FARM LEVEL EFFECTS OF EU POLICY LIBERALIZATION: SIMULATIONS BASED ON AN EU-WIDE AGRICULTURAL SECTOR MODEL AND A SUPPLY MODEL OF THE GERMAN AGRICULTURAL SECTOR

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Farm Level Effects of EU Policy Liberalization: Simulations Based on an EU-Wide Agricultural Sector Model and a Supply Model of the German Agricultural Sector

Abstract

The impact of sectoral or economy wide policy scenarios is often of strong political and public interest, yet it is a scientific challenge. When analyzing different levels of aggregation, the use of single models may not be sufficient. In this paper we establish an interface between the European Simulation Model (ESIM) and the Farm Modelling Information System (FARMIS). The linkage of the two models allows us to quantify adjustment processes both at the sectoral level and at the farm group level for the German agricultural sector. Different liberalization scenarios are presented and compared to a reference scenario. The abolishment of market price support leads to a reduction of farm incomes, especially if direct payments are also reduced. The low absolute level of return to labor, particularly in grazing livestock farms, suggests strong changes in farm structure as well as the farm input industry in Germany under the full liberalization scenario.

Keywords: Model Linkage, Policy Impact Assessment, Income Distribution

1 Introduction

The impact of sectoral or economy wide policy scenarios such as World Trade Organization (WTO) agreements or European Union (EU) policy reforms at the household or farm level is often of strong political and public interest, yet it is a scientific challenge. When analyzing different levels of aggregation, the use of single models may not be sufficient. Therefore – and due to enhanced hardware and software capacities – the linked application of models with a special focus has recently become more common (Brockmeier, Kleinhanss and Offermann 2008; Britz 2008; Banse and Grethe 2008). Nevertheless, the implementation of these integrated models is frequently carried out on an ad hoc basis (Offermann, 2008).

In the integration of simulation models, typically two different approaches are used. First, due to the difficulties involved in the simultaneous and consistent use of different types of models, combined model applications have often remained at the level of mapping results from models of a higher aggregation stage to a lower aggregation stage. Such an approach is used, for example, in mapping results from market models down to supply models of the agricultural sector (e.g. Cypris et al., 1997; Manegold et al., 1998). Also in a study by Banse and Grethe (2008) as well as the Scenar 2020 study (Nowicki et al. 2009), this approach is used for the combination of a general equilibrium (GE) with a partial equilibrium (PE) model. Second, some studies go further by aiming for a fully consistent set of solution variables via iteratively running models at different aggregation stages. This, however, is typically limited to the coupling of programming supply models with market models (Helming et al., 2006; Kuhlmann et al., 2006; Britz, 2008; Böhringer and Rutherford, 2006). In these cases, the relative supply response of the market model is effectively replaced by the relative supply response simulated by the programming model. In CAPRI (Britz, 2008), the market model is a PE model, in Helming et al. (2006) and in Kuhlmann et al. (2006) the market model is a modified GTAP version. Convergence of model results is reached by running models iteratively and mapping the vector of relative price changes from the market model to the programming model, as well as the vector of relative supply quantity changes from the programming model to the market model. Furthermore, these model linkages apply mechanisms to ensure that solution variables converge – also for cases in which implicit supply elasticities are higher than demand elasticities. A fully integrated approach of a PE model for dairy products and a GE model is presented in Grant et al. (2006). Jansson et al. (2008) present a full integration of CAPRI with a GE model.

In this paper we aim at full integration and establish an interface between the European Simulation Model (ESIM) and the Farm Modelling Information System (FARMIS). While quantifying effects of agricultural policies at the European level is straightforward in ESIM, it is not possible to measure impacts on intra-sectoral income distribution, an important driver for structural change, among farm groups. For this purpose, FARMIS is a powerful tool. Yet, FARMIS is unable to determine market effects of policy changes at the European level. The linkage of the two models allows us to quantify adjustment processes both at the sectoral level and at the farm group level for the German agricultural sector.

Section 2 of this paper presents ESIM and FARMIS as well as the approach for linking the two models. In section 3 scenarios are formulated. Section 4 explains the baseline results for 2015 as well as four policy scenarios which are compared to the baseline. Section 5 draws conclusions regarding the ESIM-FARMIS linkage and gives an outlook on envisaged further work.

2 Models and Model Linkage

2.1 ESIM

ESIM (Banse et al., 2010) is a comparative-static, net-trade, partial equilibrium model of the European agricultural sector. It depicts the EU-27 at the member state level with a strong focus on EU common agricultural policies. As a world model it includes all countries, though in greatly varying degrees of disaggregation. Except for the EU-27, some candidate countries and the US, all other countries are combined in an aggregate (the so-called “rest of the world”). Altogether ESIM contains 31 regions and 47 products and a high degree of EU policy detail including specific and ad valorem tariffs, tariff rate quotas, intervention and threshold prices, export subsidies, coupled and decoupled direct payments, production quotas and set-aside regulations.

