Economic impact of the Mid-Term Review on agricultural production, farm income and farm survival: A quantitative analysis for local sub-regions of Schleswig-Holstein in Germany

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ECONOMIC IMPACT OF THE MID-TERM REVIEW ON AGRICULTURAL PRODUCTION, FARM INCOME AND FARM SURVIVAL: A QUANTITATIVE ANALYSIS FOR LOCAL SUB-REGIONS OF SCHLESWIG-HOLSTEIN IN GERMANY

Abstract

This study analyzes the impact of the Mid-Term Review (MTR) on the agricultural sector in Schleswig-Holstein, a federal state in Germany. First, a very detailed farm group linear programming model is built to quantify the effects on agricultural production and farm incomes. The production adjustment to the MTR and its impact on farm profit vary significantly between individual farms. These results depend mainly on the farm type and the resource endowments of the farms. Second, the impact on structural change is examined with a farm survival model. Although the MTR clearly reduces the incomes of several farm types, it accelerates the structural change only gradually.

Keywords: policy reform, modeling production adjustment, farm income, structural change

JEL classification: Q12; Q18

1 Introduction

The Mid-Term Review (MTR) is certainly one of the most important reforms since the establishment of the Common Agricultural Policy (CAP). It is controversially discussed in particular, because it induces high political uncertainty for at least two reasons. First, the MTR contains new agricultural policy instruments, i.e. decoupling and cross compliance, for which their specific economic implications are not fully understood, yet. Second, in contrast to former CAP reforms the MTR includes a large range of policy options to be decided at national level, i.e. arrangement of decoupled payments. In this regard, farmers fear that depending on the decoupling option finally implemented at national level large income reductions and income redistribution among farm types will occur, while local politicians fear that agricultural production and employment will totally break down in specific local areas due to the reform. Finally, agricultural economists doubt that the MTR is really an effective political solution to the persisting structural adjustment problem in the agricultural sector.

Therefore, a detailed quantitative analysis of the economic impact of the MTR on agricultural production, farm income and farm survival is needed to reduce existing uncertainty and to provide a solid basis for rational evaluation of different reform scenarios.

In this regard the paper presents the results of a quantitative simulation analysis of the economic impact of the MTR on farm production, farm income and farm survival in 22 sub-regions of Schleswig-Holstein in Northern Germany.

In the following section a short outline of the agricultural sector in Schleswig-Holstein is given. The third section describes the model used to analyze the impact of the MTR. The model results are discussed in the fourth section. Finally, in the fifth section the paper is summarized and some conclusions are presented.

2 Agricultural Sector in Schleswig-Holstein

Schleswig-Holstein is Germany's most northern federal state (see figure 1). Its agricultural sector is relatively important with a share of 2.1% in total value added. This is twice as high as in overall Germany. Furthermore, agricultural productivity is one of the highest in Europe, especially for grain and milk production. Due to high yield of grain the previous area payments for grandes cultures amount to 429 €/ha, which is the highest in Germany.

Figure 1: Schleswig-Holstein in Germany

The average farm in Schleswig-Holstein has 55 ha agricultural land. Although this is comparably large in the “old” federal states of Germany, many farms in Schleswig-Holstein are too small to take full advantage of economies of scale.

Agricultural production is very heterogeneous in Schleswig-Holstein (see table 1). The main reason for this heterogeneity is the existence of different soils. Thus, it is convenient to divide Schleswig-Holstein into three main regions depending on the soil: “Marsch”, “Geest” and “Hügelland” (see figure 2).

Table 1: Regional Crop Areas (average 2000-2002)

	Marsch		Geest		Hügelland		Total
	1000 ha	%	1000 ha	%	1000 ha	%	1000 ha
Arable land	83	53	196	45	338	81	617
Cereals	54	34	76	18	197	47	327
Wheat	49	31	22	5	131	31	202
Rye + Triticale	1	1	30	7	16	4	47
Rapeseed	9	6	16	4	70	17	95
Feed prod. on arable land	4	3	81	19	37	9	122
Silage maize	2	1	59	14	20	5	81
Grass on arable land	2	1	21	5	16	4	39
Permanent grassland	74	47	236	55	80	19	390
Total agricultural land	157	100	432	100	418	100	1007

The “Marsch” is the most western part of Schleswig-Holstein on the coast of the North Sea. About half of the agricultural land in the “Marsch” is arable (53%). The clayey soils are highly productive, but they are also difficult and costly to cultivate. The arable land is mainly used for wheat production,

