Modelling the CAP Arable Crop Regime in Italy : Degree of Decoupling and Impact of Agenda 2000

Daniele Moro, Paolo Sckokai

HAL Id: hal-01200916

https://hal.science/hal-01200916

Submitted on 17 Sep 2015

Modelling
the CAP Arable Crop Regime
in Italy : Degree
of Decoupling and Impact
# of Agenda 2000

Daniele MORO,
Paolo SCKOKAI

Daniele MORO*, Paolo SCKOKAI*

**Modélisation du
régime de la PAC
appliqué aux cultures
arables en Italie :
degré de découplage
et impact
de l'Agenda 2000**

Mots-clés :
découplage, PAC, profit,
Agenda 2000, Italie

Résumé – Dans cet article, nous modélisons le régime de la PAC appliqué aux cultures arables, en utilisant une approche duale qui nous permet de mesurer en termes d'élasticités la réponse de la production et des décision d'allocation des surfaces au schéma des paiements compensatoires. Nous appliquons cette méthodologie à un échantillon d'exploitations du Nord de l'Italie, sur la période de transition de la réforme de la PAC. Le modèle estimé nous permet d'évaluer, pour la région considérée, les effets, en termes d'offre et d'allocation des surfaces, de la réforme de l'"Agenda 2000" et d'analyser son degré de découplage.

*Modelling the CAP
arable crop regime
in Italy : degree of
decoupling and
impact of Agenda 2000*

Key-words :
*decoupling, CAP, profit
function, Agenda 2000, Italy*

Summary – *In this paper, we model the CAP arable crop regime using a dual approach that allows us to measure in terms of elasticities the response of production and land allocation decisions to the compensatory payments scheme. We apply this methodology to a data sample of crop farms in the North of Italy, within the transition period of the CAP reform. The estimated model allows us to measure, for the area considered, supply and land allocation responses to the recent "Agenda 2000" reform package, as well as to analyse its degree of decoupling.*

* *Istituto di Economia Agro-alimentare, Università Cattolica, Via Emilia Parmense, 84, 29100 Piacenza, Italy*
e-mail: psckokai@pc.unicatt.it; dmoro@pc.unicatt.it

SINCE the 1992 reform of the Common Agricultural Policy (CAP) of the European Union (EU), modelling the new arable crop regime has been a common task of many agricultural economists. Right after the adoption of the MacSharry package, most of the research effort has been devoted to the technical nature of the new policy instruments (Fraser, 1993 and 1997; Froud and Roberts, 1993; Nardone and Lopez, 1994; Roberts *et al.*, 1996; Rygnestad and Fraser, 1996), while, more recently, some comprehensive attempts of simulating the effects of the reform have been made available (Oude Lansink and Peerlings, 1996; Guyomard *et al.*, 1996).

After the recent "Agenda 2000" reform (European Commission, 1999a and 1999b), it is crucial to evaluate the likely impact of the new reform package, which extends the MacSharry approach by reducing guaranteed prices for cereals and increasing per-hectare aids to compensate farmers' income losses. However, to evaluate the likely impact of the reform, one needs to use a model that accounts correctly for the partially "decoupled" nature of the compensatory payments.

In fact, as it is well known, one of the key issues related to the MacSharry reform is the level of "decoupling" of the regime [1]. There is some general agreement that, even though the MacSharry plan was explicitly aimed to "decouple" farm income support from current production, the new policy instruments have only partially reached the target, especially if one considers the land allocation mechanism. In fact, although current production plays no role in determining the level of the compensatory payments, the presence of crop-specific per-hectare aids ('professional producer' scheme) and the fact that such aids are provided only for some commodities (cereals, oilseeds and protein crops) do affect land allocation decisions of a profit maximising producer. This means

---

[1] "Decoupling" may be defined, in general, as the situation in which income support tools do not affect short-run marginal production decisions. This is also the idea behind the legal definition of "Decoupled income support" that can be found in point 6 of Annex 2 of the Uruguay Round Agreement on Agriculture (WTO, 1994), which defines those internal support measures which can be exempted from the domestic support reduction commitments, entering the so-called "green box". The 1992 CAP compensatory payments are not eligible under these criteria, and their exemption is linked to the Blair House compromise, which defined the so called "blue box". Since the maintenance of the blue box exemption will probably be challenged in the new World Trade Organisation (WTO) round of trade negotiations, the definition of the green box (i.e. the conditions for a policy instrument to be considered "decoupled") and the measurement of the degree of decoupling of different agricultural policy measures, or group of measures, will probably characterise the debate on the domestic support reduction commitments (see Gohin *et al.*, 1999 for an extensive discussion of these issues).

that the level of the aids does influence the current level of production through the land allocation decisions (Sckokai and Moschini, 1993; Gohin *et al.*, 1999) [2].

The importance of the land allocation distortions induced by the MacSharry package can also be inferred from the debate which accompanied the "Agenda 2000" reform process. In fact, one of the key elements of the original proposals of the European Commission, released in March 1998 (European Commission, 1998), was to make direct payments no longer crop-specific, at least for the main crops, thus reducing substantially the potential distortions in land allocation [3]. However, the final agreement (European Commission, 1999a and 1999b) reintroduced the provision that allows member states to use different reference yields for maize, thus making cereal payments crop-specific. This clearly reduces the impact of the Agenda 2000 package on the level of decoupling of the regime.

Given the above general set-up, models wishing to analyse the arable crop regime need to account for the distortions introduced in the land

---

[2] Note, however, that recently some arguments have been raised to support an effective decoupling of the CAP reform (Cahill, 1997), at least for some of the crops involved in the scheme. Although based on a broader notion of decoupling, this result seems in contrast with previous well established beliefs.

[3] The main elements of the Commission proposals (March 1998) for the arable crop regime reform were the following:

a) 20% reduction in the intervention price for cereals, in one single step; elimination of the monthly increments of the intervention price;

b) introduction of a non crop-specific area payment of 66 EUR/t (multiplied by the same historical cereals yields used for the MacSharry package), to be used for cereals, oilseeds, set-aside and non-textile linseed; additional payments allowed only for protein crops (72.5 EUR/t) and durum wheat (following the corresponding 1997 reform);

c) elimination of the possibility of determining specific base areas and yields for maize, thus equalising all cereal payments;

d) compulsory set-aside rate fixed at 0%, and voluntary set-aside admissible;

e) possibility of modifying the set-aside rate and the direct payments according to market developments.

The final agreement (March 1999) introduced some important changes compared with the initial proposals:

a) 15% reduction in the intervention price in two equal steps, starting in the 2000/2001 marketing year (from 119.19 EUR/t to 101.31 EUR/t); the monthly increments are maintained;

b) cereal payments increased to 63 EUR/t in the same two years;

c) progressive alignment (three years) of the oilseeds payments to the cereal level (63 EUR/t multiplied by the cereal reference yield);

d) the possibility of using different reference yields for maize is maintained (but in that case, the oilseed payments have to be calculated using the "other cereals" reference yields);

e) increase in reference yields for Italy and Spain, which recognises the exceptional agronomic and climatic conditions in the reference years (1986-1991);

f) the compulsory set-aside rate is fixed at 10% (the same of the 1999/2000 marketing year).

allocation mechanism. Among the methodological contributions to this literature, both Oude Lansink and Peerlings (1996) and Guyomard *et al.* (1996) have considered the land allocation issue, and have tried to incorporate the main CAP reform tools in a profit maximisation model. In both papers, the authors define a first-stage restricted profit function conditional to a given vector of land allocations, which allows them to derive second-stage land allocation equations implicitly defined by the corresponding optimality conditions (equality of the shadow prices of land allocated to different crops). Moreover, in Guyomard *et al.* (1996), the comparative statics of acreage allocations and land shadow prices defines an implicit value for supply and land allocation elasticities with respect to the compensatory payments, although based on the maintained hypothesis of nonjointness in variable inputs [4]. This two-stage approach has been applied by the authors to datasets which refer to the pre-reform period; thus, they are forced to assume that their estimation results are equally suitable for a totally different policy regime [5].

