whole, are not fully satisfactory. Although there are several models which offer accurate representations of international agricultural markets and trade policies, there are many others, including several developed and used by governments and relevant multilateral institutions, which are structurally incapable of providing reliable answers to certain policy questions they are posed. The final part of the paper identifies priorities for actions to be taken in order to improve modeling of trade policies and WTO commitments.

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Modeling agricultural trade liberalization and its implications for the European Union

1. Introduction

Over the last twenty years the international dimension has begun to assume an ever increasing relevance in defining agricultural policies. There are two reasons for this. The *first* is related to the growing importance that international trade in agricultural products has assumed for all countries: imports and exports have grown both in absolute terms, and as a share of domestic consumption and production and, at the same time, national markets have become increasingly integrated; this means that the policies of the most important players in the global market for agricultural products have ever more visible knock-on effects on the domestic markets of other countries. Consequently, the effects and the efficiency of the policies of each country can no longer be evaluated without taking into consideration the existence of the international trade flows linking countries. The *second* reason is connected with the long agricultural negotiations in the GATT Uruguay Round and their outcome; in 1994 for the first time, rules and restrictions, which had already been in place for other sectors for a good number of years, were imposed on agricultural policies. Even at the beginning of the 1980s the international trade implications of domestic agricultural policy decisions within a given country were seen as residual effects which could basically be overlooked, choices that concerned the domestic market alone as though this existed in isolation from the outside world. The calls that emerged from the negotiation in the first instance, and those from the agreement reached at the end of the Uruguay Round, clearly brought out the need to take into account the implications of the growing international trading in agricultural goods and of the “rules” introduced by the “Agreement on agriculture” which had been reached in the definition of domestic agricultural policies. The implementation of the 1994 Agreement and the start of the new WTO negotiating Round have further increased awareness of the need for careful consideration to be given to these implications.

This new and growing interest in the international dimension in assessing the impact of national agricultural policies was accompanied by a recognition of the inadequacy of the models being used for simulating the effects of these policies; most models did not take into consideration the existence of international trading or, if they did, only in an extremely simplistic manner. Thus, the last fifteen years have witnessed a progressive increase in the efforts to model agricultural markets, which have become ever more refined, better able to take into account the links between individual national markets on the one hand, and the transmission mechanisms to each market of the impact of other countries’ policies on the other.

This chapter will review the models which, since 1990, have been proposed to evaluate the effects of a trade liberalization - in other words, a reduction in protection granted to agricultural producers through variations in support policy instruments used and/or the level of activation of these instruments - for agriculture and agricultural policies of the European Union (EU). While the other chapters in this volume focus on the comparative strengths and weaknesses of a particular “class” of models (econometric, mathematical programming, general equilibrium, partial equilibrium and so on), in this one the privileged angle of analysis of the literature straddles all types of model used. Here the perspective is to evaluate the different models from the point of view of their effectiveness in representing an important specific component of agricultural markets: trade policies and the transmission mechanisms of the effects of variations of one country’s (domestic and trade) policies to all the others.

To sum up, this chapter hopes to address questions such as: among the models proposed to assess the effects on agriculture of the Uruguay Round, which best represent all the elements of the Agreement? Which best represent the implementation of the Agreement by the EU and its implications for the Common

Agricultural Policy (CAP)? What are the implications of a specific model's assumptions and modeling choices for the results it yields? Which are the best models for simulating the effects of a regional, rather than global, trade liberalization, for example, the enlargement of the EU to Central and Eastern European countries?

The chapter, therefore, aims to fulfil a dual purpose. First, to provide a "guided tour" through the large body of literature which first, while the negotiations were still in progress, tried to simulate the alternative hypotheses regarding possible outcomes of a final agreement; second, once the negotiations were concluded, tried to assess the expected consequences of the agreement reached; and third, today, simulates the effects of the alternative hypothetical outcomes of the on-going WTO agricultural negotiations. There is a second purpose, however, which is to provide an introduction to the "state of the art" for those wishing to assess quantitatively the effects of a variation in EU (domestic or trade) policies, and are looking for a preliminary answer to the problem of which model, or class of models, is best able to take into account the specific policy change under scrutiny taking into account the implications of international trading and GATT/WTO commitments.

The first part of the chapter presents a brief overview of the models used in the 1990s to simulate changes in agricultural trade policies, with particular reference to those of the EU, and changes in CAP taking into account their implications for agricultural international trade. The second part discusses the advantages and disadvantages of different models in representing: (a) the most frequently used trade policy instruments; (b) the specific trade policy instruments used by the CAP (variable levies, export restitutions, preferential tariffs and so on); and finally (c) the commitments deriving from the 1994 GATT Agreement on agriculture. The final section of the chapter gives a round up of the main results, both in terms of the effectiveness of the models considered in simulating the effects of trade policy changes relevant for EU agriculture - for example, commitments arising from the on-going WTO agricultural negotiations, the enlargement of the EU to include countries from Central and Eastern Europe, and further trade integration between the EU and non-member Mediterranean countries - also in terms of the desired extent and direction of what needs to be done to make these simulations (and their results) more reliable.

2. The main models used in the 1990s to analyze EU agricultural trade policies and the trade implications of CAP reforms

The simulation models utilized in the 1990s to analyze the implications of a trade liberalization for EU agriculture, all differ in more than one respect; consequently, there are a number of axes along which one could define their taxonomy. The most important distinction is, undoubtedly, that between *partial equilibrium* and *general equilibrium* models, i.e. between models which do not take account of the effects of what happens in the markets considered upon other markets and on the main macro-economic variables (employment, incomes, investment and savings) nor, consequently, of the feed back from all this on the markets under scrutiny, and, on the other hand, models which, albeit in a simplified form, try to take all these factors into account. The use of partial equilibrium models is justified when the particular product, or group of products, analysed represents such a tiny part of the overall economic system that a variation in its level of production or use can be assumed to cause no significant variations in other markets¹.

2.1 Partial equilibrium models

Given the specific focus of this chapter being the modeling efforts assessing the effects of CAP reforms, let us begin our review of partial equilibrium models with the ones used by the European

¹ An accurate introduction to large scale, multi-country partial equilibrium models and to general equilibrium models is provided in the chapters by Conforti and De Muro and Salvatici in this volume.

Commission itself. For a number of years the Directorate General for Agriculture has used simulation models to produce forecasts on market trends and to evaluate the likely effects of changes in the CAP. In February, 2000, for example, the results of simulations were published on the effects of the March 1999 CAP reform; these were obtained by utilizing the SPEL/EU-MFSS models of Bonn University and the FAPRI models of the Food and Agriculture Policy Research Institute of Iowa State and the University of Missouri² (European Commission, 2000). In October, 1998 the results were released of similar simulations on the effects of the proposals made by the Commission in March, 1998 utilizing SPEL/EU-MFSS (European Commission, 1998).

The SPEL/EU-MFSS model was developed at the University of Bonn (Weber, 1995). It is quite a detailed medium term simulation and forecasting model as regards the number of products considered, but it is completely unsuitable for evaluating the trade implications of policy changes because of its structure³. In fact, the model treats the EU as a “small” country with respect to the aggregation “rest of the world”, which encapsulates all the other countries. This also means, for example, that the model is not capable of considering the effects that changes in domestic policies have on production and consumption in the EU as a consequence of the variations in trade with other countries and in the prices at which such trade is conducted. Similarly, the model is not able to take into account the relevant implications, for the domestic market, of the restrictions on subsidized exports introduced by the GATT Agreement. The results obtained predict an excess supply in the EU which is greater than the volume of subsidized exports allowed under the GATT Agreement, but the model, on account of its very nature, is not able to say whether the EU price would be such to enable those exports to take place without subsidies, or, were this not the case, what market or policy mechanisms would restore market equilibrium in the EU and what their consequences would be. These limitations seriously reduce the scope of this model also from the point of view of its ability to supply reliable predictions on medium term variations in production and consumption in the EU, a function which is supposed to be its *raison d'être*.

Over the years the Food and Agriculture Policy Research Institute (FAPRI) has developed models, which can be used on their own or together, for a certain number of products and countries, including all the most important ones (Devadoss et al., 1989; 1993). Trade between countries is obtained through dynamic, non spatial, *ad hoc* partial equilibrium models, estimated econometrically. The FAPRI models were used in many ways, not only for evaluating the effects of successive CAP reforms (CARD, 1991c; European Commission, 2000, chapter 3; FAPRI, 1997 and 1998; Fuller et al., 1999; Helmer et al., 1992; Helmar, Meyers and Hayes, 1994; Meyers, Helmar and Hart, 1998; Meyers and Womack, 1997; Westhoff et al., 1992) but also for evaluating first, during the GATT negotiations, the possible effects of alternative hypotheses of its outcome, and later those of the 1994 Agreement itself (CARD, 1991a and 1991b; CARD, 1992; Helmar, Smith and Meyers, 1994 and 1995).

Recently the FAPRI component at University of Missouri, in collaboration with the Agricultural and Food Development Authority (TEAGASC) of Ireland and Queens University, Belfast, have developed a model for EU agriculture - FAPRI-GOLD (*Grains, Oilseeds, Livestock and Dairy* model) – which for cereals, oilseeds, meats and dairy products also includes sub-models for some of the member countries, including Italy (European Commission, 2000, chapter 3; Westhoff and Young, 2000). The models developed by FAPRI are among the best for their careful modeling of policy instruments of the EU and other countries, and are able to determine endogenously the prices of most products, export subsidies and stock variations. Among the most interesting aspects of its modeling of the EU, is the endogenous resolution of recourse to “intervention” and export subsidies; endogeneity is introduced by defining the

² For a detailed description of the structure of FARPI and SPEL/EU-MFSS see Conforti in this volume.

³ It is no coincidence that while in European Commission (2000) a chapter presenting the results of the simulations obtained with SPEL/EU-MFSS also contains information on EU exports, in the final chapter summarizing the results obtained by different models this information is omitted.

price elasticity of the “intervention” as a function of the distance between the domestic and the “intervention” price and that for subsidized exports as a function of the difference between the domestic price and the international price. The non spatial nature of the models, however, does not allow consideration of trade preference policies and, thus, these models cannot provide satisfactory simulations of the effects of an enlargement of the EU to countries in Central and Eastern Europe.

Among the other large scale partial equilibrium models deserving special mention are AGLINK, developed by the OECD in collaboration with a number of member countries (OECD, 1998c) and the World Food Model (WFM) of the United Nations Food and Agriculture Organization (FAO, 1998)⁴.

Of all the large scale models, AGLINK has probably received most attention in recent years, and its simulations have been most often cited. AGLINK is a partial equilibrium, recursively dynamic, non spatial, multi-country, multi-product model. Since 1993, it has been used by the OECD for its periodical medium term periodic forecasts (OECD, 2000) and has been continuously improved and up-dated. One of its most recent applications is a simulation of the March 1999 CAP reform (OECD, 2000). AGLINK has an “integrated modular” structure; in other words, the models relating to each country can be solved jointly, but, at the same time, they are still fundamentally independent of one another and simulations can be done solving single country modules as well, representing the links with other countries through a set of exogenous parameters. The credibility of the results produced by AGLINK is, however, reduced by the fact that these are subjected to a validating and “calibrating” process, which takes account of the evaluations expressed by member countries. Another relevant drawback of AGLINK is the lack of documentation about the structure of the model. Having said that, AGLINK is today probably the most interesting example of multi-product, multi-country model which aims to evaluate the effects of changes in trade and agricultural policies. Moreover, the on-going work to improve certain elements in the structure of the model - which, as will be shown later on, have not been entirely successful, gives rise to the hope that, over the next few years, there shall be improvements both in the individual components of each module and in the elements describing their integration.

