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# **Modeling Agricultural Trade Liberalization. A review.**

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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. The main aim of the paper 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 reached is that the efforts to model agricultural trade and trade policies, taken as a whole, are not fully satisfactory. Although several models offer accurate representations of international agricultural markets and trade policies, many others, including several developed and used by governments and relevant multilateral institutions, are structurally incapable of providing reliable answers to some of the policy questions they are asked to address. The final part of the paper identifies priorities for actions to be taken for improving modeling of trade policies and WTO commitments.

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## **Modeling Agricultural Trade Liberalization. A review.**

The paper presents a selective review of the models which, since 1990, have been used to evaluate the effects of a multilateral or a regional agricultural trade liberalization. The review of the literature is somewhat biased toward contributions which did not focus on a specific country, or, if they did, it was on the European Union (EU). Comparative strengths and weaknesses of the different models<sup>1</sup> are assessed looking at them from the point of view of their effectiveness in representing trade policies and the commitments dictated by the 1994 GATT “Agreement on Agriculture”. The paper is eventually addressing questions like: among the models proposed to assess the effects on agriculture of the Uruguay Round, which best represent the commitments of the “Agreement on Agriculture”? Which are the best models for simulating the effects of a regional liberalization? What are the implications of a specific model’s assumptions and modeling choices for the results it yields?

The paper aims to provide a “guided tour” through the large body of literature covering those contributions which first, while the negotiations were still in progress, tried to simulate the alternative hypotheses regarding possible outcomes of a final agreement; second, when the negotiations had been concluded, tried to assess the expected consequences of its implementation; and third, today, simulates the effects of alternative hypothetical outcomes of the on-going WTO agricultural negotiations.

Most of the paper discusses the advantages and disadvantages of different models in representing the most frequently used trade policy instruments and the commitments deriving from the “Agreement on Agriculture” reached at the end of the Uruguay Round. The final section gives a round up of the main results

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<sup>1</sup> An excellent introduction to the different types of most frequently used models is found in Francois and Reinert. Reviews of agricultural trade policy modeling efforts include Thompson (dated 1981 and still useful); Francois, McDonald and Nordstrom (1996); Francois and Rombout; Meilke, McClatchy and de Gorter; Pohl Nielsen and Staehr; van Tongeren and van Meijl; van Tongeren et al. (2000).

and offers a discussion of priorities to be addressed for a better modeling of WTO commitments and agricultural trade policies.

### **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.

#### *Reduction in domestic support*

The commitments to reduce domestic support have not so far created any problems and none are envisaged in the future; hardly any country, and not a single one of the most important ones has been forced to modify its policies as a result of having to satisfy the commitments undertaken. 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 and Harrison, Rutherford and Tarr - 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 interventions.<sup>2</sup> 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);<sup>3</sup> (b) they overlook the fact that the AMS is a measurement of *overall* support, not just

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<sup>2</sup> Roberts et al. impose a 36% reduction in the “level” of domestic policy instruments used to support producers.

<sup>3</sup> 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 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).

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;<sup>4</sup> this is because a country which was already applying a tariff lower than the bound one at the time of implementation of the Agreement, 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.<sup>5</sup>

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<sup>4</sup>This is the case, for example, with SPEL-TRADE and the FAO’s WFM. Anania (2001); Bach, Frandsen and Jensen; Hertel et al. (1999); and Weyerbrock (1998a), among the 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.

<sup>5</sup> The most obvious example are the many non-tariff barriers which, for one reason or another, have not been subject to “tariffication”.

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).

Using MEGABARE, a general equilibrium model developed at ABARE (Australian Bureau of Agricultural and Resources Economics), Mai et al. 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.

Josling and Rae 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 an approach different 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). Even the model developed few years ago by UNCTAD (Brown and Richards; Brown) and the FAO's WFM (*World Food Model*)<sup>6</sup> (FAO, 1998), 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).

Modeling preferential tariffs - and, more in general, discriminatory trade policies - 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" model<sup>7</sup>. 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 which, as ESIM, have been constructed with the specific objective of evaluating a typical discriminatory trade policy such as the EU enlargement to Central and Eastern European countries.<sup>8</sup>

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<sup>6</sup> Assessments of the "Agreement on Agriculture" using the WFM include FAO (1995); Greenfield, de Nigris and Konandreas; and Sharma, Konandreas and Greenfield (1996, 1997, 1999).

<sup>7</sup> "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 policies. "Non spatial" models, on the other hand, are unable to determine bilateral trade flows, or take into account 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 of the country.