In this paper, we use a methodology that seems to overcome some of these problems. The most important difference between our model and the previous ones is that we apply our profit maximisation set-up to farm data that refer to the implementation period of the MacSharry reform. In this framework, relying on a proper multioutput profit function specification, we can derive flexible land allocation equations, which can be estimated simultaneously with output supply and input demand equations; this allows us to compute directly the elasticities of all these choice variables with respect to the exogenous variables (prices and compensatory payments).

These elasticities become extremely useful to evaluate the impact of the arable crop regime on the area considered in our analysis. In fact, the magnitude of the elasticities allows us to evaluate the relative importance of price variations and compensatory payment variations in terms of their impact on producers' choices. Moreover, postulating exogenously the relevant changes in the key policy parameters, the elasticity values can be used to simulate the impact of the new "Agenda 2000" reform package. Finally, we can verify empirically whether or not this package can be considered effectively decoupled, since it is also possible to compute, under alternative scenarios, some measure of the degree of decoupling.

To do so, we rely on the estimation of a normalised quadratic profit function, applied to a dataset from the Italian Farm Accounting Data

---

[4] In their footnote 4, Guyomard *et al.* (1996) state that their model can be generalised to accommodate jointness in input quantities, but this would make their land allocation equations very "*…untransparent and messy*" (p. 419).

[5] The authors of both papers acknowledge this important limitation of their analyses.

Network (FADN); in particular, we refer to a sample of farms located in the North of Italy, where production of cereals and oilseeds is particularly important.

THEORETICAL FRAMEWORK

The specification of the profit function

Consider a multioutput technology in which a vector q of N variable netputs is involved in the production process in a given period of time (with the usual sign convention, positive for the n outputs and negative for the *(N-n)* inputs); in the short run, this technology is assumed to be restricted by the presence of a vector s of fixed allocatable inputs and a vector z of other fixed inputs which are not allocatable [6]. This specification is fairly general. However, for agricultural production, land is the most typical element of the vector *s*, and it is also the key element of our analysis; thus, for notational convenience, we will consider *s* as a scalar (total land availability). Given the netput price vector *p*, this set-up leads to a standard profit maximisation problem, where producers choose simultaneously netput quantities and land allocations (Chambers, 1988; Chambers and Just, 1989).

Now, considering the 1992 CAP reform framework, for some specific commodities (cereals, oilseeds and protein crops) EU producers receive a per-hectare aid based on their acreage declarations. Furthermore, the reform allows these specific commodities to be produced under three different schemes: without receiving any compensatory payment (the non-participation case, or *scheme A*); receiving a per-hectare compensatory payment under the provision that the total area allocated to program crops does not exceed a given level $\bar{s}_B$ (the "small producer" case, or *scheme B*) [7]; receiving a crop-specific per-hectare aid with the obligation of setting aside a fixed percentage of land allocated to program crops, for which farmers receive an additional set-aside compensatory payment (the "professional producer" case, or *scheme C*). The only further limitation is that a producer cannot participate at the same time in *scheme B* and *scheme C*.

---

[6] This specification can be easily extended to account for fixed output, as it is the case of the CAP dairy and sugar programs (Moschini, 1988).

[7] The 1992 reform defines as "small producers" those farmers receiving compensation for an amount of land that does not exceed the fixed amount which would be necessary to produce 92 tonnes of cereals, calculated for a given historical regional average yield.

Thus, if $m < n$ is the number of crops covered by the new regime, a is the vector of the crop-specific per-hectare aids, b is the set-aside premium and c the fixed set-aside percentage under *scheme C*, d is the per-hectare aid under *scheme B*, s_A, s_B, and s_C are the vectors of land allocation decisions under the different schemes, s_x is the land allocated to set-aside (thus $s_x = \sum_{i=1}^{m} s_{Ci} \dfrac{c}{1-c}$) and s_y is the vector of land allocated to non-program crops, we can write the following maximisation problem:

$$\pi(p, s, \bar{s}_B, z, r, d, c) \equiv \max_{q, s_A, s_B, s_C, s_y} \left\{ \begin{array}{l} \sum_{i=1}^{N} p_i q_i + d \sum_{i=1}^{m} s_{Bi} + \sum_{i=1}^{m} r_i s_{Ci} : \quad T(q, s_A, s_B, s_C, s_y, s, z) \geq 0 \\[2ex] \sum_{i=1}^{m} s_{Bi} \leq \bar{s}_B \\[2ex] \sum_{i=1}^{m} s_{Ai} + \sum_{i=1}^{m} s_{Bi} + \sum_{i=1}^{m} s_{Ci} \dfrac{1}{1-c} + \sum_{i=m+1}^{n} s_{yi} \leq s \\[2ex] \sum_{i=1}^{m} s_{Bi} + \sum_{i=1}^{m} s_{Ci} = 0 \end{array} \right\} \quad (1)$$

where we define $r_i = a_i + b \dfrac{c}{1-c}$ and the binding constraint $s_x = \sum_{i=1}^{m} s_{Ci} \dfrac{c}{1-c}$ is substituted for in the maximization problem [8]. The last constraint in (1) is a participation constraint that accounts for the mutual exclusion of *scheme B* and *scheme C*. Finally, it is straightforward to show that, under fairly general conditions, $\pi(p,s,s_B,z,r,d,c)$ is nonincreasing in input prices and nondecreasing in output prices and compensatory payments, positively linearly homogeneous in (p,r,d), convex and continuous in (p,r,d).

The function in (1) is fairly general, accounting for the whole set of possibilities each producer is facing. For empirical application, it may give some problems, since all the constraints in (1) may not necessarily be binding. Furthermore, the function, although continuous, may not be differentiable in some points, given the existence of points in which producers find profitable to switch regime. However, in empirical work, we can overcome these problems by concentrating our interest on specific cases.

In our view, the most interesting case relates to the so called "professional producer scheme" (*scheme C*) where payments are crop-specific and are tied to the obligation of setting aside a fixed percentage of land allocated to program crops [9]. In this case, we can write the following sim-

---

[8] In this set-up r_i is the per-hectare amount a producer receives under *scheme C*, taking into account that a fixed percentage c is set aside.