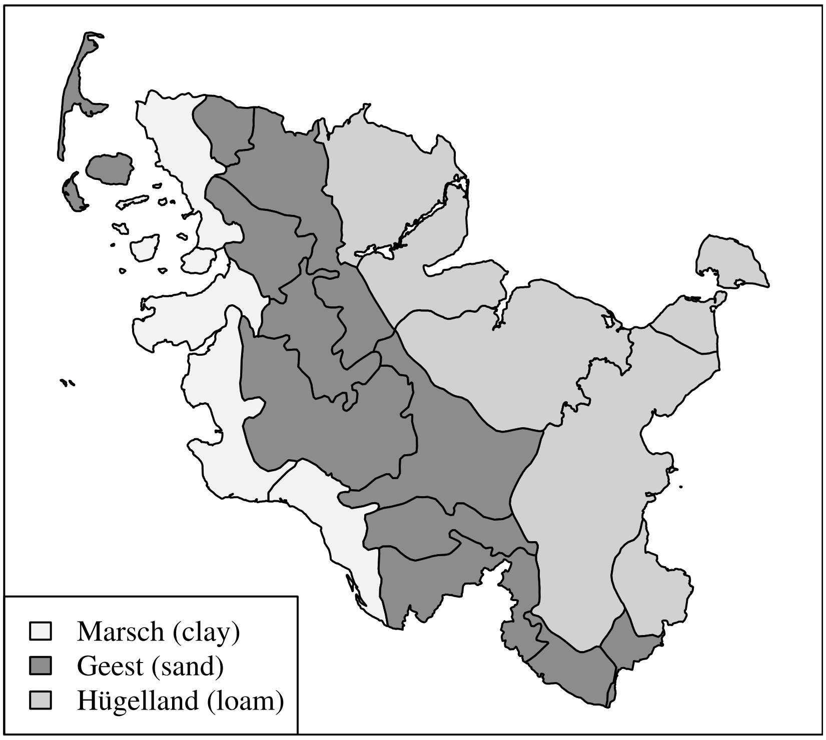

Figure 2: Regions and Soils in Schleswig-Holstein

which generates very high yields on this soil. The grassland is mainly used as pasture for sheep, suckler cows and cattle fattening. Animal production is very unevenly distributed. Suckler cows, cattle fattening and pigs are concentrated in different subregions.

The “Geest” mainly lies in the center of Schleswig-Holstein. Most soils are more or less sandy, but there are also several bogs. Less than half of the agricultural land in the “Geest” is arable land (45%), because the bogs and several other areas are suitable only for grassland. The arable land is mainly cultivated with silage maize and cereals. While maize and rye grow quite well even on poor sandy soils, some areas with better soils are even capable to grow more demanding grains (e.g. barley, wheat) and rapeseed. Almost 10% of the arable land is used for grass production. Milk production is predominant in almost all subregions (on average 3420 kg milk quota per ha of total agricultural land). In several subregions there are also suckler cows. Intensive bull fattening based on maize is important especially in the northern subregions of the “Geest”.

The “Hügelland” lies on the east coast adjacent to the Baltic Sea. The loamy soils are productive for many agricultural activities. Most of the agricultural land is arable (81%). The arable land is mainly used for wheat and rapeseed production. While cattle keeping is not very important in this region, there are several subregions with extensive pig production.

3 Model Description

The quantitative effects of the MTR on the agricultural sector in Schleswig-Holstein are analyzed with a sector model including 416 individual linear programming (LP) models. Each LP model corresponds to a specific farm size, farm type and subregion. The gross margin is maximized under general conditions of the years 2001 to 2003 (before MTR, “baserun”) as well as under conditions that are expected in 2013 (after completion of MTR). The political conditions expected in 2013 can be simulated to analyze the effects of different national options like regionalization and partial decoupling. Furthermore, also economic conditions like prices can be simulated to analyze their impact on the agricultural sector. To take different land qualities, production intensities, crop rotation restrictions and cross compliance requirements into account, the LP model is strongly disaggregated. Each individual model includes roughly 1100 production activities and roughly 550 restrictions. Since a complete description of all details of the model would go beyond the scope of this article, only the most important features are described in this section. A more detailed description is available in Henning et al. (2004).

3.1 Farm-level Data

The arrangement of the 416 individual farm types is based on data that the farms submit when they apply for direct payments. Since almost all relevant farms receive some kind of direct payment, the data almost completely represent the agricultural sector of Schleswig-Holstein.