The WFM is a recursively dynamic, non spatial model that considers 13 products and 146 countries/regions (the EU-15 is considered as a single country) (FAO, 1998). Created in 1981 as a medium term forecasting tool, WFM was then adapted to be utilized to evaluate the effects of the GATT Uruguay Round (FAO, 1995; Sharma, Konandreas and Greenfield, 1996, 1997 and 1999; Greenfield, De Nigris and Konandreas, 1996). The potential value of WFM in assessing the domestic and external effects of modifications in EU policies, or the effects of policy changes by other countries on the EU, is quite limited; this stems from the fact that, since its focus is on developing countries, the actual depth of the detail on EU policy tools is, not surprisingly, rather shallow. Furthermore, as its original purpose was different from its present one, it has - as will be illustrated later - a number of rather serious shortcomings as regards its ability to represent GATT commitments and the adjustment mechanisms needed to satisfy them.

SPEL-TRADE (Henrichsmeyer et al., 1995) was developed at the University of Bonn within a project financed by the EU; it is a partial equilibrium model specifically designed to simulate the effects of agricultural trade policy changes. SPEL-TRADE is a non-spatial, multi-product multi-country model. It was used to simulate the effects of the Agreement on agriculture which was reached at the end of the Uruguay Round (Henrichsmeyer et al., 1995). Recently, a new model, called WATSIM, *World Agricultural Trade Simulation System*, (Von Lampe, 1998, 1999 and 2001) based on SPEL-TRADE has been developed. A non spatial partial equilibrium model like its predecessor, it considers 29 products and 15 countries/regions; it has been developed with the specific objective of carrying out medium and long term simulations of the impact of policy changes.

⁴ For a detailed description of the structure of these models see Conforti and Londero and Conforti in this volume.

One of the most frequently cited simulation models of the effects of agricultural policies is SWOPSIM, *Static World Policy Simulation Model*, (Roningen, 1986; Roningen, Sullivan and Dixit, 1991) developed by the Economic Research Service of the United States Department of Agriculture in the second half of the 1980s. SWOPSIM's popularity also derives from the fact that its data base⁵ has been frequently used as an data source for the construction of many simulation models, even ones of a very different nature from its own. SWOPSIM can be described as a spatial, partial equilibrium, static, multi-product, multi-country model which, in its most expanded version (22 products, 36 countries/regions) allows researchers to choose the aggregation of countries and products they wish to analyze. Applications of SWOPSIM include Ames, Gunter and Davis (1996); Andrews et al. (1990); Andrews, Roberts and Hester (1994); Roningen and Dixit (1990); Hartmann and Schmitz (1992); Makki, Tweeten and Gleckler (1994); and Vanzetti et al. (1994). Peterson, Hertel and Stout (1994) offer a critical analysis of SWOPSIM, which is seen as "representative" of reduced form static models based on supply and demand functions.

MISS, *Modèle International Simplifié de Simulation*, is a partial equilibrium multi-product model originally proposed by Mahé and Moreddu (1987) and developed within a study supported by the European Commission (Commission of EC, 1988). Johnson, Mahé and Roe (1993) utilize a modified version of MISS, which enables them to model a game structure of government decisions in the USA and the EU as regards agricultural support, in order to find out whether an equilibrium existed among the feasible decision sets of the two countries. Modified versions of MISS are also the basis of simulations whose results are presented in AA. VV. (1994, appendix, D); Guyomard, Mahé, Tavéra and Trochet (1991); Kennedy and Atici (1998); Kennedy, von Witzke and Roe (1996); and Mahé and Guyomard (1991).

Brown and Richards (Brown and Richards, 1990; Brown, 1992) simulated the effects of alternative trade liberalization hypotheses utilizing a partial equilibrium model developed at UNCTAD, which considers 25 products and 19 countries/regions. Both the model's structure and the simulations pay careful attention to the implications of liberalization for developing countries.

McCorriston (1993) used a non spatial, partial equilibrium model with 3 products and 9 countries to analyze the proposal made by the EU during the course of the Uruguay Round negotiations for "rebalancing" protection for wheat and feed grains and for oilseeds.

Partial equilibrium, multi-product models are also used in the contributions by Anderson and Tyers (1991, 1992 and 1993), Tyers and Anderson (1992) and Tyers (1994); Cox et al. (1999); Cramer, Wailes and Shui (1993); Haniotis (1990); Larivière and Meike (1999); Leetmaa, Krissoff and Hartmann (1996); Mechemache and Requillart (1999, 2000); Peeters (1990); Zhu, Cox and Chavas (1999); and finally, the OECD's MTM (*Ministerial Trade Mandate* model) (Huff and Moreddu, 1990).

The University of Wisconsin at Madison has recently developed a spatial partial equilibrium model along the lines proposed by Takayama and Judge⁶ (1971) to analyze to effects of the Uruguay Round and alternative hypotheses on the outcome of the current WTO negotiations on world markets for dairy products (Zhu, Cox and Chavas, 1999; Cox et al., 1999). The model, which is referred to as the *UW-Madison World Dairy Model*, considers 21 countries, 5 different kinds of milk and 8 dairy final

⁵ That relating to an older version is in Sullivan, Wainio and Roningen (1989).

⁶ Takayama and Judge (1971) developing an intuition by Samuelson in 1952, proposed the use of a class of mathematical programming models to simulate the functioning of markets where production and consumption take place in a certain number of points in space. The simulation implies the solution of a problem of constrained optimization the variables of which are given by trade flows between each pair of points (including flows from each point towards itself). In simpler formulations the objective function is quadratic and constraints are linear, but in many applications the complexity of the policy modeling requires that the non linearity of the objective function is of a higher order than two and the constraints are non linear.

products and is characterized by its careful modeling of the commitments deriving from the 1994 GATT Agreement.

Many partial equilibrium models consider a single product only but with a more careful and more detailed description of the policies than is usually found in multi-product models. Examples of single product partial equilibrium models are Anania (1999, 2001); Borrell (1997); Gunter, Jeong and White (1996); Kersten (1995); and Poonyth et al. (2000).

2.2 General equilibrium models

Let us begin our brief review of the general equilibrium models with CAPMAT⁷, the general equilibrium model utilized by the EC DG Agriculture (European Commission, 2000, chapter 4; 1998, chapter 5). CAPMAT, which is an updated version of ECAM⁸ (Folmer et al., 1995), is a multi-product general equilibrium model that considers 9 member countries individually alongside the aggregate EU-15. CAPMAT, like SPEL-EU/MFSS, devotes little attention to the trade links between the EU and other countries: the European Union is modeled as a “small” country, that is to say a variation in market equilibria in the EU does not cause variations in international prices, which are exogenous. The model assumes that stock changes are equal to zero and, consequently, all the EU’s excess supply is exported. Finally, CAPMAT, also because of its structure, does not take into account GATT commitments, which are important for the EU: there is no room for the existence of minimum access quotas and exports are allowed to exceed the limits laid down in the Agreement⁹.

Among the first large scale general equilibrium models, RUNS, Rural/Urban-North/South, (Burniaux and van der Mensbrugge, 1991) is probably the one which has taken most trouble in its modeling of the agricultural sector¹⁰. RUNS characterizes itself for its careful modeling of a good number of developing countries and of the linkages between the rural and urban sectors in each country. It is a recursively dynamic model considering 22 countries/regions, only six of which are members of the OECD, and 20 products, 15 of which are agricultural products; 12 among these are food products. RUNS forms the basis of the work of Burniaux and Waelbroek (1990), Brandao and Martin (1993) and Goldin and van der Mensbrugge (1995) and it has also been used by the European Commission to simulate the effects of the 1992 McSharry Reform (AA. VV., 1994, chapter 4 of the Appendix). A direct descendent of RUNS is the FIESTA model, *Framework for Integrated Economic Simulation of Trade in the Americas*, which van der Mensbrugge and Guerrero (1998) used to simulate the implications of an extension of MERCOSUR to all countries of South and Central America (excluding Mexico), and the creation of a free trade area including all the countries of the American continent.

In more recent years the output from GTAP, Global Trade Analysis Project, has been particularly impressive (Hertel, 1997); this interesting and weighty effort has generated a data base and a multi-regional general equilibrium model and made them available to potential users. GTAP is hosted by the University of Purdue and is promoted by an international consortium, which includes, among others, institutions such as the World Bank, OECD, WTO, UNCTAD, the European Commission and the US International Trade

⁷ CAPMAT was developed by the Centre for World Food Studies at the University of Amsterdam, in collaboration with two other Dutch institutions, the Central Planning Bureau and the Agricultural Economics Research Institute (LEI-DLO).

⁸ ECAM was used by the Commission to simulate the possible effects of the 1992 CAP reform (AA. VV., 1994, chapter D in Appendix).

⁹ Van Tongeren, Van Meijl and Veenedaal (2000) in order to overcome the structural limitations of CAPMAT have recently used CAPMAT in conjunction with a modified version of GTAP, a general equilibrium model which shall be discussed shortly.

¹⁰ RUNS was developed jointly by the World Bank and the OECD. The OECD also developed WALRAS, World Agriculture Liberalization Study, about the same time (Burniaux et al., 1990). It was one of the first general equilibrium models to consider agricultural policies specifically.

Commission. The model is constructed in such a way as to allow users to define with relative ease the group of countries they wish to study (in the most recent version this can be up to 45) and the sectors (up to 50, 10 of which are from the agricultural sector, *strictu sensu*). Both the data base and the model itself are subject to periodic revision and updating; the model is well documented and introductory courses are regularly offered on both. Many researchers have used GTAP and its data base to analyze problems relating to international agricultural trade, to the effects on agricultural trade of policy changes or of trade liberalization both at regional and multilateral level: among these are Anderson et al. (1997); Anderson, Erwidodo and Ingco (1999); Bach et al. (2000); Bach, Frandsen and Jensen (2000); Diao, Somwaru and Raney (1998); Elbehri et al. (1999); Francois (2000); Francois, McDonald and Nordstrom (1995); Gehlhar (1998); Harrison, Rutherford and Tarr (1997); Herok and Lotze (2000); Hertel, Brockmeier and Swaminathan (1997); Hertel et al. (1999); Josling and Rae (1999); Liapis and Tsigas (1998); Mac Laren (1997); Roberts et al. (1999, chapter 2); and, finally, Swaminathan, Hertel and Brockmeier (1997).

Weyerbrock (1998a) is another contribution based on a general equilibrium model. It is one of the most interesting contributions in recent years analyzing the implications of the agricultural policy reform of the EU from the perspective of its “compatibility” with the commitments introduced by the 1994 GATT Agreement. Weyerbrock proposes a model with 6 countries (the EU considered is that with 12 member countries) and 13 sectors (wheat, other cereals, sugar, meat, dairy products, oilseeds, other food products and non edible agricultural products; 4 industrial sectors and services). The work is notable for the particular care taken in explicitly modeling the main policy instruments, both domestic and those applied at the border, used under the CAP, including production quotas for sugar and milk, variable levies and variable export restitutions. While these instruments are all modeled explicitly, the “intervention” purchases are represented in the model through an exogenous translation of the supply function. The results of the simulations suggest the liberalization of the CAP in 1992 did not go far enough to meet the commitments undertaken by the EU with the 1994 Agreement; the work also offers alternative hypotheses for possible adjustments in the percentage of set aside, intervention prices and quotas for sugar and milk which would be sufficient to guarantee the “compatibility” of EU agricultural policies with the GATT Agreement commitments.

The same model is utilized in Weyerbrock (1998b) - this time, however, in a much less satisfactory manner - to evaluate the impact of the enlargement of the EU to include several Eastern European countries. The simulations hypothesize the extension of the CAP to the new member states, taking into consideration both CAP pre Agenda 2000, and the reform proposal put forward by the Commission in 1997. The elimination of the EU tariffs applied to imports of industrial goods from the new member countries and a 50% reduction in tariffs applied on non edible agricultural products are assumed, while the model, surprisingly, not only does not foresee the elimination of the EU tariffs on food imports from new members, it does not even foresee any reduction; Weyerbrock justifies this decision by stating that the Eastern European countries considered were not in a position to make use of many of the preferential quotas already laid down by the EU (Weyerbrock, 1998b, p.15).