[9] In the 1995/96 campaign (the last year of our estimation period), the "professional producer scheme" absorbed about 60% of total EU expenditure for the arable crop regime in Italy.

plified maximisation problem, under the assumption that all producers considered participate in *scheme C*:

$$\pi(p, s, z, r, c) \equiv \max_{q, s_C, s_y} \left\{ \sum_{i=1}^{N} p_i q_i + \sum_{i=1}^{m} r_i s_{Ci} : \quad T(q, s_C, s_y, s, z) \geq 0; \ \sum_{i=1}^{m} s_{Ci} \frac{1}{1-c} + \sum_{i=m+1}^{n} s_{yi} \leq s \right\} \tag{2}$$

Moreover, if we assume that $\pi(p,s,z,r,c)$ is twice continuously differentiable, the most interesting empirical implication is the expression of the derivative property [10]:

$$q_i(p, s, z, r, c) = \partial \pi(p, s, z, r, c)/\partial p_i \quad i = 1,...,N$$
$$s_{Ci}(p, s, z, r, c) = \partial \pi(p, s, z, r, c)/\partial r_i \quad i = 1,...,m \tag{3}$$

Note that the derivation of the land allocation equations in (3) does not require nonjointness in variable inputs, which can rather be tested, following for example the procedure suggested by Chambers and Just (1989), which takes into account the presence of allocatable fixed inputs. Moreover, using Young's theorem, it is straightforward to derive symmetry and reciprocity results which involve the new CAP tools; for example, netput supply and land allocation equations are linked by the following relationship:

$$\partial q_i(p, s, z, r, c)/\partial r_j = \partial^2 \pi(p, s, z, r, c)/\partial p_i \partial r_j \equiv$$
$$\equiv \partial^2 \pi(p, s, z, r, c)/\partial r_j \partial p_i = \partial s_{Cj}(p, s, z, r, c)/\partial p_i \quad i = 1,...,N \quad j = 1,...,m \tag{4}$$

The empirical model

The results derived in the previous section allow us to specify a parametric form for both the netput supply/demand functions and the land allocation functions for the crops involved in the new CAP regime. This can be done by choosing any flexible functional form among those suggested by the literature to approximate the profit function.

We rely on the normalised quadratic profit function, originally proposed by Lau (1974) and largely applied to agricultural data [11]. Among

---

[10] Note that, given the derivative property, this model does not allow to specify land allocation functions for non program crops, except for the special case where we have only one excluded commodity, whose land allocation is defined by the total land constraint.

[11] In choosing the functional form for the profit function, we have also considered the hypothesis of using the symmetric version of the normalised quadratic, which has some desirable properties (Kohli, 1993). However, the specific structure of this form introduces further non-linearities in a model which is already highly non-linear because of the imposition of convexity in prices (see section 3): despite the higher number of parameters, the log-likelihood of the symmetric model turned out to be lower than the standard normalised quadratic model. Thus, we have adopted the latter relying on the likelihood dominance criterion proposed by Pollak and Wales (1991).

the properties of this functional form, it is valuable to recall that it has a Hessian of constants, such that the curvature property of convexity can hold globally. Moreover, it allows negative realisation of profits, a possibility which cannot be exploited using forms where logarithmic transformations are required.

Choosing p_N as the numeraire, let $\overline{p} \equiv p / p_i$ and $\overline{r} \equiv r / p_N$ be respectively the normalised price vector and the normalised per-hectare aid vector, and $v = (s,z,c)$ be the vector of all fixed resources. Then, the normalised quadratic profit function takes the following form:

$$\overline{\pi} = \alpha_0 + \sum_{i=1}^{N-1} \alpha_i \overline{p}_i + \frac{1}{2}\sum_{i=1}^{N-1}\sum_{j=1}^{N-1} \alpha_{ij} \overline{p}_i \overline{p}_j + \sum_{i=1}^{m} \beta_i \overline{r}_i + \frac{1}{2}\sum_{i=1}^{m}\sum_{j=1}^{m} \beta_{ij} \overline{r}_i \overline{r}_j + \sum_{h=1}^{l} \gamma_h v_h + \frac{1}{2}\sum_{h=1}^{l}\sum_{k=1}^{l} \gamma_{hk} v_h v_k$$
$$+ \sum_{i=1}^{N-1}\sum_{j=1}^{m} \delta_{ij} \overline{p}_i \overline{r}_j + \sum_{j=1}^{N-1}\sum_{k=1}^{l} \phi_{jk} \overline{p}_j v_k + \sum_{j=1}^{m}\sum_{k=1}^{l} \varphi_{jk} \overline{r}_j v_k \tag{5}$$

where $\overline{\pi} \equiv \pi / p_N$ is the normalised profit and $\alpha's, \beta's, \gamma's, \delta's, \phi's$ and $\varphi's$ are parameters to be estimated. This profit function is linearly homogeneous by construction, while symmetry can be maintained by further imposing $\alpha_{ij} = \alpha_{ji}$, $\beta_{ij} = \beta_{ji}$ and $\gamma_{hk} = \gamma_{kh}$.

Using the derivative property in (3), output supply and input demand equations can be written as:

$$q_i = \alpha_i + \sum_{j=1}^{N-1} \alpha_{ij} \overline{p}_j + \sum_{j=1}^{m} \delta_{ij} \overline{r}_j + \sum_{k=1}^{l} \phi_{ik} v_k \quad i = 1,....,N-1 \tag{6}$$

while the land allocation equations for the CAP program crops take the form:

$$s_{Ci} = \beta_i + \sum_{j=1}^{m} \beta_{ij} \overline{r}_j + \sum_{j=1}^{N-1} \delta_{ij} \overline{p}_j + \sum_{k=1}^{l} \varphi_{ik} v_k \quad i = 1,....,m \tag{7}$$

The implied parametric form of the numeraire equation (output supply/input demand for netput *N*) can be retrieved by the normalised profit function in (5).

The impact of "Agenda 2000"

One of the most obvious application of our model is to evaluate the impact of the recent "Agenda 2000" package. In fact, given our estimation results, the foreseen rate of change in production can be derived

simply differentiating each supply equation with respect to prices and compensatory payments :

$$\frac{dq_i}{q_i} = \sum_{j=1}^{N} \varepsilon_{ij} \frac{dp_j}{p_j} + \sum_{h=1}^{m} \eta_{ih} \frac{dr_h}{r_h} \qquad i = 1, ..., N \tag{8}$$

where ε_{ij} and η_{ih} represent the estimated price elasticity and payment elasticity of supply, respectively, while the foreseen rate of change in land allocation can be computed in a very similar set-up :

$$\frac{ds_{Ci}}{s_{Ci}} = \sum_{j=1}^{N} \lambda_{ij} \frac{dp_j}{p_j} + \sum_{h=1}^{m} \theta_{ih} \frac{dr_h}{r_h} \qquad i = 1, ..., m \tag{9}$$

where λ_{ij} and θ_{ih} are the corresponding elasticities of land allocation.

In this context, our baseline scenario is the continuation of the 1992 MacSharry package, whose results are simply the fitted values of the estimated model under the hypothesis of no policy changes. The relevant elements of the Agenda 2000 reform which can be analysed within our model are the reduction in the intervention price for cereals, the increase in the corresponding compensatory payments, the alignment of the oilseed payments to the cereal level, the provision of using different reference yields for maize and the specific increase of reference yields for Italy (see footnote 3 for details). The point is that, when these models are used for policy analysis, one of their strongest limitations is that the impact of policy changes on equilibrium prices has to be postulated exogenously, while, in reality, it is the final result of all the adjustments induced by the changes in policy parameters. In this sense, the results of our simulation must be taken with some caution, since they take into account only the supply side of the market. However, since it is too simplistic to assume perfect transmission between institutional price changes and market prices, we decided to adopt the arable crop price projections made, for the whole EU, by the FAPRI modelling system, where the impact of the Agenda 2000 package has been analysed in a world-wide partial equilibrium policy simulation model (FAPRI, 1999) [12].

