Modelling CAP Decoupling in the EU: A Comparison of Selected Simulation Models and Results

Oliver Balkhausen, Martin Banse and Harald Grethe[1]

Abstract

This article reviews ways of representing the effects of decoupling in the European Union (EU) on land allocation and production in eight selected simulation models (AGLINK, AG-MEMOD, CAPRI, CAPSIM, ESIM, FAPRI, GOAL and GTAP). It then compares the simulated effects of decoupling and traces them back to the model specifications and parameter assumptions. In particular, roughage is not included in most models, so that changes in ruminant production are not necessarily consistent with the changes in fodder area. Models also differ in the extent to which they reflect the substitution possibilities in ruminant feeds. Notwithstanding the considerable differences in model types and specifications, all the studies considered here predict that as a result of decoupling, areas allocated to cereals (and silage maize) and beef and sheep production in the EU-15 will decline, while fodder area will increase. Differences in the projections about pasture, oilseed and set-aside areas can be attributed to different model or scenario specifications. The most important factor affecting the results is the extent to which the models assume that the Common Agricultural Policy (CAP) 2003 Reform (regarding Single Farm Payments) involves a substantial decoupling of support compared with the baseline (Agenda 2000) policy.

Keywords: *Common Agricultural Policy; decoupling; direct payments; mid-term review; 2003 reform; simulation model.*

JEL classifications: *Q110, Q180.*

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[1] Harald Grethe is at the Humboldt University of Berlin, International Agricultural Trade and Development, Faculty of Agricultural Sciences, Luisenstrasse 56, Berlin 10099, Germany. E-mail: harald.grethe@agrar.hu-berlin.de for correspondence. Oliver Balkhausen is at the University of Gottingen, Germany, and Martin Banse is with the LEI, The Hague, The Netherlands.

1. Introduction

Under the 2003 Reform of the Common Agricultural Policy (CAP) of the European Union (EU), most direct payments to agricultural producers were decoupled from production and granted to producers as Single Farm Payments (SFPs), with effect from 2005 (though with variations between Member States). In contrast to Agenda 2000 direct payments, SFPs are not coupled to the current production of any specific agricultural commodity (Agra Informa, 2006).

Decoupling is expected to affect the composition of agricultural production in the European Union (EU) in various ways, with the overall net effect unclear at this stage. The decoupling of area payments will raise the relative gross margins of crops which were not subject to direct payments before the 2003 Reform (mainly fodder crops), compared with set-aside and the *grandes cultures* (cereals, oilseeds and protein crops), which were eligible for direct payments under Agenda 2000. This could result in higher fodder supply, leading to lower prices and potentially increasing the supply of ruminant products. However, decoupling beef payments will reduce the gross margins of beef production, potentially leading to reduced beef supply and less demand for fodder. This would in turn cause fodder prices to decline, and could thus shift the supply functions for *grandes cultures* to the right. Moreover, decoupling potentially affects the voluntary set-aside area.

Economic simulation models are routinely used to analyse the effects of changes in agricultural policies such as the decoupling of direct payments. The objective of this article is to provide an overview of the results of simulation model-based analyses of decoupling direct payments in the EU, and to explore the implications of model assumptions for results.

The article is structured as follows. Section 2 considers the reflection of decoupling effects in selected simulation models which depict the agricultural sector, focusing on land allocation mechanisms and the link between the livestock and the fodder/crop sectors. Section 3 examines and compares the simulation results of decoupling scenarios from these models, and traces them back to the model specifications and parameter assumptions. Section 4 concludes with a discussion of the main findings and suggests some implications for future research.

2. Decoupling of Direct Payments in Selected Simulation Models

The selected models are listed in Table 1 in alphabetical order. The general criteria for their inclusion are as follows: they should provide comprehensive coverage of EU agriculture;[2] they should have a multi-commodity structure; model

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[2] For example, many programming models such as DRAM (Helming, 2005) or FARMIS (Bertelsmeier, 2004) refer to individual Member States and are therefore not included in this review. All models covered here include the EU-15 countries, and most the EU-10, although often in less detail. The EU-15 are depicted at individual Member State level in most models (CAPRI, CAPSIM, AG-MEMOD, AGLINK and GTAP); in ESIM and GOAL as a single region; while only in FAPRI are some Member States depicted as individual regions with others included in a separate aggregate 'other EU'.

