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**Impact of alternative implementations
of the Agenda 2000 Mid Term Review**

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Abstract

An agricultural sector model for ex ante policy analysis is developed and applied for the simulation of alternative implementations of the Agenda 2000 Mid Term Review (MTR). The model uses an adapted version of Positive Mathematical Programming allowing simultaneous modelling of individual farms. It applies farm level calibrated quadratic cost functions to a sample of the Farm Accountancy Data Network to account for the large variability among farms. The farm level approach is important for the evaluation of the MTR, because MTR policy instruments rely on differences between farms. Extending the model for coping with the MTR implies three important elements: i) modelling the activation of decoupled direct payment entitlements, ii) simulating the modulation and iii) the transfers of direct payment entitlements. While most MTR analysis's focus on the first element, the current paper also tries to deal with the two last elements of the MTR.

JEL Keywords

Positive analysis of Policy-making and Implementation, Programming models, Computational techniques, Firm behaviour

1 Introduction

Although the MTR is agreed, and in some EU member states transposed into national legislation, in some member states certain components are still subject to further choices. The three main elements in the MTR are decoupling, cross-compliance and modulation (European Council, 2003). Decoupling means that one single farm payment will replace the direct payments to activities. Secondly, the MTR links the full payment of direct aid to compliance with rules relating to agricultural land, agricultural production and activity. Those rules, called cross-compliance, should serve to incorporate in the common market organisations basic standards for the environment, food safety, animal health and welfare and good agricultural and environmental condition. Finally, modulation is a system of progressive reduction of direct payments. The modulation will reduce all direct payments beyond 5000 euro per farm by a maximum of 5% in 2007. The savings made should finance measures of the rural development pillar. The government of the member state simulated in this paper has decided to decouple all direct payments except the suckler cow payments and veal payments.

Recently, several studies analyse the impact of the MTR on agriculture. Some of the models rely on representative farms, such as in Judez *et al.* (2003) and Offerman (2005), while other models mainly operate at regional or a higher level such as in Britz *et al.* (2002), Casado and Gracia (2005), Commission of the European Communities (2003), Guindé *et al.* (2005), Helming *et al.* (2002), Lips (2004) and Tabeau and van Leeuwen (2003). However, simulation of the response of farms on modulation, direct payment entitlement transfers and even decoupling is more straightforward at individual farm level. E.g., the amount of farms that receive direct payments beyond 5000 euro can only be simulated at farm level, because farms can try to avoid this modulation by exchanging direct payment entitlements. These transfers of direct payment entitlements among farms require also a farm level approach.

Exploiting the richness of the FADN data, current analysis therefore employs a model with farm level profit function optimization. The applied model is part of an effort to develop a decision support system (DSS) for agricultural and environmental policy analysis. Since this model only rests on accountancy data from the FADN, it is conceivably applicable to all the EU-15 58,000 representative commercial farms recorded in this database accessible by any national or regional administrative agencies.

The paper starts by explaining the basic model and its equations. The third chapter deals with the extensions introduced for modelling the main elements of the MTR. Chapter 4 assesses the numerical solving problems appearing for the proposed simulation model. Chapter 5 includes the impact analyses and finally, chapter 6 concludes.

2 The basic model

The model applied in this paper relies on a collection of microeconomic mathematical programming models each representing the optimising farmer's behaviour at the farm level. Parameters of each MP model are calibrated on decision data observed at a base period exploiting the optimality first order conditions and the observed opportunity cost of limiting resources. Simulation results can be aggregated according to the farm's localisation, type and size.

The model relies on a modified version of the standard PMP calibration method, which skips the first step of the standard approach (Howitt, 1995) for two reasons. The first argument for not using the first step of PMP is the availability of data on limiting resources, as argued also by Judez *et al.* (1998). The second motivation is the bias in the estimation of the dual of the resource constraints as demonstrated by Heckelei and Wolff (2003). An additional reason for the current application is that the farmland resources constraint is not limiting at farm level during simulation. Farms are indeed able to acquire land from other farms. Consequently, this first step is redundant implying the direct start of step two, the cost function calibration.

The model relies on a farm level profit function using a quadratic functional form for its cost component. In matrix notation, this gives:

$$Z_f = \mathbf{p}_f' \mathbf{x}_f + \mathbf{a}_f' \mathbf{Subs}_f \mathbf{x}_f - \frac{1}{2} \mathbf{x}_f' \mathbf{Q}_f \mathbf{x}_f - \mathbf{d}_f' \mathbf{x}_f \quad (1)$$

with

\mathbf{p}_f : a (n x 1) vector of output prices per unit of production quantity,

\mathbf{x}_f : a (n x 1) vector of production quantities,

\mathbf{Q}_f : a (n x n) diagonal matrix of quadratic cost function parameters,

\mathbf{d}_f : a (n x 1) vector of linear cost function parameters,

\mathbf{a}_f : a (n x 1) vector of technical coefficients determining how much land is needed for \mathbf{x}_f ,

\mathbf{Subs}_f : a (n x n) diagonal matrix of subsidies per acreage,

f : index for farms,

n : index for production quantities.

