Working Paper n.7

THE COMMON AGRICULTURAL POLICY IN MAIN PARTIAL EQUILIBRIUM MODELS

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September 2001

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Abstract

The paper reviews seven partial equilibrium global models used over the last 10 years to the analysis of the Common Agricultural Policy (ESIM, FAO-WFM, FAPRI-CARD, MISS, SPEL/EU, SWOPSIM and WATSIM). The discussion starts from the basic modelling assumptions, the data and parameters employed, by looking first at the common aspects of the models, and then at the unique characteristics of each model for simulating the effects of the CAP. Then the effectiveness of the modelling of five specific CAP tools is discussed; these are - direct price support, trade measures, supply management tools, partially "decoupled" payments, and voluntary schemes. It is argued that considerable improvements have taken place in the ability to capture the effects of changes in some of the main CAP tools, especially in relatively more recent efforts, and especially in terms of the explicit modelling of different measures. Further work is required on the quality of functional forms, the parameters and of the data employed in the models to complement the achievements already made in modelling agricultural and trade policy tools.

1. Introduction

The aim of this chapter is to analyse a group of partial equilibrium models employed in quantitative analysis of the effects of changes in agricultural policies. The paper is focused on global models that include a number of agricultural products and markets, together with certain processed products. A grid consisting of five elements was used in the selection of models.

First, all the models considered aim to simulate alternative policy scenarios, including hypotheses on the variables characterising agricultural policy, and never at measuring parameters, which are always calculated outside the models. This approach excludes econometric studies that employ the partial equilibrium assumption, which are dealt with in the chapter by Paolo Sckokai in this volume. Second, the models considered here are all based on market equilibrium, and from this point of view they have to be distinguished from those in which the behaviour of variables is deduced directly from a statistical evidence, e.g from time series, while there is no economic theory providing *a priori* information on the functioning of the relations studied.[1] The third element considered in the selection of models is the inclusion of several products and markets; this excludes all partial equilibrium models that simulate the effects of agricultural and trade policies for a single product in more than one country. Finally, the fourth and fifth elements of selection were, the application to the Common Agricultural Policy (CAP), and the selection of last decade as a time frame during which models were built and operated respectively.[2]

On the basis of this grid, the following models were identified, listed here in alphabetical order:

- *European Simulation Model* (ESIM)
- FAO *World Food Model* (FAO WFM)
- *Food and Agricultural Policy Research Institute–Center for Agricultural and Rural Development* (FAPRI-CARD)
- *Modèle International Simplifié de Simulation* (MISS)
- *Sektorales Produktions- und Einkommensmodell der Landwirtschaft der Europäischen Union* (SPEL/EU)
- *Static World Policy Simulation Model* (SWOPSIM)
- *World Agricultural Trade Simulation Model* (WATSIM).

AGLINK should also be added to this list. However, given its peculiar institutional characteristics as OECD model, it is dealt with specifically in the next chapter of this volume.

Most of the models considered here were built up in response to an explicit demand for information by policy makers and institutions involved in the management of public intervention to applied research groups and institutions. For this reason, the results generated have played a primary role in the academic and political debate on the effects of agricultural and trade policies at national and international level. However, this chapter, as the rest of this volume, is not focused on the models' results; rather, the aim is to evaluate the conditions under which results are generated, observing particularly the models' degree of effectiveness and reliability in simulating the effects of agricultural policy tools, with special reference to those employed by the European Union (EU).

The models surveyed have several common features, particularly in terms of basic assumptions, the relations modelled, functional forms, and the data and parameters employed. The section below contains an overview of the models' most general aspects. The third section highlights the particular characteristics of each model. Their advantages and limitations are analysed with special reference to the aim of simulating the effects of the CAP. Based on this, the

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[1] For a wider discussion of this difference, the reader is referred once more to the chapter by Paolo Sckokai, where this second type of model is classified as "non-structural".

[2] Reviews of the previous work can be found, among others, in Meilke *et al.* (1996), Cuffaro (1990), Goldin and Knudsen (1990), and in Thompson (1981) with special reference to international trade models.

fourth section discusses each model's effectiveness in the modelling of the specific tools of the CAP. As in the other chapters in this volume, these are grouped into five types: direct price support, trade policies, supply management tools, partially decoupled payments, and voluntary schemes. Concluding remarks are reported at the end of the chapter.

2. Theoretical and Methodological Characteristics

2.1 Basic Hypotheses and Parameters

From the common partial equilibrium assumption, all the models analysed in this chapter describe agriculture as a system where the supply and demand of products and factors do not affect the rest of the economy. Within agriculture, factor allocations are modelled for land only, and cross-price effects are modelled only with respect to the supply of different products. The effects of what happens in the rest of the economy on agriculture is modelled exclusively through modification of macroeconomic variables, whose trend is deduced by separate evaluation and projection exercises.

It is useful to recall that, in general, the extent to which the partial equilibrium assumption is acceptable depends primarily on the model's aims. The analysis of policies for a specific sector is a case where this kind of assumption can be justified, especially if the relative size of the activity concerned is limited, and if inputs are fairly specific to that activity. At least in principle, these conditions hold in all the models considered. On one hand, interest is increasingly centred on countries where agriculture is a relatively small economic sector. On the other, competition for factor use between agriculture and other industries is limited, particularly as far as land is concerned. If this condition holds, the effects of agriculture on the economy as a whole can be considered negligible, and the same applies to the feedback of such effects on agriculture. At the same time, the effects of what happens in the rest of the economy on agriculture, which are far more important, can still be accounted for in partial models, as exogenous shocks.

The advantages and limitations of partial models, however, should be assessed with reference to general equilibrium models, given that the aims of these two types of framework are somewhat similar: both are aimed at supplying projections on market developments under alternative agricultural policy scenarios. On this matter it must be noted that the possible advantages of partial equilibrium models are certainly not to be found at a theoretical level; they lack an overall budget constraint fully accounting for the opportunity cost of resources, and there is no linkage between factor income and expenditure.[3] However, from a practical and operational point of view, it might be argued that partial models require less statistical information; traditionally, being focused on a more limited set of variables, partial models represented policy tools in greater detail than general equilibrium frameworks. Yet, this is probably no longer the case in fact (van Tongeren *et al.*, 2000), due, among other things, also to the improvements in the power of computers.

If this is so, the superiority of the partial approach can only be found in the fact that it enables to obtain indications on the effects of policies based on a limited dataset, that would prevent general equilibrium analysis. Indeed, "it may be difficult to justify devoting otherwise scarce resources to more complex and less transparent models, when they may yield only marginal extensions of the basic insights taken from simpler approaches" (Francois and Hall, 1997, p. 122). This seems to suggest that specifying a partial equilibrium model is worthwhile when the increase of information arising from treating the same problem within a general equilibrium framework is smaller than the increase in the "costs" associated with the time spent in data processing and the more complex specification of the model.

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[3] These elements are advantages of the partial equilibrium framework, that are widely discussed in the chapter by De Muro and Salvatici .

However, partial equilibrium is only one of the simplifying assumptions adopted in the models analysed in this chapter, and certainly not the most restrictive. As mentioned, all models are relatively simplified from a theoretical point of view: agents' behaviour is driven by maximisation of utility and profit functions within perfectly competitive markets, in which economies of scale are absent, information is perfect, transaction costs are absent, and goods are perfectly homogeneous.

Behavioural equations are written in reduced form; thus maximisation is modelled through the restrictions of additivity, homogeneity in prices and income, symmetry of substation effects, and curvature conditions. These imply, that consumers are on their budget constraints, that firms are on their isocost line, the absence of money illusion, the symmetry of substitution in production and consumption, and the sign of the same substitution effect, in other words, ultimately, the direction of the agents' response to price incentives respectively. In the models analysed, however, not all the theoretical restrictions are imposed; frequently only homogeneity and symmetry.

Some of the models considered are comparative static exercises: they compare solutions of two equilibrium points referred to two different periods in which the level of exogenous variables is different. If this is the case, the changes indicated by the model are referred to the period in which the adjustment of endogenous variables is supposed to have taken place, without indicating the adjustment path of endogenous variables from one period to another.

Other models considered in this chapter include some elements of dynamics. In this case, adjustment is generally modelled by including lagged variables in the equations, according to a recursive criteria: models generate an equilibrium solution based on the forecast of exogenous variables, and on the basis of the value of the endogenous variables obtained in the previous period. This type of dynamic implies that agents' behaviour is optimal in each single period, but not through time. Moreover, in more than one of the models considered here, the specification is not homogeneous in the different equations; e.g supply often includes a partial adjustment mechanism – a naive representation that generates results by assuming that entrepreneurs are unaware of prices and quantities in the previous period - while in the demand equations there are only some lagged price variables.

The most frequent functional forms in the models considered are constant elasticity linear and log-linear. This is another serious drawback, since agents' behaviour is modelled in very simplified terms. More sophisticated functional forms can be found in a few cases; e.g. flexible supply and demand.[4] In some models, the supply of livestock products includes the allocation of herds to different products on the basis of relative prices and discounted costs, so that the size of the herds in each period depends on allocation in the previous one.

The behavioural parameters required to run the models considered are demand and supply price elasticities, and/or or value added elasticities,[5] income-elasticities and budget shares in the demand equations, as well as the corresponding substitution elasticity and budget shares for inputs in the supply equations. Econometric estimates of simultaneous equation systems would definitely provide the most accurate basis for deriving parameters, since they offer indications on the statistical reliability of parameters, and ensure that estimates are made with the same functional forms of the simulation model. In fact, none of the models considered are entirely based on the estimation of simultaneous equation systems, due to the lack of homogeneous data through space and time. They are always based, rather, on a set of parameters taken from different sources, including single-equation estimates, simultaneous equations estimations, parameters reported in the literature, expert judgements, and calibration.

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[4] Examples include translog, quadratic forms, and Almost Ideal Demand Systems. A discussion of the meaning of these functional forms can be found in the chapter by Paolo Sckokai .

[5] Added value elasticities presume that producers' decisions correspond to the difference between intermediate earnings and consumption rather than product price; their use thus implies a temporal horizon where labour and capital costs cannot be modified.

Single equation estimates may suffer from the distortion induced by simultaneity, and/or by incomplete specifications, particularly when simple estimation methods are employed, such as OLS[6]. Parameters taken from the literature are usually less accurate, both because they may be obtained from functional forms that are completely different form those used in the simulation model, and because data on which they are based may not be comparable with those used in simulation exercises. Calibration is, in fact, another usual method to calculate missing parameters. This procedure consists of using available parameters to generate missing ones on the basis of the (known) level of the endogenous variables in the base period, of equilibrium conditions, and on theoretical restrictions. As in the case where parameters are derived simply from expert judgements, the main problem with calibration is that it does not allow any assessment of the statistical reliability of the parameters obtained, and, therefore, of the results generated by the model.

All the models analysed here require considerable effort in terms of the data, that needs to be collected from different sources and assembled in a consistent fashion. All the information must be reported to a homogeneous time frame – there are generally problems in the comparison of fiscal year data with information referred to crop years – and to a common base period. A calibration procedure is required to adjust the result to the base period, so that it generates the (known) level of endogenous variables. In dynamic models this calibration is used to generate a "baseline", that is a set of solutions based on a *status quo* hypotheses for policies. The baseline will, in turn, be used as a starting point to evaluate changes following exogenous shocks in policy variables.

2.2 A General Structure

A *general* partial equilibrium model consists of a set of behavioural equations, a set of equilibrium relations between supply and demand, and a set of identities that aggregate variables. Equations can be grouped into a supply component, a demand or utilisation component, and a foreign trade component; this pattern is repeated for each region and product included in the models. In addition, there are price transmission equations, linking world to domestic prices, and world market equilibrium conditions that close the models. In some models there are also sets of identities representing the national budget for agricultural and trade policies, and/or groups of equations modelling the generation of agricultural income.

A simplified representation of the standard structure of the models examined in this chapter is reported below.

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[6] An extensive discussion of these aspects is found in the chapter by Paolo Sckokai.