<sup>8</sup> Munch and Munch and Banse, in an attempt to overcome the limitations of ESIM, utilized it in conjunction with general equilibrium models of each of the 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.

Using a non-spatial econometric model, Devadoss and Kropf 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 (*Global Trade Analysis Project*) (Hertel), 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 (Hertel, p. 41).<sup>9</sup> Unfortunately, the current version of the model and its data base do not appear capable of adequately modeling preferential trade policies. If it is true that the model considers different tariffs (and export subsidies) depending on the country of origin (destination) of the imports (exports), but 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 tariffs applied by a country on imports from 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 country (Gehlhar et al.).<sup>10</sup> 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 means that in the case of GTAP discriminatory tariff policies are

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<sup>9</sup> Many contributions analysing the effects of multilateral or regional trade liberalizations are based on GTAP and its data base, including Anderson et al. (1997); Anderson, Erwidodo and Ingco; Bach et al. (2000); Bach, Frandsen and Jensen; Diao, Somwaru and Raney; Elbehri et al.; Francois ; Francois, McDonald and Nordstrom (1995); Gehlhar; Harrison, Rutherford and Tarr; Herok and Lotze; Hertel, Brockmeier and Swaminathan; Hertel et al. (1999); Josling and Rae; Liapis and Tsigas; Mac Laren; Roberts et al. (1999, chap. 2); and Swaminathan, Hertel and Brockmeier.

<sup>10</sup> In the case of agricultural products “equivalent tariffs” are used instead of tariffs; these are drawn from the data bank which forms the base on which PSEs are calculated.



assumed even when they do not exist, while where they do, indeed, exist, they are ignored, as the tariffs utilized to calculate that applied on a specific bilateral trade flow are those applied on a “most favored nation” basis.

For all the models which, like GTAP, albeit “non-spatial” in nature, are used to represent discriminatory trade policies based on the assumption of imperfect substitutability in consumption of goods according to their country of origin, simulations are based on an assumption 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) in the best of cases this happens eliminating barriers to trade and export subsidies between the new member countries and the EU, and bringing domestic and trade policies of the new members into line with the policies of the EU. This implies 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 induce 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 discernible change in this direction of the parameters of the model.

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. 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 FAPRI (Devadoss et al., 1989, 1993)<sup>11</sup>, SPEL-TRADE (Henrichsmeyer et al.), SWOPSIM (Roningén; Roningén, Sullivan and Dixit)<sup>12</sup>, WATSIM (vonLampe, 1998, 1999, 2001) or WFM of the FAO.

Although AGLINK (OECD, 1998b) 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 goods 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).

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<sup>11</sup> Contribution using FAPRI to evaluate, first, the effects of alternative hypotheses regarding the outcome of the GATT negotiations and, later, of the 1994 Agreement itself include CARD (1991a, 1991b, 1992); and Helmar, Smith and Meyers (1994, 1995).

<sup>12</sup> Applications of SWOPSIM include Ames, Gunter and Davis; Andrews et al. (1990); Andrews, Roberts and Hester; Roningén and Dixit; Hartmann and Schmitz; Makki, Tweeten and Gleckler; and Vanzetti et al.. Peterson, Hertel and Stout offer a critical review of SWOPSIM, which is seen as representative of reduced form static models based on supply and demand functions.

Following the approach introduced by Armington, general equilibrium models frequently assume imperfect substitution of goods produced in different countries. Amongst others, this is the case of Fehr and Wiegard; Francois, McDonald and Nordstrom (1995); Weyerbrock (1998a, 1998b); van der Mensbrugghe and Guerrero; and, as already mentioned, GTAP. Imperfect substitution in consumption between domestic and imported products is also assumed in Sadoulet and de Janvry. 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, and Leetma, Krissoff and Hartmann.

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 outside 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. It is true that agricultural products are not perfectly interchangeable, but can we be sure that this 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? 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 employed<sup>13</sup>.

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 consider this possibility, nor do they discuss the fact that countries are assumed not to take advantage of this opportunity.

To sum up, 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 need to make a “non-spatial” model provide answers to policy questions involving discriminatory trade policies, which should only be dealt with by using a truly “spatial” model.

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 one of them). Despite this, there have been contributions focusing on the implications of the Agreement which completely overlook them, even

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<sup>13</sup> RUNS (Burniaux and van der Mensbrugghe), for example, adopts the hypothesis of imperfect substitutability for manufactured goods, but not for agricultural products. Alston et al. 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 in the GTAP’s data base.

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 at the same time a given good, 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 (European Commission, 2000, chpt. 4; 1998, chpt. 5)<sup>14</sup>, 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 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

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<sup>14</sup> 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 Agrarian -Economic Research Institute (LEI-DLO).