All behavioural functions in ESIM are isoelastic. Supply at the farm level is defined for 15 crops, 6 animal products, pasture and voluntary set-aside. Human demand is defined for processed products and each of the farm products except for rapeseed, fodder, pasture, set-aside and raw milk. Some of these products enter only the processing industry, e.g. rapeseed, and others are used only in feed consumption, e.g. fodder or grass from permanent pasture. Processing demand is defined for raw milk (which is divided into its components, fat and protein), oilseeds and inputs for biofuel production. ESIM has a very detailed depiction of the complex system of substitution of land among different products and the relationship between ruminant production and agricultural area. The price formation mechanism in ESIM assumes an EU point market for all products except for non-tradables, for which the price results from a domestic supply and demand market clearing equilibrium at the EU member state level (raw milk, potatoes, fodder, silage maize and grass). Domestic price formation in the EU depends on endogenous world market prices, EU market and price policies, and the EU net trade position (Banse and Grethe, 2006).

2.2 FARMIS

FARMIS is a comparative-static process-analytical programming model for farm groups (Osterburg et al., 2001; Bertelsmeier, 2005; Offermann et al., 2005). Production is differentiated for 27 crop and 15 livestock activities. The matrix restrictions cover the areas of feeding (energy and nutrient requirements, calibrated feed rations), intermediate use of young livestock, fertilizer use (organic and mineral), labor (seasonally differentiated), crop rotations, and political instruments (e.g., set-aside and quotas). The model specification is based on information from the German farm accountancy data network covering about 11,000 farms, supplemented by data from farm management manuals. Key characteristics of FARMIS are: 1) the use of improved aggregation factors that allow for a representation of the sectors’ production and income indicators; 2) input-output coefficients which are consistent with information from farm accounts; and 3) the use of a positive mathematical programming procedure to calibrate the model to the observed base year levels. Prices are generally exogenous and are provided by market models. An exception to this applied to specific agricultural production factors, such as the milk quota, land and young livestock, where (simplified) markets are modeled endogenously, allowing the derivation of respective equilibrium prices under different policy scenarios. FARMIS uses farm groups rather than single farms to ensure the confidentiality of individual farm data, but also to increase manageability and the robustness of the model system when dealing with data errors that may exist in individual cases. Homogenous farm groups are generated by the aggregation of single farm data. Generally, stratification of farm groups is flexible and can be adjusted depending on the specific policy to be analyzed. Using appropriate stratifications allows for representation of the decision level of farms. One of the key functions of such a model is the analysis of the sectoral impacts of policy instruments applied at the farm level. For this study model specification is based on data from the accounting years 2003/04 and 2004/05. Farms were stratified by region, type and size, resulting in 597 farm group models.

2.3 ESIM – FARMIS Interface

2.3.1 General Approach

As a final step, we linked ESIM and FARMIS through the exchange of solution variables (vectors of price and yield changes from ESIM to FARMIS and vectors of quantity changes from FARMIS to ESIM) until both models converged on these variables in the analysis of joint scenarios. Before this final and rather mechanical procedure was pursued, considerable preparatory work was carried out.

1. Agreement on a wide range of policy parameters in the model base period (2004/2005 in ESIM and 2003/05 in FARMIS) was made, including policy parameters such as the degree of decoupling of direct payments and the level of the modulation rates.
2. For a first scenario (called “baseline”, see Section 3 below), policy assumptions as well as a wide range of parameters exogenous to both models were harmonized, including technological progress, GDP growth, changes of labour and capital costs.
3. Consistent product interfaces were defined. In some cases the product aggregation level is different in ESIM and FARMIS and decisions were made about adequately mapping solution variables between both models
4. For a first stand alone baseline scenario for 2015, a vector of price and yield changes was created by ESIM and implemented (as exogenous variables) into FARMIS. Afterwards, a detailed comparison and analysis of the reaction of both models to the same vector of price changes concerning area allocation for crops and supply for livestock products was conducted. For most of the commodities the models reacted in a similar way. Nonetheless, some divergences occurred which hinted at uncoordinated assumptions and different model specifications. This led to adjustments in the stand alone versions of the models (see Section 2.3.2).
5. Finally, the iteration process began. Based on the ESIM generated vector of price and yield changes, FARMIS calculated changes of area allocation for crops and supply changes for

livestock products. This vector was then given back to ESIM, which was fixed to the respective supply/area values in 2015, and used to create a new vector of price changes for FARMIS. Altogether three iteration steps were necessary to obtain convergence[1] between the models for the baseline scenario. As a final result, the German supply component in ESIM was replaced by FARMIS.

2.3.2 Model Harmonization

To understand the differences in supply response for both models and to reflect upon the validity of the underlying assumptions, a detailed ex-ante analysis (prior to the iteration process) of model results was carried out. The intention was to have a high degree of analogous model behaviour and to understand (and where appropriate remove) arising differences. For most of the products, the results were in agreement with each other even in the unmodified stand alone versions; however, at some points the investigation of different supply responses led to interesting findings and adjustments, some of which are mentioned below.

It turned out, for example, that different price elasticities of supply in intensive animal production (pig and poultry production) were assumed. In this case, it was simply decided to adopt the ESIM elasticities in FARMIS.

Treatment of the impacts of obligatory set-aside is different in the two models. In FARMIS, all formerly set-aside land can be used for production. In ESIM, only half of the land which was set aside in the base period can become productive again in scenarios with an abolishment of obligatory set-aside, accounting for the fact that marginal land is more likely to be set-aside. To match this effect on total production for the model linkage, the yield changes generated by ESIM were downwardly adjusted before being transferred to FARMIS. Therefore, it was taken into account that increasingly marginal land with lower than average yields will be used.