For each of these about 15,000 farms the data include the

- subregion, where the farm is located,
- agricultural area, divided into arable land and permanent grassland,
- area that is eligible for compensation payments for “grandes cultures”,
- area used for sugar beet, potato and vegetable production,
- milk quota,
- received suckler cow premiums,
- received slaughter premiums,
- received special premium for male animals, divided into bulls and steers, and
- received ewe premiums.

The number of kept suckler cows and ewes as well as the number of slaughtered bulls, steers and other cattle can be directly calculated from the amounts of received premiums. The number of *kept* bulls, steers, dairy cows and other cattle is evaluated using additionally production and bookkeeping data (Landwirtschaftlicher Buchführungsverband, 2002a).

Since it is not possible with standard computers to calculate the LP model for all 15,000 farms in an appropriate time, we decided to construct a farm group model. Thus, the farms are divided into different groups according to the following attributes:

- 22 subregions
- 5 farm types, and
- 4 farm sizes.

The 22 subregions are selected to have relatively homogeneous soils and climatic conditions. The “Marsch” is divided into 5 subregions, the “Geest” is split into 11 subregions and the “Hügelland” is broken down into 6 subregions.

The farms are classified into farm types according to the proportions of the standard gross margins of the individual production areas. The five farm types used in the LP model are:

- specialized cash crop farms
- specialized forage-growing farms with predominantly milk production
- specialized forage-growing farms with predominantly beef production (cattle fattening and suckler cows)
- cash crop farms with some forage growing
- forage-growing farms with some cash crop production

The farm sizes are 5-60 ha, 60-100 ha, 100-200 ha and $\geq$200 ha agricultural land. Farms with less than 5 ha agricultural land are excluded from the model, because their total agricultural land accounts only for a small share in Schleswig-Holstein. Furthermore, these farms are either hobby farms or they produce special or niche products, so that their production decisions are hardly affected by the MTR.

From the 440 possible groups (22 subregions $\times$ 5 farm types $\times$ 4 farm sizes), 290 groups were selected, whose agricultural land accounts for at least 2% of the subregion or 0.05% of Schleswig-Holstein. For each group we calculated average values, to represent the group by an average farm in the LP model. Thus, the result for a total group can be calculated by multiplying the result of the individual (average) farm by the number of farms in the corresponding group. Furthermore, the aggregated results for each subregion, region or total Schleswig-Holstein can be identified by adding up the results of all groups in the respective area.

Unfortunately, the individual farm data provide no information on pig farming. Although pig production is not affected by the MTR, it has impact on other branches of production (e.g. via manure, labor requirements). Since this impact is only indirect, an approximate treatment of the pig production seems to be warrantable. Since most pigs are kept by cash crop farms, we assume for simplicity that all pigs are kept by farms that are so far considered as “specialized cash crop farms”. To implement this, we split this farm type into four farm types. All sizes of the “specialized cash crop farms” are divided into

- specialized cash crop farms without pig production
- cash crop farms with pig production
- pig farms with cash crop production
- specialized pig farms with some cash crop production

These subdivisions are done on a subregional level according to the proportion of these four farm types that are taken from a report based on bookkeeping data (Landwirtschaftlicher Buchführungsverband, 2002b). The number of sows and fattening pigs per farm are taken from the same source. Due to the addition of farm types the number of farm groups increased from 290 to 416.

The area of permanent grassland was divided into permanent grassland on organic soils (bogs) and on mineral soils (sand, loam, clay). The particular proportions in each subregion are assessed by experts. Total agricultural area on mineral soils (all arable land plus permanent grassland on mineral soils) was split into ten quality categories. For each farm (group) the proportions of these categories are set equal to the proportions in the respective subregion. The permant grassland on organic soils (bogs) was divided into 5 quality categories. The proportions of each category are assessed by experts.

The data do not provide any information on family workers on the farms. Since the low opportunity costs of family workers on many farms heavily influence production decisions, this has to be evaluated (see table 2). We assume that there are 1.5 family workers on each dairy farm (“specialized forage-growing farms with predominantly milk production”) and one family worker on each farm of other farm types. Further, we presume that each family worker works 2000 hours per year. One exception are “specialized cash crop farms without pig production”. Since a farmer on this farm type cannot utilize his labour capacity during the winter, it is assumed that he can only work 1500 hours per year on the farm.

