Modelling the Effects of Partial Decoupling on Crop and Fodder Area And Ruminant Supply in the EU: Current State and Outlook

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Abstract

Various simulation models uniformly project a decline of the cereal and silage maize area as well as ruminant production in the EU-15 in the course of decoupling of direct payments. In contrast, model results are heterogeneous with respect to the direction of the decoupling effect on oilseed and pasture as well as voluntary set aside area. The model type (behavioural partial or general equilibrium model, or programming model) is not found to have a systematic effect on model results. It is rather the ad hoc assumptions about the effectiveness of direct payments on production which differ widely and drive model results to a large extent.

1. Introduction

Under the Mid Term Review (MTR) reform package of the Common Agricultural Policy (CAP) of the EU, most direct payments granted to agricultural producers will be decoupled from production. This is expected to have effects on the composition of agricultural production in the EU. On the one hand, decoupling of area payments will raise the relative gross margins of crops which were not subject to direct payments before the MTR (mainly fodder crops) compared to those crops which were already eligible for direct payments under Agenda 2000 policies (cereals, oilseeds, protein crops and set aside, hereinafter referred to as pre-MTR DP products). This reform may shift fodder supply functions to the right, which could lead to lower fodder prices and potentially to higher supply of ruminant products. On the other hand, decoupling of beef payments will reduce gross margins of beef production which could lead to

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lower beef supply and less feed demand for fodder. This would lead to lower fodder prices and thus shift the supply functions for Grandes Cultures to the right. Moreover, it has also been argued that payments under the new CAP scheme would lead to a higher amount of voluntarily set-aside area. Thus, decoupling can be expected to have complex effects and the net effect on crop and fodder area is unclear.

Against this background, this paper has a double purpose. First, it looks at what the effect of decoupling on area distribution between fodder/pasture and other crops may be. It does so by, i) a literature review of existing model applications, and ii) a quantitative analysis performed with a new version of the European Simulation Model (ESIM-GAMS). The second purpose is more general: to review the current state of depicting substitution effects between fodder area and crop area which result from decoupling of direct payments in economic simulation models. The paper is structured as follows. In Section 2, an overview of the state of depicting decoupling effects in various economic simulation models of the agricultural sector is presented. The focus in this section is on mechanisms of land allocation, the link between the livestock and the fodder/crop sector, and the depiction of direct payments. In Section 3, simulation results of decoupling scenarios from various simulation models are presented and compared. Section 4 then presents the application of the ESIM-GAMS model to simulate effects of decoupling. Finally, in Section 5 findings are discussed and an outlook on future research questions is given.

2. Depiction of Decoupling of Direct Payments in Selected Simulation Models

This section provides an overview of how the main aspects determining the effects of decoupling are captured in various economic simulation models. Models covered in this section are listed in Table 1. All but one of the models presented in Table 1 are partial equilibrium models. Only GTAP is a general equilibrium (CGE) model. In all partial equilibrium models included in Table 1, the core of the supply as well as the demand side are systems of behavioural equations, except in CAPRI, which consists of a two-tiered modelling system. For the EU, CAPRI is composed of a supply and a market module, which are coupled iteratively. The supply module consists of PMP-calibrated programming models at the NUTS II level, which are fed with exogenous prices for each iteration. That is, after each run of the NUTS II models, crop areas, herd sizes etc., are aggregated at member-state level supply models. Then member state supply models, having an identical structure as the regional models, are calibrated to the aggregated results, linked, and solved for young animal prices. In the EU-market module, supply quantities from member state models are confronted with demand functions at EU level and the market module solves for new member state-specific market prices, which drive the next iteration in the supply models.

Table 1. Economic Simulation Models Covered in this Chapter

Model	Location of development
AGLINK	OECD
CAPRI	University of Bonn
CAPSIM	University of Bonn
ESIM	ERS/USDA, Stanford and Göttingen University
FAO WORLD FOOD MODEL	FAO
FAPRI MODEL	Iowa State University
GTAP	Purdue University
PENN STATE TRADE MODEL	Pennsylvania State University
WATSIM	University of Bonn

Sources: Standard documentation for AGLINK is OECD (year unknown); for CAPRI, Britz (2004a); for CAPSIM, Eurostat (forthcoming); for ESIM, Münch (2002); for the FAO WORLD FOOD MODEL, FAO (2001); for the FAPRI MODEL, Westhoff (2004); for GTAP, Hertel (1997); for the PENN STATE TRADE MODEL, Stout and Abler (2003); and for WATSIM, Kuhn (2003). All model information presented in this paper is based on these sources, if not indicated otherwise.

2.1 Area Allocation

In all of the selected models, supply of crops in the EU is modelled as yield multiplied by area. The area component of the supply function is determined endogenously in each model. However, there are significant differences in the design of area equations as well as the process of area allocation. In ESIM, area is allocated as a function of current own and cross prices, direct payments, and labour and capital cost indices. Area allocation in WATSIM also depends on current own and cross prices and direct payments, but in contrast to ESIM, also on prices and subsidies as well as area of the previous year. Also, in the FAO WORLD FOOD MODEL, the supply response is time lagged. For cereals, area allocation only depends on lagged own and cross prices, on lagged area, and on a trend factor. For oilseeds, area is just a function of lagged prices of the related oil and oilmeal. Current prices and direct payments are not considered in area allocation (Yanagishima, 2004). Area in the PENN STATE TRADE MODEL depends on own and cross producer prices. Direct payments, which are considered as "coupled", are included in the producer prices. In addition, area functions have partial adjustment factors which establish a lagged price response, and also have area of the pre-period as an explanatory variable. The area allocation functions in CAPSIM are derived from a restricted normalized 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 of outputs and net prices of inputs are the explanatory variables of area allocation and herd size.

In the FAPRI MODEL, total area allocated to cereals and total area allocated to oilseeds is modelled separately and no other crops are modelled. Total cereal area is a function of weighted average expected real gross returns, mandatory set-aside rate, and area used for oilseeds. The weights reflect average historical shares of various cereals in total cereal area. For each commodity, expected gross return is a function of trend yields, a weighted average of market prices from the past three years, and expected direct payments multiplied by a factor between 0 and 1 which reflects the degree of "coupledness" of the payment. Once the total area used for cereal production is determined, area is allocated to individual cereals based on expected market gross returns (excluding payments) for the commodity in question relative to average expected market returns for all cereals. Area for oilseeds is determined similarly, except that expected cereal returns are an argument in the total oilseed area equation, instead of the oilseed area term used in the total cereal area equation.