Other simulations using general equilibrium models are found in Anderson (1998); Coyle and Wang (1998); Fehr and Wiegard (1996); Harrison, Rutherford and Wooton (1995); Le Mouel (1995); Mai et al. (1996); Nguyen, Perroni and Wingle (1993); Sadoulet and de Janvry (1992); and Scandizzo (1992).

In recent years there have also been many contributions reviewing models or discussing controversial questions to do with modeling international trade in agricultural products and related policies, including, naturally, the modeling of the 1994 GATT Agreement.

As long ago as 1981, Thompson produced a review of the models analyzing international agricultural trading which is still a useful introductory guide to the different types of models available, their strengths and weaknesses. Cuffaro (1990) offers a thoughtful overview of the models which in the 1980s estimated the possible benefits of a liberalization of agricultural policies, first dealing with the structural differences and the

hypotheses and then comparing the results. Buckwell and Medland (1991) discuss the shortcomings of the various attempts to model the possible effects of a liberalization in international agricultural trade in the 1980s.

An excellent introduction to the differences in the different types of models most frequently used today is found in Francois and Reinert (1997).

Tyers (1991) discusses the implications of the fact that certain “standard” simulation models of the international agricultural trading fail to consider risk, market insulation from fluctuations in international prices which stem from policy interventions, and dynamic adjustment processes. Meilke, McClatchy and de Gorter (1996) discuss the limitations of quantitative evaluations of the possible outcomes of the GATT Agreement and the role that these evaluations have played in the agricultural negotiations in the Uruguay Round. Francois, McDonald and Nordstrom (1996) present a brief overview of the analyses using general equilibrium models of the effects of the Agreement which concluded the Uruguay Round. Meilke and Larivière (1999) discuss the problem of modeling minimum access quotas set out in the 1994 GATT Agreement with particular reference to dairy products.

Within a project financed by the EU (FAIR6 CT 98-4148), van Tongeren and van Meijl carried out a careful study of the main simulation models of international agricultural markets and of the linkages between them and national policy interventions (van Tongeren and van Meijl, 1999; van Tongeren et al., 2001). Under the same project, a series of contributions recently made available analyze models using GTAP to study the expected effects of the CAP reform process (El Mekki et al., 2000), of the enlargement of the EU to include Eastern and Central European countries (Pohl Nielsen and Staehr, 2000) and of the multilateral process of liberalising policies and trade (Francois and Rombout, 2000).

3. On the ability of models used to simulate the implications of liberalization processes for EU agriculture

The objective of this section of the chapter is to evaluate the strengths and weaknesses of the models used over the last few years to analyze the expected effects of liberalizing agricultural policies, multilaterally or regionally. The first part of this section will consider the most important hypotheses which underpin different models - both those of a more general nature involving the structure of the model itself, and those relating more specifically to the modeling of the main instruments of CAP - focusing on their ability to do their job, that is to simulate the effects of a trade liberalization. In the second part different modeling of the commitments introduced by the 1994 GATT Agreement on agriculture are discussed.

3.1 On the implications of certain general hypotheses

The European Union as a “small” country

The majority of models consider the European Union as a “large” country, assuming that world prices are influenced, or, at least, may be influenced, by changes in the domestic market price equilibria in the EU.

This, however, is not always the case: there are models, even among the large scale ones, that assume, instead, that international prices are exogenous as regards the EU; as has already been said, this happens, for example, with SPEL-EU, CAPMAT (European Commission, 2000 chapter 4) and ECAM (Folmer et al., 1995); these consider the trade linkages between the EU and the other countries in a very simplistic manner, aggregating all countries but the EU together in a single region and assuming that international prices can be considered exogenous, in other words uninfluenced by changes in prices within the EU as a result of policy changes. This means they assume that demand functions of imports from the

EU and the supply functions of exports to the EU are infinitely elastic. Even if this hypothesis could be accepted as reasonable in the case of a relatively small country¹¹, it certainly cannot be with the EU, whose imports and exports make up such a large slice of world trade in many agricultural products. If the EU, as a result of a domestic policy change, reduces exports of a given product by 20% or 30% this has a notable effect on prices in other countries (and, therefore, on their production, consumption and net trade position). These effects, in turn, modify the impact within the EU of the hypothesized policy change: for example, there will be a price readjustment, or a change in spending or revenue relating to export restitutions and the imposition of variable levies (like those applied by the EU on its cereal and rice imports). Hence, a simulation which uses a model based on the assumption that the EU is a “small” country - unless one is considering a single product where the EU is of marginal importance from the point of view of world production, consumption and trade - is bound to produce a distorted estimate of the effects of the policy change being analyzed.

Competition and market structure

International trade in agricultural products is often concentrated in a small number of companies. Around the beginning of the 1990s roughly 80% of the world trade in cereals was controlled by just six multinationals; four firms controlled 80% of the world trade in oilseeds; four controlled 60% of the trade in sugar, and so on (Scoppola, 2000, p. 64). It is unlikely that the figures are much different today. This being the case, it is clear that international agricultural markets are characterized by the existence of firms large enough to exercise significant market power, although the overwhelming majority of simulation models assume perfect competition both in domestic and international markets.

Yet, firms are not the only actors who are in a position to exert market power: the same is true for “large” countries (of such a size that the import demand and the export supply they face are not infinitely elastic) who could use trade policies to enhance their own welfare.

Despite all this, there are very few models which take into account the possibility of countries exercising their market power to their own advantage or the “tit for tat” reaction by others if this happened. Brockmeier, Hertel and Swaminathan (Hertel, Brockmeier and Swaminathan 1997; Swaminathan, Hertel and Brockmeier, 1997) simulate the impact of the enlargement of the EU to include Eastern and Central European countries using version 3 of the GTAP data base and hypothesize the existence of monopolistic competition in certain sectors. Francois, McDonald and Nordstrom (1995) demonstrate the importance of the assumptions related to the market structure in evaluating the effects of liberalization processes simulating the effects of the Uruguay Round assuming constant return to scale and perfect competition, and rising return to scale and monopolistic competition.

Herrmann and Sexton (1999) analyze the effects of reduced tariff quotas which regulate the importation of bananas into the EU, hypothesizing different market structures, showing how these effect estimates of the impact of the policies considered in terms of welfare. Nevertheless, despite the marked concentration of the export supply of bananas to the EU, the results of the econometric analysis carried out do not show any evidence of the exertion of oligopolistic or monopolistic power by firms.

Kawaguchi, Suzuki and Kaiser (1997) proposed the extension of the spatial, partial equilibrium, mathematical programming model first put forward by Takayama and Judge (1971) to represent imperfect market structures intermediate between perfect competition and monopoly. Veeman, Fulton and Larue (1999) proposed the structure of a model which could take into account non competitive behaviours of

¹¹ As in Sadoulet and de Janvry’s analysis (1992) which considers three different “archetypal” countries among the poorest developing countries and in Anderson (1998) which evaluates the interactions between the effects of a multilateral liberalization as a result of the Uruguay Round and domestic distortions in nine developing countries.

public and semi-public agencies, which enjoy monopoly or monopsony power over the imports or exports of a given country (*State Trading Enterprises*).

Finally, the interdependence between the public decision makings in the various countries is explicitly taken into account in the simulations which form the basis of the work of Johnson, Mahé and Roe (1993) and Makki, Tweeten and Gleckler (1994).

Product homogeneity

Agricultural products, especially primary ones, tend to be relatively homogeneous. This does not mean to say that they should be considered identical; nevertheless, two glasses of milk or two sacks of corn *with the same quality characteristics* are from the point of view of the consumer extremely similar, or, to put it another way, they have a price cross-elasticity which is probably close to infinity. The same may well not be the case for two cars, two perfumes or two pairs of trousers.

It should come as no surprise, therefore, that in the majority of cases agricultural products are considered as homogeneous goods in the models, that is, although produced by different firms in different countries, they are assumed to appear to the consumer (or to the user, in the case of intermediate goods) as perfect substitutes. In general, this assumption is made in the larger partial equilibrium models such as AGLINK¹², FAPRI, SPEL-TRADE, SWOPSIM, WATSIM or WFM of the FAO.

Following the approach introduced by Armington (1969), general equilibrium models frequently assume imperfect substitution of goods produced in different countries. Amongst others, this is the case of Fehr and Wiegard (1996); Francois, McDonald and Nordstrom (1995); Weyerbrock (1998a and 1998b); van der Mensbrugghe and Guerrero (1998); and GTAP. Imperfect substitution in consumption between domestic and imported products is also assumed in Sadoulet and de Janvry (1992). The same hypothesis is at the basis of one of the versions of SWOPSIM and the partial equilibrium models whose results are presented in Haniotis (1990) and Leetma, Krissoff and Hartmann (1996).

When constructing a model, the choice to treat products as perfectly homogeneous or dishomogeneous according to their country of origin gives rise to various questions.

First of all, to assume that goods produced in different countries are not perfect substitutes implicitly introduces a certain element of protection for domestically produced goods. This is not a problem *per se*: if the substitutability between domestic and imported products is truly not perfect, then the use of the Armington approach simply means representing in the model something which reflects reality, i.e. the existing implicit protection of the domestic market. If, on the contrary, imperfect substitutability of domestic and imported products does not, in fact, occur in the real world, then a distortion is being introduced, imposing, or overestimating, the market protection which derives from differences in quality between domestic and imported products.

A second issue is linked to exactly what kind of dishomogeneity can be explained by the Armington approach. If it is true that agricultural products are not perfectly interchangeable, can we be sure that this

¹² Although AGLINK is a “non spatial” model which assumes perfect substitutability between goods produced in different countries, the equation that describes the domestic and international price linkage contains a component which represents the effect on the “wedge” between the two prices of qualitative differences between a good produced domestically and imported ones (OECD, 1998a, p. 10). This implicitly means assuming imperfect substitutability between domestic goods and those produced elsewhere (which, however, are assumed to be homogeneous). This approach, which is also found in other models, is contradictory. Let us consider, for example, a world with three countries A, B and C; in the equation which links the price of A to the world price, the production of A is assumed to be dishomogeneous with that of B and C, while these two - inevitably, given the “non spatial” nature of the model - are assumed to be homogeneous; on the other hand, in the equation which links the price of B to the world price, the production of B is assumed to be non homogeneous with that of A and C (this is the first contradiction) which are assumed to be homogeneous (the second contradiction).

dishomogeneity can be entirely explained on the basis of the country where the goods are produced? In other words: is it reasonable to assume, for example, that pork from Greece and Denmark are perfect substitutes - the EU being considered as a single country - whereas the same product is not interchangeable with pork produced in Poland (which is perfectly homogeneous), which, in turn, is not a perfect substitute for pork produced in Russia (also perfectly homogeneous)? Which are likely to be more different, pork meat exported from Poland and Russia to the EU or meat consumed and meat exported in either of the two countries?

The introduction of the assumption of imperfect substitutability *a la* *Armington* certainly serves to take into account existing product differentiation which can be explained by the country of origin, but it should not be used instrumentally as a means to find a solution to the problem of how to model products which are dishomogeneous when this dishomogeneity cannot be entirely explained on the basis their country of origin (as it is probably the case for most agricultural products). Moreover, even where differences are exclusively connected with origin, whether models represent this accurately will depend on the realism, in the literal sense, of the matrix of cross-elasticities employed¹³.

Finally, the assumption that there cannot be perfect substitutability between products from different countries increases the possibility that countries may exercise market power to their own advantage, as a result of the fact that they face export supply or import demand functions which are not perfectly elastic, extending market power also to countries which can rightly be considered “small”. Hardly any of the models which assume product differentiation on the basis of the country of origin considers this possibility, nor do they discuss the assumption that countries do not take advantage of this opportunity.