Crop products	_livestock product_

<table>
<tr><td colspan="2" align="center">supply</td></tr>
<tr>
<td>

(1) $s_{i,n} = s(p_{v,i,n}, p_{v,j,n}, Pols)$

(2) $r_{v,i,n} = r(p_{v,i,n}, PR)$

(3) $Qo_{v,i,n} = s_{i,n}\ r_{v,i,n}$
</td>
<td>

(8) $c_{i,n} = c(p_{z,i,n}, p_{z,j,n}, Polc)$

(9) $AL = al(p_{v,i,n}, p_{v,j,n})$

(10) $r_{z,i,n} = r(p_{z,i,n}, AL, PR)$

(11) $Qo_{z,i,n} = c_{i,n}\ r_{z,i,n}$
</td>
</tr>
<tr><td colspan="2" align="center">demand</td></tr>
<tr>
<td>

(4) $Cu_{v,i,n} = cu(p_{v,i,n}, Y_n, POP_n)$

(5) $AA_{v,i,n} = aa(Qo_{z,i,n})$

(6) $SE_{v,i,n} = se(s_{v,i,n})$

(7) $Qd_{v,i,n} = Cu_{v,i,n} + AA_{v,i,n} + SE_{v,i,n}$
</td>
<td>

(12) $Qd_{z,i,n} = qd(p_{z,i,n}, Y_n, POP_n)$
</td>
</tr>
</table>

<div align="center">

price transmission

(13) $p_{i,n} = p(p_{i,w}, tc, Polp)$

trade

(14) $(E_{i,n} - I_{i,n}) = Qo_{i,n} - Qd_{i,n}$

closure

(15) $\boldsymbol{S}(E_{i,n} - I_{i,n}) = 0$

</div>

where:

i, j = products;	E = exports
v = crops;	I = imports;
z = livestock;	tc = exchange rate
n = country;	PR = yield trend;
and	Y = GDP;
s = land (hectares);	POP = population;
c = heads (number);	
AL = index of feed cost;	
r = yield (per hectare or per head);	
$Polp$ = policies directly affecting prices;	
$Pols$ = policies based on land;	
$Polc$ = policies based on livestock heads;	
Qo = supply;	
p_n = price in country n;	
p_w = world price;	
Cu = demand for human consumption;	
AA = demand for feed;	
SE = demand for seeds;	
Qd = total demand.	

The supply component generally consists of equations (1)-(3) for crops and (8)-(11) for livestock; supply is obtained as the product of a yield per hectare of land or per head, times the number of hectares employed or the herd size. Yields often depend on a trend variable - which is used to represent technical change - on output prices, and on feed costs for livestock. These are

often included in an aggregate feed price index. Land and heads allocation usually depends on relative output prices, and on the policies directly affecting their allocation.

This type of modelling is simplified in several respects. First, production is entirely deterministic: no uncertainty factors are accounted for, such as, climatic variability. No assumptions are made concerning farmers' attitude toward risk, unless they are included in the parameters. Input demand is only included for land, herds, and where primary products are employed as inputs in the production of other (processes) goods included in the model, as is the case with feed crops, oilseed – where seeds are inputs for meals cakes and oils – and in dairy production, where milk is the input of butter, cheese casein etc. The demand for non-agricultural inputs, such as fertilisers, pesticides and machinery is included in few models. Land use and herd size depends solely on the price obtained for agricultural products, rather than on the prices of land and heads themselves, and the sale price of live animals is only considered in few models as a determinant of the size of a herd. In some models there is a more complex treatment of the vertical relations in supply, including feed use of crops based on feed rations calculated through cost optimisation, or livestock allocation based on the relative prices of different final products; in the latter case the choice between slaughtering and breeding will depend on the relative price of the two alternatives, and on production costs.

Moreover, all the supply relations fail to consider food processing and distribution: rather, agricultural output supply is directly related to the demand for final consumption, and only a few models include fixed price differentials between consumer and producer prices, which are introduced to represent roughly the presence of processing and distribution sectors.

The demand component for crops of the typical partial equilibrium model consists of an aggregation, by means of identity (7), of the amount used for human consumption, for feed, and for seeds. For livestock, only the last one is included. Along with the prices of products, the demand for human consumption usually includes the prices of a few more direct substitutes, together with the GDP level and the population as exogenous shifters; theoretical restrictions are rarely applied. The demand for feed is directly related to the number of livestock, through (exogenous or calibrated) technical coefficients. By the same token, the demand for seed is directly related to the number of cultivated hectares.

The typical partial equilibrium model considered here is comparative static, and does not include stock formation. The reason for this choice is usually that stocks cannot be increased or depleted after a given point, and thus, their variation must add-up to zero. Nonetheless, the absence of stocks from the model can be a considerable problem, especially in modelling those markets where they have assumed a structural character, that has a significant effect on the behaviour of economic agents. In the models considered in this chapter, stocks are only included in dynamic ones, and they are never strictly speaking endogenous, due the recursive nature of the dynamic specification. Moreover, public intervention stocks, that are of particular interest in the case of agricultural policies, are clearly influenced by political considerations, and therefore they are also difficult to model in the framework of inter-temporal optimisation. In fact, as it will be shown in section 4, public demand for stocks is included in some kind of endogenous form in some of the most recent partial models, in association with the modelling of minimum guaranteed prices.

Domestic prices are linked to world prices through the price transmission equations, an example of which is relationship 13 in the above box. Along with the exchange rate and trade policies that directly affect prices, transmission equations include price differentials due to transport costs, and those used to approximate differences in the quality of products.

In all the models considered in this chapter, the trade component is made from excess supply equations, an example of which is relation (14) in the above box. Goods produced in different countries are assumed to be perfectly homogeneous, and world markets are treated as a single arbitrage mechanism of excess supplies. The closure rule is defined by relation (15): excess supply in all markets must be zero. The trade component being homogeneous and not spatial, the solutions can only generate countries' net trade positions, and do not include information on bilateral trade

flows, nor on intra-industry trade.[7] Price changes occurring in domestic markets are always transmitted to all the other markets in the model; thus, all markets influence prices throughout the model, unless they are deliberately considered exogenous. This is generally the case if there is a lack of information about supply and demand parameters, or for "rest of the world" aggregations.

The choice of endogenous and exogenous variables needs to follow the general rule whereby, for the model to have a unique solution, the number of the endogenous variables must be equal to the number of equations. The exogeneity of macroeconomic variables makes this choice a relatively simple one; nonetheless, a certain degree of discretion in the definition of the closure rule is possible in more than one model, depending on the aims for which the model is used; e.g. in more than one model it is possible to generate a trend in world prices by setting certain domestic prices as exogenous, or, alternatively, to make the world price exogenous and generate domestic prices endogenously. It is also common for the models to be made up of several sub-models – for single region or product – that can be solved independently by making other parts exogenous. In other words, the closure rules can change, to a certain extent, according to the interest of the user.

2.3 Regions and products

The regions and products included in the models considered are time asymmetric in most cases. The areas and the sectors on which attention is focused are modelled in detail, while the others are often grouped in wide and often heterogeneous exogenous aggregations. As mentioned, this is often the case with supply and demand of the "rest of the world" regions, or the "other agricultural products". Aside from the availability of statistics and parameters, these choices may also be dictated by the relative size of the markets in some areas, or by the development of trade integration. Indeed, all the models include the OECD markets in some detail, especially the US and the EU. The choice of products always includes grains, dairy, meat and oilseeds, although with different degrees of detail, while other products, such as sugar or cotton, are less frequent. Vegetables, fruit, wine and other Mediterranean goods, on the other hand, are always omitted.

The time frame is variable. In dynamic models the definition of several reference periods is frequently used for the simulations, due to the fact that this gives researchers the possibility to take into account the adjustment of endogenous variables, and also, but this is rarely carried out, the possibility to distinguish short-run from long-run parameters in behavioural equations; baselines and simulations often cover up to ten years. On the contrary, comparative static models are more often referred to a single time period, the duration of which depends on the degree of fixity assumed in factor markets, from the treatment of technical change, and from the reliability of behavioural parameters after significant changes in the exogenous variables. In general, given the assumption of complete adjustment, comparative static models tend not to lend themselves to the simulation of short-run scenarios.

3. General characteristics[8]

This section deals with the general characteristics of each of the models analysed. The aim is to shed some light particularly on the differences with respect to the standard structure described in the

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[7] A totally different approach to modelling trade relations is provided by spatial models, in which world markets are represented as a network of bilateral flows, whose level is reported in the solution. Spatial models can also take into account product differentiation according to country of origin, and allow treatment of intra-industry flows. Some of the partial models considered in this chapter include an exogenous representation of intra-industry trade flows. An extensive discussion of these aspects is found in the chapter by Giovanni Anania. An overview and classification of treatment of trade in models for agricultural products can also be found in Thompson (1981). For a systematic treatment of the trade component in partial equilibrium and other types of models, see Francois and Reinert (1997).

[8] A synthetic representation of the models' characteristics is provided in Table 1.

previous section. Special attention will be paid to the general characteristics of the models that are most relevant for the representation of the CAP tools, which will be discussed in greater detail in section 4.

3.1 European Simulation Model (ESIM)

The model was built by the Institute of the Agricultural Economics of the University of Göttingen, in co-operation with the Economic Research Service of the USDA, to analyse the enlargement of the EU to Central and Eastern European countries (CEECs), and the extension of the CAP to those areas, together with market developments in the EU. Descriptions of the most recent version of the model can be found in Münch (1999) and Münch and Banse (1999).[9] The model is applied in combination with CGE models to which ESIM supplies input on the behaviour of the agricultural sector, and from which ESIM receives feedback on macroeconomic variables.[10]

Together with the EU, ESIM includes seven CEECs and a single "rest of the world" region. The products considered include six grains, three oilseeds, six products for oilseed processing (three for cakes and three for oils), three feeds, four dairy products, three types of meat, sugar and eggs. The base period is 1994-96. Data is taken from national statistics for the CEECs, and from standard EUROSTAT and OECD sources for the other regions.

The model is comparative static. Wholesale prices are calculated by deducting a (fixed) trade margin from production prices; an "effective price" is used to represent the shadow-price incorporating the effects of supply quotas. Goods are divided into tradables and non-tradables, and closure requires the equality of supply and demand in each market, yielding a matrix of local prices. The "rest of the world" region is exogenous.

Land allocation in the supply component is relatively accurate; it depends on an aggregated index of the cost of capital, from the price of products, and policies. Relations between crop and livestock markets are treated in the standard way. The supply of processed goods is equated to the demand for raw products multiplied by exogenous technical coefficients.

The parameters for the CEECs are taken from *ad hoc* estimates, while others are taken from the literature. The database and model are not available to the public. Calibration of constant elasticity log-linear functional forms ensures respect of homogeneity and symmetry, as well as the sign of direct price elasticity.

The land allocation mechanism appears to be one of the most interesting features of the model, together with the respect for theoretical restrictions and the definition of domestic prices, even though lack of sufficient documentation does not make a full evaluation possible. Having said that, ESIM's main weakness is undoubtedly its representation of foreign trade; one can observe that a model aimed at the evaluation of EU enlargement and the effects of applying the CAP to CEECs should include a spatial trade component, enabling it to take into account changes in the origin and in the destination of trade flows. Moreover, it appears difficult to justify the assumption of an exogenous "rest of the world" region that is not influenced by the enlargement process.

3.2 FAO World Food Model (FAO WFM)

The model has been built and operated by the FAO Commodities and Trade Division, with two aims; firstly, it is designed to provide medium- and long-term projections on the main agricultural markets. Secondly, the model is aimed at simulating the effects of the 1994 GATT Agreement on Agriculture, and other scenarios in relation to the future World Trade Organisation (WTO)

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[9] A more extensive documentation appears to be under way as doctoral thesis of the University of Gottingen (FAIR 6 CT 98-4148, 1999).

[10] In particular, the mentioned applications are focused on the effect of the application of the CAP in CEECs on the nominal protection rates and on the exchange rates, with a 2010 scenario.

negotiations, with special reference to the consequences for developing countries. The latest version is described in FAO (1998). Main applications are reported in FAO (1995), Greenfield *et al.* (1996), and in Sharma *et al.* (1996; 1997; 1999). Medium- and long-term projections are published regularly and made available by the FAO. Compared to the first version, the model has been improved especially in the representation of the commitments made under the 1994 GATT Agreement, although the basic structure has remained substantially unchanged.

One of the most important features of FAO-WFM is the inclusion of an extensive number of countries, and particularly of developing countries. The total number of areas and regions included is 146, including 112 developing and 23 regions "in transition". A total of thirteen products are considered: five grains, four types of meat, together with dairy goods (milk and butter) and two aggregates for all oilseed and the related meals, cakes and oils.[11] The model makes projections over a 10-years period; the present version is calibrated on a 1993-95 base period and provides projections up to the year 2005.[12]

The model is partially dynamic; the supply component includes partial adjustment mechanisms. Relationships between different markets are represented in a standard way. Price transmission equations are distinguished according to whether countries have made commitments in the Uruguay Round. If this is not the case, domestic price changes are regulated by a constant elasticity of transmission, both for production and consumer prices. For countries that have subscribed commitments into the Uruguay Round, the model includes trade policies aggregated in a price component of PSE.

