Studies on the Agricultural and Food Sector in Central and Eastern Europe

Christoph Sahrbacher

Regional structural change in European agriculture

Effects of decoupling and EU accession

LEIBNIZ-INSTITUT FÜR AGRARENTWICKLUNG
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Leibniz-Institut für Agrarentwicklung in Mittel- und Osteuropa (IAMO)
Theodor-Lieser-Straße 2
06120 Halle (Saale)
Tel.: 49 (345) 2928-0
Fax: 49 (345) 2928-199
e-mail: iamo@iamo.de
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Halle (Saale), Juli 2011 Christoph Sahrbacher

ZUSAMMENFASSUNG

Die Halbzeitbewertung der Agenda 2000 führte zur Entkopplung der Direktzahlungen von der landwirtschaftlichen Produktion. Diese wird dadurch nicht mehr direkt von den Direktzahlungen beeinflusst und handelsverzerrende Wirkungen wurden abgebaut. Die Produktionseffekte dieser Politikänderung wurden umfassend untersucht (EUROPEAN COMMISSION 2003a, FRANDSEN et al. 2003, BINFIELD et al. 2004, GOHIN 2006 and KÜPKER et al. 2006). Die vorliegende Arbeit geht deshalb über die Untersuchung der Produktionsstruktur hinaus und befasst sich mit der Fragestellung, wie sich die Entkopplung auf die Entwicklung der Strukturen landwirtschaftlicher Betriebe, die Einkommen und die Überwälzung der Direktzahlungen auf die Pachtpreise in unterschiedlich strukturierten Regionen auswirkt.

Hierbei wurde das agentenbasierte Modell AgriPoliS genutzt. AgriPoliS ermöglicht im Vergleich zu anderen Modellen die modellendogene Untersuchung von Strukturwandel hinsichtlich des Wachstums und des Ausscheidens von Betrieben aus der Landwirtschaft. Hierzu wird die Agrarstruktur einer Region abgebildet und die Entwicklung der Betriebe in der Region simuliert. Durch die räumliche Modellierung ist es möglich Transportkosten und Interaktionen auf dem Bodenmarkt zu berücksichtigen. Die Betriebe können durch Investition ihre Spezialisierung ändern. Die Größe der Betriebe ändert sich durch Zupacht oder Abgabe von Flächen sowie Investitionen. Darüber hinaus können die Betriebe die Produktion auch einstellen, sofern sich eine außerlandwirtschaftliche Tätigkeit mehr lohnen würde oder der Betrieb illiquide ist.

Ziel der Arbeit war es AgriPoliS, das bisher nur an die kleinstrukturierte Region Hohenlohe angepasst wurde, an sechs weitere Regionen innerhalb der EU (Bretagne, Südostengland, das Mittelsächsische Lößgebiet, Jönköping und Västerbotten in Schweden, und Vysočina in Tschechien) anzupassen, um einen Überblick über die Anpassungsreaktionen von Betrieben in unterschiedlich strukturierten Regionen zu bekommen. Dies stellt die Grundlage für die anschließende Untersuchung der Auswirkungen der Halbzeitbewertung auf die Indikatoren Betriebsaufgabe, Viehbesatzdichte, Betriebseinkommen und Pachtpreis in der EU-15 dar. Um die Entwicklung in den der EU 2004 und 2007 beigetretenen osteuropäischen Ländern darzustellen, wurde zusätzlich die Region Vysočina in Tschechien untersucht. Da sich die politischen und strukturellen Rahmenbedingungen in den neuen EU-Mitgliedsländern deutlich von denen in den alten Mitgliedsländern unterscheiden und auf Grund des Beitrittsprozesses, wird die Region Vysočina gesondert untersucht.

Ziel des Vergleichs der Regionen in den alten Mitgliedsländern war es herauszufinden, ob die Auswirkungen der Halbzeitbewertung von der Ausgangsstruktur einer Region abhängen. Neben dem von der EU-Kommission ursprünglich vorgeschlagenen historischen Entkopplungsmodell wurden die von den nationalen Regierungen gewählten Ausgestaltungsformen der Entkopplung in einem Szenario berücksichtigt. Zusätzlich wurden als Alternative in einem Szenario die Auswirkungen des von SWINBANK and TRANTER (2004) vorgeschlagenen Bond schemes untersucht. Um die Auswirkungen der Entkopplung auf einzelne Betriebe besser zu erfassen, wurden in zwei tiefer gehenden Untersuchungen für die Region Hohenlohe in Südwestdeutschland und die Region Vysočina einzelbetriebliche Daten unter anderem differenziert nach Rechtsform und Betriebstyp ausgewertet.

Die Untersuchungen zeigen, dass im Vergleich zu einer Fortführung der Agenda 2000 die Halbzeitbewertung neben einem Rückgang der Rinderhaltung auch zu einem Rückgang der Betriebsaufgaben führt. Letzteres ist darauf zurückzuführen, dass sich die Betriebe mit der Entkopplung der Direktzahlungen von der Produktion stärker am Markt orientieren und dadurch ein höheres Einkommen erzielen. So überleben z.B. viele Betriebe durch Aufgabe der Rindermast bei Pflege ihres Grünlands durch Mulchen.

Der Vergleich der Regionen zeigte, dass die Halbzeitbewertung in allen Regionen vergleichbare Auswirkungen auf die Tierhaltung, die Betriebsaufgabe und das Einkommen hat. Dies gilt jedoch nicht für den Bodenmarkt. So steigen die Pachtpreise für Ackerland im Vergleich zur Agenda 2000 in Regionen, die vorher stark durch Rinderhaltung geprägt waren, stärker, da es dort zu einer Umverteilung der Prämien von der Rinderhaltung zugunsten der Flächennutzung kommt. In Südostengland und im Mittelsächsischen Lößgebiet, wo Rinderhaltung von geringer Bedeutung ist, ist dies nicht zu beobachten.

Vergleicht man das BOND Szenario mit der Halbzeitbewertung, so lässt sich eine deutliche Zunahme der Betriebsaufgaben beobachten. Gleichzeitig kommt es dabei zu einem Abfluss von Direktzahlungen aus der Landwirtschaft, da die ausscheidenden Betriebe weiterhin Direktzahlungen erhalten. Der daraus resultierende Einkommensverlust für die in der Landwirtschaft verbleibenden Betriebe kann jedoch zum einen durch die Realisierung von Größeneffekten und zum anderen durch einen deutlichen Rückgang der Pachtpreise je nach Region teilweise oder vollständig kompensiert werden.

Die Analyse von einzelbetrieblichen Daten von sowohl in der Landwirtschaft verbleibender als auch ausgeschiedener Betriebe in der Region Hohenlohe ergab, dass sich einzelne Betriebe auf Grund ihrer kurzfristigen Sichtweise von den Politikänderungen fehlleiten lassen und in der Landwirtschaft bleiben, obwohl es für sie langfristig lohnender wäre aus der Landwirtschaft auszuscheiden. Diese kurzfristige Sichtweise könnte auch die Persistenz und die großen funktionalen Einkommensdisparitäten in der westdeutschen Landwirtschaft erklären.

Die Untersuchung der Einführung der GAP in den neuen Mitgliedsländern und der sich später anschließenden Entkopplung der Top-ups ergab, dass die Auswirkungen der Einführung der GAP deutlich stärker sind als die Entkopplung der Top-ups und letztere dadurch deutlich überlagert werden. Durch den Vergleich der Simulationsergebnisse des Beitrittszenarios mit empirischen Daten ließen sich die Simulationsergebnisse bestätigen. So zeigen sowohl die Simulationsergebnisse als auch die empirischen Daten, dass sich die Betriebsaufgaberate mit dem Beitritt leicht reduziert hat. Dies lässt sich durch die Einkommenssteigerung auf Grund der von Jahr zu Jahr steigenden Direktzahlungen erklären. Gleichzeitig nimmt aber auch die Überwälzung der Direktzahlungen auf die Pachtpreise zu, so dass nicht nur die Landwirte von den steigenden Direktzahlungen profitieren, sondern auch die Bodeneigentümer.

Die Entkopplung der Top-ups in 2009 führt nur zu einer minimalen Reduzierung der Betriebsaufgaberate, was sicherlich mit der zunehmenden Überwälzung der Direktzahlungen auf den Bodenmarkt und dem damit einhergehenden Gewinnrückgang zusammenhängt. Es hat sich gezeigt, falls die neuen Mitgliedsländer ihre Top-ups wie ursprünglich geplant 2009 hätten entkoppeln müssen, es im Falle der Einführung des Regionalmodells zu abrupten aber geringen Prämienumverteilungen zwischen den Betrieben gekommen wäre. Da die Entkopplung der Top-ups für die neuen Mitgliedsländer jedoch im Rahmen des 2008 durchgeführten Gesundheitschecks auf 2013 verschoben wurde, ergibt sich die Situation, dass es zu einer schrittweisen Entkopplung und Einführung des Regionalmodells kommt. Dazu kommt es, da die Top-ups automatisch reduziert werden, sobald die Summe aus Top-ups und entkoppelten Flächenprämien dem endgültigen Gesamtvolumen der Flächenprämien in 2013 entspricht. Der Vorteil dieser schrittweisen Einführung ist, dass die Landwirte sich leichter daran anpassen können.

SUMMARY

The mid-term review of the Agenda 2000 led to the decoupling of direct payments from production. Thus, agricultural production is no longer directly influenced by direct payments and trade distortions have been reduced. The production effects of this policy have been analysed in detail (EUROPEAN COMMISSION 2003a, FRANDSEN et al. 2003, BINFIELD et al. 2004, GOHIN 2006 and KÜPKER et al. 2006). The present study goes further, however, and deals with the question of how decoupling affects the development of farm structures, farm incomes and the capitalisation of direct payments into rental prices in differently-structured regions.

The agent-based model AgriPoliS was used to carry out this analysis. Compared to other models, AgriPoliS allows the analysis of structural change with respect to farm growth and farm exit. Therefore, AgriPoliS represents the structure of an agricultural region and simulates the development of farms located in the region. The modelling of space allows the consideration of transport costs and interactions on the land rental market. Farms can also change their production structure by investing in new activities. Furthermore, they change their size by renting or releasing land. Moreover, farms stop production if it is more profitable or if they are illiquid.

The objective of this study was to adapt AgriPoliS to six further study regions (Brittany, South East England, the Central Saxonian Loess Region in East Germany, Jönköping and Västerbotten in Sweden, and Vysočina in Czech Republic), given that it has only been applied to the small-structured Hohenlohe Region in Southwest Germany previously. Thereby, it was possible to observe the adjustment reactions of farms located in differently-structured regions. The adaptation of AgriPoliS to additional regions was the basis for the analysis of the mid-term review's impacts on the farm exit rate, livestock density, farm income and rental prices in the EU-15. The Czech region Vysočina has been analysed separately because of the differences in the political framework between the New Member States and the Old Member States, as well as in the accession process.

The objective of comparing the regions in the Old Member States was to find out whether impacts of the mid-term review depend on the initial structure of a region. In addition to the historical model as initially suggested by the EU Commission, the decoupling options chosen by the national governments have also been modelled. Additionally, the bond scheme suggested by SWINBANK and TRANTER (2004) has been analysed. To cover the impacts of decoupling on different farms, individual farm data and data on farms with different legal forms or specialisations have been analysed for the region Hohenlohe and the region Vysočina, respectively.

The analyses show that compared to the Agenda 2000, the mid-term review is leading to a reduction in cattle, as well as to a reduction of the farm exit rate. The latter can be explained by the increase in profits due to the stronger market orientation caused by the mid-term review, including the option to receive direct premiums merely for mulching marginal land. For example, many farms ceased beef fattening and are instead maintaining their grassland in GAEC.

The regional comparison showed that for all regions, the mid-term review has comparable impacts on livestock production, farm exit rate and farm incomes. However, this does not hold for the rental market. Rental prices increase in regions with a high share of cattle compared to the Agenda 2000 because cattle payments have been redistributed to land. This cannot be observed in South East England and the Central Saxonian Loess Region where cattle are of minor importance.

The comparison of the BOND scenario with the mid-term review shows a strong increase in the farm exit rate for the BOND scenario. Simultaneously, there is a run-off of direct payments from the agricultural sector because the exiting farm households still receive the payments. Potential income losses for farms remaining in the sector can be partially or fully compensated, depending on the region. This compensation is possible due to realised economies of scale and due to the reduction of rental prices.

Data analysis of model farms remaining in the sector and those exiting showed that for the region Hohenlohe during the policy change, some farms have been misled by their short-term perspective. They stayed in agriculture despite it being more profitable to exit agriculture in the long term. However, such a short-term perspective may exist in reality and could explain the persistence and the very large income disparities in West German agriculture.

Analysing the impacts of the introduction of the CAP in the NMS and of the following decoupling of top-ups showed that the impacts of introducing the CAP are significantly stronger than those of decoupling top-ups. The latter are even overlaid by the introduction of the CAP. Furthermore, it was possible to validate the simulation results for the accession scenario with empirical data. The simulation results, as well as the empirical data, show a slight reduction of the farm exit rate due to accession to the EU. The reason for this development is the increase of farm incomes due to the annually increasing direct payments. However, capitalizing payments into land prices is simultaneously increasing. Accordingly, not only do farmers benefit from the increasing direct payments but so do landowners.

Decoupling top-ups in 2009 only slightly reduces the farm exit rate. This is probably due to the increasing capitalization of payments into rental prices and the resulting decline in profits. If the New Member States had to decouple top-ups

in 2009 as initially planned, and if they had decided for the regional model, a small share of the payments would have been abruptly redistributed among farms. But this did not happen in reality because within the Health Check of the MTR in 2008, decoupling top-ups has been postponed to 2013. Due to this postponement, top-ups will be stepwise decoupled and the regional model will be stepwise introduced until 2013. This gives farms more time to adapt to the new situation. The reason for this development is that top-ups have to be automatically reduced when the sum of top-ups and decoupled area payments equals the total volume of area payments in 2013.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AgriPoliS	Agricultural Policy Simulator
AWU	Annual Work Unit
BMELV	German Federal Ministry of Food, Agriculture and Consumer Protection
CAP	Common Agricultural Policy of the European Union
CEEC	Central and Eastern European Countries
CF	Corporate farms
CNDP	Complementary National Direct Payments
COP	Cereals, Oilseeds and Protein plants
CZ	Czech Republic
DFG	German Research Foundation
DOE	Design of Experiments
EA	Eligible Area
EAAE	European Association of Agricultural Economists
EARL	Exploitation agricole à responsabilité limitée (=legal entities)
ESIM	European Simulation Model
ESU	European Size Unit
EU	European Union
FADN	Farm Accountancy Data Network
FAMOS	FarM Optimization System
GAEC	Groupement agricole d'exploitation en commun (=partnerships)
GAEC	Good Agricultural and Environmental Conditions
GTAP	Global Trade Analysis Project
HC	Health Check
IAAE	International Association of Agricultural Economists
IACS	Integrated Administration and Control System
IF	Individual farms
KTBL	Kuratorium für Technik und Bauwesen in der Landwirtschaft
LU	Livestock unit
MIP	Mixed-integer programming
MTR	Mid-term review

NMS	New Member States
OECD	Organisation for Economic Co-operation and Development
OMS	Old Member States
SAFER	"Société d'Aménagement Foncier et d'Etablissement Rural"
SAP	Single Area Payment
SAPS	Single Area Payment Scheme
SDI	Shanon's diversity index
SFP	Single Farm Payment
SPS	Single Payment Scheme
UAA	Utilized agricultural area
URAA	Uruguay Round Agreement of Agriculture
WTO	World Trade Organization

1 GENERAL INTRODUCTION

1.1 Problem assessment

For a decades market price support was the major element of the EU's Common Agricultural Policy (CAP). However, because of overproduction and increasing costs, the MacSharry reform of 1992 introduced change to the system. Tariffs and intervention prices have since been reduced and farmers began to receive direct payments for specific crops and animals as compensation for the reduction of intervention prices. This development was taken further by the Agenda 2000 reform, as price support has been stepwise reduced and direct payments have increased. Indeed, these reforms lessened the pressure from WTO negotiations by increasing market access for other countries as well as reducing export support. However, direct payments still caused production surpluses and high costs. At the same time, additional pressure on the agricultural budget was created by EU enlargement. Thus, the "mid-term review" (MTR) of the Agenda 2000 in 2003 led to a fundamental change in the CAP. Thereafter, approximately 90% of direct payments granted for crops (crop-specific area payments), meat and milk (animal payments) were converted to area payments decoupled from production. Farmers now have to fulfil cross compliance obligations and have to maintain land in Good Agricultural and Environmental Condition (GAEC) to receive the payments, i.e. payments are coupled to land use. Simultaneously, market price support has largely been reduced and currently only functions as a safety net (BASCOU et al. 2005). The European Commission called the new system the Single Payment Scheme (SPS), because payments are no longer differentiated according to production activities (crops, meat and milk). Initially, it was planned to calculate area payments according to the historical production of a farm, which is why they are also called "single farm payments". However, the initial proposal of the SPS was weakened by several member states that preferred only partially decoupled payments. Additionally, the proposal was extended by the possibility of introducing a regional payment instead of the single farm payment, where the level of area payments varies among farms. An expected impact of decoupling direct payments was the reduction of trade and production effects (OECD 2001a and DEWBRE et al. 2001). Farmers now decide what to produce depending on market prices, rather than producing a specific product to receive payments. BALKHAUSEN et al. (2008) compares the results of several simulation models, and each of them estimated that beef, cereal and silage maize production all decrease. Vacant land will be used for fodder plants other than silage maize, and a part of the land is also used as set-aside (BALKHAUSEN et al. 2005 and KÜPKER et al. 2006).

A key issue of this thesis is the analysis of the MTR's impact on structural change. As production effects are reduced to a minimum with the decoupling of direct payments, aspects of structural change other than production come to the forefront. BOEHLJE (1992) states that the structure of an industry includes many dimensions: i) the size distribution of firms; ii) the industry's technological and production characteristics; iii) the characterization of the workforce; iv) the resource ownership and financing pattern; and v) inter- and intrasector linkages. Less analysed, however, are the impacts of decoupling on farm size distribution, that is, farm exit and growth (BALMANN 1997, HAPPE 2004, HAPPE et al. 2008, HENNINGSEN et al. 2005 and HENNESSY and REHMAN 2006). This topic may in future be of particular interest because of the structural deficits present in European agriculture. For example, the average farm size in the EU is 12 ha, while in the USA it is 180 ha (EUROPEAN COMMISSION 2009). Comparable structures can only be found in East Germany (197 ha), the Czech Republic (135 ha), Slovakia (113 ha) and the UK (75 ha) (HEMMERLING et al. 2009 and EUROSTAT 2010).[1] It may be assumed that the MTR reduces farm exit rates because farms can stop unprofitable production activities and simply maintain land in GAEC to receive area payments. In addition to policy changes within the MTR, potential future policy changes also suggest a stronger focus on farm exit and growth. For example, the modulation of direct payments dependent on farm sizes agreed to in the Health Check (HC) of the MTR in 2008 can improve small farms' ability to compete for land compared to large farms. Another interesting aspect of the MTR is that direct payments have only been decoupled from production (output), but not from the input of production factors, that is, the payments are still coupled to land use. This linkage leads to the capitalization of payments into land rents, and it is interesting to analyse what would happen if payments would also be decoupled from land use. BASCOU et al. (2005) state that in 2004, the knowledge of: i) structural changes in agriculture; ii) the interaction of land markets with changing agricultural policies; iii) producers' adjustment process to the policy reform; and iv) the competitiveness of agriculture were all limited, thus, further empirical research is needed to extend the modelling tools. Since then, knowledge of these areas has been extended. On the one hand, various empirical analyses have been conducted to gain understanding of farmers' entry and exit behaviour. On the other hand, modellers extended their models to consider land markets or structural change, and new models have been built. Empirical analyses are conducted, for instance, by econometric regression models or Markov chains. Regression models are used to identify variables explaining

[1] Only farms larger than 2 ha are considered. In the EU, the average size of farms bigger than 2 ha is 24 ha (EUROSTAT 2010).

structural change rather than predicting structural change.[2] In contrast, Markov chains are used for predictions. Most studies using Markov chains concentrate on the transition between farm size classes and on-farm entry and exit (WEISS 2007).[3] Therefore, both transition probabilities that can be fixed over time (stationary) or can change over time (non-stationary) are estimated (ZIMMERMANN et al. 2009). Indeed, econometric models are well-based on empirical data, but it is difficult to analyse future policy changes. Therefore, assumptions about how structural change will be affected must be made (WEISS 2007).

A recent extension of general and partial equilibrium models, as well as mathematical programming models, has allowed modellers to incorporate land markets. For example, VAN MEIJL et al. (2006) implemented a land supply function in the general equilibrium model GTAP (Global Trade Analysis Project) to allow changes in total land use in their model. Further, VAN MEIJL et al. (2006) used this land supply function to analyse how land use will change in response to various possible WTO negotiation outcomes. BALKHAUSEN (2007) used the same approach for the partial equilibrium model ESIM (European Simulation Model). Compared to previous versions of ESIM, extending agricultural areas for production due to product price increases are buffered by increasing land prices.[4] BERTELSMEIER (2005) extended the mathematical programming model FARMIS by introducing a land market. This extension allows the transfer of land among farm groups and the calculation of equilibrium prices for rented land based on a land exchange equation. In AROPAj, another mathematical programming model, shadow prices are used as an indicator of land rents, but land is not transferred between farm groups (JAYET et al. 2007). Other researchers implemented a structural change module in their models instead of land markets. For example, HENNINGSEN et al. (2005) have built a farm group model for the German Federal State of Schleswig-Holstein, which considers farm succession based on a model by TIETJE (2004). HENNESSY and REHMAN (2006) implemented a similar module in the FAPRI EU GOLD model[5] for Ireland. For this model, the probability for the choices of: entering farming; entering a non-farming

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2 Recent studies using regression models for the analysis of structural change and its determinants were carried out by GLAUBEN et al. (2004), BALTENSWEILER and ERDIN (2005), GLAUBEN et al. (2006), MISHRA and EL-OSTA (2006), VÄRE (2006), WEISS (2006), BREUSTEDT and GLAUBEN (2007), MARGARIAN (2007) and HÜTTEL and MARGARIAN (2009).

3 ZIMMERMANN et al. (2009) provides an overview on studies using Markov chains for predicting structural change.

4 In the EU, there is a land reserve of on average 8% that can be used for agriculture (BALKHAUSEN 2007). That means the utilized agricultural area in the EU can be expanded. The land reserve varies among the member states between 1.8% in Belgium and 23% in Portugal, but in most countries it is around 6%.

5 The GOLD (grains, oilseeds, livestock and dairy) model is a dynamic, partial equilibrium model of the EU agricultural sector that is maintained by FAPRI at the University of Missouri and has been used for the analysis of recent changes in EU policy (BINFIELD and WESTHOFF 2003 and BINFIELD et al. 2003).

occupation; or entering part-time farming are estimated by a multinomial logit. WEISS (2007) has chosen another approach; he calculates the probabilities for changes in farm capacities (stables, land) and for farm exit with a regression model. These probabilities are then implemented in the Austrian farm group model FAMOS (FArM Optimization System). A disadvantage of these models is that structural change is estimated based on historical data, which might not be valid for a fundamental policy change like the MTR. Additionally, models by HENNINGSEN et al. (2005), HENNESSY and REHMAN (2006) and WEISS (2007) do not consider land markets, and vice versa, models considering land markets do not consider structural change in a detailed manner.[6] A model that does consider both is the Agricultural Policy Simulator (AgriPoliS), developed by HAPPE (2004), HAPPE et al. (2006) and KELLERMANN et al. (2008), based on BALMANN (1997) (c.f. BALMANN 1995). With the exception of inter-sectoral linkages, AgriPoliS considers all dimensions of BOEHLJE's (1992) definition of agricultural structures. AgriPoliS is bottom-up oriented and explicitly represents farms and their endogenous development over time in a study region. The regional development is the aggregated result of the single farm's development. Land, being a key factor for farm development, is released by shrinking and abandoned farms and is offered for rent by an auctioneer. Until 2003, AgriPoliS had only been adapted to one case study region, "Hohenlohe", in Southwest Germany. HAPPE and BALMANN (2002, 2003) and HAPPE (2004) used it to analyse the general effects of decoupling on structural change and efficiency. However, the results were for just one region, and thus of a limited representativeness.

1.2 Objectives of the study

The objectives of this study can be divided into policy-related and methodological categories. The ***policy-related objective*** is to analyse the impacts of the MTR on farm size and income distribution. The following questions should be answered in this regard:

1) Does the impact of the MTR depend on the structure of an agricultural region?
2) Does the MTR reduce the farm exit rate?
3) Who are winners and losers of the MTR?
4) What would the impact be of also decoupling direct payments from land input?

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[6] In these models, structural change is only considered as a general trend. At the moment, the FARMIS modelling group works on this problem within the project "Strukturwandel im Agrarsektor – Eine unternehmens- und politikbezogene Analyse", which is financed by the German Research Foundation from 2007 to 2010. This group attempts to differentiate the general trend of structural change by assigning to each farm group an exit probability derived from empirical analyses.

The ***methodological objective*** is to improve and extend the agent-based model AgriPoliS so that it is able to cope with challenges of further policy analysis described by BASCOU et al. (2005). AgriPoliS can contribute to scientific discussions about the impact of policy changes on structural change (farm exit), on land markets and on the development of farm incomes under consideration of structural change. For example, policy changes can have negative impacts on some farmers' income, while others can gain by realizing scale efficiency due to increased farm size. The improvements to AgriPoliS should facilitate coping with future policy changes like the HC or policy changes that will come after the end of the budgetary period in 2013.

To achieve the stated objectives, the approach will be the following. *First*, a theoretical background about the concept of decoupling and its potential impacts will be provided. Theoretical considerations about the impacts of decoupling on land markets and changes in farm size will contribute to discussing and interpreting the model's results. The *second* step is to apply AgriPoliS to several regions across the EU. Regions will be selected according to characteristics like farm size (small/large), intensity of production (high/low), level of income (high/low), predominant legal form of farming (individual farms/legal entities), type of decoupling (farm-specific/regional/hybrid) and location (Old and New Member States). Modelling several regions is, on the one hand, an extension of AgriPoliS, and on the other hand the foundation for analysing the MTR. Modelling a region and the input data will be described in detail to ease the adaptation of AgriPoliS to further regions. Further model extensions were done to better cope with possible future policies. One example is the consideration of modulation, which facilitates analysing the impacts of modulation on the competition for land among farms.

With these methodological improvements, it is now possible to analyse the impacts of the MTR. To answer the first question, whether decoupling has different impacts depending on the initial farm structure of a region, results for the different regions in the Old Member States (OMS) will be compared. The focus of the analysis will be on indicators of structural change (farm exit, farm size, and livestock density), farm income (profit per hectare) and land markets (average rental prices). Part of the analysis will also be to answer the second question, whether simulation results show that the MTR reduces the farm exit rate. To answer the fourth question regarding the impacts of also decoupling direct payments from land input, a kind of Bond scheme suggested by TANGERMANN (1991) and SWINBANK and TRANTER (2004) will be implemented into AgriPoliS as an alternative decoupling scheme. The impacts of such a policy will be analysed in the regional comparison, as well as in the more in-depth analysis of two regions. The in-depth analysis aims to identify the winners and losers of decoupling. In this in-depth analysis, individual farm data provided by AgriPoliS will be used. The two analyses are on the regions Hohenlohe in Southwest Germany, and Vysočina, a region in the Czech Republic. In Hohenlohe, the income development of farm households that left agriculture will also be considered in the analysis. In Vysočina, the winners and losers of payment redistributions will be identified. The separate analysis of a New Member State (NMS) region is necessary because the initial conditions are completely different to those of the OMS. On the one hand, restructuring large cooperative farms is ongoing. On the other hand, the political framework is different. The NMS started from a system with low but coupled payments, and in 2004 implemented a system of increasing decoupled area payments and additional coupled payments. The latter have been planned to be decoupled in 2009. Thus, one task will be to analyse the effects of different decoupling policies on payment allocation to various farm groups.