The mechanism of area allocation in AGLINK is similar to those of CAPSIM and the FAPRI MODEL. Area allocation depends on own and cross commodity gross market returns as well as on different kinds of direct payments (von Lampe, 2004).

In GTAP, land is allocated according to a Constant Elasticity of Transformation (CET) function expressing the constrained mobility of the factor land (Brockmeier and Salamon, 2004). Some extensions of the GTAP standard version include a nested structure of land allocation, i.e. the CET function is assumed separable for different categories of uses such that land allocation takes place in successive steps. The parameter of the CET function determines the mobility of land between uses at each stage, thereby having the same value at each allocation stage and higher value the more land becomes similar in the allocation framework (Brockmeier, 2005).

In the regional supply models of CAPRI, which are PMP-calibrated (Positive Mathematical Programming) programming models, area is distributed according to the contribution of the respective product to the objective function (market revenue and direct payments), the explicitly modelled constraints as well as the cost terms resulting from the PMP-calibration process.

2.2 Variability of Total Agricultural Area

The process of product-specific area allocation often results in total area exceeding or undershooting the total area in the base period. This raises the question of technical feasibility. Can additional area move into production of products covered by the model, from products not covered by the model? Are there uncropped land reserves? And, in case of area moving out of modelled products: what will happen to this area, and is this legally possible? The lower 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. But variation in this area should somehow be consistent with feed demand of ruminants. All models described in this section include area allocation to cereals and oilseeds. Table 2 indicates whether roughage products and voluntary set aside are included.

Table 2. Inclusion of Roughage Products and Voluntary Set Aside in Simulation Models

Product	AGLINK	CAPRI	CAPSIM	ESIM	FAO WFM	FAPRI	GTAP	PENN STATE	WATSIM
Grass		x							
Silage maize		x	x						
Other fodder		x	x						
Vol. set aside		x		x					

Source: Own composition.

Table 2 shows that product coverage of roughages is very limited. Only CAPRI treats all of the four area uses as endogenous variables. In CAPSIM, this is only true for silage maize and other fodder. Grassland is treated as exogenous according to recent trends. Voluntary set aside is not modelled explicitly, but is taken into account in the function of the overall set-aside area. More precisely, the overall set-aside area function includes a set-aside elasticity which ought to capture the opposite change in voluntary set aside usually accompanying an increase in the mandatory rate. The other models capture neither roughages nor voluntary set aside.

In order to ensure that all crop area (except mandatory set aside area) is used for agricultural production, ESIM, WATSIM, and AGLINK use a scaling process by which the area allocated as described above is scaled evenly up or down according to total crop area available (for AGLINK, see von Lampe, 2004). Other models allow for variation of total area covered by the respective model. These are the FAPRI MODEL, the PENN STATE TRADE MODEL, and the FAO WORLD FOOD MODEL. In addition to the individual crops in the model, the PENN STATE TRADE MODEL contains one residual land use category, which represents all other land that could potentially move into production of crops in the model, or absorb movements of land out of the crops covered by the model. For each region an assignment for a level of additional land is made, ranging from about 5 to 20 percent of total cropland, depending on the country/region. One characteristic of the supply elasticity matrix of crops explicitly covered by the model is that if prices for all crops rise in the same proportion, there will be a slight increase in the area planted to each crop. Hence, total area used for products explicitly modelled would increase. If the exogenously determined area limit for the EU is exceeded during the allocation process, the allocated area is scaled down until the limit is met. If the sum of allocated area is less than the limit, there is no scaling process. For all regions other than the EU, no such scaling is applied (Abler, 2004).

In the FAPRI MODEL and in the FAO WORLD FOOD MODEL land can move into and out of production without further restrictions (for the FAO WORLD FOOD MODEL, see Yanagishima, 2004). However, for the European countries included in the FAPRI MODEL, the observed elasticity of total covered agricultural area with respect to weighted net returns is generally 0.1 or less. In CAPSIM and GTAP, allocated area is not scaled. Since the land market is endogenous to the model, the rental price for land adjusts such that fixed total available area is not exceeded nor undershot. A land market is not included in the regional supply models of CAPRI. But CAPRI comprises two land balances, one for arable land and one for grassland and both of them must be met. In 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 can be depicted 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 Sector

To depict the effects of decoupling, various links between the crop and fodder sectors and the livestock sector have to be incorporated in the model structure. The most crucial questions in this context are if and how feed prices affect livestock production and how feed requirements are modelled. In the FAPRI MODEL, a ratio of output prices and weighted payments (with lower weights on less coupled payments) to input prices is used to determine livestock production. Each of the major feeds is weighted by its share in the base ration for the animal in question. In the PENN STATE TRADE MODEL, livestock production depends on own and cross livestock prices, direct payments, and on a feed cost index for the considered animal product. This feed cost index is a weighted average of feed prices, using the base-period feed component mix as constant weights. This is almost the same for AGLINK (von Lampe, 2004) and ESIM. In these models, supply of animal products is a function of effective own and cross prices (including premiums) as well as a feed cost index and, in case of ESIM, prices for other inputs. However, weights of individual feedstuffs in the feed cost index are not fixed, but vary with the feed component mix. In the FAO WORLD FOOD MODEL, livestock production depends on own and cross livestock prices as well as on a feed cost index, but this feed cost index is not animal specific. In WATSIM, livestock production does not depend on a feed cost index, but on single own and cross feed prices in addition to own and cross prices of animal products.

In CAPSIM, livestock production depends on individual market prices for feed, however, corrected by the shadow prices for energy and protein (Witzke, 2005). In GTAP, those feed types which are included in the model are inputs to animal production, thus, feed prices determine livestock production. Thereby, the response of animal production to feed prices depends on the value share of the feed type in question in the total inputs.

In AGLINK, ESIM, the PENN STATE TRADE MODEL, the FAPRI MODEL, and the FAO WORLD FOOD MODEL, feed demand is determined by own and cross feed prices and by the level of livestock production. This implies a possibility of substitution among feed components. However, different types of feedstuffs cannot be substituted completely freely. In fact, own and cross price elasticities imply certain requirements on protein and energy content, which affect the degree of substitutability among different feeds and thus the response of livestock supply to changes in feed prices. In the FAPRI MODEL, negative own-price elasticities of feed demand are slightly larger in absolute terms than the sum of the cross-price elasticities. This implies that livestock producers can substitute other feedstuffs (e.g., cereal substitutes, forage) for cereals and oilseed meals. In ESIM, feed demand elasticities are homogeneous of degree zero in the prices of model-endogenous feed components. As roughages are not covered, the implicit assumption is that no substitution possibilities between roughages and other feed components exist. In most above mentioned models, the feed composition is reflected for each type of livestock product. Only in AGLINK and the FAO WORLD FOOD MODEL are feed composition related to an aggregate of all animal products (for AGLINK, see von Lampe, 2004).