Foreign trade assumes homogeneous goods in a non-spatial framework, but it includes equations for the exports of net importing countries and for the imports of net exporting countries. The former depends on the ratio between internal and world prices, according to an elasticity calculated through calibration. In other words, total imports include a quota of internal excess demand that depends on the relative level of internal prices in comparison to world prices according to an elasticity calculated on the basis of the observations in the base period. Imports of net importing countries depend on the presence of tariff-rate quotas, the trend of domestic consumption, and also on a calibrated elasticity. This allows the model to take into account intra-industry trade. Closure is defined by setting the sum of imports and exports at zero in all regions.

The equations are specified in linear and log-linear constant elasticity form, without imposing any theoretical properties. The parameters are taken from the OECD and the USDA; some elasticities are the same as those used in the SWOPSIM model, while others – particularly those relating to developing countries – are taken from FAO estimates. Great importance is attached to the calibration process that, according to the documentation, systematically incorporates expert judgements on market trends.[13] Data are taken primarily from the FAOSTAT archives, and particularly from commodity balance sheets. Coefficients are applied to adjust the data to represent raw product equivalents of processed goods. The database and the set of parameters are not available to the public.

The model's main strength is probably the inclusion of a number of countries that hardly ever appear as separate markets in similar models. At the same time, the frequent use of calibrated parameters that this requires, and the absence of a sound theoretical basis for the behavioural equations may constitute considerable limitations with respect to the reliability of results generated. The representation of intra-industry trade flows also appears to be unsatisfactory, since it depends on *ad hoc* parameters.

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[11] This group includes olive oil.

[12] Calibration is done on a three-year average to make performance more stable (FAO, 1998).

[13] FAO commodity specialists are systematically involved in controlling the plausibility of the results, in the design of the equations and in the definition of parameters.

3.3 Food and Agricultural Policy Research Institute–Center for Agricultural and Rural Development (FAPRI–CARD).

Rather than a single model, FAPRI_CARD is a wide inter-linked modelling system that can be used simultaneously. It was originally developed by the Food and Agricultural Policy Research Institute of Iowa State University, with the aim of modelling United States agriculture. Since that time the system has undergone progressive expansion with the co-operation of other US and foreign Universities. Each year the system produces a ten-year baseline for US and world agriculture, and it is used extensively to simulate the effects of short- and medium-term changes in domestic agricultural and trade policy. A new version of the model was recently developed for the EU market, known initially as the Grain, Oilseed, Livestock and Dairy (GOLD) Model (Young *et al*., 1999; Westhoff and Young, 2000; FAPRI, 2000). This includes the main EU countries as separate areas (France, Germany, Italy and the United Kingdom), and it aims to provide a more in-depth representation of the CAP.

Apart from its evaluations of US agricultural policy, FAPRI-CARD applications have focused above all on simulating the effects of changes in the CAP (Helmar *et al.,* 1992 Westhoff *et al*., 1992; Meyers and Womack, 1997; FAPRI, 1997; FAPRI, 1998; Young *et al*., 1999; FAPRI, 1999) and the impact of the Uruguay Round Agreement on agriculture (CARD, 1991; 1991a; 1991b; 1992; Johnston *et al*., 1993; Helmar *et al*., 1994). Concerning the latest CAP reform - Agenda 2000 and the Berlin Agreement - there are projections available generated with both the standard version and the GOLD versions of the model (European Commission, 2000).

The first baseline was built for the year 1988. The standard FAPRI-CARD model includes twenty-four products and twenty-nine regions. Both these, however, can change with the specific sub-models, especially depending on the importance of the specific areas for the markets of a given product. Concerning the EU, for instance, representation of the markets and CAP tools was expanded at the beginning of the 1990s, in order to simulate the effects of the 1992 MacSharry reform (CARD, 1991), and, later, the 1994 GATT agreement (Helmar *et al*., 1994). The first European meat model (beef, pork and poultry), dairy products and sugar was also developed in 1992; previously, the region was only considered for grains and oilseed. Further improvements in the meat sector have been made to the EU model in recent years (Shaw *et al*., 1997) - most recently the effects of Agenda 2000 (FAPRI, 1999; Young *et al*., 1999, FAPRI, 2000) – and also for dairy products (Fuller *et al*., 1999) [14].

The model is partly dynamic, and it includes lagged variables and partial adjustment mechanisms in several supply components. The functional forms change according to the information available and the performance of the estimations; flexible, translogarithmic and quadratic normalised forms are employed in some of the supply systems, as is the Almost Ideal Demand System for demand. In most products and regions, however, the typical simplified, linear and log-linear forms are employed. Respect for theoretical restrictions appears to vary widely among the parts of the system, according to the functional forms. The most frequently imposed properties are homogeneity and symmetry, while adding-up and curvature conditions are less frequent, according to the documentation. Parameters are quite frequently based on *ad hoc* econometric estimates, based on simultaneous equation systems or, more frequently, on single equations. Methods of estimation also seem to change with different parts of the system, from OLS to non-linear iterative methods allowing for ML estimates (Devadoss *et al*., 1989; 1993).

The original modelling system is made-up of five sub-models of US agriculture, that can be solved independently or simultaneously. These are described as follows.

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[14] Other examples are Shaw *et al.* (1997), Fuller (1997) and Barret and Fabiosa (1998); these papers document relatively recent developments in the meat model aimed at including Mexico and some Asian countries.

- A livestock model, including four types of meat (beef, pork, poultry and turkey). In the supply component, a set of logistic form equations represent heads allocation[15] on the basis of the relative profitability of each alternative, on the basis of output prices and interest rates. The demand is driven by retail prices, that are related to production prices by a (linear) trade margin function. Consumer behaviour is modelled with short- and medium-run parameters.
- A crop model, whose main feature is the its representation of farmers' participation in the support programs. The model does not include different farm types allowing for different behaviour, but rather a simple participation rate that depends upon the difference in expected returns of participants – in terms of gross income that depend on policies as well as product prices and factors – and non-participants; through a calibrated parameter, the ratio of the two expected returns determines the participation rate. Another interesting characteristic of this model is that it takes into account the change in production decisions throughout the year; in particular it is assumed that producers adjust yields – through the application of variable inputs – according to the expected price trends over the year.
- A standard trade component. Excess supply and demand functions can be made exogenous in the domestic models, if these are solved independently. *Viceversa*, domestic supply and demand can be exogenous variables if the trade component is solved independently.
- A set of accounting identities called the "government cost model" that calculates the public budget for the policy given domestic prices, and the participation rates calculated in the crop model.
- A model that calculates farmers' incomes (net farm income model).

An important limitation of the description provided for the original models (Devadoss *et al.*, 1989, 1993), has to do with the demand component, that was modelled in most countries without imposing behavioural hypotheses. A more accurate treatment, however, is reported in subsequent papers for some of the sub-models (Shaw *et al.*, 1997; Fuller, 1997; Barret and Fabiosa, 1998, Weshoff and Young, 2000), indicating the use of parameters estimated through simultaneous equation systems and, in some cases, the imposition of theoretical restrictions.

The system's basic data is taken from USDA sources, particularly from information in outlook reports on international markets and in the PS&D View archives. Macroeconomic exogenous variables are taken from projections of the World Economic Forecast Association for the United States, and from the International Monetary Fund for all other countries. Demographic evolution is taken from United Nations projections. Access to the database and model is only granted to contributors to the system.

The model has several interesting features. In general, the parameters obtained through sophisticated functional forms seem fairly broad, at least in some modules; for crops, the effort to generate the degree of program participation in the representation of the US agriculture is certainly notable; and the same applies to the representation of livestock heads allocation.

On the other hand, one of the greatest weaknesses is the fact that all the mentioned features can at best only be "eyeballed" in the documentation; consequently it is not always easy to understand how the equations are structured at any specific point in the modelling system. Most FAPRI-CARD papers reporting applications of the model contain at most a brief and general description of the original model, referring to Devadoss *et al.* (1989; 1993). Moreover, this paper only describes what seems to be an older version of the system, while other references are often to working papers which are not easily found outside the FAPRI-CARD system. The benefits of this decentralised system, thus, appear to imply some costs as well: sometimes the model appears as a sort of "black box". An example, in this respect, is provided by the EU model, for which additional details on the representation of the domestic market have been made available only very recently (Westhoff and Young, 2000; FAPRI, 2000).

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[15] E.g. for breeding, for slaughtering or for meat or milk production, etc.

3.4 Modèle International Simplifié de Simulation (MISS)

The model was built up by the Rural Economy and Sociology Laboratory of the INRA in Rennes, mainly to simulate scenarios of multilateral trade liberalisation during the Uruguay Round, as well as the effects of changes in the CAP, and the MacSharry reform in particular. The model's original version is described in Mahé and Moreddu (1987). Subsequent applications indicate changes in the structure, aimed at improving the theoretical grounds of the model (Mahé and Tavéra, 1989), and at introducing technical improvements (Guyomard et al., 1991; Mahé and Guyomard, 1991). The model was used in combination with grain supply estimates on various hypotheses regarding the degree of "coupling" of CAP direct payments (Guyomard et al., 1993). Other applications can be found in Kennedy et al. (1996), and in Kennedy and Atici (1998).

MISS includes from three to five regions: EU, USA, Japan and the "rest of the world". The last region can be further divided into planned and market economies. At most, there are ten agricultural products in the model, including grains, vegetable proteins, vegetable oils – excluding olive oil – grain substitutes, beef, pork, poultry and eggs, dairy, sugar and a "other agricultural products". Land allocation is not modelled among inputs, but six agricultural products are also considered as by-products – grains, vegetable proteins, maize, cassava, other grain substitutes and dairy – together with four non-agricultural inputs – other feed, intermediate consumption, fertilisers, and interest on capital. The data is primarily taken from EUROSTAT. The first version of the model was calibrated on 1986, while the later one uses 1990 as a base period.

The model is comparative static, with a more simplified structure than the standard version. Supply and demand are linear functions of consumer and production prices, i.e supply is not broken down into separate equations for yields and land area (or livestock heads). The demand for processed goods depends directly on the (production) prices of raw products, and the demand for grain substitutes depends on the demand for livestock. The model includes an identity representing the EU budget, that identifies expenditure and income in proportion of exports (through subsidies) and imports (through revenues from levies) respectively. The "rest of the world" and the planned economies are exogenous.

MISS provides information over a three to five year period. Behavioural parameters are taken from the literature, and are calibrated for the same length of time. Compared to the first version, the model has been improved especially with respect to homogeneity, symmetry and curvature conditions, especially in the supply equations, that are derived from a profit function estimated through theoretical constraints (Guyomard et al., 1991). This version also includes greater accuracy in policy representation. The database and model are publicly available upon request.

Despite its simplicity, MISS appears to be capable of simulating trade policy changes on a theoretically sound basis, particularly in relatively recent applications. At the same time, its simplicity, mostly in the supply component, can be a significant limitation when dealing with the explicit representation of CAP measures other than coupled policies.

3.5 Sektorales Produktions- und Einkommensmodell der Landwirtschaft der Europäischen Union (SPEL/EU)

Also SPEL/EU is as a modelling system rather than a single model. The system consists of a base module (BS) and two simulators: a short-term simulator (SFSS), and a medium-term one (MFSS). The BS is an accounting system, based on an agricultural social accounting matrix, that describes production processes and uses. The SFSS simulator is used regularly twice a year to update the BS data with the changes occurring throughout the year, and to project variables for up to one or two years. The MFSS simulator, on the other hand, is used for projections over a two to six year period,

for policy analysis and includes a residual trade component.[16] The entire system was developed in Germany by the Institute of Agricultural Economics of the University of Bonn, on behalf of and in co-operation with EUROSTAT. The documentation which is so extensive to be more a group of user manuals, is found in Wolf (1995a), Weber (1995), Henrichsmeyer *et al.*, (1995b), Zintl and Gruel (1995). The EU Commission published the results of the base module for 1985-96 (EUROSTAT, 1997), in which the last year of was obtained through the SFSS. Medium-term projections for the period 1996-2001 are found in EUROSTAT (1996). The model is one of those used to simulate the effects of the Agenda 2000 CAP reform (European Commission, 1998; 2000).

SPEL/EU includes up to 114 products for the fifteen EU member states. As mentioned, the trade component only includes a single "rest of the world" region. Data is taken from EUROSTAT; the documentation illustrates the extensive preparation work required on the database, and the error and plausibility control procedures. The entire database is available to the public from EUROSTAT.