Two sets of equations calibrate the parameters of the matrix \mathbf{Q}_f and the vector \mathbf{d}_f , relying on output prices \mathbf{p}_{f0} , direct payments \mathbf{Subs}_{f0} and average variable production costs \mathbf{c}_{f0} observed during the base period. The first order conditions of model determine the first set of equations as following:

$$\mathbf{p}_{f0} + \mathbf{Subs}_{f0} \mathbf{a}_f = \mathbf{Q}_f \mathbf{x}_{f0} + \mathbf{d}_f \quad (2)$$

The second set of equations equates the observed average costs \mathbf{c}_{f0} to the average costs implied by model (1) as following:

$$\mathbf{c}_{f0} = \frac{1}{2} \mathbf{Q}_f \mathbf{x}_{f0} + \mathbf{d}_f \quad (3)$$

with \mathbf{c}_{f0} the vector of observed average variable costs per unit of production quantity that include costs of seeds, fertilizers, pesticides and contract work gathered from the FADN for each farm f .

Following two sets of equations calibrate the diagonal matrix \mathbf{Q} and the vector \mathbf{d} for each farm f of the sample as following:

$$\mathbf{Q}_f = 2 (\mathbf{p}_{f0} \mathbf{x}_{f0}' + \mathbf{Subs}_f \mathbf{a}_f \mathbf{x}_{f0}' - \mathbf{c}_f \mathbf{x}_{f0}') (\mathbf{x}_{f0} \mathbf{x}_{f0}')^{-1} \quad (4)$$

$$\mathbf{d}_f = \mathbf{p}_{f0} + \mathbf{a}_f * \mathbf{Subs}_f - 2 (\mathbf{p}_{f0} \mathbf{x}_{f0}' + \mathbf{Subs}_f \mathbf{a}_f \mathbf{x}_{f0}' - \mathbf{c}_f \mathbf{x}_{f0}') (\mathbf{x}_{f0} \mathbf{x}_{f0}')^{-1} \mathbf{x}_{f0} \quad (5)$$

With these parameters, model (1) is exactly calibrated to the base period and is ready for simulation applications.

2.1 Feeding constraints

Feeding constraint extend the basic model to deal with the specificities of the animal sector. On farms with animal production, the fodder crops serve as inputs for the animal activities such as milk and beef production. Because fodder crops are only marginally sold and because of the large variation in quality, a market price of fodder crops cannot be observed in the accountancy data. Instead, the model relies on a maximum entropy estimation that simultaneously assigns prices and costs for fodder crops. The substitution between different fodder crops to produce one animal output such as milk or beef is based on a calibrated CES function.

2.2 Quota constraints

To model sugar beet supply and quota transfers among sugar beet growers, the model relies on a precautionary C supply and a quota exchange mechanism as explained in Buysse *et al.* (2004). In contrast with sugar, the dairy quota does not allow delivery outside the quota at world market price. The penalty of delivery outside quota is even higher than the milk price. Consequently, it is sufficient to model dairy quota by a simple quota constraint.

3 Mid-term Review extensions

Following subsections explain how additional constraint and variables extend the basic model to deal with the MTR policy instruments.

3.1 Activation of decoupled direct payments

The MTR assigns a reference area to each farm. The reference area includes all the area used in the reference year for asking direct payments, including the land for cereals, oil yielding and protein (COP) and fodder crops, but not including land for potatoes, vegetables or sugar beets. The reference amount of direct payments granted to the farm is divided over the reference area to assign the single farm payment entitlement per ha for each farm.

Area with eligible crops, all crops except potatoes and vegetables in open air, can activate the subsidy entitlements.

Three situations could occur:

1. A farm with the same area of eligible crops as during the reference period will receive the same amount of direct payments as before, even if there is some non-eligible land in the crop plan.
2. Increasing eligible area will not increase the amount of direct payments.
3. The amount of direct payments will decline by a reduction of the non-eligible land, because there is not enough eligible land to activate all the direct payment entitlements.