These price projections are used to model three different scenarios concerning compensatory payment levels, whose impact is the most relevant for the issue of decoupling. As a benchmark, we consider the hypothetical scenario of equilibrium price changes with no compensatory payment changes (scenario 1). This is compared with two alternative levels of

---

[12] The postulated price changes for maize, other cereals and oilseeds are FAPRI projections of EU prices for the season 2002/2003, after the transition period of the Agenda 2000 package (the three years progressive alignment of oilseeds payments). These projections, compared to a baseline which assumes a continuation of policies that were in place prior to March 1999, are the following : - 9.7 % for the price of maize; - 6.6 % for the price of wheat (which is the main component of our aggregate "other cereals"); an average of + 0.4 % for the price of oilseeds.

Agenda 2000 payments: the first one considers the hypothesis of maintaining the provision (currently adopted by the Italian authorities) of using differentiated maize yields (scenario 2), while the second assumes its elimination (scenario 3). Prices of inputs and other crops are held constant.

The degree of decoupling of "Agenda 2000"

In a fairly recent paper (Cahill, 1997), there is an attempt to evaluate the rate of decoupling provided by the CAP reform at the EU level. The argument in that paper is that compensations must be seen as a package, without limiting the attention to a single crop: thus, although in principle payments are not decoupled since they depend upon the actual planted area of a given crop, the payment scheme may be "effectively" fully decoupled, when "the *compensatory payments package results in production that, for any crop, does not exceed the level that would exist without compensation*" (Cahill, 1997, p. 351). Results in the paper suggest that for some crops (wheat, rapeseed and soybeans) compensatory payments are indeed effectively fully decoupled.

We try a similar exercise with our estimated model. As in Cahill (1997), we consider the CAP reform as a package of measures, which imply cross-crop substitution effects. The advantages of our procedure, although limited to a specific homogeneous area in Italy and to a specific category of producers, are that elasticity values are derived from a model estimated within the period of application of the compensatory payments scheme, which allows us to evaluate the rate of change in production as in (8).

We define full coupling as the case in which $\frac{dq_i}{q_i} = 0$ after a price change, that is the compensation scheme fully restores the price change (*i.e.* the case of a deficiency payment), and full decoupling as the case in which the change in production only corresponds to that under a price change, that is $\frac{dq_i}{q_i} = \sum_{j=1}^{N} \varepsilon_{ij} \frac{dp_j}{p_j}$. Partial decoupling lies normally between the two extremes, although in principle it is possible for the change in production of some crop to overshoot that due only to the price change.

We define the rate of decoupling as:

$$DR = 1 + \frac{\sum_{h=1}^{m} \eta_{ih} \frac{dr_h}{r_h}}{\sum_{j=1}^{n} \varepsilon_{ij} \frac{dp_j}{p_j}} \tag{10}$$

that takes the value of 0 in the case of full coupling and the value of 1 in the case of effective full decoupling.

We focus our attention on the "Agenda 2000" package, where, for the area considered, we know the specific changes in compensatory payments. Again, in order to compute DR, we have to assume a plausible impact of policy changes on equilibrium prices. As before, we consider the price projections made by FAPRI (1999), comparing them with the scenario of full transmission of intervention prices to market prices, since EU policy makers have fixed the amount of the payments in proportion to the decrease in intervention prices. All other prices are again held constant.

These rates of decoupling can be compared with the ex-post rates evaluated for the MacSharry package (baseline scenario), which are computed under the assumption that per-hectare aids guarantee full compensation for the revenue losses of crop producers. In fact, the spirit of the 1992 reform was to fix the amount of compensatory payments in order to give full revenue compensation for the price cut.

DATA AND ESTIMATION

The dataset employed in this paper has been obtained from a sample of farms located in the North of Italy during the MacSharry transition period (1993-1995); these farms belong to the FADN class "Field Crops". Information from the FADN data-base is highly detailed, both on the output and on the input side, such that the dataset has been integrated only for the series of regional input prices, which are from the Italian Official Statistics (ISTAT), and for the CAP reform variables (regionalised compensatory payments, set-aside percentage).

From the initial sample we have selected 426 farms which participated in the "professional producer" scheme and whose revenue came for more than 90% from field crops [13]. This allows us to assume, with a reasonable approximation, that total variable costs refer to these crops. However, the data set remains very disaggregated, especially in terms of number of outputs and number of variable inputs; thus, to make the estimation feasible, we have postulated some aggregates.

We have considered four output categories (maize, other cereals, oilseeds and other field crops) with their respective land allocations, where the first three represent those crops for which the CAP reform guarantees different levels of the per-hectare aids [14]. We have also considered

---

[13] We are aware that this particular choice of the dataset precludes some interesting implications of the analysis, such as the cross effects of the arable crop scheme with livestock production (and policy). However, since the focus of this paper is on the issue of "decoupling", specialised crop production is certainly the best "case study", given the peculiar structure of the MacSharry package.

[14] Protein crops play a marginal role in this sample, thus they have not been considered in the analysis.

two variable inputs (seeds and chemicals and other inputs) and four fixed inputs (capital, total land, family labour and set-aside percentage). We decided to incorporate hired labour in the aggregate "other inputs" because only a small percentage of farms in the sample (about 13%) utilises hired labour; the price of "other inputs" is also our numeraire in the normalised quadratic specification. The aggregates have been obtained as Divisia indexes, while profit has been computed as the sum of total gross sales and total CAP aids minus total variable costs. Descriptive statistics of the main data series are provided in Table 1 [15].

Table 1. **Descriptive statistics of the main data series**

	Quantities[a]		Prices[b]		Land allocations[c]		Per hectare aids[d]	
	Mean	Std.dev.	Mean	Std.dev.*	Mean	Std.dev.	Mean	Std.dev.
Maize	82.307	82.716	1.000	0.138	17.695	17.028	0.819	0.263
Other cereals	8.862	13.125	1.000	0.261	4.546	6.063	0.517	0.167
Oilseeds	10.624	15.115	1.000	0.460	7.695	8.401	1.591	0.224
Other field crops	15.392	19.522	1.000	0.140	4.220	5.483		
Seeds and chemicals	-21.101	15.687	1.000	0.056				
Other inputs	-32.983	30.774	1.000	0.085				
Set aside					4.976	3.671	1.011	0.214
Total land	39.132	26.272						
Capital	157.619	155.743						
Family labour	3092.575	1740.466						

[a] Constant million ITL for outputs, variable inputs and capital; hectares for total land; hours per year for family labour
[b] Divisia price indices
[c] Hectares
[d] Million ITL   * *std. dev:* standard deviation

Finally, we had to deal with the problem of zero values of some production variables, because, as one can easily imagine, many farms in the sample do not produce some of the crops considered in our model. The problem arises because normally this choice does not depend on relative output prices or relative CAP aids, our key explanatory variables, but rather on other structural characteristics of the farm (environmental conditions, rotations, experience of the farmer, traditions, specific capital endowment…), and these variables are difficult to incorporate in a simple model like ours.

