hg220500.doc (first drafts: melboui.doc ; date: 24/05/2000)

AGE Assessment of CAP Reform: Implications of Policy Modeling Choices

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Third Annual Conference on Global Economic Analysis

Melbourne, Australia, June 27-30, 2000

Abstract: Heterogeneous simulation results, particularly in terms of signs of effects, are not easily comprehensible for policy makers. It is well known that many factors can have a substantial bearing upon model outcomes. In that context, the objective of this paper is to highlight the key importance of policy instrument modeling as regards to the assessment of the likely impacts of the Agenda 2000 Common Agricultural Policy reform. We show that not only policy modeling matters, but also production technology specification which should be thought to reproduce the working of policy instruments.

1. Introduction

The Agenda 2000 Common Agricultural Policy (CAP) reform adopted in Berlin on March 1999 deepens and extends the 1992 McSharry reform through further shifts from price support to direct payments. Support prices are significantly reduced for cereals, beef meat and dairy products, and induced income decreases are compensated by augmented direct payments to farmers linked to primary factors of production.

Quantitative assessments of the likely impacts of the Agenda 2000 CAP reform differ across studies. An USDA synthesis report compares simulation results obtained with various models, i.e., the USDA-ERS analysis conducted using the ESIM model, the FAPRI analyses and two studies commissioned by the European Commission (EC) with the SPEL model and the CAPMAT model, respectively (USDA, 1999).[1] All modeling exercises concur that cereal area and production would increase in the European Union (EU), but the magnitude of expected rises varies across studies: wheat production increases range from +3 % to +8 %, and coarse grain production increases range from +1 % to +6 % (relative to a baseline scenario corresponding to a 1999 CAP continuation scenario). Most studies find that

[1] The FAPRI (Food and Agricultural Policy Research Institute) model is developed at both the University of Missouri, Columbia (FAPRI-UMC) and the Iowa State University (FAPRI-ISU). The SPEL model is developed at the University of Bonn, and the CAPMAT model is developed at the University of Amsterdam.

oilseeds area and production would also rise, but the FAPRI-UMC analysis foresees a decrease of -2.8 % and -2.5 %, respectively. Some studies find that beef production would increase (from +0.5 % to +3 %) while others expect a decrease (from -0.5 % to -2 %). Some studies find that the Agenda 2000 reform would lead to an increase in EU pork and poultry production (from +0.5 % to +2 %), but others foresee a drop ranging from -0.5 % to -1 %. More marked differences are obtained for EU consumption and export patterns.

Heterogeneous simulation results, in particular in terms of signs of effects, are not easily comprehensible for policy makers. In fact, many factors can have a substantial bearing upon model predictions and outcomes: partial versus general equilibrium approach, sector disaggregation and data sources, production technology and consumer preference specification as well as corresponding parameter calibration, macro-economic closure rules (in the case of general equilibrium models), forecasting versus counterfactual analysis, modeling of economic policy instruments, etc. In that context, the main objective of this paper is to highlight the key importance of CAP instrument modeling as regards to the assessment of the likely effects of the Agenda 2000 reform.

The crucial role of policy instrument modeling has been recognized for a long time. It has been illustrated, both analytically and empirically. In a general equilibrium framework, Whalley and Wigle (1990) show that the suppression of the US wheat program induces a positive effect on agricultural income and a negative effect on wheat production when this program is modeled in an explicit way. Results are opposite in signs when the program is modeled in an implicit way, i.e., using ad-valorem equivalents. In the same spirit, Whalley (1986) and Hertel (1999) argue that the modeling of public policies is an important feature, particularly in agriculture where income transfers are high, public interventions are diverse and many agricultural policies are not easily amenable to an ad-valorem equivalent modeling. More recently and more directly related to the modeling of CAP instruments, Nielsen (1999) highlights, with the GTAP model, how simulation results of an UE enlargement scenario are modified when shifting from an ad-valorem equivalent to an explicit modeling of CAP policy instruments. The main differences, in terms of signs and magnitudes of effects, are obtained for the milk sector. Discrepancies are much more limited for the sector of arable crops.

The contribution of this paper relative to studies quoted above is twofold. Firstly, our analysis focuses on the Agenda 2000 CAP reform. It is clear that the sensitivity of model outcomes to policy instrument modeling depends on simulated scenarios. To our knowledge, the Agenda 2000 reform has not been investigated on this basis. Secondly, attention is centered on the modeling of CAP direct payments. The first reason is that we believe, with others (see, e.g., Swinbank, 1999) that these CAP direct payments will constitute a key element in the upcoming round of agricultural negotiations under the World Trade Organization (WTO). The question is to know whether the Agenda 2000 CAP reform, in particular the slightly modified system of direct payments, represents a sufficient step in the direction of a more decoupled EU agricultural support policy to be accepted by other WTO member countries.

The second reason is that the modeling of the CAP direct payment system represents a difficult challenge for applied agricultural economists (Salvatici et al., 2000). In particular, capturing how these direct payments interact with associated policy instruments intended to control agricultural supply (set aside in the sector of cereals and oilseeds, ceilings and maximum stocking density in the beef sector) is not an easy task to deal with.