1.3 Structure of the study

As a basis for the analysis, the theoretical background on the impacts of decoupling direct payments will be provided in section 2. Then, the AgriPoliS model will be presented in section 3. The impacts of decoupling will be analysed in three steps. In section 4 it will be analysed by the comparison of six regions of the OMS regarding specific regional impacts of decoupling. A more detailed analysis at the individual farm level in section 5 will answer the question of who are the winners and losers of decoupling. Section 6 provides a study about a region in the NMS aiming to differentiate the impacts of accession and the impacts of decoupling.

In section 2, the concept of decoupling will be explored. Decoupling as applied by the Organisation for Economic Co-operation and Development (OECD) only focuses on production effects, that is, a policy measure is counted as decoupled when it does not cause any production effects. Thus, production effects caused by decoupling, as well as the degree of decoupling of different policy measures, will be discussed. However, focusing only on production effects does not fully reveal the impacts of a policy measure on farm incomes. Rather, this can be measured by the concept of transfer efficiency, according to which, policy measures cause economic costs and distributive leakages, the lowest being lump-sum transfers. In the case of area payments, economic costs caused by production effects are very small, but therefore leakages to land (capitalisation of payments into land rents) are higher. However, these leakages depend on the way area payments are implemented (single farm payment or regional payment). Thus, the different possibilities of implementing them within the SPS are described in the following. Finally, several theories about the capitalization of area payments under the SPS are discussed.

In section 3, the agent-based model AgriPoliS is briefly described.[7] Afterwards, the methodology for adapting AgriPoliS to a region is described in detail. Within

[7] For a detailed description of AgriPoliS, readers are referred to KELLERMANN et al. (2008), who provide the latest description of the model.

this study, this methodology has been applied to seven regions across the EU. The regions have been selected to cover the diversity of agriculture in the EU, to test whether AgriPoliS results are region-specific or whether they are generalisable. The study regions are Hohenlohe and the Central Saxonian Loess Region in Germany, Brittany in France, South East England, consisting of the Counties Surrey, Kent, West and East Sussex, Jönköping County in south-central Sweden, Västerbotten County in north Sweden, and the Vysočina region in the Czech Republic. Adapting AgriPoliS to a study region contains two steps: first, a virtual region based on individual farms has to be created. Then the individual farms and their behaviour have to be represented within a mixed integer programming model (MIP-model). For both steps, data have to be collected and calibrated to correctly represent the agricultural structure and production of the region. To represent the latter, input data like production costs, prices, investment costs and other parameters have to be calibrated such that the MIP-model represents the production of the base year. Additionally, test simulations have to be conducted and results have to be discussed with regional partners. The collection and calibration of all these data to represent the structure of the regions and the production of the farms builds the foundation for the analyses conducted in the sections 4, 5 and 6.

In section 4, the impacts of decoupling on structural change, land markets and farm income will be analysed. Furthermore, three of the four research questions will be answered, namely whether the impacts of the MTR depend on the structure of an agricultural region; whether the MTR slows down structural change; and what would the impact be of also decoupling direct payments from land input. To answer these questions, four different policies have been defined. The *first* scenario, called AGENDA, holds as a reference point. In this scenario, the Agenda policy is continued over the whole simulation. The *second* scenario, called Single Farm Payment (SFP), corresponds to the initial proposal of the European Commission, where farms receive a fully decoupled payment based on their production in the years prior to decoupling. In the *third* scenario (REFORM), policies actually implemented in the different regions are modelled. In this scenario, the spectrum of policies ranges from a partially decoupled single farm payment in Brittany, to a regional payment with coupled top-ups in the Czech region Vysočina, and a combination of both systems, the so-called hybrid decoupling. England, Sweden and Germany opted for hybrid decoupling, where parts of the direct payments are transferred to a regional payment and the rest is distributed via a farm-specific payment. In England and Germany, farm-specific payments are stepwise transferred into regional payments, known as a dynamic hybrid. All these policies are detailed in section 4.2.1. The results of the analyses show that under the assumption that there are more payment entitlements than agricultural land, payments will be capitalized into rental prices, which is in line with the theoretical thoughts of ISERMEYER (2003), KILIAN and SALHOFER (2008) and COURLEUX et al. (2008). Thus, a *fourth*, more radical scenario according to the

"Bond scheme", suggested by KOESTER and TANGERMANN (1977), TANGERMANN (1991) and SWINBANK and TRANTER (2004) is implemented. Section 4 ends with a summary of the results.

Section 5 provides a more in-depth analysis than section 4. Instead of regional aggregates, individual farm data from the simulations for the Hohenlohe region are analysed. In particular, exiting farms are considered in the analysis. The objective of this section is to identify winners and losers of decoupling by visualizing individual farm data. The behaviour of individual farms is observed and compared to phenomena actually occurring. This section shows two exemplary extensions of AgriPoliS. The *first* is made to analyse the development of exiting farm households, i.e. the income development of these households is considered and displayed in comparison to farm households that stay in the sector. The income of these farms consists of the incomes of family members, rents for owned land and interests for equity minus the depreciation and interest costs of existing assets. The *second* extension is an improvement of the expectation formation of farms regarding rental prices for policy change. Depending on the policy, rental prices for arable land and grassland can increase or decrease in the year of the policy change. Such price changes influence farmers' opportunity costs and their decision to exit agriculture. Thus, these rental price changes are considered in the expectation formation by a factor which so far was set externally by test simulations (HAPPE 2004). This has been changed, and for all analyses presented here, the factor for the rental price expectation at the policy change is calculated endogenously in AgriPoliS.

Furthermore, section 6 provides a detailed case study for the NMS. The study region is the Czech region of Vysočina. Compared to the OMS regions, not only does the structure of Vysočina differ, so does the political framework. In the NMS, two policy changes occur. *First* is EU accession in 2004, where the previous system consisting of low-level coupled payments was changed to a system with decoupled area payments and additional coupled payments (top-ups) that increase over time. The Czech Republic introduced coupled top-ups for cereals, oilseeds and protein plants (COP) and ruminants. The *second* policy change is the decoupling of these top-ups, which was initially planned for 2009 (COUNCIL REGULATION (EC) No 1782/2003, Article 154a). But within the Health Check (HC), the European Commission extended the deadline for decoupling in the NMS to 2013 (COUNCIL REGULATION (EC) No 73/2009, Article 122 (3)). In this study, the reference scenario, which simulates the effect of EU accession, is validated against empirical data. After the validation of simulation results, we analysed the impact of different decoupling options, which are, however, less pronounced than in the OMS because in the NMS, the share of coupled payments is relatively low. A special focus of the analysis was to check how payments will be redistributed among large legal entities and small individual farms, as well as between farms specialised in different types of production.

Finally, in section 7, model improvements and results of the policy analyses will be discussed. The model results are compared with theoretical considerations provided in section 2. Furthermore, the results of other studies are used to discuss the findings of using AgriPoliS for the impact analysis of decoupling.

Depending on the region or the research question, regions have to be modelled in more detail for better representation. Such improvements are the result of the calibration and validation, and cover three areas: i) the modelling of production activities, ii) the modelling of special characteristics of a region, for example the age distribution of farmers, and iii) policy modelling. These improvements are documented in three further publications to which the author of this study contributed:

- BRADY, KELLERMANN, SAHRBACHER and JELINEK (2009) analyse the impacts of decoupled support on farms' structure, biodiversity and landscape mosaic. Since in the Swedish regions beef fattening is important for land use, it is modelled in more detail.
- HAPPE, SCHNICKE, SAHRBACHER and KELLERMANN (2009) analyse impacts of the exit and entry behaviour of farm successors on structural change in the Slovak region Nitra. Additionally, different age distributions of farmers are considered.
- KELLERMANN, SAHRBACHER, A., SAHRBACHER, C. and BALMANN (2009) extended AgriPoliS to explicitly model the progressive reduction of direct payments in Germany within the Health Check.

As these improvements are beyond the objective of this study to analyse the impact of decoupling on structural change and farm income, they are briefly summarized in the following.[8]

A further article which is not included in this study, but which focuses on the same question is:

- HAPPE, BALMANN, KELLERMANN and SAHRBACHER (2008). This paper presents the extension of AgriPoliS to a second German study region, the Central Saxonian Loess Region, in order to analyse the impact of farm structures on policy effects.

The goal of this paper is to analyse whether the different farm structures of both study regions lead to different impacts of policy changes. Both study regions, Hohenlohe in the Southwest of Germany and the Central Saxonian Loess Region, illustrate the huge difference in farm structures in West and East Germany. Hohenlohe is characterised by small family farms, with a high share of owned land (42%), high amounts of equity (~10,000 Euros/ha) and intensive livestock

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[8] For more information, the full publications, as well as the extensive AgriPoliS documentation, are attached to this thesis as separate compendium.

production (fattening pigs, sows for breeding, turkeys and dairy cows). Whereas in the Saxonian Loess Region, large legal entities with a low amount of equity (2,000 Euros/ha) and a high share of hired labour dominate. In contrast to Hohenlohe, farms are mainly specialised towards cultivating crops. Both regions are confronted with a change from the coupled payments under Agenda 2000 towards policies with decoupled payments. In the first decoupling scenario, single area payment (SAP) payments are decoupled from products, but still coupled to land use. The connection to the land use is skipped in the second decoupling scenario, the idealised decoupled Single Farm Payment (iSFP).[9] In this scenario, single farm payments are paid to the farmer independent from the continuation of farming. Comparing different indicators such as farm size, rental prices and profits shows that different initial structures lead, to some extent, to different policy effects. In both regions, a gradual increase of the average farm size can be observed for the SAP, as well as for the Agenda 2000 policy, yet the Saxony rate is lower than in Hohenlohe. Compared to the Agenda 2000 scenario, one can observe a sudden increase in farm size after switching to the iSFP. In both regions and decoupling scenarios, small farms are mainly affected by the policy change. Regarding rental prices, opposite developments can be observed in both study regions. In Hohenlohe, rental prices for arable land increase in the SAP scenario, but in Saxony they are slightly decreasing compared to the Agenda 2000 scenario. In the case of iSFP, rental prices for grassland decline in Hohenlohe to a similar level as in Saxony, where they stay more or less constant. The increase in grassland rental prices in both regions in the SAP scenario leads, together with the different shares of rented land, to different developments in profits. In Hohenlohe, they are only slightly declining, but in Saxony they decline strongly because of the higher share of rented land.

The objective of BRADY et al. (2009) is to evaluate decoupling concerning its environmental impacts. In particular, the impact of structural change caused by decoupling on the landscape mosaic and biodiversity is assessed. This policy change leads to changes in production structure and even to a decline in output. To avoid land abandonment, farmers are required to keep agricultural land in Good Agricultural and Environmental Condition (GAEC). Land use change also affects the environment. This study particularly focuses on the impact of changes in the landscape mosaic, which affects the value of a landscape and its biodiversity. A landscape mosaic is measured by using an adaption of Shanon’s Diverstiy Index (SDI), which measures the evenness (homogeneity) and richness (heterogeneity) of a landscape. Biodiversity is measured by the number of red-listed species in a habitat and the scarcity of habitats with a high number of species. A relatively large reduction in a common habitat leads to a relatively small reduction in biodiversity value, whereas a marginal decrease in relatively scarce habitat leads to

[9] This scenario mimics the Bond scheme suggested by KOESTER and TANGERMANN (1977), TANGERMANN (1991) and SWINBANK and TRANTER (2004).

a relatively large loss in biodiversity. To analyse changes in landscape mosaic and biodiversity, the landscape is modelled in an abstract way by considering block boundaries, fields within blocks and the crop grown on each field. Changes in field size and production caused by agricultural structural changes affect landscape mosaic and biodiversity. For five regions, the impacts of two different decoupling scenarios are compared with the continuation of the Agenda 2000 policy. The Jönköping and Västerbotten regions in Sweden are characterised by extensive production. The Italian regions Marche and Calabria are characterised by intensive Mediterranean agriculture, and the fifth region, Vysočina in the Czech Republic, is characterised by large scale farming. The first decoupling scenario, REFORM, represents the actually implemented policy in the respective countries. Italy decided on a single farm payment, while Sweden opted for a hybrid scheme with a regional payment and an additional single farm payment. With its accession to the EU in 2004, the Czech Republic introduced the single area payment scheme (SAPS) and top-ups for COP and ruminants. In the SAPS, a regional payment is granted to farmers. In the actually implemented policy, farmers have to fulfil the minimum requirement of keeping land in GAEC to receive payments. In the second decoupling scenario, BOND, this requirement is skipped and support is converted to a lump-sum income transfer or bond, which farmers receive even if they exit farming. The environmental impacts of these policies are diverse, for example the characteristics of the study regions and the actually implemented policies. Generally, the minimum requirement of land being kept in GAEC to receive payments leads to the capitalization of payments into land rental prices, which is contrary to the goal of providing income security for farmers. A bond-type scheme would break this link, but at the same time it leads to the abandonment of agricultural land. Land abandonment has negative impacts on the environment because it reduces the landscape mosaic and biodiversity. However, as the example of Sweden shows, this negative impact could be softened by implementing agri-environmental schemes. The requirement of keeping land in GAEC is, however, not sufficient to provide environmental benefits. For example, in Sweden the GAEC obligation leads to homogenised land use, which has negative impacts on the landscape mosaic and biodiversity. In the Italian and Czech regions, the GAEC obligation is of minor importance, because market prices are high enough to keep land in production. The GAEC obligation can also not provide any incentive to change the intensity and scale of production in the Czech Republic, which has negative environmental impacts.

HAPPE et al. (2009) focus on so-called dual farm structures in Central and Eastern European countries and how they are influenced by i) the entry and exit behaviour of individual farms, and ii) a high share of farmers nearing retirement. Therefore, AgriPoliS was extended in two ways. First, we introduced a probability factor, which determines whether a successor exists and whether he is willing to take over the farm. As in the standard AgriPoliS version, a willing successor only takes over the farm if the expected farm income is higher than the expected off-farm income. *Second*, in addition to the uniform age distribution of farmers normally used in AgriPoliS, a triangular age distribution skewed to the left is introduced in AgriPoliS. In a first step, the impacts of the different age distributions are analysed. Thereby, it is assumed that for each farm a successor exists and that he is willing to take over the farm, i.e., the abovementioned probability factor is one. In a second step, the age distribution is differentiated in the same way, but the probability factor of whether a successor exists is set to 0.5. The chosen probability factors are boundaries between which the willingness to take over a farm is assumed to vary. The results show that the decision to take over a farm is strongly influenced by the policy environment. Due to the phasing-in of SAPS payments implemented in Slovakia after EU-accession, more successors decided to enter agriculture in a medium-term and the dual structure sustains. This is more distinctive when there is a high share of older farmers. The increasing payments attract successors to take over the farm, but at the same time payments were increasingly capitalised into land rental prices and labour costs are assumed to increase. When SAPS payments reach their final level, the structure suddenly changes because increasing costs for land and labour cannot be covered. Many small farms then exit agriculture. Thus, farm structures become more homogenous, with fewer but larger individual farms next to a group of corporate farms that slightly reduced their size. This change from a dualistic farm structure to a more homogenous structure is smoother when not all successors are willing to take over the farm. In this case, already more farms exit during the phasing-in of payments.

In KELLERMANN et al. (2009) the consequences of payment reductions within progressive modulation in two German regions are analysed. The first region is Hohenlohe. There, the average farm size was 26 ha in 2001, whereas in the Central Saxonian Loess Region it was 174 ha. Within the HC, the European Commission introduced several measures, one of which is progressive modulation. Initially, the European Commission proposed that the HC increase the modulation rate from 5% in 2008, in steps of 2%, to 13% in 2013. Additionally, payments should have been progressively reduced depending on the volume per farm. The first 5,000 Euros per farm are not modulated, and for payments up to 100,000 Euros, the abovementioned modulation rate should hold. Payments above 100,000, 200,000 and 300,000 Euros should have been reduced by an additional 3, 6 and 9%, respectively. That is, in 2012, the maximum reduction would have been 22% for payments above 300,000 Euros. Due to pressure from different member states, the European Commission decided upon a lower increase of the modulation in time, and for a lower progression. It was decided that the modulation rate increases from 5% in 2008 to 10% in 2012, and an additional cut of 4% is made on payments above 300,000 Euros. The focus of this paper is on the impact of a progressive modulation on structural change and efficiency. In view of further changes in the CAP after 2013, the impacts of an annual flat rate of 150 Euros per hectare, introduced after 2013, are analysed, as well as whether the progressive payment reduction until 2013 would help farmers to cope with such a strongly decreased area payment. The first scenario analysed is the continuation of the MTR policy, which is used as a reference point for the other scenarios. Concerning the HC scenarios, both the initially-proposed modulation and the actually implemented modulation are modelled. All three scenarios are simulated till 2020. In a second set of scenarios, the flat rate payment is introduced in the three abovementioned scenarios from 2013. To consider modulation in AgriPoliS, the mixed integer programming model, which represents farm production, had to be extended. The simulations showed that the structural impacts of modulation are low in the short- and medium-term, despite strong income reductions. Long-term modulation favours small farms, which can especially gain land in the case of the initially-proposed modulation. At the same time, large farms become less competitive and lose land because of the progressive modulation. This is, however, less pronounced in the case of the actually-implemented modulation. After introducing a flat rate payment in 2013, structural change increases. Mainly small farms exit agriculture, whereas large farms can grow. This shows that especially the initially proposed strong modulation for larger farms would provide incorrect incentives, because more small farms are staying in agriculture and withdrawing land from large farms. As already mentioned, this incentive is weaker for the actually implemented modulation. However, it also does not better prepare farmers for a flat rate payment than the MTR policy of 2003.

2 THEORETICAL BACKGROUND ON THE IMPACTS OF DECOUPLING DIRECT PAYMENTS

Until the MTR, agricultural support in the EU was coupled to production. This especially holds for market price support, which was stepwise reduced since the MacSharry reform in 1992, as well as for direct payments granted in the form of output subsidies (e.g. slaughtering payments for beef cattle) and crop-specific area payments. These direct payments were introduced as compensation for the reduction in price support (compensation payments). In the economic literature it is well known that coupling support to production or factor input negatively affects social welfare (HENRICHSMEYER and WITZKE 1994 and OECD 1994). Coupled payments also affect production, trade, farm income, the environment and structural change. However, the impact of payments on production and trade strongly depends on the way they are granted, i.e. payments can be more or less coupled or decoupled. The OECD (2001a) defines five categories of policy measures: (i) payments based on variable input; (ii) market price support; (iii) payments based on output; (iv) area payments[10]; and (v) lump-sum payments.[11] The degree of decoupling increases according to the mentioned order. Policy measures or packages of policy measures are fully decoupled when they do not distort producer decision-making and when markets adjust as if there would be no policy in place (CAHILL 1997). According to CAHILL's (1997) definition, the degree of policy measure decoupling only depends on production and trade effects; impacts on income, structural change and the environment are not considered. A theoretical concept that also considers the impacts of policy changes on income distribution is the concept of transfer efficiency developed by GARDNER (1983). By applying GARDNER's (1983) concept of transfer efficiency, the OECD (2003) shows that transfer efficiency can be doubled with area payments compared to output support. However, this depends on the share of rented land, the functioning of land markets and how area payments are implemented. Based on these factors, area payments are capitalised into land values. Furthermore,

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[10] Area payments have to be further distinguished into crop-specific area payments, which require the planting of specific crops, and area payments that only require remaining land in agricultural use, as for area payments granted within the SPS. The level of crop-specific area payments can vary among crops, as was the case in the MacSharry reform and the Agenda 2000. Thus, they cause stronger production effects than more decoupled area payments, which do not require planting and which are granted for all agricultural land. Here, we generally analyse area payments, which only require remaining land in agriculture, if not, we speak about crop-specific area payments.

[11] With the exception of market price support, all these payments are made directly to the farmers, thus they are also called direct payments.

area payments impede the exit of inefficient farms compared to lump-sum transfers HENNING (2003).[12]

In the following, the term decoupling will be defined and the impacts of different policy measures on production will be described. This shows the degree of decoupling of the different policy measures. Afterwards, the concept of transfer efficiency will be described, as well as the impacts that different policy measures have upon it. How the EU decoupled agricultural support within the MTR will then be described. Thereafter, considerations on the impact of the MTR on land values, farm income and farm exit are presented.

2.1 Definition of decoupling

Several authors provide overviews of decoupling and how to define it (OECD 2001a, ANDERSSON 2004 and BAFFES and GORTER 2005). Further, all of these authors mention that this topic has been discussed in academic literature and among agricultural policy-makers since 1945.[13] ANDERSSON (2004) argues that in general, ***ex ante*** and ***ex post definitions*** of decoupling can be distinguished. The ***ex ante definitions*** are criteria-based. ANDERSSON (2004) provides two examples. *First*, within the Uruguay Round Agreement of Agriculture (URAA) the WTO provided a list of five criteria, which are similar to the OECD (1994) definition of direct payments. The criteria listed in Article 6 of Annex 2 to the URAA are:

1) Eligibility for such payments shall be determined by clearly-defined criteria such as income, status as a producer or landowner, factor use or production level in a defined and fixed-base period.
2) The amount of such payments in any given year shall not be related to, or based on, the type or volume of production (including livestock units) undertaken by the producer in any year after the base period.
3) The amount of such payments in any given year shall not be related to, or based on, the prices, domestic or international, that apply to any production undertaken in any year after the base period.
4) The amount of such payments in any given year shall not be related to, or based on, the factors of production employed in any year after the base period.
5) No production shall be required in order to receive such payments.

[12] Assuming that lump-sum transfers would be tradeable in the form of bonds, which would avoid the market imperfections that occur in the case of payment entitlements for area payments.

[13] For example, NICHOLLS and JOHNSON (1946), SWERLING (1959), NASH and ATWOOD 1961, URI 1970, KOESTER and TANGERMANN 1977, TANGERMANN 1991, BEARD and SWINBANK (2001) and SWINBANK and TRANTER 2004.

A *second* criteria-based definition is from BURFISHER and HOPKINS (2003), who argues that decoupled subsidies do not depend on prices, factor use, or production. A critique of criteria-based definitions is that they do not guarantee that support does not influence production *ex post*. In contrast, ***ex post definitions*** are consequently based on the outcome of the policy, e.g. CAHILL (1997) argues that a policy or a policy package is decoupled if it does not affect the level of production. Another difference to the criteria-based definition is that CAHILL (1997) argues for the evaluation of policy packages instead of single policies, because a package of policies might have a small or zero net effect, while the single policies might have significant effects on production. CAHILL (1997) differentiates between two concepts of decoupling. The more restrictive form means a policy package is ***fully decoupled*** when the demand and supply functions remain unchanged with the introduction of the policy package, that is there is no change in equilibrium prices and quantities, and an outside shock causes the same adjustment reactions as does a scenario without the policy package. The less restrictive concept of decoupling defines policy packages that do not affect production as compared to a situation without the policy package, and is called ***effectively fully decoupled***. The OECD adopted CAHILL's (1997) definitions of decoupling (OECD 2001a).

2.2 Impacts of different policy measures on production

The OECD (2001a) groups production effects into (i) static effects, (ii) risk-related effects and (iii) dynamic effects. Static effects can be further distinguished into ***price effects***, ***cross-subsidisation effects*** and ***income effects***. ANDERSSON (2004) mentions that the focus of studies up to the MTR has been on static effects, which are also well-known from welfare economics. The ***price effect*** either increases production or it avoids non-profitable production from being stopped. Farmers produce the amount of a product for which its marginal costs equal the market price, plus the direct payment per production unit. Compared to a situation without direct payments, farmers will increase their production when they receive payments coupled to the production. On the other hand, farmers who would normally stop production due to higher production costs than the market price continue farming with the introduction of direct payments (BERTELSMEIER 2005). From a welfare economics perspective, farmers can lose a part of their payments, because prices fall with an increasing supply. Additionally, farmers lose payments because they continue to produce and use a part of the direct payments to compensate for losses associated with the current production. An example of direct payments coupled to current production is the payment for beef cattle and suckler cows introduced with the MacSharry reform in 1992, and extended within the Agenda 2000.

Cross-subsidisation effects can be distinguished into cross-effects among different products as discussed by CAHILL (1997) and RUDE (2000, 2007), and cross-subsidisation effects discussed by GOHIN et al. (2001). For instance, cross-effects occur when a measure that involves moving from a coupled to a decoupled payment for only one product creates additional production of other products competing for factors such as land (OECD 2001a). GOHIN et al. (2001) speaks about cross-subsidisation when farms stay in agriculture because payments are coupled to the current use of fixed or quasi-fixed production factors. This leads to a reduction of fixed costs and implies a lower break-even point and increasing profits for farms whose break-even point and marginal costs have already been lower than the market price. For farms whose marginal costs have been lower than the market price, but not equal to its breakeven point, cost-effective production is possible with direct payments. Such farms are thus able to continue farming and do not cease production. ANDERSSON (2004) categorises price and cross-subsidisation effects as ***direct effects***, and income, risk-related and dynamic effects as ***indirect effects***. ***Direct effects*** arise as a consequence of changes in incentive prices. ***Indirect effects*** arise broadly as a consequence of, or expectations of, changes in income and wealth.

Income effects only occur when labour markets are imperfect BENJAMIN (1992) and capital and land input are fixed (GOHIN et al. 2001). BERTELSMEIER (2005) concludes, based on HENRICHSMEYER et al. (1993) and BENJAMIN and GUYOMARD (1998), that with direct payments, farm incomes, as well as the possibilities for consumption, increase. The latter determine household demand for commodities, as well as its labour supply. As there exists a competition between work time and leisure time, increasing possibilities increase leisure time at the expense of working time, and with a reduction of working time, on-the-farm production is also reduced. The income effect can occur under all measures of support initially mentioned above.

The OECD (2001b) and DEWBRE et al. (2001) conducted simulations to estimate the price and cross-subsidisation effects of different policy measures. These studies show that production effects are the highest in the case of ***input subsidies***. One reason for this strong impact might be that input subsidies are directed to the inputs that are most elastic in supply, whereas ***market price support*** goes to all types of input, including land, which is inelastic in its supply. Thus, the production effects of market price support are smaller. Compared to market price support, ***output subsidies*** cause slightly less production effects. The simulations show the lowest impact on production for ***area payments***. At first glance this is surprising, because area payments are technically input subsidies, but land supply is very inelastic and any increase in supply is limited. DEWBRE et al. (2001) further distinguishes between ***crop-specific area payments*** that require the planting of specific crops, such as the COP payments granted within the MacSharry reform and the Agenda 2000, and ***area payments***, which only require maintaining land in agricultural use, for example the area payments within the SPS. The latter only cause one-tenth of the production effect of market price support, and crop-specific area payments just one-fourth. This shows that the reduction of production effects due to the MTR was not as strong for crop payments as for animal payments, which can be categorised as output payments.

A possibility for avoiding price and cross-subsidisation effects would be introducing ***lump-sum transfers*,** which are based on historical production and granted independently of current production. However, with lump-sum transfers, indirect effects cannot be avoided and still can induce income effects. For example, in the case of imperfect labour markets, farmers tend to reduce their labour input and thus their output when they receive income support. Furthermore, risk-related effects arise since risk-averse producers may stay in business and continue production as a consequence of income support. Finally, dynamic effects may affect output through investment decisions and expectations affected by the policy.

2.3 Definition of transfer efficiency

Concerning the evaluation of direct payments' impact on income distribution, one can utilise the concept of transfer efficiency developed by GARDNER (1983) and further developed and used by the OECD in several studies (OECD 1995, 1996, 1999, 2002, 2003). The transfer efficiency of an agricultural support instrument is usually defined as the ratio of income gain of the targeted beneficiaries (farmers) and the sum of associated government expenditures and consumer costs. Transfer efficiency varies among various agricultural support instruments, and two major sources of transfer losses can be distinguished:

- ***economic costs*** resulting from inefficiencies in the use of productive resources and distortions in consumption patterns; and
- ***distributive leakages*** due to income gains accruing to groups other than the intended beneficiaries of support (OECD 1995).

