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AGLINK: THE OECD PARTIAL EQUILIBRIUM MODEL

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AGLINK: The OECD partial equilibrium model

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Abstract

The paper presents a general introduction to the structure and the characteristics of AGLINK, in comparison with the other most important global multi-commodity partial equilibrium models. Special reference is made to policy modelling, and particularly to the representation of the most important CAP tools, grouped into four types; direct price support, trade measures, supply management tools, and partially decoupled payments. The model is one of the most interesting efforts, especially in terms of its ability to effectively represent EU agricultural policy tools. The high level of institutional control exerted by the OECD member countries provides AGLINK with a particularly high-level of *expertise*, and a constant update of information; but it also prevents its results from being solely of a scientific nature.

1   Introduction

AGLINK is a partial equilibrium model of the agricultural sector that represents the most important markets in the world agriculture. Its basic characteristics are similar to those of the models reviewed in the chapter by Conforti in this volume; the reason why AGLINK is analysed here in greater detail stems, on the one hand, from the growing importance attached to its results by the OECD member countries and, on the other hand, from its current developments: conceived about a decade ago, it has developed significantly over the last few years, both in terms of coverage of products and regions, and, especially, in the accuracy of its modelling agricultural policy tools. An increasing number of OECD member countries are actively contributing to the database and to the further development of the model.

AGLINK's results are mainly employed in the preparation of the OECD *Medium Term Outlook*, i.e. the periodical reporting the medium-term forecasts on the market development for main agricultural commodities in OECD countries, and their main trading partners.[1] The model was first conceived in the early 1990s; before that period, the OECD used to formulate its forecasts by means of the information gathered from member countries through the *Medium Term Questionnaire*[2]. Originally this information was just collected and discussed by the OECD Secretariat, but no analytical tools were used to ensure overall consistency in the forecasts of individual countries. This situation did not allow researchers to formulate forecasts on world markets, particularly concerning world prices, or to understand the main determinants of predicted trends.

Therefore, the OECD decided to develop a global model of the agricultural sector, mostly by employing the tools available at the time in the national agencies of member countries; the choice not to build a specific model *ex novo* was largely taken on account of the considerable cost that the construction of a new model would have required, while the data and the parameters of existing national models were readily available. Furthermore, there was a general consensus that pooling the existing national modelling efforts would simplify the discussions between member countries about the results generated at a global level.

Thus AGLINK was built by the OECD Secretariat in co-operation with a number of members and several independent consultants; efforts were made to keep the approach as simple and uniform as possible among the countries modelled. The first version included seven countries, and it became operational by the summer of 1992. Since then the model has systematically incorporated the information collected through the *Medium Term Questionnaire*. On the one hand, this questionnaire has remained the main means for disseminating information at the national level that is not dealt with in the model; on the other hand, its role has been progressively modified, so that now it has become the tool for finding the exogenous variables to be inserted into AGLINK's member country modules. In recent years, besides its original institutional role in forecasting trade balances and prices, AGLINK has also come to play an increasing role in the simulation of the effects of policies. The model's runs have included alternative scenarios concerning both agricultural policy variables, and macroeconomic variables. This has had a significant effect on the structure of the equations. OECD countries have continued to exert relatively tight control over the model; the results are published after a long and accurate three-stage validation process. The first stage consists mostly of merging the information received from member countries via the Medium Term Questionnaire with those drawn from the specialised international database. On this basis a first baseline scenario is prepared, i.e. a set of forecasts on the expected trend of the world market, conceived on the assumption

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[1] The latest published *Outlook* is OECD (2001).

[2] The *Medium Term Questionnaire* is currently sent by the OECD to all Member countries, to collect the medium-term national forecasts formulated by national experts, both on the basis of expert judgements and with quantitative analysis tools.

that the policy environment will not change. In the second stage, the baseline forecasts produced by AGLINK are compared with those reported in the questionnaires completed by members; discrepancies are discussed with the OECD Secretariat in bilateral sessions. Based of these discussions and the updates made to the model, a second baseline scenario is produced, which is discussed at the annual meeting of the working groups of the OECD Agricultural Committee. In the third and final stage, the observations raised at the Committee meetings, and the corresponding updates in the model, lead to the final baseline version, whose main results are presented and published in the *Medium Term Outlook*.