To model the MTR single farm payment adequately, a set of variables extends to the model: aa_f , the area on each farm that can activate decoupled MTR direct payments. In addition, two farm level constraints should be added. The first constraint prevents that the direct payments exceed the reference amount. The second constraint links the direct payment with the eligible area:

$$aa_f = \mathbf{a}_f \mathbf{0}' \mathbf{S}_f \mathbf{x}_{f0} \quad (6)$$

$$aa_f = \mathbf{a}_f' \mathbf{E}_f \mathbf{x}_f \quad (7)$$

\mathbf{S}_f : a $(n \times n)$ diagonal matrix with unit elements indicating whether the crop j has been declared for obtaining subsidies during the reference period and zero elements for other crops,

\mathbf{E}_f : a $(n \times n)$ diagonal matrix with unit elements for eligible crops and zero elements for others,

aa_f : the area of each farm for which decoupled subsidies can be activated

The direct payments extend the profit function, as following:

$$Z_n = \mathbf{p}_f' \mathbf{x}_f + \alpha a_f \mathbf{a}_{f_0}' \mathbf{Subs}_{f_0} \mathbf{D}_f \mathbf{x}_{f_0} (\mathbf{a}_{f_0}' \mathbf{x}_{f_0})^{-1} + \mathbf{a}_f' \mathbf{Subs}_{f_0} (\mathbf{I} - \mathbf{D}_f) \mathbf{x}_f - \frac{1}{2} \mathbf{x}_f' \mathbf{Q}_f \mathbf{x}_f - \mathbf{d}_f' \mathbf{x}_f \quad (8)$$

\mathbf{D}_f : a (n x n) diagonal matrix with the decoupling ratio of production j,

\mathbf{I} : a (n x n) unit matrix

3.2 Modulation of direct payments

Modulation reduces all direct, couple and non-coupled, payments, beyond 5 000 euro per farm by a maximum of 5% in 2007. Farms with direct payments higher than the threshold of 5000 euro can choose either to not activate their direct payment entitlements or to transfer their direct payment entitlements to farms with direct payments lower than the threshold of 5 000 euro. This transfer mechanism is also included into the optimisation process of the model instead of calculating beforehand the part of the modulated direct payments for each farm.

Following constraint introduces modulation into the model:

$$md = a_{f_0}' \mathbf{Subs}_{f_0} \mathbf{D}_f \mathbf{x}_{f_0} (\mathbf{a}_{f_0}' \mathbf{x}_{f_0})^{-1} + \mathbf{a}_f' \mathbf{Subs}_{f_0} (\mathbf{I} - \mathbf{D}_f) \mathbf{x}_f - mt \quad (9)$$

md: positive variable amount of direct payments subject to modulation

mt: amount of direct payments free from modulation

Modulation extends the profit function as following:

$$Z_n = \mathbf{p}_f' \mathbf{x}_f - md \cdot mp + \alpha a_f \mathbf{a}_{f_0}' \mathbf{Subs}_{f_0} \mathbf{D}_f \mathbf{x}_{f_0} (\mathbf{a}_{f_0}' \mathbf{x}_{f_0})^{-1} + \mathbf{a}_f' \mathbf{Subs}_{f_0} (\mathbf{I} - \mathbf{D}_f) \mathbf{x}_f - \frac{1}{2} \mathbf{x}_f' \mathbf{Q}_f \mathbf{x}_f - \mathbf{d}_f' \mathbf{x}_f \quad (10)$$

mp: modulation percent

The presented approach allows each farm to escape from modulation by not activating direct payment entitlements or by transferring direct payment entitlements to other farms.

The MTR proposes that the modulation percent increases in three steps. The first year the modulation percent is only 3%, while later on it increases to 5%. Because of the comparative static properties of the applied model, current analysis only allows for simulating the impact of the final modulation percent. The consequences of modulation in two steps are therefore not explicitly simulated.

3.3 Transfers of direct payment entitlements

To model the MTR implementation completely, the model also deals with the exchange of direct payment entitlements. Transfer of direct payments entitlements can occur both with as without transfer of land. Each member state can confiscate a certain percentage of the transferred entitlements. For transfers with land 10% of the entitlement can revert to the national reserve while for transfers of direct payment entitlements up to 30% can revert to the national reserve. Modelling these transfers of direct payment entitlements is quite complicated. Unobserved transaction cost will play a major role in the decision to exchange direct payment entitlements.

This model makes a first attempt in modelling the transfers of direct payment entitlements by the introduction of 7 constraints and 7 extra variables. Current approach still ignores however the unobserved transaction cost.

Following paragraphs explain each constraint and why it is added.

First, a constraint determines per farm the amount of not activated direct payments entitlements, as follows:

$$na_f = \mathbf{a}_{fo}' \mathbf{S}_f \mathbf{x}_{fo} - aa_f \quad (11)$$

na_f : not activated direct payment entitlements (in ha)