Economic costs of agricultural policies correspond to deadweight losses caused by distortions of the resource allocation. The impacts of distortions of the resource allocation on welfare are already mentioned within the concept of decoupling, that is, how coupled payments affect production (resource allocation). The concept of transfer efficiency additionally distinguishes several sources of deadweight losses (domestic deadweight losses, economic costs of taxation, deadweight costs of programme administration, and deadweight losses in other countries). In contrast to economic costs, ***distributive leakages*** do not constitute net income losses to the economy, but represent income flows to non-target groups. The OECD (1995) distinguishes distributive leakages in i) administrative costs; ii) leakages to upstream and downstream industries; iii) leakages within the farm sector; and iv) income transfers to and from foreign countries. The ***administrative costs*** of market price support tend to be lower than for direct payments because the administrative effort is concentrated on border transactions, involving only a relatively small number of exporters and importers. Direct payments require both implementation and supervision at the farm level and therefore accrue more administrative costs. However, they do not cause costs for stock-keeping, as it is necessary for market price support. On the other hand, one has to differentiate between direct payments not coupled to the current production or factor input (lump-sum payments), and direct payments coupled to the current production (output payments). The former only require high costs for its implementation, whereas the latter cause durable costs for collecting information on current production at the farm level. BERTELSMEIER (2005) summarises that ***upstream leakages*** are related to an increase in factor demand caused by policy instruments. The change in factor demand can be caused by an increase in production or by factor substitution. The stronger the price reaction caused by increased demand for any production factor, the lower is the possibility to substitute the production factor. Further, the lower the share of fixed and quasi-fixed production factors owned by the producer, the higher are the upstream leakages. Especially in the case of fixed or quasi-fixed production factors, agricultural supports may increase input prices, and thereby support is transferred outside of agriculture.

An example of payments affecting factor demand is the area payment introduced with the MTR. As it is coupled to the use of land, this payment increases the demand for land on the one hand, but on the other hand, landowners try to benefit from the payment and ask for higher rental prices. Thus, area payments become capitalised into land values. BERTELSMEIER (2005) notes that the amount of this upstream leakage depends on two factors: *first*, on the increase in land rental prices, and *second*, on the share of rented land. The stronger the price increase and the higher the share of rented land, the stronger is the upstream leakage in the form of capitalising payments into land values. But even if the area payments introduced with the MTR are coupled to the land input, this does not necessarily mean that they are capitalised into the land prices. Within the MTR, EU Member States had different possibilities to implement the area payments. Depending on the option they have chosen, transfer efficiency is lower or higher. A detailed description of these options can be found in section 2.5. In section 2.6, it will be shown how the different options affect land values and transfer efficiency.

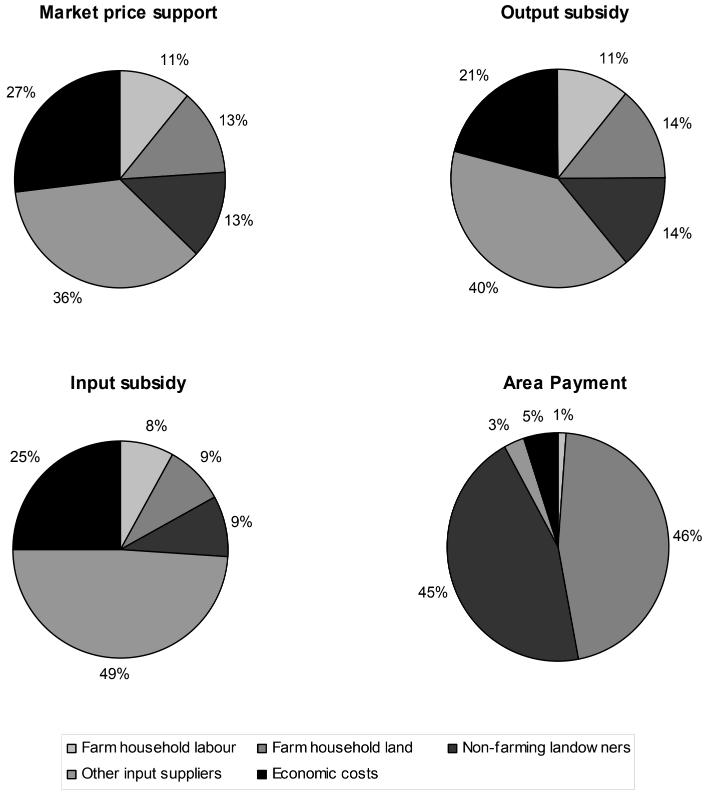
Downstream leakages depend on the impact of policy instruments on the production and the price of an output. An increase in output can induce price reductions, from which the processing and distribution industries or consumers can benefit. ***Leakages within the farm sector*** occur when payments should be transferred to certain groups of farmers. Such polices often offer an incentive for rent seeking (OECD 1995 and HENRICHSMEYER and WITZKE 1994, p. 196).

2.4 Impacts of different policy measures on farm income

In section 2.2 it was shown that area payments introduced with the MTR have only a small impact on production compared to market price support or output payments. Evaluating area payments through the lens of transfer efficiency reveals that in the case of area payments, farmers still do not fully benefit from the payments even if transfer efficiency is twice as high compared to market price support or output subsidies. Figure 2-1 shows which share of payments goes to farmers (farm household labour, farm household land), to non-farming landowners, to suppliers of inputs other than land (upstream leakages), as well as the payments' economic costs (production and trade effects). It can be seen that economic costs slightly vary between market price support (27%), output subsidies (21%) and input subsidies (25%), which corresponds to the estimations of production impacts carried out by (OECD 2001b and DEWBRE et al. 2001). For area payments, economic costs are significantly lower (5%). This shows that the increase in transfer efficiency caused by switching from market price support and output subsidies to area payments is mainly caused by the reduction of economic costs. The share of distributive leakages hardly differs among the policy measures. In fact, the only difference is the proportion of distributive leakages associated with non-farming landowners and other input suppliers. In the case of input subsidies, the proportion of distributive leakages associated to input suppliers is the highest (49%), whereas it is the lowest in the case of area payments (3%). Therefore, distributive leakages associated to land owners are the highest in the case of area payments.[14] Comparing the transfer efficiency of the different policy measures, it is estimated that in the case of ***area payments*,** farmers will receive 47 cents of each Euro spent for agricultural support. The policy measure with the lowest transfer efficiency is the ***input subsidy*** (17%), followed by ***market price support*** (24%) and ***output subsidies*** (25%). To conclude the results of the impacts of different policy measures on production and farm income, it is obvious that policy measures that cause the greatest production effects are also the least efficient in providing income benefits to farm households (DEWBRE et al. 2001). To evaluate the impact of the MTR on farm incomes, one can compare the transfer efficiency of output subsidies with that of area payments. This shows that the MTR almost lead to a doubling of transfer efficiency. However, it has to be considered that before the MTR, only animal payments can be counted as output subsidies; crop-specific area payments are rather a mixture of output subsidies and area payments, which explains why the increase of transfer efficiency due to the MTR might be lower than expected (DEWBRE et al. 2001).

[14] The OECD assumes in its analysis that area payments are fully capitalized into land value, that is, rents increase, and farmers renting land do not benefit from the payments.

Figure 2-1: Where does the money go? The income transfer efficiency of agricultural support

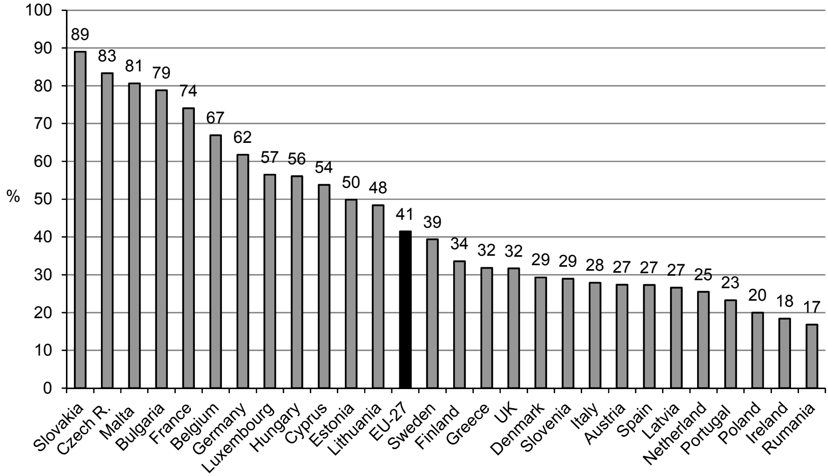


Note: The OECD calculated the transfer efficiency for deficiency payments, but one can count output subsidies as a kind of deficiency payment, since the goal of the output subsidies implemented with the MacSharry reform and the Agenda 2000 was to compensate the income loss caused by the reduction of tariffs.

Source: OECD (2003).

As already mentioned in section 2.3, it has to be considered that upstream leakages to land owners strongly depend on the share of rented land and how the EU Member States implemented the SPS (cf. section 2.5 and 2.6). The share of rented land varies among farms, countries and over time. For its analysis, the OECD (2003) assumes that farms operate on average with a share of 50% rented land. However, in the EU-27, farms rent only 41% of the agricultural area (Figure 2-2). Thus, the impacts of transfer efficiency in the EU might be lower on average and vary among countries. The country with the lowest share of rented land is Romania (17%), and Slovakia has the highest share (89%). There are five countries (France, Bulgaria, Malta, Czech Republic and Slovakia), for which the switch from output subsidies to area payments could even have negative impacts due to the high share of rented land in these countries. However, the capitalisation of area payments into land values depends on the functioning of land markets and the way area payments are implemented. Especially in NMS, land markets are characterrised by imperfections (CIAIAN and SWINNEN 2006, 2009). In France, rental markets are highly regulated (cf. LATRUFFE and LE MOUËL 2006). Thus, the capitalisation of area payments might not be so strong in these countries.

Figure 2-2: Share of rented land by country in 2007



Source: EUROSTAT (2010).

However, the capitalisation of area payments not only affects farm incomes directly, but indirectly as well through cross-subsidisation. Inefficient farmers tend to continue agriculture, and thereby the efficient redistribution of land is impeded (GOHIN et al. 2001 and HENNING 2003). This effect can especially be analysed with the agent-based model AgriPoliS, where farms act independently, decide whether or not to leave agriculture, and where released land is redistributed among surviving farms. The reallocation of land, released by farms exiting agriculture, increases the efficiency of agricultural production (cf. BALMANN 1996, HAPPE and BALMANN 2002, 2003, HAPPE 2004 and HAPPE et al. 2005).

Since they are able to avoid production effects, lump-sum transfers would be the solution to avoiding transfer losses as well. Such payments would only be coupled to the farmer and no production would be necessary, that is, farmers could also exit agriculture.

2.5 Decoupling within the MTR

Within the Agenda 2000 it was decided to carry out a mid-term review of the agreed-upon policy changes. The time window was to be approximately 2002-2003, and the idea was to consider market developments, the development of the agricultural budget, as well as the expected changes due to the upcoming EU enlargement and WTO negotiations. This MTR ended in a radical reform of the CAP pushed by the European Commission and its Commissioner Franz Fischler. Direct payments were decoupled from current production in 2005[15], which simultaneously should solve several problems:

- The production effects of coupled direct payments described in section 2.2 have been reduced to a minimum.
- Direct payments moved into the Green box and the EU improved its position in WTO negotiations.
- The steady increase of the agricultural budget was capped by calculating the payments based on a historical reference period.
- Consumer and environmental issues have been considered by introducing cross-compliance.

Decoupling direct payments was done by implementing the so-called single payment scheme (SPS) (see COUNCIL REGULATION (EC) no 1782/2003). To avoid land abandonment payments, entitlements are introduced, which can be activated by the use of land to receive a specific payment per hectare. Payments are calculated based on historical production, and farmers only have to maintain their land in good agricultural and environmental conditions (GAEC) to receive payments. Thus, payments are decoupled from current production, but coupled to the current input of land. However, decoupling within the SPS was weakened, so the EU allowed 25% of the direct payment to be kept for cereals, oilseeds and protein plants (COP), and 40-100% of the various historical premiums in the beef sector to be coupled. Furthermore, the SPS allows different methods for calculating the payment entitlements:

1) Divide the average historical payment of a farm by the number of hectares of crops for which payments have been granted, plus the forage area. Payments calculated according to this method will later be called the Single Farm Payment (SFP), also known as the ***historical model***.
2) Divide the total average payments in a region by total farm hectares to provide a uniform flat rate payment per hectare across the region. These

[15] France used the option to decouple payments in 2006 and for the NMS the deadline for decoupling was 2009 (COUNCIL REGULATION (EC) No 1782/2003, article 154a), but with the Health Check in 2008 this was postponed to 2013 (AGRA informa).

payments will be called single area payments (SAP), also known as the ***regional model***.

3) Vary payment levels between arable land and grassland.
4) Combine the regional model with the historical model depending on the commodity. Such a combination is called hybrid decoupling, or the ***hybrid model***.

The reference period for calculating the payment entitlements were the years 2000-2002. Furthermore, payment entitlements belong to the farmers and can be traded separately from land. Depending on the calculation method, the value of the payment entitlements varies among farms, and also the number of payment entitlements can be different. Partial decoupling will still affect production. In both the regional and hybrid models, payments will be redistributed among farms, which affects farm incomes. Additionally, it is expected that both models have a greater effect on land prices than the historical model. The latter indeed causes no redistribution, but it does have another disadvantage. Directly after decoupling, farmers may be satisfied because they don’t lose any payments, but the bigger the time distance to decoupling, the more inequitable becomes this system, because beef fattening farms can stop their production and receive payments by fulfilling the same condition as the other farmers, namely to maintain their land in GAEC. Especially organisations for nature conservation, consumer protection, animal welfare and farmers associations representing small farms alerted their governments to this problem, namely that some EU countries engaged themselves to extend the initially suggested (by the European Commission) SPS by also allowing the regional and hybrid models. However, in the regional model, redistribution effects are the strongest. There, especially intensive beef fattening or dairy farms may lose a great deal of subsidies, because before decoupling they normally received a high payment per hectare. After decoupling, these payments have been redistributed to all farms within a region. One possibility for reducing redistribution is to differentiate payments between arable land and grassland, or to introduce a hybrid model. But the hybrid model also causes inequalities, which explains why some member states decided to stepwise reduce the differences caused by the historical part. Table 2-1 provides an overview for which calculation method the OMS and Malta and Slovenia decided upon.

Table 2-1: National implementation of the SPS

	Historical	Regional	Static hybrid	Dynamic hybrid
Maximum possible coupling	F			
Partial decoupling	A, B, GR, I, NL, P, E, GB (Scotland)	M, SLO	DK, S	FIN, D
"Full" decoupling	IRL, GB (Wales)		L, GB (NIRL)	GB (England)

Source: HALMAI et al. (2006).

For NMS, an additional option existed. Because they acceded to the EU in 2004 – one year before the SPS was implemented – they had not fully implemented the Integrated Administrative Control System (IACS), which was necessary to calculate the average payment of the reference period. Thus, they had the option of either implementing the Agenda 2000 policy measures and decoupling them at the latest in 2009, or implementing a simplified system called the single area payment scheme (SAPS). Malta and Slovenia decided for the first option, and decoupled the payments in 2007. All other NMS decided for the SAPS, within which a payment for each agricultural hectare is paid. Additionally, NMS could implement coupled payments which have to be co-financed. These payments are called complementary national direct payments (CNDP), or top-ups. The NMS should have switched to the SPS at the latest in 2009, but with the Health Check, this was postponed to 2013. Even if SAPS and top-ups are not part of the SPS, one could sort the policy scheme of all NMS states into the group of partially decoupled regional payment.

2.6 Impact of the MTR on land values and farm exit

The effects of the SPS on the capitalisation of payments into land values and thus on transfer efficiency are different depending on the method for calculating payment entitlements. The important factor is the number of allocated payment entitlements. In the historical model, the reference area only includes the area of all crops that received payments before decoupling and the forage area. For example, the area for potatoes, sugar beets or vegetables is not included, that is, the number of distributed payment entitlements is lower than the total agricultural area. In the regional model, the number of payment entitlements is almost equal to the total agricultural area, because all agricultural land used during the reference period is considered. The only reason that the number of payment entitlements is smaller than the agricultural area is that agricultural land was not used during the reference period. ISERMEYER (2003), KILIAN and SALHOFER (2008), COURLEUX et al. (2008), CIAIAN et al. (2008) and KILIAN et al. (2008) show in their theoretical models that payments are not transferred to land owners when there is an efficient market for payment entitlements and the number of payment entitlements is smaller than the agricultural area. This means transfer efficiency would be higher in the ***historical model*** and lower in the ***regional model***. KILIAN and SALHOFER (2008), COURLEUX et al. (2008) and CIAIAN et al. (2008) show that transfer efficiency of the ***hybrid model*** would lie between both extremes. In the following, the basic model of ISERMEYER (2003) is presented. Afterwards, extensions made by the other authors will be explained.

ISERMEYER (2003) assumes that: a) all payment entitlements have the same value, that is, he analyses the impacts of the *regional model*; b) there is only a lease market and no sales market for payment entitlements; c) rental contracts are only of a short duration; d) special relationships between landlords and tenants are not considered; and e) cross-compliance only holds for areas eligible for payments. In his analysis ISERMEYER (2003), showed that the rental price for payment entitlements is equal to its value, minus the costs for maintaining land in GAEC when the number of payment entitlements (E) is smaller than the agricultural area (A), because then there is a competition for payment entitlements. When E>A, then owners of payment entitlements without land compete for land and are willing to share almost all payments with the land owner, that is, payments are transferred to the landowner and transfer efficiency is low.

KILIAN and SALHOFER (2008) extend ISERMEYER's (2003) model by considering sales markets and the *historical model,* as well as conducting a welfare analysis. In the *historical model*, the number of payment entitlements is normally smaller than the agricultural area, because in the reference period not all land was eligible for payments. In this case, the result is the same as in the *regional model* with E<A, that is, no payments will be transferred to landowners and transfer efficiency is high. If the market for payment entitlements is distorted, as in the case of the *hybrid model*, the number of payment entitlements can be higher than the agricultural area. Then, payments will only be partially transferred to the land owners, because the values of payment entitlements are heterogeneous. The price for payment entitlements is equal to the payment entitlement with the lowest value, minus the costs for maintaining land in GAEC. Farmers whose payment entitlements have a higher value can keep the difference of the value and the price for the payment entitlements. Transfer efficiency is then in-between the one in the case of E<A, and in the case of the *regional model* with E>A. In their welfare analysis, KILIAN and SALHOFER (2008) show that the SPS leads to deadweight losses independent of which method is applied to calculate the payment entitlements because land with a negative economic land rent is used. The deadweight loss is bigger when E>A, because all agricultural land is used. If E<A, land use is equal to E, and hence deadweight losses are smaller.

Instead of using an aggregated graphical model like ISERMEYER (2003) and KILIAN and SALHOFER (2008), COURLEUX et al. (2008) and CIAIAN et al. (2008) formulate an analytical model based on an agricultural economy with two profit-maximising producers. CIAIAN et al. (2008) additionally analyse what happens when payment entitlements are non-tradable. This is interesting because in some member states (e.g. Portugal and Austria), tradability is restricted by regulations. Another reason for the non-tradability of entitlements could be market distortions. Furthermore, CIAIAN et al. (2008) analyse dynamic effects, like the impact of productivity growth and the impact of farm exit and entry. These authors assume that in the *historical*, as well as in the *regional* and the *hybrid model*, E=A. They show in their analysis that also in the case of a static world with or without tradability, payments will not be transferred to landowners. In a dynamic world, CIAIAN et al. (2008) differentiate between symmetric and asymmetric productivity growth. Productivity changes cause a shift in farmland demand. Symmetric productivity growth is a general growth in productivity, that is, farmland demand increases for all farms. CIAIAN et al. (2008) shows that in such a situation, land prices indeed increase, but land distribution remains the same, and landowners do not benefit from payments. When productivity only increases for some farms, one speaks about asymmetric productivity growth. Farms with increasing productivity can gain land, and capitalisation is not affected if payment entitlements are tradable. In contrast, the non-tradability of entitlements constrains restructuring and leads to the partial capitalisation of payments. When new farmers enter into agriculture and do not receive entitlements from the national reserve, results do not change, but when entrants are eligible for entitlements, E>A and all benefits are transferred to landowners independent of the implemented model and independent of whether payments are tradable or not.

Whereas all studies described above compare the implementation of the SPS with a situation without any subsidies, KILIAN et al. (2008) compare it with the situation before the MTR. Additionally, they analyse the empirical data of 12 regions in Bavaria, a Federal State of Germany. Before the MTR, crop-specific area payments and animal payments had been granted to farmers. KILIAN et al. (2008) show that a high share of the crop-specific area payments is capitalised into the land rent, whereas the capitalisation of animal payments into the rental price is smaller. With the MTR, crop-specific area payments and animal payments have been transferred into area payments that require no planting. Including the animal payments into the area payments increased their value. Thus, capitalisation of the area payments within the MTR is expected to be higher and rental prices should increase. However, this development is only possible when E>A, which is the case in the study regions in Bavaria because Germany decided for hybrid decoupling. The empirical analysis carried out by KILIAN et al. (2008) proved this consideration.

The studies described so far have focused on the impact of the SPS implementation on land markets, whereas HENNING (2003) has a broader view of this topic. Indeed, that author differentiates between a welfare economics perspective and a politico-economic point of view. Thereby, he adds to the welfare economic point of view, that area payments not only reduce production distortions and the capitalisation of rental prices when E<A, but they also foster structural change[16] in a way that allows inefficient farms to sell their payment entitlements to efficient farms and then use this money as compensation for leaving agriculture. From the politico-economic point of view, HENNING (2003) shortens this consideration by bearing in mind the commitment problem between politicians and economic actors in a shrinking sector formulated by DIXIT and LONDREGAN (1995). Politicians who are interested in maximising their political support would favour groups when their support is higher than the loss of support from the unfavoured group. The net support depends on the size of the group, the transparency and the legitimacy of the income redistribution in favour of one group. In the case of agricultural policy, net-support is high when there is pressure for farmers to adjust and when the payments are not transparent. However, with decoupling, adjustment pressure will be reduced because of increasing structural change and transparency increases as well. Thus, politicians would reduce direct payments for agriculture. If efficient farms anticipate this development, their willingness to pay for payment entitlements of inefficient farms will be lower. HENNING (2003) concludes that on the one hand, this will impede structural change, and on the other hand it will distort the market for payment entitlements in a way that there could be a regional surplus of payment entitlements, which ends in at least a partial capitalisation of the payment into the land value. According to this consideration, payments would be capitalised into land values even if E<A. ISERMEYER (2003) supports this conclusion, but with other arguments. He estimates that in Germany, in the case of the *historical model* only, 3% of the agricultural land will be without payment entitlements. Considering that farms which increased their size between 2000 and 2003, as well as young farmers, can receive payment entitlements from the national reserve, and that for example, in Germany 50,000 ha of agricultural area annually gets lost for settlements and infrastructure, the share of agricultural area without payment entitlements will decline. Thus, there will be a surplus of payment entitlements in the long-run, and payments will become capitalised into land values. This assumption can also apply for other OMS. According to SWINNEN et al. (2008), the share of distributed entitlements to the total eligible area in Belgium, Finland, France, Ireland, Scotland and Northern Ireland is at least 95%.[17] Of these countries, Belgium, France, Ireland and Scotland implemented the *historical model*. Lower shares of distributed entitlements of the total eligible area can be observed for Greece (60%) the Netherlands (80%) and Spain (78%). According to the considerations of HENNING (2003) and ISERMEYER (2003), and considering that the abovementioned models are based on the assumption of perfect information

[16] The term structural change is here restricted to farm exit and the growth of remaining farms.

[17] For Germany, the share of distributed entitlements to the total eligible area is 90%, but the share of eligible area of the total UAA is 110%. Hence, the share of distributed entitlements to the total eligible area should be 100%.

and no transaction costs, it is likely that in the *historical model*, at least long-term area payments will be capitalised into the land values.

2.7 Conclusions

Various concepts can be used to evaluate policies. The OECD (2001a) concept of decoupling evaluates policies according to their impact on production and trade. Policies or policy packages that do not affect production as compared to a situation without the policy package are called "effectively fully decoupled". A more restrictive condition is that demand and supply functions remain unchanged with the introduction of the policy package, i.e. an outside shock causes the same adjustment reactions as does no policy package. A policy package is then called "fully decoupled". Analyses for the area payments implemented in the MTR show that they are almost "effectively fully decoupled" DEWBRE et al. (2001) and OECD (2001b). Another concept for evaluating policies is the concept of transfer efficiency. This concept also considers the problem of distributive leakages, i.e. whether the target group receives the full amount of payments or whether other groups benefit from them. Production and trade effects are grouped under the term of economic costs. Using the concept of transfer efficiency shows that the transfer efficiency of area payments is twice as high as the one for market price support or output subsidies. However, the increase in transfer efficiency is lower than one would expect when only considering production and trade effects (economic costs). The strong reduction of economic costs is partially used up by distributive leakages to non-farming landowners. The OECD (2003) estimates that with area payments, farm households receive 47% of the payments, and non-farming landowners receive 46%. Summarising these results shows that the MTR can lead to higher farm incomes due to the reduction of production and trade effects. This would support the assumption that the MTR would reduce the number of farm exits. But the share of distributive leakages to non-farming landowners depends on: i) the share of rented land; ii) the increase in rental prices; and iii) the way the EU Member States have implemented the SPS. For the historical model ISERMEYER (2003), KILIAN and SALHOFER (2008), COURLEUX et al. (2008), CIAIAN et al. (2008) and KILIAN et al. (2008) show that distributive leakages in the form of capitalising payments into land rents will be low or almost zero, whereas in the case of the regional model, payments will be fully capitalised into land rents, as the OECD (2003) assumes in its analysis. In the regional model, payments are fully capitalised, because there are more payment entitlements than agricultural land. Owners of payment entitlements are willing to pay higher rents so that they can activate their payment entitlement to receive payments. In the historical model, the reverse is true. However, ISERMEYER (2003) assumes that also in the case of the historical model, agricultural land will become scarce because a sizeable part of all agricultural land is annually lost to infrastructure and settlements. Thus, in AgriPoliS, single farm payments are considered in the calculation of rental prices, as well as regional payments; that is, in the long-run they will be capitalised into land rents. HENNING (2003) supports this assumption with the argument that farmers might expect payment reductions, that is, their willingness to pay for payment entitlements will be lower. This behaviour could lead to a regional surplus of payment entitlements and at least a partial capitalisation of payments into the land value. Furthermore, HENNING (2003) argues that this would slow down structural change compared to a well-functioning market scenario for payment entitlements, where exiting farmers can fully benefit from the payments by selling the entitlements. Such a situation would be similar to the bond scheme suggested by KOESTER and TANGERMANN (1977), TANGERMANN (1991) and SWINBANK and TRANTER (2004). Thus, the simulation of a bond scheme could show what would happen if markets for payment entitlements were perfect. The impact of a bond scheme would be that farm exit rates increase, because farmers can exit agriculture and still receive direct payments.

3 Adaptation of the agent-based model AgriPoliS to 7 study regions in the enlarged EU[18]

3.1 Introduction

For modelling structural change, the term "agricultural structures" must first be defined. ZIMMERMANN et al. (2006) show that many definitions of this term exist. Here, we focus on three definitions that cover the main components of agricultural structures. BOEHLJE (1992) states that the structure of an industry includes several dimensions: i) the size distribution of firms; ii) the technology and production characteristics (type of activity and level of specialisation); iii) workforce characteristics (age, education, skills, part-time versus full-time status, etc.); iv) the resource ownership and financing pattern; and v) the inter- and intrasectoral linkages. One can conclude that BOEHLJE's (1992) definition focuses on the characteristics of the individual components of agricultural structures (size of farms, specialisation, age of workforce, ownership, etc.) and the relationships between them (e.g. contract production). The definitions of GODDARD et al. (1993) "What, where and how is output produced?" and BALMANN (1997) "Who produces what, in what amounts and by what means?" also consider this when they ask how output is produced and by which means it is produced. But both extend BOEHLJE's (1992) definition by asking what is produced. BALMANN (1997) additionally asks "Who produces?", but this can be also considered as a question about the characteristics of the individual components. Furthermore, GODDARD et al. (1993) add the dimension of space when asking, "Where is output produced?"