Indirect representation of trade policies through the use of “equivalent tariffs”

The mere existence of trade policies implies that domestic prices (both for exports and imports) are different from those at the border (*fob* and *cif*, respectively) expressed in the currency of the country. In addition, many trade policies tend to reduce the strength of the causal link between price changes of a given product on the world market and its domestic price.

This explains why in most cases, rather than representing each policy explicitly in the model, policies are jointly represented synthetically by an equation which describes the *price transmission* or *price linkage* mechanisms¹⁴. In a *price transmission* equation the changes in prices on the world market are only partly reflected in changes in domestic prices; the extent of the transmission will depend on the value of transmission elasticity, which is exogenous to the model¹⁵. *Price linkage* equations, on the other hand, represent the effect of trade policies as a wedge, a margin between the domestic price and that on the world market¹⁶; this wedge is represented in the model by a “net tariff equivalent”, which represents and synthesizes the effects of all the policies of the country on the difference between the two prices.

¹³ RUNS, for example, adopts the hypothesis of imperfect substitutability for manufactured goods, but not for agricultural products. Alston et al. (1990) reject Armstrong’s hypothesis of imperfect substitutability in the international markets for grain and cotton. The sensitivity of simulation results to the hypotheses adopted regarding the values of the elasticity of substitution between domestic goods and those produced elsewhere is discussed in Bach et al. (2000) and in Anderson et al. (1997). In the latter these are assumed to be twice those given by GTAP’s data base.

¹⁴ A useful introduction to the problem of representing trade policies in simulation models is in Laird (1997).

¹⁵ In Anderson and Tyers (1991, 1992, and 1993), Tyers and Anderson (1992) and Tyers (1994) the price transmission equations are estimated econometrically.

¹⁶ Some models, including RUNS, SWOPSIM (for developing countries) and WFM (only for countries whose policies are assumed to change as a result of the Uruguay Round) utilize equations which embrace both price linkage and price transmission mechanisms between domestic and world prices.

The main problem with this approach to modeling trade policies - an approach which is frequently used - stems from the fact that the use of non tariff barriers (NTBs) is quite common and these cannot be represented adequately by an “equivalent tariff”, simply because such equivalence does not exist.

For example, it is well known that with changes in market equilibrium - caused perhaps by a policy change, which is just the sort of occurrence simulation models try to assess - it is not possible to identify an “equivalent tariff” for an import quota. The “equivalent tariff” for an import quota which is not binding is zero; the “equivalent tariff” for a binding import quota will be a function of the equilibrium price and will change if the market equilibrium, on the domestic and/or the world market, changes. In fact, the “equivalent tariff” of an import quota (that is a tariff which would determine the same volume of imports as the quota) varies, and can only be obtained endogenously, as a result of the simulation itself.

At the end of the Uruguay Round, the EU agreed to impose a constraint on its import tariffs for cereals and rice in addition to the maximum levels indicated in its “schedules”. These should be such that the tariff inclusive import price does not exceed a certain percentage of the intervention price.¹⁷ In practice, this has meant that the EU has continued to utilize a “variable import tariff” for these products, a policy tool which is difficult to distinguish from a “variable levy”. Most models represent variable tariffs through “equivalent tariffs” as though they were dealing with a “fixed” tariff of a known (exogenous) amount. A variable tariff whose value is given by the difference between an exogenously determined “threshold” price and the *cif* price at the border expressed in the currency of the country can not be represented by an “equivalent tariff”. The value of the variable tariff, depending on the equilibrium price at the border, must necessarily be determined endogenously as part of the simulation. The difference is significant: a variable tariff, similar to a variable levy and unlike a fixed tariff, perfectly isolates the domestic market both from fluctuations in the prices on world markets and from the effects of policies by other countries aimed to expand their exports (such as, production or export subsidies).

When explicitly represented, export subsidies are modeled as unitary fixed or *ad valorem* export subsidies. Similarly with a variable import tariff or a variable levy, a variable export subsidy (in the jargon of the EU Common Agricultural Policy, an export restitution) cannot be represented through an exogenous “export subsidy equivalent”: also in this case, in fact, its value must be determined endogenously as one of the elements in the solution of the model.

MISS (Johnson, Mahe and Roe, 1993) models variable import tariffs explicitly, endogenously determining the value of the variable tariffs based on an exogenous threshold price. Anania (1999, 2001), CAPMAT (European Commission, 2000, Chapter 4), GTAP (Hertel, 1997), Harrison, Rutherford and Wooton (1995), Fehr and Wiegard (1996) and Weyerbrock (1998a) model both variable tariffs and export restitutions explicitly. The same is true for ECAM (Folmer et al., 1995); in this case, however, subsidized exports are defined as a fixed percentage of the country’s excess supply at the intervention price. In other words, if the EU domestic price remains above the intervention price, which itself is higher than the world price, there will be no exports. GTAP also offers the chance to model variable import tariffs and export restitutions explicitly. Surprisingly, in the work of Bach, Frandsen and Jensen (2000) - which claims to offer a detailed and reliable model of the CAP and uses a slightly modified version of GTAP - the “variable tariffs” for cereals and rice resulting from the GATT Agreement are ignored and border protection for these products by the EU is represented by fixed import tariffs. In the FAO’s WFM model, export restitutions are represented indirectly, through an exogenously determined “price effect” of export subsidy policies.

With specific reference to the CAP, other non tariff barriers which cannot be modeled through “equivalent tariffs” are reduced tariff import quotas (like those for bananas, sugar and several fruit and

¹⁷ 155% in the case of wheat, 180% and 188% for Japonica and Indica rice, respectively.

vegetable products) and the tariffs which change over the course of the year (such as those applied on most fruit and vegetable imports). For these non tariff barriers there is no “equivalent tariff”.

Many models take into consideration explicitly only *ad valorem* tariffs. Per unit fixed tariffs are transformed into their *ad valorem* equivalent using a reference border price¹⁸. Every time the border price in the model’s solution is different from the reference border price used to calculate the *ad valorem* “equivalent tariff”, the tariff protection imposed in the model will be distorted, because the monetary value of the “equivalent tariff” used in the model will be different from the fixed tariff actually imposed.

PSEs (Producer Subsidy Equivalents) are often used to represent the price wedges in order to represent trade policies in “price linkage” equations; PSEs had been calculated annually from 1987 until 1998 by the OECD for a certain number of products and countries (OECD, 1998b). The PSE is defined as the value of monetary transfers from consumers and/or tax payers to farmers as a result of agricultural policies; it is given by the sum of “market price” support (given by the transfer to producers as a result of policies which have the effect of increasing the market price); of direct payments to farmers; of subsidies which reduce input costs; of public spending for general services for agriculture; and of transfers to farmers due to “other measures” (OECD, 1998a).

The use of the per unit total PSE as a wedge in a “price linkage” equation between domestic and international prices has more than one drawback.

First: it is a measure of the support the agricultural sector receives as a result of *all* policies and not just trade ones; generally speaking, this means that the wedge overestimates the effect of trade policies¹⁹.

Second: the per unit PSE may change (in fact, it can change a great deal from one year to the next) even if the policies remain the same; this is due to the fact that the PSE is calculated by dividing the overall transfer in monetary terms by overall production, and the latter can change as a result of factors which have nothing to do with policy changes.

Third: the PSE can also change even if there is no change in either policy or volume of production because of fluctuations in world prices or exchange rates.

Forth: it might make sense to use the PSE as the margin between domestic and international prices when the goal of the simulation is to predict the effects of a complete liberalization of a country’s policies²⁰ (that is to say, the simultaneous abolition of all relevant policies, both trade and domestic). However, since the PSE does not allow researchers to consider the effects of different support policy instruments separately, its use is much less justified when the aim is to evaluate the effects of a partial liberalization; even less justified when the partial trade liberalization is associated to a variation in the distribution of the support between the different instruments employed, or to the introduction of a new policy instrument (Laird, 1997)²¹. This means that to represent trade policies through the use of the “margins” between prices drawn from per unit total PSEs appears inadequate when one needs to simulate the effects of a reform which is based not only on a reduction in support but also on modifications in the support instruments themselves. The reform of the CAP in the past ten years is a case in point, it entails not only a reduction in support, but the gradual shifting from “coupled” forms of support to a “partially decoupled” support. Consider the extreme case of a country where support to farmers is linked to completely “coupled” policy instruments (an import tariff, for example), and assume that a decision has been made to maintain support to producers

¹⁸ WFM (FAO) and SPEL-TRADE (Henrichsmeyer et al., 1995) utilize both *ad valorem* and fixed tariffs explicitly in equations which link domestic prices to world prices.

¹⁹ Nguyen, Perroni and Wigle (1993, p. 1542) represent farmer support using both the PSE as a measure of domestic support and the margins between domestic and international prices caused by border policies. Since the PSE already measures the effect on domestic price of existing trade policies, this means taking account of the effect on domestic price of border policies twice.

²⁰ As, for example, in Roningen and Dixit (1990) and in one of the scenarios considered by Hartmann and Schmitz (1992).

²¹ Rather similar considerations are in Haley (1989), who discusses some of the problems connected with the use of PSEs and Consumer Subsidy Equivalents (CSEs) in SWOPSIM to represent the policies of the EU and the US.

unchanged by using completely “decoupled” direct transfers to farms instead. If the total per unit PSEs were used to represent trade policies, no effect of the policy change would show up in the simulation, even if no tariff imposition would now take place. The model would not be able to reproduce the effects of the policy change on prices, production, consumption and trade.

Whereas in the past the total PSE was utilized to represent the effects of policies as “wedge” between domestic and international prices, in recent years many models have used one component only of the PSE, the “market price support”, as the “wedge” between these two prices²². This undoubtedly reduces the distortion, but does not completely resolve the problem: in fact, the second, the third, and to some extent also the first and fourth point above regarding the use of the total PSE are still valid. Besides, all the problems described above relating to the use of an “equivalent” tariff to represent all trade policies synthetically remain unresolved.

In 1999, the OECD (OECD, 1999a p. 84) modified its methodology for calculating both direct and indirect transfers to farmers through policy interventions and introduced the Producer Support Estimate (with the same acronym, PSE), which is obtained by the sum of eight specific components of the support benefiting farmers, defined on the basis of the different support instruments utilized. This new classification of the components of support appears to be a great improvement in the ability of models using the PSE to represent the effects of policies. The component of the new PSE given by “market price support” measures the annual monetary value of support to farmers deriving from domestic and trade policies which make the domestic price different from the border price. However, as with the old PSE, even the new estimates carried out by the OECD do not allow us to break down “market price support” into the part which is due to trade policies and the part due to domestic policies.

Attempts at *implicit* modeling of the policy instruments of the CAP through the use of synthetic “equivalent tariffs” and “equivalent taxes” used as “wedges” between the domestic price and the international one, and between consumer and producer prices respectively, are totally unsatisfactory because of the number and variety of instruments involved in the CAP. The approach based on such implicit aggregated representation of the policy instruments is also doomed to failure by the nature of the reform process of the CAP itself, which, alongside a reduction of support to farmers, envisages a radical redesigning of the instruments as well: the effects of this cannot be captured by a variation of a synthetic price “wedge”.

Representing trade policies through explicit modeling

²² This is the case, for example, with WFM, GTAP and the work carried out by the OECD (1999b) to develop an approach to the evaluation of the effects of agricultural policies based on Policy Evaluation Matrices. RUNS (Burniaux and van der Mensbrugge, 1991) utilize a similar approach, albeit constructed before the breakdown of the PSE became available, something which other models mentioned were able to benefit from: in this case, in fact, an ad hoc estimation was carried out for OECD member countries of the value of the part of the PSE related to price support (used in the model as “equivalent tariff”, as a margin between prices) and that not connected with price support (used in the model as subsidy to production factors). SPEL-TRADE (Henrichsmeyer et al., 1995) tries to reduce, at least partly, the problem by considering various components of the PSE separately, i.e. the market price, direct payments and indirect payments components. In SPEL-TRADE the wedges in the linear equations which describe the links between the EU domestic price and “the rest of the world” price contain both the tariffs (fixed and ad valorem) and the PSE. Since the PSE already captures the effects of tariff protection, this implies counting twice the support to producers from the latter. In order to avoid this distortion in SPEL-TRADE simulations either the tariffs or the market price component of the PSE are set at zero (Henrichsmeyer et al., 1995, p. 29); this, however, does not entirely resolve the problem of justifying the modeling choices made. In addition, the links between the projections of the basic model and those obtained in the simulations of the impact of the variations in the policies considered remain unclear. The most recent version of AGLINK also uses PSEs as wedges between prices, but work is being done to move to an explicit modeling of support policy tools individually, in particular fixed and ad valorem tariffs, production quotas, reduced tariff import quotas and variable import tariffs.