In CAPSIM, feed demand depends on market prices for individual feeds corrected by the shadow prices for energy and protein. More precisely, if the price of a certain feedstuff increases and the demand accordingly decreases, nutrient balances ensure that neither a deficit in energy nor in protein can materialise. This is because shadow prices for protein and/or energy rise the more the required quantity of protein and/or energy is binding. The increase in these shadow prices moderates the increase in the net price of the feedstuff in question, which is the market price minus the nutrient shadow prices. As a consequence, demand for the feedstuff in question decreases less than without such a restriction and nutrient balances are maintained (Witzke, 2005). A similar approach is applied in WATSIM which includes no protein balance but only an energy balance (Kuhn, 2004). In CGE models, the link between livestock and fodder or crops is often modelled much more simply than in partial equilibrium models due to a high level of aggregation, e.g. “meat products” and “cereals.” However, given a CGE structure, it is possible to illustrate an expansion effect, i.e. the demand quantity for a feed product responds to changes in the production of livestock products. In addition, demand for single feed products can also change when the price in any feed product changes since the input requirement of livestock production may allow for substitution between feed products instead of the standard Leontief-specification.

In the regional programming supply models of CAPRI, the profit-maximising animal herds are determined simultaneously with cost-minimising feed composition. Nontradable fodder such as grass, fodder, maize, etc. are treated as individual feeding activities whereas tradable feeding activities such as wheat or soybean meal are aggregated into different categories (cereals, rich energy, rich protein, etc.). Substitution among feeding activities is possible but restricted by very detailed nutritional requirements regarding animal needs for energy, protein, lysine, dry matter, etc. Substitution of feed components belonging to different feed categories is not possible. The regional supply models are solved independently from each other. The feed quantities obtained in these models are aggregated per member state and enter the market model as fixed variables. Then the market module determines the mix of the feed categories, e.g. the share of wheat, barley, and maize in the cereals aggregate, and simultaneously the prices for the components. The elasticities used to determine the feed shares are partly based on estimated cost functions for the German feed compound industry. Feed demand in the market model depends on raw product prices, and on changes in the supply of animal products weighted with the share the feed in question has in the fodder ration. Feed use thus increases proportionally if the supply of livestock products increases and price changes cause substitution inside the feed mix. The new prices resulting in the market model as well as the nutrient content of the feed bulks are then handed back to the regional supply models.

2.4 Production Effectiveness of Direct Payments

The impact of decoupling on area allocation and production in simulation models heavily depends on the way direct payments enter the behavioural functions, in the coupled as well as decoupled form. In ESIM and WATSIM, direct payments enter the area allocation functions similar to prices, i.e. market price and direct payment per product unit make up an "effective market price" which is the explaining variable. In some other models a "decoupling coefficient" between 0 and 1 applies to direct payments. For example in the PENN STATE TRADE MODEL, Agenda 2000 direct payments are considered to be neither completely coupled nor decoupled as the EU requires farmers to plant (but not necessarily to harvest) a crop to receive the payments. As a result only 50% of the payments for Grandes Cultures and milk as well as set aside and cotton enter the area allocation function. The second half of these payments is assumed to have no effect on production and, thus, is excluded. Headage payments and suckler cow premiums, in contrast, are treated as fully coupled. In the FAPRI MODEL direct payments multiplied by a decoupling coefficient enter the expected gross returns function, which in turn is a determinant of the oilseed and cereal area functions. Also AGLINK applies a decoupling coefficient to direct payments as a variable of the return function (von Lampe, 2004).

In CAPSIM, decoupled payments are represented as a homogeneous land premium given to all agricultural land within each country. As mentioned above, direct payments determine, besides other factors like prices, the area allocation by influencing the net revenue function. In GTAP, area payments are modelled as wedges between the return on land in crop production and the cost of using the land. Animal payments are modelled as price wedges between producer and market prices. All decoupled payments are modelled similar to area payments, though in case of decoupled payments the wedge is equal across all crops.

Recently there has been discussion as to what production effects decoupled payments may have. It is often argued that so-called decoupled payments lead to increasing wealth levels and thus to higher production by risk-averse producers (Burfisher and Hopkins, 2003). Also the better position of farmers on credit markets may affect production (OECD, 2001). None of these effects is explicitly covered by the simulation models reviewed in this paper.

3. Results from Selected Simulation Models

In recent studies, some of the models presented above have already been used to simulate decoupling effects on agricultural production and area allocation. This section looks at these studies by describing the underlying scenarios, assumptions, and results. Two simulation studies have been prepared, one by the European Commission and one on its request. One of them is based on ESIM, the other was carried out by EuroCARE (University of Bonn) with CAPSIM. The key findings of these studies have been brought together in European Commission (2003). The third impact assessment study was conducted in 2004 by the AG-MEMOD/CAPSTRAT group using CAPRI (Britz, 2004b). Two more studies have been carried out by FAPRI using the FAPRI MODEL (Binfield et al., 2004) and by the OECD using AGLINK (OECD, 2004). GTAP has been used in a study of the Danish Research Institute for Food Economics (Frandsen et al., 2003). The last study (Kleinhanß et al., 2004) addressed in this section is based on FARMIS. FARMIS is a comparative-static linear programming (LP) model designed for the agricultural sector in Germany. The illustration of the agricultural sector is not based on individual farms, but on representative groups of farms. Currently, FARMIS includes 26 cropping and 15 livestock activities, which produce 44 primary products, intermediate products, and by-products (Bertelsmeier, forthcoming). Although FARMIS is not discussed in the above sections, it is included in the comparison of study results to see to which extent results from this pure LP model differ from results obtained by running other models.

3.1 Scenarios

The studies mentioned above are different with respect to the level of policy disaggregation and reference scenario when illustrating the effects of new policy measures. The studies using the FAPRI MODEL, AGLINK, CAPRI, CAPSIM, ESIM, and FARMIS only show the aggregate effect of implementing all MTR measures together (including decoupling and some price cuts) compared to a reference scenario of continued Agenda 2000 policies. The study using the GTAP model illustrates the isolated impact of decoupling, but it analyses the effects of decoupling the Agenda 2000 and not the MTR direct payments. Although measuring the isolated impact of decoupling has, of course, the highest explanatory power for the purpose of this paper, the simulated effects of studies which introduce all MTR measures together are also included in this overview. Such a scenario still allows to draw some, though slightly weaker, conclusions regarding the effects of decoupling since decoupling is the most crucial and clearly dominant element of the MTR. Almost all results summarised below apply to the EU-15. The study carried out with FARMIS, however, illustrates the decoupling effects only for Germany.

