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Impact of the CAP reform on agricultural production in four different European regions

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Abstract

The impact of the European Common Agricultural Policy (CAP) reform is of great interest with respect to the development of the agricultural sector. The Agro-eConomic pRoduction model at rEgional level (ACRE) was used to simulate the CAP reform 2003 up to 2013 for four European regions: England, Baden-Württemberg, Bavaria and Austria. The selected regions range in their production intensities from more intensive arable farming in England to more extensive grassland farming in Austria. Nomenclature of Territorial Units for Statistics 3 level (NUTS3) districts were clustered to 'regional farm clusters' representing different land use patterns within the regions. ACRE calculated the impact of the CAP reform 2003 under different price scenarios for agricultural products. The development of selected indicators was analysed to investigate the reaction of economic and environmental impacts as well as changes in agricultural production of the 'regional farm clusters'.
The results show, that CAP changes affect agricultural production more than changes in prices for agricultural products. The agricultural income decreased in regional farm clusters with a high share of arable crop production and increased in grassland farming clusters. Agricultural production tends to get more extensive and nitrogen input is reduced. Pessimistic and optimistic price scenarios change the impact of CAP reform slightly.

1 Introduction

In Luxembourg on June 26, 2003, EU farm ministers adopted a fundamental reform of the Common Agricultural Policy (CAP), which completely changed the way the EU supports its farm sector (EC, 2003).

Three key elements of the reformed CAP 2003 which are significant for agricultural production are: decoupling of payments, cross-compliance and modulation. Decoupling of payments means that single farm payments are paid to EU farmers according to the Single Payment Scheme, independent from production. Limited coupled elements may be maintained to avoid abandonment of production. Cross-Compliance implies that the decoupled payments are linked to environmental, food safety, animal and plant health and animal welfare standards, as well as to the requirement to keep all farmland in good agricultural and environmental condition. Modulation includes a reduction of direct payments for bigger farms to finance the new rural development policy (EC, 2003).

The impacts of the reformed CAP and possible changes in agricultural market conditions are the focus of interest with respect to the development of agricultural income, agricultural production and environmental effects. These topics were investigated by several impact studies for Member States of the European Union (e.g. EC, 2003; OECD, 2003), as well as for specific regions (e.g. Lobley and Butler, 2004; Roeder et al., 2006). As tools for simulation of policy impacts on agricultural markets and production, several agricultural models were developed and partially reviewed (Balkhausen et al, 2008; Kuhlmann and Möller, 2006; Garforth and Rehman, 2005).

This study presents the results of model calculations for the CAP reform 2003 up to 2013 under different price scenarios for agricultural products in four European regions: England, Baden-Württemberg, Bavaria (both in Southern Germany) and Austria. Section 2 presents the model ACRE, which was used for the scenario calculations and the underlying scenario assumptions. The analysis of the results is described in Section 3, followed by a validation of the results in Section 4, a summary of the results and then concluding remarks in Section 5.

2 Method: Model and scenarios

2.1 The model

For the simulation of the CAP reform 2003 the regional model ACRE (Agro-eConomic pRoduction model at rEgional level) was used. ACRE is a comparative static optimization model which maximizes total gross margin by calculating the optimal combination of production activities for each Nomenclature of Territorial Units for Statistics 3 level (NUTS3) district. The production factors of each district are aggregated and farming in each district is represented by a single farm (regional farm approach). The shortest simulation period is one year. ACRE has been calibrated on statistical data at NUTS3 level. For calibration the Positive Mathematical Programming (PMP) approach was used, which was first published by Howitt (1995) and extended by Röhm and Dabbert (2003). The extended version distinguishes between main (or total) activities (representing e.g. crop activities) and variant activities (representing e.g. crop production intensities). Hence, ACRE considers two production variant activities (intensive variant activities and extensive variant activities) in the optimization process. Overall, agricultural production includes up to 24 food and non food crops and 15 production processes for livestock. Production of energy crops is not included. ACRE is based on a process analytical approach. Cash crops or fodder crops for livestock production can be produced. The animals produce manure which is used for fertilization in crop production. Mineral fertilizer and feed concentrates can be purchased. Trade activities between the districts are not defined. Further details of ACRE-Danube are published in Winter (2005) and Henseler et al. (2006).

ACRE was developed within the project GLOWA-Danube[1] as a tool to simulate the impact of changes in climate and socio-economic conditions on farming in the Upper Danube catchment area. This model region includes 74 districts (on NUTS3 level) of which 16 districts are located in Western Austria, 43 in Bavaria (Southern Germany) and 10 in Baden-Wuerttemberg (South-West Germany).
For the EU project RIVERTWIN-Neckar[2] ACRE was applied to the Neckar river basin, including 30 districts of Baden-Württemberg (South-West Germany). The model was recently extended to complete Baden-Württemberg as 'ACRE-BW'.
In an initial run ACRE was tested for transferability to England. This run only provided satisfactory results for a few NUTS3 districts in England (Henseler, 2006).
Table 1 shows the versions of the ACRE model used for the calculations presented here, as well as the number of the modelled districts. Obviously the models represent the complete administrative regions (i.e. the Federal States) with a varying number of districts. While Baden-Württemberg and Austria are represented by a relatively high number of modelled NUTS3 districts, ACRE-England represents only 17 (20%) out of the total number of districts (93).

Table 1. Overview of the ACRE versions used in this study

Model name	Project region	Administrative region (number of districts)	Modelled districts	Publications
ACRE-England	England	England (93)	17	Henseler (2007)
ACRE-BW	Baden-Württemberg	Baden-Württemberg (44)	44	--
ACRE-Danube	Danube river basin	Bavaria (96)	48	Winter (2005)
	Danube river basin	Austria (36)	16	Wirsig et al. (2007)

2.2 Scenarios

2.2.1 CAP reform scenario

The CAP reform 2003 scenario was calculated for the four selected regions for the year 2013, with the subsidies being those expected for this final state of the reform. Decoupled subsidies were assumed, which were only partially coupled to crops such as protein crops and renewable resource crops. Table 2 presents the assumed subsidies in the study regions in the reference scenario year 2000 under Agenda 2000 and in the CAP reform 2003 scenario. For England, the payments of the second pillar were not considered because the data researched provided too little information to model the agri-environmental measures (AEM) for England.