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. Cox et al.; Zu, Cox and Chavas; and Anania (2001) – all using a partial equilibrium “spatial” model of the type first introduced by Takayama and Judge - 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. Elbehri et al. use a modified version of 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 things at the same time.

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 the 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 the 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 (2001) and Bach, Frandsen and Jensen find, respectively, that the EU undertakings on the volume of subsidized exports for cereals and for two product aggregations out of four 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 of the implementation of the Agreement. A 36% reduction of the per unit export subsidies is assumed, among others, by Anderson, Erwidodo and Ingco; Hertel, Brockmeier and Swaminathan; and Swaminathan, Hertel and Brockmeier. Harrison, Rutherford and Tarr 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)<sup>15</sup>. 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, could even not exist).

In an ABARE study (Roberts et al.), 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., 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 laid down 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).

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<sup>15</sup> A similar approach is taken by Nguyen, Perroni and Wigle 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



Although commitments on export subsidy reductions for dairy products have created most problems for the EU, Fuller et al. 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 (European Commission, 2000, chpt. 3; Westhoff and Young); WATSIM; and Mai et al.. 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 (2001); Bach, Frandsen and Jensen; Cox et al.; and Zhu, Cox and Chavas.

In most cases it is not completely 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 the “intervention” (and consequent stock management) in markets where GATT commitments were binding, including meat and dairy products.<sup>16</sup> 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 (2001); Anderson and Tyers (1991, 1992); Cox et al.; Tyers and Anderson; Tyers; and Zhu, Cox and Chavas.

The failure to carry out an endogenous determination of the quantity of products withdrawn from the market excludes the possibility that, as has been seen 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, chpt. 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

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<sup>16</sup> The existence of “intervention” withdrawals in the EU is ignored in the work of Bach, Frandsen and Jensen 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.

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., 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 with the international market price.

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. 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).

## **Conclusions**

This paper 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 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 decision-making, which are clearly not up to the tasks they have been given.

It is by no means easy (and, probably, meaningless) 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 to answer. 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 modification of their basic 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) of the EU assuming they are “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 (Weber), CAPMAT (European Commission, 2000 chapter 4; 1998, chapter 5) and ECAM (Folmer et al.). The same is true for CEASIM (*Central European Agricultural Simulation Model*) (Frohberg et al.) which is used to analyze the enlargement of the EU to Central and Eastern European countries.

CEASIM models eight CEECs separately, but considers all other countries – including EU member countries - as a single country, and assumes that the equilibrium price in this aggregate country is exogenous. The use of such models to simulate changes in agricultural policies - not just trade policies - seems difficult to justify, 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 in them.

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 representation of current policies which makes the model incapable of simulating changes in single policy instruments or the introduction of a new one. 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 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 make it 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 are 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 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, how much will it drive down the domestic price and what effect will this have on market withdrawals by the public sector?

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 problem, rather, is “simply” to put to good use what is already available; it goes without saying that there is room for improvement.

As regards what would be opportune to do to have a supply of more effective simulation models for the disposal of 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 whatever 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 to be addressed. To put it another way: a “non-spatial” model cannot (and should never 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 creation of a large customs union, it must be reiterated that this should be carried out with a genuinely “spatial” general equilibrium model, which is capable of covering both the direct market effects on countries which join the customs union and on those which remains outside, and the indirect macroeconomic feed back from these effects on agricultural markets 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 utilize different models in an integrated way, 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 a large customs union, 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 of 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 and Munch and Banse 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 projects: the CAPRI Project (Heckeley and Britz)

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 where University of Reading's Land Use Allocation Model (LUAM) was extended to the European Union and expanded in order to endogenously determine consumption, prices and the net trade position of each country. Finally, Serrão 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 there seem to be three main research priorities to be pursued: (i) make partial equilibrium models (different from those based on the Takayama and Judge approach) and general equilibrium models genuinely “spatial”; (ii) improve the realism and detail of the representation of the different policy instruments, explicitly modeling each of them individually; and (iii) improve the realism of the model 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 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 model 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 over the years of the researchers at Purdue, 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 full 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)<sup>17</sup> and GTAP's data base are two good examples to follow for the way they provide relatively easy access to extensive data bases, including a very much needed full documentation.

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

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<sup>17</sup> 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

contrary, a great many of the possible solutions to the outstanding problems are already available: it is “merely” a question of using them. Besides, recent years have seen several developments along the lines which have just been indicated. Thus, in conclusion, as far as the future of modeling international agricultural markets and trade policies is concerned, we can look forward with reasonable, albeit cautious, optimism.

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