Another important issue was a divergence in the reaction of beef production caused by biophysical constraints implemented in FARMIS: The assumed increase of milk output per animal leads to a reduction of calf stocks in FARMIS because supply of milk is limited by quotas in the reference scenario. This, in turn, leads to a strong decline in beef production. In ESIM, beef and milk are modelled as complementary goods via cross price elasticities. Due to a drop in world market prices for dairy products, a declining milk price led “accidentally” to a moderate reduction in beef production; however, a technical link between milk output change per animal and beef production

[1] Convergence is referred to here as the fact that between two iteration steps, the difference in price and area (supply for livestock) changes is less than 1% and in the case of potatoes it is less than 5%.

was missing. To improve the depiction of beef supply in ESIM, such a link was implemented: In case of a binding quota, the beef supply curve is shifted depending on the assumed increase of milk output per animal.

Further differences between the models emerged when a scenario of the abolishment of the EU milk quota was run. In FARMIS, the new policy situation led to a 15% extension of the milk supply compared to the baseline scenario in 2015, while in ESIM milk supply increased only 3%. This spread could be reduced only partially prior to the iteration process by adopting the rates of technical progress in feed use from FARMIS in ESIM. Reasons for remaining differences are model inherent: Prices for roughages are endogenous in FARMIS and tend to fall more when direct payments are decoupled compared to ESIM. This leads to increases in the marginal return of milk production in FARMIS. Furthermore, FARMIS is more sensitive to changes in output increase per dairy cow of milk production because increases in dairy yield have no impacts on costs (with the exception of feed costs) in the model specification. With an assumed 26% increase of dairy yields in the baseline, dairy gross margins and quota rents in the FARMIS specification rise significantly. In this case, no further convergence of the stand alone versions was aimed at and was achieved via the iteration process.

3 Scenarios

We define a reference scenario ("baseline") and four policy scenarios for 2015. The baseline includes the full implementation of the 2003 Reform and the Health Check of the Common Agricultural Policy except for the abolishment of milk quotas. The baseline here refers to the Agenda 2000 situation, including a 2% quota increase in 2008 and the fat adjustment in 2009/10, resulting in a total increase of the milk quota by 4.75% compared to the base year. Based on the biofuel targets of the European Commission (2009) it is assumed that a biofuel share of almost 6% in total EU transport fuel consumption will be reached by 2015. Furthermore, sugar market reform is implemented and set-aside obligations are removed in 2008. The decoupling of direct payments takes place in 2006 because it is assumed that farmers already made their production decisions for 2005 when the Mid Term Review reforms were implemented. In addition, the baseline adopts constant levels of tariffs, export subsidies, tariff rate quotas (except for sugar) compared to the base situation, and the current system of intervention prices2.

Further assumptions are made for variables that are exogenous to the model, such as demographic developments, macroeconomic growth and consumer preferences (Eurostat, 2009; U.S. Census

[2] Maize, durum wheat and barley are excluded from intervention from 2009 on.

Bureau, 2009; USDA, 2009). Technical progress is implemented as an extrapolation of a historical trend of yield per hectare (FAO, 2009). For the international environment, we calibrate ESIM to FAPRI world market price projections (FAPRI, 2009) and assume no changes in external trade policies of the EU.

We furthermore define three liberalization scenarios: first, we simulate the full market liberalization of EU agricultural policies (i.e., the abolishment of all price policies) and a cut in direct payments by 50% ("MPS & 50% DP"). To single out the effects of different policy instruments, we analyze the isolated effects of the abolishment of price policies in a second scenario ("MPS") and the reduction of direct payments by 50% ("50% DP") separately in a third scenario. The full market liberalization of the European agricultural sector implies the abolishment of all intervention prices, tariffs, quotas and subsidies. That means that in 2015, the EU price level equals the world market price for tradable products. Direct payments are cut by no more than 50% because a higher reduction would lead to strong supply changes in FARMIS, which are likely to be dampened in reality by structural changes within the farming sector as well as other components of the value chain such as the input industry. These changes, however, are not depicted in the current model versions.

Finally, we define a scenario which does not change any policies compared to the baseline except an abolishment of the EU milk quota ("Quota Exit"). A question of special interest is: To what extent does an abolishment of the EU milk quota result in an increase in the German milk supply?

4 Results

4.1 Integrated Baseline

The overall trend of world market prices in the baseline is based on projections published by FAPRI for 2015 (FAPRI, 2009). The development of world market prices between 2005 and 2015 is characterized by diverging developments of crop prices and livestock prices (see Figure 1). While real crop prices increase over time, livestock prices decline in real terms until 2015. The price index of all farm product shows a slight increase which indicates that crop prices more than outweigh falling livestock prices.

[insert Figure 1]

For the EU, a similar outcome occurs (see Figure 2). In this analysis the two latest member states, Romania and Bulgaria, are not included because they joined the EU in 2007 which is after the first year (2005) of the baseline. The quantity weighted index of crop prices shows an increase of 8% compared to the base year while the price index for livestock products decreases by almost the same amount. Effects are less strong compared to the world market due to market policies carried out by the EU. The supply of crops and livestock products increases until 2015 in the EU-25.