Empirical consequences of modeling choices are analyzed on the basis of simulations performed with the MEGAAF model, a CGE model of the French economy focused on agricultural and food sectors (Gohin et al., 1999a). This CGE model is characterized by a complete disaggregation of the French economy into sectors, products and primary factors of production, and detailed specifications of production technologies, household preferences and primary factor mobility. These aspects are critical for the relevance of CGE analysis (Hertel, 1989 ; Kilkenny and Robinson 1990).

This paper is organized as follows. Section 2 provides a brief overview of the MEGAAF model. Section 3 gives a detailed description of the modeling of main CAP policy instruments, with a particular emphasis on the two alternative methods of modeling CAP direct payments. Section 4 defines simulation experiments. Section 5 analyses simulation results. Section 6 concludes.

2. Model overview

The structure of the MEGAAF model is outlined in Annex 1. It is a static, agriculture- and agrifood-focused CGE model of the French economy benchmarked to data for 1994. The two foreign regions, i.e., the Rest of the European Union (RoEU) and the Rest of the World (RoW), are incorporated in a reduced manner as they simply enter as suppliers of French imports and demanders of French exports. The model is neoclassical and Walrassian in spirit, in the tradition of Shoven and Whalley (1984).

The model identifies eight agricultural industries, seven food processing industries and eight industries for the rest of the economy. The eight agricultural industries produce fourteen agricultural products and the seven food processing industries produce twelve food products. The industry and product disaggregation of the model is reported in Annex 2. The disaggregation level on the production side is sufficiently detailed to capture the main forward and backward linkages among the various agricultural industries, as well as between the aforementioned agricultural industries, the food processing industries and the raw material suppliers. It facilitates agricultural production technology modeling where substitution among intermediate inputs, and between intermediate and primary inputs, plays a crucial role. In addition, it allows us to accurately represent the working of main CAP instruments.

Production technologies are constant returns to scale. They are modeled by means of nested CES input production functions and CET product transformation functions. There is one representative household which saves a fixed proportion of its disposal income. The household's commodity demands are derived by constrained maximization of a nested Stone-Geary utility function. Foreign trade is modeled according to the Armington specification which means that domestic and foreign goods are differentiated. France is assumed to be a large country with respect to the RoEU. It is assumed to be a small open economy relative to the RoW, with the exception of cereals and dairy products.

The resource endowment of the economy consists of a fixed supply of the three primary inputs, i.e., labor, capital and land. Labor is assumed to be imperfectly mobile between the two industry aggregates, i.e., the agricultural industry and an aggregate including all other sectors. Labor is perfectly mobile across sectors belonging to a given aggregate. Capital is fixed in each sector. Land is used by the various agricultural sectors. It is assumed to be imperfectly mobile between the two agricultural sub-aggregates corresponding to the sector of arable crops and the livestock sector. It is perfectly mobile across sectors belonging to a given agricultural sub-aggregate.[2]

The French government is modeled as an explicit, but non-optimizing agent. It uses its income to save (in fixed proportion) and for purchases of labor services, subsidy expenditures, transfer payments to the domestic household and the two foreign zones. Nominal government demand in services is set exogenously. The French government budget is balanced through transfers to/from the domestic household and the RoEU. The European Agricultural Guidance and Guarantee Fund (EAGGF) is modeled in a simplified way. It pays all input, output and export subsidies corresponding to CAP expenditures. Its budget is balanced through income transfers from the RoEU.

The model is solved in a neoclassical way. Investment is savings driven. The balance of payments with respect to the RoEU is balanced through the domestic deficit/surplus relative to this foreign zone. The balance of payments with respect to the RoW is constrained by an externally defined deficit level, and the model is solved for the real equilibrium exchange rate.

3. Modeling the Common Agricultural Policy

The Agenda 2000 CAP reform involves significant changes in the three Common Market Organizations (CMOs) of arable crops (cereals, oilseeds and protein crops, hereafter COP crops), beef meat, and milk and dairy products. Main changes in the milk CMO have been delayed to 2005 and some are still subject to debate. As a result, they are not considered in this paper.[3] Changes in the two other CMOs will become effective in 2000. In the sector of COP crops, they include a cut in the intervention price of cereals, a compensation of induced income decreases by augmented area direct payments and the annual fixing of a mandatory set-aside rate. In the beef sector, they include a cut in

[2] The degree of imperfect mobility of a primary input is captured by the elasticity of transformation of a CET function. We assume that this parameter equals 0.5 for labor and 1.1 for land.

[3] For a complete description of the modeling of policy instruments used in the EU dairy sector (i.e., the quota system, the intervention price mechanism for butter and skimmed milk powder, import tariffs, export subsidies, and output as well as input subsidies), see Gohin and Guyomard (1999). We do not consider the milk sector also because direct payments are significant only in the COP and beef sectors. This is true today. This will remain the case after full implementation of the Agenda 2000 CAP reform.

the intervention price, a compensation of income decreases by augmented headage payments and supply control measures via the fixing of outlay ceilings and stocking density constraints. We first describe the modeling of the intervention mechanism in force in both the sector of COP crops and the sector of beef meat. We continue by a description of the two modeling strategies (i.e., explicit and implicit) used to capture production and income effects of direct aids.

3.1. Modeling the intervention mechanism

The basic elements of the EU legislation applied to cereals and bovine meat include public purchases at minimum intervention prices, export subsidies and protection against imports through tariffs. The intervention price is the delivered to store price at which EU purchases, through national boards, are made. In practice, intervention buying serves to maintain EU market prices at a minimum level in a regime where domestic supply exceeds internal demand.