Table 1

Economic simulation models covered

Model	Model type	Development institution
AGLINK	Behavioural PE	OECD, Paris
AG-MEMOD	Behavioural PE	AG-MEMOD partnership
CAPRI	Programming (EU supply) and behavioural (other supply, and demand) PE	University of Bonn
CAPSIM	Behavioural PE	University of Bonn
ESIM	Behavioural PE	ERS/USDA, Stanford, Göttingen and Berlin (Humboldt) universities
FAPRI[a]	Behavioural PE	Missouri State University
GOAL	GE	INRA, Rennes
GTAP	GE	Purdue University

Sources: The standard documentation for AGLINK is OECD (not dated); for AG-MEMOD, Chantreuil *et al.* (2005); for CAPRI, Britz (2004a); for CAPSIM, Witzke and Zintl (2005); for ESIM, Banse *et al.* (2005); for FAPRI, Binfield *et al.* (2005); for GOAL, Gohin (2006); for GTAP, Hertel (1997). All model information presented in this article is based on these sources, if not indicated otherwise.

[a]From FAPRI, only the FAPRI-GOLD model is included here as the most detailed with regard to the EU of all FAPRI models (Binfield *et al.*, 2005).

documentation should be available; and they should have been used recently in decoupling scenario analyses.[3]

All of the above models are partial equilibrium (PE) models except for GTAP and GOAL, which are general equilibrium (GE) models. In the PE models, the core supply and demand systems are represented by behavioural equations, except in CAPRI, which links EU supply and world trade modules. The EU supply module consists of positive mathematical programming-calibrated models at the Nomenclature of Territorial Units for Statistics (NUTS) II regional level, based on exogenous prices for each iteration. These prices stem from the world trade module, in which supply quantities from Member State models are confronted with demand functions at the EU level, and solved for new Member State-specific market prices, which drive the next iteration in the supply models.

2.1. Land allocation

In all the PE models, EU crop supply is modelled as 'yield' × 'area', with 'area' determined endogenously in various ways. In ESIM, 'area' is allocated as a function of current own and cross-prices, direct payments, and labour and capital cost indices. In AGLINK, area allocation depends on own and cross-commodity gross market returns as well as on direct payments adjusted by a factor of between 0 and 1, reflecting the degree of 'coupledness' of the payment (Von Lampe, 2004).

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[3] For example, the 'Partial Equilibrium Agricultural Trade Simulator' (Abler, 2006) fulfils the first three criteria, but has not yet been used to simulate the decoupling of direct payments in the EU.

The area allocation functions in CAPSIM are derived from a restricted normalised quadratic profit function. Dual values of the physical area and feed requirement restrictions are subtracted from revenues (per production activity) and input prices. The resulting net revenues (including direct payments) of outputs and net prices of inputs are the explanatory variables of area allocation and herd size.

In AG-MEMOD, land allocation occurs in two steps. First, total area is allocated to three major groups of crops, namely grains, oilseeds and root crops, with land allocation within each crop group modelled as a second step. The total area equations for product groups are dependent on lagged prices, the lagged area, and on a vector of exogenous variables such as the set-aside rate and direct payments multiplied by a factor indicating the coupledness of the payment. The share of crops within groups is determined purely by lagged prices and the share of the respective crop in the previous year.

In a similar fashion, FAPRI also allocates land in two steps. The total areas allocated to cereals and oilseeds are modelled separately, with no other crops considered. As in AG-MEMOD, direct payments enter area allocation only at the product group stage and not at the single product stage.

In the GOAL and GTAP GE models, land is allocated according to a constant elasticity of transformation (CET) function which expresses the constrained mobility of the factor 'land' among products. GOAL and some extensions of the GTAP standard version include a nested structure of land allocation, with land mobility differentiated between different crop groups (see, e.g. Huang *et al.*, 2004). In the CAPRI regional programming supply models, area is distributed according to the contribution of the respective product to the objective function (market revenue including direct payments), plus the modelled constraints and the cost terms resulting from the calibration process.