[insert Figure 2]

In Table 1, price changes and corresponding quantity/supply changes for single products of the German agricultural sector are displayed. Columns 1-3 refer to the baseline development of ESIM and FARMIS as stand alone models (before the iteration process). Crop prices follow the world market trend and increase significantly in 2015 compared to 2005. Together with the abolishment of obligatory set-aside in 2008, this leads to a strong extension of area for grand cultures. In the stand alone version of FARMIS this effect is even stronger than in ESIM. Milk supply increases 5% in both models, which is the effect of a slight expansion of the EU milk quota. At the same time, milk prices decline by 24% compared to 2005. Besides the extended milk quota, the driving forces here are mainly the world market price for dairy products and the output increase of milk per animal. The latter also causes a decline in beef production, as with higher milk output per animal less milk cows are needed to fulfil the milk quota and thus calf production is reduced.

The remaining differences in supply response between both models were dealt with by the iterative procedure described under Section 2.3, resulting in a convergence of model results after three iterations. Results are presented in the last four columns of Table 1. For the majority of products, Germany is a small country inside the EU. This means that (EU determined) prices do not react on relatively small changes of the supply in Germany. For these products, quantity changes determined in FARMIS do not generate any relevant price feedback. As a result, after one iteration step convergence is already reached. In contrast, the model linkage is rather relevant for non-tradable goods or goods produced in Germany that play a big role in the total EU supply. An example for the latter is rye: a 4% area extension in 2015 results in a 2% decrease in prices. Potatoes and raw milk are the only two farm products except fodder that are modelled as non-tradable in ESIM and at the same time are relevant for the model linkage. While in case of potatoes a strong price effect occurs which counteracts the area extension, there are no effects in the supply of milk. This is due to EU milk quota restrictions. Here, the iteration process would become relevant in case of a non-binding quota.

[insert Table 1]

In the final baseline scenario, area is reallocated to a great extent from set-aside to crop production (even more than obligatory set-aside had accounted for before its abolition in 2008). The effect is clearly stronger in FARMIS which reacts more price sensitive than ESIM. For beef supply, biophysical restrictions are crucial for the decline in quantity. Milk supply is determined by the quota.

4.2 Policy Scenarios Compared to the Baseline

4.2.1 Liberalization Scenarios

In this chapter, three different liberalization scenarios are presented and compared to the reference scenario. We simulate the full market liberalization of EU agricultural policies, i.e. the abolishment of all price policies, and a cut in direct payments by 50% ("MPS & 50% DP"). Furthermore we analyze the effects of an abolishment of price policies ("MPS") and a reduction of direct payments by 50% ("50% DP") separately (see Chapter 3).

First, results for the European level are presented. Here the analysis refers to outcomes of the ESIM model. Figure 3 shows that the abolishment of price policies has much stronger effects on market development than a cut in direct payments. Overall, prices for farm products decline by almost 30%. Furthermore, supply indices for crops decrease by 14% and for livestock by 19%. In the "50% DP" scenario, only minimal differences compared to the baseline can be recognized. Moreover, one can conclude that effects of removing price policies are not boosted by an additional cut in direct payments.

[insert Figure 3]

Table 2 presents results for the scenario "MPS & 50% DP" for Germany. The first three columns again refer to the stand alone results of ESIM and FARMIS and the last two columns refer to the version after iteration. In this table, on the other hand, numbers indicate differences compared to the baseline and not to the base year (2005). One of the most remarkable changes appears in the case of sugar. With total market liberalization in ESIM, sugar production is abandoned in 2015. With current model specifications in FARMIS, sugar beet will not drop out of production when it was produced in the base year. Because of time constraints preventing the adjustment of model behaviour in FARMIS, we leave sugar out of the iteration process and assume the ESIM solution.

Among the other field crops in ESIM, roughage area declines quite heavily compared to the reference scenario, while the decline of area is more equally distributed (except for corn) in FARMIS. Another notable difference is the development of set-aside land under market liberalization. In FARMIS set-aside land increases 34% while it decreases 4% in ESIM. In ESIM the 50% cut in direct payments has strong negative effects on set-aside area because area allocation depends on relative incentive prices, which comprise direct payments as well as market prices. They fall strongly for set-aside with the reduction of direct payments, as incentive prices do not include any market prices. Incentive prices of other crops, in contrast, decline less in relative terms because they comprise market prices. In FARMIS production is determined by rates of marginal return. A cut in direct payments reduces the marginal return of all activities by the same amount. Additionally, the abolishment of price policies reduces the marginal return of crops, which in turn makes set-aside area relatively favorable.

[insert Table 2]

Prices for animal products decrease quite a lot compared to the baseline. Beef prices drop by more than 50% because of the tariff removal, causing a huge decline in supply. This explains the strong changes of roughage area in ESIM. In this scenario the EU milk quota is abolished. In ESIM this leads to a decline in milk production while in FARMIS this leads to an increase of 5%. This difference stems from significantly increasing dairy gross margins in FARMIS due to the reasons discussed in Section 2.3.2 above. After iteration the change in supply is once again at the level it was in the baseline with a binding quota. For the other products, the price levels are again not strongly affected by the changes in German supply, except for rye. No fully consistent livestock balances could be achieved in this scenario in FARMIS. Despite lowering the calf prices to zero, demand for calves was smaller than supply due to very low beef prices. This could imply either rising exports of live calves (which seems unrealistic given the EU-wide reduction of beef production) or the utilization of calves in low value products.