The only effective way to conduct simulations of EU agricultural policies is to model the instruments of the CAP explicitly, rather than implicitly, *one at a time*, using models which are capable of simulating the actual functional mechanisms of each. This approach is relatively more simple with partial economic spatial models which use mathematical programming, for example those developed from the ones proposed by Takayama and Judge (1971)²³; besides, recent improvements in general equilibrium models (GTAP; Weyerbrock, 1998a) open the way for promising developments within this class of models in the desired direction of representing explicitly each policy instrument individually.

Explicit individual modeling of trade policy instruments is not, however, all that easy. Even when the only policies involved are “simply” import tariffs, their representation in the model is not without its difficulties. Models inevitably make use of a definition of products which is usually much more aggregated than that used when laying down tariff line specifications: for example, the EU schedules which describe the commitments to tariff reductions under the GATT Agreement consider more than 80 tariff lines for cereals and more than 100 for dairy products. This means that in order to obtain the tariff value for a given product to be used in the model, it will be necessary to aggregate these lines down to a few numbers. Irrespective of the way this aggregation is carried out, there will inevitably be some distortion in the model’s representation of the level of protection granted to the domestic market (Bach and Martin, 1997; Salvatici, Carter and Summer, 1999). If a simple average is used, market protection will be underestimated: relatively low tariffs - usually imposed on imports of products which have little influence on the prices of domestic products - will tend to hide the existence of much higher tariffs - applied on the more “sensitive” products. On the other hand, even when tariff lines are weighted by using the value of the imports they are applied to, there will still be a distortion in the same direction: in this case, in fact, relatively low imports associated with higher tariffs will determine low weights in the calculation of the aggregated average tariff. The extreme case scenario is that of prohibitive tariffs: being associated with zero imports, these simply “disappear” in the calculation of the weighted average tariff. The higher (a) the aggregation of products in the model, (b) the variability of the tariffs, and (c) the disaggregation used in the definition of the single tariff lines, the greater the likelihood of obtaining distorted aggregate tariff estimates to be used in the model. This problem is generally more acute with general equilibrium models which, in many cases, especially in the past, considered products in a very aggregated way, for instance “agriculture”, “vegetable” and “livestock” products (Bach and Martin, 1997)²⁴.

In the overwhelming majority of cases, when tariffs are represented explicitly, they are introduced into the models as “wedges” between the domestic price and the *cif* border price. If, however, a tariff is prohibitive this does not make much sense, since imposing that the domestic and the international prices must differ by the value of the tariff forces an unrealistic difference between the two²⁵. In this case the problem is caused by the fact that, in general, it is not known *a priori* whether a given tariff is prohibitive or not: this can be found out only once the simulation has been completed.

Yet, even if these problems could be ignored, the definition of the tariffs to be used in the model is still not a simple matter. Often when building the data base for the model, use is made of the tariffs indicated by each country in the schedules appended to the Agreement on agriculture signed at the end of

²³ Cramer, Wailes and Shui (1993), though utilizing a multiproduct simulation model of this type, which would have allowed them a direct modeling of the different protection instruments in rice markets, choose instead to represent liberalization by varying (arbitrarily) the parameters describing the linear export supply and import demand functions.

²⁴ Today this is no longer necessarily the case: CAPMAT/ECAM, RUNS and GTAP, for example, consider a relatively high number of agricultural products.

²⁵ Indeed, conditions of spatial equilibrium are such that the prices in two countries differ by a “margin” determined by their current trade policies and by transport costs only if trade takes place between them. If there is no trade, the difference between the equilibrium prices in the two countries should be less than (not equal to) the “margin” caused by trade policies plus the per unit transportation cost.

the GATT Uruguay Round²⁶. The tariffs listed in these schedules, however, are the maximum values of the tariffs which can be imposed and, in general, are much higher than those actually applied; this is practically the rule with developing countries but also happens with certain products in developed countries, including some in the EU. The consequence of the use of the GATT schedules is an overestimation of the level of existing market protection.

The EU has currently in place a considerable number of preferential trade agreements, especially with developing countries, which allow for the importation of agricultural products from these countries into the EU with the imposition of a much lower tariff than that applied to countries with a WTO “most favoured nation” status. In the case of the EU, for quite a few products tariffs based on “most favoured nation” status are rarely applied, since all or most of the imports are subject to the more favorable preferential treatment. This is true, for example, for imports of bananas, sugar, olive oil and many kinds of fruit and vegetables. Where this happens, to utilize tariffs which are applicable to imports from “most favoured nations” means, in fact, to considerably overestimate the level of protection enjoyed by the domestic market.

Another interesting question concerns the modeling of discriminatory trade policies, like those which impose different tariffs on imports from different countries²⁷. The EU concedes different preferential margins to different countries or groups of countries. For many products even export restitutions are different based on their destination. Modeling discriminatory trade policies - both those actually in use and hypothetical ones, where one wants to evaluate possible effects of a particular policy, say EU expansion - involves the need to take into consideration both the trade *creation* and trade *diversion* effects of these policies. It is possible to do so only by using a “spatial” model²⁸. Most models, including large scale partial equilibrium models are, unfortunately, “non spatial”. Surprising as this may seem, this is also true for several of the models constructed with the specific objective of evaluating EU enlargement. A case in point is ESIM, where a single region, “rest of the world”, is added to the seven Eastern and Central European candidate countries and current EU member states; this “rest of the world” is treated as completely exogenous and is assumed to be unaffected by the enlargement and the associated policy changes²⁹.

Using a non-spatial multi-product partial equilibrium model (CEASIM, Central European Agricultural Simulation Model), Frohberg et al. (1998) analyse the entry of Eastern and Central European countries into the EU. CEASIM models eight candidate member countries separately, but considers all the others - EU countries included - as a single unit, and assumes that the equilibrium price in this aggregate is exogenous for the Eastern and Central European countries considered. The analysis is conducted considering the likely effects of different price levels and the introduction of production quotas for milk and sugar in the new member states. The structure of the model, however, does not allow either for changes in trade policies in these countries as a result of enlargement (it is not possible to consider the elimination of trade barriers with the other members, nor the aligning of tariffs and export subsidies), or for border price

²⁶ This is the case, for example, with the FAO’s WFM.

²⁷ A discussion of some methodological questions to do with the modeling of discriminatory trade policies is in Anania and McCalla (1991).

²⁸ “Spatial” models can simulate the trade flows between each pair of countries and not merely the net trade position of each country; for this reason they are also able to model discriminatory trade policies - that is policies which impose different “rules” depending on the country imports come from, or exports are directed to. “Non-spatial” models, on the other hand, are unable to determine bilateral trade flows, or take account of discriminatory trade policies. They determine market equilibria on the basis of a world equilibrium price to which prices in every country are linked. In equilibrium, the sum of exports and imports over all countries will be equal and the simulation will determine the net trade position for each country, without however being able to determine the origin of the imports or the destination of the exports.

²⁹ Munch (2000) and Munch and Banse (1999) in an attempt to overcome the limitations of ESIM utilized it in conjunction with general equilibrium models of the single Eastern and Central European member candidates considered. Both contributions assume that goods are differentiated on the basis of their country of origin and by doing so the limitations caused by the fact that ESIM is a non-spatial model are, at least partly, avoided.

adjustments following enlargement. Moreover, these are the same regardless of the fact that the exports (imports) of the new members are directed towards (coming from) the EU or towards (from) non-member states. All this renders the hypotheses problematic and considerably reduces the credibility of the results.

Gehlhar (1998) simulated the effects of EU enlargement to CEECs making the tariffs on imports from third countries uniform and eliminating the tariffs on trade between the new Central and Eastern European members and the countries of the EU-15, but surprisingly left unchanged both domestic support for farmers and export subsidies in the new member countries (Gehlhar, 1998, p. 38).

Liapis and Tsigas (1998) unify border protection policies of the new members and EU-15, eliminating trade barriers between them, making support to domestic farmers uniform, but, once again, leaving export subsidies unchanged.

Because of its structure, the FAO's WFM cannot take into account the fact that it is developing countries that largely benefit from preferential trade policies.

Using a non-spatial econometric model, Devadoss and Kropf (1996) simulate the effects of trade liberalization in sugar; the model they use is structurally unable to take into account EU trade preference policies or the fact that the EU, as a result of these policies, imports and exports considerable volumes of sugar at different prices.

GTAP, on the other hand, is able to model different tariffs and subsidies according to the origin and destination of the traded goods, thanks to the assumption of the imperfect substitutability of goods produced in different countries: the use of the Armington assumption is explicitly justified in GTAP with the need to make the model able to reproduce both intra-industry trade and bilateral trade flows, i.e. not merely the net trade position of each country (Hertel, 1997, p. 41). Unfortunately, the current version of the model and its data base do not appear capable of modeling preferential trade policies adequately. If it is true that the model considers different tariffs (and export subsidies) depending on the country of origin (destination) of the imports (exports), it is also true that these differences do not reflect actual discriminatory trade policies but, rather, differences in the composition of bilateral trade flows. Indeed, GTAP calculates the tariff applied by a country on imports of each of the other countries for each of the products considered in the model (which, of course, are aggregates of a certain number of products) weighting each tariff line in that specific product aggregate by the importance of imports within that line coming from that particular country³⁰ (Gehlhar et al., 1997). As already mentioned above, in the case of a tariff which is so high as to render imports from a given country unprofitable, this means that the tariff will be irrelevant in the calculation of the average tariff applied on imports of the aggregated product from that country. Moreover, and this is probably the most relevant point, this implies that in the case of GTAP discriminatory tariff policies are assumed to exist even when they do not, while where they do, indeed, exist, they are ignored, as the tariffs utilized to calculate the one applied on a specific bilateral trade flow are those applied on a "most favoured nation" basis. Again: in GTAP the difference between the tariffs applied on imports of the same product from different countries is determined exclusively by the composition of the imports of each country within the aggregate basket of products considered, not by the existence of discriminatory tariffs.

For all the models which, like GTAP, though "not-spatial" in nature, are used to represent discriminatory trade policies based on the assumption of imperfect substitutability in consumption according to their country of origin, simulations of regional trade liberalization processes appear linked to implicit assumptions on the homogeneity, or lack of it, of products, which is not always easily justifiable. When, for example, the model is used to simulate the enlargement of the EU (considered as a single country) to Central and Eastern European countries, in the best of cases this happens eliminating barriers to trade and exports subsidies between these and the EU, and bringing domestic and trade policies of the new members

³⁰ In the case of agricultural products "equivalent tariffs" are used instead of tariffs; these are drawn from the data base which forms the base on which PSEs are calculated.

into line with the policies of the EU (in the latter case totally or only partly, depending on the assumptions made regarding the reform process of the CAP before the enlargement). It follows that the simulation will assume that after the enlargement goods produced by the original EU member countries will remain imperfect substitutes of those produced in the new members; in other words, pork produced in Portugal or in Denmark will be perfect substitutes for each other, but, in the new enlarged market, Danish and Portuguese pork will be considered by the consumer a different product from pork produced in Poland or Hungary. However, since these goods are now produced within the same market and subject to the same rules and regulations, this hypothesis is hard to justify. Moreover, it can lead to serious distortions in the simulation results. It would be probably more reasonable to assume perfect substitutability after the enlargement between goods produced by old and new member countries, or, at least, to introduce a discernable change of the parameters of the model in this direction.