2.2. *Total agricultural area specifications and treatment of fodder and set-aside*

Product-specific area allocation can result in the total area being inconsistent with base period agricultural areas. This raises the important question of how total land area adjustments are treated in the models. The smaller the area coverage of the respective model, the easier it is to argue that aggregate area changes of model products are buffered by 'other products'. This, however, is problematic, as in many models the category of products not covered mainly consists of fodder and pasture area, for which variation should be consistent with the feed demand of ruminants. Table 2 indicates whether fodder areas and voluntary set-aside are included in each model.

Only CAPRI and ESIM treat all four area uses as endogenous variables. Area allocation elasticities in ESIM are very low for pasture and voluntary set-aside compared with other crops, because substitution is considered limited due to differing soil qualities and geographical/climatic conditions. Voluntary set-aside is modelled as being limited by a quota, with this quota set at the level of voluntary set-aside in the base period and a shadow premium of 90% of the real premium, as set-aside was restricted under Agenda 2000 to a maximum level per farm.

In CAPSIM, only silage maize and other fodder are endogenous. Pasture is treated as exogenous according to recent trends. Voluntary set-aside is not modelled explicitly, but is included in the function determining the overall set-aside area. More precisely, the overall set-aside area function includes a set-aside elasticity

Table 2

Inclusion of roughage products and voluntary set-aside in simulation models

Product	AGLINK	AG-MEMOD[a]	CAPRI	CAPSIM	ESIM	FAPRI	GTAP	GOAL
Pasture		?	X		X			X
Silage maize		?	X	X	X			A
Other fodder		?	X	X	X			X
Vol. set-aside		?	X		X			

Notes: X, included as a separate product category; A, included in a product aggregate; ?, differs per country model.
Source: Own composition.
[a]AG-MEMOD consists of country models which differ in terms of product coverage, especially for roughage and voluntary set-aside. In addition, central parts of the model are not treated consistently among country models, such as the land market as well as the link between the fodder, crop and livestock sectors. Because of these differences, and in the absence of detailed documentation for all country models, AG-MEMOD is not described in sections 2.2 and 2.3. However, the model is included in the comparison of simulation results in section 3.

designed to capture the opposite change in voluntary set-aside that usually accompanies an increase in the mandatory rate.

In the two GE models, GOAL contains fodder from arable land (including silage maize) and fodder from pasture land as endogenous variables; in GTAP, by contrast, none of these products is modelled explicitly. However, land is an input to ruminant production, which reflects the substitution relationship between ruminant and crop production. The other models do not capture either roughage or voluntary set-aside.

To ensure that all crop area (except mandatory set-aside) is used for agricultural production, ESIM and AGLINK scale model land uses to match the total land available, as reflected in base areas, which constrains the land allocation process considerably (for AGLINK, see von Lampe, 2004). This implies that the area used in any product is not determined by behavioural functions alone. In FAPRI, land can move in and out of production without any restrictions, but the elasticity of total agricultural area with respect to weighted net returns is generally 0.1 or less.

The land market is endogenous in CAPSIM, GTAP and GOAL, and thus the rental price for land is adjusted against a fixed total supply set as the base available area. In CAPRI, land balances for arable land and for pasture must both be satisfied. In the case of arable land, idle land not eligible for set-aside premiums is an explicit activity which closes the balance. For permanent pasture, two types with different yields are distinguished. Thus, extensification of pasture land is represented as a lower production intensity resulting from a change in the mix between the two intensities.

2.3. Linkage between the livestock and the fodder/crop sectors

To reflect fully the effects of decoupling, two critical links between the crop and fodder and the livestock sectors need to be considered: feed prices and livestock production, and feed requirements. With respect to the first link, FAPRI uses a ratio of output prices and weighted direct payments (with lower weights on less

coupled payments) to input prices to determine livestock production. Prices of major feed products are weighted by their shares in the base ration for the animal in question. In AGLINK (von Lampe, 2004) and ESIM, the supply of animal products is a function of own and cross-prices and direct payments as well as a feed cost index, which is a weighted average of feed prices, using current period feed component quantities as weights.

In CAPSIM, livestock production depends on output and input prices including individual market prices for feed, corrected by shadow prices for energy and proteins (Witzke, 2005). In GTAP and GOAL, the feed products included in the model are inputs to animal production. Thus, feed prices have an impact on livestock production, and the response of animal production to feed prices depends on the value share of the feed product in question in total inputs.