The rest of this paper presents a general introduction to the structure of the equations, aimed at showing how the most important markets are modelled. The peculiarities of AGLINK are highlighted, especially with respect to the general characteristics of the global multi-commodity partial equilibrium models described in the chapter by Conforti in this volume. The third section deals with the policy modelling in AGLINK, and particularly with the representation of the most important CAP tools, grouped into four types; direct price support, trade measures, supply management tools, and partially decoupled payments; voluntary schemes – the other type considered in another chapter of this volume with reference to other modelling approaches - are not taken into account here, since they are not modelled in AGLINK. Given the general purpose of the volume, AGLINK's more technical aspects relating to how the the model is used are not thoroughly discussed; rather, emphasis is placed on the effectiveness of the structure of the equations in modelling markets and policies. This contribution is based on the documentation relative to the year 1998 and on the version of the model used for the 2000 *Outlook* (OECD, 2000).

2 AGLINK's general characteristics

2.1 Product and Country coverage

From the geographic point of view AGLINK is made up of 10 fully-fledged country-modules (or region-modules) plus a "rest of the world" (OECD, 2000). OECD members include Australia, Canada, Japan, New Zealand, South Korea, Mexico, the EU, as a single block, and the US. Among non-OECD countries, Argentina and China are modelled as separate modules while all the other countries are either included in the "rest-of-the-world", or included only with few equations when a particular country or region can have a significant affect on the world market for a certain product and, thus, is of interest for the *Medium Term Outlook*. This is the case with Brazil, Chile, Paraguay and Uruguay that are included for the beef market, and when the objective is simulating the effects of the Mercosur trade agreements.

AGLINK includes over thirty of the most important products, in terms of output and trade in the OECD area. Concerning grains, wheat is included (common and durum wheat in a single product) as well as rice (added recently), barley, maize, oats, millet and rye (only in some countries) and a group of "coarse grains" that includes different products according to specific regions[3]. In the oilseed sector, products are considered at three different processing stages, i.e. seeds, cakes and oils. Soybean, rapeseed and sunflower are included as single products, while as regards oil, palm-oil and other vegetable oils are included, but olive oil is excluded. For livestock products AGLINK includes beef, pork, sheep, poultry, eggs and wool. The dairy sector includes liquid and concentrated milk, whole and skimmed milk powder, butter, cheeses, other fresh dairy products, casein, whey, and an aggregate of "other" dairy products. As in other main partial models, fruit and vegetables are not included nor, more generally, Mediterranean products, such as wine and olive oil.

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[3] E.g. for Australia, Mexico, the US and the rest of the world this includes maize, barley, oats and sorghum; this latter product is absent for Canada, New Zealand and for the EU, where rye and the so-called "mixed grains" are included.

AGLINK is based on country modules that have been built according to uniform criteria, although each module contains several country-specific details. The idea is that problems can be solved both as single country models, assuming the rest of the system exogenous, or as a whole. This characteristic suits the purpose of the *Medium Term Outlook*: single country modules are at first solved separately, and then aggregated through market clearing identities to generate the medium-term forecasts on world prices. Moreover, this feature facilitates the extension of the model to new regions, since a new country-module can be added, or an existing module can be broken into more than one new module, without disrupting the overall system.

2.2   Main assumptions

Like other main partial equilibrium global models, AGLINK consists of a set of behavioural equations, of technical relations, and a set of identities that model the relations among the agricultural activities, and between agriculture and the rest of the economy. Schematically, these can be grouped into a supply component, a utilisation component, a trade component, a set of transmission equations of world and domestic prices, and a set of world market clearing equations.

Not all this information, however, is available in the model for all products; often AGLINK only calculates output and prices for a specific good, while the demand component in determined only for a more aggregated product group. This is the case with oilseeds: there are equations endogenously determining output and domestic prices of soybeans, rapeseeds and sunflower seeds, but the demand is specified exclusively for a single "oilseeds" product group. Thus, for single products the model does not really calculate actual equilibrium prices; rather, the equilibrium price of the aggregate product determines the prices of the single items, through a weighting system. This is also true for coarse grains, and for the trade component, where export supply and import demand equations are specified only for coarse grains as a group.