For models which take account of discriminatory trade policies through assuming imperfect substitutability between goods based on their country of origin³¹, the problem - as it has already been stated - is to evaluate whether such assumptions conform with reality, or are only introduced as a sleight of hand to get around limitations due to the non-spatial nature of the model. If there are sufficient reasons for claiming that the assumptions relating to differences in products based on their country of origin reflect the perceptions of consumers, or manufacturers in the case of intermediary goods, then the model, even if it is “non-spatial” can, indeed, be used to analyse discriminatory trade policies. If, on the contrary, this is not the case, then we are obliged to turn to a “genuinely” spatial model.

Finally, in general equilibrium models, the problem is often in the definition of countries/regions, which are usually more aggregated than is the case with other types of models; thus the difficulty to represent the countries which concede preferences, and those which benefit from them, coherently.

3.2 Modeling the 1994 GATT Agreement commitments

The signing of the “Agreement on Agriculture” in 1994 at the end of the Uruguay Round of the GATT entailed commitments in three distinct areas: those relating to (a) the reduction of domestic support, (b) increasing market access and (c) the reduction of subsidized exports.³²

Reduction in domestic support

The commitments to reduce domestic support have not so far created any problems to the EU and none are envisaged in the near future (INEA, 2000, Chapt. 3); hardly any country, and none of the most important ones has been forced to modify its policies as a result of having to satisfy the commitments undertaken, nor is there any danger of their having to do so in the foreseeable future. This is because the definition of the AMS (Aggregate Measurement of Support) adopted in the Agreement was quite generous (including the exemption from reduction obligations of policies included in the so called “blue box”) and also because many countries had already reduced “coupled” support to farmers in the years between those used as the “base period” for calculating the value of the AMS subject to the reduction commitments, and 1995.

This notwithstanding, there are models – for example, Anderson, Erwidodo and Ingco (1999) and Harrison, Rutherford and Tarr (1997) - which impose the 20% reduction commitment foreseen in the Agreement for the AMS to the per unit support enjoyed by producers as a result of domestic policy

³¹ For example, Haniotis, 1990; Swaminathan, Hertel and Brockmeier, 1997; Weyerbrock, 1998b and the simulations using GTAP.

³² For an accurate description of the content of the “Agreement on Agriculture” see Anania (1996) and Corazza (1997, chapter VIII).

interventions.³³ In this way not only is a reduction of support assumed which will not materialize, but (a) exemptions provided for in the Agreement are ignored (those which fall inside the “green” and “blue” boxes and those for which the *de minimis* clause can be invoked);³⁴ (b) they overlook the fact that the AMS is a measurement of *overall* support, not just support deriving from domestic policies, and its value changes when other GATT commitments are satisfied (Anania, 1997); and (c) no account is taken of the fact that when a 20% reduction in per unit “coupled” support is imposed, this determines also a reduction in the quantity of the good produced, and this will cause a reduction in the AMS which is greater than 20%. For all these reasons, a simulation model imposing a 20% reduction in the total support enjoyed by farmers will grossly overestimate the liberalization impact of the implementation of the domestic support commitments of the 1994 GATT Agreement.

Increasing market access

The GATT Agreement entails a commitment to reduce tariffs by 36% on average over six years (each tariff line had to be reduced by a minimum 15%) and the introduction of Tariff Rate Quotas (TRQs).

When, as often happens, tariff reduction commitments are modeled by reducing the maximum allowed in the base period (overlooking the fact that applied tariffs are often lower than the bound ones) the results overestimate the impact of the GATT Agreement in terms of reduction in market protection;³⁵ this is because a country which was already applying a tariff lower than the bound one at the time of implementation, would obviously not be required to modify it. A distortion in the same direction can also occur when the tariff reductions laid down are applied in the model to a “tariff equivalent” given by the per unit PSE (either the total PSE or its, “market price support” component) or by the observed difference between the domestic price and the *cif* border price; in fact, both “tariff equivalents” also reflect the distorting effects of policies other than tariffs, which are implicitly assumed to be subject to reduction commitments, when this, in fact, is not the case.³⁶

When setting up a model, the definition of the products is inevitably more aggregated than that used in the *schedules* to describe reduction commitments. In the majority of cases the 36% average reduction stipulated in the Agreement is modeled as a uniform reduction over all tariffs. Since most countries fulfilled their obligations for an overall 36% average reduction by reducing the lower tariffs, those applied on imports of the less “sensitive” products, by a higher percentage, and by reducing the higher tariffs, applied on imports of the more “sensitive” products, by a lower percentage, this way of modeling the commitment will lead to an overestimation of the expected reduction in protection as a result of the implementation of this component of the GATT “Agreement on Agriculture” (Bureau, Fulponi and Salvatici, 2000).

Using MEGABARE, a general equilibrium model developed at ABARE (Australian Bureau of Agricultural and Resources Economics), Mai et al. (1996) simulate the effects of the 1994 GATT Agreement. However, they do not impose any reduction on the tariff equivalents used, judging the “tariffication” of non-tariff barriers and tariff reductions laid down in the Agreement totally ineffective from the point of view of their capacity to bring about a reduction in border protection.

³³ Roberts et al. (1999) impose a 36% reduction in the “level” of domestic policy instruments used to support producers.

³⁴ In most cases when this occurs it is because of the structure of the model itself (or the information base used) which does not allow us to unravel the support deriving from the various domestic policy instruments which are “treated” differently in the GATT Agreement (those falling in the “green”, “blue” and “amber” boxes).

³⁵ This is the case, for example, with SPEL-TRADE and the FAO’s WFM. Anania (1999, 2001); Bach, Frandsen and Jensen (2000); Hertel et al. (1997, 1999); and Weyerbrock (1998a), among others, avoid this problem by using the tariffs applied when these were lower than the maximum indicated in the *schedules* attached to the 1994 Agreement.

³⁶ The most obvious example are the many non-tariff barriers which, for one reason or another, have not been subject to “tariffication”.

Josling and Rae (1999) simulate the possible outcomes of the current WTO negotiations as regards market access, hypothesizing four scenarios: the universal abolition of tariffs on cereals and oilseeds (the “zero for zero” approach); a uniform 36% reduction of all tariffs; a tariff reduction based on the “Swiss formula”, which entails a more marked reduction for higher tariffs; and a reduction based on a different approach from the “Swiss formula”, but also involving more sizeable reductions for the higher tariffs.

An additional problem is that of modeling a multilateral tariff reduction in the presence of preferential trade policies. The omission of trade preferences in the models leads to an overestimation of the effects of a reduction of the tariffs applied on a “most favored nation” basis. Moreover, it also leads to a distorted assessment of the effects of the trade liberalization in terms of the distribution of its costs and benefits among countries; in particular, there will be an overestimation of the benefits for countries which prior the Agreement enjoyed preferential treatment, and, similarly, an underestimation of the benefits for countries which were penalized by the trade preferences (Anania, 1989). This problem can only be dealt with adequately by simulations which are able to reproduce bilateral trade flows and the specific effects of policies on the differences in equilibrium prices in each pair of countries. “Spatial” models have the capability to do this but, as we have seen, it can also be undertaken by models which assume imperfect substitutability between products based on their country of origin (in this case, of course, the model must be able to take into account the relevant differences between a good produced in one country and a similar product from *each* of the others). Even the model developed few years ago by UNCTAD (Brown and Richards, 1990; Brown, 1992) and the FAO’s WFM, which both have an “institutional” role in evaluating the implications of the Uruguay Round devoting special attention to the effects on developing countries, are not able to fully account for the existence of trade preferences because of their structure. The FAO itself, moreover, reckons that the Uruguay Round could bring about a 34% drop in benefits arising from trade preferences in agriculture for developing countries (Yamazaki, 1996).

The TRQs (*Tariff Reduced Quotas*) stipulated in the Agreement are particularly relevant for certain sectors (meat and dairy, for example) and countries (the European Union is certainly one). Despite this, there have been contributions focusing on the implications of the Agreement which completely overlook them, even when - as in the case of Mechemache and Réquillart (1999, 2000) - attention is focused on dairy products and the EU. Any adequate modeling of these quotas must take into account the possibility of switching from one tariff (lower) to another (higher), the former applied to imports within the quota, the latter applied to additional imports once the quota has been filled. Furthermore, if imports are in excess of the quota, the existence of the latter becomes irrelevant except for the rents associated to the imports within the quota. Moreover, the model needs to account for the possibility that each country which has access to a TRQ may import and export at the same time, even in the case where product homogeneity is assumed; this is essential because very often, as in the case of the EU, the country which has assumed the obligation to introduce a tariff reduced quota is a net exporter of the product in question (as a result of its policies). The existence of intra-industry trade, that is a country importing and exporting a given good at the same time, in the case of homogeneous products can be fully accounted for only in “spatial” models. Unfortunately, most models, including the large scale partial equilibrium ones, are “non-spatial”. When the model is only able to simulate the net trade position of each country, it is not possible to evaluate the use of a TRQ by a country which is a net exporter. This is the case with SWOPSIM, SPEL-TRADE, WATSIM, FAPRI’s model and with CAPMAT, to name but a few. The WFM, even hypothesizing that goods are perfectly homogeneous, introduces exogenously the possibility that a net exporter can also be an importer of the same good by tying imports to domestic consumption.

Larivière and Meilke (1999) use a “non-spatial” model to study the effects of a reduction of subsidized exports and the introduction of TRQs. The procedure is based first on calculating the price, for each country, which makes its net trade position compatible with the GATT imposed restriction on the volume of subsidized exports and the TRQs (i.e. such that exports equal the maximum subsidized exports

allowed, minus the volume of the quota), then solving the model again imposing a constraint on the prices. This procedure, however, does not seem to be able to adequately reproduce either of the two commitments considered. In fact, actual imports of the good within the quota depend on the domestic price and the in-quota tariff, while subsidized exports depend on the domestic price and the per unit export subsidy. The modeling procedure adopted implies that if subsidized exports are equal to the maximum allowed, then imports must equal the quota; if, instead, these do not reach the maximum, the quota may not be used at all, if it is not profitable at the equilibrium price. The problem of representing reduced tariff quotas in models is discussed by Meilke and Larivière (1999), who also propose a procedure for modeling TRQs for dairy products. Cox et al. (1999); Zhu, Cox and Chavas (1999); and Anania (1999, 2001) – all using partial equilibrium “spatial” models of the type first introduced by Takayama and Judge (1971)- propose explicit representations of TRQs trying to reproduce their actual implementation as stipulated in the Agreement.

In some cases the representation of TRQs in the model is carried out by assuming that net exporters import a quantity equal to the tariff reduced quota. Among others, this is the case with AGLINK, FAPRI’s models, the FAO’s WFM and with François, McDonald and Nordstrom (1995, p. A5). Yet, this choice is neither coherent with the text of the Agreement (which stipulates the undertaking to *allow*, if profitable at the reduced tariff, imports up to volume of the TRQ, not to import a quantity equal to the quota), nor with what has actually happened in the years since the implementation of the Agreement (for many TRQs imports have remained well below the volume of the quota).

To introduce a minimum constraint on a bilateral trade flow (rather than impose an equality constraint) in a general equilibrium model leads to later computational complications. A procedure for modeling TRQs in GTAP was proposed by Bach and Pearson (1996). Elbehri et al. (1999) modify version 4 of GTAP to simulate the effects of alternative hypotheses on trade liberalization which include (a) a tariff reduction on imports within the TRQs, (b) an increase in the volume of TRQs, and (c) both at the same time.³⁷

Many TRQs indicate explicitly the exporting country or countries quotas are allocated to; in this case too, the modeling of this important aspect of the GATT commitments can take place only if the model is “spatial” (or if it assumes imperfect substitutability between imports depending on their country of origin).