In this paper, to deal at least partially with the problem and trying to avoid further complications in the estimation procedure, we use a set of dummy variables. In practice, we have introduced four dummy variables, one for each output considered in the model, which take the value of 1

_____

[15] Given the different variance of our observations, we need to account for heteroscedasticity. In our estimation procedure, we have calculated the standard errors of the parameter estimates using a heteroscedastic-consistent variance-covariance matrix, as computed by the econometric software TSP 4.3A.

when that output is produced (and the corresponding land allocation is positive), and 0 otherwise. Multiplying output prices and per-hectare aids, as well as the corresponding intercept terms, by their specific dummy variables allows us to estimate model parameters which relate only to positive relationships between dependent variables (outputs and land allocations) and explanatory variables (prices and aids) [16]. One drawback of this procedure is that, by estimating the basic relationships using only non-zero observations, the model is not able to satisfactorily approximate the farm decision of producing or not producing a particular crop within the CAP policy regime.

Equations (6) and (7) define, for our specific application, a system of nine simultaneous equations: an appropriate estimation method for this system is the maximum likelihood estimator, which guarantees, under the usual stochastic assumptions, consistency, asymptotic normality and asymptotic efficiency (Davidson and MacKinnon, 1993).

Our system requires the estimation of 76 parameters. However, convexity in prices of the estimated model turned out to be violated, and for this reason the system was reestimated imposing convexity by means of the Cholesky reparameterisation, which guarantees negative semidefiniteness of the coefficient matrix. For a matrix A, a necessary and sufficient condition to be negative semidefinite is that it can be written as $A = T'T$, where $T \equiv [\tau_{ij}]$ is an upper triangular matrix.

The estimation of a model with curvature imposed commonly produces convergence problems, therefore making the estimation of the fully convex model difficult. To reach convergence, a semiflexible version of the model was estimated, adopting the technique proposed by Diewert and Wales (1988) and applied to demand analysis by Moschini (1998). The solution originally adopted is that of restricting the rank of the Hessian matrix, consequently constraining the substitution possibilities and destroying flexibility of the chosen functional form [17]. In practice, once the *(maximum rank)* of the Hessian has been chosen, the semiflexible model can be obtained by restricting the rank of the matrix $T'T$: if we want to restrict such matrix to a rank $K < $ *(maximum rank)*, we just need to set to zero all the τ_{ij} elements for $i > K$ (that is to set to zero all the rows of T from $(K + 1)$ to *(maximum rank)* [18].

---

[16] A more rigorous treatment of the zero-observation problem would imply the use of a two-step estimation procedure for systems of equations with limited dependent variables, like the one proposed by Heien and Wessels (1990) for demand analysis, which has been recently extended by Shonkwiler and Yen (1999).

[17] Note, however, that these restrictions are not imposed according to *a priori* subjective beliefs, but letting the data to "suggest" the relevant rank of the matrix, which should represent the "best" substitution matrix that can be obtained under the restriction of convexity (Moschini, 1998).

[18] In our application, the unrestricted rank of the coefficient matrix is $M = 8$, but we were forced to restrict this rank to 5, which allows 6 additional parameters to be set to zero. Thus, the semi-flexible system requires the estimation of 70 parameters.

RESULTS AND DISCUSSION

Elasticities

Estimation results, with parameter estimates retrieved from convexity restrictions, are reported in Table 2. The single-equation R^2 coefficients are not fully satisfactory, especially for the oilseed equation, but this is a common result when dealing with farm data; however, the system R^2 indicates a much better goodness of fit for the whole system. It is also remarkable that almost 70% of the retrieved parameter estimates are significant.

Table 2. **Maximum likelihood estimates of normalised quadratic parameters** [a]

	q_1	q_2	q_3	q_4	q_5	s_1	s_2	s_3
				Dependent Variables				
Intercept	-20.316	3.721	5.834	6.609	-14.288	-2.012	-0.986	-4.284
	(8.714)	(1.565)	(2.831)	(3.130)	(5.124)	(0.793)	(0.289)	(1.534)
Prices:								
Maize (p_1)	70.643	-13.775	-17.963	-8.989	0.730	11.776	-2.603	-7.143
	(9.260)	(1.703)	(3.071)	(1.445)	(1.138)	(1.150)	(0.405)	(0.911)
Other cereals (p_2)		8.570	-0.489	-2.063	0.025	-2.293	3.094	-1.799
		(1.097)	(0.743)	(0.721)	(0.489)	(0.374)	(0.380)	(0.506)
Oilseeds (p_3)			9.429	1.614	1.887	-4.143	-0.485	7.647
			(1.958)	(0.904)	(0.783)	(0.596)	(0.225)	(0.851)
Other field crops (p_4)				15.087	-1.464	-2.437	-0.592	-1.634
				(3.006)	(0.547)	(0.297)	(0.171)	(0.501)
Seeds and chemicals (p_5)					12.292	-3.795	1.381	-0.340
					(3.219)	(0.957)	(0.376)	(1.009)
Per-hectare aids:								
Maize (r_1)						4.058	-1.481	-2.677
						(0.541)	(0.260)	(0.453)
Other cereals (r_2)							1.838	0.049
							(0.261)	(0.185)
Oilseeds (r_3)								10.687
								(1.672)
Total land	76.134	12.100	26.292	14.065	-22.516	17.971	2.886	13.294
	(8.341)	(2.459)	(7.077)	(2.150)	(1.208)	(1.848)	(0.504)	(2.101)
Capital	2.696	-0.462	2.818	0.168	-0.420	0.561	-0.194	0.099
	(3.657)	(0.900)	(2.330)	(1.314)	(0.693)	(0.681)	(0.205)	(0.831)
Family labor	2.544	-0.118	-6.834	-0.770	-1.785	0.795	0.163	-1.638
	(4.689)	(1.250)	(2.992)	(1.392)	(0.976)	(0.941)	(0.299)	(1.118)
Set-aside percentage	-32.098	9.444	4.535	4.102	5.166	-2.021	0.994	2.194
	(6.612)	(1.698)	(4.508)	(1.748)	(3.434)	(1.379)	(0.485)	(1.842)
$R^{2(b)}$	0.698	0.492	0.351	0.549	0.852	0.757	0.524	0.510

[a] Standard errors in brackets
[b] A system R^2 was also computed, which is equal to 0.998. This system R^2 indicates the proportion of the generalised variance of the matrix of dependent variables "explained" by variation in the right-hand side variables of the system of equations, and is computed as in Berndt (1991, p. 468).

In Table 3 we report elasticities for the mean point of the sample, where almost 80% of the values are statistically significant. Note that the elasticities with respect to the deflator (price of other inputs) are retrieved from the homogeneity condition, while the elasticities of other inputs demand are retrieved from the Cournot aggregation condition.