In the studies applying ESIM and CAPSIM, only one MTR scenario, which includes price reductions and fully decoupled payments, is simulated. Projections with the FAPRI MODEL and AGLINK are each specified for a maximum and a minimum decoupling scenario. That is, according to member countries' possibility of determining the degree of coupling on their own, one scenario treats payments as decoupled from production as much as possible, while payments remain coupled as far as allowed in the other. The degree to which payments are coupled in the maximum and minimum decoupling scenarios corresponds to the coupling ratios as agreed in the final Luxembourg meeting. The results obtained with CAPRI correspond to a scenario including assumptions which try to reflect each country's specific way of implementing the Single Farm Payment. That is, according to each country's current position at the time, the CAPRI study assumes the implementation of different decoupling models and coupling rates across the EU-15 member countries.

3.2 Treatment of Decoupled Payments

In the study using ESIM, decoupled payments are considered as lump sum payments with no impact on production; their contribution to the "effective producer price" is reduced to zero. "However, the cross-compliance requirements, the respect of good agricultural practices, the eligibility conditions attached to the decoupling scheme as well as agricultural legislation in member states have been assumed to constrain the shift between activities, notably between grassland and arable land production and between agricultural activities and abandonment of production" (European Commission, 2003). The FAPRI MODEL relies on the assumption that even the new payments have some impact on farmers' production decisions, which is 15% of the production-influencing effect of price support, compared to 50% under the subsidies they replace (Binfield et al., 2004). In the AGLINK study, the new payments are assumed to have a production impact amounting to 6% of the corresponding impact of price support compared to 14% for the former direct payments under the Agenda 2000 (OECD, 2004). CAPSIM, CAPRI, and FARMIS treat decoupled payments as uniform non-crop-specific payments at national or regional level. Also GTAP treats decoupled payments by converting coupled payments into a region-specific homogeneous payment to land (Frandsen et al., 2003).

3.3 Comparison of Results

The comparability of study results is restricted for two reasons. First, simulations carried out do not relate to the same projection period. While results obtained in the studies using ESIM, CAPRI, and CAPSIM relate to the year 2009, results in the AGLINK, FARMIS, GTAP, and FAPRI study refer to the years 2008, 2012, 2013, and an average of 2007 to 2012, respectively. Secondly, scenarios chosen in ESIM and CAPSIM relate to the Commission's proposals in the run up to the ministerial meeting in June 2003. Policy assumptions in AGLINK, CAPRI, FARMIS, and the FAPRI MODEL are based on the decisions made in Luxembourg. The scenario in the GTAP study neither refers to the Commission proposal nor to the final decisions. In particular the decoupling as well as modulation rates differ among studies. Decoupling rates in the GTAP, ESIM, CAPSIM, FARMIS studies and under the maximum decoupling scenarios in the AGLINK and FAPRI studies are 100% for cereals and oilseeds, beef, and sheep meat. For CAPRI and the minimum decoupling scenarios in the AGLINK and FAPRI study they are lower. Modulation rates are up to 18% for studies which simulate the Commission proposals, and down to 5% for those that simulate the final decision, or even 0% in GTAP. However, despite those restrictions a comparison of study results still seems to make sense. At least the rough direction of effects should not depend too much on the differences in projection year and in the policy changes corresponding to the proposals on the one hand and the final decisions made in Luxembourg and in member states on the other. Therefore, Table 3 presents projected changes in area and production due to the implementation of the MTR compared to the continuation of Agenda 2000 policies. As a first observation, Table 3 shows that area and quantity changes simulated with the FAPRI MODEL and AGLINK are far below those generated with other models with very few exceptions. This seems logical, because the difference in "production effectiveness" of the Agenda 2000 and the MTR payments is considered to be only 8% compared to price support in Aglink and 35% in the FAPRI MODEL.

Looking at individual product groups, all simulations show a reduction of total cereal area under the MTR compared to the Agenda 2000 reference. In the FAPRI and AGLINK simulations, this decline is only about 1% in the maximum decoupling scenarios. In other simulations the decrease differs between 4% in CAPSIM and 7.5% in CAPRI. For Germany, FARMIS projects even an 11% decline of cereal area. According to results stemming from the ESIM version applied in European Commission (2003), and CAPSIM, the reduction of cereal area is partly offset by an increase in oilseed area. However, in the studies conducted with the other models, oilseed area is expected to decline by 0.1% (AGLINK) to 4.8% (CAPRI). Under the scenario of decoupling Agenda 2000 payments, which is simulated with the GTAP model, oilseed supply is even projected to decrease by 9%. 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, the origin of the increase of oilseed area in CAPSIM and especially ESIM is unclear to us.

Table 3. Change of Area and Production Due to Implementation of the MTR Package Compared to the Baseline (Continuation of Agenda 2000, in %)

Product	ESIM	CAPSIM	CAPRI	FAPRI		AGLINK[a]		GTAP[b]	FARMIS[c]
				Max. dec.	Min. dec.	Max. dec.	Min. dec.		
	2009	2009	2009	Average 2007 – 2012		Average 2004 - 2008		2013	2012
Cereals (area)	-5.0	-4.0	-7.5	-1.3	-1.1	-0.7	- 0.7	-6.9[d]	-11.1
Oilseeds (area)	+6.0	+1.5	-4.8	-0.6	-0.2	0.0	-0.1	-9.0[d]	-4.1
Grass (area)	-	-	-1.0	-	-	-	-	-	+1.9
S-Maize (area)	-	-5.3	-5.2	-	-	-	-	-	-6.9
Other fodder (area)	-	+9.2	+15.0	-	-	-	-	-	+20.4
Vol. set aside (area)	+20.4	-	-7.9	-	-	-	-	-	-[e]
Beef (production)	-5.7	-9.3	-6.4	-2.6	-0.2	-0.6	-0.1	-10.8	-8.5
Sheep (production)	-	-3.1	-6.2[f]	-5.5	-1.7	-	-	-	-
Pork (production)	-	+0.2	-0.2	-	-	+0.1	-0.1	-	+0.5
Poultry (prod.)	-	+0.2	+0.5	-	-	0.0	-	-	+0.1

Sources: European Commission (2003), (Britz, 2004b), Binfield et al. (2004), OECD (2004), Frandsen et al. (2003), Kleinhanß et al. (2004).