Reduction of subsidized exports

The undertakings on reducing subsidized exports are, possibly with the TRQs, the component of the 1994 “Agreement on Agriculture” that has had most effect; these stipulate a 36% reduction in export subsidy expenditure and a 21% reduction in the volume of subsidized exports over a period of six years.

In many models such undertakings are represented by imposing a 36% reduction on per unit export subsidies. In general, however, this does not guarantee a minimum 21% reduction in the volume of subsidized exports. What happened, in fact, in the first few years of implementation suggests rather the opposite: much more often it has been the commitment on the reduction of subsidized exports which was binding, and not that on the export subsidy expenditure; similar indications, moreover, emerge from simulations in which both restrictions related to subsidized exports are represented explicitly and independently. Anania (1999, 2001) and Bach, Frandsen and Jensen (2000) find that the EU undertakings on the volume of subsidized exports for cereals, and for two product aggregations out of four, respectively, have been binding (as regards the other two aggregations it is the commitment on the subsidy expenditure which has been binding). This means that to model the two undertakings as a 36% reduction of the per unit export subsidies can lead to an underestimation of the expected reduction of subsidized exports as a result

³⁷ For the procedure used for modeling TRQs, rather than the work of Bach and Pearson (1996), they refer to another “GTAP technical paper” (Elbehri and Pearson, 2000).

of the implementation of the Agreement. A 36% reduction of the per unit export subsidies is assumed, among others, by Anderson, Erwidodo and Ingco (1999); Hertel, Brockmeier and Swaminathan (1997); and Swaminathan, Hertel and Brockmeier (1997). Harrison, Rutherford and Tarr (1997) apply reductions of 24 and 36%, those stipulated in the Agreement for export subsidy expenditure, to *ad valorem* per unit export subsidies in developing and developed countries respectively.

Hertel et al. (1999) simulate the effects of a hypothetical outcome of the on-going WTO negotiation with a 40% reduction in the “wedge” between border and domestic prices, assuming that such a reduction, operating uniformly over all products and countries, may represent a possible outcome of the negotiation with respect to liberalizing various instruments of border protection (tariff reductions, increase in TRQs, in-quota tariff reductions, removal of non-tariff barriers still in force, reductions in subsidized exports, and so on)³⁸. This choice, however, leaves us in the dark as to the specific elements of a concrete agreement that would lead to such a uniform reduction of that amount of the “tariff equivalents” (an agreement which, in principle, might not even exist).

In an ABARE study (Roberts et al., 1999), which uses a model based on GTAP, the implementation of the Uruguay Round is represented by a 36% reduction not only of tariffs but also of domestic support and export subsidies (Roberts et al., 1999, p.37). The motive for this choice is to be able to model an evenly distributed support reduction applied to all support policy instruments. It hardly needs to be said that this is quite different from what was stipulated in the Agreement; it is also highly unlikely that such a choice could adequately represent a *uniform* reduction in support across the board: what it does represent is a 36% reduction in support policy instruments, which is not the same thing. In addition it assumes : (a) the imposition of a reduction in domestic support deriving from policy instruments which are not subject to any restrictions in the GATT Agreement, (b) a greater reduction than the one stipulated (20%) for domestic support resulting from the use of policy instruments which are subject to reduction commitments (assuming that the agreed undertakings become binding, which, as said before, is highly unlikely), (c) an underestimation of the expected reduction of subsidized exports, and (d) a probable overestimation of the reduction in border protection (even if the modeling ignores the existence of TRQs).

Although commitments on export subsidy reductions for dairy products have created most problems for the EU (INEA, 2000, Chapt. 3), Fuller et al. (1999) study the implications of the 1999 CAP reform and the enlargement of the EU to the Czech Republic, Poland and Hungary, ignoring their existence (along with the other commitments deriving from the Agreement). This choice is justified by the consideration that the actual EU member states and the three new members are “natural exporters” of dairy products (p. 121).

Other models impose an explicit restriction on the volume of subsidized exports though frequently as a restriction on exports *tout court*; by so doing they implicitly introduce the assumption that there cannot be unsubsidized exports once the commitment on the volume of subsidized exports becomes binding. This is the case, for example, with SPEL-TRADE; FAPRI-GOLD; WATSIM; and Mai et al. (1996). To allow unsubsidized exports once the commitment on the volume of subsidized exports becomes binding is particularly pertinent in the case of the EU, by far the largest user of export subsidies in agricultural trade, where in recent years there has been an increase in unsubsidized exports of dairy products, poultry and fruit and vegetables once the limit for subsidized exports has been reached.

An explicit modeling of both constraints - that on the volume of subsidized exports and that on spending on export subsidies - is found in Anania (1999, 2001); Bach, Frandsen and Jensen (2000); Cox et al. (1999); and Zhu, Cox and Chavas (1999).

³⁸ A similar approach is taken by Nguyen, Perroni and Wigle (1993) to model the reduction in border protection laid down in the Draft Final Act of the Uruguay Round; in this case, however, agricultural goods and food products are aggregated into a single product, which reduces the distorting implications of the (implicit) assumptions needed to justify their choice.

In most cases it is not entirely clear how a model determines the market equilibrium when commitments become binding. From this point of view the modeling of government market withdrawals (“intervention”, in the CAP jargon) and both private and public stock changes, become crucial.

In most models, the net trade position of each country is given by the difference between domestic production and consumption (both modeled explicitly) at equilibrium prices, completely ignoring stock reactions to price variations. In some models this approach is justified by invoking the fact that the aim is to produce medium term simulations, a temporal horizon which renders stock variations insignificant (because over time their value, on average, must be equal to zero). If the omission to model stocks may well lead to difficulties, it becomes particularly problematic in the case of modeling EU policies, because of the increased importance in recent years of “intervention” (and consequent stock management) in markets where GATT commitments were binding, including meat and dairy products.³⁹ There are some exceptions to this rule among the larger models; for instance ECAM, which assumes that a certain percentage of goods acquired through “intervention” ends up in community stocks and that the remaining part is sold abroad using export subsidies; AGLINK endogenously determines the volume of EU “intervention” stocks in products such as grain and beef, while stocks of other products, for example dairy products, are treated exogenously; and FAPRI. Stock changes are also determined endogenously in the models presented in Anania (1999, 2001); Anderson and Tyers (1991, 1992); Cox et al.(1999); Tyers and Anderson (1992); Tyers (1994); and Zhu, Cox and Chavas (1999).

The failure to carry out an endogenous determination of the quantity of products withdrawn from the market makes it impossible to consider the eventuality that, as has occurred in the EU in recent years with coarse grains and dairy products, when one of the export subsidy commitments becomes binding the excess supply puts downward pressure on the domestic price leading to a significant increase of government withdrawals (where they exist and the minimum guaranteed price is high enough to come into play).

The application of CAPMAT to simulate the effects of the CAP reform decisions taken in Berlin in 1999 (European Commission, 2000, Chapt. 4), assumes that stocks do not change and places no constraint on the volume of subsidized exports or on the export subsidy expenditure, which, therefore, can exceed the maximum allowed under the Agreement. However, the application of the same model to study the effects of the reform proposals in 1997 by the Commission (European Commission, 1998, Chpt. 5) presents more useful and interesting simulations. In this application, in fact, two extreme scenarios are considered when GATT restrictions on subsidized exports are violated in the equilibrium obtained by searching for an unconstrained solution: in the first scenario the excess supply that cannot be exported with subsidies is withdrawn from the market; in the second, an increase in the compulsory set aside rate ensures a reduction in supply bringing production into line with the maximum subsidized exports allowed.

In SPEL-TRADE if the restriction on the volume of subsidized exports is not satisfied in the simulation, domestic production is reduced (but not the price, which is exogenous) so as to bring subsidized exports into line with the maximum allowed (Henrichsmeyer et al., 1995, p. 80). In this way, an implicit assumption is made that the only adjustment instruments used to guarantee compatibility between the CAP and the GATT Agreement commitments are those which directly control output, such as the set aside rate and production quotas.

AGLINK models market equilibrium and GATT commitments on subsidized cereal exports by using a deterministic procedure, which involves “intervention” and the possible occurrence of unsubsidized exports; this procedure is based on the comparison of the domestic price with the “intervention” price and

³⁹ The existence of “intervention” withdrawals in the EU is ignored in the work of Bach, Frandsen and Jensen (2000) as well, which proposes itself as an accurate modeling of the CAP. Moreover, it is hard to justify the choice of representing the Agenda 2000 CAP reform proposal by the Commission with regard to a reduction in “intervention” prices through a reduction in the “margin” between the domestic and world market prices.

with the international market price. For certain products, such as wheat and feed grains, AGLINK foresees the possibility for unsubsidized exports to occur when the commitment on subsidized exports becomes binding if the comparison between the domestic and the international price makes this profitable.

The FAPRI models allow for the existence of exports exceeding the GATT restrictions only when the domestic price equals the international price, that is (because of the way export subsidies are endogenously determined) when all exports are unsubsidized.

The approach utilized in the WFM (Sharma, Konandreas and Greenfield, 1996), instead, is to intervene exogenously for the countries which subsidize their exports, modifying the parameters of the model (yields, land allocations, etc.) to ensure that exports do not exceed the GATT commitment. In the case of countries where it is assumed that some unsubsidized exports can take place, on the other hand, exports are free to exceed the maximum allowed under the GATT Agreement, but their competitiveness is reduced by exogenously modifying the “factor” which represents the effect of the existence of export subsidies in the equation which describes the “linkage” between the domestic and world market price. No restriction, however, is imposed on the export subsidy expenditure.

Finally, a different approach to the same problem is to use a model to determine which policy changes would be needed in order to make a country satisfy the commitments undertaken with the GATT Agreement. Poonyth et al. (2000) make use of an econometric partial equilibrium model to simulate the variations in production quotas and/or “intervention” prices needed to enable the EU to satisfy its commitments in the area of subsidized sugar exports. A similar approach is used by Weyerbrock (1998a).

4. Conclusions

The growth of the international trade in agricultural goods and the Uruguay Round GATT negotiations on agriculture have considerably heightened awareness both of the importance of the international dimension in the functioning of agricultural markets and of the need to develop models to reproduce the linkages between this dimension and agricultural and trade policies.

With the increasing flows of goods between countries, it becomes inevitable that the effects of policy changes in one country are felt across the border in other countries. The differences in the results of the policy evaluations which take the international dimension into account, and those which ignore it are widening all the time. Moreover, international negotiations, be they multilateral, regional or bilateral, have led to explicit demands by policy makers for answers to the kind of question, “*What would happen if...?*”

This new and ever growing demand for information led to numerous efforts in the 1990s to improve modeling of international agricultural markets and their linkages with domestic policies in order to come to a better understanding of the international dimension in agricultural policy making and the implications of the commitments deriving from the 1994 GATT Agreement.

This chapter has tried to provide an overview of the efforts to model agricultural international markets and domestic and trade policies in order to come to a better understanding of the international dimension in agricultural policy making and of the implications of the commitments introduced by the 1994 GATT Agreement; the differences between the various classes of models used have been discussed along with their strengths and weaknesses. The final picture that has emerged leaves much to be desired. Despite all the efforts over recent years, alongside models which give us accurate representations of markets and policies, there are many others, including some of those used by institutions playing an important role in policy making, which are clearly not up to the tasks they have been assigned.

It is by no means easy (and, probably, pointless) to try to draw a dividing line between the “good” models and the unsatisfactory ones: if certain models appear to do a good job in providing answers to the questions they are posed, there are others which are utilized to produce answers both to questions for

which they are structurally well equipped, and to questions which they should never had been asked. One of the main reasons why so many models are less than satisfactory is that they were built a number of years ago for a specific purpose - often to forecast medium term market trends - and were then adapted for another without any significant modification of their structure. The problem, then, is that many models are “a priori” structurally unfit to address the kind of agricultural policy issues they are asked to deal with.