One can see that different components have to be considered to model structural change. Depending on the type of model, the number of considered components

[18] This chapter is based on SAHRBACHER, C., SCHNICKE, H., HAPPE, K. and GRAUBNER. M. (2005): Adaptation of the agent-based model AgriPoliS to 11 study regions in the enlarged European Union, and on SAHRBACHER and HAPPE (2008): A methodology to adapt AgriPoliS to a region. SAHRBACHER et al. (2005) is working paper no. 10 of the project IDEMA (The Impact of Decoupling and Modulation in the Enlarged Union: A sectoral and farm level assessment), supported by the European Community's Sixth Framework Programme (SSPE-CT-2003-502171). In IDEMA, four additional regions have been modelled which are not considered in this thesis because they have been mainly modelled by Hauke Schnicke (Nitra in Slovak Republic and Siauliai in Lithuania), and the Italian project partner Antonello Lobianco (Colli jesini and Pina di Sibari). Hauke Schnicke also contributed to the calibration of the study regions in France and the UK. Kathrin Happe coordinated the project and contributed to the discussion about the calibration. Marten Graubner and Hauke Schnicke provided the description of the regions in SAHRBACHER et al. (2005). This description is not included here.

varies. Sector models like ESIM, AGLINK, AG-MEMOD, CAPRI, CAPSIM and FAPRI[19] consider what is produced in what amounts and in which country. Regional models like RAUMIS and farm models like FARMIS, AROPAj and FAMOS[20] provide the same kind of answers, but they are more detailed regarding the location of production. Additionally, these models provide detailed information for the base year about the specialisation and farm size distribution. However, changes to these characteristics are limited in these models. Furthermore, these models are based on farm groups whose characteristics are derived from the average of the group. The ideal solution for modelling agricultural structures would be to model each farm because all farms have different characteristics such as i) capital resources; ii) ownership structure of land and capital; iii) age of assets; iv) age and skills of the manager; v) location of the farm.

A model that considers all of these aspects is the agent-based model AgriPoliS, which explicitly represents the agricultural structure of a region. However, until 2003, AgriPoliS was only applied to one region, namely the Hohenlohe region in Southwest Germany. One goal of this thesis was to apply AgriPoliS to seven regions all over the EU. Thereby, the variety of the EU's agriculture should be considered. Before the presentation of the input-data in this section, AgriPoliS will be briefly described to provide the reader with a better understanding of the modelling process, while the interpretation of simulation results will follow later.[21] Afterwards, how AgriPoliS is adapted to the agricultural structure of a region will be described in detail. Then, the regions selected to represent EU agriculture will be briefly described. The results of the regional adaptation of AgriPoliS will be presented for one region,[22] which will include the presentation of data on the selected farms and regional structures. For modelling the farms in the virtual region, mixed integer programming is used. Therefore, key production activities and investment options for each case study region will be identified and presented. In addition to the farm-specific parameters, some region-specific global parameters such as interest rates, transport costs, etc., have to be set in AgriPoliS.

The data presented here will be used for further analyses conducted in sections 4, 5 and 6. Section 4 compares the impact of the MTR on structural change and farm income in six OMS regions. Additionally, it will be tested whether the impacts of the MTR on structural change are region-specific or whether the results of one region also hold for the others. Following this general analysis comparing regional averages, two in-depth analyses are conducted, where two regions are

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19 In BALKHAUSEN et al. (2008) simulation results of these models for the MTR are compared.

20 Sources for these models are HENRICHSMEYER et al. (1996), JACOBS (1998), JAYET et al. (2007) and HOFREITHER et al. (2005).

21 For a comprehensive description of AgriPoliS, see KELLERMANN et al. (2008). Technical change, the general market rule and the price trend for products, as well as the transaction cost framework described in KELLERMANN et al. (2008), are not applied in this study.

22 Data for the other regions can be found in appendices A.1 and A.2.

analysed in more detail. Section 5 seeks to identify the "winners" and "losers" of decoupling for the Hohenlohe region. To complete the picture of EU agriculture, the NMS region Vysočina, in the Czech Republic, is analysed in section 6. This analysis is conducted separately because of the different situation in the NMS compared to the OMS. *First*, there occur two policy changes: accession to the EU in 2004, and decoupling in 2009. And *second*, the restructuring of large co-operative farms is still not finished.

3.2 The agent-based model AgriPoliS[23]

The Agricultural Policy Simulator (AgriPoliS) is an agent-based model that represents the agricultural structure of a region. The key components are the farm agents, the explicit spatial representation of farms and agricultural plots, and markets for outputs and inputs (land, milk quota). The agent-based approach enables us to model individual farms and to investigate how farms interact in space and evolve over time. The model shows the dynamic development of the farms, and thereby, that of the agricultural structure. Farms can individually produce, invest, exit, shrink or grow. The land rental market is the main linkage between individual farms, as a farm can only expand its acreage if other farms shrink or exit. Land becomes available on the competitively organised rental market if rental contracts end or if a farm exits agriculture at the end of a simulation period, which is equal to a year.

3.2.1 Consideration of space and landscape elements

In AgriPoliS, farms are modelled explicitly and appear in a certain location. A region is modelled spatially by a grid of equally-sized cells that equate to agricultural plots. Plots can have different attributes; they can be rented or owned by a farm or be held as abandoned land. The agronomic quality of the plots can vary; in general, quality is differentiated between arable land, grassland and non-agricultural land. Non-agricultural land may represent infrastructure, settlements and other landscape elements such as forests, lakes, rivers, etc. Further plot attributes are whether a farm is located on it, whether the plot is rented, and if so the rental price paid for it, transport costs between the plot and the farmstead of the owner/tenant of the plot and the value of the payment entitlement.

3.2.2 Farm agents

Farms actions mainly consist of producing, investing, renting or releasing land and if necessary exiting agriculture. In the following a description of how these actions are modelled is provided, as well as the behavioural rules of the farm agents. Renting and releasing land is described in section 3.2.3.

[23] In this section, the most important and (for this study) relevant features of AgriPoliS are described. For more details, see KELLERMANN et al. (2008). Technical change, the general market rule, the price trend for products and the transaction cost framework described in KELLERMANN et al. (2008) are not applied in this study.

3.2.2.1 Production and investment

Mixed integer programming (MIP) is used to model the farms. Within the MIP-model, farms can choose between different continuous production activities (i=1,…,l) and integer investment options. They can also utilise auxiliary activities for an optimal use of factor endowments consisting of own manpower, land of various quality (e.g. grassland (GL) and arable land (AL)), capital, machinery, buildings and production quotas. Auxiliary activities consist of: hiring fixed and variable labour, fixed and variable off-farm employment, borrowing capital for the short-term (BC_s), saving own capital, agri-services to extend machinery capacities and leasing or leasing out of production quotas. The short-term borrowing of capital can be used to cover variable costs of production and the equity share of investments. The following financing rule (3.1) limits short-term borrowing, thereby farms can use only 70% of their land assets (LA) and 30% of the equity share of other assets (A_{ec}; buildings and machinery) as security.

$$BC_s \leq 0.7 \cdot LA + 0.3 \cdot \sum_{l=1}^{L} A_{ec,l} \; . \tag{3.1}$$

For investment options, economies of scale are assumed according to acquisition costs and labour demand per unit. Investment costs are depreciated over the entire useful life of the investment. At the end of the investment's useful life, farms have to reinvest if they want to maintain their production capacities. As investments in agriculture can hardly be used for any other purpose than agricultural production, their opportunity costs are set to zero, that is, investment costs are sunk. Investments are financed by liquid assets (L) and long-term borrowed capital (BC). The share of equity (v) and borrowed capital (1-v) of an investment is fixed for all farms in a region. Long-term borrowing is indirectly restricted. Farms can borrow capital for the long-term if an investment is profitable.

In addition to the financing rule for short-term borrowing, the MIP-model also includes other restrictions depending on the modelled region. For example, there are fodder restrictions for ruminants, restrictions regarding crop rotation, set aside, livestock density, the balance of organic nitrogen, etc. The objective function of the MIP-model is to use the factor endowment (**b**) of a farm for the production of **x** entities of different products (i=1,…,l) with the expected price $\mathbf{p}^{\mathbf{e}}$, variable costs (**c**) varying by the management factor (MF) and given factor demands $(\mathbf{r})$ to maximise household income (Y). Thereby, factor demand (**r**) for the production of **x** entities of various products has to be smaller than or equal to the factor endowment. Factor endowment can also be extended by different investment options (**I**). The interest received (IR), subsidies (S) and wages from off-farm labour (W) are added to the total gross margin from agriculture $(\mathbf{x}'(\mathbf{p}^{\mathbf{e}} - \mathbf{c}))$. Rent expenditures (RE), depreciation (D), interest (IC) and maintenance costs (MC) for machinery and buildings, as well as farming overhead (OV), transport costs (TC) and wages paid for hired labour (HW) are subtracted from the total gross margin from agriculture.

$$
\begin{aligned}
&\max Y^e = (\mathbf{x}, \mathbf{p^e}, \mathbf{c}, \mathbf{A}, \mathbf{I}, \mathbf{r}, MP, D, RE, L, BC, IC, GL, AL, MF, ...) \\
&\text{with } Y^e = \mathbf{x}'(\mathbf{p^e} - \mathbf{c}) + IR + S + W - RE - D - IC - MC - OV - TC - HW \\
&\text{s.t.} \quad \mathbf{b} \geq \mathbf{x}'\mathbf{r} \quad \text{with} \quad \mathbf{r} = (r_1, ..., r_I, ..., r_H, ..., r_J) \\
&\qquad \mathbf{x} \geq 0 \quad .
\end{aligned}
\tag{3.2}
$$

Farms with their own manpower withdraw from the total household income some money per family working unit $(FAWU)$ for their own consumption. The level of the withdrawal (WD) depends on household income (Y). If the household income is higher than $(WD_{\min} * FAWU)$, farms withdraw additional money for consumption determined by (ε) (3.3).[24] The remaining household income is added to the equity capital of the farm. If the household income is smaller than the $(WD_{\min} * FAWU)$, the equity capital will be reduced.

$$
WD = \begin{cases} WD_{\min} \cdot FAWU + (Y - WD_{\min} \cdot FAWU) \cdot \varepsilon, & if \; Y > WD_{\min} \cdot FAWU \\ WD_{\min} \cdot FAWU, & else \end{cases}
\tag{3.3}
$$

with $0 < \varepsilon \leq 1$.

3.2.2.2 Exit decision

Regarding the decision to exit agriculture, farms follow two rules. *First*, farms have to exit agriculture when they are illiquid, that is, when financing rule (3.1) is zero. *Second*, farms exit when the expected opportunity costs for their production factors (owned land, labour, capital and production quotas) are higher than the expected farm income for the following year. The calculation for the expected farm income considers changes in the factor endowment due to disinvestment, the end of land rental contracts, as well as any arising policy changes and prices changes. Product price changes caused by policy changes are exogenously given from partial equilibrium models like ESIM or CAPRI. Since policy changes can also influence rental prices, they are adjusted by π, which reflects the rental price change between the year before and the year after the policy change.[25]

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[24] The factor ε is for all regions 0.7.

[25] For more details, see section 5.3.

To conclude, farms' decision-making is myopic and not strategic. They do not know about other farms' production decisions, factor endowments, size, etc., and are only informed about policy changes one year in advance. Thus, their behaviour can be described as adaptive and boundedly rational.

3.2.3 Land market[26]

Although farms are initialised with both owned and rented land, transactions on the land market take place exclusively via renting activities. There are two reasons for this decision: *first*, it is assumed that the capitalised rent equals the sales price of a unit of land. Even though this equivalence could not be observed in reality, the difference in capitalised rents and sales prices is often explained by determinants such as reliability, stability, eligibility for use as collateral or taxation reasons. Since all of the mentioned determinants are beyond the scope of the model, this simplified assumption seems acceptable. The *second* reason for the decision to focus on rental markets is that in many countries, land transactions take place on land rental markets. This is especially true for NMS (cf. SWINNEN et al. 2006) such as the CZ, where in 2003, 89% of the land was rented (MINISTRY OF AGRICULTURE 2004) and the majority of land transactions still take place on the rental market; but it also holds for the other case study regions (LATRUFFE and LE MOUËL 2006).

Concerning rented land, two types of contracts are modelled. The *first* is a rental contract with a fixed duration. The duration of such a contract varies between a minimum and maximum length and is randomly assigned to a contract when a plot is rented. The contract cannot be terminated or renegotiated for the entire duration, except if the farm exits agriculture. The *second* type of contract provides more power to the farmers. The duration of such contracts is generally indefinite. They can only be cancelled by the farmer if he exits agriculture or if the utilisation of a plot is no longer profitable, that is, the shadow price (q_{Land}) of the plot is lower than the rent $(R_{y,x})$ for the plot, plus transport costs $(TC_{y,x})$ and additional costs $(C_{y,x})$ (3.4).

$$q_{Land} < \max_{y,x}(R_{y,x} + TC_{y,x} + C_{y,x}).^{27} \tag{3.4}$$

This type of contract leads to a slower increase in rental prices than in the case of fixed contract durations because fewer contracts are renegotiated. Rental prices increase only if land changes ownership. As farmers only quit contracts that are unfavourable for them, only a small share of land is available on the rental market. The "renegotiation" contract is only used in regions with highly

26 Here, only the land market is described. A description of the output markets can be found in KELLERMANN et al. (2008).

27 Adjacent (contiguous) plots are not considered when rental contracts are terminated.

restricted rental markets like in France, where Société d'Améngement Foncier et d'Etablissement Rural (*SAFER*, Society for Land Management and Rural Development) a private body with public mission, can refuse contracts if they do not conform with their goals (LATRUFFE and LE MOUËL 2006).

Free land coming from farms exiting agriculture or from terminated contracts is allocated among farmers via a sequential first-price auction. At each sequence, only one plot is auctioned and the auction continues until all plots are allocated or until there are no further positive bids. In each sequence, farms select the plot which is most valuable to them and then calculate their bid accordingly. The farm with the highest bid receives the plot with the highest value for the farm. That farms bid for their most valuable plot instead of bidding for a plot offered to all farms by the auctioneer avoids first-mover advantage. To consider complementarities between different soil types, the auction alternates between them. Bids $\left(R_{y,x}\right)$ of farms are equal the shadow price of an additional plot $\left(q_{Land}\right)$ minus transport costs $\left(TC_{y,x}\right)$ from the farmstead to the plot, and minus the additional costs $\left(C_{y,x}\right)$ associated with this plot. Because a mixed integer approach for farm optimisation is used, it is not possible to derive the shadow price from the dual solution. Instead, the optimisation problem given in (3.2) is solved twice. First it is solved with the current acreage of the farm. Then the acreage is increased by the size of one additional plot (N). The shadow price of a plot is the difference of both results as shown in (3.5):

$$q_{Land}^{N} = \frac{\max Y^{e}(...,b_{Land} + N \cdot sizeof(p_{y,x}),...) - \max Y^{e}(...,b_{Land},...)}{N}. \tag{3.5}$$

Because of the indivisibility of investment options, the shadow price may change rapidly if a farm rents more than one plot at a time. Taking this non-convexity into account, farm agents compute the shadow prices additionally for a fixed number of additional plots $N = 8$. The maximum shadow price of both calculations ($N = 1$ and $N = 8$) is used for the bid. As farms normally do not transmit the whole rent (shadow price) to the land owners, the parameter β is introduced to adjust the bid.

$$R_{y,z} = \beta \cdot (\max(q_{Land}^{1}, q_{Land}^{PLOTN}) - TC_{y,x} - C_{y,x}), \text{ with } \min_{y,x}(TC_{y,x} + C_{y,x}).^{28} \tag{3.6}$$

Additional costs $\left(C_{y,x}\right)$ can be considered as transaction costs $\left(TAC_{y,x}^{i}\right)$ that occur on less developed land markets in some NMS, or they can account for economies of scale $\left(EOS_{y,x}\right)$ where farms already utilise adjacent plots. The number of

[28] By calculating a bid, farms search for the closest free plot with the lowest additional costs.

adjacent plots (n_{adj})[29] is then multiplied by δ, which reflects the cost savings per additional land unit.

$$EOS_{y,x} = -\delta \cdot n_{adj} \,. \tag{3.7}$$

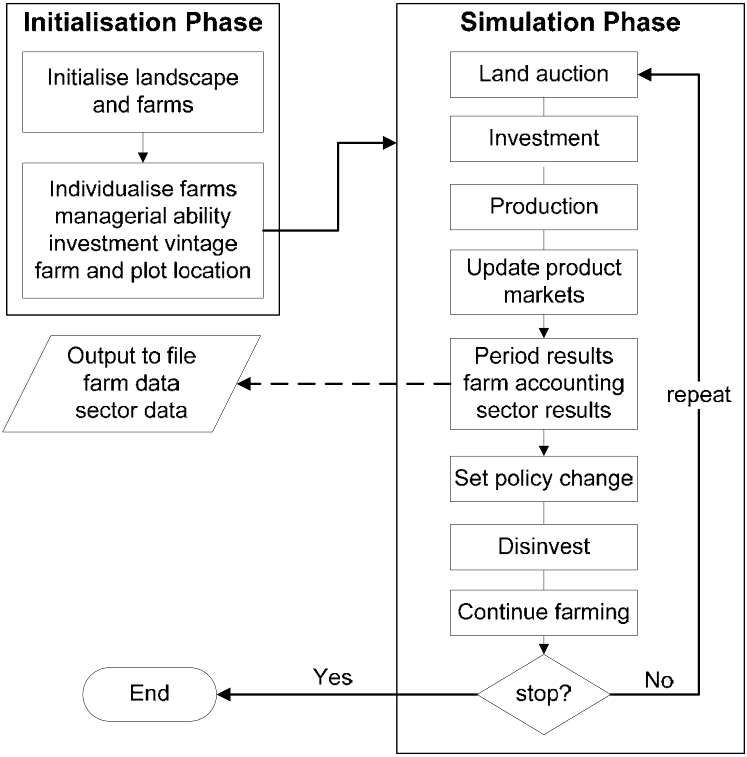
3.2.4 Model dynamics

Thus far the components of AgriPoliS (farms, space and land market), as well as their attributes and actions have been described. In the following, the sequence of the individual operations (actions) in AgriPoliS will be described (Figure 3-1). The modelling approach encompasses two phases, the initialisation phase and the simulation phase. In the initialisation phase, data about farms and production activities, as well as the weighting factors of the farms are read by AgriPoliS and the virtual landscape is initialised. Farms are individualised according to their location, farmer's age, vintage of assets and managerial ability.[30] In the first period, all land is allocated to farms, thus the simulation begins directly with the investment step. After farms have invested, they make decisions regarding production with knowledge of current prices. Output prices are then adjusted depending on the total production and farms sell their products at adjusted prices. After that, farms do their accounting with the adjusted prices. The results of individual farms' accounting are saved in an output file, as are the aggregated results at the sector level. A selection of data saved in these files is listed in appendix A.1. Finally, the farms receive information on the upcoming year's policy and they have the opportunity to check whether some of their investments or rental contracts have ended. Based on the new factor endowment, actual prices and policy information, the farms calculate their expected income for the next year and compare it with the opportunity costs for their owned land, labour and capital. If the opportunity costs are higher than the expected farm income, then farms exit agriculture. Illiquidity is another reason for farm exits. At the beginning of the following period, first policy changes are set and then free land is allocated among the remaining farms via the land auction. This procedure continues until the number of specified simulation periods is reached.

[29] One plot has a maximum of eight adjacent plots.

[30] Managerial ability is defined by a management factor that is randomly assigned to each farm and changes the variable costs (c.f. Heterogeneity of farms section 3.7).

Figure 3-1: Sequence of operations in AgriPoliS



Source: Based on HAPPE (2004).

3.3 Methodology for adapting AgriPoliS to a region

To simulate the development of an agricultural region with AgriPoliS, the agricultural structure of the region has to be virtually represented for the base year. This representation is done in two steps. The *first* step is to create a virtual region which represents the structure of the study region based on a number of farms. The *second* step is to represent the internal organisation of these farms, that is to say, their specialisation, main production activities, and their asset and capital endowments.

3.3.1 Creating a virtual region based on selected farms

The agricultural structure of a region can be described by *general characteristics* like total number of farms, total utilised agricultural land and total number of livestock and *structural characteristics* like number of farms per farm type or legal form, share of different land qualities, number of farms in different size classes and number of livestock per herd size class. All these characteristics result from the structure of the individual components of a region. Following this approach, the best way to represent a region would be to model each individual farm in a region, but this would be very time consuming depending on the size of the region and also be restricted to the available data. As in AgriPoliS, each individual farm has to be represented with a mixed integer programming model and the data have to be calibrated to represent the farms' production; an appropriate number of farms for modelling is between 20-30. Potential data sources for aggregated regional data are statistical offices, while for individual farm data the FADN, the Integrated Administration and Control System (IACS) or conducted surveys are potential sources. These sources can deliver data about 100 or more farms. To reduce the number of farms and to represent a region, an approach created by BALMANN et al. (1998) and further developed by KLEINGARN (2002) and SAHRBACHER (2003) is used.

Following BALMANN et al. (1998), *first*, a set of farms representing the variety of farms in the study region has to be selected from the initial farm sample. If no FADN or IACS data are available, representative farms can also be defined by experts (HEMME et al. 1997, BERG et al. 1997). *Second*, regional data such as the number of farms, farm-size distribution, farm specialisation and overall livestock numbers are defined as goal criteria. *Third*, an optimisation problem is formulated, which assigns weights to each farm and minimises the quadratic deviation between the sum of weighted farm characteristics and the respective regional goal criteria. Negative weights are ruled out since the model farm properties are correlated, and negative farm numbers would be unrealistic.

Regarding typical farms, there are two ways to select them. One is to select them manually from the farm samples, for example, based on expert opinion, survey data or regional statistics. BALMANN et al. (1998) and KLEINGARN (2002) chose this approach. Depending on the availability of individual farm data, the selection of representative farms can be a tedious undertaking. Facing the problem of selecting 25 farms from a set of more than 100, the selection process is automated here, i.e., farms are simultaneously selected and weights to scale up farm production capacities (stable size, land) to the region are derived. This means that the selection of farms occurs together with step 3, by the optimisation problem that was previously only used to derive the weights to scale up farm production and capacities. As FADN data were available for all case study regions, this second approach was followed. The goal of this method is to select and weight farms with which a region can be best represented.

In mathematical terms, the weighting and, in the latter case, the selection procedure, can be explained as follows according to BALMANN et al. (1998):

Let $\mathbf{b} \in \Re^m$ be the vector of *m* farms and let $\mathbf{y} \in \Re^n$ be the vector of weights for *n* statistical goal criteria in the region. Furthermore, let $v_{i,j}$ be the contribution *j* of farm *i,* and $V \in \Re^{m \cdot n}$ be the matrix of contributions for all farms. From this we derive the vector of all goal criteria $\hat{\mathbf{y}}$ for the virtual region

$$\hat{\mathbf{y}}^0 = \mathbf{b}^T \mathbf{V}^0 .$$

Now we can construct a normalised matrix $\mathbf{X} \in \Re^{m \cdot n}$, with

$$\mathbf{X} = \left[a_j \frac{v_{i,j}}{y_j} \right]_{\substack{i=1,\dots,m \\ j=1,\dots,n}},$$

and a_j as the priority level of criterion *j*, or $\mathbf{a} \in \Re^m$ as the vector of priority levels of all criteria in the region. The priority level is used to achieve a better adjustment of a criterion in the case there is a big difference between a weighted criterion and the real characteristic. The vector of weights $\mathbf{b}$ then results from the minimisation problem

$$\min_{\mathbf{b}^k} \left\{ \left(\mathbf{X} \ \mathbf{b} \ - \mathbf{a} \ \right)^T \left(\mathbf{X} \ \mathbf{b} \ - \mathbf{a} \ \right) \right\} \quad \text{with } \mathbf{b} \geq \mathbf{0} \ .$$

This problem can be solved with a quadratic programming algorithm. Only farms with $b_i > \mathbf{0}$ are considered to represent the region.

3.3.2 Representing selected farms

After selecting farms with the help of the quadratic programming algorithm, the second step is to represent these farms by an MIP model, which serves as a basis for farm production and planning (see section 3.2.2.1). The MIP model represents the behaviour and organisation of the selected farms and simultaneously brings together farm factor endowments, production activities, financing activities, alternative labour uses, investment possibilities, and restrictions to farming activities. Here, we assume that selected farms maximise farm household income. Figure 3-2 shows an exemplary matrix of the optimisation problem.

Figure 3-2: Exemplary scheme of a mixed-integer programme matrix

Mixed-integer programme		Short-term loans/savings	Buy/sell variable labour	Hire contractor	Plant production	Livestock production	Set-aside land	Buy/sell manure	Buy/sell milk quota	Investment activities	Buy/sell fixed labour
		c	c	c	c	c	c	c	c	i	i
	Objective function	*Gross margin*									
Factor capacities	Liquidity (€)	x		x	x	x	x			x	x
	Min. equity capital reserve (€)				x	x	x			x	x
	Labour (h)		x		x	x	x	x		x	x
	Utilised agricultural area (ha)				x			x			
	Milk quota (litres)					x					
	Livestock capacities (places)					x				x	
	Machinery (ha)			x	x		x			x	
Other restrictions	Organic N-balance (kg N/ha)				x	x					
	Rape seed max. (% of UAA)				x		x				
	Sugar beet max. (% of UAA)				x						
	Set aside (% of UAA)				x		x				
	Winter fodder (ha)					x			x		
	Direct payments (€)				x	x	x				
	Stocking density (LU/ha)				x	x	x				

Notes: c = continuous activities, i = integer activities.

Source: HAPPE (2004).

The MIP model is used to fulfil two tasks: task 1 is to represent and – as far as possible – reproduce the selected farms' observed organisational scheme, which consists of production activities, factor endowments, and economic indicators. Task 2 is to provide options for alternative farm organisations, which are given by investment options, buying and selling of labour, contracting, and savings.

To represent the selected farms by means of an MIP model:

- Typical production activities and their restrictions must be defined.
- Typical investment options have to be defined.
- Investment options have to be assigned to selected farms based on their size and the amount of their livestock husbandry.
- Alternative production activities have to be identified;
- An MIP matrix has to be set up and compiled based on farms' specific factor endowments.

- Parameters of the MIP model have to be calibrated for the following criteria:
- New investments should not occur in the initial setting, because this would lead to a large deviation between observed and optimised production in the base period.
- Factor endowments (land, machinery and stables) have to be fully used.
- Losses have to remain limited, as this would mean farms would exit too quickly in AgriPoliS due to illiquidity.

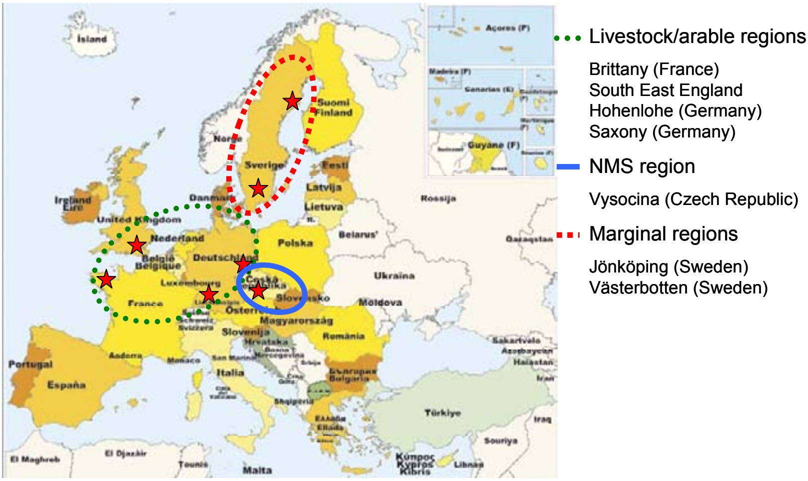
3.4 Overview of case study regions[31]

The objective for the selection of the case study regions was to cover the diversity of EU agriculture in order to determine whether simulation results could be generalised independent of the modelled region. At the same time, the regional characteristics should meet the simulation model's requirements. From the modelling perspective, the regions themselves should be homogenous, especially regarding environmental conditions. In regions with heterogeneous production conditions, yields vary strongly, and additional production activities for different soil qualities must be defined. The smaller the region, the more likely it will be homogenous. Hence, it is better if regions are small. But on the other hand, the size of the selected regions also depends on data availability. Therefore, the region should be, from a modelling point of view, as small as possible in order to guarantee homogenous conditions, and as large as necessary to ensure the required data availability.