[a] Figures for beef and pork refer to the year 2008. [b] Figures only refer to the isolated impact of decoupling.

[c] Figures refer only to Germany. [d] Figures for cereals and oilseeds refer to supply, not to area. [e] Overall set-aside area is simulated to increase by 47.1% in Germany based on FARMIS. [f] Including goat meat.

Beef and sheep meat production is projected to decline by 0.1% to 10.8% and 1.7% to 6.2%, respectively. Again, for beef, AGLINK and the FAPRI MODEL project the lowest effects whereas results of all other models vary between a decline of 6.4% and 10.8%. The area of silage maize is projected to decline between 5.2% and 6.9% under the MTR compared to the continuation of Agenda 2000 policies. This is consistent with the lower production level of ruminants as well as a potential substitution effect due to lower premiums for silage maize compared to other feedstuffs such as "other fodder" and "grass," which become eligible for direct payments under the MTR. In consistency with a priori expectations and the decrease in Grandes Cultures area (including silage maize) area allocated to other arable fodder is projected to increase significantly by 9.2% (CAPSIM) to 20.4% (FARMIS). The strongest increase in other fodder area projected with FARMIS is consistent with the fact that FARMIS projects the full decoupling option for Germany in contrast to the partial decoupling option for the EU depicted in CAPRI. Surprisingly, although grassland becomes eligible for direct payments under the MTR, area is projected to stay more or less constant in the future. This probably results from rather limited substitution possibilities in land allocation and/or feed composition.

Simulation results for voluntary set aside vary extremely. While this area is projected to increase by more than 20% in the study using the old ESIM, it is projected to go down by almost

8% in the study based on CAPRI. Declining voluntary set aside seems consistent with a priori expectations based on the declining premium for set aside under decoupling compared to other products. The reason for the increase in voluntary set aside in ESIM is that decoupled payments after the MTR are considered fully production effective for voluntary set aside in the respective analysis whereas they are assumed to have no impact on the production of crops (Münch, 2005). Pork and poultry production is simulated to stay quite constant under the MTR compared to continued Agenda 2000 policies. This is no surprise as pork and poultry production is neither directly affected by decoupling nor by other MTR reforms, but only indirectly via cross effects from other products.

4. Analysis with ESIM-GAMS

4.1 Model and Scenario Description

ESIM-GAMS is a multicountry agricultural sector model which covers 34 products and 16 regions. The focus is on the EU and the details of EU agricultural policies as well as on EU accession candidates. World market prices are endogenous and trade is modelled as net trade. ESIM-GAMS is based on the ESIM model discussed above but has recently been updated and extended in terms of base period, product and country coverage, policy formulation and software platform (GAMS and GSE) (Banse et al., 2005). In order to distinguish between the new and the old version, the new version is referred to as ESIM-GAMS throughout this paper. Supply of crops and fodder in ESIM-GAMS is determined by a yield function, dependent on the own price and price indices for intermediate inputs and labour, and an area allocation function dependent on own and cross prices as well as intermediate input, capital, and labour cost indices. All area allocation functions are isoelastic, homogeneous of degree zero in all in- and output prices, and locally symmetric. Supply of animal products is a function of own and cross incentive prices (including premiums) as well as a feed cost index (FCI) and price indices for other intermediate inputs, capital and labour. Direct payments enter the area allocation functions in the same way as prices; that is, market price and direct payment per product unit make up an "incentive price," which is the explaining variable. Voluntary set aside is modelled as a quota product with the base period level being the quota and the shadow premium being at 90% of the real premium. This is because set aside was restricted under Agenda 2000 to a maximum level per farm; some farms reached that maximum.

Feed demand is modelled for 15 feed components plus silage maize, grass, and other fodder. Product-specific feed demand per unit of animal output is isoelastic, homogeneous of degree zero in the prices of all feed products, locally symmetric, and the possibility to substitute roughages for other feed components exists. Total product-specific feed demand in a country is the product of feed demand per unit of animal output and the level of animal output, plus a model exogenous additive intercept which represents feed demand of animals not covered in ESIM-GAMS. An endogenous animal product-specific FCI is an average of feed prices weighted by the actual feed demand quantities. In this modelling approach, an increasing feed price for any feed component results in reduced demand for this component due to two effects. First, the substitution effect, in which other components are substituted for the more expensive one, and second, the output effect which results in an increasing FCI, in lower animal production, and therefore lower feed demand.

Certain parameters are considered crucial in simulating the effect of decoupling direct payments for ruminants as well as crops on area distribution between fodder and crops as well as ruminant supply. These are own price and feed cost elasticities of ruminants, own and cross price elasticities of area allocation, especially for cereals, oilseeds, silage maize, other fodder and pasture, and the own and cross price elasticities of feed demand with emphasis on the substitution possibilities between roughages and other feed components. These parameters are displayed in Table 4. Area allocation elasticities in ESIM-GAMS are very low for pasture and voluntary set aside area compared to other crops. This is because pasture is permanent pasture and the substitution for crop land is limited due to different soil qualities and geographical/climatic conditions. The same holds for voluntary set aside, which is generally marginal land. Supply elasticities for ruminants are about 1 and elasticities for milk are not shown as they are irrelevant due to the binding milk quota under all scenarios presented below. Allen-elasticities of substitution show that roughages are a significantly less suitable substitute for oilmeals or cereals than products within the respective groups. Also the substitutability within the group of roughages is considered relatively low mainly due to feeding technology (grazing/nongrazing).

Table 4. Selected Elasticities for the EU-15 in ESIM-GAMS

	Own price elasticities	**Selected cross- and input-price elasticities**	
Elasticities of area allocation			
Cereals and oilseeds	0.31 to 0.88	up to -0.16 within group	
Silage maize	0.77	-0.12 corn price	
Other fodder	0.68	-0.16 common wheat price	
Pasture	0.07	-0.01 common wheat price	
Vol. set aside	0.12	-0.01 common wheat price	
Elasticities of supply			
Beef	1.06	-0.42 FCI; 0.13 milk price	
Sheep meat	1.27	-0.36 FCI	
Feed demand elasticities			
Cereals	-1.0 to -1.7	up to 0.3 within group	
Oilmeals	-0.8 to -1.6	up to 0.6 within group	
Silage maize	-0.7 to -1.0	up to 0.31 within group "roughages"	
Other fodder	-0.6 to -0.8	up to 0.5 within group "roughages"	
Grass	-0.6 to -0.8	up to 0.5 within group "roughages"	
Allen-elasticities of substitution (only cross-elasticities)			
	Cereals	**Oilmeals**	**Roughages**
Cereals	2.5 to 9.0	0.4 to 1.3	0.2 to 1.6
Oilmeals	symmetric	5.0 to -10.0	0.3 to 1.9
Roughages	symmetric	symmetric	0.9to 1.8

Source: Banse et al. (2005).