We assume that French cereals and bovine meat that are initially purchased for public storage can be disposed of on the French market, exported to RoEU markets, and/or exported to RoW markets through the use of variable export subsidies. The latter are intended to bridge the gap between French and world prices.[4] We assume that domestically produced cereals (respectively, bovine meat) for sale on the two export markets are perfect substitutes for domestically produced cereals (respectively, bovine meat) for sale on the French market. This assumption is more realistic than the alternative of imperfect substitutability because the intervention mechanism largely prevents French farmers from differentiating production according to destination markets in a regime of excess supply and support prices.

To simplify notation, we have dropped the *i* subscript corresponding to the commodity (i.e., bovine meat and the four types of cereals distinguished in the model, common wheat, barley, maize and other cereals). The perfect substitutability assumption implies that the standard CET export aggregation function is replaced by a simple sum and that equilibrium prices of domestic sales, exports to the RoEU and exports to the RoW are all equal, i.e.,

$$Y = YD + E_{RoEU} + E_{RoW} \quad (1)$$

$$P = PD = PE_{RoEU} = PE_{RoW} \quad (2)$$

[4] Export subsidies are granted in the light of market situations. As a result, the subsidy can be a tax if world prices are greater than EU prices. Following Weyerbrock (1998), we do not allow for agricultural export taxes because we think that the EU is not able to defend export taxes over an extended period. In practice, we will assume that EU market prices cannot be lower than world prices.

where Y is the domestic production with price P, YD is the domestically produced commodity sold on the French market with price PD, E_{RoEU} are exports to the RoEU with price PE_{RoEU}, and E_{RoW} are exports to the RoW with price PE_{RoW}.

To accommodate the intervention price regime ($P=PI$, where PI is the intervention price) and the competitive price regime ($P>PI$) simultaneously, we use the mixed-complementarity approach (Rutherford, 1995 ; Löfgren and Robinson, 1997) by specifying a set of inequalities-equalities:

$$P \geq PI \tag{3a}$$

$$S.(P - PI) = 0 \tag{3b}$$

with $S = s.P.E_{RoW}$, where S are export subsidies and s is the ad-valorem unit export subsidy.

Equations (3a) and (3b) show that the price regime is endogenously determined. When export subsidies S are strictly positive, the domestic market price P is equal to the intervention price PI. The latter is strictly greater than the world export price and the unit export subsidy covers the difference between both prices according to the following equation:

$$PI = PWE_{RoW}.ER_{RoW}./(1-s) \tag{4}$$

where PWE_{RoW} is the export world price in world currencies and ER_{RoW} is the exchange rate with respect to the RoW.

When export subsidies S equal zero, the domestic market price P is greater than the intervention price PI. This can arise when the unit export subsidy is null (in that case, $P = PWE_{RoW}.ER_{RoW}$) and/or when exports to the RoW equal zero.

3.2. Modeling the mechanism of direct aids applied in the COP sector

Area direct payments were introduced in 1992 in the COP sector to offset income effects due to support price reductions. Payments were based on historical average yields and they were limited to a aggregate historical base area. Producers of COP crops got these payments only if they set aside part of their land. The set-aside rate was fixed annually and compensation for set aside was also paid on a per hectare basis.[5] Payments varied according to commodities, payments for oilseeds and protein crops being greater than payments for cereals. With the Agenda 2000, per hectare payments are now equal for all COP crops and for the land set aside, with the exception of protein crops and durum wheat.

This system of per hectare direct payments has been modeled in several ways in the applied general equilibrium literature (Weyerbrock, 1998 ; Jensen et al., 1998 ; Keyser and Merbis, 1998 ; Nielsen,

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[5] COP producers may also set aside additional areas on a voluntary basis and receive area compensatory payments in return.

1999 ; Blake et al., 1999).[6] The two extremes are the fully coupled approach (in that case, aids are modeled as output subsidies) and the fully decoupled approach (in that case, aids are modeled as lump-sum transfers). In this paper, we analyze the consequences of considering and modeling per hectare direct payments either as land subsidies (hereafter, the explicit approach) or as output subsidies (hereafter, the implicit approach).

The explicit modeling strategy considers direct payments applied in the COP sector as land subsidies. The two area constraints, i.e., the base area constraint and the compulsory set-aside constraint, are also modeled in an explicit way. More precisely, COP producers maximize their profit subject to technological and market constraints. The first-order conditions of this program determine in particular the optimal derived demand for land used for each crop. This derived demand is a function of the corresponding crop price, the market price of land minus the land subsidy, and variable input prices (i.e., fertilizers, pesticides, etc.). Per hectare direct payments have thus a direct effect on land demands used for each crop. Corresponding expenditures are simply obtained by summing over all crops benefiting from the per hectare compensation system.

$$l_i\,(.) \equiv l_i\,(p_i, \tilde{w} - a_i, v) \tag{5}$$

$$D_{COP} = \sum_i a_i l_i \tag{6}$$

where l_i is the area devoted to crop *i*, p_i is the producer price of crop i, $\tilde{w}$ is the market price of land used in the sector of COP crops, a_i is the per hectare direct payment for crop *i*, *v* are variable input prices, and D_{COP} are public expenditures corresponding to per hectare direct payments.