Of all the models examined in this chapter, SPEL/EU is the one that is most different from the standard introduced in section 2.2. Firstly, because it includes several mathematical programming elements; secondly, it is largely based on statistical projections. For each activity, the BS module contains a vector of technical coefficients and one of activation levels, that are employed to calculate input use and output. This is allocated between different uses both within each sector and for consumption. The technical coefficients are taken from observation, i.e. by dividing overall production by land area or by the number of livestock: yields are, therefore, fixed. Input use is allocated among activities on the basis of available statistics and qualitative information. Production, technical coefficients and input use are first reconstructed in physical terms, and then as values through the application of different types of price. The generation of gross income is modelled on this basis. All the sizes of the base module are calculated firstly for single member states, then checked for plausibility and aggregated in Ecu values. This allows the model to calculate yield and activation levels for the entire EU. The result is a sort of data base describing in detail inter- and intra-sectoral flows for agriculture.

The SFSS simulator is largely based on the estimate of trend variables combined with the expert judgements; thus, it is more a statistical model than an equilibrium one. It operates within a time frame in which most production decisions cannot be changed, and it provides projections on output and price levels - particularly those most directly influenced by policies - as well as on technical coefficients and process activation levels in physical and value terms. These can be treated exogenously in the module, in order to generate endogenously the component of use, i.e. the different types of final consumption and agricultural reinvestment, as well as purchases from outside the sector.

MFSS is the one most often used for CAP simulations and the most representative of the partial models considered in this chapter. MFSS can be described as being made up of a demand component, a supply component, and a residual trade component. Supply assumes that farmers first decide an *activity yield*, based on product and factor price expectations, and then decide on the activation level of each process, on the basis of their unit added value.

This means that there are three main elements in the supply component: first, the *price expectation model*, which generates expected prices according to a partial adjustment mechanism. Then, based on price expectation, the *yield model* generates technical coefficients based on polynomial production functions; yields, however, are more frequently determined exogenously, from expert judgements and calibration procedures. The third element, once yields and the activities' unit added values are known, is the *activity model* that maximises expected net income, generating outputs and inputs.

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[16] Initially, the SPEL system also included a multi-regional trade component named SPEL/TRADE, primarily aimed at assessing the effects of the 1994 GATT agreement (Henrichsmeyer *et al.*, 1995a). The SPEL/TRADE project was continued with the development of the WATSIM model, and will therefore be discussed in section 3.7.

This last part of the model is based on the solution of a programming problem with non-linear terms of the objective function and linear constraints, incorporating behavioural restrictions. The main parameters are value added elasticities, that are calibrated through a further non-linear programming procedure that minimises the difference between parameters taken from external sources through constraints imposing homogeneity, symmetry and the sign of elasticities. The number of livestock is dynamically dependent upon choices made in previous years. The amount of land available is one of the constraints found in planning.

The demand component includes different outputs, and includes stocks. This too is based on the solution of a mathematical programming system, where the objective function gives the destination of available production, while the constraints include parameters on consumer behaviour, import demand and stock demand, as well as technical relations. As in the case of supply, behavioural parameters are taken from the literature, expert judgements, and trends. Consumer prices are calculated from production prices through *ad hoc* transmission elasticity. Also this part of the model may be operated with exogenous prices, to assess, for example, the effect of policies on levels and different uses of output.

MFSS can be solved individually for each member state of the EU, and then aggregated for the fifteen countries in what is called, the *EUR-pool* model. Here, as the name suggests, supply and demand are determined from the aggregation of countries' net positions. Prices are weighted averages of national unit values expressed in Ecu, and this weighting is based on a specific transmission equation. Expert judgements allow the model to add coefficients aimed to account for quality differentiation, and other elements such as transport costs. Bilateral trade flows between member states are not taken into account.

The *EUR-pool* interacts with a "rest of the world" region; the model is closed by setting at zero the sum of net exports of the two areas. Here too, there is a transmission equation between world prices and (average) EU prices. Similarly to what happens in the member states models, this equation takes into account quality differences and transport costs. The equilibrium conditions between the EU and the rest of the world can be used both to simulate world market prices, with exogenous EU domestic prices, and the formation of EU domestic prices, with exogenous world market prices.

In conclusion, the main strengths of the SPEL/EU system are to be found both in the detail of the products and of the description of production processes, which provides us an explicit model of factor use and the relations between crop and livestock production. Equally important is the amount of detailed work carried out on the database, and the fact that the data is homogeneous being taken from a single source, EUROSTAT. Nevertheless, the extensive use of trends and calibration to estimate parameters sometimes gives the impression that the system ultimately mixes theoretical bases, especially in the medium-term module, with statistical and accounting procedures that are dominant in the other two. In other words, it is more difficult than in other models to see to what extent the model rests on a combination of well-informed opinions and to what extent it is based on behavioural hypotheses about reactions to changes in market conditions. Moreover, the trade component seems so limited in structure and range that it can only be used with reference to intra-EU trade.

3.6 Static World Policy Simulation Model (SWOPSIM)

The model was built by the Economic Research Service of the USDA in the second half of the 1980s, primarily to simulate trade liberalisation hypotheses during the Uruguay Round, and to assess the welfare effects of alternative scenarios. Applications are found mostly as USDA working papers; they deal both with the effects of trade liberalisation on OECD countries – first of all the US and the EU - but also on Asian and the CEECs. Agricultural policies affecting trade are the other main area covered in SWOPSIM, and extensions of the model have been applied also to environmental issues (Liapis, 1994). The model is also available in a spreadsheet version, that

provides simulations to non-expert users (Roningen, 1997). The original version is described in Haley (1989), Liapis (1989), Roningen *et al*. (1991a; 1991b) and Gardiner *et al*. (1991); this was calibrated on 1984 as a base year. The model was then re-calibrated on 1986, and the most recent applications have been carried out with this version (Roningen and Dixit, 1990; Andrews *et al*., 1990; Hartmann and Schmitz, 1992; Vanzetti *et al*., 1994; Makki *et al*., 1994; Andrews *et al*., 1994; Ames *et al*., 1996). A dynamic extension of the original version is the DWOPSIM (Roningen, 1997).[17]

SWOPSIM includes twenty-two products: four grains, four types of meat, eggs, sugar, tabacco and cotton and another six aggregates including oilseed and relative meals and cakes. A maximum of thirty-six countries and regions are considered, including the EU (as a single block from which Spain and Portugal can be separated) a group of exporting developing countries (Asian and Latin American), the group of former command economy countries, and an "other developing countries" group. The model can be run with a variable number of regions, assuming excluded regions as exogenous.

The model is comparative static. Equations are rather simplified compared to the standard reported in section 2.2.. In particular, supply does not determine yields and land allocation separately: it only depends on domestic prices of output and input through the relative elasticities. The demand structure is similar, but it depends on both domestic prices of products and on the price of the closest substitutes. Relations between different markets are modelled solely through output prices.

A price transmission equation represents policies in terms of wedges between domestic and world prices or, where wedges cannot be calculated, in terms of an aggregated transmission elasticity.[18] The trade component of the base model and most of the applications have a standard form. The documentation shows that it is possible to re-formulate the model to include the product differentiation using the Armington hypothesis (Roningen *et al*., 1991b)[19].

The functional forms of the equations are constant-elasticity linear and log-linear, and in most applications no restrictions are imposed on agents' behaviour.[20] The database is drawn from USDA projections on international market trends (outlooks). Elasticities are taken from external sources, and subject a calibration procedure to reproduce the base year results. SWOPSIM parameters are among those more frequently employed in other partial models. The database and model are available upon request.

The main advantages of SWOPSIM are undoubtedly its simplicity, accessibility of information and, to a certain extent, the popularity it has acquired thanks to its association with the institution that produced it. Just as with the MISS, its simplicity can also be a defect, depending on the purposes for which it is used. The standard version is applicable above all to overall trade liberalisation scenarios for agricultural products. It is not, however, well-suited to CAP simulation and partial liberalisation scenarios, mostly due to the limited nature of the instruments that can be represented, an issue that will be discussed more extensively in section 4.

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[17] An exhaustive list of model applications - mostly USDA-ERS working papers - is provided in FAIR 6 CT 98-4148 (1999).

[18] These are often reference values for large country aggregations; e.g. price transmission for all economies in transition is set at 0.2 while it is set at 0.5 for all developing countries in Roningen and Dixit (1990).

[19] This is the so-called "Armington" assumption, that is widely discussed in the chapter by Anania. In short, this approach introduces bilateral flows by means of an additional assumption, i.e. by supposing that there is less than perfect substitutability in consumption between a domestically produced good and the same good produced in another country.

[20] An exception is Liapis (1994), where supply includes modified elasticities for input demand and output supply, estimated from a profit function under the restrictions of homogeneity and symmetry.

3.7 World Agricultural Trade Simulation Model (WATSIM)

This model has been developed and maintained by the Institute of Agricultural Economics of the University of Bonn, originally as a part of the SPEL/EU project, with the name of SPEL/TRADE. The projects aimed at building a multi-regional trade component for the SPEL system, including less detailed product information. Despite the fact that the two models can still be considered compatible, WATSIM has become increasingly differentiated from the original SPEL/TRADE; the present version is described in von Lampe (1998; 1999); the SPEL/TRADE version is described in Henrichsmeyer *et al.* (1995a).

Following the original SPEL/EU criterion, there are two different versions of WATSIM; one is aimed at formulating long-term projections on the impact of socio-economic conditions and the availability of natural resources on agricultural markets. The medium-term model is aimed at evaluating the effects of agricultural policy on trade, production, demand and prices. The difference between these two versions is basically in the number of exogenous variables. In the near future, the model should also be equipped for the analysis of short-term shocks. The present version is calibrated on 1994 base year data, and it provides projections from 2005 to 2020. Being quite recent, the model has not been applied extensively; one application is found in von Lampe (2000).

WATSIM considers up to twenty-nine product, including five grains, four oilseeds, plus the same number of processed products (oils and cakes), four types of meat, eggs, four dairy products, and sugar, starchy products and legumes. A maximum of fifteen regions are considered, including the EU as a single block, the CEECs, the former Soviet Union, a block of "other" Eastern European countries, the US, Canada and Australia. The model includes a relatively high number of developing areas: India, China, Sub-Saharan Africa and an aggregate for the Middle East and North Africa, a single group of Latin American countries, and more than one Asian group.

The model is comparative static. Demand parameters include a shifter to account for urbanisation together with population and GDP growth. The trade component is standard in the present version, but a new one including the Armington assumption is currently being developed. In the long-run version, supply and demand shifters are the results of trend estimates plus expert judgements. Technical change and other factors influencing land availability are included, as usual, as supply shifters.

Equations are mostly constant-elasticity linear functions. Parameters are taken from the literature – some elasticities come from SWOPSIM – and they are calibrated with the restrictions of homogeneity, symmetry, and those concerning the sign of compensated elasticities (as a proxy for curvature conditions). Data is pooled from the balance sheets of the FAOSTAT archives of the FAO, from PS&D View archives, from the OECD and USDA, especially for policies. Macroeconomic variables are taken from the World Bank, and the demographic projections from the United Nations. The database and model are not available to the public.

To sum up, the model has many interesting features; the relatively high number of regions included can be considered a strong point.

Table 1. Summary of general characteristics of the models

	ESIM	FAO WFM	FAPRI	MISS	SPEL/EU	SWOPSIM	WATSIM
Aims of analysis	simulations (extensions of CAP to the CEECs)	forecasts and simulations (1994 GATT agreement)	sorecasts and simulations (US agriculture, GATT negotiations and 1994 agreement, MacSharry reform, Agenda 2000)	simulations (1994 GATT agreement, MacSharry reform)	forecasts and simulations (Agenda 2000)	simulations (1994 GATT agreement scenarios and agreement)	forecasts and simulations (agricultural and trade policies)
Base year	1994-96	1993-95	from 1988 on	1986 and 1990	from 1986 on	1984 and 1986	1994
Time frame	fifteen years	ten years	ten years (maximum)	three-five years	six years (maximum)	medium-term	medium- and long-term
Max. no. Of products	27	13	24	10	114	22	29
Max. no. Of countries or regions	9	146	29	4	2; 15 EU member states	36	15
Static/dynamic	static	recursive dynamic	recursive dynamic	static	recursive dynamic	static	static
Parameters	calibration and estimate	calibration	estimate and calibration (little)	calibration	estimate and calibration	calibration	calibration
Theoretical restrictions	homogeneity, symmetry and curvature	none	homogeneity, symmetry and curvature (depending on the parts)	homogeneity, symmetry and curvature in most recent versions	homogeneity and symmetry	homogeneity and symmetry only in some parts and applications	homogeneity and symmetry
Data sources	EUROSTAT, OECD, CEEC national statistics	FAOSTAT, OECD	USDA	EUROSTAT	EUROSTAT	USDA	FAOSTAT, PS&D View, OECD

4. Modelling Common Agricultural Policy tools

As shown in the two previous sections, the models considered have all been applied to the simulation of the effects of changes that took place in the CAP over the 1990s. At present, most models' baselines include the main elements of the 1992 reform, the commitments undertaken with the 1994 GATT Agreement, and, more recently, those of the Agenda 2000 reform. Among partial equilibrium models simulation of the EU enlargement, however, has only been carried out with ESIM.