Table 2: Family Workers

Farm type	**Family workers**	**Working hours**
Specialized forage-growing farms with predominantly milk production	1.5	3000
Specialized forage-growing farms with predominantly beef production	1	2000
Cash crop farms with some forage-growing	1	2000
Forage-growing farms with some cash crop production	1	2000
Specialized cash crop farms without pig production	1	1500
Cash crop farms with pig production	1	2000
Pig farms with cash crop production	1	2000
Specialized pig farms with some cash crop production	1	2000

3.2 Activities and Restrictions

Each farm can choose its activities from roughly 1100 available possibilities. However, this choice is subject to roughly 550 restrictions. Data about the production activities are based on evaluations of bookkeeping data of farms in Schleswig-Holstein, data collections for planning purposes and assessments of experts. Furthermore, these data have been adjusted to converge the model results of the baserun with the real data. Depending on the availability of the data this calibration is done for subregions, regions or the whole federal state.

The farms can choose from all land cultivation activities that are relevant in Schleswig-Holstein. There are three main groups: cash crops, set-aside and forage production. The cash crops consist of several types of cereals, rapeseed, legumes, sugar beets, potatoes and cabbage. Set-aside activities include continuous fallow, rotational fallow, phacelia and non-food rapeseed. Forage production comprises silage maize, grass silage and pastures. Grass can be grown on arable land, permant grassland on mineral soils and on organic soils. The grass can be mowed once, twice, thrice or four times a year. If it is mowed less than four times a year, it can be used as pasture afterwards. Pastures can be cultivated with four different production intensities. All these production activities differ depending on the soil quality. Production activities on arable land additionally differ depending on the previous cropping on the same field. Especially the yield of wheat is heavily affected by the previous cropping and the yield of rapeseed decreases with an increasing share of cruciferous plants in the crop rotation.

The fertilization of the crops can be done by purchased mineral fertilizers as well as by manure. Leaching of nitrogen and potash is considered and depends on the soil quality and the kind of the fertilizer (mineral fertilizers or manure).

In our “realistic” scenario for 2013 we assume that the prices of cash crops do not change from 2003 to 2013. One exception is rye. The price of rye is assumed to decrease, because the MTR implies a discontinuation of the intervention of rye. Farms that feed their pigs with self-produced barley, rye or triticale benefit from the difference between the market price and the feeding value of these crops. Since the consumed quantities of potatoes and cabbage are more or less fixed, we assume in the model that the farmers cannot extend their sales quantity. At the time when the LP model was built, it was totally unclear how the European sugar market regime will change. Therefore, we also fixed the sugar beet production to the current amount.

The farms can choose from several kinds of animal production. These are dairy production, suckler cows, fattening of calves, intensive fattening of bulls with maize silage, fattening of bulls on pastures, sheep farming, sow keeping (farrow production) and pig fattening.

To account for economies of scale in dairy farming, the labor requirements per dairy cow decrease with an increasing herd size (see figure 3). This is implemented in the following way: The first dairy-cow requires 723 working hours, while all following cows require only 23 working hours.

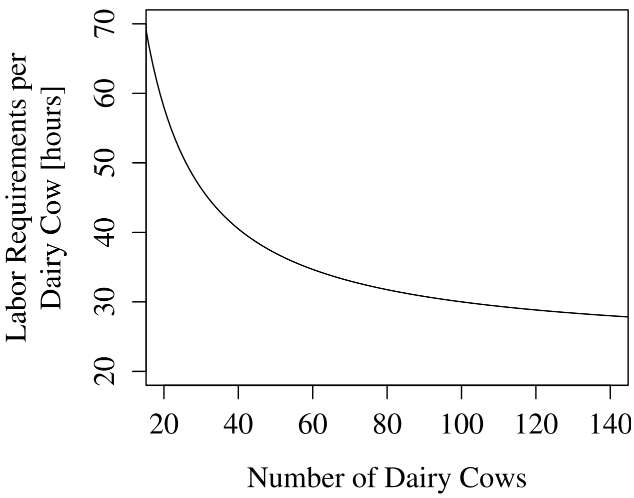

Figure 3: Labor Requirements per Dairy Cow

The milk production per cow of each farm was set equal to the average milk yield in the respective subregion. The feed requirements as well as the variable costs (e.g. concentrated feed, veterinary costs) increase with the milk yield per cow. It is assumed that the milk yield per cow increases by 10% from 2003 to 2013.

The requirements for forage of the cattle and sheep was divided into five parts: silage and pasture feed split into four grazing periods. While silage can be substituted for pasture feed, pasture feed of a certain grazing period cannot replace any other part of forage demand.

From the number of all kept animals, the indoor space for livestock husbandry was derived. It is assumed that 97.5% of the capacity for cattle and 100% of the capacity for sows and fattening pigs is utilized.