The set-aside requirement is captured by the following equation:

$$lf = \alpha L_{COP} = \alpha(\sum_i l_i(.) + lf) = \frac{\alpha}{1-\alpha}\sum_i l_i(.) \tag{7}$$

where lf is the land let in fallow under the compulsory set-aside program, α is the mandatory set-aside rate, and L_{COP} is total land devoted to all COP crops, including cultivated as well as non-cultivated area. The mandatory set-aside rate is exogenous, but total land let in fallow is endogenous because L_{COP} is an endogenous variable (eventually constrained by the base area limit).

The base area constraint is also introduced using the mixed-complementarity approach so that the status of the constraint (i.e., binding or not) is endogenously determined. Due to the land imperfect mobility assumption, the land-owner program may be defined as follows:

[6] For a review of possible modeling strategies, see Salvatici et al. (2000).

$$\max_{L_{COP}, L_{FOD}} \; w_{COP} L_{COP} + w_{FOD} L_{FOD} \tag{8}$$

subject to:

$$\overline{L} = CET(L_{COP}, L_{FOD}) \tag{8a}$$

$$L_{COP} \leq \overline{L_{COP}} \tag{8b}$$

where w_{COP} is the price of land used in the COP sector, L_{COP} is the corresponding area, w_{FOD} is the price of land used in the livestock sectors, L_{FOD} is the corresponding area, $\overline{L}$ is total agricultural land, and $\overline{L_{COP}}$ is the base area limit. Constraint (8b) is introduced in a complementary fashion.[7]

In the implicit modeling strategy, per hectare direct payments are modeled as output subsidies. Equations (5) and (6) no longer hold. They are replaced by the following equations:[8]

$$l_i(.) \equiv l_i(p_i + s_i, \tilde{w}, v) \tag{9}$$

$$D_{COP} = \sum_i s_i y_i \tag{10}$$

3.3. Modeling the mechanism of direct aids applied in the beef sector

In the beef sector, the intervention mechanism applies to bovine meat but direct aids are based on live animals, i.e., on livestock units. The 1992 CAP included two main types of headage payments, i.e., a special premium for male animals (bulls and steers) and a premium for maintaining suckler cow herds. Both types of premia might be supplemented by an extensification premium granted if the stocking density was low. The Agenda 2000 CAP reform introduces an additional slaughter premium which concerns bulls, steers, cows, heifers and calves. All types of premia are subject to ceilings which are defined in function of historical references and density constraints. If the number of claims for one given premium exceeds the ceiling in any year, then all claims are scaled back proportionately. As a result, public outlays are capped for each premium.

In the explicit modeling case, we consider that suckler cows are part of the capital used by cattle farmers to produce slaughter animals. The suckler cow premium is thus modeled as a capital subsidy. This results in a price wedge between the market price of capital and the price of capital paid by cattle farmers holding suckler cows. Male animals correspond to final products sold by cattle farmers to the slaughtering industry. The special premium for male animals is thus considered as an output subsidy for cattle farmers producing bulls and steers. The slaughter premium is also modeled as an output

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[7] Details are available from the authors upon request.

[8] The two area constraints are modeled in the same way in both the explicit and the implicit case.

subsidy. It is perceived by the two agricultural sub-sectors producing bovine animals, i.e., the dairy farming and the beef farming. The rate of each premium is determined endogenously so that corresponding outlay ceilings are satisfied.

In the implicit modeling case, only the suckler cow modeling is modified. It is now an output subsidy. Its rate is endogenously defined in the same way that special premium and slaughter premium rates are calibrated.

4. Experiment design

Four experiments are performed. They are summarized in Table 1. The following assumptions are common to all scenarios. As far as the COP sector is concerned, the intervention for cereals is decreased by -22.90 % with respect to 1994 to reach 101.30 euros per ton ; the compulsory set-aside rate is fixed to 10 % which corresponds to a decrease of - 33.33 % with respect to the 1994 rate ; the per hectare payment is equal to 63 euros for all COP crops and for land set aside ; and the base area is equal to the sum of 1994 areas devoted to COP crops or let in fallow (in other words, the base area constraint is binding and the corresponding dual value is initially equal to zero). As far as the beef sector is concerned, the intervention price for bovine meat is decreased by -25 % relative to 1994 to reach 2224 euros per ton ; and public expenditure ceilings are fixed to 3080 million French Francs for the special premium and to 3070 million French Francs for the slaughter premium (Chatellier, 1999).

In experiment 1, all direct payments are modeled in an explicit way. The land subsidy rate corresponds to an equivalent of 63 euros per ton for cereals and oilseeds, and to an equivalent of 72.5 euros per ton for protein crops (in French francs and relative to 1994, these figures represent a +48 % increase for cereals, a -17.13% decrease for oilseeds and a -3.35% decrease for protein crops). Public expenditures corresponding to suckler cow premia are increased from 4096 million French Francs to 6385 million French francs (Chatellier, 1999). In experiment 2, all direct payments are modeled in an implicit way, i.e., as output subsidies. Output subsidy rates are endogenous. They are adjusted to reproduce premium outlays obtained in experiment 1.

Experiments 3 and 4 are performed for comparison reasons. In experiment 3, direct payments applied in the COP sector are modeled as output subsidies, but the suckler cow premium is considered as a capital subsidy. On the contrary, in experiment 4, direct payments applied in the COP sector are modeled in an explicit manner, but the suckler cow premium is considered as an output subsidy.