[1] The project GLOWA-Danube is funded by the Federal Ministry of Education and Research (BMBF). URL: www.glowa-danube.de
[2] The project RIVERTWIN (A Regional Model for Integrated Water Management in Twinned River Basins) was funded by the European Commission (Contract-No. GOCE-CT-2003-505401). URL: www.rivertwin.org.

Table 2. Payments of the first and the second pillar in the reference situation in 2000 (Agenda 2000) and the CAP reform scenario in 2013

	England [a]		Baden-Württemberg [b]		Bavaria [b]		Austria [c]	
Scenario year	2000	2013	2000	2013	2000	2013	2000	2013
	EUR ha^{-1}							
1st pillar payments								
Cereals	371	300	302	302	325	340	309	--*
Grain maize	319	300	427	302	441	340	309	--*
Legumes	463	356	384	358	406	396	382	56*
Oilseeds	534	354	499	347	507	385	437	45*
Root crops	0	300	0	302	0	340	0	--*
Special crops	0	300	0	302	0	340	0	--*
Silage maize	319	300	427	302	441	340	309	--*
Clover	0	300	0	302	0	340	0	--*
Set aside	437	300	310	302	329	340	309	--*
Intercrops	--	--	--	392	0	90	109	109
Intensive grassland	250	300	30	302	95	390	65	110
Extensive grassland	250	300	50	302	100	440	36	66
Fattening bulls (EUR head^{-1})	170	0	160	0	160	0	160	0
2nd pillar: Agri-Environmental measures [d]								
Intensive grassland	--	--	30	40	95	50	65	110
Extensive grassland	--	--	50	90	100	100	36	66
Intercrops	--	--	110	90	0	90	109	109

In Austria regional farms are assumed to receive payments for utilized agricultural area according to the historical payment scheme. In this study the regional farm clusters receive: 262 EUR ha-1 in cash crop cluster (CC), 90 EUR ha-1 in fodder crops cluster (FC), 56 EUR ha-1 in the intensive grassland cluster (IG), 19 EUR ha-1 in the extensive grassland cluster (EG). Source: Own calculations based on … a) … DEFRA, 2007; Holland, 2007; b) … BMVEL, 2005; KTBL 2001; Wirsig (in. prep). c) … BMLFUW, 2001, 2003; d) … Wirsig (in. prep).

2.2.2 Price scenarios

In order to investigate the impact of changing markets, three price scenarios were simulated: a 'baseline price scenario', a 'pessimistic price scenario' and an 'optimistic price scenario'.

The 'baseline price scenario' assumes the perpetuation of the market prices of the reference year 2000. Thus, the impacts observed in this scenario are fully caused by the agro-political conditions of the CAP 2003 reform. The pessimistic price scenario was taken from the study of Gömann et al. (2005), who derived this scenario from a study of the Mid-Term Review (Gömann et al., 2005: 39). In this scenario the prices of several products were assumed to be decreasing. The price changes of the optimistic price scenario were calculated from the agricultural product prices of the year 2006 and 2007 in Germany and indicate an increase in the prices of most of the agricultural products.

The prices of the reference scenario, as well as the relative changes of the prices in the three price scenarios, are presented in Table 3.

Table 3. Reference prices and prices of the different price scenarios in 2013 in the investigated regions

	Reference scenario year 2000				Price scenario		
					Baseline	Pessimistic g)	Optimistic h)
Region[a]	E d)	BW e)	BY f)	AT f)	E, BW, BY, AT		
	EUR dt^{-1}				% of reference price		
Winter wheat	11.7	11.6	12.2	12.2	100	101.5	122
Spring wheat	11.7	12.2	12.2	12.2	100	101.5	101
Winter barley	12.0	11.3	11.0	11.0	100	96.0	108
Spring barley	12.0	13.6	13.3	13.3	100	96.0	123
Rye	10.0	10.4	11.7	11.7	100	81.0	119
Oat	10.0	10.4	9.5	9.5	100	100	109
Triticale	10.0	0.0	11.4	11.4	100	100	109
Grain maize	12.6	12.6	11.6	11.6	100	100	122
Legumes	11.1	11.1	15.7	15.7	100	100	135
Winter rapeseed	18.0	25.0	21.4	21.4	100	100	122
Sunflowers	18.0	22.4	19.1	19.1	100	100	119
Potatoes (late)	10.5	7.8	0.0	0.0	100	100	181
Potatoes (early)	10.5	0.0	13.5	13.5	100	100	181
Sugar beet	4.5	5.2	4.3	4.3	100	63.0	103
Vegetable[b]	6.4	6.4	5.5	5.5	100	100	112
	EUR per (corresponding unit)				% of reference prices		
Milk (100 kg)	29.6	34.0	30.7	30.7	100	79	95
Beef (100 kg SG[b])	160.0	365.0	144.0	144.0	100	95	105
Pork (100 kg SG)	135.0	132.0	154.2	154.2	100	100	93
Poultry (100 kg SG)	125.0	125.0	126.1	126.1	100	100	114
Eggs (100 eggs)	8.0	10.0	8.5	8.5	100	100	118
Lamb (per head)	60.0	66.0	69.8	69.8	100	100	110

a) E: England, BW: Baden-Württemberg, BY: Bavaria, AT: Austria; b) representing special crops; c) SG: slaughter weight; d) to h) Sources: own calculations based on … d) … DEFRA 2007; … e) StaLa BW, 2004; LBV BW, 2004; LEL, 2004, BayWa, 2004; ZMP, 1997-2000; f) … Wirsig (in prep.); g) … Gömann et al (2006); h) … VTI (2007).

3 Analysis of the results

3.1 The 'regional farm clusters'

Out of the four European regions, regional farms were selected (i.e. NUTS3 districts) which differ in their patterns of agricultural production. The regional farms are either dominated by cash crop or fodder crop production or by intensive or extensive grassland farming.

The selected regional farms were clustered according to their production patterns into 'regional farm clusters'. These clusters shall represent characteristic regional farms in the investigated regions. This method simplifies the analysis and allows drawing of more general conclusions for comparable regions. However, the calculated results have to be carefully interpreted regarding their transferability to other regions.