In the realistic scenario for 2013 we assume that the prices of beef, pork and sheep meat do not change from 2003 to 2013. However, due to the decoupling of the slaughter premium and the special premium for bulls, the prices of male calves will decrease. In the model the prices of bull calves are endogenous. They are chosen to get a market equilibrium in Schleswig-Holstein. This allows us to model also the impact of the decoupling on this price. The producer price of milk is assumed to decline from 0.291 €/kg in 2003 to 0.219 €/kg in 2013 due to the reduction of the intervention prices of butter and skimmed milk powder. In 2003 the surcharge for fat and protein was about 5% of the price in Schleswig-Holstein. We suppose that this surcharge will decrease proportional to the milk price and, thus, will remain 5% of the milk price.

The model contains all relevant premium payments. These premium schemes are exactly implemented in the model, both before the MTR as well as after the MTR. Since many forage-growing farms have only a small area with grandes cultures, also the small farmers scheme was implemented, again, both in the baserun and after the MTR. The modulation was 1% in the baserun and 5% in 2013.

The farms can hire labor as well as sell family labor. The wage for hiring labor is set to 10 €/hour. The opportunity cost of the family workers strongly varies. While it may be quite high for young well educated family members, it may be close to zero especially for older family members, who have almost no chance on the labor market. Furthermore the feasible wage outside the farm must be reduced by a certain amount to account for the preferences of most family members to work on their own farm. Due to these considerations we set the opportunity costs of the family workers in the model to 3 €/hour. In the long run (>15 years) this value would of course be higher.

3.3 Calculation of Profits

The calculation starts with the gross margin already maximized in the LP model. First, the profits of the farms are reduced by general expenses that are not accounted for in the LP model. These general expenses are taken from farm type specific bookkeeping data (Landwirtschaftlicher Buchführungsverband, 2002b).

Second, expenses for the tenancy of land and milk quota have to be deducted. These depend on the share of rented land and milk quota as well as on their price. Roughly half of the land and about 25% of the milk quota are rented in Schleswig-Holstein.

The shares of rented land (differentiated between arable land and permanent grassland) and milk quota represent statistical data and expert information. It is regarded that larger farms have higher shares of rented land than smaller farms.

The price for rented land depends on the shadow price of the specific soil category in the specific subregion and on the decoupled payments. The aggregated shadow price is calculated by taking the weighted average of the shadow prices of the particular soil category of all individual farms in the respective subregion. The area payments influence the price by the level of the payment and by the way these payments are established. To calculate the effect of decoupling we follow Isermeyer (2003). His model is extended to account for heterogeneous payments which occur either by single farm payments or by regional payments that differ between permanent grassland and arable land (for more details see Henning et al., 2004). Following his approach we presume that in case of single farm payments the payment entitlements are scarcer than land and, thus, land owners compete for entitlements. As a result the whole rent is transferred to the entitlement owners and the area payments are not included in the rental prices, which correspond only to the average shadow prices in the respective subregion.

In case of regional payments we again follow Isermeyer (2003) and assume that land is relatively rare compared to the payment entitlements. Then the competition for land will raise the willingness to pay for land by the level of the regional payments. Thus, in this case the rental prices correspond to the average shadow prices plus the level of the regional payments.

3.4 Implementation of the Model

The programming of the model and the analysis of the model results are implemented in the free language and environment for statistical computing "R" (R Development Core Team (2004), see also `http://www.r-project.org`). The underlying linear programming models have been solved with the R packages "lpSolve" (Berkelaar and Buttrey, 2004) and "linprog" (Henningsen, 2003) that internally use the LP software "lp_solve" (Berkelaar et al., 2003). The maps are produced with the R packages "shapefiles" (Stabler, 2003) and "maptools" (Lewin-Koh and Bivand, 2004).

3.5 Analysis of the Structural Change

Though the LP model described above is certainly appropriate to analyze the short and medium-term effects of the MTR on production decisions and farm income, it cannot examine the long-term effects on structural change.

Farm structure developments are determined by survival of farms. We divide farms into different categories according to farm type and size. The effects of the MTR on the survival of different farm categories are analyzed using following model:

$$N_i^t = N_i^0 \left(p_i^t q_i + \left(1 - p_i^t\right) r_i^t + s_i^t \right) \tag{1}$$

where for each farm category i, N_i^0 is the number of farms in the base period, N_i^t is the number of farms at time t, p_i^t is the share of farmers that retire between the base period and time t, q_i is the share of retired farmers who have a successor, $\left(1 - r_i^t\right)$ is the share of farms that leave the farm category between the base period and time t although the farmer does not retire (e.g. switch to another farm category), and s_i^t is the number of farms that enter the farm category between the base period and time t represented as a share of N_i^0.