Among the "new" tools introduced in the CAP over the 1990s, those most frequently included in PE models are mandatory set-aside, compensation payments tied to land and livestock, and the reduction of intervention prices. Other important policy measures are absent despite their direct influence on markets; this is the case with the provisions of Regulation n. 2078/92, that, not referring to a specific product, are difficult to represent in the kind of models analysed in this chapter.

Among the multilateral obligations undertaken in the 1994 GATT Agreement, the commitments on the reduction of export subsidies are the policy measures most frequently included in the baseline. Tariff Rate Quotas, i.e. an important group of provisions of the 1994 Agreement, and domestic support provisions, on the other hand, tend to be ignored.

The changes brought about by the Agenda 2000 reform that are most frequently found in this survey, are primarily those in direct payments for arable crops, the reduction of intervention prices in this sector, the setting of the obligatory set-aside at an indicative rate of 10%, the change in direct payments in the meat sector, and the growth of some of the national milk quotas. In this case too, main partial models neglect a number of important elements of the reform; e.g. the introduction of ceilings in production levels, or the elimination of a differentiated treatment for "large" and "small" arable crop farmers.

Concerning EU enlargement, ESIM has been run mainly to simulate the extension of direct price support, production quota systems, and direct payments to candidate countries. The rest of this section focuses on the representation of individual groups of CAP tools.[21]

4.1 Direct Price Support

Until recently the CAP has provided direct price support in a number of sectors, especially arable crops, dairy and beef products. The common market organisation of these products has been marked by intervention purchases at a minimum price, by the presence of *de facto* variable levies on imports, and by exports refunds. Both the 1992 and the Agenda 2000 reforms have placed limitations on the application of these measures, particularly by setting a ceiling to the difference between the intervention and the "threshold" price (relevant for imports); in the case of beef, intervention is being gradually phased out after the Berlin Agreement (INEA, 1999). Price integration, which was used for olive oil, for example - a product that is generally excluded from the models - is much less frequent today.

Price support is often modelled as a percentage price wedge; the price transmission equations set the EU domestic price at a higher level than the world market price. ESIM, SPEL, MISS, FAO-WFM, and SWOPSIM use this type of approach. In the last three models, wedge data is taken from the price component of the Producer Subsidy Equivalents (PSEs) and Consumer Subsidy Equivalents (CSEs), published by the OECD and the USDA.[22]

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[21] Synthetic indications about the modelling of single types of measure are reported in Table 2.

[22] PSEs and CSEs are aggregate support measures, indicating the amount of expenditure required to provide producers and consumers a level of support corresponding to existing policies. Recently, the OECD has modified the criteria to

In general, the use of price wedges to represent direct price support policies suffers from the problem of aggregation. The wedges include all those measures influencing output and input prices, including domestic and trade policies: it is impossible, therefore, to have a separate assessment of the effects of a change in individual measures. In other words, a 10% tariff reduction and a 10% reduction in the intervention price in the domestic market are both implemented in the model as a 10% reduction in the price wedge, although it is generally recognised that the effects of the two changes can be significantly different.

Problems in modelling price support arise especially with respect to the operation of minimum guaranteed prices. Many of the models considered here implicitly tend to confuse institutional prices, that are the object of policy makers' decisions – intervention prices or threshold prices – with the domestic market price. In this way, the modelling neglects the existence of a transmission mechanism between institutional and market prices. In other words, in the real world, policy makers set an intervention price level, and this level influences price formation in the domestic (and world) market; several models tend implicitly to assume that policy makers set the domestic market price itself.

It is worth recalling, in this respect, the mechanism proposed in the GOLD version of FAPRI-CARD for the EU, that appears to offer an effective way of modelling guaranteed minimum prices (Westhoff and Young, 2000; FAPRI, 2000). This requires a sort of behavioural equation that endogenously derives the demand for public (intervention) stocks. The stock level depends on the output price observed in the domestic market, on world price, on domestic supply, and on a term representing the need to maintain a minimum amount of stocks whatever market conditions. The equation takes the following form

(1) $$S_t = c\, S_{POLt} + b\, Qo + a\, max\, [0, (1 - p_{UE}/p_{int})]$$

where

S_t = amount of stock;

S_{POLt} = (exogenous) minimum stocks;

Qo = supply in the EU;

p_{UE} = market price in the EU;

p_{int} = intervention price;

$a, b. c$ = calibrated coefficients.

The idea is that $p_{UE} > p_{int}$ (the domestic price is above the intervention level) the demand for stocks depends only on the minimum level decided by policy makers, and on supply. If, however, a point is reached in which $p_{UE} < p_{int}$ then stocks will rapidly increase, until p_{UE} increases again above p_{int}. In the model, as in the real world, the market price does not fall below the intervention level because output is bought by a public agency, and the speed of an increase in stocks at the intervention price level is represented through the calibration of the coefficient a, which assumes a high value (FAPRI, 2000). A similar approach to modelling minimum prices is also adopted in AGLINK among partial models [23], and in WATSIM. In the latter, however, intervention buying only starts when the quantitative limit on subsidised exports is reached (Von Lampe, 1999).

This approach is based primarily on the calibration of the stock reaction with respect to the market price; there is no consistent theory underpinning the determination of an optimum public stock level, but only the empirical notion that stocks will rapidly increase at given price levels; in this respect, it should not be considered as a fully fledged "endogenous" stock determination. Nonetheless, the mechanism does provide a more explicit modelling of the measure, because it

calculate these measures, renaming them as "Producer Support Estimate" and "Consumer Support Estimates" (OECD, 1999). A wider discussion of the advantages and disadvantages of these measures in the representation of agricultural and trade policies can be found in the chapter by Giovanni Anania.

[23] As mentioned, this model is discussed separately from other partial equilibrium models in the chapter by Conforti and Londero .

allows model to implement an exogenous variable that constitutes a closer proxy of the choices that policy makers actually make: the intervention price level. This can be a considerable advantage, especially if simulations are aimed at assessing quantitatively the effects of a *change* in the support policy, rather than a complete elimination of such a policy[24].

As seen, this approach requires a sort of behavioural equation for stock demand, which is more frequently absent from models; this is the case of ESIM, MISS and SWOPSIM. FAO-WFM includes an equation that determines the stock level - depending on domestic supply and on the domestic market price though a calibrated parameter[25] - but it does not model the use of stock for price control purposes. Also SPEL-EU includes the level of public stocks as an exogenous quantity; a choice justified on the basis of the political nature of the decisions involved.

It should be pointed out that, in general, although there are clearly a number of theoretical problems involved in their modelling, the absence of a behavioural relationship for public stock is an important limitation in models aimed at evaluating direct price support within the CAP. The reason is that stocks have had a significant influence both on European markets and, in more than one case, also on the policy decisions themselves, not to speak of the costs involved in holding stocks, that are even more frequently ignored by the models.

Other direct price support tools, that are less important for the CAP, are, in principle, more easily modelled. This is particularly the case of deficiency payment schemes and, more generally, of all "coupled" aid granted to producers, such as output and input price integrations; they can be represented by introducing a wedge between consumer and producer prices. Nevertheless, although measures can be introduced explicitly in the model, the above-mentioned drawbacks arising from the need to aggregate different measures in a single wedge still hold.

4. 2 Trade Policies

The structure of the foreign trade components in the models considered in this chapter is a crucial element that significantly restricts the type of policies that can be modelled and simulated. In particular, the lack of indications about bilateral trade flows excludes a whole realm of discriminatory policies, such as preferential treatment to specific countries, and all bilateral policies, such as quantitative restrictions. As already mentioned, this can be an important limitation with respect to the simulation of specific perspectives, as is the case with ESIM, whose aim is the study of the effects of EU enlargement, as this can be conceived as a set of discriminatory provisions. The same consideration applies to models, such as FAO-WFM and, to some extent, WATSIM, that are built with the aim of simulating effects on the developing countries, given the importance of special provisions for these areas. At the same time, the absence of intra-industry trade flows from the models, means that certain measures that have been crucial over the last few years, such as the minimum access provision introduced by the 1994 GATT Agreement, cannot be accounted for. These measures have played a major role in shaping flows among the major agricultural trading partners. This weakness is one of the main reasons why more than one of the models considered in this chapter has introduced the "Armington" assumption, which is one of the simplest means to introduce bilateral trade flows.

In the common versions of the models in this survey, however, also trade policies are frequently represented through price wedges among regions. Here as well, as seen for direct price

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[24] It is clear that, if the purpose of the model is the study of the effects of a complete elimination of price support, then the exogenous wedge system can be effective, since changes in the level at which single measures are operated is not relevant.

[25] More precisely, in FAO-WFM the stock level for net-exporters depends on the ratio between supply and the domestic producers' price; for net-importers the stock level depends on the ratio of domestic consumption to consumers' price.

support, the aggregation of different measures prevents an explicit modelling, and, in turn a separate assessment of the effects of each policy.

Percentage price wedges, in terms of trade policies modelling, correspond to *ad valorem* tariff equivalents; most price transmission equations linking domestic prices to world prices, include the wedge as an independent (exogenous) variable, together with i) a term aimed at taking into account specific tariffs, and ii) another aimed at taking into account transport costs and quality differences between countries, according to

(2) $$p_{UE} = t_s + (1+b)\,p_w + \boldsymbol{d}$$

where

p_{UE} = EU internal price;

p_w = international price;

t_s = specific tariff;

b = *ad valorem* tariff equivalent;

$\boldsymbol{d}$ = qualitative differences and transport cost.

This approach can be found, in slightly different forms, in all the surveyed models.[26] Information on tariff equivalents can be derived from different sources. Some models, notably FAO-WFM, SWOPSIM and WATSIM, employ the price component of the PSE and CSE indicators, while others employ nominal protection rates. Tariff reductions implemented after the 1994 GATT Agreement are in some cases taken from the Prospects of bound tariffs notified to the WTO: this is the case of FAO-WFM, and FAPRI-CARD. The choice of this source of information carries a strong risk of overestimating the starting point from which tariff reduction was implemented, since bound rates are often higher than those effectively applied, a phenomenon known as "dirty tariffication". Thus, implementing a reduction in the bound rates in a model leads to an overestimation of the degree of liberalisation brought about by the 1994 GATT Agreement. At the same time, the applied tariffs rates are not easily available.[27]

Moreover, it is also worth recalling that the inclusion of tariff data within a quantitative model can, in general, cause serious problems when it comes to product aggregation. Tariff measures are usually defined at a very detailed level, so that the relevant information needs to be aggregated in relatively few groups to match products as they are defined in a model; and the aggregation procedure is not neutral in terms of the effect of a change of a single measure on the aggregate (Salvatici, Carter e Sumner, 1999). On the issue of quantitative assessment, this point is discussed extensively in the chapter by Giovanni Anania.

Aside from the already mentioned aggregation issue, the use of price wedges for modelling trade policies can create significant difficulties when trade is influenced by non-tariff measures. These are sufficiently frequent in agricultural trade – e.g. all kinds of qualitative constraints and tariff quotas – to lead to a significant equivalence problem, that is common to most types of model, and is also extensively discussed in the chapter by Giovanni Anania. It is sufficient to note here that a major limitation of price wedges arises when the tariff barrier takes the specific form of a variable import levy, or of a variable export subsidy that complements domestic intervention at a minimum price in controlling trade flows, as is still the case of many products covered by the CAP. If

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[26] Different specifications include, the absence of *ad hoc* terms to account for transport costs and qualitative differences; the latter term is (often) only a residual resulting from calibration procedures. Contrary to other models, WATSIM pays particular attention to non-price elements affecting price transmission; these are included in a sinusoidal form terms that takes into account transaction costs associated with a switch in the net trading position of a country. The idea is that transmission costs account for a high quota (the maximum one) when a country imports all its consumption, that this quota is zero when all consumption is produced domestically, and that this quota reaches a minimum when exports are equal to domestic consumption (von Lampe, 1999).

[27] A relatively recent and very important contribution in this respect is the project Agricultural Market Access Database (AMAD, web site www.amad.org), aimed at building up a publicly accessible international database including both applied and bound tariffs for a large number of countries.

domestic direct price support is modelled through the same wedge, it will be impossible to distinguish a change in the trade regime from a change in domestic support; on the contrary, in those models where the price support mechanism is modelled explicitly, the variable import levy and export subsidy system will be explicit: the price wedge between the import or export prices and world price will be determined by the model run, i.e. the term b in equation (2) will be endogenous. Moreover, as is the case for direct price support, this is a better proxy for the real world mechanism than the exogenous wedge, especially if the aim of the analysis is not a complete liberalisation scenario, or one of full removal of domestic measures, but rather a change in the way support is provided, or a reduction in the amount of support, as was the case with the CAP reforms over the 1990s. In the models surveyed, import levies and export subsidies are endogenous - depending on the difference between threshold and world prices - where the EU domestic price is also endogenous. This is the case of the latest MISS version, of FAPRI-CARD (GOLD version) and of WATSIM.