Then, following constraint calculates the average amount of direct payments per ha of not activated entitlements:

$$avs = \sum_f (na_f \mathbf{a}_{fo}' \mathbf{Subs}_{fo} \mathbf{D}_f \mathbf{x}_{fo} (\mathbf{a}_{fo}' \mathbf{x}_{fo})^{-1}) / \sum_f na_f \quad (12)$$

avs : the average amount of direct payments per ha of not activated entitlements

Farms with eligible land not yet used for activating decoupled direct payments will induce the direct payment entitlement transfers, because they are interested in buying entitlements. Following constraint calculates the free eligible land on each farm:

$$ef_f = \mathbf{a}_f' \mathbf{E}_f \mathbf{x}_f - aa_f \quad (13)$$

ef_f : free eligible land

The farms with free eligible land can obtain additional entitlement both with as without land transfer. To distinguish between activated direct payments with land transfer and without land transfer, a constraint calculates the amount of land acquired by the farm, as following:

$$wl_f = \text{absolute value}(\mathbf{a}_f' \mathbf{x}_f - \mathbf{a}_{fo}' \mathbf{x}_{fo}) \quad (14)$$

$$wl_f = 0$$

wl_f : land used for activating transferred direct payments with land transfer

In addition, a constraint limits the sum of activated direct payments of both with and without land transfer to be smaller than the free eligible land:

$$ef_f = wl_f + ol_f \quad (15)$$

wl_f : land used for activating transferred direct payments without land transfer

The sum of not activated direct payment entitlements should always be larger than the sum of transferred direct payments, expressed by following constraint:

$$\sum_f na_f = \sum_f wl_f + ol_f \quad (16)$$

The dual of equation (16) gives an indication of the price of the direct payment entitlements. A zero dual indicates that there is more supply than demand for the entitlements. The price will then be low. The higher the dual the more demand and the higher the price of the entitlements will be.

A complementary slackness constraint prevents farms from at the same time buying and selling direct payments entitlements.

$$ef_f na_f = 0 \quad (17)$$

Finally, the transferred direct payments extend the profit function, as following:

$$\begin{aligned} Z_n = & \mathbf{p}_f' \mathbf{x}_f + wl_f avs rw + ol_f avs ro - md mp \\ & + aa_f \mathbf{a}_{fo}' \mathbf{Subs}_{fo} \mathbf{D}_f \mathbf{x}_{fo} (\mathbf{a}_{fo}' \mathbf{x}_{fo})^{-1} + \mathbf{a}_f' \mathbf{Subs}_{fo} (\mathbf{I} - \mathbf{D}_f) \mathbf{x}_f \\ & - 1/2 \mathbf{x}_f' \mathbf{Q}_f \mathbf{x}_f - \mathbf{d}_f' \mathbf{x}_f \end{aligned} \quad (18)$$

rw : part of the transferred direct payments with land transfer not confiscated by the administration

ro : part of the transferred direct payments without land transfer not confiscated by the administration

In this profit function, production, \mathbf{x}_f , activated direct payments, aa_f , direct payments with land transfer, wl_f , or without land transfer, ol_f , and the average transferred direct payments, avs are positive variables.

Cost function parameters, \mathbf{Q}_f and \mathbf{d}_f' , are farm dependent calibrated parameters.

\mathbf{a}_{f0} , \mathbf{Subs}_{f0} and \mathbf{x}_{f0} are observed from the base year.

The decoupling matrix, \mathbf{D}_f , the modulation threshold, md , the modulation percent, mp and the reduction parameters of transferred direct payments, ro and rw , are external parameters directly set by the policy. The vector of output prices, \mathbf{p}_f , is also external to the model and can, depending on the crop, be set by the policy makers.

3.4 Cross-compliance

Another important element in the MTR is cross-compliance. Currently, the model assumes that every farm satisfies the conditions imposed by the member state. The model further assumes that these conditions do not generate additional costs. This is a reasonable assumption given that most of these conditions were already compulsory before the MTR.

4 Numerical solving problems

An important but often not in detail described problem of operational modeling is optimizing the developed simulation model. Currently, GAMS with the CONOPT3 solver optimizes the proposed model. Three problems arise during optimization, the use of the absolute value function (ABS), the discontinuities in the model and the complementary slackness constraints. Due to the size of the model, i.e. the large number of variables and constraints, solving the optimization problems remains the most difficult task in current analysis.

4.1 The ABS function

The use of the ABS function in GAMS requires that the model runs as a dynamic non linear programming (DNLP) model instead of a non linear programming (NLP) model. The NLP solvers used by GAMS can also be applied to DNLP models. However, it is important to know that the NLP solvers attempt to solve the DNLP model as if it was an NLP model (Drud, 2004).

Therefore, Drud (2004) suggests two approaches to rewrite the ABS function in a NLP model. In the first approach, the term $z = \text{ABS}(f(x))$ is replaced by $z = f_{\text{plus}} + f_{\text{minus}}$, f_{plus} and f_{minus} are declared as positive variables and they are defined with the identity: $f(x) = f_{\text{plus}} - f_{\text{minus}}$. The discontinuous derivative from the ABS function has disappeared and the part of the model shown here is smooth. The discontinuity has been converted into lower bounds on the new variables, but bounds are handled routinely by any NLP solver. The feasible space is larger than before (Drud, 2004).

The second approach relies on a smooth approximation. A smooth GAMS approximation for $\text{ABS}(f(x))$ is $\text{SQRT}(\text{SQR}(f(x)) + \text{SQR}(\delta))$ where δ is a small scalar. The value of δ can be used to control the accuracy of the approximation and the curvature around $f(x) = 0$.