This study investigates the development of the 'regional farm clusters' under the different scenarios with respect to the development of economic (agricultural subsidies and income) and environmental impacts as well as changes in agricultural production. For this reason, the development of selected indicators was analyzed: volume of subsidies, volume of total gross margin, proportion of different land use classes, number of dairy cows and fattening bulls and nitrogen input from fertilization. The developments within the 'regional farm clusters' were analysed by average changes. For the indicators subsidies, total gross margin, livestock and nitrogen input, the percentage change related to the reference scenario was used. Changes of land use are represented by changes of percent of utilized agricultural area (UAA) in percentage points (pp). The changes applied refer to the reference scenario for year 2000 under the political framework of Agenda 2000.

In Table 4, the definition of the 'regional farm clusters' and the calculations of the development in the scenarios are presented exemplarily by the cash crop clusters in Baden-Württemberg. The three NUTS3 districts 'Holborn', 'Main-Tauber Kreis' and 'Karlsruhe' were clustered to a cash crop farm cluster (CC) for the region Baden-Württemberg. The average total gross margin ranges from 1,168 EUR ha^{-1} in the Main Tauber Kreis to 1,811 EUR ha^{-1} in Heilbronn and resulted on average in 1,414 EUR ha^{-1} for the CC cluster. The area of cereal production ranges from 46% to 56% of UAA and is on average for the CC cluster 51% of UAA. The baseline price scenario was chosen to represent an exemplary scenario. Here, the total gross margin ranges from 93% to 97% and results in an average value of 95% for the CC cluster. The change of cereal area of 4pp (4 percentage points) was calculated as the average increase of 1pp in Heilbronn and 5pp in the Main-Tauber Kreis and in Karlsruhe.

Table 4. Example of calculation the values for the definition and scenario changes of cash crop regional farm cluster in Baden-Württemberg

NUTS3 districts	SUB [a]	TGM [b]	Cereals	Fodder crops	Oilseed [c]	Root crops	Others [d]	Set-aside	Int. GL [e]	Ext. GL [f]	Dairy cows	Bulls	Nitrogen
Definition of cash crop farm cluster	EUR ha^{-1}				% of UAA [g]						heads 100ha^{-1}		kg ha^{-1}
Heilbronn	243	1811	46	5	5	14	14	4	9	3	14	4	154
Main Tauber Kreis	336	1168	56	7	14	3	1	6	4	8	18	5	143
Karlsruhe	284	1263	51	3	8	3	12	9	7	8	5	1	174
Average as value for the cash crop cluster (CC)	288	1414	51	5	9	7	9	6	7	6	12	4	157
Calculation of changes of indicators in the baseline scenario	% of REF [h]				Percentage points (% of UAA [i])						% of REF [h]		
Heilbronn	107	93	1	-1	-2	-1	0	2	1	1	89	95	100
Main Tauber Kreis	98	96	5	1	-8	0	0	1	1	-1	89	95	98
Karlsruhe	121	97	5	-1	-3	0	0	-9	-2	9	87	97	106
Average as value fort he cash crop cluster (CC)	109	95	4	0	-4	-1	0	-2	0	3	88	96	101

a) SUB: Volume of subsidies; b) TGM: Volume of total gross margin; c) Including legumes; d) Including special crops: vegetables, fruit; e) Int. GL: Intensive grassland; f) Ext. GL: Extensive grassland; g) UAA: utilized agricultural area; h) % of REF: percent of level in reference scenario; i) UAA: utilized agricultural area.

3.2 Reference scenario: Characteristics of the regional farm clusters

Due to the fact that the initial model for England has some weaknesses in its calibration data, as well as in the defined production systems, only those NUTS 3 regions were used for the simulation which ACRE calibrated with sufficient precision. For example no arable fodder production is defined in the model. Thus, the results calculated for the English region should be seen as the less valid results of this study. For England we clustered regional farms with a high share of arable crops (AL), regional farms with a high share of grassland (GL) and mixed regional farms (MIX) with shares of arable land and grassland in-between. The sample of grassland districts is problematic because it consists of only a few small grassland districts, which cannot be considered as representative districts. Thus, the results of the investigated grassland cluster in England might be valid only for few indicators.

In the regions Baden-Württemberg, Bavaria and Austria, statistical data provided a more differentiated clustering: cash crop farm clusters (CC), with a high share of cash crops, fodder crop farm clusters (FC), with a high share of fodder crops, extensive grassland and intensive grassland farm clusters (IG and EG) with a high share of intensive and extensive grassland, respectively. The clusters were selected from the number of available NUTS3 districts modelled in ACRE (cf. Table 1).

The regional farm clusters differ in their characteristics depending on the region they are located. For instance, the share of grassland in EG cluster in Baden-Württemberg is only 58% of UAA, while the grassland share of EG cluster in Bavaria is 91% of UAA.
In the following text we referred to the 'regional farm clusters' simply as 'farm clusters' or as 'clusters'. Table 5 presents the characteristics of the farm clusters in reference scenario.

Table 5. Mean values of the indicators of the 'regional farm clusters' in the reference situation

	# districts [a]	UAA [b]	SUB [c]	TGM [d]	%GL [e]	Cereals	Fodder crops	Oilseed [f]	Root crops	Others [g]	Set-aside	Int. GL [h]	Ext. GL [i]	Dairy cows	Bulls	Nitro-gen
		10^3 ha	EUR ha^{-1}		% of UAA [c]									head 100 ha^{-1}		kg ha^{-1}
England (E)																
AL [j]	4	99	294	1142	14	58	0	13	9	5	0	2	12	4	2	147
MIX [k]	9	105	250	1011	35	48	0	10	3	3	0	6	29	13	5	115
GL [l,*]	3	2 [*]	175	921	55	35	0	4	1	2	3	6	49	-- [*]	-- [*]	77
Baden-Württemberg (BW)																
CC [m]	3	44	288	1414	13	51	5	9	7	9	6	7	6	12	4	157
FC [n]	3	65	291	1674	33	41	12	9	1	1	3	10	24	36	10	131
IG [o]	3	57	196	1648	61	21	6	2	1	8	2	38	23	40	4	109
EG [p]	3	34	272	934	58	26	6	6	0	0	4	9	49	27	6	81
Bavaria (BY)																
CC [m]	8	51	281	1317	16	16	12	8	10	5	4	5	11	24	14	133
FC [n]	4	56	323	1380	17	17	21	7	5	1	3	8	10	37	29	143
IG [o]	5	75	193	1558	82	82	8	1	0	0	0	36	46	95	6	138
EG [p]	6	34	249	1014	91	91	6	0	0	0	0	16	75	63	4	94
Austria (AT)																
CC [m]	3	45	390	1795	77	46	16	5	1	1	2	45	1	79	27	179
FC [n]	4	52	189	934	121	94	4	0	0	0	0	40	54	61	7	96
IG [o]	3	39	160	782	115	99	0	0	0	0	0	34	65	48	4	77
EG [p]	4	63	95	333	119	100	0	0	0	0	0	13	86	19	1	32