[insert Table 3]

The other two scenarios are presented in Table 3 in a more aggregated style. In the scenario “MPS” only price policies are abolished. Direct payments are still paid to farmers with the “normal” rate of modulation. Again, the cut in direct payments does not have strong effects on market development; however, compared to the scenario “MPS & 50%” more area is kept in production and demand for set-aside area is higher in the scenario “MPS”. In a situation where current price policies are kept constant, a cut in direct payments has less effects than in a totally liberalized market because in the former direct payments are not a crucial factor in the production decision as marginal returns are in general higher. Milk supply is not changing in any of the three scenarios compared to the baseline. In the two scenarios that include an abolishment of price policies, it is a coincidence that the emerging market price equals the shadow price that was determining supply in a situation with quota restrictions. Again, this is conditional on the assumption of yield increases for milk.

4.2.2 Quota Exit Scenario

Besides the three liberalization scenarios presented in Chapter 4.2.1, we defined a scenario which does not change any policies compared to the baseline, except an abolishment of the EU milk quota (“Quota Exit”). In the aggregate EU-25 this leads to minimum changes in area allocation (less than 1% for all crops) compared to the baseline. Mentionable changes occur only in the dairy sector. Total supply of raw milk and dairy products increases (e.g. raw milk increases 3.44% and cheese increases 2.91%).

In Germany the milk quota is still fulfilled in 2015 under baseline assumptions. With an abolishment of the quota production will increase. In our scenario, the stand alone version of ESIM predicts an increase of production by 2.6% and a drop in price by 4% compared to the baseline. For the same price, FARMIS calculates a 16% increase of milk supply. This effect goes back to the quite strong assumption of a 2.1% annual growth in milk output per animal which is implemented in both models. After iteration, milk supply in Germany is 8.5% higher and prices are 8.8% lower than in the baseline scenario. Because of the strong effects that are caused by the assumption on output increase per animal, a sensitivity analysis was performed. With an assumed annual output increase per animal of 1.1% (which is 1% less than before), supply increases 2.7% less than it did in the baseline (where the milk quota was still constraining production). This shows how much the models depend on the assumption of rates of annual output increases. So far, this analysis quantified the effects of policy scenarios for Germany as an aggregate. A next step is to analyze at a deeper aggregation level and study effects of different policy scenarios on the distribution of farm income among different farm groups.

4.2.3 Income Distribution Effects

To assess the impact of the different scenarios on the farm income of different farm groups, two indicators were calculated based on FARMIS for each of the fully integrated scenarios. Farm net value added (FNVA) measures the return to land, labor and capital resources irrespective of their ownership. As labor intensity may differ between farms and scenarios, FNVA is shown per unit of farm labor, measured in agricultural work units (AWU). Family farm income provides information on the return to land, labor and capital resources owned by the farm family, as well as the entrepreneurial risk. Due to the dominance of legal farms especially in eastern Germany, family farm income plus wages per AWU was used as an indicator for return to labour.

Generally, average income in the baseline is substantially higher than in the base year (FNVA/AWU +30 % on average, Table 4), due to increasing prices for crop products, technological progress, and the continuing exit of mostly small farms from the sector. The last-mentioned in particular is very important for the development of the average figures.

The reduction of direct payments (50% DP) reduces FNVA/AWU by 14 % on average (Table 4), with much higher effects on small arable farms and other grazing livestock farms, for which direct payments contribute a large share of income. The impact on family farm income is often much smaller (Table 5), as – according to the model results – the reduction of direct payments reduces land rental prices. The difference of the impact of a reduction of direct payments between the two income indictors is especially large for farms with a high share of rented land (e.g., large arable farms). The quota exit scenario mostly affects dairy farms. Furthermore, in this scenario all farm groups face a reduction of their income, which highlights the fact that the reduction in milk prices cannot fully be compensated for by the expansion of milk production and the elimination of quota costs.

The abolishment of market price support leads to a strong reduction of farm incomes, especially if direct payments are also reduced (MPS & 50 % DP). The low absolute level of return to labor, particularly in grazing livestock farms, suggests strong changes in farm structure as well as the farm input industry in Germany under the MPS & 50 % DP scenario. The medium-term supply projections of ESIM and FARMIS for this scenario should be interpreted against the background of the low-income levels that indicate that significant structural change can be expected, which is not depicted in the current model specifications.

[insert Table 4]

[insert Table 5]

5 Conclusions and Outlook

In this paper we replace the supply component of the EU-wide agricultural sector model ESIM by the supply model of the German agricultural sector FARMIS. The linkage is carried out via an iterative process in which a consistent outcome of the models is achieved. The most important step in the linking process was the ex-ante (before the iteration) analysis of model reaction to the same scenario. In this step, many details and specifications could be clarified and harmonized which made a consistent use of the models possible at later stages.