For the assessment of decoupling effects with ESIM-GAMS, four scenarios are formulated and results for the EU-15 are compared for the projection year 2011. All scenarios include the accession of the 10 new member states in 2004 and the accession of Bulgaria and Romania in 2007. The "rest of the world" component is calibrated such that FAPRI world market price projections (FAPRI, 2004) for 2011 are met. The four scenarios include:

1. A benchmark scenario, COUPLED, with full implementation of the MTR reforms but coupled direct payments.
2. A crop decoupling scenario, CROPS ONLY, in which area payments are partially decoupled according to the MTR. The average EU decoupling rates in 2011 are based on estimates from the European Commission and are 91.2% for cereals and oilseeds, 62.8% for durum wheat, and 57.6% for rice. Direct payments for ruminants remain coupled. Decoupled crop payments are distributed equally over total agricultural area as a uniform per ha payment. The quota restriction for voluntary set aside is relieved.
3. A ruminant decoupling scenario, ANIMAL ONLY, in which ruminant direct payments are partially decoupled according to the MTR results. Average EU decoupling rates in 2011 are based on estimates from the European Commission and are 74.5% for beef, 72.9% for sheep meat and 100% for milk. Direct payments for crops remain coupled. Decoupled animal payments are distributed equally over total agricultural area as a uniform per ha payment. The quota restriction for voluntary set aside is relieved.
4. A complete decoupling scenario, DECOUPLED, which combines scenarios CROPS ONLY and ANIMAL ONLY and in which all direct payments are partially decoupled according to the MTR.

4.2 Model Results

Table 5 depicts ESIM-GAMS results for the scenarios described above. Only direct payments are expressed in absolute terms. Other results are set at 100 for the benchmark scenario COUPLED and are expressed relative to the benchmark scenario results for all other scenarios.

Table 5 shows that direct payments (rows 2-8) for ruminants remain constant under the scenario CROPS ONLY, whereas they decline for cereals, oilseeds, and voluntary set aside. For fodder and pasture, direct payments increase significantly to almost the same level as for cereals and oilseeds. Direct payments for fodder and pasture result in higher area (rows 38 and 39) and thus production, and, because products are nontradables, significantly lower feed prices for fodder and grass (rows 23 and 24). This results in declining feed costs for ruminants (rows 18 and 19), which overcompensate slightly lower incentive prices (rows 10 and 11; incentive prices are the sum of farm gate prices and direct payments per product unit) and lead to slightly higher beef and sheep meat production than under the scenario COUPLED (rows 29 and 30).

Table 5. ESIM Results under Various Decoupling Scenarios Compared to Coupled Payments

		Scenarios			
ROW		COUPLED	CROPS ONLY	ANIMAL ONLY	DECOUPLED
(1)	**PREMIUMS AND PRICES**				
(2)	**Direct payments (€)**				
(3)	**Beef (€/t)**	547	547	139	139
(4)	**Sheep meat (€/t)**	1187	1187	322	322
(5)	**Cereals, oilseeds (€/ha)**	240	118	302	180
(6)	**Set aside (€/ha)**	240	97	302	159
(7)	**Fodder (€/ha)**	0	97	62	159
(8)	**Grass from pasture (€/ha)**	0	97	62	159
(9)	**Incentive prices**				
(10)	**Beef**	100.0	98.9	91.6	91.0
(11)	**Sheep meat**	100.0	98.5	88.3	87.7
(12)	**Nonruminants**	100.0	100.3	100.5	100.5
(13)	**Cereals and oilseeds**	100.0	87.6	106.9	94.3
(14)	**Silage maize**	100.0	87.9	104.6	92.1
(15)	**Fodder**	100.0	113.2	108.0	123.0
(16)	**Grass from pasture**	100.0	189.5	151.5	243.0
(17)	**Feed cost indices**				
(18)	**Beef**	100.0	94.8	94.3	89.5
(19)	**Sheep meat**	100.0	91.9	92.3	84.9
(20)	**Nonruminants**	100.0	100.3	100.2	100.6
(21)	**Feed prices**				
(22)	**Maize**	100.0	104.2	92.8	96.6
(23)	**Fodder**	100.0	85.2	90.1	76.6
(24)	**Grass from pasture**	100.0	89.7	87.3	78.8
(25)	**PRODUCTION, AREA, AND FEED COMPOSITION**				
(26)	**Animal production**				
(27)	**Ruminants**	100.0	100.4	97.3	97.8
(28)	**Milk**	100.0	100.0	100.0	100.0
(29)	**Beef**	100.0	100.9	93.5	94.7
(30)	**Sheep meat**	100.0	101.6	89.0	91.3
(31)	**Nonruminants**	100.0	100.2	100.7	100.9
(32)	**Area**				
(33)	**Pre-MTR DP products**	100.0	94.0	98.3	93.0
(34)	**Cereals**	100.0	94.4	98.0	93.1
(35)	**Oilseeds**	100.0	90.8	99.3	90.9
(36)	**Silage maize**	100.0	90.7	97.9	89.1
(37)	**Voluntary set aside**	100.0	90.1	102.3	95.1
(38)	**Fodder**	100.0	110.9	99.6	111.0
(39)	**Pasture**	100.0	103.6	101.6	105.0
(40)	**Share of pre-MTR DP products in total feed**				
(41)	**Beef**	100.0	90.2	93.8	84.7
(42)	**Sheep meat**	100.0	88.7	91.4	81.2

Source: Own calculations.

Although total ruminant production is increasing by only 0.4%, pasture area increases by 3.5% and fodder area by more than 10% compared to the COUPLED-Scenario. This is because of changes in relative prices of feed components: fodder and grass are substituted for other feed components. The share of pre-MTR DP products in total feed demand for beef and sheep meat (rows 41 and 42) is about 10% lower than in the COUPLED scenario. The production of milk and nonruminants does not vary significantly among scenarios. This reflects the binding milk quota and the rather constant incentive and feed prices for nonruminants.