Selected regions are grouped according to the following criteria: Socio-economic considerations (high income/low income regions), mode of operation (intensive/extensive agriculture), farm size (small/large) legal form (individual farm/legal entity) and type of decoupling (farm-specific/regional/hybrid). Based on these considerations, the regions displayed in figure 3.3 have been chosen.

[31] Detailed information on the study regions can be found in SAHRBACHER et al. (2005).

Figure 3-3: Location of case study regions



Source: EUROPEAN COMMISSION (2007).

Table 3-1 presents an overview of the selected regions and of the criteria they embody. Regional experts classified the regions according to production intensity. In general, regions with high capital input (e.g. Hohenlohe, Brittany, South East England, Saxony[32]) were classified as intensive production regions. The Swedish regions of Västerbotten and Jönköping have been classified as extensive production regions because of the importance of extensive livestock production, e.g. suckler cows, beef cattle and ewes, which are raised on a greater proportion of land than in the other regions.

Regarding farm size, three phenomena can be observed: There are regions with low average farm sizes (around 30 ha), e.g. Jönköping, Västerbotten, Hohenlohe and Brittany. In South East England, large-scale farms dominate. Saxony and Vysočina show dualistic farm structures with a large number of small individual farms on the one hand, and a smaller number of large farms on the other. In Brittany, there is also a kind of dualistic structure in that there are large corporations specialising in intensive livestock production without agricultural area. Hence, in this case, the economic size of the operation is the decisive factor.[33]

[32] For the sake of convenience, we use the term Saxony even if we only modelled the Central Saxonian Loess Region and not the whole Federal State of Saxony.

[33] This is not specific to Brittany. In other regions of the EU there are also agricultural companies specialising in livestock production that operate without land. Since in many cases these companies are not classified as farms but as regular companies, data cannot be obtained from agricultural statistics.

Table 3-1: Criteria for selecting the regions

		Sweden		UK	Germany		France	Czech Republic
		Jönköping	Västerbotten	South East E.	Hohenlohe	Saxony	Brittany	Vysočina
Socio-economic	High income	X	X	X	X	X	X	
	Low income							X
Mode of operation	Intensive			X	X	X	X	
	Extensive	X	X					X
Scale of farm operation	Small	X	X		X	X	X	X
	Large			X		X	X	X
Legal form	Individual farms	X	X	X	X	X	X	X
	Legal entities					X	X	X
Average farm size		35	30	47	26	174	33	114
Livestock unit (LU)/ha		1.1	0.8	2.0	1.8	0.5	1.4	0.8
Single farm payment							X	
Regional payment								X
Hybrid model		static	static	dynamic	dynamic	dynamic		

Source: Own presentation based on the opinion of regional experts.

The legal form of farms is strongly correlated with their size. In regions with a dualistic structure (Brittany, Saxony and Vysočina) there are legal entities as well as individual farms. In all other regions, individual farms dominate. Finally, the bottom row of Table 3-1 indicates the respective policy introduced, either with the MTR (OMS) or with NMS 2004 EU accession.

Table 3-2 provides an overview of the size of the regions, the number of farms which are located in the regions and the regional structure concerning the share of grassland and average farm size. The number of farms depends on the limit above which farms are counted in the regional statistics. This lower limit is shown in Table 3-2 as well. Brittany is the largest region, with 1.7 Mio ha and more than 50,000 farms larger than 1 ha.[34] The smallest regions are Västerbotten and Hohenlohe, with around 74,000 ha and an average farm size of 30 and 26 ha, respectively. The regions with the highest share of permanent grassland are South East England (42%) and Jönköping (32%). However, in Jönköping and especially Västerbotten, huge portions of agricultural land are temporarily

[34] It was not possible to choose a sub-region of Brittany, because data for identifying typical farms for the sub-regions was not available.

used to produce grass for silage or pasture. Thus, the share of grassland is much higher in both regions.

Table 3-2: Size and structure of the selected regions

	Total UAA ha	Lower limit in statistics	Number of farms	Average farm size in ha	Part of grass-land of total UAA
Jönköping	134,216	2 ha	3,824	35	32%
Västerbotten	74,414	2	ha 2,506	30	6%
South East E.	530,696		11,214	47	42%
Hohenlohe	73,439	2 ha	2,869	26	23%
Saxony	496,451	2 ha	2,858	174	13%
Brittany	1,701,568	1 ha	51,219	33	13%
Vysočina	393,726	1 ha	3,433	114	21%

Source: STATISTICS SWEDEN (2003), DEFRA (2002), STATISTISCHES LANDESAMT BADEN-WÜRTTEMBERG (1999), LFL (2002), AGRESTE BRETAGNE (2003) and CZECH STATISTICAL OFFICE (2004).

3.5 Data for the regional representation

To represent the agricultural structure of a region in AgriPoliS, both regional data and data about individual farms are needed. In the following, an overview of the available farm data is provided. Then the farms selected to represent the Swedish region Jönköping are presented as an example of farms for all regions. The quality of the representation of a region depends on three factors, which will be explained below, but basically it can be evaluated based on the deviation of the upscaled farm characteristics to the real structural characteristics of the region. This evaluation is done verbally and only the results for the Jönköping area are shown in the text. Results for all other regions can be found in appendix A.3.

3.5.1 Selected farms

Table 3-3 provides an overview of the size and the composition of the farm samples from which the farms have been selected to represent the structure of the case study regions. Moreover, the table shows how many farms were selected in the different regions from the respective farm samples. In South East England, Västerbotten and Jönköping, only 12 to 13 farms were selected, whereas in the other regions 24 to 30 farms were chosen.

Table 3-3: Description of farm samples of each study region

Country	Region	Number of Selected farms	Number of farms in sample	Number of farms per farm type (FADN codes for different farm types)				
				FC (13,14, 60)	D (41)	GL (42,43, 44)	M (71,72, 81,82)	P (50)
Sweden	Jönköping	13	63	2	43	12	6	-
	Västerbotten	12	32	3	24	1	3	1
UK	South East England	12	74	15	8	12	39	-
Germany	Hohenlohe	24	141	30	19	25	21	46
	Saxony	30	1,852	1,288	526*		17	21
France	Brittany	28	605	54	256	36	178	81
Czech Republic	Vysočina	27	465	205	41	33	179	7

Notes: FC – Field crops; D – Dairy; GL – Grazing livestock; M – Mixed; PP – Pig and Poultry.
* Dairy and grazing livestock farms are pooled in Saxony.

The number of farms selected depends on several factors. *First* is the availability of farm data. In Saxony, for instance, data is available for farm sizes above 10 ha from the IACS. The IACS includes data about farm size, share of arable land and grassland, and livestock numbers for which farmers apply for subsidies; it does not include economic data such as the FADN, which was not attainable for Saxony. Farm samples for Västerbotten, Jönköping and South East England (32, 62 and 74 farms) are quite small compared to Saxony. *Second*, the regional structure is of vital importance. If there is a low variation in both farm sizes and farm specialisation, only few farms are necessary to represent the region in AgriPoliS. This is partially valid for the Swedish regions. *Third*, the number of selected farms also depends on the quality of regional data. In regions where more data are available, more characteristics of the region can be considered and therefore more farms are necessary to represent the region. This is the case in Hohenlohe, Saxony, Brittany and Vysočina.

Using the selected farms of Jönköping, Table 3-4 shows, for all regions, which farm indicators are considered for the representation of a region.[35] The indicators are normally:

- The legal form (individual farms and legal entities).
- The farm type (e.g. field crop farm, dairy farm, mixed farm etc.).

[35] For the selected farms of the other case study regions, see appendix A.2.

- The area of arable land and grassland.
- The type and number of livestock.

In Jönköping, eleven farms were selected from the initial farm sample, with each farm weighted differently. The weighting factor shows how often each selected farm exists in the virtual region. The focus of the selected farms is cattle: seven farms are dairy farms, five are grazing livestock farms and one is a mixed farm that also keeps sheep. The area of arable land and grassland was rounded before the selection and weighting of the farms, that it, it was made divisible without a remainder by the plot size of the region. Cattle stocks of less than five animals, as well as breeding and fattening pig stocks of less than ten animals, were also not considered in the selection and weighting of the farms, because such small stables are not available in AgriPoliS. In Jönköping, almost all farms are managed as individual farms, thus no farm with another legal form was selected.

According to the FADN definition (EUROPEAN COMMISSION 2002a), individual (family) farms are holdings where the economic result covers the compensation for the unpaid labour input and own capital of the holder/manager and her/his family. The FADN considers two addition legal forms: partnerships, which are holdings where the economic result covers the compensation for the production factors brought into the holding by several partners, of which at least half participate in the work on the farm as unpaid labour; and legal entities, which are holdings with no unpaid labour and other holdings not classified as individual farms or partnerships (EUROPEAN COMMISSION 2002a). Beyond that, France and Germany differentiate individual farms into part-time and full-time farms. Farms with an economic size smaller than 16 European Size Units (ESU)[36], or which require less than one Annual Work Unit (AWU) for agricultural production, are called part-time farms because farmers need only spend a part of their time on the farm; instead they earn the main part of their income outside agriculture (HESSENAUER 2002). As part-time farming is often the first step towards quitting farming, and as it is important for the majority of individual farms in Hohenlohe, this differentiation of individual farms is considered in the representation of both Hohenlohe and Saxony. In Saxony, partnerships and legal entities also exist. By German law, these partnerships and legal entities are differentiated through their kind of liability. Owners of a partnership are also liable for their private assets, while legal entities are only liable for the assets belonging to the corporation or cooperative.

[36] 1 ESU is equal to a standard gross margin of 1,200 Euros (EUROPEAN COMMISSION 2002b).

Table 3-4: Selected farms in Jönköping, Sweden

Legal form	Farm No.	Farm type[a)]	Weight	Total UAA	Arable land	Grass-land	Beef cat-tle	Dairy cows	Suckler cows	Sheep
Individual farms	**1**	D	147	22	14	8	-	10 - 24		-
	2	D	218	30	18	12	-	10 - 24		-
	3	D	59	32	24	8	-	< 10	< 10	-
	4	D	320	62	48	14	-	25 - 49		-
	5	D	73	80	58	22	< 10	25 - 49		-
	6	D	156	120	100	20	-	75 - 150		-
	7	D	92	128	102	26	25 - 49	25 - 49		-
	8	GL	393	40	16	24	10 - 24	-		-
	9	GL	244	46	28	18	-	-	10 - 24	-
	10	GL	9	58	30	28	< 10	-	25 - 49	-
	11	GL	164	70	40	30	-	-	25 - 49	-
	12	GL	160	92	66	26	50 - 74	-		-
	13	M	130	40	24	16	-	-	10 - 24	50 - 75

Notes: [a)] D: Dairy farms; GL: Grazing livestock farms; M: Mixed farms.

Source: Derived from FADN data by regional partners.

In Brittany, farms are differentiated into the legal forms of individual farm, Groupement agricole d'exploitation en commun (GAEC), which are partnerships, Exploitation agricole à responsabilité limitée (EARL), which are legal entities, and other legal entities. Individual farms are also differentiated into part-time and full-time farms as in Germany, but as there was no part-time farm in Brittany's farm sample, it was not possible to consider part-time farming in this region.

For the case of the Czech region Vysočina, only individual and legal entities are considered. The latter are normally former cooperatives or state-owned farms. Differentiation into individual farms and legal entities is important in NMS because of the dual structure of agriculture in these countries (SARRIS et al. 1999, LERMAN et al. 2004).

3.5.2 Virtual regions

As mentioned at the beginning of section 3.3.1, the study regions are represented by the selection and weighting of farms from a larger farm sample. In the following, the structure of the region Jönköping will be compared to the structure of the virtual Jönköping region (Table 3-5). Results for the other regions are shown in appendix A.2. Table 3-5 is divided into two parts. General characteristics such as total number of farms, total utilised agricultural area (UAA), and total number of livestock are presented in the first part, while structural characteristics like number of farms per farm type and legal form, amount of arable land and grassland, number of farms per size classes, and number of animals per herd sizes are presented in the second part.

In the second column of Table 3-5, regional statistical data are presented. Not all of these data are consistent, because they are from different sources. Thus, they have been adjusted, as explained below in more detail. Another reason to adjust the data was that not all types of farms are considered in the modelling. Only the main types of production (field crops, milk, grazing livestock and pig and poultry), which use arable land and grassland, are considered. Because the total UAA also includes land used for orchards, vineyards and other crops, it was adjusted for the representation of the regions. Furthermore, depending on the region, farms smaller than 5 or 10 ha have not been considered for the representation of the regions for two reasons. *First*, the FADN-farm samples did not include such small farms. *Second*, the behaviour of small subsistence and hobby farms cannot be represented in a MIP model under the assumption that they maximise their household income. The regional data are adjusted either by special queries at the statistical offices like in Saxony, or based on information by local experts. Adjusted data are bold and can be found in the third column of Table 3-5. The fourth column shows the weighted farm characteristics, that is, the structure of the virtual region. The fifth column shows the relative deviations between the individual characteristics of the (adjusted) real region and the virtual region. The last column compares data from the virtual region to regional data. In Jönköping, the virtual region covers only 57% of the farms in reality, but they use 94% of the total UAA. This difference is mainly present because farms smaller than 10 ha are not considered in the representation of Jönköping. The deviation between the number of farms in the virtual region and the number of farms considered for the representation is only 2%. The maximum deviation of 4% to the considered data occurs for arable land and grassland. For all other characteristics, the deviation is smaller. Thus, one can say that the agricultural structure of Jönköping is well represented in AgriPoliS. The only disadvantage is that it was not possible to consider the distribution of farms specialising in different types of farming. If one would rank the regions by the quality of their representation, Jönköping would be in the middle, because types of farming are not considered.

Table 3-5: Representation of the Swedish region Jönköping in AgriPoliS

General characteristics	Regional data	Considered and adjusted data	Virtual region	Deviation to considered data [1-(4)/(3)]	Coverage of the regional data [(4)/(2)]
(1)	(2)	(3)	(4)	(5)	(6)
Number of farms	3,824	**2,216**[1)]	2,165	-2%	57%
Utilised agricultural area (UAA; ha)	134,216	**125,204**[2)]	126,704	1%	94%
Number of beef cattle older than 1 year	20,403	20,403	20,605	1%	101%
Number of dairy cows	33,158	33,158	33,322	0%	100%
Number of suckler cows	12,173	12,173	12,262	1%	101%
Number of ewes and rams	8,548	8,548	8,580	0%	100%
Sows after the first mating	4,826				
Fattening pigs	14,325				
Structural characteristics					
Area (ha)					
Arable land	91,369	**82,357**[2)]	85,606	4%	94%
Grassland	42,847	42,847	41,098	-4%	96%
Total	134,216	**125,204**[2)]	126,704		
Number of farms specialised in[4)]					
Field crop farms (13, 14, 60)	1,166				
Grazing livestock (41, 42, 43, 44)	2,054				
Pig and poultry (50)	19				
Mixed farms (71, 72, 81, 82)	931				
Total	4,170				
Number of farms in different size classes					
2-10 ha	1,608				
10-20 ha	779	779	758	-3%	97%
20-30 ha	438	438	433	-1%	99%
30-50 ha	506	506	493	-3%	97%
50-100 ha	400	400	389	-3%	97%
More than 100 ha	93	93	92	-1%	99%
Total	3,824	2,216	2,165		
Number of dairy cows per herd size class					
1-9	474	**478**[3)]	472	-1%	100%
10-24	5,332	**5,374**[3)]	5,394	0%	101%
25-49	14,717	**14,832**[3)]	14,976	1%	102%
More than 50	12,377	**12,474**[3)]	12,480	0%	101%
Total	32,900	33,158	32,322		

Notes: [1)] Farms with less than 10 ha are not considered.
[2)] The regional expert Mark Brady reduced the total UAA by 5.6 ha for each of the 1,608 farms not considered.
[3)] There is a small difference in the total number of dairy cows and in the sum of dairy cows by herd size, thus the number of each herd size is adjusted to the total number of dairy cows.

Source: STATISTICS SWEDEN (2003), [4)] REGIONAL DATA (2002).

The representation of Saxony, Hohenlohe and Vysočina is better, because more data are available, and in Saxony all data are consistent because they are from just one source.

The representational quality of a region depends on three factors. *First*, it depends on the quantity of the regional structural data. The main structural indicators are the distribution of farm size; farm type and distribution of herd sizes of the most important branches of livestock husbandry in the regions (see Table 3-6). Legal form distribution is only relevant for the initialisation of the region, because in AgriPoliS farms cannot change their legal form except between part-time and full-time farming. This differentiation is based on labour input in agriculture and on the economic size of the farm, and can be calculated by the model.[37]

Table 3-6: Structural characteristics considered in the study regions

	Number of farms by farm type	Number of farms by legal form	Number of … in different herd size classes
Jönköping	+ not used	- mainly IF	Dairy cows
Västerbotten	+ not used	- mainly IF	Dairy cows
South East England	+	- mainly IF	Dairy cows, sheep
Saxony	+ also area by type	+ also area by legal form	Dairy cows, breeding sows and fattening pigs
Hohenlohe	+ also area by type	+ also area by legal form	Dairy cows, breeding sows and fattening pigs
Brittany	+ also area by type	+ also area by legal form	Dairy cows, breeding sows and fattening pigs
Vysočina	+	+	Dairy cows, breeding sows and fattening pigs

Note: + indicates available and – not available.

Source: Own presentation.

Second, regional data consistency is important for the quality of regional representation. For example, in Hohenlohe the total UAA and the area of grassland and arable land are from different sources, while in Brittany the same holds for the total number of dairy cows and the number of dairy cows by herd size. To represent the regions well, these data have to be adjusted. Furthermore, adjustments are necessary in regions where small farms or specific types of farming are not considered. In such cases, the total UAA, the area of grassland and arable land and the total numbers of livestock must be reduced. In Saxony it was possible to recalculate the regional data, and in Hohenlohe all farms are consi-dered. Additionally, in these two regions it was also possible to consider the area used by different types of farming and legal forms as shown in Table 3-6. Thus, the regional data are the least biased in these two regions. The representation of the Vysočina region in the Czech Republic is also quite good, even if 1,561 farms bigger than 1 ha and smaller than 10 ha are not considered (see appendix A.3).

[37] Farms whose economic size is smaller than 16 ESU, or which use less than one AWU in agriculture are defined as part-time farms.

Therefore, the total UAA is reduced by assuming an average size of 5 ha for these farms. The number of breeding sows and fattening pigs are not reduced, because they are mainly produced in bigger farms, whereas the number of dairy cows was slightly reduced.

The *third* factor that influences the quality of the regional representation is the number of farms available in the initial sample as shown in Table 3-3. Even though the number of farms in the Jönköping sample is small, the representation of this region is quite good. The maximum deviation is -4% for grassland and +4% for arable land. Jönköping is a quite homogenous region dominated by family farms, which is why a differentiation according to legal forms is not necessary (Table 3-6). The variation in farm size is not too large and dairy cows are the most important livestock, which explains why only this livestock type is differentiated by herd size. Given this homogeneity, the diversity among farms in the sample is large enough to represent the region well. The opposite is the case in Brittany, where 605 farms are found in the sample (Table 3-3), but the representation of the region is not so good (appendix A.3). The number of beef cattle (-19%) and grassland (-12%) are strongly underrepresented, as is the number of mixed farms (-14%). The number of dairy cows (+9%) and the number of suckler cows and fattening pigs are over-represented, as are the number of pig and poultry farms (all +6%). A reason for these strong deviations might be that the area of specific types of farming and legal forms are not correctly adjusted after deleting horticulture, permanent crops, sheep and other farms.

If less structural indicators are available, the data are not consistent and the farm sample is small, then it is difficult to achieve a good representation of a region. This is the case for both Västerbotten and South East England. In the virtual region for Västerbotten, the area of grassland (-23%) and the number of farms larger than 50 and smaller than 100 ha (-15%) are under-represented, whereas the number of dairy cows in herds of 10 to 24 (+16%) and the total number of dairy cows (+6%) are over-represented. Additionally, it was not possible to consider the distribution of farms by farm type because there are only 32 farms in the initial sample (Table 3-3). In South East England, only farms larger than 8 ESU are considered. Most of these (not considered) small farms produce sheep and manage mostly grassland. Therefore, the corrected total UAA in the region contains some uncertainty regarding the estimated distribution of arable land and grassland. This has some consequences for the accuracy of the region's representation in the model. On the one hand, the under-representation of grassland (88%) indicates that the area of grassland should have been reduced. On the other hand, the number of grazing livestock farms, as well as mixed farms, is overestimated (19 and 39% respectively); actually, due to the proportion of grassland those farms manage, they kind of "replace" the small sheep farms not considered in the analysis in terms of grassland coverage in the overall region.

As mentioned above, small farms are not considered in the AgriPoliS modelling. Table 3-7 provides an overview of how this affects the regional representation. The second column lists the minimum farm size for counting farms in the national statistics. The third column shows the minimum size of farms considered in AgriPoliS. For example, in both Swedish regions (Jönköping and Västerbotten) and in Saxony, only farms larger than 10 ha are considered. In South East England, farms are not classified by size in hectares, but by their economic size. The measure for the economic size is the European Size Unit (ESU), which is equal to a standard gross margin of 1,200 Euros (EUROPEAN COMMISSION 2002b). Unfortunately, the farm type in the UK is only calculated for farms larger than 8 ESU. Hence, it was not possible to consider farms smaller than 8 ESU, and it was also not possible to adjust the total UAA to the UAA used by farms larger than 8 ESU. Thus, as written in the fifth column, 77% of all farms are not considered in the representation of South East England. In columns six and seven from Table 3-7, the area not considered in the virtual region is shown in absolute and relative numbers. It is obvious that farms larger than 10 ha use most of the agricultural area. The share of farms which are not considered in 5 out of 7 regions is greater than 35%, but among these 7 regions there are only two in which the share of agricultural land not considered is above 5%. This shows that not considering small farms is not a problem regarding production.

Table 3-7: Adjustments in the regional data

Regions	**Minimum farm size in statistics**	**Farms not considered**			**UAA not considered**	
		Criteria	Number	%	Area in ha	%
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Jönköping	2 ha	<10 ha	1,608	42	9,012	7
Västerbotten	2 ha	<10 ha	1,006	40	6,382	9
South East England	-	<8 ESU	8,688	77	0	0
Hohenlohe	2 ha	–	0	0	0	0
Saxony	2 ha	<10 ha	1,006	35	17,351	3
Brittany	1 ha	<5 ha	6,043	12	32,537	2
Vysočina	1 ha	<10 ha	1,561	45	8,013	2

Source: Own calculations based on appendix A.3.

3.6 Data for the farm representation

Representation of the selected farms requires both factor endowment (land, labour, capital, stable capacities) of the individual farms, which are shown for Jönköping in Table 3-4, as well as data about:

- *Production activities*: gross margins, variable costs, (coupled) subsidies, technical coefficients on factor use (feeding requirements, liquid capital demand, labour demand, crop rotation, nitrogen production/uptake), average annual milk yield per cow, percentage of variable costs bound during a production period, crop rotation.
- *Investment options*: investment costs, typical share of equity bound in investments, size/capacity of the investment, useful life, average work requirement per unit, estimates on maintenance costs.
- *Financing activities*: interest rates for long-term and short-term borrowed capital, savings interest.
- *Labour activities*: wages for unqualified farm-labour, wages for unqualified off-farm labour.

Data about production activities and investment options will be presented in this section, whereas data about financing and labour activities are summarized in section 3.7, where global model parameters and key assumptions are described. In the following, an overview is provided about production activities in the different regions. Afterwards, the economical data of two production activities – barley and breeding sows – for the different regions are shown as an example. All other production activities are described in appendix A.5. The economical data presented in these tables are from various data sources, such as farm management pocket books, or in some cases the FADN. As mentioned in section 3.3.2, these input data have to be calibrated to correctly represent production in the regions during the base period. The adjusted gross margins used for the simulations are shown in appendix A.7. These tables also include technical coefficients of the production activities like labour requirements, machinery requirements and maximum nitrogen uptake for crops, crop rotation limits, as well as nitrogen excretion in livestock husbandry.

3.6.1 Production activities

The variety of plant and livestock production activities in the study regions is shown in Table 3-8 and Table 3-9. The most common crops in all regions are barley, wheat, rape seed and protein plants, followed by sugar beets, which are planted in Hohenlohe and Saxony. For ruminant fodder, mainly permanent grassland is used as pasture or for silage. The most common forage crop on arable land is forage maize, except in Sweden. Because of the climate conditions and the low soil quality there, farmers also use arable land as temporary grassland for silage or even pasture to fatten beef cattle or to produce milk.

Table 3-8: Plant production activities in the study regions

Plant production	Västerbotten	Jönköping	South East E.	Hohenlohe	Saxony	Brittany	Vysočina
Crops							
Barley	x	x	x		x	x	x
Wheat			x	x	x	x	x
Triticale		x				x	
Oats	x	x	x				
Rape seed			x	x	x	x	x
Potatoes			x				x
Sugar beets				x	x		
Protein plants			x[1)]	x[2)]	x[3)]	x[3)]	
Ruminant fodder							
Forage maize			x	x	x	x	x
Arable pasture	x	x	x				
Arable grassilage	x	x				x	x[4)]
Grassland pasture	x	x	x	x	x	x	x
Grassland grassilage				x	x	x	x

Notes: [1)] Winter beans, [2)] Field beans, [3)] Peas, [4)] Fodder crops.

Source: Own presentation.

As beef fattening is important in Sweden, it is differentiated into the fattening of bulls, bullocks and bull sucklers (Table 3-9). The activity "fattening bulls" is comparable to bull fattening in other regions. Bullocks are extensively fattened on-pasture, thus the fattening period is 200 days longer than for bull fattening. Bull sucklers are young bulls from suckler cows, raised on-pasture till a weight of 300 kg and then fattened in a stable.[38] In addition to these special beef fattening activities, a calf market has been introduced, where dairy farms can sell their male calves to farms that specialise in bull fattening. Furthermore, heifer breeding is also explicitly modelled, in contrast to the other regions where replacement is included in the variable costs.

[38] More details about these activities can be found in appendices A.5 and A.7.

Table 3-9: Livestock production activities in the regions

Livestock production	Västerbotten	Jönköping	South East E.	Hohenlohe	Saxony	Brittany	Vysočina
Breeding Sows			x	x	x	x	x
Fattening pigs			x	x	x	x	x
Beef cattle	x	x	x	x	x	x	x
Suckler cows	x	x	x	x	x	x	x
Dairy cows	x	x	x	x	x	x	x
Sheep	x	x	x				
Poultry chicken						x	
Hens						x	
Turkey				x			

Source: Own presentation.

Regarding livestock husbandry, beef cattle, dairy and suckler cows are produced in almost all regions, followed by breeding sows and fattening pigs. Poultry production is important only in Brittany and Hohenlohe. In Brittany, poultry chicken and hens dominate, while in Hohenlohe turkeys do. Sheep are kept in regions with a high share of grassland, such as Sweden and South East England.