With regard to the second link, feed demand in AGLINK, ESIM and FAPRI is determined by own and cross-feed prices and by the level of livestock production. Own and cross-price elasticities reflect requirements for proteins and energy, and affect the degree of substitutability among different feeds and thus the response of livestock supply to changes in feed prices.

In CAPSIM, feed demand depends on market prices for individual feeds moderated by the shadow prices for energy and proteins (which are derived from nutrient balance constraints for energy and proteins). Increases in shadow prices have a moderating effect on increases in the net price of the feedstuff in question, which is defined as the market price minus the nutrient shadow price (Witzke, 2005).

In GTAP, the link between livestock and fodder or crops is simpler than in GOAL and in partial equilibrium models because of a high level of aggregation, e.g. 'meat products' and 'cereals'. However, given the structure of both GE models, the demand quantity for a feed product responds to changes in the production of livestock products. In addition, by modelling the feed product requirements of livestock production as a constant elasticity of substitution (CES) structure, rather than the standard Leontief specification, both models can reflect the substitution effect among feeds.

In CAPRI's regional programming supply models, profit-maximising animal herds are determined simultaneously with cost-minimising feed composition. Nontradable fodder, such as grass and maize, is treated as individual feeding activities, whereas tradable feeds such as wheat or soyabean meal are aggregated into different categories (cereals, energy rich, protein rich, etc.). Substitution among feeding activities is possible, but is restricted by the very detailed nutritional requirements regarding the animals' specific needs for energy, protein, lysine, dry matter, etc. It is not possible to substitute feed components belonging to different feed categories.

2.4. Implications for modelling decoupling

Table 3 summarises the most important model specifications with respect to the models' ability to depict the effects of decoupling.

The models depict fodder and pasture to a very different extent. However, given that these are products which benefit from direct payments under the 2003 Reform, thereby affecting relative returns compared with *grandes cultures,* their inclusion should have an effect on area allocation. Models which do not depict these products can therefore be expected to underestimate the potential reduction of the area allocated to *grandes cultures* because of decoupling.

Table 3
Summary of model specifications relevant for depicting decoupling

	AGLINK	AG-MEMOD	CAPRI	CAPSIM	ESIM	FAPRI	GTAP	GOAL
Inclusion of fodder and pasture	Not	Not	Good	Weak	Good	Not	Weak	Good
Land scaling	Yes	No	No	No	Yes	No	No	No
Effect of area payments	Single product	Product group	Single product	Single product	Single product	Product group	Single product	Single product
Coupling factors	Yes	Yes	No	No	No	Yes	No	Implicit[a]
Substitution of feed components	Yes	?	Yes	Yes	Yes	Yes	Possible	Yes

Source: Authors' own composition.
[a]In the GOAL model, decoupling factors are implicit in the modelling ceilings for livestock payments and assumptions on the limited capitalisation of direct payments in land prices (see below, section 3.2).

Two models assume a constant base area, even though this restricts their ability to depict declining total agricultural area because of decoupling. This also holds for models which depict a land market (CAPRI, CAPSIM, GTAP and GOAL) with inelastic land supply. FAPRI and AG-MEMOD assume that direct payments only have an effect at the land allocation level with regard to product groups such as cereals or oilseeds, but not on land allocation between single products. As other models assume direct payments to be effective at the single product level, and the share of direct payments in total revenue differs per product because of different market returns, these models would display area share changes within product groups due to decoupling, which would not be the case in FAPRI and AG-ME-MOD. For FAPRI, area allocation elasticities at the product group level are very low (around 0.05). Therefore, the effect of decoupling tends to be small, as Binfield *et al*. (2005) show.

AGLINK, AG-MEMOD and FAPRI multiply direct payments in the area allocation functions by a factor which expresses their coupledness to production (the 'coupling factor'). The effect of decoupling therefore depends to a significant extent on the size of this parameter in the baseline (Agenda 2000) as well as under the 2003 Reform. All other models except GOAL assume that direct payments have an effect on area allocation similar to that of market returns. On the one hand, decoupling can therefore be expected to have a relatively weak effect on overall crop production levels, as it does not affect the overall level of payments. On the other hand, decoupling is depicted in these models by switching from area payments only for *grandes cultures* and set-aside to uniform area payments for all crops. This establishes a strong change in the relative incentives between *grandes cultures* on the one hand and fodder and pasture on the other, and should therefore have a significant effect on area allocation among products.