Table 1. Experiment design

Assumptions	All experiments			
COP sector				
Intervention price for cereals	101.30 euros per ton			
Set-aside rate	10 %			
Set-aside payment	63 euros per ton			
Base area	Land used in the COP sector in 1994, including land let in fallow			
Beef sector				
Intervention price	2224 euros per ton			
Male premium outlays	3080 million French Francs			
Slaughter premium outlays	3070 million French Francs			
	Exp. 1 (explicit exp.)	Exp. 2 (implicit exp.)	Exp. 3 (implicit COP exp.)	Exp. 4 (implicit suckler exp.)
Direct payments in the COP sector	Land subsidies: 63 euros/ton for cereals and oilseeds 72.5 euros/ton for protein crops	Output subsidies: Rates adjusted to reproduce exp. 1 outlays	Output subsidies: Rates adjusted to reproduce exp. 1 outlays	Land subsidies: 63 euros/ton for cereals and oilseeds 72.5 euros/ton for protein crops
Suckler cow premium	Capital subsidy: Rate adjusted so that outlays reach 6385 million French Francs	Output subsidy: Rate adjusted so that outlays reach 6385 million French francs	Capital subsidy: Rate adjusted so that outlays reach 6385 million French francs	Output subsidy: Rate adjusted so that outlays reach 6385 million French francs

5. Experiment results

Attention is focused on the agricultural sector. Experiment results are presented in Table 2 (effects on production, market prices, exports, and domestic use), Table 3 (effects on land allocation) and Table 4 (effects on agricultural incomes, public expenditures and national welfare).

Experiment 1

Let us first consider experiment 1 which corresponds to the explicit modeling assumption of all direct payments. This experiment leads to domestic production decreases for all COP crops, the supply of common wheat falling the most (-8.41 % relative to the base) and the supply of protein crops falling the least (-1.77 % relative to the base). The supply of oilseeds decreases by a larger percentage (-6.36 %) than the supply of barley (-5.92 %) and maize (-4.40 %).

Market price reductions are equal to intervention price cuts for wheat and barley. In the case of maize, the market price decrease is lower than the intervention price cut (respectively, -16.01 % and -22.90 %) because we move from a binding intervention price regime to a competitive price regime. The market price of maize becomes an endogenous variable which adjusts so that the French maize market clears. As a consequence, French exports of maize to the RoW vanish. The market price of protein crops experiences a slight decrease (-1.10 %) and the market price of oilseeds increases by a rather large percentage (+5.14 %).

Total domestic demand (feed demand and food demand) increases by large percentages for all cereals (+15.10 % for barley, +6.16 % for wheat and +3.90 % for maize). France continues to export wheat and barley to the RoW, thanks to (reduced) export subsidies, but exported volumes decrease by drastic percentages relative to the base (-77.98 % for wheat and -73.92 % for barley).

This first experiment affects also animal productions and markets. In a general way, simulated effects are less marked than in the case of COP crops. The intervention price constraint is not binding for bovine meat in the final situation. The price of bovine meat is thus the market price which ensures that the French market clears. Accordingly, the market price reduction of bovine meat is (significantly) lower than the corresponding intervention price cut (respectively, -12.79 % and -25.00 %). The market price decrease of beef cattle (-15.08 %) is slightly more pronounced than the market price decrease of bovine meat. Market prices of pork and poultry adjust to market price decreases of cereals. However, price declines are low relative to price decreases of cereals (-4.06 % for poultry and -2.52 % for poultry meat, -5.12 % for pigs and -2.99 % for pig meat). The combined effect of unequal price reductions for the various animal productions is to increase the price competitiveness of beef relative to pork and poultry. On the domestic demand side, own- and cross-price effects favor beef meat consumption relative to poultry meat and pig meat. Experiment 1 leads to a production decrease for pork and poultry and to a production increase for beef (thanks to the three types of premia which offset the market price decrease).

Table 2. Experiment results: Impacts on agricultural markets (changes in per cent with respect to the base)

Variables	Base year (1)	Exp. 1	Exp. 2	Exp. 3	Exp. 4
COP production					
Wheat	25 221	-8.41	+6.20	+6.54	-8.84
Barley	6 713	-5.92	+1.46	+1.78	-6.36
Maize	12 926	-4.40	+11.62	+11.97	-4.72
Oilseeds	6 953	-6.36	-4.13	-3.93	-6.64
Protein crops	2 890	-1.77	-4.07	-3.84	-2.11
COP market prices					
Wheat	1	-22.90	-22.90	-22.90	-22.90
Barley	1	-22.90	-22.90	-22.90	-22.90
Maize	1	-16.01	-22.90	-22.90	-15.86
Oilseeds	1	+5.14	+3.57	+3.39	+5.38
Protein crops	1	-1.10	+0.30	+0.12	-0.84
Exports to the ROW					
Wheat	4 416	-77.98	+6.21	+8.23	-80.61
Barley	1 592	-73.92	-39.78	-37.86	-76.55
Maize	1 535	-100	-76.38	-74.23	-100
Domestic use					
Wheat	15 019	+6.16	+6.00	+5.99	+6.20
Barley	3 102	+15.10	+14.16	+13.98	+15.35
Maize	5 966	+3.90	+16.85	+16.96	+3.58
Live animals					
Beef cattle	44 525	+1.06	+2.31	+1.40	+2.22
Poultry	27 099	-0.39	-0.65	-0.44	-0.67
Pork	18 843	-2.60	-3.02	-2.69	-3.02
Live animal prices					
Beef cattle	1	-15.08	-17.41	-15.77	-17.19
Poultry	1	-4.06	-4.31	-4.31	-4.06
Pork	1	-5.12	-5.47	-5.48	-5.10
Meat production					
Bovine meat	54 572	+0.43	+1.54	+0.73	+1.46
Poultry meat	30 500	-1.20	-1.55	-1.25	-1.58
Pig meat	66 196	-2.61	-3.03	-2.70	-3.03
Meat market prices					
Bovine meat	1	-12.79	-14.53	-13.31	-14.35
Poultry meat	1	-2.52	-2.78	-2.70	-2.63
Pig meat	1	-2.99	-3.39	-3.18	-3.26

(1) Millions of 1994 French Francs, except for prices which are normalized to 1.