AGLINK assumes perfect competition in all markets, and perfect homogeneity for products from different countries. The functional form of the equations is constant elasticity log-linear in most cases; hence, the coefficients of the variables directly represent partial elasticities. A calibration term, called *add factor*, is added to all behavioural equations. Add factors are employed in the "multilateral" process of revision of the results to take into account the indications provided by member states.

The model includes some dynamics, exclusively of the recursive type. In particular, in the supply component for livestock products, of heads for each type of livestock – e.g. the number of calves in a given age-range – depends dynamically on the number of younger calves available in the previous period; the choice between slaughtering and breeding depends on the relative output prices of the two alternatives, and on a feed cost index. On the demand side there are only lagged variables – mostly previous periods' prices – in the equations for beef.

The trade component is homogeneous and non-spatial, and the model only determines net trade positions. Exports of net importing countries and imports of net exporters are always taken into account as exogenous (fixed) quantities deducted from the trade balance; they are mostly the minimum and current access envisaged by the 1994 GATT Agreement, that for AGLINK, as for other partial models, cannot be accounted for in a more accurate way.

The closure rule determines equilibrium prices for most products, by assuming that adjustment in all markets takes place until total demand, given by the sum of consumption, exports and stock changes, equals total supply, given by production and imports.

2.3   Modelling of the main products

The supply component in AGLINK determines yields and land areas separately. Competition by crops for land is represented through cross-price effects. The equation for land allocation is of the form:

(1) $$T_{i,t} = exp\{ \boldsymbol{a}_i + \boldsymbol{S}_j [\boldsymbol{b}_{i,j} \, log(R_{j,t})] \}$$

where:

i, j = crops;

t = period;

$T_{i,t}$ = land allocated to the i-th crop;

$R_{j,t}$ = revenue per hectare from the j-th crop;

$\boldsymbol{b}_{i,j}$ = elasticity of land to crop i with respect to revenue of the crop j $\dfrac{\partial T_i}{\partial R_j}$.

Yields are defined by means of linear trend functions, that are intended to approximate technical change. Market prices are introduced as explanatory variables of the yields only for grains and oilseeds, and only for some countries.

For oilseeds AGLINK includes an equation that relates the amount of processed product to the prices of the raw one, of the oilmeals and oil. The supply of oil and oilmeals is calculated as the overall amount of these times an exogenous crushing rate.

Livestock supply includes a representation of farmers' decisions through the main stages. In the case of cattle, meat and milk production are linked through the allocation of heads. AGLINK assumes that farmers invest in breeding animals– in which case calves and heifers are not slaughtered – when the capital value of the cattle exceeds the market price at slaughtering. The capital value is defined on the basis of the revenue that can be obtained from selling the calves; hence investment in breeding animals will increase as the expected value of future meat and milk production increases. In turn, the number of animals for reproduction has an influence on the availability of cattle for slaughtering in the short run. Since prices affect the expected level of future prices, in the short run the elasticity of meat output with respect to prices can assume negative (abnormal) values.

The system as a whole is presented schematically in Figure 1. Production in each period depends on both market prices, and on the number of cattle for milk and meat production (lagged two periods), and on an aggregate index of feed costs. Together with direct payments, the market price contributes to determine

Figure 1. Beef supply
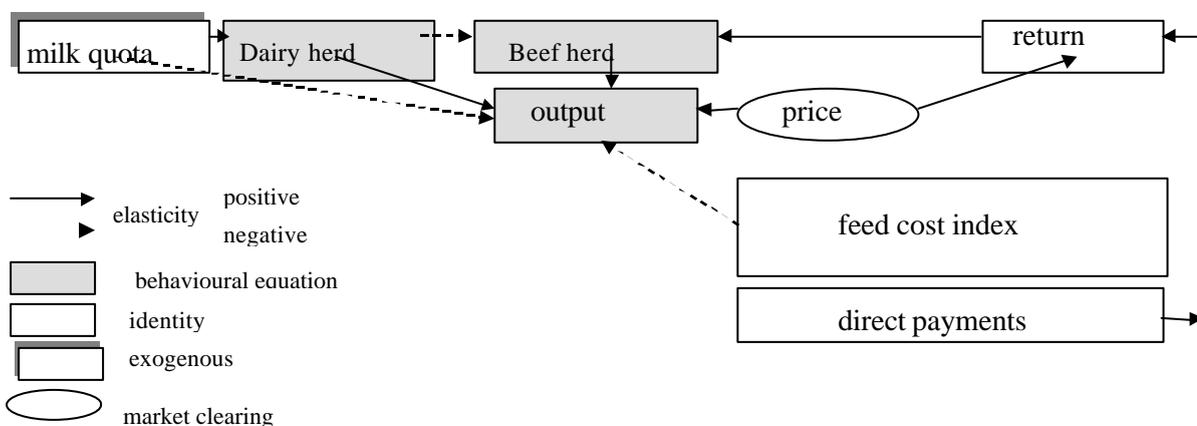
a variable that represents the gross profitability of meat livestock farming; this, in turn, affects the destination of the cattle for milk or meat production. Thus beef production depends on the number of heads in the previous periods, reproducing a cyclical pattern.