3. Decoupling Modelling and Results

This section compares the underlying scenarios, assumptions and results for the models presented above in simulating the effects of decoupling direct payments. The simulation studies are based on CAPSIM and a predecessor of the ESIM version described above (ESIM-OLD)[4] (European Commission, 2003), ESIM (Balkhausen *et al.*, 2005), CAPRI (Britz, 2004b), FAPRI (Binfield *et al.*, 2004), AGLINK (OECD, 2004a), AG-MEMOD (Chantreuil *et al.*, 2005), GTAP (Frandsen *et al.*, 2003) and GOAL (Gohin, 2006).

3.1. Scenarios

The AGLINK, AG-MEMOD, CAPRI, CAPSIM, ESIM-OLD, FAPRI and GOAL studies only report the aggregate effect of implementing all 2003 Reform measures together (including decoupling and some price cuts), compared with a reference scenario of continued Agenda 2000 policies. The studies using ESIM and GTAP illustrate the isolated impact of decoupling. In the ESIM study, a reference scenario of implementing all 2003 Reform measures except decoupling was compared with a decoupling scenario implementing all 2003 Reform measures. The GTAP study shows the effects of decoupling Agenda 2000, rather than analysing the 2003 Reform.

Although measuring the isolated impact of decoupling has, of course, the highest explanatory power for the purpose of this paper, this overview also includes the results of studies which introduce all 2003 Reform measures. As decoupling is the dominant element of the 2003 Reform, such a scenario still allows us to draw some conclusions regarding the effects of decoupling, even if these are slightly weaker.

The studies also differ in terms of whether and how they take into account the options for EU Member States not to decouple fully all direct payments. In the ESIM study, the decoupling of direct payments is simulated as partial according to average EU-15 decoupling rates in 2011, based on European Commission estimates. The CAPRI, GOAL and ESIM-OLD decoupling results reflect country-specific factors. CAPSIM and AG-MEMOD, by contrast, suppose that direct payments are fully decoupled everywhere. Finally, projections made using FAPRI and AGLINK are each specified for a maximum and a minimum decoupling assumption, reflecting Member States' scope to maintain part of their direct payments coupled.

3.2. Treatment of decoupled payments

In the studies reviewed here, the estimated effects of Agenda 2000 and 2003 Reform direct payments on area allocation and ruminant production can be expressed by a coupling factor of between 0 and 1, as displayed in Table 4, which is multiplied by the value of direct payments (per ton of product). A factor of 1 would reflect an

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[4] The old ESIM version is documented in detail in Münch (2002). All model description on ESIM presented above also holds for the old version, with two exceptions: 'ESIM-OLD' (a term solely used in this article in order to distinguish the two ESIM versions) does not include pasture, silage maize and other fodder, and it does not depict voluntary set-aside as a quota activity.

Table 4

Coupling factors for area payments under Agenda 2000 and decoupling scenarios (%)

	AGLINK	AG-MEMOD	CAPRI	CAPSIM	ESIM	ESIM-OLD	FAPRI	GTAP	GOAL
Agenda 2000	14	? [a]	100	100	100	100	50	100	100/50[b]
2003 Reform	6	30% of Agenda 2000	100[c]	100[c]	100[c]	0	15	100[c]	0

Source: Authors' own composition.

[a]Differs among products and member states.

[b]No coupling factor is applied, but alternative baselines with full capitalisation and 50% capitalisation of direct payments into land prices.

[c]Decoupling is depicted as a switch from area payments only for *grandes cultures* and set-aside to uniform payments for all areas.

equally significant effect as price support; factor 0, on the other hand, would reflect no effect on area allocation.[5]

In the AGLINK study, SFPs are assumed to have an impact of 6% of the corresponding impact of price support on area allocation, compared with 14% for the former direct payments for arable crops under Agenda 2000. The AG-MEMOD study assumes that the new payments have 30% of the area allocation effect of arable crop payments under Agenda 2000, for which the effect on area allocation differs among Member States and product groups. FAPRI assumes that SFPs have an effect of 15% of the effect of price support on land allocation to product groups, compared with 50% for direct payments under Agenda 2000. In the ESIM-OLD study, direct payments under Agenda 2000 are assumed to have a full effect on area allocation, whereas the new direct payments are considered to have no production effect at all.