Concerning these variable trade measures, of particular interest are the effects of the restrictions imposed on export subsidies by the 1994 GATT Agreement, and especially quantitative limitations, since these have proven to be among the most binding constraints, as regards the EU, for goods such as grain, beef, dairy and sugar (INEA, 2000). Quantitative constraints on export subsidies are implemented in most of the models surveyed, although with different approaches. The most common one, employed in FAPRI-CARD, MISS, SPEL/EU and WATSIM, is the setting of a maximum constraint on the quantity of subsidised exports. Where the EU domestic price is endogenous – in version GOLD of FAPRI-CARD and in WATSIM - the constraint together with the supply of exports determines the EU domestic price. In the first of these two models this is implemented by determining exports on the basis of the relative position of domestic prices compared to world prices. The equation expresses the supply of exports in the following way

(3) $\qquad Q_{exp} = min [L_{GATT}, (Q_s+S_t-Q_d) (p_{UER}/p_w)] + s \{max [0, (1-(p_{UER}/p_w))]\}$

where

Q_{exp} = exports;
L_{GATT} = GATT quantitative restriction of subsidised exports;
Q_s = EU domestic supply;
S_t = EU domestic stocks;
Q_d = EU domestic consumption;
p_{UER} = EU export price (including the subsidy);
p_w = world price;
s = calibrated coefficient.

If $p_{UER} > p_w$, the second term is null, and exports are equal to the minimum between the GATT quantitative limit and excess supply. If $p_{UER} < p_w$, exports will be given by the maximum quantity that the GATT Agreement allows to be subsidised, plus a second term which, through the calibrated parameter s, will make (unsubsidised) exports rise rapidly. Given, as mentioned above, that S_t is endogenous, the model represents simultaneously the functioning of price intervention, the export subsidy, and its quantitative limit.

In WATSIM, the other model in which the EU domestic price is endogenous, quantitative restrictions are modelled through intervention stocks: these start to accumulate as exports reach the quantitative GATT restriction on subsidised exports. The structure of the equations is different from that of FAPRI-CARD, but the functioning of the mechanism is substantially similar. The excess supply equation – which is derived, as usual, from the algebraic sum of the domestic supply, private (exogenous) stocks, public (endogenous) stocks and domestic utilisation – is subject to a set of constraints, allowing i)exports to reach the GATT quantitative limit when the domestic price level is above world price; in this case stocks will accumulate if exports reach the GATT quantitative

limit; ii) exports to go beyond the GATT quantitative limit when the domestic price is higher than world price.[28]

In FAO-WFM and ESIM, the restrictions on subsidised exports are represented through their effects on domestic prices; the constraint is defined in terms of maximum expenditure on export refunds, and an *ad hoc* term in the price transmission equations link the excess supply and domestic prices by means of a calibrated coefficient. In principle, this modelling strategy is less direct than the one proposed in FAPRI and WATSIM, since the effect on the domestic price is determined by a single calibrated coefficient, while in the first case this is also the result of the interaction with the intervention mechanism.

Finally, some models – notably FAO-WFM and the GOLD version of FAPRI-CARD – account for other market access provisions of the 1994 GATT Agreement, mostly by assuming that tariff rate quotas are always completely filled. In fact, this means, in the first model - where intra-industry trade is determined by a calibrated parameter – that the quota is more or less filled according to the trade flow observed in the base year; in FAPRI-CARD, given the absence of a representation of intra-industry trade, that a fixed quantity is detracted by the (net) trade flow, equivalent to the amount covered by the minimum or current access provision. In both cases, given the absence of explicit consideration of bilateral trade flows, the modelling approach is totally empirical, and must be considered unsatisfactory.

4.3 Supply management

There are two main kinds of measures within this area: those applied in output markets, such as milk and sugar quotas, and those applied the input market, such as mandatory land set-aside.

As far as output quotas are concerned, where they are modelled explicitly, a quantitative supply restriction is in place, allowing output to become price-insensitive as the (maximum) quota level is reached. This approach is found in SPEL/EU, where the medium-term module includes an inequality constraint that leads to the solution of the model. What is absent from the model, however, is the acknowledgement of the rent associated to the quotas when these are binding.

In other models, quotas are not modelled explicitly. For example in ESIM, output limitations are introduced through what is called the "effective price", that is used to represent a shadow price. The documentation is not fully clear on this issue: it is not explained how the "effective price" is calculated, nor if it determined endogenously or exogenously (Munch e Banse, 1999, pp 3-4). Should the second alternative the true, ESIM's modelling approach would be similar to that adopted in MISS: here the quota is modelled through an inequality constraint imposed on the price that corresponds, on the supply schedule, to the quota. A price reduction, however, affects output only if it is above a certain percentage, which is arbitrarily assumed to correspond to the rent associated to the quota. Output is, thus, insensitive to price reductions below a given threshold; for milk, for example, it is assumed that output only starts reacting if the price reduction is higher than 5%, that being the supposed percentage incidence of the rent on the price (Mahé and Tavera, 1989).

In other models, output quotas are simply modelled through an equality constraint, i.e. output is fixed exogenously at the (maximum) quota level, whatever the price level. This is the case of the GOLD version of FAPRI-CARD, and of WATSIM. Despite the fact that it may be true in the specific case of the EU that the maximum output established with the quota system – especially for milk – has become rather fixed by now, and that, in fact, the Berlin Agreement postponed any reform of this, it is also true that an exogenous output prevents both consideration of the rent associated with the quota system, or any assessment of a reform scenario, be this in terms of the phasing out of quotas or price reductions.

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[28] Equations that represent this mechanism are described in von Lampe (1999, p. 30).

Alternatively, to avoid exogenous treatment of supply, it is possible to fix the price on the supply schedule exogenously, at a level corresponding to the (maximum) amount allowed by the quota system. This is suggested as a way to implement quotas in SWOPSIM. However, this approach does not seem fully satisfactory either; beside from failing to provide any indication on the quota rent, an endogenous translation of the supply curve, induced, for instance, by technical change or by a change in input prices, could allow output to increase beyond the quota level, thus making the constraint ineffective. Moreover, the model could not distinguish between the effects of these elements and those due to a change in the quota regime.

Turning now to quantitative restrictions affecting input markets, mandatory set-aside is probably the measure that is most commonly implemented in the partial equilibrium models in our survey. The importance assigned to this tool stems from the importance it has assumed in the CAP since the 1992 reform. In the system originally set out in the MacSharry reform, set-aside was mandatory only for "large" producers, and for "small" ones participation in the "general" direct support regime. None of the models surveyed describes the implementation of different land set-aside regimes; therefore, it is supposed that participation in this regime was generalised. The Agenda 2000 reform indicated mandatory land set-aside to be set at the indicative rate of 10%, and that the distinctions between the "general" and the "forfait" aid regime would gradually disappear. Some models, e.g FAPRI-CARD, assume in the baseline that mandatory set-aside percentage will be further reduced in the future.

The way set-aside is implemented in the models surveyed largely depends on the structure of the supply component. Where this is the product of a yield per hectare and land area - i.e. in all the models with the exception of MISS and SWOPSIM - set-aside can be a term: i) in the land allocation equation, as in the GOLD version of FAPRI-CARD and WATSIM, but not in the yield equation; ii) in both equations, as in ESIM. In the latter case the modelling is more accurate, because it takes into account the so-called "slippage" effect, i.e. increased yields on land remaining in production, that may occur when land is set aside.

In the original FAPRI-CARD model for the US, land set-aside is linked to the degree of farmer participation in the support programs; the modelling is based on calibrated parameters, that define the degree of participation as a function of the ratio of expected net returns of participants and non-participants. As in the case of ESIM, the also takes into account the maintenance costs of the set-aside land.

In the medium-term module SPEL/EU set-aside is considered as a possible destination for land, with other agricultural activities; set-aside is, thus, included in the activity model, with an additional constraint that ensures that the base area – assumed as a reference for arable crops - is not exceeded; in this case too set-aside includes the maintenance costs of the land. However, the effect on yields of set aside is not taken into account, since yields are fixed in SPEL-EU, or determined separately in the yield model.

In those models in which the supply component does not include a separate equation for land allocation and yields, set-aside is modelled as an exogenous shift of supply schedule, the size of which is taken from the literature. This is the case of MISS and SWOPSIM; in these models is still possible to include a (fixed) slippage effect, through a reduction in the size of the supply shift. As in the case of output quotas, however, this type of modelling does not allow the model to distinguish the effect of set-aside (and slippage) from that of other endogenous supply shifters, such as a change in input prices.

4.4 Partially decoupled Payments

The most relevant measures in this group for the EU are the direct support schemes introduced first with the 1992 MacSharry reform of the CAP. At that time, such payments were meant to be "compensatory" for the concurrent reduction in intervention prices. These measures are deemed to

have only partly influenced production decisions, because they are defined on a quantity (per tonne) basis, but with a fixed reference yield per hectare o per livestock, that is relatively homogeneous for different products. The Agenda 2000 reform has further reduced payment differentiation among arable crops, thus reducing the degree of "coupling" of these payments from output decisions; payments for livestock have been further conditioned to ceilings in terms of production levels, which also moves in the same direction. Moreover, payments were no longer seen as "compensatory" for intervention prices; rather, they are conceived as a form of direct income support (INEA, 1999).

Payments being proportional to land area and livestock, the way in which they are modelled depends on the presence, in the supply component, of specific equations for the allocation of these inputs. Therefore MISS and SWOPSIM - in which supply is directly a function of output and input prices - cannot provide an effective modelling of the effects of these measures: either they have to be considered as fully "coupled" measures, and in this case they will be equivalent to a price increase in output in the model; or they have to be considered as fully "decoupled", and in this case they should not appear at all, since this would imply that they do not affect supply.

In ESIM and FAPRI-CARD, CAP direct payments are assumed to affect land and livestock allocation, but not yields. This should be regarded as a simple and acceptable proxy of the partially coupled nature of these measures. In the real world, they certainly do affect yields, mostly through investment choices, decisions about labour use, and producers' attitude toward risk; but they do not affect marginal costs and marginal revenues directly, hence the indirect and "partial" effect of production decisions.[29]

In some of the models surveyed, compensatory payments are treated, instead, as if they should be entirely "coupled" to output. This is the case of SPEL/EU, a model that, from another point of view, provides an accurate representation of direct payments, through the presence of single member states, and the consequent possibility this gives the model to account for the related differences in the level of the payments. Nonetheless, yields are fixed in SPEL/EU, so that the effects of a change in the payments is fully equivalent to a change in the output price (Witzke and Zintl, 2000). Also in WATSIM, direct payments are equal to direct price support, since they enter the calculation of the "effective" producer price for EU producers (von Lampe, 1999). The same also applies to FAO-WFM, where they are included in the price transmission equations, and are used in the calculation of price wedges. (Sharma *et al.*, 1996).

4.5 Voluntary Schemes

Voluntary market policy schemes have been adopted by the CAP mainly through regulations 2078/92 and 2080/92. These are aimed at promoting a reduction in production, and at creating incentives for the forestation of agricultural land, by proving farmers with conditional payments. Other measures, worth mentioning in this area, are the voluntary set-aside schemes.

Voluntary measures are not included in any of the models in this survey. The only exception to this, as mentioned previously, is found in US model of the FAPRI-CARD system, due to the importance of conditional schemes in US agricultural policy. In that case, the participation rate is derived from a calibrated parameter, linking participation to the ratio of expected net returns form participation/non-participation. While this is presented as an "endogenous" treatment of the participation rate (Devadoss *et al.*, 1989, 1993), the model does not, in fact, provide any explanation, apart from the observations made in the years in which the model was calibrated. A more satisfactory approach, from an economic point of view, would require the degree of participation in a voluntary scheme to be determined by the technology underlying supply, and by a

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[29] Gohin *et al.* (1999) provides an in depth discussion of these issues.

differentiation of farmers in this respect; in other words, it seems difficult to imagine that one could have a genuinely endogenous treatment of the participation rates – and consequently of the effects of a voluntary scheme – without introducing some differentiation among production units in terms of their production functions.

With reference to the CAP, therefore, the solution adopted by FAPRI-CARD does not appear entirely convincing, also because the EU's present voluntary schemes are not tied to specific products, but rather to the adoption of a specific production technique.