For countries where trade in live animals is significant, meat supply includes a carcass-weight equivalent, in such a way that it can be aggregated with the heads that are slaughtered domestically; in other words, meat and live animal trade end up in a single product group, expressed in terms of a meat equivalent.

For dairy products in the EU, supply of skimmed milk powder and butter is calculated from the protein fraction remaining as a residual from the production of cheese, whole milk, whey and other fresh products, that are determined separately, from the output set by the quota system. The same occurs in Canada and Japan, whereas for the other countries it is a yield based on the production of number of dairy herds. With the exception of Australia, milk production also includes estimates of domestic consumption. For most countries, the model determines both domestic and world prices of butter, skimmed milk powder, whole milk powder and cheese.

Also for pork supply, the number of breeding heads in a given period depends dynamically on the revenue and the output of the previous periods, and on output prices and feed costs in the current period. Since demand is assumed to adjust immediately, and it does not include lagged variables, equilibrium tends to be unstable; it is only reached with a relatively inelastic supply and a relatively elastic demand[4].

For poultry and eggs, the relationship between output and prices is considered to be sufficiently stable annually to assume that input costs are also stable, except for changes in feed prices. This means that output prices are determined exclusively by the feed index cost, while supply is determined as the sum of domestic demand – which is endogenous – and the trade balance, that is assumed exogenous for most countries[5].

On the demand side, as for most of the other partial models, AGLINK considers the possible utilisation for human consumption and for feed. For wheat, coarse grains and for vegetable oils, human consumption is calculated through a behavioural equation of the type:

(2) $\qquad D_{i,t} = exp\{ \boldsymbol{a}_i + \boldsymbol{S}_j [\boldsymbol{b}_j \, log(P_{j,t}) \,] + \boldsymbol{g} \, log(Y_t) + log(Pop_t)\}$

where:

i, j = products;

t = period;

$D_{i,t}$ = demand for human consumption;

$P_{j,t\,t}$ = prices;

Y_t = per capita income;

Pop_t = population;

$\boldsymbol{a}_i$, $\boldsymbol{b}_j$, $\boldsymbol{g}$ = elasticities.

This is repeated with minor changes for specific goods; e.g. the Japanese and the "rest of the world" module includes a demand for human consumption for oilseeds, whereas for other countries, the only utilisation considered for the raw product is for animal feed. In the Japanese and Chinese modules, in the demand for meat, the prices of substitutes include fish and certain cereals whereas in other countries only the prices of other types of meat are considered[6].

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[4] It is not by chance that the so-called "cobweb" adjustment model is also called "*hog cycle*".

[5] This is the case, particularly, with Canada; here, due to the presence of import quotas, the trade balance is linked to the US production in the previous year.

[6] The Chinese module, particularly includes, among other things, two separate equations for urban and rural demand for human consumption.

The utilisation of grains and oilcakes for feed depends directly on the level of livestock production, and is modelled through an expenditure equation that allocates wheat, coarse grains, oilcakes according to their relative prices. The EU module includes also cassava and corn gluten.

Adjustment of the demand for feed with respect to prices includes two components: a substitution and a scale effect. Livestock production is treated exogenously in the estimation of the demand system; this generates "constant-scale" elasticities that only reflect cross-price relations between different kinds of feed. The other component takes into account the scale effect, i.e. the possibility that the production scale changes after a change in output prices; this latter component depends on livestock supply.