Looking at the results of the integrated baseline, one can conclude that the iterative process mostly is relevant for non-tradable goods and such goods for which the analyzed member state is a large country and thus quantity changes affect the price level. In case of Germany, scenarios regarding an abolition of the EU milk quota bear a high potential for this kind of analysis. Another advantage of the joint use of the models is that research questions affecting different levels of aggregation can be addressed. Effects of liberalization scenarios can be examined in greater detail compared to stand alone models.

The achieved model linkage between FARMIS and ESIM opens a wide field of further research questions to be examined. A detailed analysis of policy scenarios for the distribution of farm income among different farm groups (according to specialization, size and region) which show that the degree to which farm groups are affected by liberalization of agricultural policies differs substantially, can be carried out by a joint use of the models. Furthermore, for scenarios which strongly affect farm incomes, an extension of the FARMIS model to explicitly and endogenously account for farm exits is envisaged.

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Table 1: Price and Area/Quantity Changes (in %) in the Baseline (2015 Compared to 2005) for Germany Before and After Iteration

Products	Before iteration			After iteration			
	Change in price	Change in area/supply in ESIM	Change in area/supply in FARMIS	Change in price		Change in area/supply	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	% comp. to 2005	% comp. to 2005	% comp. to 2005	% comp. to 2005	% points difference with (1)	% comp. to 2005	% points difference with (2)
Crops (area)							
Wheat	18	4	3	18	0	3	1
Barley	44	15	21	44	0	20	5
Corn	26	10	21	26	0	21	11
Rapeseed	33	28	36	32	1	36	8
Rye	47	12	19	45	2	16	4
Sugar [a]	-7	-35	-40	-7	0		
Other Grains [b]	32	9	2	32	0	3	6
Potatoes	-22	-14	-4	-30	8	-11	3
Fodder [c]	-	2	8	-	-	9	7
Silage Maize	-	-17	-23	-	-	-22	5
Grass	-	0	0	-	-	0	0
Set-aside	-	-73	-90	-	-	-90	17
Animal products (supply)							
Pork	2	-1	2	1	1	2	3
Beef	8	-9	-11	8	0	-11	2
Milk	-24	5	5	-24	0	5	0

[a] Sugar was excluded from the iteration process because of different implementations of the EU sugar quota in the models.

[b] Other grains: triticale and oats.

[c] Fodder: other fodder except silage maize and grass.

Source: Own calculations.

Table 2: Price and Area/Quantity Changes (in %) in the MPS & 50% DP Scenario (2015 Compared to the Baseline in 2015) for Germany Before and After Iteration

	Before iteration			After iteration			
	Change in price	Change in area/supply in ESIM	Change in area/supply in FARMIS	Change in price		Change in area/supply	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	%	%	%	%	% points difference with (1)	%	% points difference with (2)
Crops (area)							
Wheat	-8	0	-3	-8	0	-2	2
Barley	-8	0	-3	-7	1	-3	3
Corn	0	5	6	0	0	6	1
Rapeseed	-6	6	-4	-6	0	-3	9
Rye	-9	0	-5	-7	2	-3	3
Sugar [d]	-70	-100	4	-70	0		
Set-aside	-	-4	34	-	-	30	34
Fodder	-	-21	-4	-	-	-7	14
Silage Maize	-	-22	-7	-	-	-9	13
Animal products (supply)							
Pork	-16	-20	-6	-16	0	-7	13
Beef	-55	-50	-27	-55	0	-27	23
Milk	-21	-7	5	-27	6	0	7

[d] With an abolishment of all price policies, sugar will not be produced in the EU in 2015 according to ESIM. In FARMIS a crop cannot drop out of the production process when it was produced in the base year due to model specifications. Therefore, some sugar is produced in the EU in 2015 even without market protection.

Source: Own calculations.

Table 3: Changes (in %) Compared to the Baseline in Different Liberalization Scenarios for Germany, Integrated FARMIS-ESIM Model

	MPS & 50% DP	MPS	50% DP
	(1)	(2)	(3)
Crop production [e]	%	%	%
Crop area	-3.0	-1.0	0
Crop price	-22.4	-22.9	-0.5
Crop production value	-20.6	-19.5	-0.5
Set-aside area	30.0	58.0	0
Roughage area	-3.0	-2.0	0
Animal production			
Animal production quantity	-7.9	-7.9	-1.3
Animal product price	-28.5	-28.6	0.3
Animal product production value	-27.1	-26.6	-0.8
Beef supply	-27.0	-27.0	0
Milk supply	0	0	0

[e] All scenarios were run under the assumption that sugar is still produced in 2015. Otherwise inconsistencies would occur when area and production value are compared.

Source: Own calculations.