In the ESIM, CAPSIM, CAPRI and GTAP studies, Agenda 2000 payments for crops are treated as fully coupled to area allocation. Decoupled payments are also modelled as being coupled to area allocation, but as uniform non-crop-specific area payments differentiated at national or regional level. Therefore, decoupling establishes a strong change in relative incentives between the *grandes cultures* on the one hand and fodder and pasture on the other. The GOAL baseline assumes that direct payments capitalise 100% (standard) or 50% (alternative) into land prices, and that the SFPs have no effect on area allocation.

In all but the FAPRI and GOAL studies, premiums for ruminant production are assumed to be fully coupled to production under Agenda 2000. All of these studies, however, take into account the fact that payments are subject to ceilings: payments actually granted are scaled down so that they meet budgetary expenditures for beef

[5]Several factors may be behind a positive coupling coefficient even in the case of fully decoupled payments. For example, it is often argued that they lead to increasing wealth levels and thus to higher production by risk-averse producers (Burfisher and Hopkins, 2003; OECD, 2003, 2004b). The better position of farmers on credit markets may also affect production through investment (OECD, 2001).

and sheep payments in the base period. This way of taking into account ceilings for ruminant payments suggests that producers are cross-subsidising their ruminant production, which exceeds farms' individual ceilings. In the FAPRI study, ruminant payments under Agenda 2000 are coupled to production in a range of between 50% and 100% (Binfield *et al.*, 2004; Westhoff, 2004). In the standard GOAL study baseline, premiums for ruminant production under Agenda 2000 are treated as fully coupled. In the alternative baseline, ceilings are taken into account by explicitly allowing for non-subsidised above-ceiling suckler cow and beef production. For all studies, decoupled payments after the 2003 Reform are modelled as having no direct effect on ruminant production.

3.3. Comparison of results

Table 5 presents the projected changes in area and ruminant production caused by the implementation of the 2003 Reform, and compares them with the continuation of Agenda 2000 policies, as projected by each of the models considered here.

The comparability of study results is limited for two reasons. First, as shown in Table 5, there is some difference between the models' final projection years. Second, decoupling policy scenarios differ somewhat. CAPSIM uses the European Commission proposals, rather than the agreed upon reform package, while GTAP models an artificial scenario – the full decoupling of Agenda 2000 payments. All the other models, however, use the actual 2003 Reform. However, modulation[6] rates also differ among studies. Decoupling rates in the AG-MEMOD, CAPSIM, ESIM-OLD and GTAP studies are 100%, as they are also under the maximum decoupling scenarios in the AGLINK and FAPRI studies, whereas they are lower for CAPRI, ESIM, GOAL and the minimum decoupling scenarios in the AGLINK and FAPRI studies. Modulation rates are set at 12% for CAPSIM, at 5% for those models that simulate the final decision (CAPRI, ESIM, AGLINK and FAPRI), but at 0% in the AG-MEMOD, GTAP and GOAL studies.

However, despite these differences, a comparison of results is still sensible. At the very least, directions and the extent of effects should not be sensitive to differences in projection year or the detail of the policy differences.

Table 5 clearly shows that the assumptions made about the extent to which the 2003 Reform payments are less coupled than the Agenda 2000 area and headage payments dominate the results. AGLINK assumes that the coupling coefficient only declines by 8 percentage points, while FAPRI assumes a decline of 35 percentage points. Both these models show substantially smaller effects than the other models, which assume either that the 2003 Reform payments are fully decoupled against previously fully coupled payments (ESIM-OLD), that the coupling coefficient is substantially decreased (by 70% according to AG-MEMOD), or that direct payments remain fully coupled, but are converted to a uniform per-hectare payment (all others).