2.4   Data and parameters

AGLINK is based on an ad hoc data set developed by the OECD, that consists of two parts: a "historical" part, that includes information from 1960 to the base year, and another part that contains exogenous medium-term projections. Information provided by member states is mostly in the historical part and is used to estimate the parameters. Projections are mostly drawn from the *Medium Term Questionnaire*, and include information about the exogenous variables of the model[7]. This information is supplemented by data drawn from specialised sources – such as FAO, the United Nations, the World Bank, the International Monetary Fund, ABARE, the *PS&D view* archives of USDA – which is utilised to define macroeconomic assumptions and population projections. Moreover, these sources contribute to completing the "historical" database for non-OECD countries. A detailed list of the statistical sources, for each country, is reported in the appendix to the most recent Outlooks (OECD 2000, 2001).

All the data is reported to the calendar year; this can pose considerable problems for some products, especially for cereals, protein crops and dairy products; in model runs these may show anomalies in the short-term reaction of supply and demand to price changes. However, this does not significantly affect the results over the medium term, that is to say, the time frame on which AGLINK provides projections.

The parameters for AGLINK are mostly supplied by member states, either from national models, or from expert assessments. In fact, quite a high number of parameters are drawn from the SWOPSIM model, that supplies a comprehensive and consistent set of elasticities, although a fairly old one. Others are drawn from the literature, and made consistent with those from *ad hoc* econometric analyses through calibration carried out by the Secretariat.

3.   Representation of the CAP tools in AGLINK

The most important CAP tools are modelled in AGLINK, particularly those most frequently adopted for continental products, as well as a number of aspects of the agricultural trade policy. These are schematically reported in Table 1, according to the four types mentioned in the introduction , and adopted throughout this volume. Specific aspects of the modelling of the CAP tools have been modified in the recent past, with the aim of improving the model's capability to simulate the effects of the Agenda 2000 reform (OCSE, 2000).

3.1   Direct price support

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[7] In fact, it is not only the exogenous variables that are drawn from the *Medium Term Questionnaire*. As mentioned, also the outlook at the national level for several variables that AGLINK itself calculates is drawn from the Questionnaire; this is the especially case for supply and demand in specific markets. These are compared with the results of the model, and discrepancies are eventually introduced into the add factor database. Hence, the *Medium Term Questionnaire* ends up providing national expert judgements and plausibility controls on the results of the model.

Of the direct price support measures included in AGLINK perhaps the most important is intervention purchases which are represented both through a stock equation, and through the trade component. The EU domestic market allows for the market price to be distinguished from the intervention price, and the former is not allowed to fall below the latter by the stocks, that rapidly accumulate as the market price approaches the intervention level. This important advantage of the model is shared by few other recent partial models among those reviewed in the chapter by Conforti in this volume.

Depending on the relative position of the domestic market price with respect to the floor price, the model allows intervention purchases to operate - and the corresponding accumulation of public stocks - or the selling from intervention and, eventually the reduction in public stock. Moreover, the model includes (endogenous) export subsidies, and the quantitative restriction imposed on this by the 1994 GATT Agreement, that also affects market price. A representation of this type can also be found in the GOLD version of the FAPRI-CARD, and in WATSIM.

Any modelling approach requires, first of all, a sort of behavioural equation for stocks; in AGLINK this is the sum of private stocks - pre-determined outside the model - and of intervention stocks, that are endogenous. Public stocks depend on the difference between the EU market price and the level at which purchasing starts. For wheat and coarse grains, the equations includes a set of logical statements of an "if, then" type, allowing an elasticity of intervention stock with respect to price, to vary according to the price level. Public stock demand becomes extremely elastic as the EU market price approaches the floor price, whereas it becomes extremely inelastic as EU market prices significantly exceed the floor level. Parameters are drawn from calibration procedures, and the logical statements are set according to the floor price level. The mechanism attempts to approximate what happens in the real world explicitly: as market prices come under pressure, intervention purchasing keeps them up.