Table 4: Farm Net Value Added per Agricultural Work Unit under Different Scenarios

	Base-year	Baseline	Baseline[f]	MPS & 50% DP	MPS	50% DP	Quota exit
	€ / AWU	% change to base-year	€ / AWU	percent change to baseline			
All farms	28,066	30%	36,379	-55%	-41%	-14%	-4%
Arable	32,574	35%	44,100	-50%	-33%	-16%	1%
Grazing livestock	25,241	33%	33,451	-73%	-58%	-15%	-11%
Mixed	24,328	38%	33,543	-55%	-35%	-19%	-6%
Pig+poultry	34,749	33%	46,119	-40%	-31%	-10%	-1%
Arable farms							
Small	12,761	37%	17,468	-60%	-34%	-25%	1%
Medium	35,044	21%	42,321	-48%	-31%	-17%	1%
Large	46,475	26%	58,486	-43%	-25%	-18%	0%
Dairy farms							
Small	14,751	50%	22,079	-77%	-58%	-19%	-15%
Medium	29,725	27%	37,706	-74%	-59%	-15%	-15%
Large	37,925	21%	45,860	-68%	-56%	-14%	-15%
Other grazing livestock farms	21,594	19%	25,716	-78%	-48%	-27%	9%

[f] in 2004 prices

Source: Own calculations.

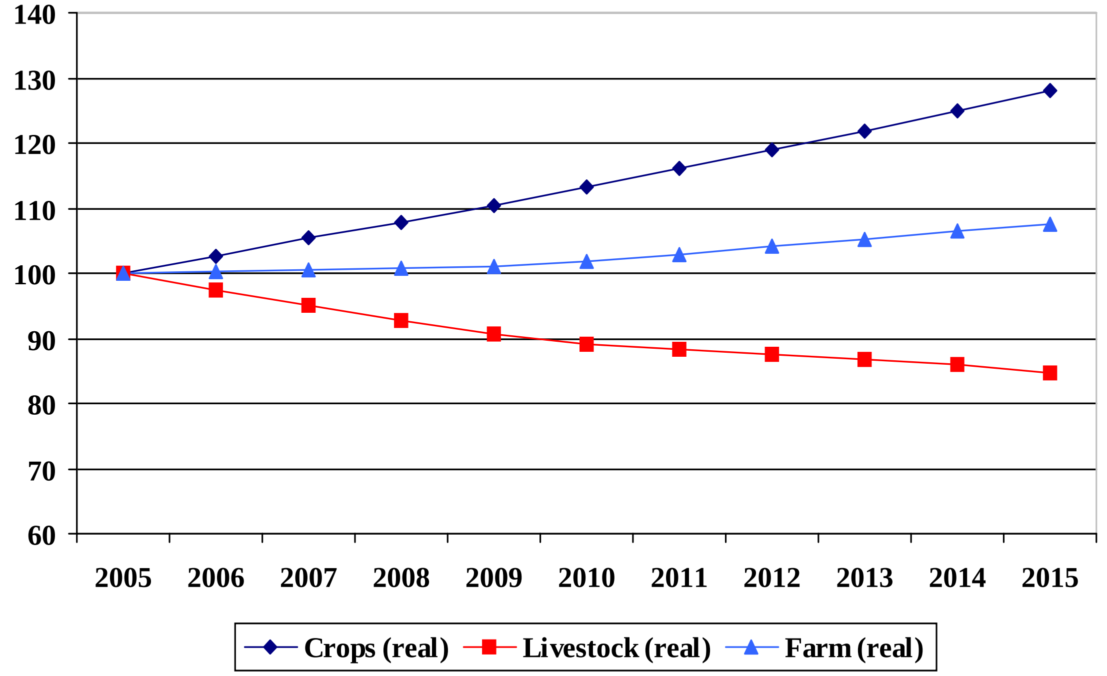
Table 5: Family Farm Income plus Wages per Agricultural Work Unit under Different Scenarios

	Base-year	Baseline	Baseline[g]	MPS & 50% DP	MPS	50% DP	Quota exit
	€ / AWU	% change to baseyear	€ / AWU	percent change to baseline			
All farms	20,512	25%	25,598	-50%	-42%	-7%	-6%
Arable	22,100	37%	30,293	-40%	-30%	-8%	-1%
Grazing livestock	18,676	19%	22,199	-80%	-70%	-9%	-13%
Mixed	16,504	29%	21,371	-56%	-45%	-8%	-13%
Pig+poultry	25,516	37%	35,029	-40%	-35%	-4%	-2%
Arable farms							
Small	7,744	47%	11,372	-64%	-42%	-19%	0%
Medium	24,338	25%	30,494	-45%	-35%	-8%	0%
Large	31,918	24%	39,700	-34%	-27%	-6%	-1%
Dairy farms							
small	11,215	46%	16,403	-82%	-67%	-13%	-18%
medium	22,079	16%	25,613	-81%	-73%	-8%	-17%
large	28,380	3%	29,230	-74%	-70%	-5%	-16%
Other grazing livestock farms	14,630	1%	14,819	-95%	-73%	-17%	14%