Table 3. **Elasticity estimates at the mean point** [a]

	p_1	p_2	p_3	p_4	p_5	p_6	r_1	r_2	r_3
Maize (q_1)	0.964	-0.188	-0.245	-0.123	0.010	-0.446	0.161	-0.036	-0.097
	(0.126)	(0.023)	(0.042)	(0.020)	(0.016)	(0.105)	(0.016)	(0.006)	(0.012)
Other cereals (q_2)	-1.165	0.725	-0.041	-0.174	0.002	0.738	-0.194	0.262	-0.152
	(0.144)	(0.093)	(0.063)	(0.061)	(0.041)	(0.160)	(0.032)	(0.032)	(0.043)
Oilseeds (q_3)	-0.698	-0.019	0.366	0.063	0.073	0.097	-0.161	-0.019	0.297
	(0.119)	(0.029)	(0.076)	(0.035)	(0.030)	(0.083)	(0.023)	(0.009)	(0.033)
Other field crops (q_4)	-0.522	-0.120	0.094	0.876	-0.085	0.028	-0.142	-0.034	-0.095
	(0.084)	(0.042)	(0.053)	(0.175)	(0.032)	(0.183)	(0.017)	(0.010)	(0.029)
Seeds and chemicals (q_5)	-0.031	-0.001	-0.081	0.063	-0.529	0.461	0.163	-0.059	0.015
	(0.049)	(0.021)	(0.034)	(0.024)	(0.139)	(0.136)	(0.041)	(0.016)	(0.043)
Other inputs (q_6)	0.831	-0.230	-0.018	0.050	0.371	-1.178	-0.100	0.070	0.203
	(0.247)	(0.068)	(0.072)	(0.116)	(0.110)	(0.241)	(0.038)	(0.014)	(0.053)
Land to maize (s_1)	0.682	-0.133	-0.240	-0.141	-0.220	0.057	0.235	-0.086	-0.155
	(0.067)	(0.022)	(0.034)	(0.017)	(0.055)	(0.063)	(0.031)	(0.015)	(0.026)
Land to other cereals (s_2)	-0.848	1.007	-0.158	-0.193	0.450	-0.391	-0.482	0.598	0.016
	(0.132)	(0.124)	(0.073)	(0.056)	(0.123)	(0.120)	(0.085)	(0.085)	(0.060)
Land to oilseeds (s_3)	-0.531	-0.134	0.568	-0.121	-0.025	-0.356	-0.199	0.004	0.794
	(0.068)	(0.038)	(0.063)	(0.037)	(0.075)	(0.103)	(0.034)	(0.014)	(0.124)

[a] Standard errors in brackets

The signs of own-price elasticities are obviously consistent with the theory, because convexity was imposed using the "semiflexible" Cholesky factorisation. Although this implies restrictions on substitutability, the magnitude of both own-price and cross-price elasticities turns out to be quite reasonable. All outputs show inelastic supply, but price responsiveness is quite important for all of them, especially for maize, other cereals and other field crops. The demands for variable inputs is inelastic for seeds and chemicals and elastic for the aggregate "other inputs"; the main components of this aggregate are energy and hired services, which seem to be particularly responsive to their own prices.

Cross-price elasticities among outputs determine mainly substitutability relationships, which are particularly strong among CAP reform crops; this seems to reflect the prevalent agronomic conditions in the area. Cross-price elasticities between the two inputs also determine substitutability relationships.

From our point of view, the most interesting results are those which relate to elasticities involving the CAP compensatory payments and the land allocation functions. The first observation relates to the nature of the aids r_i, which are linear combinations of the crop-specific per-hectare aids, the set-aside payment and the set-aside percentage; this clearly im-

plies that even a change in the set-aside premium, or in the set-aside percentage, does affect land allocation decisions and supply levels.

The supply of maize, other cereals and oilseeds is inelastic with respect to their own compensatory payments, but the positive response to the aids implies a likely incentive to production, and shows once again that the CAP reform tools are not fully decoupled. In fact, if production decisions had to be considered as independent of the aids, we would have registered elasticity values much closer to zero [19]. However, the aid responsiveness is not particularly high, and this may be due to the fact that production is influenced mainly indirectly by the aids, through land allocation decisions. Finally, cross-elasticities with respect to compensatory payments are negative, although quite low.

Similar considerations arise from the analysis of the elasticities of land allocations. First, they are strongly responsive to prices of their respective crops; moreover, they are positively influenced by the aids. It is somehow interesting to note that land allocation elasticities with respect to compensatory payments are higher than the corresponding supply elasticities, thus showing that the direct effect of the CAP payments is typically on land allocations, which also implies lower yields and more extensive techniques. The same considerations apply to most of the corresponding cross-elasticities.

Input demands are also responsive to compensatory payments, and these responses are mainly crop-specific. However, in general we observe very low elasticity values, especially for seeds and chemicals, and this may again justify the hypothesis that CAP reform tools tend to disincentive intensive agricultural practices. In particular, some positive elasticities of input demands with respect to compensatory payments are lower than the corresponding land allocation elasticities. This seems to suggest that farmers respond to crop-specific payments increasing land allocated to that crop, but this higher investment does not imply a corresponding increase in input use.

The impact of "Agenda 2000"

Output supply, input demand and land allocation responses to the "Agenda 2000" package are summarised in Table 4 [20]. Our simple sim-

---

[19] The size of these own-payment elasticities, and in particular their departure from the theoretical value of zero, may be considered, for each single crop, as a first approximate measure of the degree of "coupling" of the compensatory payments.

[20] The table does not report results for the aggregate "other inputs" because, since we did not estimate the profit function jointly with the supply/demand and land allocation equations, we lack some of the parameter estimates which are needed to recover the absolute values of the endogenous variable for the "numeraire" equation. Note also that the percentage changes in the table are computed using the elasticities at the sample mean in 1995, at the end of the transition period of the MacSharry package, when institutional prices and compensatory payments reach their final level.

ulation shows that oilseeds would be negatively affected by the reform, but their potential supply reduction could vary remarkably under different scenarios. At first, this result comes mainly from the strong decrease in oilseed aids, due to the progressive realignment of these payments to the cereal levels; in fact, under the hypothesis of price reductions with no compensation changes (scenario 1), we would experience a remarkable increase in both oilseed production and land allocation. However, the provision of allowing a differential treatment for maize (scenario 2) could critically affect the supply of oilseeds. In fact, allowing a single reference yield for all cereals, and thus equalising all arable crop payments, the impact would be much lower (scenario 3), since the reduction in the cereal intervention price leads to a significant reduction in market prices for both maize and other cereals, accompanied by virtually unchanged oilseed prices, for which no intervention mechanism is in place.

Table 4. **Output supply, input demand and land allocation responses to "Agenda 2000" policy changes under different scenarios**

	Baseline scenario[a]	Scenario 1 [b] (% change)	Scenario 2 [c] (% change)	Scenario 3 [d] (% change)
Maize	84.21	-8.7%	-0.7%	-6.7%
Other cereals	7.41	7.6%	19.4%	34.9%
Oilseeds	10.16	8.2%	-13.8%	-6.2%
Other field crops	11.10	9.2%	12.6%	11.7%
Seeds and chemicals	-19.79	0.3%	1.5%	-4.2%
Land to maize	17.05	-6.5%	6.0%	-5.2%
Land to other cereals	4.31	0.6%	0.9%	39.3%
Land to oilseeds	8.16	6.7%	-41.3%	-24.8%

[a] Continuation of the MacSharry package (see table 1 for units of measurement)
[b] FAPRI price changes (see footnote 12) and no compensatory payment changes
[c] FAPRI price changes (see footnote 12) and Agenda 2000 payments with different reference yields for maize
[d] FAPRI price changes (see footnote 12) and Agenda 2000 payments with single reference yields for all cereals

Other cereals (mainly wheat) would be largely favoured by the reform, but, again, the size of this effect depends upon the scenario considered. Maintaining a differential treatment for maize would reduce the potential supply increase of other cereals, mainly because of the reduced unit payment. On the contrary, equalising payments, the increase would be much stronger, with a sort of "compensation" with respect to the MacSharry package, which strongly favoured maize and oilseeds, at least in the area considered.