The approximation shown above has its largest error when $f(x) = 0$ and smaller errors when $f(x)$ is far from zero. If it is important to get accurate values of ABS exactly when $f(x) = 0$, then Drud (2004) suggest following smooth approximation:

$$\text{SQRT}(\text{SQR}(f(x)) + \text{SQR}(\delta)) - \delta$$

The presented model has employed both the smooth as the non-smooth reformulation of the DNLP to the NLP model. In contrast to what Drud (2004) suggest, the value of the objective function shows that in current model the DNLP is in all simulations better than the reformulations to NLP.

4.2 Complementary slackness constraints

A complementary slackness constraint prevents farms from at the same time buying and selling direct payments entitlements.

$$ef_f \quad na_f = 0$$

The use of so-called complementary constraints is bad in any NLP model (Drud, 2004). The feasible space consists of the two half lines: ($ef_f = 0$ and $na_f = 0$) and ($ef_f = 0$ and $na_f = 0$). Unfortunately, the marginal change methods used by most NLP solvers cannot move from one half line to the other, and the solution is stuck at the half line it happens to reach first (Drud, 2004). One way to solve the complementary slackness constraint problem in current model is the use of different starting points. The objective value of the different simulations should then determine the final retained solution. The problem here is that a good starting point for one farm can be a bad starting point for another. Global optimization looks like the only solution to identify the magnitude of the problem and to overcome it.

4.3 *Discontinuities in the model*

The GAMS solver stops each simulation run with following message.

```
** Feasible solution. The tolerances are minimal and  
   there is no change in objective although the reduced  
   gradient is greater than the tolerance.
```

The message indicates that there is no progress at all in the solution process. However, the optimality criteria have not been satisfied. The problem in presented model will be caused by discontinuities. A complex nonlinear model may — and frequently will — have multiple locally optimal solutions. In most realistic cases, the number of such local solutions is unknown, and the quality of local and global solutions may differ substantially. Therefore multi-extremal decision models can be very difficult, and — as a rule — standard optimization strategies are not directly applicable to solve them (Pinter, 2001). Here too, global optimization should be a solution to the problem

5 **Impact analysis**

Previous section shows that the impact analysis should rely on a global optimization solver. However, the size of the model does not allow us to come up with reasonable global optimization results. Consequently, GAMS with CONOPT3 optimizes the model for the impact analysis. For reasons mentioned in the previous section, the results of the analysis should be interpreted with caution. In a later version of the paper different model versions and solvers will be compared to quantify the mistakes in current analysis.

Furthermore, the present data do not include all farms of the FADN sample. Because of the non-representativeness of this sub-sample, one has to be careful to extrapolate the calibrated parameters and the simulation results to the whole sector. Being only indicative of the outcome of the MTR, the simulation results illustrate the various possibilities of the model in simulating differential effects of changes in the policy-controlled parameters.

The model is calibrated and run for a FADN sub-sample of 159 arable and cattle farms for which data are available for the year 2002. The impact analysis focuses on the decoupling and modulation elements of the MTR. The following sub-sections show the effects of three policy-controlled parameters: the decoupling ratio, the modulation threshold and the modulation percentage on land allocation and gross margin according to farm size. Results are given in percentage changes with respect to the reference period.

5.1 *Impact analysis of the decoupling ratio*

Figure 1 shows the effects of increasing the decoupling ratio from 0 to 100% on land allocation among different types of crops with a modulation threshold set at 5 000 euro and percentage set at 5%. The parameter rw is 90% and ro is 70%.

Farms allocate less land to the arable crops that received direct payments in the Agenda 2000, but that will only receive the decoupled direct payments in the MTR. These ‘subsidized crops’ include mainly wheat and barley in the selected sample. The land, allocated to subsidized crops, declines with 7% for full decoupling, the scenario chosen in Belgium.

In Belgium, there are also fodder maize direct payments during the base year. Due to the decoupling, the simulations show that farms in the sample allocate more land to fodder crops without direct payments in the base year. The decline in allocated land is smaller for the subsidized fodder crops than for other subsidized crops. There are two reasons for this smaller decline. Substitution of fodder crops is more difficult as a result of feeding constraints. Secondly, farms with animal production have less alternative crops to switch to than arable farms without animal production.

This explains at the same time that the increase of land allocation to crops without direct payments in the base year, the ‘non subsidized crops’, is larger than the increase of fodder crops without direct payments in the base year, the ‘non subsidized fodder crops’. Note that the results of ‘non subsidized crops’ only include crops that are eligible and that land allocated to these crops can be used to activate the decoupled direct payments of the MTR.

In contrast to other some studies where the land allocation to the category of ‘non eligible crops’ declines, current model shows a small increase of non eligible crops. This difference can be explained by the way of modeling the decoupled direct payments. E.g., Henry de Frahan *et al.* (2004) applies the decoupled direct payments to every hectare of eligible land. Whereas in current model, farms can not activate more decoupled direct payments than received during the reference year.