a) # districts: Number (#) of districts considered in regional farm clusters; b) UAA: utilized agricultural area; c) SUB: Volume of subsidies; d) Volume of total gross margin; e) %GL: Percentage share of utilized agricultural area; f) Including legumes; g) Including special crops: vegetables, fruit; h) Int. GL: Intensive grassland; i) Ext. GL: Extensive grassland; j) to p) regional farm clusters with… j) AL: … with high share of arable land; k) MIX: … with nearly equalized share of arable land and grassland; l) GL: … high share of grassland; m) CC: … large share of cash crop area; n) FC: … large share of fodder crop area; o) IG: … large share of intensive grassland; p) EG: … large share of intensive grassland. * The selection of grassland districts in England is problematic, due to consisting only of small districts. Thus, the results for these districts might be not representative and only for the not marked (by *) indicators suggested as valid.

3.2 Analysis of scenario results

3.2 Analysis of scenario results

Table 6 to 9 present the results for the calculated scenarios in the different 'regional farm clusters' in the four regions.

3.2.1 England

The district clusters in England show an increase of subsidies in all three price scenarios (Table 6). The subsidies in GL clusters increase dramatically, by more than 100%, due to the subsidies received for grassland area. Subsidies in the AL and MIX clusters increase by about 5 and 10%, respectively. The increase of payments for grassland compensates for the losses caused by the reduction of payments for the most important arable crops (e.g. payments for cereals were reduced from 371 EUR ha^{-1} to 300 EUR ha^{-1}, cf. Table 2).
In the baseline price scenario under CAP 2003, the losses in total gross margin due to the reformed subsidies can only be compensated in GL clusters. Total gross margin in AL clusters and MIX clusters decreases due to an increase of set-aside area and a reduction of oilseeds,

legumes and fattening bulls. The number of dairy cows is reduced because the assumption of a milk quota restricts the amount of milk produced to that of the reference situation. In combination with a yearly increase in milk performance, number of dairy cows decreased to the level corresponding to the milk quota allowed. Nitrogen input increases in GL farm types by 12% due to the increase of cereal production by 5% of UAA (5pp).

In the pessimistic price scenario the loss of total gross margin in AL and GL clusters is as high as in the baseline scenario. GL cluster lost 13% of total gross margin. Cereals area increases are similar to the developments in the baseline price scenario, because the price change for the most important cereal wheat is small (+1.5%). The development of the other crops, livestock and nitrogen input is also similar to the development in the baseline price scenario.

In the optimistic price scenario the increased prices for cash crops result in an increased total gross margin and in an increase of cereal production area in all farm clusters in comparison to the baseline scenario. The reduction of fattening bulls was provoked by the abolishment of payments for fattening bulls. Higher beef prices (+5%) did not result in a significant change compared with the other price scenarios. Nitrogen input increased slightly in all clusters

Table 6. Development of indicators for the development of economic, agricultural production and environmental impact in regional farm clusters in England

Price scenario		SUB[a]	TGM[b]	Cereals	Fodder crops	Oilseed[c]	Root crops	Others[d]	Set-aside	Ab. AL[e]	Int. GL[f]	Ext. GL[g]	Ab. GL[h]	Dairy cows	Bulls	Nitrogen
		% of REF[i]		Percentage points (% of UAA[j])										% of REF[i]		
Base line	AL[k]	105	67	1	0	-6	-1	0	6	-1	0	-1	1	92	57	99
	MIX[l]	118	76	2	0	-6	0	0	5	0	0	0	0	92	50	101
	GL[m]	222	104	3	0	-4	0	0	0	0	5	0	-5	92*	-- *	115
Pessimistic	AL[k]	104	66	2	0	-7	-1	0	6	-1	0	-1	1	92	57	103
	MIX[l]	117	76	2	0	-6	0	0	5	0	1	-1	0	92	47	102
	GL[m]	221	87	3	0	-3	0	0	0	0	0	4	-4	92*	-- *	99
Optimistic	AL[k]	104	100	4	0	-8	-1	0	6	-1	0	-1	1	92	57	105
	MIX[l]	119	93	3	0	-6	0	0	5	-1	0	-1	1	92	45	104
	GL[m]	221	104	3	0	-4	0	0	0	0	0	4	-4	92*	-- *	100

a) SUB: Volume of subsidies; b) TGM: Volume of total gross margin; c) Including legumes; d) Including special crops: vegetables, fruit; e) Ab. AL: Abandoned arable land; f) Int. GL: Intensive grassland; g) Ext. GL: Extensive grassland; h) Ab. GL: Abandoned grassland; i) % of REF: percent of level in reference scenario; j) UAA: utilized agricultural area;
k) to m) regional farm clusters with…k) AL: … with high share of arable land; l) MIX: … with nearly equalized share of arable land and grassland; m) GL: … high share of grassland; * The selection of grassland districts in England is problematic, due to consisting only of small districts. Thus, the results for these districts might be not representative and only for the not marked (by *) indicators suggested as valid.

3.2.2 Baden-Württemberg

The CAP reform results in an increased subsidy volume in all farm clusters (Table 7). Due to the high share of grassland in the IG cluster and EG cluster the increase of subsidies is higher than in the CC and FC clusters.

In the baseline price scenario, the EG and IG clusters gain in total gross margin due to the increased payments for grassland. In the CC cluster, the loss of subsidies for oilseeds and the decreased animal production result in a decrease of total gross margin. The area planted with cereals in the CC cluster increased. Number of dairy cows decreased in all districts by nearly 10% due to the milk quota assumptions. The FC cluster kept total gross margin stable. The losses due to the reduction of cash crops and the cancellation of premiums for fattening bulls were compensated by the increase of the area payments for grassland. The extensification of crop production and grassland results in a lowered nitrogen input in the clusters FC, IG and EG.