As one can expect, the size of the potential impact on maize supply depends critically on the political decision concerning its differential treatment. The impact of Agenda 2000 would be negative under all scenarios, given the strong price reduction for coarse grains projected by FAPRI, but, maintaining a differential treatment, the higher amount of compensatory payments would make the change with respect to the

baseline very small. Finally, under all scenarios, we would register a significant increase in supply of other arable crops, while these crops are now largely penalised by the MacSharry package.

In general, the above results show how crop supplies would be sensitive to the foreseen price and per-hectare aid changes, and this turns out to be true also for the effects in terms of planted areas. In this respect, it is interesting to note how critical would be, once again, the choice concerning the differential treatment of maize, since land allocation decisions are particularly sensitive to the level of the payments. For example, equalising crop payments (scenario 3) would generate quite a strong increase in land allocation to other cereals, which would be consistently higher, in percentage terms, than that of production, thus showing a trend towards a more extensive production. The opposite would happen, for the same crops, maintaining the differential treatment for maize. The behaviour of maize depends upon the compensation scenarios, but the general tendency is towards more extensive production, while the opposite is true for oilseeds [21].

Finally, the decision on the maize treatment would play a crucial role also on the impact on the demand for seeds and chemicals, which would be consistently reduced under the more "decoupled" scenario of equalising payments, the one that would generate a stronger trend towards the adoption of more extensive techniques.

The degree of decoupling of "Agenda 2000"

In Table 5 we report the rate of decoupling (DR) of the "Agenda 2000" package for the three main reform crops (maize, other cereals and oilseeds), under different scenarios [22], as well as the "total" degree of decoupling, which is computed as a weighted average of the single crop rates, using as weights the projected crop supplies under each scenario [23]. It is immediately clear that the three crops register quite a different behaviour.

---

[21] Some of the results of these simulations must be taken with some caution, both in terms of their size (very strong decrease/increase of some endogenous variables) and in terms of their internal consistency (strong differences in land allocation and supply changes for the same crop). However, one should interpret these numbers as an indication of the general tendency in producer responses to policy changes, knowing that real world changes will be the result of all the relevant market adjustments (for example demand changes) as well as of some technological constraints which cannot be fully accounted in our simple set-up.

[22] As for the simulations provided in Table 4, the rates of decoupling are computed using the elasticities at the mean in 1995 (see also footnote 20).

[23] The choice of such weights is totally arbitrary (one may use, for example, projected land allocations) and it is done only to derive a synthetic index of decoupling.

Table 5. **Degree of decoupling of the "Agenda 2000" package under different scenarios**

	Baseline scenario [a]	Different reference yields for maize		Single reference yields for all cereals	
		Full price transmission [b]	FAPRI price changes [c]	Full price transmission [b]	FAPRI price changes [c]
Maize	0.50	0.34	0.08	0.84	0.78
Other cereals	1.40	2.82	2.56	5.19	4.60
Oilseeds	0.28	-0.77	-1.68	-0.16	-0.76
Total [d]	0.55	0.45	0.14	1.19	1.02

[a] *Ex post* evaluation of the MacSharry package
[b] Full transmission of institutional price changes to market equilibrium prices
[c] See footnote 12
[d] Weighted average of single crop rates (weights = projected crop supplies for each scenario)

Maize shows values between 0 and 1, thus a partial rate of decoupling. However, for a given change in compensatory payments, the degree of effective decoupling is positively correlated with an increase in the cereal price cut: this is the main reason of the higher degree of decoupling that we register under the two "full price transmission" scenarios, where full transmission of institutional price changes generates lower market prices. It is also interesting to note that the rate of decoupling of the MacSharry package (baseline scenario) is intermediate between the rates computed under the hypothesis of continuing to allow a differential treatment for maize and those for the hypothesis of equalising all payments. In the first case, our results show that the increase in maize payments introduced with Agenda 2000 would make the package more "coupled".

For other cereals, we register large and positive values of DR, which imply that, under all scenarios, both the price cut and the compensatory payment increase act in the same direction, giving a stronger increase in production than the price change only; the size of this effect turns out to be much higher than under the MacSharry package. Since, under all scenarios, we assume some reduction in cereal market prices, the supply increase must be caused by the strong cross-price effects estimated for these crops. The specific size of the cross-price effects also makes the degree of decoupling less sensitive to the amount of the foreseen reduction in market prices.

Oilseeds show all negative signs, which is an indication that the effect of the change in the compensatory scheme overshoots in absolute value the effect of the price change. In this case, oilseeds prices are virtually unchanged under all scenarios, which means that the impact of the specific structure of the payment changes gives a larger impact on oilseed production than the cross effects due to the cereal price changes. Thus, we can say that "Agenda 2000" is (negatively) skewed toward oilseeds.

However, as already illustrated for the case of maize, the most important result is that the provision of allowing different reference yields for maize makes the whole package less decoupled. In fact, for all the three crops, the values of DR increase consistently under the alternative scenarios of equalising payments, thus confirming theoretical predictions. The same conclusions can also be drawn analysing the "total" degree of decoupling of the policy package.

Given these results, one can also claim that, under some specific price scenarios, the "Agenda 2000" package may provide effective full decoupling (*i.e.* DR = 1) for some program crops. Of course, this is not the same as saying that the package is effectively fully decoupled *per se*, since we may also have, for the same reasoning, full coupling of the scheme. It is also interesting to note that, at least for the area considered, cross effects play an important role in determining the degree of decoupling, thus suggesting that any consistent measure of decoupling should account for them.

Finally, we need to stress that these results refer to a specific area and cannot be generalised to the EU level; thus our conclusions are not fully comparable to those in other studies. Nevertheless, they may be seen as a reference point for further empirical evaluations of the level of decoupling of the "Agenda 2000" package.

CONCLUDING REMARKS

The 1992 reform of the CAP arable crop regime has been largely analysed by agricultural economists: a major interest has been devoted to the evaluation of the nature of the adopted instruments, but mainly in a qualitative manner. There have been only a few attempts to provide a quantitative evaluation of the impact of the reform, taking into account correctly the partially decoupled nature of the compensatory payment scheme. Given that a new reform of the CAP has just been released, and its contents will become the base for discussion in the new WTO round of trade negotiations, we need a reliable framework to analyse quantitatively the impact of the arable crop regime in different EU regions.

In this paper we try to address these relevant questions, focusing our analysis on a sample of crop farms in the North of Italy. We use a dual approach through a profit function to model agriculture under the 1992 CAP reform, aiming at accounting for the response of production and land allocation decisions to the compensatory payment scheme. Since the MacSharry package has structurally changed the policy environment of crop production, we estimate the above responses within the transition period of the reform.

Our analysis shows that the compensatory payment regime can be easily, although not trivially, modelled in a profit function framework.

Estimated responses for the area considered provide evidence that this regime is not neutral towards crop production: the crop specific aids, the set-aside obligation and the related payments do affect crop supply, mainly through the land allocation mechanism. There is also a partial support to the policy makers' claim that the MacSharry reform induces more extensive agricultural production, reducing the use of inputs and the supply surplus.