For all these production activities, economical data and technical coefficients have been collected in collaboration with IDEMA partners. Note that the presented revenues could not be calculated exactly out of yields and prices, because they often include revenues from additional or joint products (e.g. in livestock production, the revenue also includes revenues from the sale of old animals). For barley and breeding sows, economical data from two additional NMS regions – Nitra in the Slovak Republic and Siauliai in Lithuania – are shown to highlight the differences with OMS regions.[39]

Table 3-10 presents data from all regions in which barley is planted. The first column lists the yields in tonnes per hectare. It is obvious that the Västerbotten and Jönköping regions in Sweden are unfavourable field crop regions, with a yield of between 2.0 to 3.5 t/ha.[40] The other regions are more favourable for field crop production, but it is not obvious for all of them. In Vysočina and Nitra, barley yields are not as high as in South East England or Saxony. However, this is not caused by environmental conditions, but by transition conditions such as low levels of education and a lack of capital. The lack of capital leads to lower

39 The Nitra and Siauliai regions have been further modelled within the project IDEMA.
40 In Västerbotten we even differentiate between a high and low soil quality for arable land.

factor input, e.g. less plant protection or nitrogen input, compared to other regions as shown in appendix A.4.

The price for one ton of barley is approximately 100 Euros. However, revenues per hectare of barley vary from 227 Euros/ha in Västerbotten to 750 Euros/ha in Brittany because of high yield differences.

Table 3-10: Economical data for barley production in the study regions

	Yield	Price	Revenue	Variable cost	Gross margin	Premium before 2004
	t/ha	€/t	€/ha	€/ha	€/ha	€/ha
Västerbotten	2.0l	99	198	265	-67	273
Västerbotten	2.7h	99	267	265	2	273
Jönköping	3.5	99	346	275	71	186
South East E.	6.4	101	648	286	362	355
Saxony	7.0	91	616	380	257	392
Brittany	7.5	100	750	344	406	355
Vysočina	5.2	90	490	296	194	
Nitra	4.1	119	444	238	206	

Sources: Sweden: AGRIWISE (2004). Prices are based on actual levels for 2003.
South East E.: NIX (2003) and calculations by Paul Webster, Wye Campus, Imperial College London.
Saxony: LFL SACHSEN (2003).
Brittany: Price for peas and yields of field crops except rape seed are from TEYSSIER (2002); yield for rape seed and prices of field crops except peas are from AGRESTE BRETAGNE (2003).
Vysočina: Yields and prices from KAVKA et al. (2000); variable costs from JUŘICA et al. (2004) and calculated by Zdeněk Louda, UZEI in Prague, Department "Centre for Economic Modelling" and Jana Poláčková, UZEI in Prague, Division of Structural and Economic Development of Agriculture.
Nitra: Commodity Reports 2003 – SR average data: SIROTSKÝ (2003); TIBENSKÁ (2003). Yields of plant production are out of: special query for Nitra region in 2002 from central database of Ministry of Agricuture of the Slovak Republic and from database of own costs and economic re sults of agricultural enterprises in the Slovak Republic.

Costs per hectare of barley vary from 275 Euros/ha in Västerbotten (Sweden) to 344 Euros/ha in Brittany and 380 Euros/ha in Saxony. The latter two regions are intensive field crop regions with a high level of factor input (fertilizer, plant protection). Low gross margins in Västerbotten and Jönköping can be compensated by premiums, which also include national payments. In Västerbotten, two soil qualities for arable land with a lower and a higher yield level are considered.

In Table 3-11 economical data for breeding sows are presented, as are the number of piglets per year and the price per piglet. For other livestock production activities like beef cattle and fattening pigs presented in appendices A.5 and A.7, we also show the starting weight, the weight at the end, the number of fattening days, the carcass weight and the daily weight gain. The daily weight gain is a performance indicator allowing comparison between the different regions. Revenues, variable costs and gross margins of all livestock production activities are calculated per year.

Table 3-11 shows that the number of piglets per year, per sow varies from 15.3 in Vysočina and Nitra to 21 in South East England and Saxony. There is also a large variation in price per piglet. Whereas in the NMS, the price is around 27 Euros per piglet, prices in the OMS are around 50 Euros. The lower number of piglets per sow and the nearly half cost per piglet lead to an extremely low revenue (around 400 Euros) in the NMS per breeding sow compared to the OMS (around 1,000 Euros). But since costs are 50% lower in NMS as well, it partially compensates for the large difference of 600 Euros in total revenue. It should be considered here that labour costs are not included in the variable costs and that they are lower in the NMS than in the OMS. Hence the difference in gross margins becomes smaller. Another important issue is that prices here are from pre-accession, and that they have been getting adjusted between Old and NMS since the accession.

Table 3-11: Economical data for breeding sows in the study regions

	Piglets per Year	Price per piglet	Revenue	Variable cost	Gross margin
		€	€/year	€/year	€/year
South East England	21.0	41	915	544	371
Hohenlohe	17.4	61	1,151	683	468
Saxony	21.6	49	1,098	754	344
Brittany	19.5	52	1,087	657	430
Vysočina	15.3	26	402	238	164
Šiauliai		29	290	103	187
Nitra	15.7	29	455	276	179

Notes: No value means we didn't receive data from our partners.

Sources: South East E.: NIX (2003) and calculations by Paul Webster, Wye Campus, Imperial College London.
Hohenlohe: SAHRBACHER (2003) based on REGIERUNGSBEZIRK MITTELFRANKEN (2000).
Saxony: LFL SACHSEN (2003).
Brittany: TEYSSIER (2002).
Vysočina: KAVKA et al. (2000); variable costs same source as for plant production, see Table 3-10.
Nitra: Commodity Reports 2003 - SR average data: BORECKÁ (2003).
Lithuania: LAEI (2004a, b).

Total labour costs are also influenced by labour input, which differs for each production activity from one country to another. These differences are shown in Table 3-12, considering more or less the same operation size for each country. As we do not model all production activities in all regions, there are some empty cells in the table. For example, in Sweden breeding sows and fattening pigs are not modelled. The same holds for suckler cows in Nitra. In Hohenlohe the largest suckler cow stable holds 40 animals. For crops it is assumed that the labour input per hectare decreases with increasing farm size, because farmers can use larger and more efficient machinery. In Table 3-12 labour input is compared for wheat or barley on a 100 ha farm.

Differences in labour input of the various production activities between the OMS and the NMS are high, especially in the case of Lithuania (Šiauliai) and the Slovak Republic (Nitra). In the Czech Republic, the differences from the OMS are quite small. However, there are also differences within the OMS. In Sweden for example, crop production is very extensive and labour input is low. The huge difference to the other regions is also caused by a high input of agri-services. Plant protection and fertilisation is carried out by contractors.

Table 3-12: Annual labour input per head or hectare in the study regions for the same operation size

	Beef Cattle	Suckler cows	Dairy	Sows	Pigs	Crops
Capacity [places]	100	100	120	ca. 120	600	100 [ha]
Sweden	6.0	9.7	35.0	-	-	2.5
South East E.	7.9	6.5	30.0	16.5	1.8	8.0
Hohenlohe	15.0 1)	28.0 1)	51.0	20.0 2)	2.0	8.8 3)
Saxony	14.5	20.0	37.0	16.0 2)	1.3	8.5
Brittany	11.5	20.0 4)	37.0	15.0 5)	1.3	8.5
Vysočina	15.0 6)	9.7 4)	33.0 4)	17.0 6)	1.6	8.5
Šiauliai	26.1	38.0	28.0 7)	21.0	2.6 8)	13.0
Nitra	23.1	-	72.0 7)	29.2 9)	3.7	11.0

Notes: "-", means this production activity is not considered in the region.
1) 40 places, 2) 64 places, 3) 85 ha, 4) 90 places, 5) 72 places, 6) 80 places, 7) 100 places, 8) 400 places, 9) 120 places.

Source: AGRIWISE (2004), NIX (2003), SAHRBACHER (2003) based on REGIERUNGSBEZIRK MITTELFRANKEN (2000), LFL SACHSEN (2003), TEYSSIER (2002) and informations from Zdeněk Louda (working at UZEI, Centre for Economic Modelling, Prague), Egle Stonkute (working at Lithuanian Institute of Agrarian Economics) and Eva Uhrinčaťová (working at Research Institute of Agricultural and Food Economics (VUEPP)).

In Sweden and South East England, beef cattle and suckler cow production seem to be very extensive because labour input is much lower than in the other regions. This is due to the high share of grassland in these two regions, of which a great deal is used as pasture. In dairy production, the most labour intensive regions are

Hohenlohe and Nitra, where 50 or more hours are needed to keep a cow. In the other regions, this same labour input is between 30 and 40 hours.

3.6.2 Investment options

Farms in AgriPoliS can re-invest and invest to keep their factor endowment (machinery and stable capacities) at the same level or expand them. Hence, data about several typical investment options are collected for each region. Table 3-13 shows the different stable and machinery sizes and the respective useful life for the Swedish regions Jönköping and Västerbotten. In AgriPoliS, selected farms are provided with investment objects in the initialisation phase which correspond to the number of livestock that farms have in the empirical data. The same holds for machinery. As data on asset vintage is not available, a random age is assigned such that the residual value and the depreciation of assets can be further calculated in AgriPoliS in each simulation period.

Table 3-13: Investment options Västerbotten and Jönköping

Investment	Capacity (places, ha)	Useful life (years)
Bull or bullock	20, 50, 100, 200, 300	25
Suckler cows	20, 50, 100, 200, 300	25
Dairy	30, 60, 120, 200, 400	22
Sheep	50, 100, 200, 400	25
Machinery	20	18
	30, 50, 75	15
	100, 200, 300	12

Source: Own presentation.

Economies of scale are considered for labour demand and acquisition costs. A detailed list of the investment options with acquisition costs and labour demand per size of investment is shown in appendix A.6. Table 3-14 provides an overview about the variation of investment costs identified for the study regions. For machinery, we assume that a farmer has enough machinery to utilise all his land, meaning a farm with 15 ha receives a pool of machinery with which it can cultivate 15 ha. Costs for these machinery pools are derived from machinery assets in FADN data from various farm size classes.

Table 3-14: Investment costs in the study regions (Euros/place or ha)

	Beef Cattle	Suckler cows	Dairy	Sows	Pigs	Machinery
Capacity [places]	100	100	120	100	1,000	100 ha]
Sweden	1,416	2,623	6,851	–	–	1,347
South East England	935	1,131	3,234	1,658	256	1,200
Hohenlohe	2,454	820[1)]	4,254	2,556[2)]	358	1,239[3)]
Saxony	2,400	1,800	4,160	2,500[2)]	357	1,200
Brittany	2,190	2,057[4)]	4,000	2,300[5)]	375	1,200
Vysočina	1,541[6)]	700[4)]	3,105[4)]	1,283[6)]	334	420
Šiauliai	1,516	1,550	3,650[7)]	737	180[8)]	421
Nitra	2,208	-	4,470[7)]	842[9)]	225	900

Note: "-" means that this production activity is not considered in the region.
[1)] 40 places, [2)] 64 places, [3)] 85 ha, [4)] 90 places, [5)] 72 places, [6)] 80 places, [7)] 100 places, [8)] 400 places, [9)] 120 places.

Sources: See Appendix A.6.

Investment costs are the lowest in the Czech Republic (Vysočina) and Lithuania (Šiauliai). The highest investment costs can be found in Sweden, except for beef cattle stables, which are cheaper than in Germany or France. However, stable costs also depend on the equipment component of the investment, which is unknown. In South East England the investment costs are comparable to those in the NMS, which could be explained by a lower level of equipment in the stables than in the other OMS. Further, investment costs in Germany and France are very similar. The presentation of these data is intended to show the typical investment options introduced in the model to better cope with regional characteristics; they are by no means a suitable basis for comparison and profitability considerations.

3.7 Global model parameters and key assumptions

In addition to the input data about production activities, farm factor endowment and farm weights, a set of "global" model parameters can be changed in AgriPoliS. These parameters determine either the structure of the region or directly affect farmers' decisions. A detailed description of farmers' decision rules can be found in section 3.2.2 and KELLERMANN et al. (2008). Here, we summarize key assumptions in AgriPoliS and provide an overview about the setting of specific model parameters in the various regions. We start by exploring the assumptions and parameters at the regional level and then continue with the properties of markets (capital, labour and others), farms and finally investments.

Regional level

- Factor: The size of a region is a critical factor regarding computing time and data management capacities. Simulating a complete region over 25 periods, e.g. Saxony, with its 1,835 farms, requires approximately three hours of computing time on a 3.0 GHz processor. The output file for Saxony including data on individual farms reaches a size of 33 MB. Thus, only fractions of the regions are simulated. The structure of the full region is preserved by dividing the weighting factors of the selected farms by a certain factor, which is displayed in Table 3-15, as well as the full number of farms in the regions.
- Plot size: The size of plots in AgriPoliS can be adjusted to regional characteristics, i.e. to the standard field size in the region.
- Non-agricultural land, region-oversize: By changing the settings for non-agricultural land and oversize, it is possible to model the distribution of contiguous areas of specific soil types to generate an abstract representation of the landscape. This detailed modelling of a landscape was applied to analyse the impact of decoupling on the environment in the Swedish regions Jönköping and Västerbotten, the Czech region Vysočina, and for the Italian regions Marche and Calabria (BRADY and KELLERMANN 2005, BRADY et al. 2007 and BRADY et al. 2009). For all other regions we use defaults: for Non_Ag_Land we use 0.1, and for Oversize we use 1.1.

Table 3-15: Specific model parameters at the regional level

Region	**Number of farms**	**Factor**	**Plot size** (ha)	**Non_Ag_land**	**Oversize**	**Livestock density** LU/ha
Jönköping	2,165	10	1.0	1.3	1.20	1.4 on grassland
Västerbotten	1,469	5	1.5	0.6	1.01	1.4 on grassland
South East E.	2,813	7	2.5	0.1	1.10	2.0
Hohenlohe	2,856	5	2.5	0.1	1.10	2.5
Saxony	1,835	3	5.0	0.1	1.10	2.0
Marche	5,510	30	0.5	1.1	1.15	2.0
Calabria	4,631	30	0.5	1.1	1.15	2.0
Brittany	43,820	57	2.5	0.1	1.10	2.0
Vysočina	1,908	10	2.5	1.1	1.25	2.0

- Livestock density: Depending on the regional legislation, we have set a maximum livestock density per ha, presented in Table 3-15.

Land market

- Contract type: In AgriPoliS, two types of contracts for renting land have been implemented: a) a rental contract with a fixed duration, and b) a contract where the farmer can choose whether to terminate the contract at the end of each year ("renegotiation"). [41] With the exception of Brittany, fixed contracts are implemented in all regions.
- Contract length: The length of contracts is randomly assigned by AgriPoliS between a set minimum and maximum. The minimum and maximum duration can initially be set between 2 and an infinite number of years. Table 3-16 shows the contract length set for each region. Minimum and maximum contract length is chosen by regional experts.
- Transport costs: Farmers consider transport costs when they calculate a bid for renting an additional plot. Transport costs vary among regions because of different labour, fuel and machinery costs.
- Bid adjustment: For the formulation of a bid, we assume that the valuation of a plot is adjusted by a specific factor (bid adjustment). This factor reflects those costs not considered in the shadow price calculation (depreciation, maintenance costs, overheads, etc.) and the farmers' willingness to share their income with the landowner.[42] Normally we assume that farmers share 50% of the shadow price, minus transport costs with the land owner. However, for Hohenlohe we increased this share up to 75% because of the high competition for land in this region.

Table 3-16: Specific model parameters for the land market

Region	Contract type	Contract length (years)	Transport costs (Euros/km)	Bid adjustment (β)
Jönköping	fixed	9 – 18	50	0.50
Västerbotten	fixed	9 – 18	50	0.50
South East E.	fixed	9 – 18	50	0.50
Hohenlohe	fixed	9 – 18	51	0.75
Saxony	fixed	12 – 24	51	0.50
Brittany	renegotiation		51	0.50
Vysočina	fixed	5 – 18	15	0.50

[41] For details, see section 3.2.3.
[42] For a detailed description, see section 3.2.3.

- Payment entitlements: In the decoupling policies REFORM and SFP, payment entitlements per hectare are calculated by AgriPoliS. Contrary to reality, we assume that these payment entitlements cannot be transferred independently from land, i.e. they are not tradable without land.

Capital market

- Access to capital: Short-term borrowing is limited by a financing rule, namely that farms can only borrow money at the level of 70% of their land assets, and 30% of the equity share of other assets (buildings and machinery). Long-term borrowing is indirectly restricted. Farms can borrow capital for the long-term as far as an investment is profitable and they can afford variable production costs (see also section 3.2.2.)
- Interest rates: We differentiate between interest rates for long-term borrowed and short-term borrowed capital and for equity capital. Interest rates vary among regions (Table 3-17). They are provided by project partners.

Other markets

- Input prices: For hired labour we implemented a price change in AgriPoliS. In OMS, prices for hired labour increase by 0.5% per year. For the Czech Republic we assumed an increase of 2.5% per year. Furthermore, prices for milk quota and calves (the latter only in Sweden) change according to demand and supply on the regional markets. The milk quota market is only implemented for the OMS regions. We do not consider milk quotas in AgriPoliS for the Czech Republic. Additionally, for the two livestock-intensive regions of Hohenlohe and Brittany, we introduced a market for manure. Costs for disposing of manure by other farmers vary depending on demand and supply.

Table 3-17: Specific model parameters for capital and other markets

Region	Long-term borrowed capital interest	Short-term borrowed capital interest	Equity capital interest	Equity finance share (v)	Price trend of labour	Manure market
Jönköping	4.5%	6.0%	4.0%	25%	0.5%	No
Västerbotten	4.5%	6.0%	4.0%	25%	0.5%	No
South East E.	6.5%	8.5%	5.0%	30%	0.5%	No
Hohenlohe	5.5%	8.0%	4.0%	50%	0.5%	Yes
Saxony	5.5%	8.0%	4.0%	30%	0.5%	No
Brittany	4.5%	5.9%	2.5%	30%	0.5%	Yes
Vysočina	3.8%	5.2%	1.5%	45%	2.5%	No

- Output prices: Farms are assumed to be price takers. For decoupling scenarios, we consider output price changes. These are taken from simulations with ESIM for the corresponding decoupling scenarios. Price changes are shown in Table 4-1 in the description of the policy scenarios (section 4.1). Off-farm income increases according to the price trend for hired labour.

Farm level

- Heterogeneity of farms: As in reality, farms are differentiated in the way that their managers possess different managerial abilities that cause differences in economic performance. Thus, we assume a 10% variation of production costs between farms. Furthermore, we assume that managerial ability remains constant throughout the entire simulation.
- Farmers' behaviour: Farms purely optimise their individual situation by maximising farm household income (individual farms) or profit (for legal entities), and have no strategic decision-making abilities. They quit agriculture either if they are illiquid or if the opportunity costs for their production factors (labour, capital, land and quota) are higher than the expected on-farm income.
- Generational change: We assume that individual farms are handed over to the next generation every 25 years. In the initialisation phase, farms receive a random farm age between 0 and 25. If a farm is handed over to the next generation, we assume that opportunity costs of labour increase by 25%. In this way, a potential successor's choice to work off-farm or on the farm is reflected. If the successor decides to remain in agriculture, opportunity costs for labour are set back to the level prior to the generational change.
- Opportunity costs for farm family labour: For OMS regions we assume that all farmers have the same opportunities to work off-farm, irrespective of age. In the Czech Republic we assume that it is mostly the younger, better-educated farm family members who are able to work off-farm. Considering that the time between a generational change is 25 years, the opportunity costs of older farm-family members are 50% of the original level (10-20 years after taking over the farm) or zero (20-25 years after taking over the farm), respectively, reflecting their (in)ability to find off-farm jobs.
- Overhead costs: It is assumed that overhead costs for administration, taxes, professional association, etc. amount to 1% of the total gross margin from agriculture.
- Compensation of working family members: Each working family member withdraws from the farm income (profit inclusive off-farm income) an amount of money for consumption which differs among regions according

to off-farm income. For each family member a minimum withdrawal must be done, and if the household income is higher than the minimum withdrawal, additional money is withdrawn. This additional withdrawal is determined by the rest of the household income multiplied by the factor ε, which is set to 0.7 for all regions. For more details about withdrawals see chapter 3.2.2.1.

Table 3-18: Specific model parameters for family labour

Region	**Opportunity cost of labour**	**Costs of hired labour** (Euros/AWU)	**Income from off-farm labour** (Euros/AWU)	**Withdrawals** (Euros/AWU)
Jönköping	constant	35,568	27,000	16,000
Västerbotten	constant	35,568	27,000	16,000
South East E.	constant	20,700	16,300	16,000
Hohenlohe	constant	21,630	17,490	15,339
Saxony	constant	20,700	16,200	16,000
Brittany	constant	17,764	12,296	16,000
Vysočina	age-dependent	4,440	4,200	2,400

Investments

- Machinery and buildings: Agricultural machinery, as well as buildings and appliances, are assumed to be very specific to agricultural production. Accordingly, investment costs are sunk and cannot be recovered by farms. Farms use machinery, equipment and buildings during their entire useful life. Furthermore, we assume economies of size for machinery and buildings, which arise from decreasing costs per unit and lower labour requirements for bigger investments.
- Financing of investments: We assume that investments are financed by a specific share from own capital and a respective share of borrowed capital. The financing mix is the same for all farms in a region. However, it can vary among regions, depending on the common financing mix in the region. In Table 3-17 equity finance shares for the different regions are presented.

3.8 Conclusions

The goal of this section was to adapt AgriPoliS to several study regions across the EU to cover the diversity of its agriculture. Therefore, the regions of Brittany in France, Hohenlohe and the Central Saxonian Loess Region in Germany, South East England, consisting of the counties of Surrey, Kent, West and East Sussex, the Swedish regions Jönköping and Västerbotten, and the Czech region Vysočina have been selected. Before adapting AgriPoliS to these regions, the model was briefly described for a better understanding of both the modelling process and the results. Furthermore, the methodology to adapt AgriPoliS to a region was briefly described. This methodology mainly comprises two steps: *first,* the creation of a virtual region based on selected farms; and *second,* the representation of the selected farms with a mixed integer programming model. One can conclude that the quality of the representation of a region in AgriPoliS depends on three factors. *First*, it depends on the availability of regional data. For example, in Saxony, Hohenlohe and Brittany, the number of farms by farm type, as well as the area used by farm types, was available. *Second*, the quality of the representation of a region depends on the consistency of regional data. Inconsistencies can be caused by different data sources, or if small farms or a specific farm type are not considered because of their minor importance. In the latter case, other regional characteristics such as the total area or the number of animals have to be adjusted to ensure data consistency. The *third* factor that influences the quality of the regional representation is the number of farms for which data are available for the representation of the region. If, for some combination of structural characteristics, no farm is available, then some classes have to be merged. For example, if there is no farm available in the size class of 50 to 100 ha, the classes 30 to 50 ha and 50 to 100 ha must be merged. The results of the representation of the different regions are satisfying, despite some problems regarding data availability and data consistency.

For the representation of the selected farms, production activities and various investment options have been defined. Therefore, data on investment and production costs, as well as on yields and prices have been collected. These data have been calibrated so that i) the farms' capacities consisting of land, machinery, stables and milk quotas are used; and ii) the results of the reference scenario (AGENDA) are in line with the past development in reality. Another part of the model calibration was the setting of global model parameters. An additional calibration was carried out for the regions of Västerbotten, Jönköping and Vysocina. Here, the two parameters non-agricultural land and region-oversize were chosen so that the size and the number of contiguous agricultural areas in AgriPoliS represent the real structure of the landscape. This calibration was necessary to analyse the environmental impacts of structural change (BRADY et al. 2009).

4 IMPACTS OF DECOUPLING POLICIES IN SELECTED REGIONS OF EUROPE[43]

4.1 Introduction

The "mid-term review" (MTR) is one of the most radical reforms of the CAP. Essentially, through the MTR, the EU replaced product-specific payments for crops and beef cattle with area payments decoupled from specific products. Farmers now only have to maintain their land in Good Agricultural and Environmental Conditions (GAEC) to receive these payments. With this reform the EU solved several problems. First, consolidating the EU's agricultural budget, necessary because of continuously increasing expenditures and EU enlargement, has been achieved because expenditures for area payments are fixed and no longer depend on farmers' production decisions (DEWBRE et al. 2001 and OECD 2001b). Furthermore, the introduction of decoupled area payments reduced the pressure from WTO negotiations, because decoupled payments do not cause much production and trade effects. Another positive effect of the MTR was to reduce some negative impacts of the CAP on the environment by introducing cross-compliance. However, the switch from output-coupled payments to payments coupled only to the input of land and the accompanying reduction of production and trade effects, was the most important aspect of the MTR. This explains why many studies focused on analysing production and trade effects (EUROPEAN COMMISSION 2003a, FRANDSEN et al. 2003, BINFIELD et al. 2004, GOHIN 2006 and KÜPKER et al. 2006). Less studied are the impacts of the MTR on structural change in the form of farm exit and farm growth. By growing or shrinking farmers can react to the new policy framework in order to minimize possible income losses. In this context, land markets play an important role. A model that considers structural change and land markets is the agent-based model AgriPoliS developed by HAPPE et al. (2004), HAPPE et al. (2006) and KELLERMANN et al. (2008), based on BALMANN (1997). AgriPoliS was first applied to the Hohenlohe region in southwest Germany to analyse the impacts of decoupling on structural change and efficiency (HAPPE and BALMANN 2002, 2003 and HAPPE 2004). A criticism

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[43] This chapter is based on SAHRBACHER, C., SCHNICKE, H., KELLERMANN, K., HAPPE, K. and BRADY, M (2007): Impacts of decoupling policies in selected regions of Europe. It is working paper no. 23 of the project IDEMA (The Impact of Decoupling and Modulation in the Enlarged Union: A sectoral and farm level assessment), supported by the European Community's Sixth Framework Programme (SSPE-CT-2003-502171). Hauke Schnicke, Mark Brady and Konrad Kellermann contributed to the calibration of the input data. All co-authors contributed to the discussion of the results.

of these studies was that AgriPoliS was applied to only one region, thus rendering results difficult to generalise. Subsequently, AgriPoliS was adapted to several regions across the EU.

The objectives of this section are *first,* to analyse the impacts of the MTR on structural change, farm incomes and land markets in six agricultural regions across the EU.[44] *Second*, by comparing several regions, it will be analysed whether the MTR has region-specific impacts or whether the results of one region can be generalised. The *third* objective is to test the hypothesis that the MTR reduces farm exit rates because farms become more market-oriented and thus more efficient. That is, farms no longer decide what to produce based on product-specific payments, but rather on market signals. *Fourth*, the impacts of decoupling direct payments from land input will also be analysed.

For the analysis of the first three objectives, three different policy scenarios are implemented in AgriPoliS. As a reference point, the continuation of the Agenda 2000 policy measures are simulated. To compare the impacts of decoupling among the different regions, the European Commission's initial suggestion of a single farm payment without any coupling rates (SFP) is implemented. Since the member states mostly opted for variations of this basic policy scheme, a third scenario (REFORM), which considers the actual policy implementation in each country, is modelled in AgriPoliS to check if the various methods of implementation have different impacts. Both decoupling scenarios – SFP and REFORM – only lead to a decoupling of payments from production. The condition to maintain land in GAEC still keeps payments coupled to the land input, which leads to the capitalisation of payments into land prices (BERTELSMEIER 2005, ISERMEYER 2003, KILIAN and SALHOFER 2008 and CIAIAN et al. 2008). To show what happens when this link to land is cut, a kind of bond scheme (BOND) is simulated. A bond scheme has the additional advantage that it provides farmers certainty about future payments. To calculate the bonds, it must first be decided how long payments will still paid. Then, future payments would be converted into a bond and farmers would receive payments independent of their agricultural activities. This increases farmers' flexibility and prepares them for the continuation of farming without subsidies.