In the pessimistic price scenario, the total gross margin decreased in all farm clusters except for the EG cluster. Developments of crop production and nitrogen input are similar to the baseline price scenario. In the FC farm clusters the number of fattening bulls decreased significantly by 40% due to the decreased prices for beef (cf. Table 3).
In the optimistic price scenario the total gross margin increased in all farm clusters. The increased prices for cereals resulted in an extension of cereals production, which replaced oilseeds and legumes in the CC and FC cluster. Increased beef prices led to only slight decreases in bulls' stock in the FC cluster. The intensification of crop production resulted in an increased nitrogen input in CC, FC and IG cluster.

Table 7. Development of indicators for the development of economic, agricultural production and environmental impact in regional farm clusters in Baden-Württemberg

Price scenario		SUB [a]	TGM [b]	Cereals	Fodder crops	Oilseed [c]	Root crops	Others [d]	Set-aside	Ab. AL [e]	Int. GL [f]	Ext. GL [g]	Ab. GL [h]	Dairy dows [i]	Bulls	Nitrogen
		% of REF [i]		Percentage points (% UAA [j])										% of REF [i]		
Baseline	CC [k]	109	95	4	0	-4	-1	0	-2	0	0	3	0	88	96	101
	FC [l]	124	101	-3	-2	-4	0	0	-1	5	-1	6	0	89	96	89
	IG [m]	198	105	-11	-4	-1	0	0	-2	0	5	14	7	89	66	88
	EG [n]	164	121	-2	1	-2	0	0	0	0	5	0	0	89	96	92
Pessimistic	CC [k]	110	87	4	0	-4	-1	0	-2	0	0	3	1	88	93	102
	FC [l]	123	87	-2	-2	-4	0	0	-1	6	-3	7	2	89	61	87
	IG [m]	196	96	-9	-4	-1	0	0	-2	1	4	11	7	89	64	88
	EG [n]	164	108	-3	1	-2	0	0	0	0	6	-1	0	89	92	92
Optimistic	CC [k]	107	116	11	-1	-7	-1	0	-2	0	2	-2	0	88	97	108
	FC [l]	127	109	14	-3	-6	0	0	-1	0	-1	-2	0	89	98	107
	IG [m]	190	109	5	-3	-1	0	0	-2	0	1	1	5	89	67	109
	EG [n]	159	124	6	0	-3	0	0	0	0	5	-7	0	89	99	97

a) SUB: Volume of subsidies; b) TGM: Volume of total gross margin; c) Including legumes; d) Including special crops: vegetables, fruit; e) Ab. AL: Abandoned arable land; f) Int. GL: Intensive grassland; g) Ext. GL: Extensive grassland; h) Ab. GL: Abandoned grassland; i) % of REF: percent of level in reference scenario; j) UAA: utilized agricultural area; k) to n) regional farm clusters with…k) CC: … large share of cash crop area; l) FC: … large share of fodder crop area; m) IG: … large share of intensive grassland; n) EG: … large share of intensive grassland.

3.2.3 Bavaria

In Bavaria, the CC and FC cluster lost in total gross margin (Table 8). Losses in subsidies for crops (e.g. rapeseed and maize), as for fattening bulls, decreased the revenues of agricultural production in these districts. In the FC cluster, the decreases of fodder crop payments and premiums for fattening bulls decreased slightly the subsidy volume.
Cereal area was extended in the CC and FC cluster. The reduced cattle stock resulted in a reduced fodder demand. Thus, intensive grassland was shifted to extensive grassland. The extensification of agricultural production provoked a reduction of nitrogen input.
In the pessimistic price scenario, the total gross margin was affected by the decreased milk prices due to the high dairy cow density in all farm cluster (reaching from 24 cows in CC cluster to 93 cows per 100 ha in IG cluster, cf. Table 4). Only EG cluster increased total gross margin due to the large increase of subsidy volume. Cereal area was extended slightly. The developments of the other land use classes, livestock and nitrogen input are similar to the baseline scenario.
In the optimistic price scenario, increased prices for agricultural products resulted in an increase of total gross margin except in the FC cluster. Here, fattening bulls were an important production line (37 bulls per 100 ha and 21% of UAA fodder crops). However, due to the increased beef price the reduction of bulls to 83% is smaller than in the baseline and in the pessimistic price scenario. The CC and FC cluster extended the cereal area because of

increased cereal prices. Also extensive grassland farming tended to be increased. Overall, this led to a reduction of nitrogen input.

Table 8. Development of indicators for the development of economic, agricultural production and environmental impact in regional farm clusters in Bavaria

Price scenario		SUB [a]	TGM [b]	Cereals	Fodder crops	Oilseed [c]	Root crops	Others [d]	Set-aside	Ab. AL [e]	Int. GL [f]	Ext. GL [g]	Ab. GL [h]	Dairy cows [i]	Bulls	Nitrogen
		% of REF [i]		Percentage points (% UAA [j])										% of REF [i]		
Baseline	CC [k]	123	96	3	1	-6	0	0	2	0	-1	2	-1	89	87	95
	FC [l]	98	91	3	-2	-5	0	0	4	0	1	1	-1	90	78	94
	IG [m]	222	108	-1	0	0	0	0	1	0	-1	3	-1	90	77	92
	EG [n]	209	123	-1	0	0	0	0	1	0	-1	2	-1	89	72	91
Pessimistic	CC [k]	120	84	1	1	-4	0	0	3	0	-2	3	-1	89	80	95
	FC [l]	100	79	1	-2	-3	0	0	4	0	-3	4	-1	90	70	93
	IG [m]	219	95	-1	0	0	0	0	1	0	1	0	-1	90	68	92
	EG [n]	209	112	-1	0	0	0	0	1	0	-1	3	-1	89	67	91
Optimistic	CC [k]	116	121	4	0	-6	0	0	2	0	0	1	-1	89	87	97
	FC [l]	97	98	4	-3	-5	0	0	4	0	0	2	-1	90	83	96
	IG [m]	224	105	0	-1	0	0	0	1	0	0	1	-1	90	82	92
	EG [n]	209	120	0	0	0	0	0	1	0	-1	2	-1	89	76	90

a) SUB: Volume of subsidies; b) TGM: Volume of total gross margin; c) Including legumes; d) Including special crops: vegetables, fruit; e) Ab. AL: Abandoned arable land; f) Int. GL: Intensive grassland; g) Ext. GL: Extensive grassland; h) Ab. GL: Abandoned grassland; i) % of REF: percent of level in reference scenario; j) UAA: utilized agricultural area; k) to n) regional farm clusters with…k) CC: … large share of cash crop area; l) FC: … large share of fodder crop area; m) IG: … large share of intensive grassland; n) EG: … large share of intensive grassland.