For example, there are models, even among the large scale ones, that treat countries of the size (in trade terms) of the EU as “small”, that is to say they simulate the effects of changes in the CAP on the assumption that they do not influence prices on the world market. This happens even for some of the models used by the Directorate General for Agriculture of the European Commission, for example with SPEL/EU-MFSS, CAPMAT and ECAM. The same is true for CEASIM which is used to analyze the enlargement of the EU to Central and Eastern European countries. It seems difficult to justify the use of such models to simulate changes in agricultural policies - not just trade policies - unless the models in question are used in conjunction, and in an integrated manner, with others which are able to determine variations in the “international context”, which is considered exogenous.

Most models, rather than representing policy instruments explicitly, one by one, “reproducing” the mechanisms of their actual functioning, simplify the modeling by utilizing “synthetic” representations. This is done by exogenously introducing a “wedge” - often given by the PSE - between the domestic price and the international price in order to represent, jointly, the effects of all the policies, trade and others, which determine a difference between the two prices. The result is a model which is incapable of simulating changes in single policy instruments or the introduction of new ones. This approach, moreover, makes it impossible to separate the effects of domestic and trade policies, with the result that their ability to simulate alternative scenarios emerging from the current multilateral negotiations is very limited. Unless one wants to limit the investigation to scenarios which envisage a complete liberalization, it is difficult to imagine how a model which uses a “synthetic” representations of the main policy instruments, both those governing domestic and trade policy, can really provide an adequate simulation of the effects of policy changes including those induced by the restrictions deriving from multilateral agreements.

Not being “spatial”, most models are structurally incapable of simulating the effects of “discriminatory” trade policies, such as preferential trade policies, the creation of a customs union or the enlargement of an existing one. That said, “non-spatial” models are used to predict the effects of discriminatory trade policies -including the enlargement of the EU to CEECs - by using the *escamotage* of assuming imperfect substitution according to the country of origin of the product. In all cases where discriminatory trade policies cannot be ignored - either because they are themselves the focus of the simulation, or because they are relevant for the markets considered - the model ought to be a genuinely “spatial” model, i.e. its structure ought to be able to reproduce trade flows between each pair of countries without having to resort to additional, often dubious, hypotheses.

In the case of simulations aiming to assess the implications of the creation of a customs union, or the enlargement of an existing one, considering the multi-sectoral nature of the policy change and likely size of the shock which will result, the use of general equilibrium models seems the most appropriate.

The agricultural negotiations in the Uruguay Round gave birth to a flurry of studies devoted to assessing its likely effects; some of these took great care in modeling the commitments, while others were less satisfactory. Despite the widespread consensus that the stipulated commitments on domestic support will be totally ineffective, there are still a few models which impose a 20% reduction in support to producers; in this way, they grossly overestimate the short term liberalizing impact of the Agreement. In many cases tariff reduction is represented without taking on board the fact in 1995 many countries were already applying tariffs which were much lower than the bound ones at the end of the implementation period of the GATT Agreement; once again the consequence of this is to inflate the trade liberalizing effect of the Agreement. Many models are structurally unable to simulate the existence of intra-industry trade; as

a result they cannot model the existence of TRQs for net exporting countries. These quotas are in some cases simply ignored or, more often, represented by assuming, implicitly or explicitly, that they are fully utilized, which is very far from what we can observe. Restrictions on subsidized exports and export subsidy expenditure are often represented through a reduction in per unit export subsidies or by imposing a restriction on exports *tout court*. In the first instance, what are being represented are not the commitments stipulated with the Agreement, but something else; in the second, only one constraint is being represented, excluding, in addition, the possibility of unsubsidized exports occurring once the quota has been filled, which is quite at variance with what has actually happened. Many of the models are not able to simulate what takes place when commitments on exports subsidies become binding and how market equilibrium is reached: will there be unsubsidized exports if it is economically viable? as regards the excess supply which cannot be exported with subsidies and which remains in the domestic market, by how much will it drive down the domestic price and what effect will this have on government market withdrawals?

Besides the models which are reliable both on account of their structure and for the quality of the data they use, there are others, for one reason or another, with a large question mark over their ability to supply adequate answers on the effects of the changes in domestic and trade agricultural policies. The overall picture which emerges of the quality and reliability of the models used in recent years to simulate the effects of domestic and trade agricultural policy changes as a result of the Uruguay Round remains somewhat bleak; caution is needed, even with simulations which are the result of considerable investment, both in terms of financial and human resources, by organizations and academic institutions of great prestige.

Yet it would be wrong to extend this negative assessment to the “state of the art” in modeling agricultural trade policies and GATT commitments and conclude that most efforts are doomed to yield poor and unreliable answers. For every one of the problems underlined an effective solution already exists; the answer, rather, is “simply” to put to good use what is already available. It goes without saying that there is room for improvement. The most important thing is that greater care and attention must be paid in tailoring models to answer the specific questions addressed, and abandoning once for all the claim that, once it has been set up, a model can be used to simulate any change in the policy scenario whatsoever.

As regards what would be opportune in order to have a supply of more effective simulation models to support policy makers in need of reliable assessments of trade policy changes and the outcome of international agreements, there are five conclusions which can be drawn.

The *first* stems from the consideration that one cannot expect that a model constructed for a specific purpose can be slightly modified and then used to provide adequate answers to any other policy question: it is necessary, therefore, to devote much greater attention than has hitherto been the case to the coherence between the structure and the specific features of the model and the questions addressed. To put it plainly: a “non-spatial” model cannot (nor should it ever be) used to evaluate the effects of the creation of a free trade area of the Americas or the enlargement of the EU to Eastern and Central European countries. If, for example, the question at issue is to simulate the effects of a reform of the trade components of the CAP or the hypothetical outcomes of the current WTO negotiations, a multi-product, multi-country partial equilibrium model may very likely be suitable. In fact, even if it is not able to capture the effects of policy changes on the economic system as a whole, it is, nevertheless, generally true that it allows us a much better level of detail in its description of policies and behaviors of market agents than is possible with other types of models. The model, however, ought to describe the most important policy instruments used explicitly, one by one, in order to allow researchers to simulate variations in the use of each of the instruments or of one of the GATT commitments (a change in a bound tariff, a TRQ, a constraint on subsidized exports, and so on). If, on the other hand, the goal of the simulation is to study the effects of the enlargement of the EU, it must be reiterated that this should be carried out with a genuinely “spatial” general equilibrium model, which is capable of simulating both the direct market effects in the new member countries, and the indirect

macroeconomic feed back from these effects on agricultural markets in all countries in terms of variations in the demand for agricultural products and the allocation of resources.

The *second* consideration follows from the first, and is related to the need to integrate the utilization of different kinds of models. Instead of trying to adapt a model to get it to do things it is not designed for, it would be far more useful to use different models jointly, getting each one to reproduce part of the mechanism which will yield the final result, by exploiting its specific strengths. Let us look at a concrete example: in the case in which the goal were to simulate the effects of the EU enlargement to CEECs, if it were not possible to use a “spatial” general equilibrium model, joint use could be made of a “spatial” multi-country, multi-product partial equilibrium model and a number of single country general equilibrium models. The first could represent (usually better than a general equilibrium model) markets and sector specific policies; the others could use the results from the first to simulate the effects of the policy changes on the most important macro-economic variables of the countries concerned, relaying these back to the first model to refine the original simulation, in a (hopefully, convergent) recursive procedure. The final outcome, therefore, would be the result of an interactive process combining the workings of different kinds of models.

It should be pointed out that recent efforts have been made in this direction: van Tongeren, van Meijl and Veenendaal (2000) used two different kinds of general equilibrium models jointly; Munch (2000) and Munch and Banse (1999) made combined use of a partial equilibrium model and a number of single country general equilibrium models. Two interesting integrations between different types of models were recently carried out within the framework of the CAPRI and EUROTOOLS European projects⁴⁰: the CAPRI Project (Heckeley and Britz, 1999) produced a model in which roughly 200 mathematical programming regional models, which simulate aggregate decisions at the level of individual farms, were employed using prices generated by a spatial equilibrium model (derived from WATSIM), which, based on the results from the first models, calculated the equilibrium price in each country; a roughly similar approach was adopted by the EUROTOOLS Project (2000) where University of Reading’s Land Use Allocation Model (LUAM) was extended to the European Union and expanded in order to determine consumption, prices and the net trade position of each country endogenously. Finally, Serrão (1998) vertically integrated an econometric model (evaluating the effects of the CAP reform on different sectors) and an input-output model, using the results obtained relating to land allocations and input uses to calculate indicators of the environmental impact of the CAP reform.

The *third* issue concerns the need to carry on research into how to make the models simulate market and trade policy mechanisms more effectively. To this end three main research priorities should be pursued: (i) make partial equilibrium models (different from those based on the Takayama and Judge (1971) approach) and general equilibrium models genuinely “spatial”; (ii) improve the realism and detail of the representation of the different policy instruments used by the CAP – both the traditional ones (such as production quotas, “intervention” or import tariffs) and the relatively new ones (such as direct “compensatory” payments, modeling not only their partially decoupled nature, but their implications for yields and production technologies) - explicitly modeling each of them individually; and (iii) improve the accuracy of the representation of the commitments introduced with the 1994 GATT Agreement, with reference, above all else, to TRQs and restrictions on subsidized exports.

The *fourth* point is the need for a more effective coordination and greater cooperation between modeling efforts, through joint projects and the sharing of information on models and data bases. The only way forward is for different organizations in different countries to come together and cooperate, each one with their own specific responsibility - building or “maintaining” a specific component (such as a country module, or the design of the representation of a given policy instrument) of a large scale model – under a

⁴⁰ See Arfini, in this book.

strong central coordination. Over the last few years the most interesting examples of cooperation in the area of agricultural policy modeling are those connected with AGLINK and GTAP. However, AGLINK's limitations due to its institutional role are well known: the non transferability of models to anybody but the member countries; the fragmentation of the documentation and the difficulties to access it; the "validation" process its results are subject to, through an assessment by each of the member countries. GTAP is an example of a successful project of the kind one would wish to see copied for other types of models. The key to its success appears to be, apart from the talent and dedication of the researchers at Purdue over the years, the continuous improvements to the model and its data base, and the effective efforts to transfer project results to potential users - in terms of start-up as well catch-up training initiatives, easy access to the model, to its documentation, and to the data base.

The *fifth* need is a strategic one, that for clear improvements in accessibility to reliable data bases, which supply information needed to model both market agents' behaviors and policies. No matter how well designed the model may be, the quality of the results will always depend on the quality of the data; with reference to this, there is still much to be done both as regards availability of reliable data on behavioral parameters (typically elasticities) and on the availability of the information needed to model policies accurately. From this point of view, the Agricultural Market Access Database (AMAD)⁴¹ and GTAP's data base are two good examples to follow for the way they provide relatively easy access to extensive data bases, including very much needed full documentation.

In conclusion, there is no shortage of work left to do, but anyone who, having read this paper, concludes that the situation of the "state of the art" in modeling agricultural trade and trade policies is quite far away from what one would need to be able to comfortably look at the results of the simulations is quite mistaken. On the contrary, a great many of the possible solutions to the outstanding problems are already available: it is "merely" a question of using them. Besides, there have been in recent years several developments along the lines indicated. Thus, as far as the future of modeling international agricultural markets and trade policies is concerned, we can look forward with reasonable, yet cautious, optimism.

⁴¹ AMAD (<http://www.amad.org>) is the result of a joint effort by Agriculture and Agri-food Canada, the EU Commission, OECD, UNCTAD, FAO and USDA to make freely available a data base containing tariffs on agricultural products, both those bound under the GATT Agreement and those actually applied, information on tariff reduced import quotas introduced by the same Agreement (volumes, in-quota tariffs, actual imports within the quotas etc.) and also some basic data on international trade and production and consumption in agro-food products in different countries.

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