Let us now consider the land market. Table 3 suggests that the Agenda 2000 CAP reform would not lead to a drastic change in land allocation between the COP and livestock sectors. Land returns decrease by -5.71 % in the COP sector and by -4.71 % in the livestock sector. As a result, land used in the COP sector decreases slightly (-0.38 % relative to the base) and land used in the livestock sector increases slightly (+0.78 % relative to the base). These figures imply in particular that the base area constraint is not binding in the final situation. At this stage, it is important to recall that land is assumed to be imperfectly mobile between the two aforementioned agricultural sub-aggregates which limits, ceteris paribus, area allocation changes.

However, experiment 1 results in important land use changes between COP crops. The area under cereals increases by +6.37 % for wheat, + 9.08 % for barley and + 12.13 % for maize. The area under protein crops rises by a higher percentage (+43.62 %) because the price decrease is much weaker (-1.10 %) and the per hectare premium is higher (72.5 euros per ton instead of 63 euros per ton). The area under oilseeds decreases by a very large percentage (-26.43 %). Land marginal profitability for oilseeds is reduced relatively to other COP crops because of the decrease in per hectare payments granted to oilseeds.

Table 3. Experiment results: Impacts on land allocation (changes in per cent with respect to the base)

Variables	Base year (1)	Exp. 1	Exp. 2	Exp. 3	Exp. 4
Land allocation					
Wheat	12 635	+6.37	+7.48	+7.83	+5.88
Barley	4 015	+9.08	+2.69	+3.03	+8.58
Maize	4 780	+12.13	+13.02	+13.39	+11.76
Oilseeds	5 251	-26.43	-3.09	-2.88	-26.65
Protein crops	2 428	+43.62	-3.37	-3.13	+43.28
Set aside	5 538	-33.59	-34.42	-34.23	-32.84
Area under COP crops	36 921	-0.38	-1.63	-1.34	-0.76
Land returns in the COP sector	0.972	-5.71	-15.38	-15.53	-5.71
Area used in the livestock sector	17 309	+0.78	+3.31	+2.72	+1.56
Land returns in the liv. sector	1	-4.71	-11.52	-12.37	-3.71

(1) Millions of 1994 French Francs, except for land returns.

Experiment 1 induces a -5.28 % decrease in value added in the French sector of COP crops. On the contrary, beef cattle producers experience an +7.16 % increase in value added. At this stage, the following caveat is in order. These value added change figures are defined relative to a particular base year, i.e., 1994. Impacts on value added are positive for beef producers mainly because the market price decrease does not adjust to the intervention price cut. This outcome is partly due to the fact that 1994 data correspond to a through in production cycle. Impacts on value added for COP producers are negative because market prices of wheat and barley adjust to lowered intervention prices and per hectare compensatory payments are not sufficient to offset these price decreases. Valued added of dairy farmers is almost unchanged (+0.54 %), but policy changes in this sector have not been taken into account.

EAGGF expenditures increase by +7.96 % relative to the base, mainly because direct payments increase (+31.22 % in the COP sector and +124.76 % in the livestock sector). As expected, export subsidies decrease substantially (they vanish in the beef sector), but this is not sufficient to offset the increase in per hectare and headage payments. Experiment 1 results in an overall domestic welfare gain of +7 987 million French Francs with respect to 1994.

Table 4. Experiment results: Impacts on value added, employment, public expenditures and national welfare (changes in per cent with respect to the base)

Variables	Base year (1)	Exp. 1	Exp. 2	Exp. 3	Exp. 4
Value added					
COP farmers	49 343	-5.28	-4.57	-4.48	-5.56
Dairy farmers	32 419	+0.54	+0.01	+0.69	-0.34
Cattle farmers	26 779	+7.16	+5.68	+6.75	+5.72
Employment					
COP farms	8 980	-9.67	+8.61	+9.02	-10.09
Dairy farms	7 432	-1.60	-1.05	-0.98	-1.67
Cattle farms	9 498	-0.15	+4.20	+1.24	+3.08
All farms	76 124	-0.36	+1.01	+0.85	-0.18
Public expenditures					
Direct payments					
COP crops	20 579	+31.22	+31.22	+31.22	+31.22
Beef cattle	5 577	+124.76	+124.76	+124.76	+124.76
Export refunds					
Cereals	4 462	-91.44	-61.09	-59.97	-92.42
Bovine meat	1 944	-100	-100	-100	-100
EAGGF expenditures	53 635	+7.96	+10.60	+10.69	+7.68
Domestic welfare gain (2)		+7 987	+5 599	+5 248	+8 501

(1) and (2) Millions of 1994 French Francs.