According to empirical studies farm survival in Germany is mainly determined via farm succession (for a literature overview see Tietje, 2004, chapter 4). Thus, q_i is the most important factor influencing structural change. To determine the share of farms that have a successor (q_i) we use an existing model on farm succession decisions estimated for farms in Schleswig-Holstein (Tietje, 2004). This model estimates the probability of succession for individual farms as a function of farm type, size, profit and other socio-economic determinants. Based on these results the probability of succession can be calculated for each farm category and for different levels of profit.

Our model on the structural change (equation (1)) is calibrated using data of the agricultural censuses of 1991 and 1999. The year 1991 is taken as base period and year 1999 as time t. For each farm category the number of farms in 1991 (N_i^0) and 1999 (N_i^t) as well as the share of farmers who retired between 1991 and 1999 (p_i^t) are taken from these data. The share of retired farmers who have a successor (q_i) is evaluated for each farm category using the model of Tietje (2004). Thus, only r_i^t and s_i^t are unknown, and assuming reasonable values for s_i^t, r_i^t can be directly calculated.

Having the model on farm survival (1) fully specified, we use it to forecast the development of the farm structure. Assuming an exponential growth model ($N_i^t = N_i^0 e^{w_i t}$) the annual growth rates (w_i) of each farm category can be calculated by

$$w_i = \frac{\ln \left(p_i^t q_i + \left(1 - p_i^t\right) r_i^t + s_i^t \right)}{t} \tag{2}$$

where t, the time period between the two agricultural censuses, is 8 in our case. As the impact of MTR on farm incomes is already known from the LP model, the share of retired farmers who have a successor (q_i) can be additionally evaluated with farm incomes after the MTR. Thus, assuming that p_i^t, r_i^t and s_i^t do not change, the annual growth rates of different farm categories after the MTR can be calculated using equation (2).

4 Results

4.1 Realistic Scenario

At first the results of the realistic scenario are presented. This scenario assumes full decoupling where decoupled payments are introduced as uniform regional premiums, which will have reached 359 €/ha in 2013. Furthermore, the prices of most crop products and meat do not change, but the price of rye is slightly reduced and the milk price is clearly reduced (see section 3).

The optimal adjustment of farm production to MTR until 2013 varies significantly over individual farms. In the short and medium term individual resource endowments (i.e. milk quota, stable capacities, land and soil quality) are the most important determinants of the adjustment at individual farm level.

However, on average specific adjustment patterns can be observed for different farm types. Significant adjustments can be observed for forage-growing farms and mixed farms, while cash crop and pig farms do not significantly adjust their output structure to the MTR. On average forage-growing farms reduce bull fattening by 22% and suckler cows by 98%. Specialized dairy farms continue to produce milk and fully use their milk quota despite the milk price reduction. All forage-growing farms extensify their forage production. While forage-growing farms on low quality soils (i.e. especially in the “Geest” region) do this by increasing the area for forage production and reducing cash crop production, forage-growing farms on better soils (i.e. “Marsch” region) reduce the number of animals. Moreover, specialized dairy farms and grain farms continue to use the large part of their land for agricultural production and cease production only on a small part of their land (max. 3%). In contrast, forage-growing farms specialized in bull fattening or suckler cow farming cease production on a significant share of their land ranging up to 45% in specific areas. Farms predominantly cease production on low quality permanent grassland.

Farm incomes are significantly reduced by 20% on average due to the MTR. However, the impact of the MTR on farm profits varies significantly over individual farms, farm types and regions. In particular, dairy farms observe on average the highest profit reductions ranging from -24% up to -37%, while the income of cash crop and pig farms is not much affected by the MTR (between -4% and +8%). Forage-growing farms specialized in beef production on average observe a rise in profit of 17%. For all farm types profit reductions are lower for small farms compared to large farms. This has several reasons. The most important causes are the following: First, the modulation of the payments favors small farms. Second, small cash crop and pig farms make a higher share of their profits with products that are not negatively affected by the MTR (e.g. pig farming, cabbage) than large farms of the same type. Third, the share of costs in total revenue is smaller for small farms than for large farms, because the latter have to hire workers. Thus, for farms that can only minimally adjust their production (i.e. cash crop, pig and specialized dairy farms) a proportional reduction of the revenues (e.g. milk sales or area payments) implies that the profits of large farms are relatively more reduced than the profits of small farms.