All simulations show that decoupling reduces the total cereal area. In the FAPRI and AGLINK simulations, this area only declines by about 1%. Simulations in the other models vary between 2% (AG-MEMOD) and 9% (GOAL). According to the

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[6] As part of the 2003 Reform, direct payments are to be reduced by 5% from 2007 onwards, and funds shifted to the rural development budget (modulation).

Table 5

Change of area and ruminant production in the EU-15 under the 2003 reform compared with the baseline (continuation of Agenda 2000), as a %

Product	AGLINK[a] Max.dec.	Min. dec (Average 2004–2008)	AG-MEMOI 2010	CAPR 2009	CAPSIN 2009	ESIM[b] 2011	ESIM-OLI 2011	FAPRI Max. dec.	Min. dec. (Average 2007–2012)	GOAL Standard	Alternative (2008)	GTAP[b] 2013
Area												
Cereals	−0.7	−0.7	−2.0	−7.5	−4.0	−6.9	−5.0	−1.3	−1.1	−9.0[c]	−7.4	−6.9[d]
Oilseeds	0.0	−0.1	−6.2	−4.8	+1.5	−9.2	+6.0	−0.6	−0.2	–	–	−9.0[d]
Pasture	–	–	–	−1.0	–	+5.0	–	–	–	−7.5	−0.5	–
S-Maize	–	–	–	−5.2	−5.3	−10.8	–	–	–	–	–	–
Fodder	–	–	–	+15.0	+9.2	+11.0	–	–	–	+5.2	+1.0	–
Vol. set-aside	–	–	–	−7.9	–	−4.9	+20.4	–	–	–	–	–
Production												
Beef	−0.6	−0.1	−4.6	−6.4	−9.3	−5.0	−5.7	−2.6	−0.2	−3.6	−1.2	−10.8
Sheep	–	–	−4.4	−6.2[e]	−3.1	−8.6	–	−5.5	−1.7	–	–	–

Sources: Balkhausen *et al.* (2005), Binfield *et al.* (2004), Britz (2004b), Chantreuil *et al.* (2005), Frandsen *et al.* (2003), Gohin (2006), European Commission (2003) and OECD (2004a).
[a]Figures for beef refer to 2008; [b]figures only refer to the isolated impact of decoupling; [c]soft wheat; [d]supply, not area; [e]including goat meat.

CAPSIM and ESIM-OLD results, the reduction of cereal area is partly offset by an increase in oilseed area, yet this area is expected to decline in the other studies by anything between 0.1% (AGLINK) and 9.2% (ESIM). As under Agenda 2000, direct payments for cereals and oilseeds are at an identical level and the share of direct payments in total revenue for cereals and oilseeds is quite similar, a decline in the oilseed area seems plausible. The ESIM-OLD and CAPSIM analyses both predict more area for oilseeds because of the strong decline in the coarse grain price due to the reduction of cereal intervention prices and the abolition of rye intervention in the former, and a strong increase in sunflower seed area in the latter (with a declining rapeseed area). This corresponds to the strong decline in the durum wheat area (−24%), for which sunflower seed is a close substitute in production.

Across all nine studies, beef and sheep meat production is projected to decline, but again at figures that vary quite considerably (between 0.1 and 10.8%, and 1.7 and 8.6%, respectively). Once more, AGLINK and FAPRI project the lowest effects on beef, whereas the other models predict declines of 1.2–10.8%. In contrast to the arable crop sector, the decrease in beef production in FAPRI under the maximum decoupling scenario is much stronger than under the minimum decoupling scenario. This can be traced back to the larger difference in coupling factors between Agenda 2000 and 2003 Reform direct payments for ruminant production than for the arable crop sector. In addition, member states have more scope to keep part of the direct payments for ruminants coupled under the 2003 Reform, than for arable crops. In the GOAL study, the decrease in beef production is lower under the alternative baseline than under the standard baseline, as payments to beef producers under the latter have less of an effect on production because of the treatment of payment ceilings under Agenda 2000.