Experiment 2: The key role of direct payment modeling

Experiment 2 clearly shows the key role of direct payment modeling as regards to the assessment of the Agenda 2000 CAP reform. Differences between experiments 1 and 2 are particularly marked for cereals.

Market price changes for cereals are similar in experiment 2 relative to experiment 1, except for maize which experiences a market price decrease equal to the intervention price cut in experiment 2. By contrast, supply and export patterns are very different in experiment 2 relative to experiment 1. Since per hectare direct payments are modeled as output subsidies in experiment 2, the latter results in a production increase for wheat (+6.20 % with respect to the base), barley (+1.46 %) and maize (+11.62 %) while these three productions decrease in experiment 1 (respectively, by -8.41 %, -5.92 % and -4.40 %). In the same way, French exports of wheat to the RoW increase in experiment 2 (+6.21 %) whereas they decrease in experiment 1 (-77.98 %). Export change differences are less marked for barley (because the positive effect on production is small) and maize (because the increase in domestic consumption is much higher in experiment 2 relative to experiment 1, respectively, +16.85 % and +3.90 %, and offsets part of the higher production increase).

For oilseeds and protein crops, differences between both experiments are much less important. In a general way, effects are identical in signs but orders of magnitude are lower in experiment 2 relative to experiment 1. The same remark applies to the animal sector except that effects are now higher in experiment 2 relative to experiment 1. For example, experiment 2 leads to a production increase by +2.31 % for beef cattle (+1.06 % in experiment 1) and by +1.54 % for bovine meat (+0.43 % in experiment 1). Corresponding market prices decrease by -17.41 % and -14.53 % in experiment 2 (-15.08 % and -12.79 % in experiment 1).

From Table 3, one notes that experiments 1 and 2 have generally the same impact on land allocation patterns, but effects are again different in magnitude. Under both experiments, the area under cereals increases, the area under oilseeds decreases, by a much lower percentage in experiment 2 (-3.09 %) relative to experiment 1 (-26.43 %), and the area used in the livestock sector increases, by a higher percentage in experiment 2 (+3.31 %) relative to experiment 1 (+0.78 %). Land return decreases are lower in experiment 1 relative to experiment 2 because direct payments are considered as land subsidies in the first case and as output subsidies in the second case. Experiments 1 and 2 lead to similar value added decreases in the COP sector and to similar value added increases in the beef cattle sector. EAGGF expenditures are higher in experiment 2 relative to experiment 1 mainly because savings on export subsidies granted to cereals are lower in experiment 2 (-61.09 % with respect to the base) than in experiment 1 (-91.44 % with respect to the base). The national welfare gain is lower in experiment 2 (+ 5 599 million French Francs) relative to experiment 1 (+7 987 million French Francs).

Understanding the consequences of different modeling strategies for CAP direct payments

A simple analysis of results of experiments 1 and 2 clearly shows that the modeling option choice (i.e., direct payments as input subsidies versus direct payments as output subsidies) has mainly an impact on the COP sector, more precisely on COP supply. This conclusion is confirmed by experiments 3 and 4. As far as COP crops are concerned, results are almost identical in experiment 2 (implicit modeling of direct payments) and 3 (implicit modeling of direct payments in the COP sector, but explicit modeling in the livestock sector) on the one hand, in experiment 1 (explicit modeling of direct payments) and 4 (explicit modeling of direct payments in the COP sector, but implicit modeling in the livestock sector) on the other hand.

Let us consider the case of cereals in more detail. Since the area effects of experiments 1 and 2 are similar but the production effects are very different, it results that the explanation of differences observed between the two simulations lies essentially in the effects of the modeling strategy on yields. The wheat example can be used to illustrate this point.

Wheat production requires, with other inputs, land, fertilizers and pesticides. These three factors of production are assumed to be strongly separable from other inputs in the wheat production technology. Substitution possibilities between inputs are captured by elasticities of substitution of nested CES production functions. A first CES production function with an elasticity of substitution of 0.2 defines a "land-fertilizers" aggregate. Pesticides are then combined with this aggregate, using a second CES production function with an elasticity of substitution of 0.1, to form a "land-fertilizers-pesticides" aggregate. The latter is combined with other inputs in fixed proportion. When per hectare direct payments are modeled as land subsidies, the first direct effect of an increase in payments is thus to reduce the agent price of land. This induces a positive own-price effect on land demand and negative cross-price effects on derived demands for fertilizers and pesticides. By contrast, when per hectare direct payments are modeled as output subsidies, the first direct effect of an increase in payments is then to generate a positive expansion effect for all inputs, including land, fertilizers and pesticides. These effects are illustrated in Table 5.

In experiment 1, where direct payments for cereals are modeled as land subsidies, the price of land used for wheat production decreases by -72.48 % while market prices of fertilizers and pesticides remain almost unchanged (relative to the base). These price changes translate into a decrease in fertilizer and pesticide use (respectively, -17.69 % and –12.21 %), and finally into a yield decrease (-14.78 %) as the wheat production decreases by -8.41 % and the area under wheat increases by +6.37 %. In experiment 2, where direct payments for cereals are modeled as output subsidies, the land price decrease is limited to -15.38 %, market prices of fertilizers and pesticides remaining almost unchanged (relative to the base). In that case, the negative effect of the land price decrease (and of the product price decline) on fertilizer and pesticide use is more than offset by the positive effect of output subsidies. Fertilizer and pesticide uses increase by smaller percentages (respectively, +3.33 % and

+4.87 %) relative to the area under wheat (+ 7.48 %). Wheat yields decrease only by a very small percentage (-1.28 %).[9]

The aforementioned consequences of policy modeling choices on production and yields depend closely on substitution possibilities between land and other inputs (Hertel, 1989 ; Gohin et al., 1999b). This clearly claims for a detailed specification of production technologies.