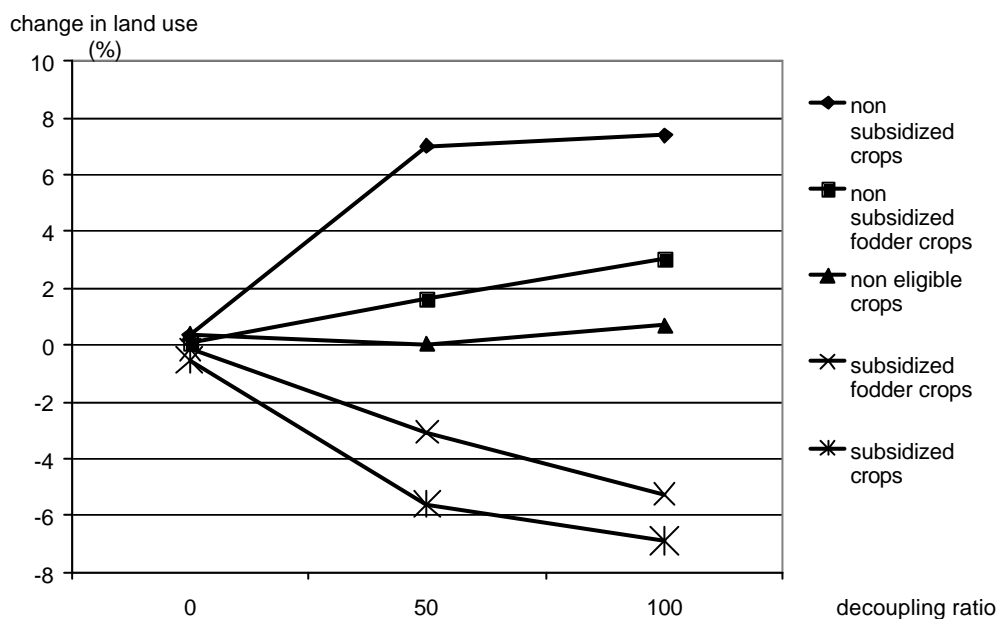


Figure 1. Change in supply for different crops types from the decoupling of direct payments

Figure 2 shows the effects of increasing the decoupling ratio from 0 to 100% on farm gross margins across farm sizes with a modulation threshold set at 5 000 euro and percentage set at 5%. The parameter rw is 90% and ro is 70%.

Effects of the MTR on farm gross margins are relative smaller than effects on land allocation. As expected, a complete decoupling of the direct payments generate a positive effect on farm gross margins across all farm sizes. The larger positive effect in gross margin for farms of smaller size is due to the 5% modulation of direct payments above the threshold of 5 000 euro.

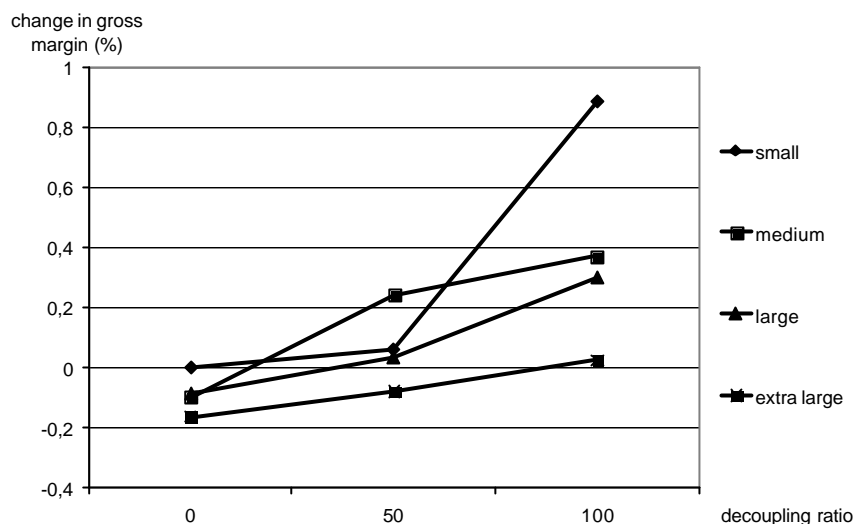


Figure 2. Change in gross margin for different farm sizes from the decoupling of direct payments

5.2 Impact analysis of the modulation

Figure 3 shows the effects of increasing the modulation percentage from 10 to 30% on farm gross margins across farm sizes with a modulation threshold set at 5 000 euro and full decoupling. The parameter rw is 90% and ro is 70%.