In the following section, the policy scenarios implemented in AgriPoliS will be described. A special focus is placed on the REFORM scenario, which considers

[44] Within the IDEMA project, four additional regions in Lithuania (Siauliai), Slovakia (Nitra) and Italy (Colli jesini and Pina die Sibari) have been modelled (c.f. SAHRBACHER et al. 2005 and LOBIANCO and ESPOSTI 2006a). Results of the policy analysis for these regions can be found in STONKUTE et al. (2007), BLAAS et al. (2007) and LOBIANCO and ESPOSTI (2006b). Further results for the Czech region Vysočina can be found in JELINEK et al. (2007). Furthermore, for the Swedish regions Jönköping and Västerbotten, a detailed analysis conducted with AgriPoliS can be found in BRADY et al. (2007) and BRADY et al. (2009), in which the focus is placed on the environmental impacts of decoupling.

the actual policy implemented in the study regions. Then, results for the AGENDA, REFORM and SFP scenario are presented and compared. In a separate analysis, the results of the BOND scenario, as an alternative policy, are discussed. Finally, the results of all scenarios will be discussed and conclusions will be drawn.

4.2 Scenarios

The time horizon of all analyses began in 2001 and ends in 2013. The year 2001 was chosen as a reference year because the decoupled payments have to be calculated based on a reference period of three years, and decoupling took place in 2005. The target year of our simulations is 2013, which is the end of the current programming period for the analysed policies. At that time, all decoupled policies will be finally implemented.

Four policy scenarios – one reference and three decoupling scenarios – have been implemented. In the reference scenario AGENDA, the Agenda 2000 policy is continued and payments remain coupled. In the first decoupling scenario, Single Farm Payment (SFP), payment entitlements for the farms are calculated based on a reference period of three years.[45] In this calculation, only agricultural land is included for which payments have been granted, plus the forage area; that is, the number of initially-distributed payment entitlements is smaller than the total utilised agricultural area. As described in section 2.6, this would theoretically avoid the capitalisation of payments into land rents. But in the long-run a surplus of land is unlikely, because young farmers can receive payment entitlements from the national reserve, and the agricultural area declines annually because land is used for settlements and infrastructure. Thus, the SFP is modelled in a way that payments are capitalised into land rents, as is the case for regional payments. In the REFORM scenario, the policies actually implemented by the countries where the study regions are located are considered. Three schemes can be differentiated:

1. France and Italy each opted for a farm-specific calculation of the payment entitlements. However, several payments stay partially coupled.
2. Sweden chose a hybrid static decoupling scheme, where payment entitlements consist of a regional-specific and a farm-specific portion. This means that a specific share of the payments is going into a regional payment, which is the same for each hectare. The other share of the payments stays on the farms and is added to the regional payment.
3. Germany and England both decided on a hybrid dynamic decoupling scheme, where the farm-specific portion of the payment entitlements is reduced over time and the regional-specific portion increases. In 2013, only a regional payment will remain. However, there are differences in the way England and Germany calculate the farm-specific part of payments

[45] For details see section 2.5.

and how the farm-specific part is transferred into the regional payment over time.

Further details of the different decoupling schemes are presented in section 4.2.1.

The third decoupling scenario displays, in a simplified manner, the BOND scheme suggested by KOESTER and TANGERMANN (1977), TANGERMANN (1991) and SWINBANK and TRANTER (2004). Here, a single farm payment is calculated for each farm, just as in the single payment scheme. However, this single farm payment is not distributed as payment entitlements per hectare, but it is linked to the farmer. Thus, the payment is granted to farmers independent of any farming activity. Hence, the farmer can produce or leave the sector.

It can be assumed that decoupling leads to price changes. Farms are given more freedom to produce, hence they are more likely to adapt their production structure and at the same time the supply of specific products changes, which induces price changes. Such price changes are predicted by partial equilibrium models like ESIM. Neglecting these price reactions in a regional model would lead to biased model results. Therefore, price trajectories are taken from results of the partial-equilibrium model ESIM, for which corresponding scenarios were defined.[46] In ESIM prices react stepwise to policy changes, i.e., they progressively change year by year. However, in AgriPoliS farms react immediately to any policy change. Therefore, in the year of decoupling (2005), price vectors as calculated in ESIM for the year 2009 (Table 4-1) have been introduced in AgriPoliS. It was assumed that four years after the introduction of the reform, ESIM would provide prices which would completely integrate the consequences of decoupling on agricultural markets. The price vectors relate to the price differences between the ESIM Agenda scenario and the ESIM scenario corresponding to the actual implemented policies in 2009.

Table 4-1: Price changes implemented in AgriPoliS in the year of decoupling

Cereals	Rape seed	Beef cattle, suckler cows and ewes
+4%	+3%	+6%

Source: Detailed ESIM-results received from Oliver Balkhausen, Institute of Agricultural Economics University of Göttingen, Germany.

Furthermore, for all scenarios we considered a price change for dairy cows because of the stepwise reduction of the intervention price for butter and milk powder.[47] To compensate for these price decreases, a milk payment of 1.81 Cents/kg

46 We have also compared the ESIM price trends with those predicted by the CAPRI-modelling system (EKMAN 2005) and found the results to be consistent.

47 The intervention price for butter was reduced by 7% in 2004, 2005 and 2006, and by 4% in 2007, whereas the intervention price for milk powder was reduced by 5% annually from 2004 to 2006 AURBACHER (2003).

milk was introduced in 2004. This payment was increased to 2.365 Cents/kg milk in 2005 and to 3.55 Cents/kg milk in 2006 (AURBACHER 2003). We assume that the milk price decrease is equal to the milk payment per cow. Milk payments are presented in the detailed description of the REFORM policy scenarios in section 4.2.1. Like all other payments, milk payments are decoupled in 2005 as well. However, to reduce the complexity of decoupling, the second increase in the milk payment in 2006 is already considered in the first increase in 2005. Otherwise, we would have to increase the decoupled payments for dairy farms in 2006.

4.2.1 Actual implemented policies

In the following, we describe how policies actually implemented in France, Germany, England and Sweden have been modelled. The decoupled payments are calculated in AgriPoliS based on farm production in a three-year reference period. The payments differ partially from the real payments in the observed regions, as they are based on the production structure taken from AgriPoliS and not from reality.

4.2.1.1 France

France decided for a partial implementation of the single payment scheme in 2006. The coupling rate for COPs is 25%, for the slaughtering payment for cattle it is 40%, and for the suckler cow and calf slaughtering payment it is 100%. In Table 4-2 payments before decoupling and the absolute values of coupled payments after 2005 are listed. Before decoupling, the fattening bull payment consists of the special male payment for cattle (210 Euros, inclusive the additional payment) and the slaughtering payment for cattle (80 Euros). The special male payment is completely decoupled, but 32 Euros of the slaughtering payment remain coupled. This means that 89% of the initial fattening bull payments are decoupled.

Table 4-2: Payments REFORM scenario for the Brittany region

	Unit	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Cereals, set aside	€/ha	355	355	89 + farm-specific payment							
Protein plants	€/ha	409	409	103 + farm-specific payment							
Grass-land	€/ha	0	0	farm-specific							
Fattening Bulls	€/head	290	290	32							
Suckler cows	€/head	388	388	383							

Source: Payments in 2004 and 2005: AGRESTE BRETAGNE (2003). Payments after 2005 are calculated based on AgriPoliS results for the years 2002-2004.

For suckler cows, the premium paid in the AGENDA scenario is comprised of a 250 Euros suckler cow premium, an 80 Euros extensification premium, a 50 Euros calf slaughtering premium, and an 8 Euros cattle slaughtering premium.[48] The first three premiums remain coupled to 100% and the cattle slaughtering premium is coupled to 40%. Thus, only 1% of the initial suckler cow premium is decoupled.

Milk payments are introduced in three steps, as in the reality, because France decoupled payments in 2006. The payments are calculated based on the average milk yield in Brittany (6,323 kg/cow, c.f. TEYSSIER 2002). In 2004 they amounted to 114 Euros/cow, in 2005 150 Euros/cow, and in 2006 for 225 Euros/cow.

4.2.1.2 Germany

Germany decided for a hybrid dynamic decoupling scheme, which results in a regional payment in 2013. In Germany, payment entitlements are calculated in the following way.[49]

- COP payments are transferred into a regional payment for arable land in each federal state.
- Slaughtering payments for cattle, additional payments for cattle and 50% of extensification payments for cattle are transferred to the grassland of each federal state.
- Payments for milk, suckler cows, special payments for male cattle, slaughtering payments for calves, ewe payments and 50% of the extensification payments for cattle remain at individual farms, but they are allocated to agricultural land as a farm-specific top-up for the arable land and grassland payment.

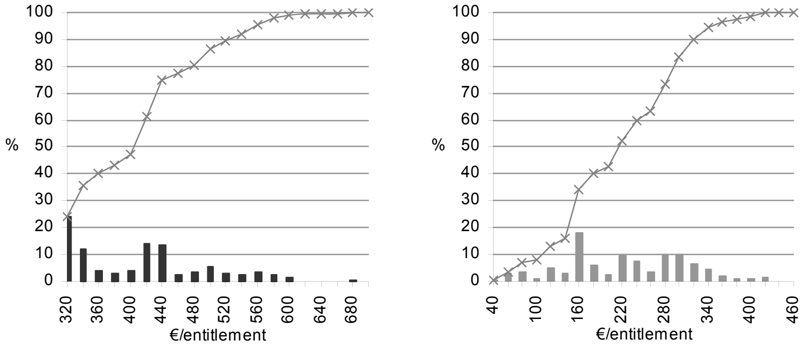
The farm-specific payments top-ups and the regional payment for arable land or grassland are put together in one payment entitlement per hectare. As coupled direct payments in the framework of the Agenda 2000 varied among the federal states in Germany, decoupled payments are different in the Hohenlohe region, which is located in the Federal State of Baden-Württemberg and the Central Saxonian Loess Region, which is a sub-region of the Federal State of Saxony.[50] This difference exists further in the decoupled payments. Payments presented in Table 4-3 and Table 4-4 do not consider the farm-specific part of payments, because it varies among farms. Instead, in Figure 4-1 we show the distribution of payment entitlements in Hohenlohe in 2005 for each range of 40 Euros.

[48] The slaughtering premium for suckler cows is 80 Euros, but it is assumed that suckler cows are kept for 10 years.

[49] This is only a short description of the decoupling scheme in Germany. We describe here only the parts which are important for modelling the regions.

[50] A detailed description of the regions can be found in SAHRBACHER et al. 2005.

Figure 4-1: Distribution and cumulative distribution of arable land (left) and grassland (right) payment entitlements among the total UAA in Hohenlohe in 2005



Source: Own calculations based on AgriPoliS simulation results.

The value of payment entitlements for arable land ranges between 323-700 Euros. As the regional payment for arable land is 323 Euros/ha, one can see that in Hohenlohe, 26% of the payment entitlements for arable land are not increased by farm-specific payments. The majority (90%) of payment entitlements for arable land have a value ranging between 323-520 Euros. The value of payment entitlements for grassland is much lower than for arable land, which is caused by the lower regional payment for grassland. This payment ranges from 54 to 440 Euros. Figure 4-1 shows also that 90% of the grassland payment entitlements have a value of more than 100 Euros.

From 2010, the difference between the values of payment entitlements and the final regional payment of 2013 is reduced stepwise by 10, 30, 60 and 100%, respectively. Simultaneously, payments for arable land and grassland are increasing.

Table 4-3: REFORM scenario payments for the Hohenlohe region

	Unit	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Cereals, set aside	€/ha	324	323	323	323	323	323	325	330	337	346
Protein plants	€/ha	384	379	379	379	379	379	381	386	392	402
Forage Maize	€/ha	459	323	323	323	323	323	325	330	337	346
Grassland	€/ha	0	54	54	54	54	54	83	142	229	346
Fatte-ning Bulls	€/head	212	0	0	0	0	0	0	0	0	0
Suckler cows	€/head	360	0	0	0	0	0	0	0	0	0

Source: Payments for 2004: KTBL (2002). Payments after 2004 are calculated based on AgriPoliS results for the years 2002-2004.

In Germany, like in France, the fattening bull payment consists of the special male payment for cattle (210 Euros) and the slaughtering payment for cattle (80 Euros). The payment per head is the same in both countries, but as we calculate the payment per head for one year, they differ between the countries because the fattening period differs. In France bull calves are bought at the age of 12 months, and afterwards fattened for a period of one year, whereas in Germany fattening starts earlier, and bulls are fattened for 500 days in Hohenlohe 500 and 515 days in Saxony. Before decoupling, in Hohenlohe and Saxony suckler cows were eligible for the 200 Euros suckler cow premium and 100 Euros of extensification payments. Additionally, in Hohenlohe a further 50 Euros are distributed as calf slaughtering payments and 10 Euros as cattle slaughtering payments. In Saxony calves are sold, thus suckler cows only receive 13 Euros more as cattle slaughtering payments.[51]

Milk payments introduced in 2004 in Hohenlohe are 104 Euros/cow and 131 Euros/cow in Saxony. In 2005 the full milk payment of 2006 was decoupled, which for Hohenlohe was 202 Euros/cow and in Saxony 258 Euros/cow. These payments are based on the milk payment per kilogram of milk presented in section 4.2.1, and the average milk yield per dairy cow and year, which in Hohenlohe was 5,700 kg REGIERUNGSBEZIRK MITTELFRANKEN (2000) and in Saxony 7,260 kg (LFL SACHSEN 2003).

Table 4-4: Payments REFORM scenario for the region Saxony

	Unit	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Cereals, set aside	€/ha	392	384	384	384	384	384	385	387	389	393
Protein plants	€/ha	452	440	440	440	440	440	384	389	398	449
Grassland	€/ha	51	44	44	44	44	44	79	149	253	393
Fattening Bulls	€/head	206	0	0	0	0	0	0	0	0	0
Suckler owsc	€/head	313	0	0	0	0	0	0	0	0	0

Source: Payments for 2004: LFL SACHSEN (2003). Payments after 2004 are calculated based on AgriPoliS results for the years 2002-2004.

4.2.1.3 England

Like Germany, England implemented a hybrid dynamic decoupling scheme, albeit a less specialised one. In 2005, each farm received a farm-specific payment based on a three-year reference period. Farm-specific payments are then reduced by 10%, which are distributed in the whole utilised agricultural area (UAA). Table 4-5 shows area payments from 2005 till 2013, which were calculated based on production in AgriPoliS three years before decoupling. In 2006 the reduction of farm-specific payments amounted to 15% and in the following years

51 We assume that in Hohenlohe, suckler cows are kept for 8 years and in Saxony for 6 years.

until 2012, that rate was 30, 45, 60, 75, 90 and 100%, respectively. The average milk yield in South East England is 6,300 kg/cow per year. The outcome is a milk payment of 114 Euros/cow in 2004 and 224 Euros/cow in 2006.

Table 4-5: REFORM scenario payments for the South East England region

	Unit	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Cereals, set aside	€/ha	355									
Protein plants	€/ha	407	30	44	89	134	178	223	267	297	297
Forage Maize	€/ha	119				+ farm-specific part					
Grassland	€/ha	0									
Fattening Bulls	€/head	151	0	0	0	0	0	0	0	0	0
Suckler cows	€/head	238	0	0	0	0	0	0	0	0	0

(The 2005–2013 payments apply jointly to Cereals/set aside, Protein plants, Forage Maize and Grassland.)

Source: Payments for 2004: NIX (2003). Payments after 2004 are calculated based on AgriPoliS results for the years 2002-2004.

4.2.1.4 Sweden

Table 4-6 and Table 4-7 show the payments and production activities of the Swedish regions Jönköping and Västerbotten. Because of the special climate conditions in Sweden, additional payments are granted. As some Swedish production activities are specific to the region, it is worth explaining their characteristics before proceeding with the description of payments.

Agriculture in Jönköping and Västerbotten is dominated by highly subsidised cattle husbandry to maintain land, especially the so-called semi-natural grazing land, which is land that is not suitable for cultivation. Therefore, semi-natural grazing land can only be maintained by animals and not by machinery to satisfy environmental or cross-compliance conditions. As the vegetation period is quite short and crop yields very low (e.g. the average yield of spring barley in Jönköping is 3 t/ha and in Västerbotten 2.3 t/ha (STATISTICS SWEDEN 2003)), around 0% of arable land is used for producing grass silage or as pasture. Other crops are mainly planted to maintain a crop rotation which avoids a decline in soil quality; otherwise farms would use their land only for grass silage and as pasture. In addition to the fodder production, farmers temporarily maintain a certain area of arable land as a "grass reserve" that provides fodder insurance in the case of poor yields. This land is also eligible for payments. Since cattle husbandry plays an important role in Jönköping and Västerbotten, it is modelled in detail in AgriPoliS. In Table 4-6 and Table 4-7 three different forms of beef fattening are presented that differ in both the intensity and duration of fattening. A detailed description can be found in appendices A.5 and A.7. In the Swedish regions we linked, contrary to other regions, calf production and bull fattening via a market for calves. Furthermore, heifers for the recruitment of dairy and suckler cows are considered explicitly in the MIP-model. Similarly, the possibility of switching from dairy to suckler cow production, as well as flexibility between arable and grassland fodder production, have also been introduced. Cereals as concentrates for cattle can either be produced by the farm or bought. These special features are necessary to represent the agricultural system in the Swedish regions appropriately.

For decoupling, Sweden decided to implement a hybrid decoupling scheme like Germany and England, but compared to those two countries, the decoupling scheme is static, not dynamic. Additionally, not all livestock payments are decoupled from the beginning. As there are several additional payments (environmental and compensation payments) in Sweden, first the structure of these payments is described, followed by an explanation of which payment is decoupled and whether it will be region-specific or farm-specific. The detailed composition of the payments for 2004, presented in Table 4-6 and Table 4-7, can be found in appendix A.8. The payments for plant production in 2004 presented in Table 4-6 and Table 4-7 consist of direct payments, environmental payments and compensation payments. Payments for plant production are higher in Västerbotten because, being in the far North of Sweden, this region receives higher compensation payments.

Table 4-6: REFORM scenario payments for the Jönköping region

	Unit	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Cereals, set aside	€/ha	186	133	133	133	133	166	166	166	166	166
Grass reserve	€/ha	192	133	133	133	133	166	166	166	166	166
Grass silage	€/ha	192	232	232	232	323	265	265	265	265	265
Arable pasture	€/ha	99	216	216	216	216	249	249	249	249	249
Grassland	€/ha	165	282	282	282	282	315	315	315	315	315
Bullock dairy	€/head	295	113	113	113	113	0	0	0	0	0
Bull dairy	€/head	200	79	79	79	79	0	0	0	0	0
Bull suckler	€/head	400	158	158	158	158	0	0	0	0	0
Heifer suckler	€/head	200	0	0	0	0	0	0	0	0	0
Suckler cow	€/head	300	0	0	0	0	0	0	0	0	0
Ewe	€/head	21	0	0	0	0	0	0	0	0	0

Source: Payments for 2004: AGRIWISE (2006). Payments after 2004 are calculated based on AgriPoliS results for the years 2002-2004.

Additionally, a drying aid for cereals is paid there. In 2005 only direct payments for plant production and the drying aid are decoupled in both regions. Direct payments are converted to a regional payment, whereas the drying aid will be added to the farm-specific part of the payments. In Jönköping, the regional payment is higher for arable land (133 Euros/ha) than for grassland (117 Euros/ha). In Västerbotten this payment is equal for arable land and grassland, amounting to 117 Euros/ha. Environmental payments and compensation payments remain coupled in both regions and are added to the regional arable payment.

The coupled environmental payments and the compensation payments for plant production also remain coupled in the SFP and BOND scenarios. Livestock payments in Jönköping and Västerbotten are identical, except for dairy cows. In Västerbotten, an additional national support scheme (Nordic Aid) of 701 Euros/cow is paid. As in plant production, for ruminant production farmers receive different payments, whereof we present in Table 4-6 and Table 4-7 only the sum for 2004. This sum includes direct payments, a slaughter premium and extensification payments. The slaughtering premium and extensification payments are fully decoupled and allocated between the regional payment and the farm-specific payment. The grassland payment calculated out of these payments amounts to 117 Euros/ha. Of the direct payments, 75% stay coupled till 2009, which can be seen in Table 4-6 and Table 4-7. In 2009 the payments are added to the regional payment for arable land and grassland.

Table 4-7: REFORM scenario payments for the Västerbotten region

	Unit	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Cereals	€/ha	273	172	172	172	172	198	198	198	198	198
Set aside	€/ha	168	117	117	117	117	143	143	143	143	143
Grass silage	€/ha	405	438	438	438	438	464	464	464	464	464
Arable pasture	€/ha	321	438	438	438	438	464	464	464	464	464
Grassland	€/ha	206	323	323	323	323	349	349	349	349	349
Grass reserve	€/ha	405	438	438	438	438	464	464	464	464	464
Bullock dairy	€/head	295	113	113	113	113	0	0	0	0	0
Bull dairy	€/head	200	79	79	79	79	0	0	0	0	0
Bull suckler	€/head	400	158	158	158	158	0	0	0	0	0
Heifer suckler	€/head	200	0	0	0	0	0	0	0	0	0
Suckler cow	€/head	300	0	0	0	0	0	0	0	0	0
Dairy cow	€/head	701	701	701	701	701	701	701	701	701	701
Ewe	€/head	21	0	0	0	0	0	0	0	0	0

Source: Payments for 2004: AGRIWISE (2006). Payments after 2004 are calculated based on AgriPoliS results for the years 2002-2004.

4.3 The impact of decoupling at regional and farm level

In this section the REFORM and SFP scenarios are compared to the AGENDA scenario to identify the impacts of decoupling. Therefore, the focus is placed on a selection of indicators which help us to trace the impacts of decoupling on structural change (number of farms, average farm size and livestock density), farm income (profit/ha) and land rental markets (arable land and grassland rent/ha). To evaluate the following results, the specific model assumptions described in section 3.7 must be considered.

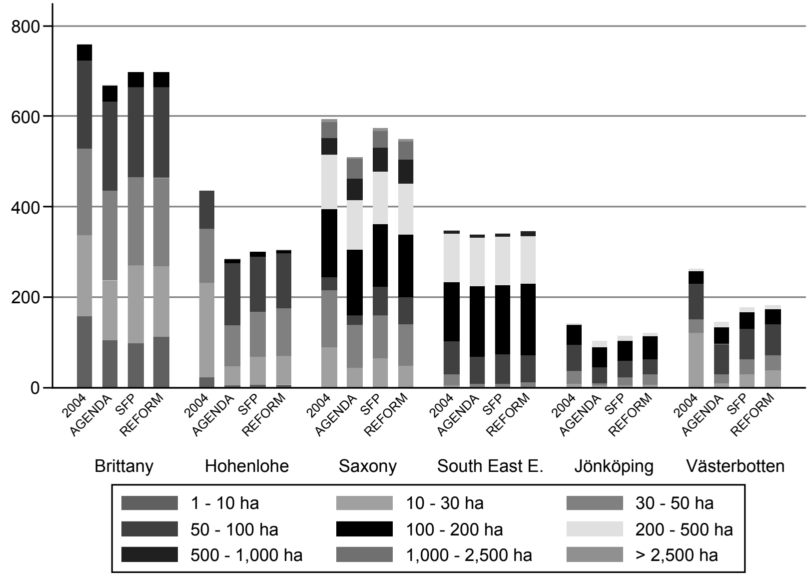
4.3.1 Structural change

Structural change has various aspects, with two key issues being changing farm sizes and changes in the number of farms. In the OMS, a constant decline in the number of farms can be observed, whereas in the NMS the number of farms, especially of individual farms, was increasing after the end of the communist era. At present, the number of farms is more or less constant, but there is still a redistribution of land from large corporate farms to individual farms. A second aspect of structural change is the change in the composition of farms, especially regarding their legal type and specialisation. Change in specialisation can become obvious through changes in the number of animals, e.g. the number of farms specialised in the fattening of beef cattle is declining, whereas the number of pig fattening farms is increasing. Another possibility is that mixed farms begin to specialise in one direction. A third aspect of structural change is the change in the number of agricultural employees. This can result from a change in specialisation, technological progress and scale effects. In the following, we focus on changes in the number of farms, the average farm size and livestock production. Since we do not consider technological progress, nor a general pressure on input and output prices, labour input is mainly influenced by changes in livestock husbandry (see Figure 4-4 and appendix A.9).

4.3.1.1 Change in the number of farms

Figure 4-2 shows the number of farms in the various regions and size classes in 2004 and 2013, depending on the implemented policy. Under the continuation of the Agenda 2000 policy, the decline in the number of farms in all regions is stronger than in the two decoupling scenarios SFP and REFORM. Thus, both decoupling schemes reduce the speed of structural adjustment in terms of farm number. The rationale behind this is that in the decoupling scenarios, especially small farms with grassland remain in the sector, because decoupled payments provide access to additional income opportunities. Yet, farms can receive payments for grassland by maintaining it in GAEC, which seems to be more profitable than off-farm labour opportunities, at least to some extent.

Figure 4-2: Number of farms in 2004 and 2013 (AGENDA, SFP, and REFORM) in different farm size classes



Source: Own calculations.

Figure 4-2 also shows that there are no strong differences in the decline in the number of farms between the two decoupling scenarios SFP and REFORM, except in the case of Saxony. Hence, the different decoupling policies actually implemented in the observed countries have the same impact on the decline in the number of farms than the general version of the single payment scheme (here SFP). In Brittany this seems plausible, because the only difference between the actually implemented policy (REFORM) and the SFP is the level of coupling rates. In the other countries it seems that the hybrid decoupling scheme is a good compromise to avoid strong and abrupt reallocations of payments, and thereby expected farm exits compared to a regional payment. Only in Saxony does the number of farms decline stronger in the hybrid scenario, because in the simulations, 4% of the total UAA was not used before decoupling. The unused land was grassland, and with decoupling animal payments, the payments are distributed on all grassland. Thus, after decoupling, the payment per hectare of grassland is lower than before.[52] Although grassland payments are increasing over

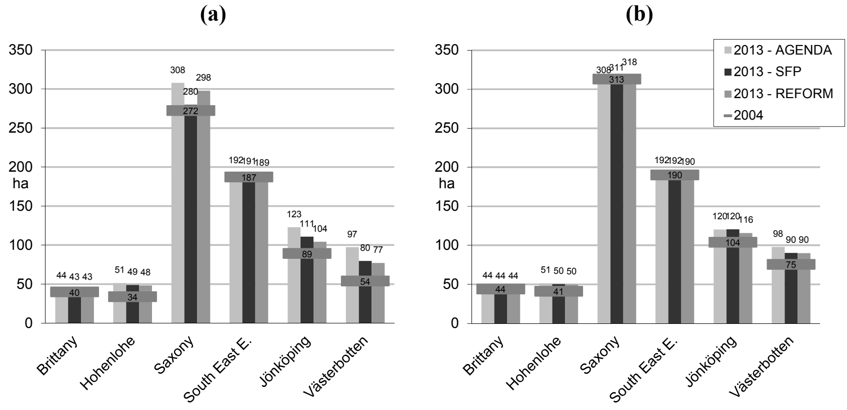
[52] Before decoupling no direct grassland payment existed, but grassland was indirectly subsidised by payments for cattle.

time because of the dynamic aspect of the implemented policy, this cannot avoid the fact that more farmers are quitting agriculture.

4.3.1.2 The average farm size

With the number of farms declining between 2004 and 2013, farms sizes are likely to change as well. Hence, Figure 4-3 shows an increase of the average farm size. In all cases, a horizontal bar indicates the average farm size in 2004, i.e. before the introduction of decoupling policies. The average farm size of 2004 is already shown by AgriPoliS, as simulations started in 2001. The first bar in the figure shows the average farm size in the year 2013 under the continuation of Agenda 2000. The following bars show the same for the two decoupling scenarios SFP and REFORM. The following graphs are structured the same way.

Figure 4-3: Average farm size in 2004 and 2013 depending on policy for (a) all farms (b) farms surviving in all scenarios



Source: Own calculations.