Under the scenario ANIMAL ONLY, direct payments for ruminants decline by more than 70%, compared to the COUPLED scenario, whereas direct payments for cereals and oilseeds increase, and are newly introduced for fodder and pasture land. As in the scenario CROPS ONLY, direct payments for fodder and pasture land boost supply and therefore result in lower prices for these nontradables. Simultaneously, incentive prices for ruminants decrease significantly by about 10% due to decreasing premiums. This overcompensates for the effect of lower feed prices, and results in ruminant production about 7.5% (beef) to 11% (sheep meat) below the COUPLED scenario. Area allocation between fodder/pasture and oilseeds/cereals changes little under the ANIMAL ONLY scenario compared to the scenario COUPLED. The effect of lower overall feed demand due to lower ruminant production is roughly outweighed by the substitution of fodder and grass from pasture land for other feed components; the value share of pre-MTR DP products in total feed demand is about 8% lower than under the scenario COUPLED.

Under the scenario DECOUPLED, direct payments for ruminants decline by more than 70% compared to the COUPLED scenario, and direct payments for all crop, fodder, and pasture production are at an almost uniform level of 159-180 €/ha. This is the highest fodder/pasture premium under all scenarios and consequently the supply shifting effect is highest, and the negative effect on prices for these nontradables is most pronounced: prices decline by more than 20%. As a result, the feed cost index for ruminants is about 11% (beef) to 15% (sheep meat) lower than under the COUPLED scenario. Further, the incentive prices are 9% (beef) to 12% (sheep meat) below the scenario COUPLED, which dominates the supply effect and results in ruminant production 5% (beef) to 9% (sheep meat) below the COUPLED scenario. In terms of area allocation, under the DECOUPLED scenario even more than under the scenario CROPS ONLY, the strong change in relative incentive prices leads to a strong decline in cereal and oilseed area by 7% and an increase in fodder and pasture area by about 11% and 5%, respectively.

Voluntary set-aside area decreases under the scenario CROPS ONLY as well as under the scenario DECOUPLED. This is because relative incentive prices change to the disadvantage of voluntary set aside because of the equal distribution of direct payments over total area. Only under the ANIMAL ONLY scenario does the premium for voluntary set aside, cereals, and oilseeds increase and therefore lead to a higher share of area allocated to voluntary set aside.

Compared to model analyses presented in Section 3 of this paper ESIM-GAMS supports a strong decline of the cereal and oilseed area in roughly the same order of size as CAPRI, FARMIS, and GTAP. Although, ESIM-GAMS displays a stronger decline in oilseed area than other partial equilibrium models. Like CAPSIM, CAPRI, and FARMIS, ESIM-GAMS projects a significant decline in silage maize area. The decline projected with ESIM-GAMS, however, is 4 to 6 percentage points higher than in other analyses. The increase in fodder area projected with ESIM-GAMS is in line with projections performed with CAPRI and CAPSIM. With respect to voluntary set aside, ESIM-GAMS supports the decline simulated with CAPRI and thus stands in strong contrast to the analysis performed by the European Commission based on the former ESIM version. For pasture land, ESIM-GAMS projects a 5% increase, which is 3 percentage points greater than the projections performed with FARMIS, and in contrast with the decline of pasture area simulated with CAPRI. Like all other models which cover these products, ESIM-GAMS projects a decline in beef and sheep meat production. In total, the order of magnitude of the decline in red meat production is similar in CAPSIM, CAPRI, and ESIM-GAMS. As in the FAPRI analysis, ESIM-GAMS projects a stronger decline of sheep meat production than of beef production, whereas CAPSIM projects a much stronger decline of beef production and CAPRI a similar decline of beef and sheep meat production.

4.3 Sensitivity Analyses

ESIM-GAMS results depend crucially on certain model parameters for which the empirical foundation is limited. As described above these are i) own price and feed cost elasticities of supply of ruminants, ii) own and cross price elasticities of fodder and pasture area as well as other crops, and iii) own price and substitution elasticities of feed demand per unit of animal output. These parameters are therefore varied for the EU-15, the 10 new member states, and Bulgaria and Romania. This is done to cover the complete agricultural market of the EU-27 in 2011 because of potential cross effects, although we only look at results for the EU-15. Parameters for Turkey, the US and the rest of the world aggregate are not varied. This is because in total they dominate the world market price development, which is calibrated to FAPRI projections and should be similar among sensitivity analyses. Sensitivity analyses performed and their justifications are the following:

1. PASTURE: Pasture area allocation elasticities are multiplied by 4. Other area elasticities are adjusted to meet homogeneity and symmetry for the area allocation matrix. As discussed above the pasture area allocation elasticity is low (0.07) in the original elasticity set. Especially in the long run, conversion from cropland to pasture land is an option and this is why these crucial elasticities which restrict this conversion are raised. The calibration of the area allocation matrix to comply with the conditions of homogeneity and symmetry is done mechanically by minimizing the sum of the squared relative deviations of price elasticities from the original matrix. Own price elasticities are kept constant, as their empirical foundation is considered relatively good.
2. RUMINANT: All ruminant supply elasticities (with respect to own prices, cross prices, feed cost, other inputs) are multiplied by 2. No adjustment of other elasticities is necessary, as the ruminant supply matrix in ESIM-GAMS contains no cross price elasticities with respect to other products. Ruminant supply is often modelled as relatively inelastic in behavioural partial equilibrium models because of its linkage to area. This linkage, however, is explicitly modelled in ESIM-GAMS through the feed demand matrix. Therefore, higher supply elasticities may be suitable.
3. FEED: All feed component demand elasticities for ruminants are multiplied by 2. No other adjustments are necessary: matrices remain homogeneous and symmetric if all elasticities are scaled. This adjustment increases the substitution among feed compo-

nents with changes in relative prices. Under the decoupling scenario it is mainly the substitution between roughages and other feed which impacts on the results.