3.2.4 Austria

In Austria, the subsidies increased in all regional farm clusters; in grassland clusters more than in arable land clusters (Table 9). In the baseline price scenario, total gross margin declined in the CC cluster, kept constant in FC, increased in EG and increased slightly in the IG cluster. Land use changes were small; in CC set-aside replaced oilseeds and in the FC and IG clusters intensive grassland was shifted to extensive grassland. The reduced intensity of production in the FC, IG and EG clusters resulted in decreased nitrogen input. In CC, the nitrogen input was kept the same as the reference level. There were no changes in land use in the EG cluster. Thus, CAP reform changes had no impact on land use in this cluster.

In the pessimistic price scenario, all clusters lost in total gross margin due to decreased prices. In the EG cluster the losses were small. In contrast to the other regions (Bavaria or Bade-Württemberg), in Austria beef production in the CC cluster is of great importance in the reference situation (27 bulls per 100 ha). In this cluster, bull stock was reduced to 30% of the reference situation due to decreased beef prices. The reduced fodder demand resulted in abandonment of arable land. The nitrogen level was similar to the baseline price scenario.

In the optimistic price scenario, only the CC cluster lost significantly in total gross margin. Land use in this cluster is similar to the baseline price scenario. However, the slight decrease of fodder crop area resulted in a reduction of nitrogen input. The development of the other indicators was similar to the baseline price scenario: grassland tended to be extensified and nitrogen input was reduced.

Table 9. Development of indicators for the development of economic, agricultural production and environmental impact in regional farm clusters in Austria

Price scenario		SUB [a]	TGM [b]	Cereals	Fodder crops	Oilseed [c]	Root crops	Others [d]	Set-aside	Ab. AL [e]	Int. GL [f]	Ext. GL [g]	Ab. GL [h]	Dairy dows [i]	Bulls	Nitrogen
		% of REF [i]		Percentage points (% UAA [j])										% of REF [i]		
Baseline	CC [k]	133	92	0	0	-3	0	0	4	0	0	0	0	87	42	100
	FC [l]	151	101	-1	-1	0	0	0	0	1	-2	2	0	89	49	92
	IG [m]	173	103	0	0	0	0	0	0	0	-2	2	0	89	64	93
	EG [n]	179	108	0	0	0	0	0	0	0	0	0	0	89	60	92
Pessimistic	CC [k]	135	86	-2	1	-3	0	0	4	1	0	0	0	87	29	102
	FC [l]	151	91	-1	-1	0	0	0	0	2	-3	3	0	89	37	91
	IG [m]	170	92	0	0	0	0	0	0	0	-2	2	0	89	41	92
	EG [n]	178	99	0	0	0	0	0	0	0	0	0	0	89	54	92
Optimistic	CC [k]	127	92	0	-1	-3	0	0	4	0	0	0	0	87	48	94
	FC [l]	152	98	-1	0	0	0	0	0	1	-2	2	0	89	52	89
	IG [m]	170	98	0	0	0	0	0	0	0	-2	2	0	89	63	91
	EG [n]	179	106	0	0	0	0	0	0	0	0	0	0	89	70	91

a) SUB: Volume of subsidies; b) TGM: Volume of total gross margin; c) Including legumes; d) Including special crops: vegetables, fruit; e) Ab. AL: Abandoned arable land; f) Int. GL: Intensive grassland; g) Ext. GL: Extensive grassland; h) Ab. GL: Abandoned grassland; i) % of REF: percent of level in reference scenario; j) UAA: utilized agricultural area; k) to n) regional farm clusters with…k) CC: … large share of cash crop area; l) FC: … large share of fodder crop area; m) IG: … large share of intensive grassland; n) EG: … large share of intensive grassland.

4 Validation of the results

The results presented in this study show that the impacts caused by the CAP reform 2003 and different price scenarios depend on the type of the investigated 'regional farm cluster' as well as their location in a more intensively or more extensively farmed region. In order to validate the modelling results other studies were drawn for comparison with the results of this modelling exercise. Several studies exist which present the impacts of the CAP reform 2003 for the EU 15 and on regional scale. For the pessimistic price scenario only one study was research for a comparison. For a comparison of the results of the optimistic scenario no study was found. These scenarios could only be validated by their plausibility.

4.1 Base line price scenario

4.1.2 Global studies for EU

In order to compare the ACRE results with results of other studies on EU level, three studies were drawn for comparison. Balkhausen et al. (2008) reviewed the results of eight different agricultural policy models and the impact studies EC (2003) and OECD (2004). The last two calculated partially with models reviewed by Balkhausen et al. (2008) (i.e. ESIM and AG-LINK). The results of these studies are similar to the results calculated by ACRE.

The European Commission (EC, 2003: 3) estimates a modest change in agricultural income, which may correspond with the observed parallel increase of total gross margin in the grassland regions and the decrease of total gross margin in the arable regions. EC (2003: 3) and Balkhausen et al. (2008: 68) predicted a reduction of cereal area. This effect was found in the ACRE calculations only in a few clusters. Corresponding to the ACRE results, a reduction of oilseed area is also expected by EC (2003: 3). In contrast, several models calculated both a decrease and an increase of oilseed area (Balkhausen et al. 2008: 68).