As expected, the effects of an increasing modulation percentage on farm gross margins are higher on farms of larger size. Since small farms with a farm gross margin lower than 56 991 euro do not receive an amount of direct payments exceeding the threshold of 5 000 euro, these farms are not affected by this simulation. The extra large farms with a farm gross margin higher than 119 163 euro have the highest share of direct payments above the 5 000 euro threshold and, therefore, see their farm gross margin reduced by almost 1% with a 30% modulation. The medium and large farms with a farm gross margin lower than 82 896 and 119 163 euro respectively see their farm gross margin reduced by about 0.3% with a 30% modulation.

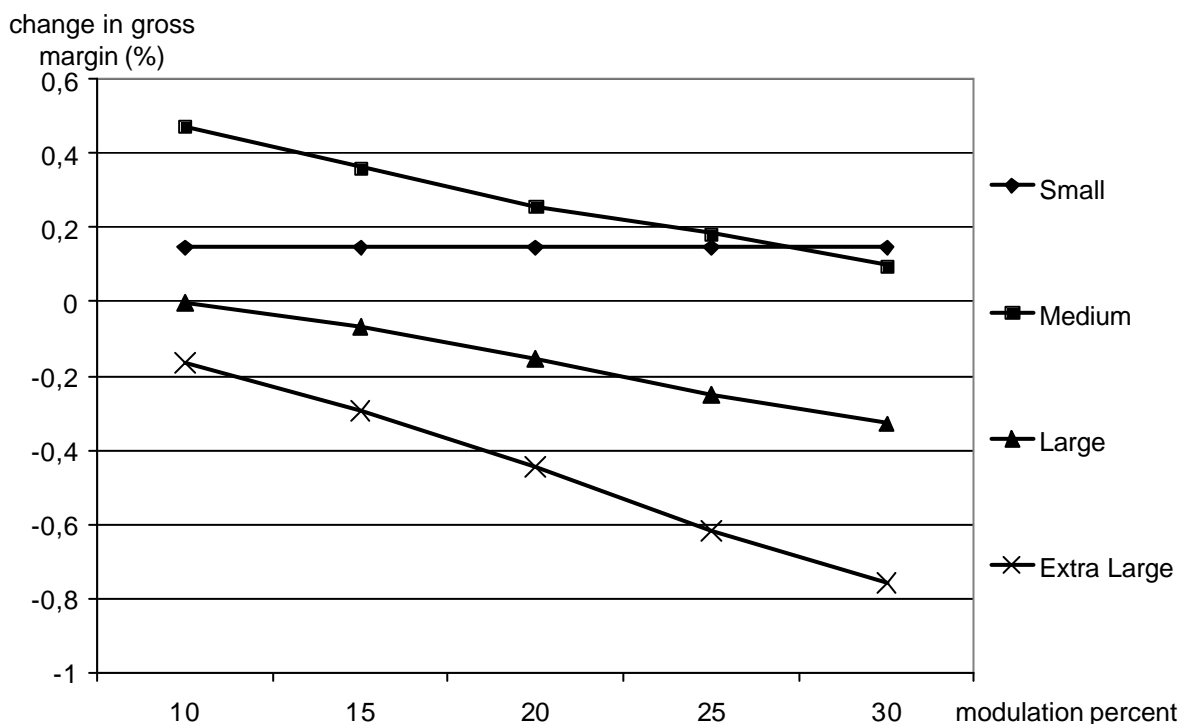


Figure 3. Change in gross margin for different farm sizes from changes in the modulation percent

Figure 4 shows the impact of the modulation threshold on the gross margins of different farm sizes. For the simulations reported in Figure 3 the model applies full decoupling and 5% modulation. The parameter rw is 90% and ro is 70%. The pattern in Figure 4 is quite irregular due to some entitlement transfers that occur. Therefore, the results should also be interpreted with caution.

It is however clear that, certainly for the extra large farms, a lower modulation threshold leads to a higher reduction of the gross margin. The reduction is very small because of the quite small modulation threshold. A combination of both reduction of the modulation threshold and an increase of the modulation percent would induce a larger decline in gross margin.

While Figure 3 shows that the modulation percent has most impact on the gross margin of the extra large farms, Figure 4 illustrates that the reduction of the modulation percent does not have a larger impact on extra large farms than on the smaller farms. A reduction of the modulation threshold has more impact on the small and medium sized farms.