At aggregate level agricultural production adjustments are much more moderate when compared to individual farm level. On average the area of cash crops is reduced by 2% and the area for forage growing decreases by 1%. However, one can observe clear regional adjustment patterns (see figure 4).

In the “Marsch” and “Hügelland”, where the soils are highly productive for grain farming, the cash crop production is slightly increased (+0.4% and +1.7%), while forage production is reduced (-1.2% and -5.6%, respectively). On the other hand, in the “Geest”, where the soils are less productive, cash crop production is reduced by 16% and forage growing is increased by 1%.

About 1.5% of total agricultural land is no longer used for production and will only be maintained to receive the decoupled premium. This land is predominantly low-quality permanent grassland and its share of all agricultural land varies from 0.3% in the “Marsch” to 2.8% in the “Geest”.

In spite of the strong decrease of the milk price the milk quota is still fully used. The number of dairy cows is reduced by 8%, because the milk yield per cow (+10%) rises more than the milk quota (+1.5%). Suckler cow farming is reduced in all regions by more than 90%. Due to the reduction of dairy and suckler cows less calves are born and, thus, less bulls can be fattened. Furthermore, the augmentation of calf fattening instead of bull fattening reduces the number of kept male cattle. The reduction of male cattle for fattening is on average 16%, but varies considerably between regions. It is

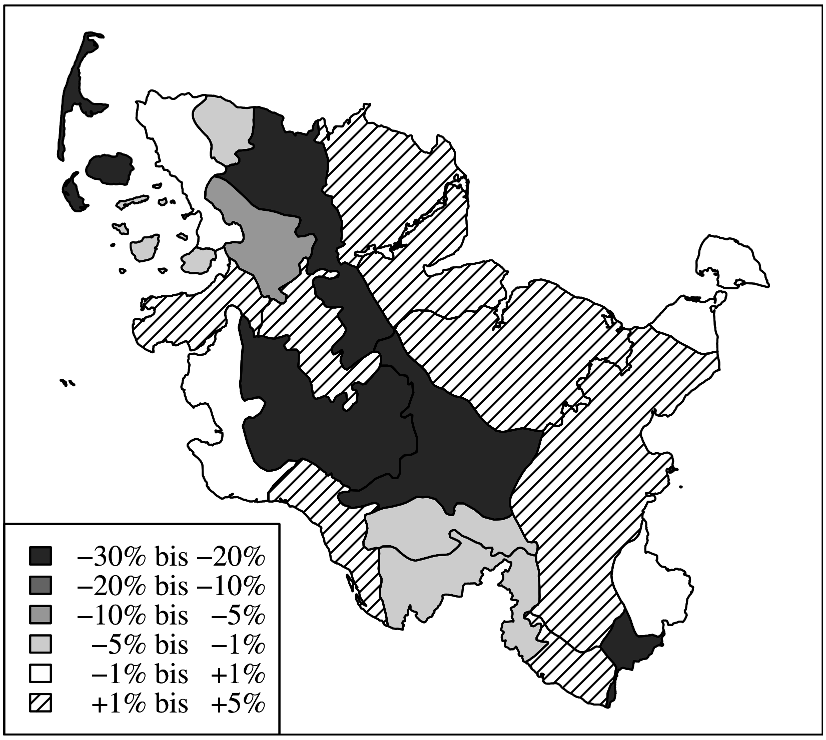

Figure 4: Changes of Cash Crop Production

48% in the “Marsch”, 11% in the “Geest” and only 1% in the “Hügelland”. Due to the decoupling of the special premium for bulls and the slaughter premium the price of bull calves decreases by 77%.

The area payments for grandes cultures before the MTR and the decoupled premiums after the MTR are both shifted to the land owners via the rent for land. Thus, the decrease of the area payments from 429 €/ha to 359 €/ha is the main reason for the decline of the shadow prices of arable land (-17%).

Since the new decoupled area premiums for permanent grassland are shifted to the land owners to a larger extent than the previous animal premiums, the shadow prices of permanent grassland rise on average by 34%. Especially the shadow prices of low quality permanent grassland that are very low before the MTR rise to the level of the decoupled premium minus the costs to maintain the area (e.g. mowing).

The shadow price of milk quota is reduced by the decrease of the milk price and the quota enlargement. However, the decoupling of other cattle and crop premiums worsens the alternative utilization of land and labor which gives a positive impact on the quota value. On average the shadow price of the milk quota decreases by 39%.

4.2 Alternative Scenarios

In the following section a few results of alternative scenarios are presented.