4. COMBINED: Combined elasticity changes from sensitivity analyses 1-3.

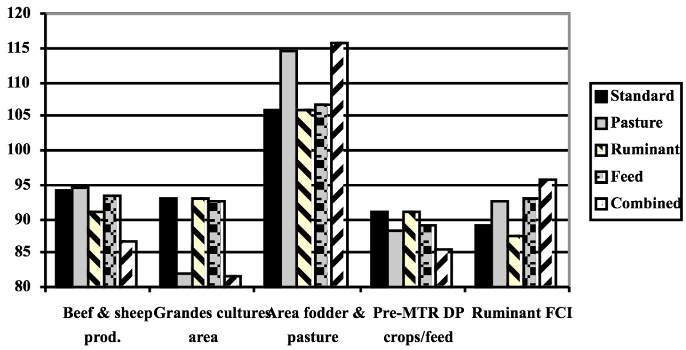
These sensitivity analyses are carried out only for the scenarios COUPLED and DECOUPLED. Results for major variables under the DECOUPLED scenario are, together with the results under the standard elasticity set, shown in Graph 1 relative to the respective scenario COUPLED which is set at 100. A first observation is that under all sensitivity analyses the direction of deviations from the scenario COUPLED is the same as under the standard elasticity set, although considerable deviations exist in some cases. Under the PASTURE elasticity set, which implies a lower price flexibility for grass, the FCI for ruminants falls less heavily than under the standard elasticity set. Accordingly, the share of pre-MTR DP crops falls more than under the standard elasticity set, which reflects the higher share of grass in ruminant rations. Most pronounced is the effect of higher area allocation elasticities for pasture on Grandes Cultures and fodder/pasture area. Grandes Cultures area falls by about 18% instead of 7%, and fodder and pasture area increases by almost 15% instead of 6% under the standard elasticity set. In spite of the higher FCI compared with the standard elasticity set, production of beef and sheep meat decreases equally under both elasticity sets. This is because the decrease of the incentive price with decoupling is more pronounced under the standard than under the PASTURE elasticity set.

Under the RUMINANT elasticity set, ruminant supply decreases more than under the standard elasticity set in case of decoupling. Accordingly, the FCI also declines more heavily due to less feed demand for nontradable feedstuffs. Effects on area and feed composition compared to the standard elasticity set are relatively small. Under the FEED elasticity set, feed composition changes more strongly in the direction of a higher share of fodder and grass in ruminant rations than under the standard elasticity set. As under the PASTURE elasticity set, higher price elasticities for grass (in this case at the feed demand side) result in a lower price flexibility and thus a less decreasing FCI compared to the standard elasticity set. Effects on area as well as beef and sheep meat production compared to the standard elasticity set are relatively small.

Under the COMBINED elasticity set the deviation of variables displayed in Graph 1 from the results under the standard elasticity set is strongest. The FCI decreases least compared to all other elasticity sets, which results from higher price elasticities for grass supply (area allocation for pasture) and feed demand for grass. The decline in Grandes Cultures area, the increase in pasture and fodder area and the decrease in beef and sheep meat production are most pronounced compared to all other elasticity sets.

As a final conclusion, the level of area allocation elasticities for pasture has by far the most significant impact on area allocation among the parameters looked at in this analysis, and also yields the highest deviation from results under the standard elasticity set in percentage points for all variables. For all variables the variation in elasticities results in the same direction or insignificant deviations compared to results under the standard elasticity set, except for the FCI. For the FCI, the effects of elasticity variation are in opposite directions: higher area allocation elasticities for pasture and higher feed demand elasticities per unit of animal output result in a less pronounced fall of the FCI with decoupling, whereas higher ruminant supply elasticities result in a more pronounced fall of the FCI.

Graph 1. Effect of the Scenario DECOUPLED Compared to the Scenario COUPLED under Various Elasticity Sets



Source: Own calculations.

5. Conclusions and Outlook

5.1 Impact of Decoupling on Area Allocation and Ruminant Production: Literature Review and ESIM-GAMS Results

All studies covered by the literature review in this paper as well as ESIM-GAMS uniformly project a decline of the cereal and silage maize (if included) area as well as ruminant production in the EU-15 in the course of the implementation of the partial decoupling of direct payments under the MTR. Only in the studies based on the FAPRI MODEL and AGLINK are the projected declines in cereal area small (about 1%); studies based on other models simulate a decline in the range from 4% (CAPSIM) to 7.5% (CAPRI). The decline of beef projected with AGLINK is negligible; all studies based on other models project a decline of beef production between 2.6% (FAPRI) and 10.8% (GTAP). For sheep meat, the projected decline varies between 3.1% (CAPSIM) and 8.5% (ESIM-GAMS). Also all analyses which cover this product category project an increase of fodder area for the EU-15 between 9.2% (CAPSIM) and 15% (CAPRI).

In contrast, model results are heterogeneous with respect to the direction of the decoupling effect on oilseed and pasture as well as voluntary set aside area in the EU-15. Studies based on CAPSIM and the old ESIM version project an increase of oilseed area between 1.5%

and 6%. Effects generated with the FAPRI MODEL and AGLINK are negligible. Other models project a decline in oilseed area between 4.8% (CAPRI) and 9.1% (ESIM-GAMS). Voluntary set aside is projected to increase by 20.4% in a study based on the old ESIM version. The two other models which cover this area use category project a decrease from 4.9% (ESIM-GAMS) to 7.9% (CAPRI). For pasture land a study based on CAPRI projects a decline of 1% whereas the analysis based on ESIM-GAMS estimates an increase of 5%. The study based on FARMIS, which simulates results only for Germany, estimates pasture area to increase by 1.9%.

5.2 Aspects of Modelling Decoupling

In order to model effects of decoupling, activities which have not been eligible for direct payments in the past become more important, because relative incentive prices between these products and the pre-MTR DP products change considerably. In addition, significant changes in feed rations for ruminants can be expected which cannot be depicted without including pasture land and fodder from cropland in simulation models. Most of the current simulation models, however, cover these product categories incompletely. To our knowledge, it is only CAPRI and ESIM-GAMS which include silage maize, fodder from crop area, and pasture area on a EU-15 level. A major drawback of modelling these products, especially beyond EU-15 borders, is poor data availability and quality.

From our model review we did not find a systematic effect of the model type (behavioural partial or general equilibrium model, or programming model) on model results (see Table 2). It is rather the assumptions about the effectiveness of direct payments on production (under Agenda 2000 as well as the MTR) which differ widely and drive model results to a large extent. Empirical studies on the production effects of various forms of direct payments are still limited, especially as no historical precedents for certain kinds of direct payments exist. Therefore, current simulation models tend to be based on rather rough ad hoc assumptions and the need for a better empirical foundation is obvious.

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 above has shown how strong area allocation responds to a change in these parameters. In addition, results generated with CAPRI, FARMIS, and ESIM-GAMS are very heterogeneous. A better empirical foundation of these parameters could therefore substantially contribute to more reliable model results.

A final aspect which has an impact on agricultural production but for which the empirical foundation is weak and simulation model results are heterogeneous, is the response of voluntary set aside to price and premium changes. For the first time, the MTR allows farmers to put the complete farm area into set aside without losing decoupled premiums, which may result in discontinuous shifts because farmers can escape a large part of their fixed cost by ending agricultural production. Aside from future observations, programming models on the regional or even farm level may be most suited to assess to what degree such processes will take place in the future.

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