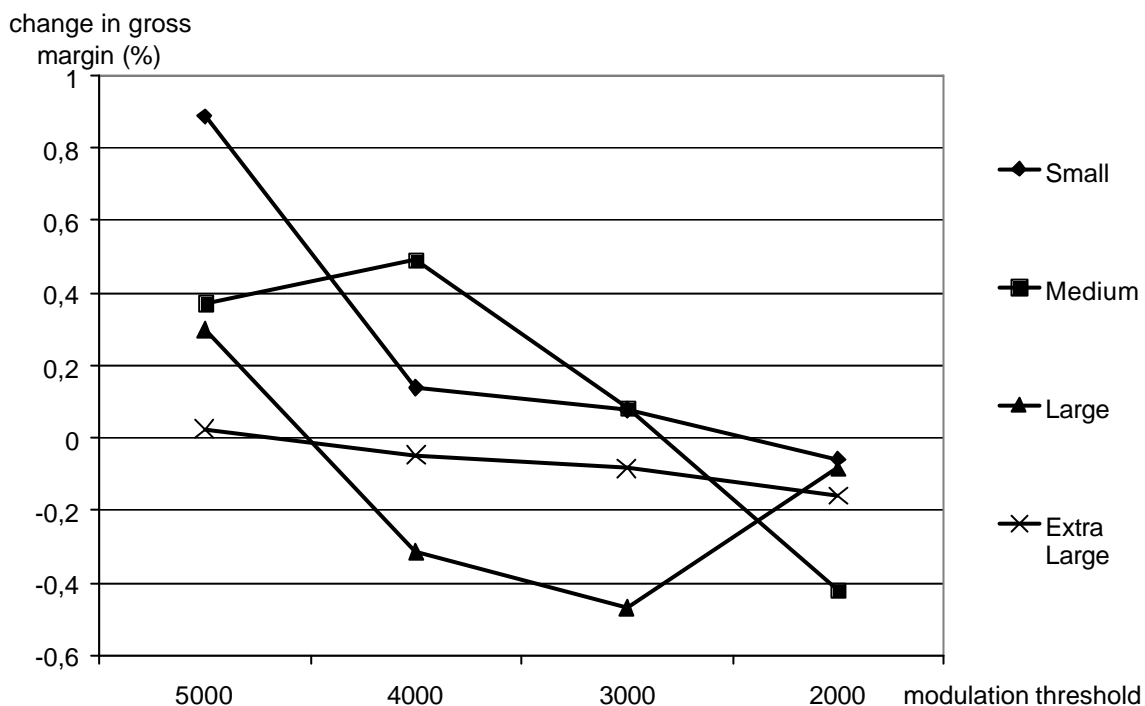


Figure 4. Change in gross margin for different farm sizes from changes in the modulation threshold

5.3 Impact analysis of direct payment entitlements transfers

The third and last impact analysis should deal with the two last policy-controlled parameters rw and ro , determining the reduction applied to the transferred direct payments. These results on the impact analysis of direct payments entitlement transfers can not be presented yet, because they depend too much on small differences resulting from not finding a global solution. A difference of 5% in the parameter rw or ro can place certain farms at a different half line of the complementary slackness constraint (17).

Therefore, further analysis with different models and solvers should try to illustrate the impact of direct payment entitlements transfers.

6 Conclusions

The paper describes an individual farm-based sector model, in which it is possible to account for the individual farm structure and the direct payments entitlements trade mechanisms. This tool proves its utility for simulating possible alternatives with respect to the implementation of the MTR.

The model deals with three MTR elements: i) modelling the activation of decoupled direct payment entitlements, ii) simulating the modulation and iii) the transfers of direct payment entitlements. While most MTR analysis's focus on the first element, current paper also tries to assess the two last elements of the MTR.

The main improvement of current approach is the straightforward application of farm level policy instruments. The farm level approach allows analyzing elements not dealt with in previous ex ante MTR studies. The number of direct payments entitlement transaction, indications of the prices of the transferred entitlements and the impact of policy-controlled parameters on these transactions are possible outcomes of the model described in the paper.

This approach makes it possible to do detailed analysis of alternative options of the MTR. Furthermore, current analysis can also enrich previous studies of the MTR by indicating the magnitude of errors that could have been made by ignoring farm level aspects of the policy. The preliminary results indicate that these effects are relatively small.

Another advantage of the farm level approach is that the results can be detailed per farm size, type or region. The paper illustrates that the effects of the MTR will be different according to farm size. The differences are even though rather small.

As expected, preliminary results point out that decoupling of direct payments will decrease the land allocation to subsidized crops and increase the land allocation to crops not subsidized in the base year. Less obvious is that the area of non-eligible crops not declines. This is due to the fact that, in contrast to some previous studies, current model does not apply the decoupled direct payments to the amount of eligible land higher than the reference area.

Decoupling of direct payments has a small positive impact on the gross margin, while modulation has a small negative impact on the gross margin. The impact of modulation is highest for the largest farms.

There are four shortcomings to current paper. The final version of the paper will be adapted for at least the two first possible improvements.

The main progress to current analysis is the application of better solver techniques. This will give more insight in the transactions of direct payments entitlements as well as mistakes made in current analysis by not checking with a global solver.

The second improvement is the use of more complete data for the base year.

The third development that would enhance the model is the introduction of more flexibility in the profit function. The profit function should allow for input substitution and cross effects between activities other than the competition for limiting inputs. Calibration of a more complex and flexible functions require however additional data or estimations as well.

Finally, the last development should consider a more detailed analysis of transactions cost and uncertainty with respect to transfers of the direct payments entitlements.

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