Since decoupled payments do not affect production decisions, the distribution of these payments (e.g. single farm payments, regional uniform payments, regional payments differentiated between arable land and permanent grassland, milk premium farm specific or regionalized) does not affect production decisions. However, this of course strongly influences the income of individual farms and the shadow prices of land and milk quota.

While a unified regional decoupled premium (realistic scenario) reduces farm incomes on average by 20%, single farm payments do not reduce the average farm profit. The main reason for this is that single farm payments lead to much lower rents for agricultural land (see section 3.3).

Interestingly, individual farm profit developments and premium payments are not perfectly correlated across decoupling scenarios, because the decoupling scenarios not only affect the premium payments, but also the prices of land and milk quota. For example, dairy farms receive the highest premium payments assuming unified regional premium payments and a farm specific milk premium. However, these farms realize their lowest profit loss assuming single farm payments.

4.3 Structural Change

The model described in section 3.5 is used to project the structural change of the agricultural sector in Schleswig-Holstein. Furthermore, it is analyzed how the structural change is influenced by the MTR. Projected annual growth rates of different farm types and farm sizes with and without the MTR are shown in table 3.

Table 3: Annual Growth Rates of Different Farm Types

	without MTR	with MTR
Cash crop farms		
≤ 50 ha	-4.5%	-4.6%
> 50 ha	-1.1%	-1.2%
Forage-growing farms		
≤ 50 ha	-4.1%	-4.3%
> 50 ha	0.0%	-0.2%
All farms		
≤ 50 ha	-4.2%	-4.4%
> 50 ha	-0.3%	-0.5%

The results show that although the MTR has a clear impact on farm profits in the short and medium run, induced profit reductions have only little impact on the survival of individual farms and, thus, on the long-run development of farm structure. Hence, structural change is independent of the MTR characterized by a clear decrease of small farms and an increasing average farm size. Our projections for 2030 show that the average farm size would be 94 ha without MTR and will be 100 ha with MTR.

5 Summary and Conclusions

The Mid-Term Review is one of the most important reforms since the establishment of the CAP. It contains new agricultural policy instruments, for which specific economic implications are not fully understood, yet. Therefore, the quantitative economic impact of the MTR on agricultural production, farm income and structural change is analyzed in this paper. This analysis is carried out exemplarily for Schleswig-Holstein, the most northern federal state of Germany. The agricultural sector of Schleswig-Holstein is highly productive and is characterized by very heterogeneous conditions for agricultural production. Especially the soil quality strongly differs between regions.

The effects of the MTR on agricultural production and farm income until 2013 are modeled using a detailed farm group linear programming (LP) model. The main advantage of this model is its excellent data base, because it is based on data of virtually all 15,000 farms in Schleswig-Holstein. These data provided by the department of agriculture are based on the data that farms submit when applying for direct payments.

Since farm survival is mainly determined via farm succession, we analyzed the effects of the MTR on structural change using an existing model on farm succession decisions estimated for farms in Schleswig-Holstein (Tietje, 2004). As the decision on farm succession depends also on the profits of the farm, we are able to analyze the effects of the MTR on structural change via the effects of the MTR on farm profits using the results of the LP model.

The effects of the MTR on optimal adjustment of farm production and on farm profits vary significantly over individual farms. Resource endowments are the most important determinants of the adjustment. While forage-growing farms and mixed farms significantly adjust to the MTR, cash crop and pig farms do not. Forage-growing farms reduce bull fattening by 22% and suckler cows by 98%. Dairy farms still fully use their milk quota despite the milk price reduction. All forage-growing farms extensify their forage production. The MTR reduces average farm incomes by 20%, but this varies significantly over farm types, farm sizes and regions. On average dairy farms observe the highest profit reductions (-31%).

At aggregate level agricultural production adjustments are much more moderate when compared to individual farm level. However, one can observe clear regional adjustment patterns. In the regions with good soils grain production slightly increases and forage growing slightly decreases. However, in regions with poor soils grain production significantly decreases and forage production slightly increases. Only a small proportion of land is no longer used for production. Though the MTR has a significant influence on farm income, its impact on the farm structure is rather low.

Although the MTR introduces new policy instruments, it does not significantly change aggregate agricultural production and farm structure - at least in Schleswig-Holstein. However, significant changes can be observed at regional and farm level. Since the effects of the MTR strongly depend on the resource endowments of the farms, disaggregated farm level models are necessary to analyze the specific impact of the MTR. Furthermore detailed farm level data are needed for modeling. Thus, the modeling approach and the data base used in this analysis are very suitable for modeling agricultural policies.

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