[g] in 2004 prices

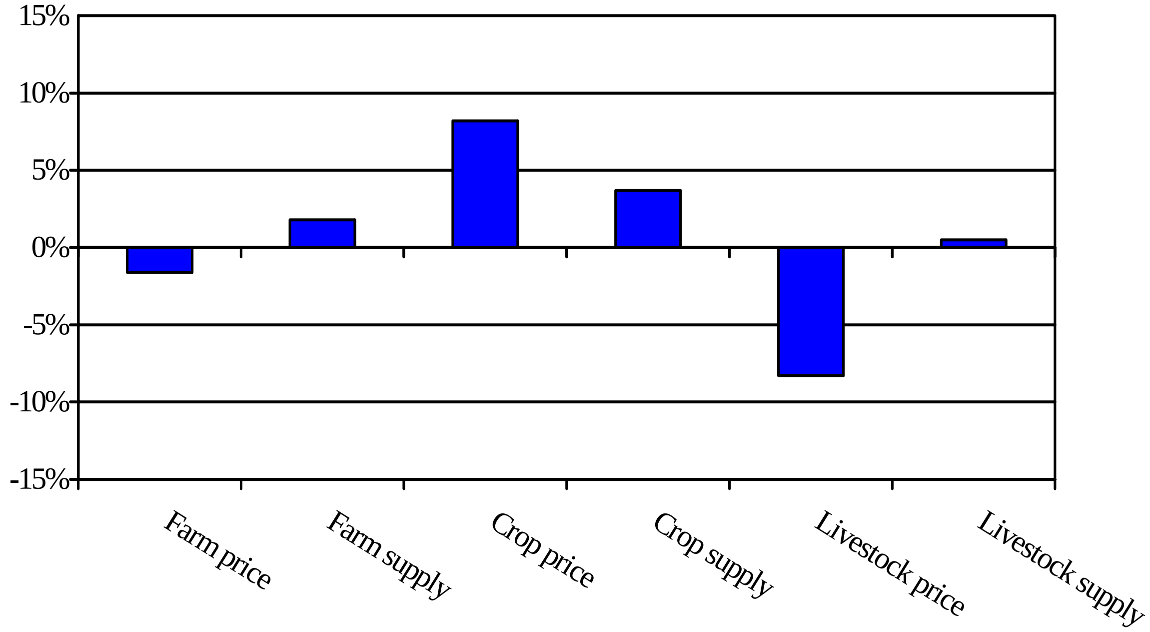
Source: Own calculations.

Figure 1: Real World Market Price Indices for Agricultural Products, 2005-2015



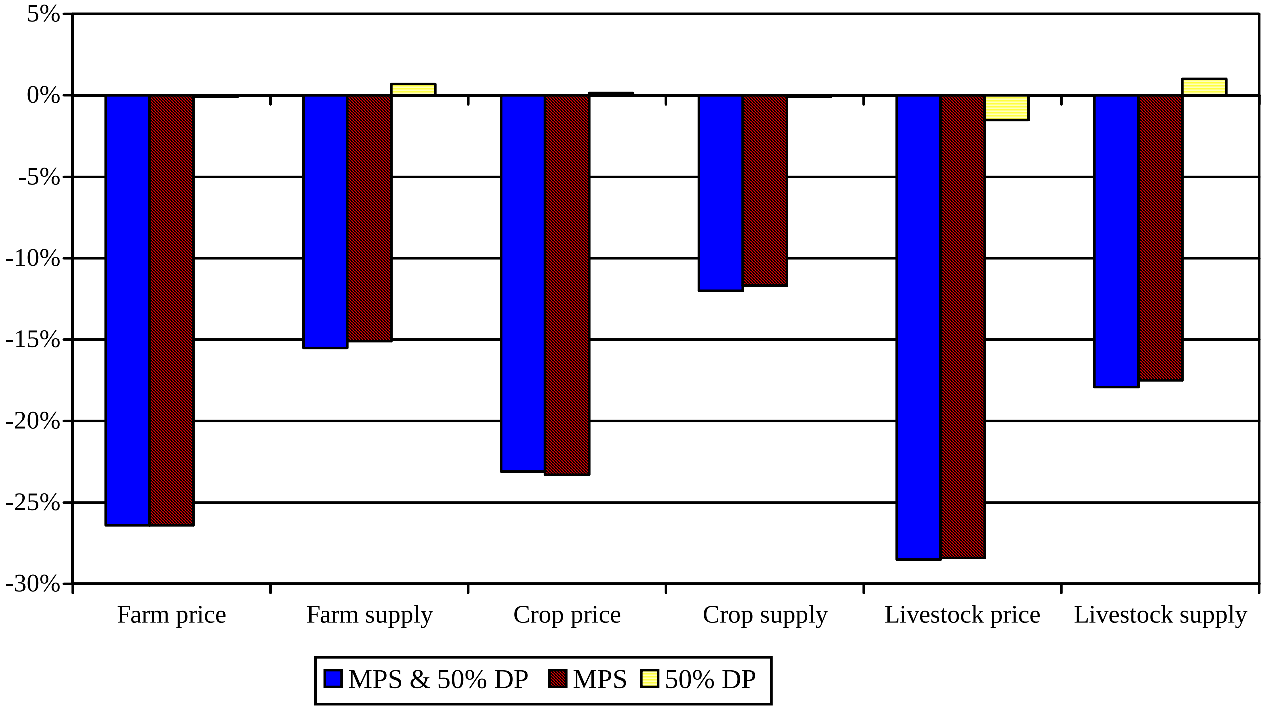
Source: Own calculations.

Figure 2: Development of EU-25 Indices of Agricultural Prices and Production, 2005-2015



Source: Own calculations.

Figure 3: Scenario Results Relative to the Baseline – EU-25 Indices of Agricultural Prices and Supply Quantities (2015)



Source: Own calculations.