Fodder area tended to remain stable or was reduced due to the declines in cattle production in the ACRE calculations. Balkhausen et al. (2008) found an increase of fodder area, which might be the result of the fact that roughage was not considered in some of the models. Balkhausen et al. (2008) also describe a reduction of fodder maize area, which corresponds to

ACRE results. A more detailed analysis than that presented here shows, that ACRE replaces silage maize partially by more extensive clover as fodder crop.
Furthermore, the increased set-aside area and abandoned area, as well as the conversion of arable land to grassland, represent forms of more extensive land use. These changes were simulated by ACRE and are also expected by EC (2003: 3) and by OECD (2004: 43). Also, the decrease of set-aside and a constant area of pasture (Balkhausen et al., 2008: 68) were observed for some ACRE clusters.
ACRE calculated a decreased milk production, which was caused by milk quota assumptions. This should be interpreted as a constant production level, because without milk quota restrictions, milk production would have remained the same. This agrees with studies of OECD (2004: 43). Changes in the modelled quota would even allow an increase in milk production, as is expected by EC (2003: 3). However, milk production in ACRE is modelled in a quite simplified way that does not allow for an adequate representation of the full complexity of interactions between milk production, milk market and trade of milk quotas. The expected decrease in beef production is also expected by all three studies.

4.1.2 England

The decrease of total gross margin calculated by ACRE in arable farm clusters, are more extreme than the marginal losses expected by Lobley and Butler (2004: 45). In grassland clusters, the reformed subsidies resulted in a compensation of the losses in total gross margin, which might represent the benefit found by Lobley and Butler (2004: 45) for lowland livestock farms.
The ACRE results expect a decrease in oilseed production and a slight increase of cereals production, which is mainly caused by an increased winter wheat area. This corresponds, partially, with the study of Drywer et al. (2006). They predict an increase of winter wheat production and set-aside area (Drywer et al., 2006: vi). However, they also expect an increase of oilseeds and a decrease of sugar beet (Drywer et al., 2006: ix), which was not found in this study.
The ACRE results suggest a decrease in dairy production due to the assumption of an increasing milk performance and the perpetuation of the milk quota. Test runs showed that without these restrictive assumptions the dairy stock remains at 100% of reference level, even with low level price assumptions. Bull stock is expected to decrease significantly. Comparable to this, minor changes for dairy farming and declines of beef cattle are expected for study regions in England and in Northern Ireland (e.g. Drywer et al., 2006: v, Moss et al., 2002: 9).
Nitrogen input is expected to be increased in grassland farm clusters, due to increased area of intensive grassland. This does not coincide with the environmental benefits which are found for marginal areas for soil and water (Drywer et al., 2006: x). However, due to the problem of the sample of small districts and problems of statistical data, the results ACRE calculated for grassland districts cannot be considered as valid.

4.1.3 Baden-Württemberg

Arable farm clusters (CC and FC) loose in total gross margin or it remains stable. The Grassland clusters (IG and EG) gain in total gross margin due to the increased payments for grassland. This development is also predicted by Segger (2005: 82) for the income of arable and grassland farms in Baden-Württemberg.
ACRE calculated an increase of cereals area only in the CC cluster. In the FC and IG clusters, cereals and fodder crop area decreased. This agrees with the decrease of cereal area found by Britz et al. (2006: 219) for Germany, whereas the expected reduction of fodder crop area (Britz et al., 2006: 219) was not simulated by ACRE.
The model version used for the calculation of the regional farms in Baden-Württemberg (ACRE-BW) allows the activity of converting arable land into grassland. This was shown by

several regional farms (not presented in this study). These findings correspond with the general movement from crop to pasture land predicted for EU 15 by OECD (2004: 43) and the increase of grassland expected for the Federal State Hesse by Weinmann et al. (2006: 548).
ACRE reduced the dairy cow stock due to milk quota assumptions. As explained above, this reaction can be interpreted as no change in dairy production, which was also predicted by (OECD 2004: 43) Also the decrease in bulls stock can be observed as it was published by OECD (2004: 43) and Britz, et al. (2006: 219).

4.1.4 Bavaria

In Bavaria the arable clusters (CC and FC) loose in total gross margin, while grassland farm clusters show an increase.
Cereal area and set-aside are extended in arable farm clusters. These developments were also predicted for Bavarian small scale grassland regions by Roeder et al. (2006: 264). They expect a decrease of silage maize as fodder crop, which is replaced by cereals and also an increase of set aside area (Roeder et al., 2006: 265). In grassland clusters (EG and IG), the reduced fodder demand results in a shift from intensive grassland to extensive grassland. This extensification of grassland farming with partially abandoning of grassland was also observed by Roeder et al. (2006: 264).
Stable dairy production as well as decreased beef production are found in Bavaria regional farm clusters, which corresponds to other studies for Germany (Britz et al., 2006: 219) and for EU15 (OECD 2004: 43).

4.1.5 Austria

Total gross margin declined or was kept constant in arable clusters and increased in grassland clusters. A stable or slightly decreased income is expected by Sinabell and Schmid (2005: 132), ÖÖI (2004: 27) and by Kirner (2005: 68) for Austrian farms. The payments from the second pillar of the CAP might have a more significant impact on agricultural production than changes of the first pillar payments (ÖÖI 2004: 27). However, the payments of the second pillar are modelled in ACRE in a simplified way, so that these effects are probably not sufficiently represented.
ACRE calculated small land use changes for all clusters, with a tendency towards extensification of arable land and grassland. Oilseed area was decreased, set-aside area was increased and intensive grassland farming was shifted to extensive grassland farming. This tendency of extensification coincide with findings of Sinabell and Schmid (2005) who calculated a general reduction of arable area, a decrease in cereal production, and an extension of extensive grassland (Sinabell and Schmid, 2005: 132).
ACRE calculated a decrease in dairy production resulting from milk quota assumptions and a decrease in bull stock. These results correspond with other studies, which predict that dairy farming in grassland region is not significantly influenced in the region Vorarlberg (ÖÖI 2004: 27) and a decrease in beef production (Wöllinger, 2004: 1; Sinabell and Schmid, 2005: 132).

4.2 Price scenarios

A comparison between the development of the results in the baseline price scenario and the other price scenarios shows, that the influence of prices is smaller than that of the CAP reform 2003. Thus, ACRE simulations show that most important changes are due to agricultural policy rather than changes in prices.