Table 2. Summary of the Representation of Policies in the Models

	ESIM	FAO WFM	FAPRI	MISS	SPEL/EU	SWOPSIM	WATSIM
Price support	price wedges	PSE and CSE	price wedges; intervention with endogenous stock	price wedges	price wedges	PSE e CSE	PSE and CSE; intervention with endogenous stocks
Trade policies	price wedges	PSE and endogenous export subsidies in price transmission	price wedges, limits to subsidised exports with endogenous export supply	price wedges	price wedges	PSE	PSE; limits to subsidised exports with endogenous export supply
Output quotas	unclear	absent	equality constraint	inequality constraint	inequality constraint	equality constraint	equality constraint
Set-aside	land allocation equations and slippage in yield equations	absent	land allocation equation and slippage in yield equations (USA)	supply shift	exogenous limitation to land use	absent	exogenous limit to land use
Direct payments	land and livestock allocation equations	Term in price transmission equations (as fully "coupled")	land and livestock allocation equations	absent	land and livestock allocation equations (as a fully "coupled")	absent	calculation of production prices (as fully "coupled")
Voluntary schemes	absent	absent	program participation rate (in US model)	absent	absent	absent	absent

5. Concluding remarks

Considering at a glance all models reviewed, the picture that emerges predictably includes lights and shadows. In general, given the breadth of the models analysed from the point of view of products and markets included - and this was one of the key elements of selection - there is more than one issue in which accuracy ultimately gives way to the limitations arising from the lack of available information, and from the need to condense the complexity of the exercises. Having said that, the effectiveness that a number of the models have demonstrated in representing some of the current agricultural policy tools, and particularly those of the CAP, can be considered as their main strength.

Concerning the partial equilibrium assumption - the other main element in the selection grid - while this offers no theoretical advantages, it is also true that it does not appear to be a particularly strong handicap for quantitative analysis of agricultural policies. Consequently, to the extent that it still allows the model to produce a more detailed analysis of certain measures, it may well be worthwhile accepting the associated limitations. In other words, there are probably several cases in which the "pragmatic advantage" of partial models does not lead to a significant decrease in information when other "costs" in terms of data and complication are considered.

However, more serious difficulties arise from other, often much more restrictive, assumptions, such as that of perfect competition in all markets. It is quite evident that, the primary products which are most fully integrated in world markets - such as the grain or the oilseed sectors - are anything but fully competitive, and this interacts in a profound way with the effects of other policies. The attempt to take these aspects into account would, therefore, be a rewarding prospect in the future development of agricultural policy modelling.

Further problematic elements as regards the models analysed here, are the frequent neglect of behavioural restrictions, the extensive use of extremely simplified functional forms, and the frequent resort to calibration as a means for deriving parameters. Concerning the first issue, it is hardly acceptable that in models that are heavily dependent on economic theory *a priori* – rather than on statistical evidence - the very basic assumptions of that theory are ignored in their implementation. Concerning functional forms, their simplicity leads to an implicit simplification of agents' behaviour, and force researchers to resort to the concept of the "representative" agent, disregarding the fact that agriculture in general – and particularly EU agriculture – is a very heterogeneous world. Finally, with respect to parameters, concern stems mainly from the lack of any statistical feedback, something that directly affects the reliability of the results.

Coming to the characteristics which most directly influence the modelling of CAP tools, firstly it should be pointed out that usually the level of detail in terms of products and measures is generally sufficient to identify the main domain of the CAP; the partial equilibrium assumption does not seem to prevent accuracy from this point of view, with the notable exception, however, of quota rents, a measure affecting both farm incomes and public expenditure. Here at least in principle, a good case could be made for using a general equilibrium framework. Nevertheless, comparison with the results in the chapter by De Muro and Salvatici, in fact, shows that general equilibrium models for agricultural policy employ very similar modelling strategies.

The quality of CAP modelling appears rather to depend on other characteristics of the models. Three major elements can be identified here. Firstly the separate determination of yields and land allocation in the supply component, that significantly affects the modelling of direct payments and set-aside provisions. Secondly, the endogeneity/exogeneity of EU market prices, that influences the modelling of intervention price reduction and of the limitation of export subsidies. Thirdly, the structure of the foreign trade component, that determines both the kind and the quality of the modelling of trade policy.

Looking at specific tools, modelling of direct price support is at its most unsatisfactory where it is based on an exogenous price wedge; thus those models that include the effect of intervention buying on market price explicitly have a clear advantage. The same cannot be said for any of the models analysed concerning trade measures; actually this appears as one of their greatest weaknesses in terms of policy representation, primarily due to the homogeneous and non-spatial structure of the trade components, that prevent modelling bilateral measures and intra-industry trade. The first of these two issues is of great relevance for ESIM, a model constructed with the intention of simulating the effects of EU enlargement. However, in the area of trade measures, the endogenous determination of EU market prices also positively affects the modelling of export subsidies.

Coming to supply management tools, an increase in the focus on these measures appears to have been made in some of the relatively more recent models, such as ESIM, or the GOLD version of FAPRI-CARD, as a result of the importance that these measures have gained in the EU after 1992. In general, however, set-aside representation seems to be more accurate than output quotas: even in the most recent efforts, which focus particularly on the CAP, a (simple) exogenous supply is a frequent solution, though not an entirely satisfactory one. Direct payments, on the other hand, are represented much more effectively in recent models than in the past.

An overall comparison of the models analysed in terms of effectiveness of the CAP representation shows that the three relatively more recent ones - ESIM, FAPRI-CARD (GOLD version) and WATSIM - appear to be better equipped both with respect to more traditional instruments, such as intervention, and for more recent ones, such as set-aside, direct payments or the restrictions on export subsidies. Moreover, the relatively older models – MISS, SWOPSIM but also FAO-WFM to some extent - appear fairly limited in their ability to isolate the effects of single instruments, in particular those on which the two CAP reforms of the 1990s were based. This is true both for the first two models, mainly due to the simplicity of the supply component, and for the third one, which, being focused on developing countries, seems to show a sort of "lack of interest" in the domestic policies of developed countries such as the CAP.

It should also be considered, however, that both MISS and SWOPSIM were originally conceived during the Uruguay Round, with the aim of simulating trade liberalisation scenarios, and hypotheses of the radical reduction in agricultural support. This in part explains why they are less well equipped to assess the effects of changes in specific tools of the agricultural and of the trade policies, that have materialised after the 1992 CAP reform and after the 1994 GATT Agreement. SPEL/EU, on the other hand, appears in a rather peculiar position; despite being a relatively recent effort, and the fact that it was created with the very aim of assessing the effects of the CAP, it seems less well equipped than other models, either concerning the effects of price and trade policies (given its non-global structure), or the use of some relatively more recent tools, such as direct payments.

As regards future work, the introduction of bilateral flows seems to be a priority for more than one of the models reviewed, opening the way to modelling bilateral measures and tariff quotas. This is a particularly important prospect, given the upcoming WTO negotiations, where these measures could play a significant role. From this point of view, even representation of partially decoupled measures could become a matter of primary importance, given the political sensitivity of assessing the distortions they can produce.

Considering the likely evolution of the CAP in the coming years, it is possible that the models will need to increase their capacity to consider measures applied at the national level in the EU, and also to deal with voluntary schemes. In this respect, considerable importance can be attached to some of the measures promoted in, what is termed "horizontal regulation" of Agenda 2000 (regulation 1259/1999), in terms of direct payment modulation and environmental cross-compliance, whose precise terms of application are left to the discretion of the member states; within the ambit of the same reform programme, another important issue for the future is the setting up of a national *envelope* for beef, to be managed by member states.

To sum up, aside from the issue of modelling agricultural policy tools, the following important aspects need to be improved: data collection, respect for behavioural assumptions, and finally the quality of parameters, and functional forms. Work on these issues is crucial, since they directly affect the accuracy and the reliability of the results of the models; and, if disregarded, they may obviate all the improvements so far achieved in the modelling of specific agricultural and trade policy tools.

References

Ames G. C. W., Gunter L., Davis C.D.
1996 "Analysis of USA-European Community Oilseed Agreements", *Agricultural Economics*, n. 15.

Anania G.; De Filippis F. (edited by)
1996 *L'accordo Gatt in agricoltura e l'Unione Europea*, R.a.i.s.a. Project, Franco Angeli, Milan.

Andrews N. *et al*.
1990 *Some Implications of Rebalancing EC Agricultural Protection*, ABARE (Australian Bureau of Agricultural and Resource Economics), Canberra, May.

Andrews N.; Roberts I.; Hester S.
1994 *The Uruguay Round Outcome: Implications for Agricultural and Resource Commodities*, ABARE (Australian Bureau of Agricultural and Resource Economics) National Agricultural and Natural Resources Outlook Conference, Canberra, February.

Barrett C.; Fabiosa J. E.
1998 "A Policy Model for the Livestock and Poultry Sectors of Mexico", *CARD Technical Report* 98-TR 39.

CARD
1991 *An Analysis of the EC Commission Plan for CAP Reform*, GATT Research Paper 92-GATT 4, Iowa State University, November.

CARD (Center for Agricultural and Rural Development).
1991a *Implications of a GATT Agreement for World Commodity markets, 1991-2000*, GATT Research Paper 91-GATT1, Iowa State University.

CARD (Center for Agricultural and Rural Development)
1991b *Determining Winners and Losers from a GATT Agreement: The Importance of Base Periods and Rules*, GATT Research Paper 91-GATT 2, Iowa State University.

CARD (Center for Agricultural and Rural Development)
1992 *Implications of a GATT Agreement for World Commodity Markets, 1993-98: An Analysis of the Dunkel Text on Agriculture*, GATT Research Paper 93-GATT, Iowa State University, April.

Cuffaro N.
1990 "Modelli di valutazione degli effetti del protezionismo agricolo: un'analisi della letteratura", Fabiani G. (edited by) *Tra protezionismo e liberalizzazione dei mercati*, Franco Angeli, Milan.

Devadoss S. D.; Westhoff P.C.; Helmar M.D.; Grundmeier E.; Skold K.; Meyers W.H.; Johnson S.R.
1989 "The FAPRI Modelling System at CARD: A Documentation Summary" *Technical Report* 89-TR 13, Center for Agricultural and Rural Development, Iowa State University, Ames, Iowa.

Devadoss S. D.; Westhoff P.C.; Helmar M.D.; Grundmeier E.; Skold K.; Meyers W.H.; e Johnson S.R.
1993 "The FAPRI Modelling System: A Documentation Summary", in *Agricultural Sector Models for United States: Descriptions and Selected Policy Applications"* Taylor C. R., Reichelderfer K.H. e Johnson S.R. (edited by), Ames, Iowa State University Press.

European Commission
1998 *CAP Reform proposals. Impact Analyses*, Directorate-General for Agriculture (DG VI), Brussels, October.

European Commission
2000 *Agenda 2000 CAP Reform Decisions. Impact Analyses*, Directorate-General for Agriculture (DG VI), Brussels, February.

EUROSTAT
1996 *SPEL/EU Model. Medium Term Trends in Agricultural Production, Demand and Value Added 1996-2001*, EUROSTAT, Luxembourg.

EUROSTAT
1997 *SPEL Data for Eu Agriculture 1985-1996*, EUROSTAT, Luxembourg.

FAIR 6 CT 98-4148
1999 *Review of Applied Models of International Trade in Agriculture and Related Resources and Environmental Modelling*, Interim report n.1, June.

FAO
1995 *Impact of the Uruguay Round in Agriculture: Methodological Approach and Assumptions* Economic and Social Department, Commodities and Trade Division, ESC/M/95/1, April.

FAO
1998 *World Food Model Technical Documentation*, mimeo, Commodities and Trade Division, May.

FAPRI
1997 *The European Union's Proposed "Agenda 2000" CAP Reforms: A First Look*, FAPRI Policy Working Paper 03-97, October.

FAPRI
1998 *Analysis of the Proposed "Agenda 2000" European Union CAP Reforms*, Working Paper 98-WP 191, April.

FAPRI
1999 *Implications of the Berlin Accord for EU Agriculture*. FAPRI-UMC Report n. 7-99.

FAPRI

2000 *The European Union Grains, Oilseed, Livestock and Dairy (GOLD) Model. Preliminary Documentation*, mimeo, University of Missouri.

Francois J. F.; Hall H. K.
1997 "Partial Equilibrium Modelling", in Francois J. F. e Reinert K. A. (edited by) *Applied Methods for Trade Policy Analysis. A Handbook* Cambridge University Press, Cambridge.

Fuller F.
1997 "Policy and Projection Model for the Meat Sector in the People's Republic of China", *CARD Technical Report* 97-TR 36.

Fuller F., Beghin J., Mohanty S., Fabiosa J., Fang C., Kaus P.
1999, "The Impact of the Berlin Accord and European Enlargement on Dairy Markets", in *Canadian Journal of Agricultural Economics*, 47.