Moreover, we have measured potential supply and land allocation responses to the recent "Agenda 2000" reform package. Among the main results, it is interesting to note that the impact of the reform in the area considered would depend crucially on the political choice of allowing a differential treatment for maize. However, in general, the "Agenda 2000" package turns out to be biased in favour of other cereals production (mainly wheat), and against oilseeds, while we would also register a tendency toward more extensive agricultural practices.

Finally, the estimated model allows us to analyse the degree of decoupling of "Agenda 2000". Under some plausible scenarios, we claim that, at least for the area considered, the recent CAP reform is far from being decoupled, since it generates strong reallocation of resources among the program crops, due also to some significant cross-price and cross-payment effects. We therefore support the qualitative analyses on the nature of the 1992 reform tools, that showed their distorting effect on production decisions.

Our analysis may also contribute to the incoming debate which will engage WTO agricultural negotiators on the issue of decoupling and its definition. As it is well known, the need of suitable empirical indicators of the degree of decoupling of agricultural policy tools/packages will probably characterise the debate on the domestic support reduction commitments. We do not claim of being able to suggest a reliable indicator, but our analysis of the partially decoupled CAP arable crop payments provides at least some preliminary insights. For example, it seems very difficult to measure the degree of decoupling of a given tool on an absolute basis, without carrying out specific empirical analysis, differentiated by product/region. In fact, one needs at least to measure some key parameters, like, for example, the relevant elasticities with respect to the (supposed) decoupled tool. Moreover, cross-crop effects seem to play a significant role in determining the level of decoupling, especially if one considers an entire package of policy instruments. Future research in this area is certainly needed, but it is valuable to note that some of these conclusions, drawn from our empirical work, are in line with those of Gohin *et al.* (1999), built on a theoretical general equilibrium model.

At the end, we must stress the limitations of our analysis, which is based on an empirical exercise related to a specific area of the North of Italy and to a sample of producers specialised in crop production. Further problems may also come from our choice of discarding, for the mo-

ment, the linkage between crop and milk production, which is important in the area, and from our treatment of zero-observations in the estimation procedure. Some further empirical research may fill these gaps.

REFERENCES

BERNDT (E. R.), 1991 — *The practice of econometrics: classic and contemporary*, Reading, Massachusetts, Addison-Wesley Publishing Company.

CAHILL (S. A.), 1997 — Calculating the rate of decoupling for crops under CAP/oilseeds reform, *Journal of Agricultural Economics*, vol. 48, pp. 349-378.

CHAMBERS (R. G.), 1988 — *Applied Production Analysis. A Dual Approach*, Cambridge, Cambridge University Press.

CHAMBERS (R. G.), JUST (R. E.), 1989 — Estimating multi-output technologies*, American Journal of Agricultural Economics*, vol. 71, pp. 980-995.

DAVIDSON (R.), MACKINNON (J. G.), 1993 — *Estimation and Inference in Econometrics*, New York, Oxford University Press.

DIEWERT (W. E.), WALES (T. J.), 1988 — A normalized quadratic semi-flexible functional form, *Journal of Econometrics*, vol. 37, pp. 327-342.

EUROPEAN COMMISSION, 1998 — *Agenda 2000. Commission proposals*, Brussels, Directorate-General for Agriculture.

EUROPEAN COMMISSION, 1999a — Council Regulation nº 1251/99 of 17 May 1999, *Official Journal of the European Communities*, L160/1.

EUROPEAN COMMISSION, 1999b — Council Regulation nº 1253/99 of 17 May 1999, *Official Journal of the European Communities*, L160/1.

FAPRI, 1999 — *Implications of the Berlin Accord for EU Agriculture*, FAPRI-UMC Report nº 7-99.

FRASER (R.), 1993 — Set-aside premiums and the May 1992 CAP reforms, *Journal of Agricultural Economics*, vol. 44, pp. 410-417.

FRASER (R.), 1997 — Land heterogeneity and the May 1992 Reform of CAP cereal price support, *Journal of Agricultural Economics*, vol. 48, pp. 65-70.

FROUD (J.), ROBERTS (D.), 1993 — The welfare effects of the new CAP cereals regime: A note, *Journal of Agricultural Economics*, vol. 44, pp. 496-501.

GOHIN (A.), GUYOMARD (H.), LE MOUËL (C.), 1999 — *Measuring the degree of decoupling of alternative internal support policy instruments: The green box issue*, Contributed paper at the 9th Congress of the European Association of Agricultural Economists (Warsaw, Poland, August 24-28, 1999).

GUYOMARD (H.), BAUDRY (M.), CARPENTIER (A.), 1996 — Estimating crop supply response in the presence of farm programmes: application to the CAP, *European Review of Agricultural Economics*, vol. 23, pp. 401-420.

HEIEN (D.), WESSELS (C. R.), 1990 — Demand systems estimation with microdata: A censored regression approach, *Journal of Business and Economics Statistics*, vol. 8, pp. 365-371.

KOHLI (U.), 1993 — A symmetric normalized quadratic GNP function and the US demand for imports and supply of exports, *International Economic Review*, vol. 34, pp. 243-255.

LAU (L. J.), 1974 — Comments, *in*: INTRILIGATOR (M. D.), KENDRICK (D. A.) (editors), *Frontiers of Quantitative Economics*, vol. II, Amsterdam, North-Holland.

MOSCHINI (G.), 1988 — A model of production with supply management for the Canadian agricultural sector, *American Journal of Agricultural Economics*, vol. 70, pp. 318-329.

MOSCHINI (G.), 1998 — The semiflexible almost ideal demand system, *European Economic Review*, vol. 42, pp. 349-364.

NARDONE (G.), LOPEZ (R.), 1994 — The welfare effects of the new CAP cereals regime: A comment, *Journal of Agricultural Economics*, vol. 45, pp. 386-388.

OUDE LANSINK (A.), PEERLINGS (J.), 1996 — Modelling the new EU cereals regime in the Netherlands, *European Review of Agricultural Economics*, vol. 23, pp. 161-178.

POLLAK (R. A.), WALES (T. J.), 1991 — The likelihood dominance criterion – A new approach to model selection, *Journal of Econometrics*, vol. 47, pp. 227-242.

ROBERTS (D.), FROUD (J.), FRASER (R. W.), 1996 — Participation in set aside, What determines the opting in price? *Journal of Agricultural Economics*, vol. 47, pp. 89-98.

RYGNESTAD (H.), FRASER (R.), 1996 — Land heterogeneity and the effectiveness of CAP set-aside, *Journal of Agricultural Economics*, vol. 47, pp. 255-260.

SCKOKAI (P.), MOSCHINI (G.), 1993 — Interventi disaccoppiati, riforma della PAC e redditi agricoli: un'analisi qualitativa, *Rivista di Economia Agraria*, vol. 48, pp. 391-412.

SHONKWILER (J. S.), YEN (S. T.), 1999 — Two-step estimation of a censored system of equations, *American Journal of Agricultural Economics*, vol. 81, pp. 972-982.

WTO, 1994 — *The Results of the Uruguay Round of Multilateral Trade Negotiations: The Legal Texts*, World Trade Organisation, Geneva.