4.2.1 Pessimistic price scenario

The observed developments in the pessimistic price scenarios all seem to be plausible. The developments of the investigated indicators are in tendency similar to the baseline scenario. Total gross margin tends to decrease in all regions due to the decreased prices for agricultural products. As in the baseline scenario the new premiums regime of the CAP 2003 results in a

decreased total gross margin in arable clusters and in an increased total gross margin in grassland clusters.
Cereal production tends to decrease in extensive regions (Bavaria and Austria). Dairy cow stock changes with the assumed milk quota restrictions as in the base line scenario, with a regular decrease in all clusters. In clusters where bull fattening is important (e.g. FC in Baden-Württemberg and CC in Austria) the decreased beef prices result in a greater decrease of bulls stock. The reduced production intensity results in a decreased nitrogen input in most of the clusters.
The results calculated for the pessimistic price scenario are similar to the results calculated by Gömann et al. (2007) for North-Eastern and Eastern Germany. Of course, the production conditions in these regions are different from the investigated regions. However, due to similar CAP reform assumptions and price scenarios the study of Gömann et al. (2007) is a suitable study for comparison. Furthermore, the RAUMIS model used by Gömann et al. (2007) is similar to the ACRE model used in this study. Both models are process analytical PMP models production at NUTS 3 level. While RAUMIS covers the NUTS3 districts for all of Germany, ACRE represents districts in Southern Germany.
Gömann et al. (2007) found an increase of cereal area (Gömann et al., 2007: 40), which was also calculated by ACRE for most arable regional farm clusters. The replacement of silage maize by clover (Gömann et al., 2007: 40) was also calculated by ACRE, but is not presented in this study. The increase of set-aside area and abandoned UAA (Gömann et al., 2007: 40) was found in regional farm clusters of Baden-Württemberg.
Dairy production in the compared study decreased little. The mechanism of trade with milk quotas is mentioned in the study of Gömann et al. (2007: 40) and might allow a more detailed simulation of milk production than is considered in ACRE and thus result in a tendency for milk production to decrease. The decline in beef production (Gömann et al., 2007: 40) coincides with the results presented here.

4.2.2 Optimistic price scenario

The optimistic price scenario resulted in more extreme changes of agricultural production than the pessimistic scenario. Total gross margin increased in most of the clusters and decreases in total gross margin were small, except in CC in Austria, where total gross margin decreased by 8%. The optimistic price scenario can be considered as quite a positive scenario for agricultural income in all regions and farm clusters.
The changes of agricultural production were similar in tendency as in baseline price scenario. In intensive regions and arable clusters cereal production tended to be greatly extended, whereas in grassland regions the grassland farming tended to be reduced. Livestock production is similar to that in the reference situation, whereas beef stock was greater than in the baseline price scenario, due to increased beef prices. The intensification of crop production resulted in higher nitrogen input than in the baseline price scenario and the pessimistic price scenario, especially in arable farm clusters.

5 Summary and concluding remarks

This study presents the development of agricultural production for intensive and extensively farmed regions and different regional farm clusters. The observed results are plausible and coincide largely with studies for EU 15 (e.g. EC, 2003; Balkhausen et al. 2008; OECD, 2004) as well as with regional studies (e.g. Lobley and Butler, 2004; Roeder et al., 2006).
The reformed subsidies of the CAP reform 2003 result in a decreased total gross margin in arable regional farm clusters and in an increased total gross margin in grassland clusters. Agricultural land use tends to be extensified due to a reduction of intensive fodder crops, a reduction of oilseed, an increase of set-aside area, and a shift from intensive to extensive grassland. Cereal area is, in part, extended and results in an increase of nitrogen input in intensively farmed areas (i.e. England and Baden-Württemberg). In grassland clusters and in

extensively farmed regions (Baden-Württemberg and Austria) the extensification of land use reduces the input of nitrogen in the 'regional farm clusters'. Dairy farming declined due to milk quota assumptions and was not affected by the decoupled subsidies. Beef production decreased significantly in all regional farm clusters in all four regions. In comparison to the baseline price scenario the pessimistic price scenario provoked a decrease in total gross margin due to reduced milk and beef prices. Agricultural production was extensified. The optimistic price assumptions increased the agricultural total gross margin in all regional farm clusters. Extended cereal production area in arable districts caused an increase in nitrogen input. Agricultural production in more extensively farmed regions (Bavaria and Austria) and in grassland farm clusters (GL, IG and EG) was less affected by CAP reform and price scenarios than in more intensively farmed regions (England and Baden-Württemberg) and in arable clusters (AL, CC and FC).

Some critical aspects have to be considered with regard to the interpretation of the results presented here.

1. The model (ACRE-England) used for the calculation of the region England is still in an initial test phase. The number of selected regional farms is too small to be representative for the complete model region. The model has to be improved and further developed by more detailed activities of agricultural production (e.g. fodder crops are not considered in this model) and agricultural policy (e.g. modelling of the regional agri-environmental measures). Thus, the interpretation of the English regional farm clusters should be done carefully. The results for the 'regional farm clusters' in England are the least valid of the results presented in this study, especially the results of the grassland cluster.

2. The methodology of clustering regional farms and analysing them by means of changes, allows a simple analysis and a generalisation for other regions. Nevertheless, these artificial clusters and the analysis of their reactions in scenarios provide no information of developments of the specific regional NUTS 3 districts the clusters are based on. A more detailed analysis might provide results for the single regional farms which are more or less extreme than the average changes calculated by these results.

3. The presented results show an increase of subsidy volume in all scenarios. Depending on the region and the share of grassland in a cluster the increase was 10 to 200% of the subsidy volume in the reference situation. This increase compensated partially for losses in total gross margin due to the reduced payments for livestock and cash crops. However, the calculations were based on aggregated utilized agricultural area and do not consider any limitations of payments for individual farms exceeding a maximal farm size. Thus, the increases of subsidy volume were overestimated in this study.

4. The scenarios modelled are not fully realistic from the viewpoint of recent developments of agricultural markets and agricultural policy. It is likely that by the year 2013 (at least up to the year 2015) milk quotas and set aside obligations will be abolished. Also, the production of energy crops is of increasing importance in agricultural production. These aspects were not considered in the calculations presented in this study.

Nevertheless, adaptations of the simulated scenarios as well as the further development of the model ACRE can be extended extend this approach to gain a better representation of the future agricultural production in the investigated regions. The consistence of the results in comparison with other models and studies demonstrate that this modelling exercise is at least suitable to represent changes in agricultural production expected for the modelled scenarios.

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