Table 5. Experiment results: Impacts on variables related to wheat production (changes in per cent with respect to the base)

Variables	Base year (1)	Exp. 1	Exp. 2	Exp. 3	Exp. 4
Wheat					
Domestic production	25221	-8.41	+6.20	+6.54	-8.84
Area	12 635	+6.37	+7.48	+7.83	+5.88
Yields		-14.78	-1.28	-1.29	-14.72
Fertilizer use	2973	-17.69	+3.33	+3.62	-18.07
Pesticide use	2726	-12.21	+4.87	+5.18	-12.62
Fertilizer market price	1	-0.88	+0.39	+0.40	-0.89
Pesticide market price	1	-1.73	+0.72	+0.75	-1.76
Land price for wheat production	0.457 or 1 (2)	-72.48	-15.38	-15.53	-72.48

(1) Millions of 1994 French francs, except for prices. (2) Price normalized to 0.457 in the explicit modeling case and to 1 in the implicit modeling case.

6. Concluding remarks

The need for an explicit modeling of public policies was one of the hidden challenges in applied general equilibrium analysis identified by Whalley fifteen years ago (Whalley, 1986). This paper illustrates this point in the particular case of direct payments granted to European farmers under both the McSharry and the Agenda 2000 CAP. Our analysis shows that particular attention should be devoted to modeling not only policy instruments, but also production technologies because a detailed specification of the latter is a necessary condition to well imitate the working of agricultural policies. In the specific case of per hectare direct payments applied on cereals, oilseeds and protein crops, experiment results highlight the key role of assumed substitution possibilities between land and other inputs, in particular fertilizers and pesticides. Of course, the difficult problem of substitution elasticity calibration claims for sensitivity analyses to examine result robustness. In the same way, sensitivity analyses should be performed to study consequences of various assumptions on land mobility.

Further research is necessary, in particular because policy implications of CAP reform assessments are divergent if they lead to production decreases (in that case, new policy arrangements could be considered as less distorting in the context of WTO negotiations) or if they lead to production

[9] In all experiments, there is also a negative own-price effect on production due to the intervention price cut.

increases (which means that the new system remains as distorting as the 1992 mechanism was). This is not a trivial matter.

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Annex 1. General characteristics of the MEGAAF model

1. Single-country, multi-sector, static CGE model applied to France, benchmarked to data for 1994, focused on agricultural and food processing sectors.
2. Two foreign markets: the Rest of the European Union (RoEU) and the Rest of the World (RoW).
3. 23 multi-product activity sectors and 35 products: 8 agricultural sectors and 14 agricultural products, 7 food processing industries and 12 food products, 8 activity sectors and 9 products for the rest of the economy (for more details, see Annex 2).
4. Multi-stage, multi-product, constant-returns to scale production technologies with substitution between inputs, including intermediate inputs.
5. Imperfect substitution between domestic and foreign commodities on both the import and export side (Armington assumption), except for some "regulated" products (see text).
6. Small country assumption on both the import and export side with respect to the RoW, except for some agricultural and food products (cereals and dairy products) ; large country assumption on both the import and export side with respect to the RoEU.
7. Four primary production factors: labor, capital, land and production rights.
8. Imperfect mobility of primary production factors across activity sectors on the basis of nested CET functions.
9. Three institutional sectors: a single representative consumer, the French government and the European Agricultural Guidance and Guarantee Fund (commonly known under its French acronym FEOGA).
10. Multi-stage budgeting process for the single representative consumer and allocation of its disposal income on the basis of linear expenditure systems.
11. Explicit modeling of public policy instruments with special attention given to CAP instruments: intervention price mechanism, export subsidies, import tariffs, production quotas, direct payments, set aside, …
12. Competitive markets and neoclassical macro-economic closure.

Annex 2. Industry and commodity disaggregation of the MEGAAF model

Industries	Commodities
Agriculture	
Arable crop farming	Soft wheat, barley, maize, other cereals, oilseeds, protein crops
Viticulture	Wine
Other crop farming	Other crop products
Dairy farming	Raw milk, cattle, fodder crops
Cattle farming	Cattle, fodder crops
Pig farming	Pigs
Poultry farming	Poultry and eggs
Other animal farming	Other animal products, fodder crops
Food processing	
Meat industry	Bovine meat, pig meat, poultry meat, other meats
Dairy industry	Butter and skimmed milk powder, other dairy products
Bakery industry	Bread and patisserie
Compound feed industry	Compound feed
Cereal processing industry	Cereal processed products
Oilseed crushing industry	Oils, oil-meals
Other food product industry	Other food products
Rest of the economy	
Fishery	Fish products
Inorganic chemistry	Fertilizers, other products of inorganic chemistry
Organic chemistry	Products of organic chemistry
Industry of pesticides	Pesticides
Pharmaceutical industry	Pharmaceutical products
Other manufacturing	Other manufacturing products
Services	Services
Retailing	-