The modelling of intervention in the beef market is similar to the one described for cereals. For dairy products, though, the model does not include a stock equation, and their level is exogenously determined. However, the intervention mechanism is reproduced, to some extent, through the trade component: depending on the relative price competitiveness of the EU domestic supply, defined through a "margin" i.e. a wedge between the EU and world price[8], the model allows the subsidised export supply to change. This reaches the quantitative limit set by the 1994 GATT Agreement if the internal price drops below the level the floor price is set at, while it is reduced if the EU market price moves above this level, and it is zero when market price exceeds the floor by more than 20%.

3.2 Trade Policies

Among the trade policies, AGLINK explicitly takes into account tariffs, which are included in the price wedges between domestic and world market prices, and export subsidies and taxes. Thanks to the endogeneity of EU market prices, AGLINK allows an endogenous determination of variable export subsidies and import duties.

Restrictions on subsidised exports are modelled exclusively in quantitative terms. For cereals the export supply equation includes, a "margin", defined as the wedge between EU and world prices, and a measure of the difference between the EU market price and floor price. When the margin is negative, i.e. when the EU price is higher than the world price, exports are subsidised up to the maximum quantity allowed by the 1994 GATT Agreement. If the domestic price is lower than the floor price, this limit is reached automatically, and subsidised exports are equal to the GATT limit. In other words, the model

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[8] More precisely the margin is defined as the difference between the world price and the domestic price increased by transport and insurance costs and by qualitative differences.

assumes that, given the public stock accumulation due to intervention purchases, the EU will export the entire amount that it is allowed to subsidise. If, on the contrary, the EU price is higher than the floor price, given a negative margin, the amount of subsidised exports will drop rapidly - exponentially - below the GATT limit. It is assumed that, given the good condition of the domestic market and the low level of public stocks, the EU will rapidly reduce the amount of subsidised exports below the GATT limit. The model is calibrated to allow subsidised exports to become zero when the domestic market exceeds the floor price by 25%.

The model also allows for a positive margin. In this case, when the EU price is lower than world market price, the EU will export without subsidies, eventually beyond the GATT limits that will no longer be relevant. This occurs both when the domestic price is higher than the intervention price, and when it is lower; the only difference between these two cases is that, in the latter, the effects of the minimum guaranteed price are such that exports will be drawn from intervention stocks, rather than from individual producers or traders.

For beef AGLINK includes an export supply equation similar to the one just described. However, the model does not envisage the possibility of unsubsidised exports, and hence the 1994 GATT Agreement commitments determine the maximum exportable amount (without considering the trade in live animals). Just as described for cereals and coarse grains, exports decrease exponentially if the EU market price increases above the floor level, reflecting the loss of competitiveness of European meat, and the fact that the EU should cease subsidising exports. If the EU market price falls below the floor level, subsidised exports will be equivalent to the GATT ceiling.

The trade component of dairy products is similar to the one described for cereals and for meat: the model draws a distinction between subsidised and non-subsidised exports using two different equations; these come into play depending on the sign of the margin.

Among the other commitments undertaken with the 1994 GATT Agreement, AGLINK takes into account minimum access provisions, but as an exogenous amount, i.e. by supposing that tariff rate quotas are always fully utilised[9].

The inclusion of a foreign trade component and consequently of trade policies in the model, is a relatively recent development for AGLINK; in the earlier versions, trade was almost always included as an exogenous term; behaviour relations were introduced first for the export supply of cereals, beef and dairy products. As with several of the main partial equilibrium models, the absence of a spatial trade representation, and bilateral trade flows is a substantial limitation; in the plans for future developments of AGLINK, one of the priorities of the OECD's Secretariat is to further improve the trade component of the model, particularly, the representation of the tariff rate quotas.

3.3   Supply management tools

The two most important instruments for CAP in the area of supply control are the set-aside and output quotas. Concerning the former, AGLINK takes into account its effect in the EU module by reducing land allocation proportionally for the crops where set-aside is mandatory to access support; this is particularly the case with cereals and protein crops. The idea is that, after the land is allocated to the alternative crops, depending on their relative profitability in the previous period, the set-aside provisions reduce effective land availability by the relative set-aside rate. Thus, after equation (1), the model includes an expression of the following type:

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[9] As is discussed in more depth in the chapter by Anania in this volume, this is a rather inaccurate way to include these provisions, as it does not correspond either with what happens in the real world – since it is frequently observed that quotas are not fully employed - or with the provisions of the GATT 1994 Agreements.