The area of silage maize is projected to decline by between 5.2% and 10.8% under the 2003 Reform compared with the continuation of Agenda 2000 policies. This is consistent with the lower production level of ruminants as well as a potential substitution effect owing to lower premiums for silage maize compared with other feedstuffs such as 'other fodder' and 'pasture', which became eligible for direct payments under the 2003 Reform. Arable fodder area is projected to increase between 1% under the 'alternative baseline' in GOAL and 15% in CAPRI, which is consistent both with *a priori* expectations and with the decrease in the *grandes cultures* area (including silage maize). Surprisingly, although pasture became eligible for direct payments under the 2003 Reform, only ESIM projects a noteworthy increase in this category. Elsewhere, the pasture area is either rather constant (CAPRI) or even falling (GOAL), probably as a result of rather limited substitution possibilities in land allocation and/or feed composition in other models, combined with decreasing beef production.

Voluntary set-aside is simulated to decrease by 4.9% in ESIM and by 7.9% in CAPRI, which seems reasonable given the relative decline of the direct payments for set-aside under decoupling compared with other products. The reason for the relative increase in payments for *grandes cultures* compared to the payments for voluntary set-aside is the partial decoupling of area payments in many Member States. While the payments for *grandes cultures* and set-aside were the same before the implementation of the 2003 Reform, partial decoupling leads to higher payments for crops than for set-aside. This, in turn, raises production incentives and lowers the area that is set aside. The outlier set-aside result shown by ESIM-OLD results from the *ad hoc* specification in that study, where SFPs are assumed to be fully cou-

pled to set-aside areas, but completely decoupled to crop areas (Münch, 2005). However, some increase in voluntary set-aside may be plausible. The abolition of the maximum set-aside area per farm, as well as the elimination of rye intervention and the resulting decrease in the price for rye, could increase the marginal value of set-aside. In particular, SFPs allow farmers to receive payment without incurring the costs of production, which might encourage some to cease production (in effect, setting aside land) while still being paid.

4. Conclusions and Implications

In modelling the effects of decoupling, activities which have not been eligible for direct payments in the past have become more important, because relative incentive prices between these products and the products which were already eligible for direct payments under the Agenda 2000 policies have been considerably altered. In particular, significant changes can be expected in feed rations for ruminants, which cannot be considered without including pasture land and fodder from arable land. However, of the nine models considered here, only CAPRI and ESIM include silage maize, fodder from arable land and pasture area as single product categories at the EU-15 level. A major difficulty of modelling these products, especially beyond EU-15 borders, is poor data availability and quality.

Notwithstanding the considerable differences in model types and specifications, all studies considered here project declines in cereal (and silage maize) areas and in beef and sheep production in the EU-15, and increases in fodder area as a result of decoupling. Differences in projections about pasture, oilseed and set-aside areas are associated with either different assumptions about the coupling of SFPs (for set-aside) or with different model or scenario specifications. Model type (behavioural PE, GE, or programming) was not found to have a systematic effect on model results. Rather, it is the different assumptions about the effectiveness of direct payments on area allocation (under Agenda 2000 as well as the 2003 Reform) which are largely responsible for the different estimates of the consequences of the 2003 Reform.

In particular, Gohin (2006) shows how strong assumptions on the degree of capitalisation of direct payments in land prices can affect results. Some models (e.g. GOAL or CAPRI) that simulate land markets can be used directly to formulate assumptions about the degree of capitalisation in land prices. Others which do not incorporate land markets but instead use a scaling mechanism, such as AGLINK and ESIM, implicitly assume full capitalisation.

Another feature which significantly drives model results is the degree of own-price response of pasture land and the substitutability of crop area for pasture land. The sensitivity analysis conducted in Balkhausen *et al.* (2005) has shown how strongly area allocation in ESIM responds to a change in these parameters. This feature is to some extent illustrated here by the differences between the results from the only two models which include pasture as a separate enterprise (CAPRI and ESIM). Having a better empirical foundation for these relationships could contribute to more reliable model results.

In general, the theoretical and empirical foundation often tends to restrict analyses, rather than the technical sophistication of models. For example, there is still a lack of empirical evidence on area allocation effects for various forms of direct payments, especially because there are no historical precedents for these kinds of direct

payments, and because the nature of the impacts (including wealth, risk and dynamic effects) has become increasingly difficult to identify, let alone reliably esti-mate (Chantreuil *et al*., 2005). As a result, simulation models have to rely on *ad hoc* assumptions, although there is an obvious need for better empirical and theoretical foundations.

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