Gardiner, W.; Roningen V.; Liu K.
1989 "Elasticities in the Trade Liberalisation Database, Staff Report, Economic Research Service, U.S. Department of Agriculture, Washington DC.

Gohin A., Gorin, O., Guyomar H., Le Mouel, C.
1999 "Interpretazione economica, vantaggi e limiti del disaccoppiamento del sostegno ai redditi agricoli", *La Questione Agraria*, 75.

Goldin I. and Knudsen O. (edited by)
1990 *Agricultural Trade Liberalisation. Implications for Developing Countries*, Oecd & World Bank.

Greenfield J. de Nigris M.; Konandreas P.
1996 "The Uruguay Round Agreement on Agriculture: Food Security Implications for Developing Countries", *Food Policy* n. 21, pp. 365-375.

Guyomard H.; Le Mouel C.; Surry Y.
1993 "Les effets de la reforme de la PAC sur les marchés céréaliers communitaires", *Cahiers d'èconomie et sociologie rurales*, 27.

Guyomard H.; Mahé L.; Tavéra C.; Trochet T.
1991 "Technical Change and EC-US Agricultural Trade Liberalisation", *Journal of Agricultural Economics*, 42, 2, pp 119-137.

Haley, S.
1989 *Using Producer and Consumer Subsidy Equivalents in the SWOPSIM Modelling Framework*, Staff Report, Economic Research Service, U.S. Department of Agriculture, Washington, DC.

Hart C.; Helmar M. D.; Hayes D.; Meyers W. H.
1993 *CAP Reform Studies: A Comparison*, paper presented at the annual Conference of IATRC, San Diego, December.

Hartmann M.; Schmitz P. M.

1992 "Free Trade versus Supply Control: the Case of the European Community", in Becker T., Gray R. and Schmitz A. (edited by) *Improving Agricultural Trade Performance under the GATT*, Wissenschaftsverlag Vauk Kiel KG, Kiel.

Helmar M. D. *et al.*
1992 *An Analysis of Reform of the CAP*, Paper presented at the 34th EAAE Seminar, Frankfurt, 7-9 December.

Helmar, D. M.; Smith D. B.; Meyers W. H.
1994 "An Analysis of the Uruguay Round: Implications for Agriculture", in Gray, R. Becker T., Schmitz A. (editors) *World agriculture in a post-GATT environment: New Rules, New Strategies*, Proceedings of a symposium organised by Saskatchewan Wheat Pool and the University of Saskatchewan, Saskatoon.

Henrichsmeyer W.; Britz W.; Eidmann U.; von Lampe M.
1995a *SPEL-TRADE Final Report*, Institute for Agricultural Policy, Bonn.

Henrichsmeyer W.; Weber G.; Wolf W.
1995b *Overview of the SPEL System (Rev. 1)* EUROSTAT, Luxembourg.

Istituto Nazionale di Economia Agraria (INEA)
1999 *La Riforma della Pac in Agenda 2000. Dalle proposte alle decisioni finali*, Rome, June.

Istituto Nazionale di Economia Agraria (INEA)
2000, *Le Politiche Agricole dell'Unione Europea. Rapporto 1998-99*, Rome, June.

Johnson, M.; Mahé L.; Roe T.
1993 "Trade Compromises between the European Community and the United States: An Interest Group-Game Theory Approach", in *Journal of Policy Modelling* 15 (2) pp. 199-222.

Johnston S.R.; Meyers W.H.; Womack A.W.; Brandt J.; Grimes G.; Devadoss S.; Westhoff P.C.; Helmar M. D.; Skold K.D.; Grundmeier E.; Shin S.Y.; Trujillo J.; Perso R.; Brown S.
1993 "Policy Scenarios With the FAPRI Modelling System" in *Agricultural Sector Models for United States: Descriptions and Selected Policy Applications"* Taylor C. R., Reichelderfer K.H. and Johnson S.R. (edited by), Ames, Iowa State University Press.

Kennedy P. L., Atici C.
1998 *A Sectoral Analysis of Agricultural Trade Liberalisation*, Journal of Agricultural and Applied Economics, n. 30, 2.

Kennedy P. L.; von Witzke H.; Roe T.
1996 "Multilateral Agricultural Trade Negotiations: A Non-Cooperative and Cooperative Game Approach", in *European Review of Agricultural Economics,* n.23, 4.

Laird S.
1997 "Quantifying Commercial Policies", in Francois J. F. and Reinert K. A. (edited by) *Applied Methods for Trade Policy Analysis. A Handbook* Cambridge University Press, Cambridge.

Liapis, P.S.

1990 *Incorporating Inputs in the Static World Policy Simulation Model (SWOPSIM)",* Technical Bulletin n. 1780, United States Department of Agriculture.

Liapis, P. S.
1994 "Environmental and Economic Implications of Alternative EC Policies" *Journal of Agricultural and Applied Economics*, 26(1), pp. 241-51.

Makki S. S. Tweeten L. Gleckler J.
1994 "Agricultural Trade Negotiations as a Strategic Game", *Agricultural Economics*, n.10.

Mahé L., Guyomard H.
1991 "An Assessment of the EC GATT proposal", J. Marsh and others, *The Changing Role of the Common Agricultural Policy: the Future of Farming in Europe*, Belhaven Press, London.

Mahé L.; Moreddu C.
1987 "An Illustrative Trade Model to Analyse CAP Changes: Unilateral Moves and Interaction with USA" *Economic Notes by Monte Dei Paschi Di Siena*, 1, pp. 52-71.

Mahé L.; Tavéra C.
1989 "Bilateral Harmonization of EC and US Agricultural Policies" *European Review of Agricultural Economics*, 15, pp. 325-348.

Meilke, K.; McClatchy D.; De Gorter H.
1996 "Challenges in Quantitative Economic Analysis in Support of Multilateral Trade Negotiations" *Agricultural Economics* Vol 14, pp. 185-200.

Meyers W. H.; Helmar M. D.; Hart C. E.
1998 "Modelling the Outcomes of CAP Reform", in *The Reform of the Common Agricultural Policy*, Ingersent K. A., Rayner A. J. and Hine R. C. (edited by), MacMillan.

Meyers W.; Womack A.
1997 "The European Union's Proposed "Agenda 2000" CAP reforms: A First Look" *FAPRI Policy Working Paper* 03-97, October.

Münch, W.
1999 "Effects of CEC-EU Accession on Agricultural Markets in the CEC and on Government Expenditure", University of Gottingen, Institute of Agricultural Economics, Progetto FAIR-CT95-0029, Draft Final Results of Task 4.

Münch, W.; Banse M.
1999 "Quantifying The Impact of EU-Accession - A Combined Partial and General Equilibrium Approach for Central European Countries" paper contributed to EAAE Congress, Warsaw, August 24 to 28.

OECD
1998a *Agricultural Policies in OECD Countries. Measurement of Support and Background Information 1998*, OECD, Paris.

Roningen V. O.

1997 "Multi-Market, Multi-Region Partial Equilibrium Modelling", in Francois J. F. and Reinert K. A. (edited by) *Applied Methods for Trade Policy Analysis. A Handbook* Cambridge University Press, Cambridge.

Roningen, V.O.; Dixit P.M.
1990 "Assessing the Implications of Freer Agricultural Trade", *Food Policy*, Vol. 15, pp. 67-75, February.

Roningen, V.O.; Dixit, P.M.; Sullivan, J.; Hart T.
1991a *"Overview of the Static World Policy Simulation (SWOPSIM) Modelling Framework"*, Staff Report, Economic Research Service, U.S. Department of Agriculture, Washington, DC.

Roningen, V.O.; Sullivan J.; Dixit P.M.
1991b *"Documentation of the Static World Policy Simulation (SWOPSIM) Modelling framework"*, Staff Report n. AGES 9151, Economic Research Service, U.S. Department of Agriculture, Washington, DC.

Salvatici L.; Carter C. A.; Sumner D. A.
1999 *The Trade Restrictiveness Index: the potential contribution to agricultural policy analysis*, in Peters G. H., von Braun J. (a cura di), "Food Security, Diversification and Resource Management: Refocusing the Role of Agriculture?", Ashgate, Aldershot.

Sharma R., Konandreas P., Greenfield J.
1996 "An Overview of Assessments of the Impact of the Uruguay Round on Agricultural Prices and Incomes", *Food Policy*, n. 21, 4/5, pp. 351-363.

Sharma R. Konandreas P., Greenfield J.
1997 "Synthesis Of Results on the Impact of the Uruguay Round on the Global and LAC Agriculture", Cordeau J.L., Valdes A. and. Silva F, (edited by), *Implementing the Uruguay Round Agreement in Latin America: the Case of Agriculture*, FAO and World Bank, Santiago, Chile.

Sharma R., Konandreas P., Greenfield J.
1999 *"A Synthesis of Assessments of the Impact of the Uruguay Round on Global and South Asian Agriculture"*, B. Blarel, G. Pursell and A. Valdes, edited by, *Implications of the Uruguay Round Agreement for South Asia: the Case of Agriculture*, World Bank & Allied Publishers, New Delhi, pp. 15-28.

Shaw I.,, Shaffer J., Premakumar V., Hayes D.
1997 "Policy and Forecasting Models for the Chinese, South Korean, Australian and European Union Meat Sectors", *CARD Technical Report* 97-TR 35.

Thompson R. L.
1981 "A Survey of Recent U.S. Developments in International Agricultural Trade Models" USDA ERS *Bibliographies and Literature of Agriculture* n. 21.

van Tongeren F. *et al.*
2000 *Review of Agricultural Trade Models: An Assessment of Models with EU Policy Relevance*, paper presented at the 65th EAAE Seminar on "Agricultural Sector Modelling and Policy Information Systems", Bonn, March.

Vanzetti D., Andrews N., Hester S., Fisher B.S.
1994 "U.S.-E.C. Agricultural Trade Relations and the Uruguay Round: A Cairns Group Perspective", G. Anania, C. A. Carter and A. F. McCalla, edited by, *Agricultural Trade Conflicts and GATT. New Dimensions in U.S.-European Agricultural Trade Relations*, Westview Press, Boulder.

Various authors
1994 "EC Agricultural Policy for the 21st Century", in *European Economy*, *Reports and Studies*, European Commission, Directorate-General for Economic and Financial Affairs, 4.

von Lampe M.
1998 "The World Agricultural Trade Simulation Model. An Overview", Discussion Paper 98-05, *Agricultural and Resource Economics*, University of Bonn.

von Lampe M.
1999 *A Modelling Concept for the Long-Term Projection and Simulation of Agricultural World Market Developments: World Agricultural Trade Simulation Model (WATSIM)*, Studien zur Agrar- und Umweltpolitik, Shaker Verlag, Aachen.

von Lampe M.
2000 "The Impact of South-East Asia Food Demand on Global Markets – An Application of WATSIM", paper presented at the EAAE Seminar "*Agricultural Sector Modelling and Policy Information Systems*" Bonn, March.

Weber, G.
1995 *SPEL system. Methodological Documentation (Rev. 1) Vol 2. MFSS*, EUROSTAT, Luxembourg, Office for Official Publications of the European Communities.

Westhoff P.; Young R. II
2000 "The Status of FAPRI's EU Modelling Effort", paper presented at the EAAE Seminar "*Agricultural Sector Modelling and Policy Information Systems*" Bonn, March.

Westhoff P.; Hayes D. J.; Meyers W. M.; Helmar M. D.
1992 "An Analysis of the European Community Commission Plan for Common Agricultural Policy Reform", in Becker T., Gray R. e Schmitz A. (edited by) *Improving Agricultural Trade Performance under the GATT*, Wissenschaftsverlag Vauk Kiel KG, Kiel.

Witzke H. P.; Zintl A.
2000 "A Modelling Tool for Policy Makers: MFSS99", paper presented at the EAAE Seminar "*Agricultural Sector Modelling and Policy Information Systems*" Bonn, March.

Wolf W.
1995 *SPEL System. Methodological Documentation (Rev. 1) Vol 1. Basics, BS, SFSS*, EUROSTAT, Luxembourg, Office for Official Publications of The European Communities.

Young R. II; Westhoff P.W.; Brown D.S.; Adams G.; Womack A. W.
1999 "Modelling the World Agri-Food Sector; The Food and Agricultural Policy Research Institute Approach" Paper prepared for the *Agricultural Economics Society*, Annual Conference. Stranmillis University College, The Queen's University, Belfast, 28 March,

Zintl A.; Gruel H. J.
1995 *SPEL System. Technical Documentation (Rev. 1) Vol 1., Basics* and *Vol 2 BS, SFSS, MFSS,* EUROSTAT, Luxembourg, Office for Official Publications of the European Communities.