(3) $T^*_{i,t} = T_{i,t} \; (1 - SA_t \, (1 - SLP_t))$

where:

i = crop;

t = period;

$T_{i,t}$ = land allocated to the i-eth product;

$T^*_{i,t}$ = land actually allocated to the i-eth crop;

SA_t = set aside rate;

SLP_t = slippage (fixed) rate.

In other words, set-aside does not affect land allocation in the model; rather, it is assumed that this is a reduction in the amount of land available after farmers have made their choices. This way of modelling set-aside is acceptable when taking into account mandatory set-aside, but it should be modified if voluntary set-aside is to be considered; this modification would appear useful, considering the Agenda 2000 reform, that aims at increasing the use of this scheme, while weakening the linkage between direct payments, especially for arable crops, and mandatory set-aside (INEA, 1999). To sum up, a change in the modelling approach should involve considering set-aside as a separate economic activity.

Concerning the slippage effect, this is represented as a fixed reduction in the set-aside quota, aimed at taking into account the presence of small farms – those defined as "non-professionals" by the 1992 MacSharry reform – that are not subject to the general set-aside obligation to be eligible for direct payments. Therefore, as it is understood in AGLINK, slippage has nothing to do with the difference in yields between land in production and fallow land: in that respect, the model assumes that there is no slippage.

Concerning output quotas, the EU module introduces dairy quotas through an equality constraint, i.e. output is exogenous, and assumed to be equivalent to the maximum amount that can be produced, both before and after the Agenda 2000 reform. This choice is qualitatively justified by the excess production capacity in the EU.

3.4   Semi-decoupled payments

As is known, these are the CAP per tonne subsidies based on the historical yields, defined for single areas within the EU, in fact, tied to hectares of land and heads of cattle, that are partially "decoupled", i.e. partially independent of output decisions[10]. For arable crops, these payments are introduced in the equation that determines the unit profitability of crops, together with revenues from sales. The equation has the following form:

(4) $R_{i,t} = P_{i,t} \, \boldsymbol{p}_{i,t} + PD_i$

where:

$R_{i,t}$ = unit profitability of the i-eth activity;

$P_{i,t}$ = output price of the i-eth product;

$\boldsymbol{p}_{i,t}$ = yield of the i-eth product;

PD_i = direct payment for the i-eth activity.

This modelling is aimed at approximating the partially de-coupled nature of the payments. In the model these are independent from the market price of the product; they affect land allocation, but they do not affect yield because they are not included in the relative equation. Despite the fact that in the real world

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[10] As is more widely discussed in the chapter by Conforti in this volume, these payments affect production decisions only through investment choices, labour use and farmers' attitude toward risk.

payments also affect yields, this can still be considered a fairly acceptable proxy to be adopted in a deterministic large-size model.

For beef, the model was modified recently, with the very objective of improving the modelling of direct payments, and the limitations imposed to by the Agenda 2000 reform. Previously the model could only calculate average payments, with the payment per head tied to weight. At present the ceilings that are imposed on the overall expenditure for the payments are taken into account, together with those imposed in terms of maximum number of cattle load per hectare. The model includes four different types of payments: those for the slaughtering of adult cattle; those for the slaughtering of calves; the special payments for bulls and steers; special payments for nursing cows.

Three variables are employed to define each type of premium: the total (maximum) expenditure; the ceiling; and an application rate, i.e. the ratio of the number of heads in production to the ceiling. When the application rate is higher than one, i.e. when ceilings are exceeded, payments no longer affect marginal profitability, and hence output and the number of heads only reflect the market price behaviour. In other words, direct payments determine a shift in supply only until the ceiling is reached (OECD, 2000, p. 31).

4 Final remarks

Among the large-size partial equilibrium models employed in the analysis of agricultural markets AGLINK is undoubtedly important, especially as regards its ability to simulate the effects of agricultural and trade policies. Both its biggest advantages and its weaknesses appear to stem from the organisation that manages and maintains the model; among the strengths, there is the close connection with an OECD publication with a clear-cut deadline: the annual publication of the *Medium Term Outlook*. This requires the model to be constantly updated, reviewed and modified, with respect to several of its components. Over the last few years this process has increasingly involved the field of agricultural policies, and has brought about significant improvements. Moreover, the maintenance of the model directly involves the OECD members; this implies that its results should be underpinned by a highly detailed and wide-ranging information base. From this point of view the joint discussion of the results involving both the OECD Secretariat and the member countries is also important. These discussions are an effective tool for the promotion of multilateral feedback that can be beneficial for all concerned; it enables member countries to improve their respective modules, and the Secretariat to include additional and updated information regularly.

At the same time, the rather high level of institutional control exerted by the OECD member countries on the model, prevents the results from being really and solely scientific. Even though the whole process is aimed at harmonising the perspectives of individual countries, the numerous mechanisms of adjustment of the results may lead to the possibility that the weight of the "experts judgement" in the model is excessive. One only has to think, in this respect, of the presence, in behavioural equations, of the so-called *add factors*, whose final values are released after all the reviews of the results, on the basis of the discussions between the OECD Secretariat and member countries.

The same observation can be made about the origin of AGLINK as a pool of national models: it is an advantage for the model to the extent that it has contributed to the gathering together of scattered and inconsistent information; this is especially true for the parameters, most of which were either taken from the literature, or already in use in the national models. Yet this may also constitute a limitation because it affects the statistical reliability of the results; it is generally recognised, that a number of the parameters referring to the late 1980s are rather out of date.

From a statistical point of view it has to be mentioned that the results have undergone a stability test, but despite this no statistical validation is available. AGLINK has proven itself capable of responding

effectively to small and medium-sized shocks; most variables appear to converge through a *cobweb* path. However, problems do seem to appear if the model is subject to relatively large shocks.

Two further limitations may be the result of the origin of AGLINK as a pool of national models. Firstly, the exogeneity of several variables in important markets; as we have seen, this is the case with stocks of dairy products, imports of beef, or the trade balance for poultry and eggs. Secondly, the "asymmetric" level of aggregation of demand, supply and/or trade in the same market; as mentioned, this implies that the model actually calculates equilibrium prices only for a few products, defined in rather aggregated form.

To some extent, these drawbacks appear not to obviate the efforts made in terms of improvement of the representation of agricultural policies, and particularly of the CAP; in this area AGLINK appears, on the whole, very well equipped, especially for intervention, and interaction with the restrictions imposed on subsidised exports; the same holds for the representation of direct payments, among these it is worth mentioning the mechanism that takes into account the ceilings imposed on beef.

As is the case for most of the other partial equilibrium global models, the trade component is generally the weakest part. The homogeneous and non spatial character of this component can cause concern, especially with respect of the modelling of important events, such as EU enlargement to the CEECs. This is likely to have a significant effect on future market developments, and needs to be included, over the next few years, in the time frame of the simulations.

In fact, among future developments of AGLINK, the representation of trade policies, and tariff rate quotas in particular rank high in the list of priorities for improvement. At a more general level, it is known that the OECD Secretariat has the intention of promoting greater decentralisation in the management of the model; this is required to some extent by the structure of country-modules, which inevitably take into account those markets where their products are of particular importance.

The model seems to keep on attracting considerable interest, as shown by the financial backing it has received, and by the recent development of several new modules, such as the ones for Poland, Hungary, Turkey and the Czech Republic, as well as the completion of the Chinese module. Also the number of products represented in the model is increasing: recent additions are rice, sugar, casein and vegetable oils. Priorities set by the OECD also include closer integration between agricultural and environmental variables in the medium term, consistent with the deadlines set by the 1997 Kyoto Protocol.

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Table 1. Main CAP tools modelled in AGLINK

	direct price support policies	**trade policies**	**supply management tools**	**semi-decoupled payments**
cereals	minimum guaranteed price	variable export subsidies variable export taxes maximum subsidised exports (quantity) variable import levies minimum access quotas	mandatory set-aside	direct payments
oilseeds			mandatory set-aside	direct payments
milk			output quotas	direct payments
other dairy products	minimum guaranteed price	variable export subsidies maximum subsidised exports (quantity) import tariffs		
beef	minimum guaranteed price	variable export subsidies maximum subsidised exports (quantity) import tariffs		direct payments
other meats		maximum subsidised exports (quantity) import tariffs		