Looking at Figure 4-3 (a), farm size is significantly increasing till 2013 in all regions except in Brittany and in South East England. In South East England this seems reasonable, because only few farms quit agriculture during the simulations. In Brittany there is a significant decline in the number of farms until 2013, but mainly farms smaller than 10 ha quit agriculture (Figure 4-2). This means that for the remaining farms, not much land is available for growth. In Hohenlohe the situation is similar; the average farm size increases slower than the number of farms decline. In contrast, we can observe a pure sample effect in Saxony, a region that has mainly large farms. There, the average farm size seems to increase due to the fact that a relatively high share of small farms quit agriculture (Figure 4-2). But Figure 4-3 (b) shows for Saxony that there is no real farm growth for the farms surviving in all scenarios. The size of the surviving farms even declines a bit, because in the AGENDA scenario 5% of the agricultural land utilised in 2004 becomes abandoned; in the SFP scenario it is 1%.[53] On the other hand, grassland that had already been abandoned before 2004 is utilised in 2013 in the REFORM scenario because the regional payment is paid for all land, i.e. the agricultural area increases by 1% compared to 2004.

Saxony is also the only region where farm size increases stronger in the REFORM than in the SFP scenario. On the one hand this is due to the stronger decline in number of farms than in the SFP scenario, and on the other hand the grassland not used before the policy change comes into production because of the regional payment.

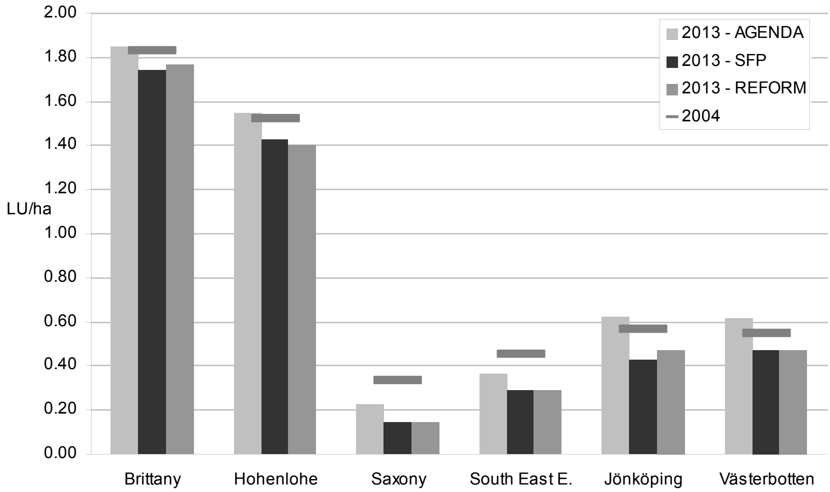
4.3.1.3 Livestock production

To analyse the development of livestock production, livestock density is presented in Figure 4-4. In addition to the development of production, the livestock density shows the importance of livestock production in a region. In Brittany and Hohenlohe, livestock density is relatively high compared to the other study regions. Farms in Brittany specialise in milk, beef, pork and poultry production, whereas in Hohenlohe pork and poultry production prevails, though milk and beef production is also common. Saxony and South East England mainly produce field crops with a low share of dairy cows and fattening bulls and almost no fattening pigs. Thus, livestock density is the lowest there. In Jönköping and Västerbotten, the production of fattening bulls and milk is very important, especially for maintaining the land. However, bulls are raised extensively, which explains why livestock density is lower than in Brittany and Hohenlohe.

Under Agenda 2000, headage payments were paid mainly for ruminants, so it is interesting to see how decoupling affects ruminant production. The figures in appendix A.9 show that in Brittany, Hohenlohe, Saxony and South East England, cattle husbandry is even declining in the AGENDA scenario with coupled payments. In Jönköping and Västerbotten, cattle husbandry would slightly increase in the AGENDA scenario because of high coupled payments. However, with decoupling cattle-specific payments, cattle husbandry would decline in all regions. These results are consistent with the sector and country level results of BALKHAUSEN and BANSE (2007).

[53] It is only grassland that becomes abandoned. Arable land is completely utilized.

Figure 4-4: Average livestock density in 2004 and 2013, depending on policy



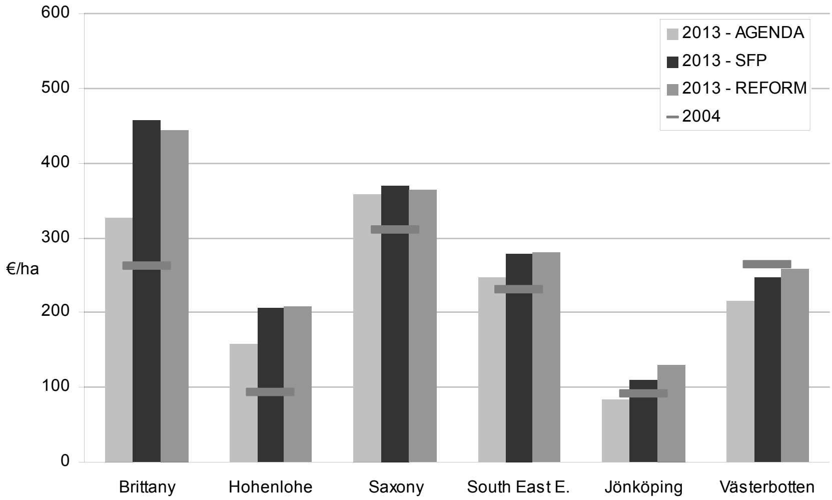
Source: Own calculations.

Unlike the decline in cattle husbandry, pig and poultry production in France and Hohenlohe increases after decoupling. This compensates for the strong decline in cattle husbandry. Thus, the decline in the total livestock density is not as strong as the decline in cattle husbandry (see appendix A.9 and Figure 4-4). In both regions in the AGENDA scenario the increase in pig and poultry production even overcompensates the decline in ruminant production.

4.3.2 Farm income

One goal of the CAP is to reduce the income disparity between agriculture and the rest of the economy. Thus, we investigated the impacts of decoupling on farm income. As an indicator for farm income, the development of the profit/ha has been presented. Since there are both corporate and individual farms in the observed regions, profit has been adjusted by imputed costs for family members working in agriculture. Calculatory costs for family labour are assumed to be equal to the costs for hired labour. The following results show that although the decline in the number of farms is lower in REFORM and SFP than in AGENDA, profits grow faster in the decoupling scenarios (Figure 4-5).

Figure 4-5: Average profit/ha minus imputed costs for own labour in 2004 and 2013 depending on policy



Source: Own calculations.

Profits vary among regions for different reasons (Figure 4-5). First of all, input and output prices as well as production conditions differ, which is translated into different gross margins (see appendices A.5 and A.7). The difference in profits between Hohenlohe and Brittany, which are very similar regions, can be explained by the level of rental prices. Both regions are characterised by small farm structures with average farm sizes of 26 and 33 ha, respectively. This suggests that there are unexploited returns to scale. In Hohenlohe all farms are individual farms; in Brittany the share of individual farm is 74%. A further common characteristic is that many farms in both regions specialise in pig and poultry production (STATISTISCHES LANDESAMT BADEN-WÜRTTEMBERG 1999 2003; AGRESTE 2000 and AGRESTE BRETAGNE 2003). Thus, farm growth strongly depends on the availability of land as a manure disposal area. In both regions, unexploited returns to scale and the presence of intensive livestock production lead to high competition for land. In France, however, land rental prices are lower, because land transactions are publicly controlled by SAFER, a private body with public service missions. SAFER can refuse contracts if they do not conform with their goals, which are the support of farmers' settlement, especially young farmers, the support of land and farm consolidation, and to favour both the transparency and functioning of rural land markets (LATRUFFE and LE MOUËL 2006).

In Jönköping and Västerbotten, agricultural land is used extensively, resulting in the low average profit/ha in Jönköping. In Västerbotten, average profits/ha are twice as high as in Jönköping, because of the higher support (see Table 4-6 and Table 4-7 in section 4.2.1.4). On average, in Jönköping (Västerbotten) support payments in 2005 were at 313 Euros/ha (656 Euros/ha) in the AgriPoliS simulations.

Looking at Figure 4-5 it is obvious that profits will rise in all scenarios except in Jönköping and Västerbotten. However, they increase more in the decoupling scenarios than in AGENDA. This is partially caused by the price change adapted from ESIM results. ESIM predicts an increase in output prices for cereals and beef production with decoupling (see section4.2). Simulations without price changes show that the average profits per hectare would be between 5% and 11% lower. This is much more than the changes in prices, which are 6% for beef cattle and 3% for cereals. Hence, price changes also affect production. With higher prices, fewer farms quit ruminant production. But decoupling nevertheless leads to higher profits, even without the consideration of price increases and thereby induced production changes.

For Brittany, Figure 4-5 shows a strong increase in profit/ha compared to the other regions. This increase is not only caused by an increase in efficiency due to farm growth. In Brittany pork and poultry production expanded much more in the decoupling scenarios than in the AGENDA scenario (see appendix A.9). This caused an increase in total production, which led to a higher profit per hectare. Furthermore, farmers in Brittany do not have to share their profit gains with land owners, because rental prices are limited due to the specific regulations and did not change in the AgriPoliS-simulations (Figure 4-6 and Figure 4-7).

4.3.3 Land market

The land market in AgriPoliS is modelled as a land rental market (see section 3.2.3), where the allocation of free land is organised via an auction. In general, we assume rental contracts with a fixed duration of between 9 and 18 years, and between 12 and 24 years for Saxony.[54] In Brittany we gave farmers more power in the negotiation of rental contracts than the land owners, because in France the SAFER regulates transactions involving the purchase or rental of land, with the goal of supporting the settlement of young farmers, supporting land and farm consolidation and avoiding extremely high prices and speculations (LATRUFFE and LE MOUËL 2006). This is modelled in the way that farmers can decide after each period whether they want to quit the contract, instead of having a fixed contract length. In contrast to the farmer, the landowner cannot terminate the rental contract.[55]

As for most products, prices remain constant (except for price changes taken form ESIM for decoupling scenarios) and as farms can only reduce input costs

[54] The minimum and maximum contract length is chosen to adjust the increase of the average rental prices in the AGENDA simulations to their development in reality.

[55] For details, see section 3.2.3.

by using scale effects, rental prices are mainly influenced by the level of payments. This has to be considered in the following evaluation of the land rental prices in the observed regions. That land prices are influenced by subsidies is a well-studied issue. For a comprehensive review of this topic see LE MOUËL (2005). There is also evidence that land rental prices are influenced by subsidies (ROBERTS et al. 2003 and LENCE and MISHRA 2003). A recent study of SWINNEN et al. (2008) on the impact of the MTR on land markets approved these findings.

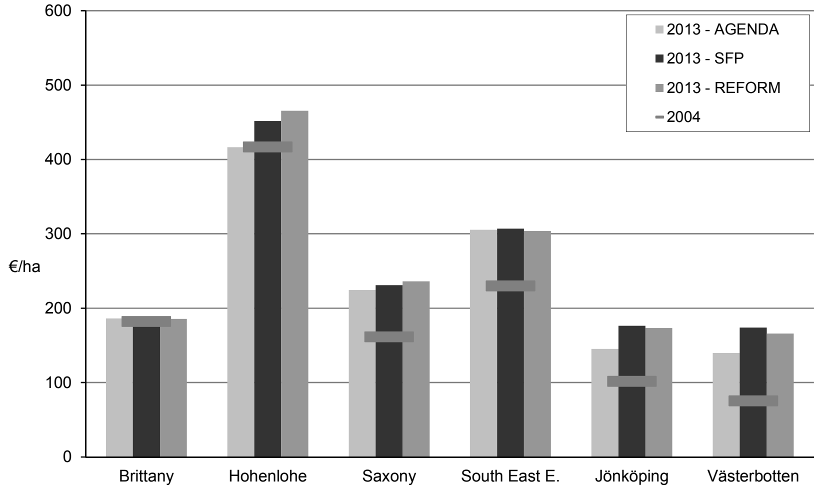
4.3.3.1 Rental prices for arable land

In Figure 4-6, rental prices for arable land in 2004 and 2013 are shown.[56] Among all regions, rental prices are highest in Hohenlohe. This seems plausible regarding the high share of specialised pig and poultry farms and farms' demand for land to dispose of manure. As argued in section 4.3.2, farms in Hohenlohe tend to operate at increasing returns to scale, with marginal returns being higher than average returns. Thus, competition for land is very high, which is reflected in a higher share of the shadow price handed over to the landowner (75%). In all other regions we assume that farmers are willing to pay 50% of the shadow price for renting an additional hectare of land (see section 3.7 "bid adjustment").

In regions with a high share of field crop farms (Saxony and South East England), rental prices are at an intermediate level compared to the other regions. Rental prices for arable land are the lowest in the two extensive Swedish regions Jönköping and Västerbotten.

[56] Although the model allows for an arbitrary number of soil types, we generally only differentiate between arable land and grassland.

Figure 4-6: Average arable land rental prices in 2004 and 2013 depending on policy



Source: Own calculations.

Between 2004 and 2013, rental prices increase in all regions and scenarios except in Brittany and in the AGENDA scenario in Hohenlohe. In Brittany rental prices do not change due to the abovementioned reasons. For Hohenlohe it seems that rental prices reached a peak in 2004 in the AGENDA scenario. In contrast, the decoupling scenarios lead to a further rise in rental prices for arable land, which holds for Jönköping and Västerbotten as well. The reason is that in the SFP and REFORM scenarios, cattle payments are redistributed from cattle to arable land. Thus, some farms receive higher payments per hectare of arable land in the decoupling scenarios than in the AGENDA scenario (Table 4-8). This particular effect is, however, very specific to the structure of beef cattle production on grazing livestock farms in the regions prior to the policy change. In Saxony and South East England, the number of fattening cattle per hectare is lower than in Hohenlohe, Jönköping and Västerbotten. Thus, in Saxony and South East England, we cannot observe a stronger increase in arable land rental prices in the decoupling scenarios compared to the AGENDA scenario.

Table 4-8: Average payment for arable land in the AGENDA, SFP and REFORM scenario in 2005

Region	AGENDA	SFP	REFORM
Brittany	343 €/ha	517 €/ha	405 €/ha
Hohenlohe	323 €/ha	337 €/ha	374 €/ha
Saxony	384 €/ha	395 €/ha	431 €/ha
South East E.	344 €/ha	319 €/ha	317 €/ha
Jönköping	170 €/ha	359 €/ha	323 €/ha
Västerbotten	356 €/ha	689 €/ha	493 €/ha

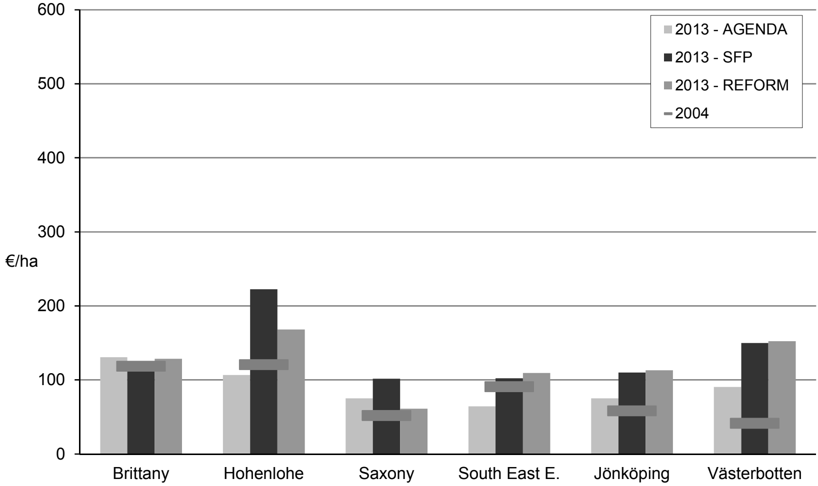
Source: Average payments are calculated based on AgriPoliS results and include the regional payments for arable land in Hohenlohe, Saxony and South East England, see Table 4-3, Table 4-4 and Table 4-5. In Jönköping and Västerbotten payments also include coupled environmental payments, see section 4.2.1.4.

4.3.3.2 Rental prices grassland

In all regions, rental prices for grassland are much lower than those for arable land. Under AGENDA only a small share of coupled beef payments was indirectly coupled to grassland via fodder production for cattle. Furthermore, direct payments coupled to cattle were needed to cover production costs, thus only a low share of the cattle payments was capitalised into rental prices for grassland. Patterns of grassland rental prices created over time are more diverse than the ones for arable land rental prices. In the AGENDA scenario we can observe a decline of grassland rental prices in Hohenlohe and South East England.

In all regions except Brittany, decoupling leads to increasing rental prices for grassland. This is because after decoupling, grassland is eligible for payments, which is contrary to the AGENDA policy. However, to receive decoupled payments, farms have to keep land in GAEC. Therefore, a lower share of payments is necessary to cover input costs and hence a larger share of payments is capitalised in the grassland rental price. Additionally, the part of cattle payments that had been devoted to arable land through fodder production prior to reform is now shifted to the grassland.

Figure 4-7: Average grassland rental prices in 2004 and 2013 depending on policy



Source: Own calculations.

Regarding the decoupling scenarios, we can define two groups of regions. The first one comprises Hohenlohe and Saxony, where grassland rental prices in the SFP scenario increase much stronger than in the REFORM scenario. This is because in Hohenlohe and Saxony, payment entitlements per hectare of grassland are much higher in the SFP scenario than in the REFORM scenario (see Table 4-9). In the second group, which contains South East England, Jönköping and Västerbotten, only small differences between the payments per hectare of the SFP and the REFORM scenario occur. Thus, almost no difference in the development of grassland rental prices among the two scenarios is observable.

Table 4-9: Average payment for grassland in the SFP and REFORM scenario in 2005

Region	SFP	REFORM
Brittany	487 €/ha	345 €/ha
Hohenlohe	383 €/ha	235 €/ha
Saxony	406 €/ha	128 €/ha
South East E.	257 €/ha	262 €/ha
Jönköping	355 €/ha	378 €/ha
Västerbotten	726 €/ha	439 €/ha

Source: Average payments for grassland are calculated based on AgriPoliS results. For Hohenlohe, Saxony and South East England they include the regional payment, see Table 4-3, Table 4-4 and Table 4-5. In Jönköping and Västerbotten coupled environmental payments are included, see section 4.2.1.4.

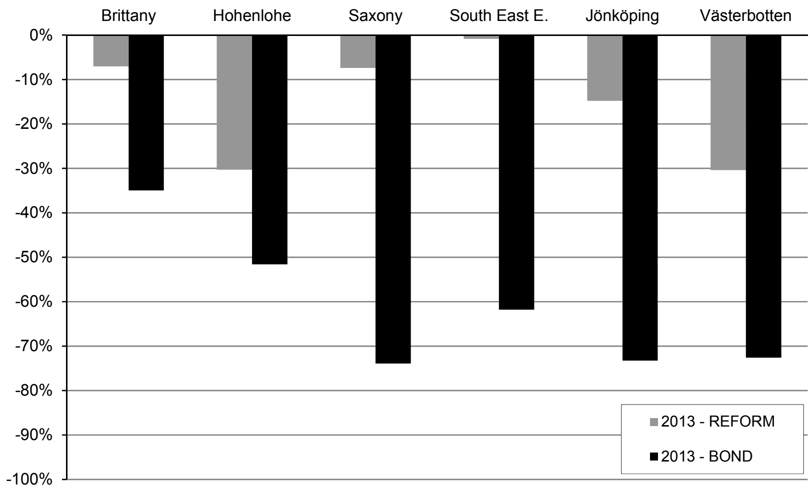
4.4 The impact of an alternative decoupling scheme

The results of the REFORM and SFP scenarios show that decoupling payments from production induces more market-oriented behaviour by farmers, and thus reduces market distortions previously caused by coupled payments. For example, beef production decreases after decoupling ruminant payments. At the same time, the farms' income situation shows some improvements compared to a continuation of AGENDA 2000 (Figure 4-5). Further, the decline in number of farms slows down (Figure 4-2) because there are farms which stop livestock production and only maintain their land in GAEC (see section 4.3.1.1). Such farms would not stay in agriculture without payments. Thus, coupling payments to land input with the obligation to maintain land in GAEC still has an impact on structural change. Another disadvantage of this linkage is that it increases rental prices. To avoid this, farmers have to share payments with landowners, and the scheme for granting payments would have to be re-designed and decoupled from land. One possibility would be to distribute payments independent from farming activities. KOESTER and TANGERMANN (1977), TANGERMANN (1991) and SWINBANK and TRANTER (2004) suggested this by implementing bonds. In this policy scheme, current and future direct payments will be converted into bonds that will provide their holders a guaranteed future stream of payments. There would be no obligation for farmers to receive the payments and the bonds can be placed on the capital market. Farmers can sell the bonds to finance investments or they can keep it and quit agriculture. Such a scheme widens farmers' adaptability and breaks the link of payments to land. It is likely that such a scenario would accelerate structural change, because farms can leave agriculture and still receive the payments. Such a development would improve the situation of farms that would like to grow and would open the possibility of efficiency increases. To analyse these impacts, a scenario that mimics the main aspects of the BOND scheme is implemented in the following.[57]

4.4.1 Structural change in the BOND scenario

In the following, results of the BOND scenario are only compared with the REFORM scenario, which simulates the impacts of the actually-implemented policies. In general, the BOND scenario causes drastic adjustment reactions. In the BOND scenario, many farmers take the opportunity to leave agriculture and cash in on their payments. Until 2013, between 21-66% more farms would close in the BOND scenario than in the REFORM scenario. However, what cannot be seen in Figure 4-8 is that most of the farmers would leave agriculture immediately after the policy change. In the following years till 2013, structural change would be moderate, as in the other scenarios.

Figure 4-8: Relative change in the number of farms from 2004 to 2013 in the REFORM and BOND scenario



Source: Own calculations.

[57] We do not implement the bond scheme completely. Only the link between land and payments is cut and the farm manager receives the payments independent from farming activities. No bonds that can be treated are introduced. The duration for which farmers can receive the payments limited the duration of the simulations. For a discussion on general advantages and disadvantages of such a policy, we refer to SWINBANK and TRANTER (2004). Here, we focus only on the structural and income effects of such a policy.

Such drastic adjustment reactions raise various questions: what happens to land released by farms leaving the sector? Will only very large farms with more than 500 ha survive?

Results presented in the following might be overestimated because of some specific assumptions in AgriPoliS. For example, it is assumed that farmers make their decision to leave agriculture based only on the opportunity costs of a possible compensation of all input factors outside agriculture (see section 3.7). Furthermore, it is assumed that each farmer and family member working on the farm can find a job outside agriculture independent of his/her age. In reality, the strong adjustment reaction caused by a BOND scheme might be buffered, because older farmers may stay in agriculture until retirement or because of frictions on the labour market. Moreover, in the model, the full range of possible adjustment reactions cannot be considered. Perhaps some farms would find a niche to survive, e.g. agro-tourism or bio-energy.

Table 4-10 shows the number of farms leaving agriculture and the amount of land released in the year the BOND scheme is introduced. In all regions except Jönköping, mainly small farms leave agriculture. In addition to the land released by quitting farms, the remaining farms do not rent grassland again which had regularly been released by terminated rental contracts, because they reduce or stop their milk and beef production due to decoupling of payments. Unlike in the REFORM and SFP scenarios, in the BOND scheme farmers do not have to maintain the land in GAEC. In the BOND scheme, farmers receive payments independently of what they are doing. Thus, especially grassland will not be re-rented and is abandoned.

Table 4-10: Farms quitting agriculture, area released and abandoned due to the introduction of a BOND scheme in 2005

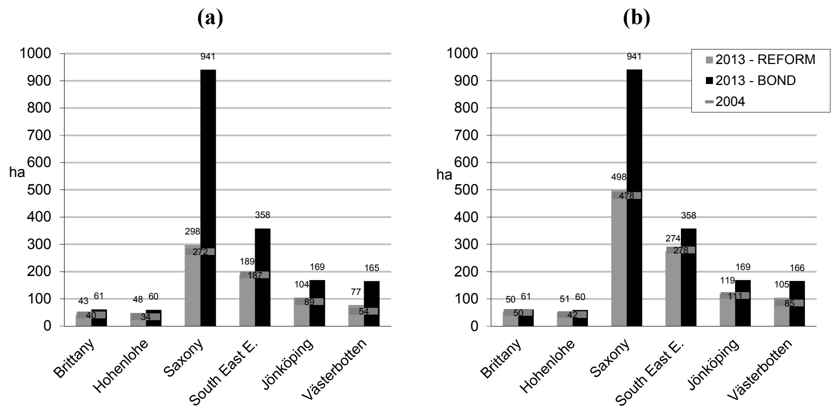
	Brittany	Hohenlohe	Saxony	South East E.	Jönköping	Västerbotten
Farms	-21%	-22%	-55%	-58%	-46%	-46%
Land released by quitting farms	8%	25%	22%	41%	50%	36%
Total released	12%	34%	33%	44%	51%	41%
Rented by other farms	12%	16%	20%	20%	16%	28%
Abandoned land	0%	18%	13%	24%	35%	13%

Source: Own calculations.

However, this is different in Västerbotten and Jönköping. There, arable land is also used for fodder production (grass silage and pasture), while in Jönköping even arable land is abandoned. In Västerbotten, permanent grassland is not affected by the BOND scheme, because the relatively high national environmental payments are not decoupled. Thus, in Västerbotten only arable land is abandoned. In all regions except Jönköping, 50% and more of the released land will be rented again by farms remaining in agriculture.

The logical consequence of the strong decline in the number of farms would be a strong increase in the average farm size. Figure 4-9 (a) and (b) confirm this assumption. However, the increase in farm size is not as strong as expected from the decline in number of farms and one can again observe the sample effect by comparing Figure 4-9 (a) and (b). In Hohenlohe farms surviving in both scenarios grow in the BOND scenario by an average of 18 ha from 2004 till 2013, and by 11 ha in Brittany. With an average farm size of 60 and 61 ha in 2013, these regions are still far away from the large farm structures in South East England and Saxony. However, it should be considered that in Hohenlohe, as well as in Jönköping and Västerbotten, a relatively high share of land is abandoned after the switch to the BOND scenario (see Table 4-10, above).

Figure 4-9: Average farm size in 2004 and 2013 in the REFORM and BOND scenario for (a) all farms, and (b) farms surviving in both scenarios



Source: Own calculations.

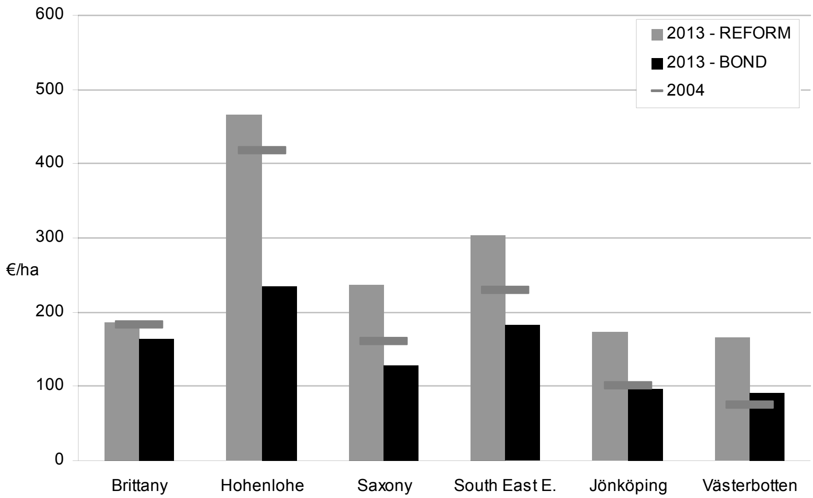
In Saxony, the average size of surviving farms increases from 498 ha in 2004 to 941 ha in 2013. Surviving legal entities expand their size from around 1,196 ha to 1,655 ha, and surviving individual farms grow from 193 ha to 439 ha.[58]

[58] Surviving partnerships increased their size from 853 ha to 1,642 ha.

4.4.2 Development of land rental prices in the BOND scenario

As mentioned above, it is expected that a BOND scenario would avoid having payments capitalised into rental prices for land. This is confirmed by Figure 4-8 and Figure 4-9, which show the development of rental prices for arable land and grassland. In all regions except Västerbotten, where national payments are still coupled, rental prices for arable land decline in the BOND scenario.

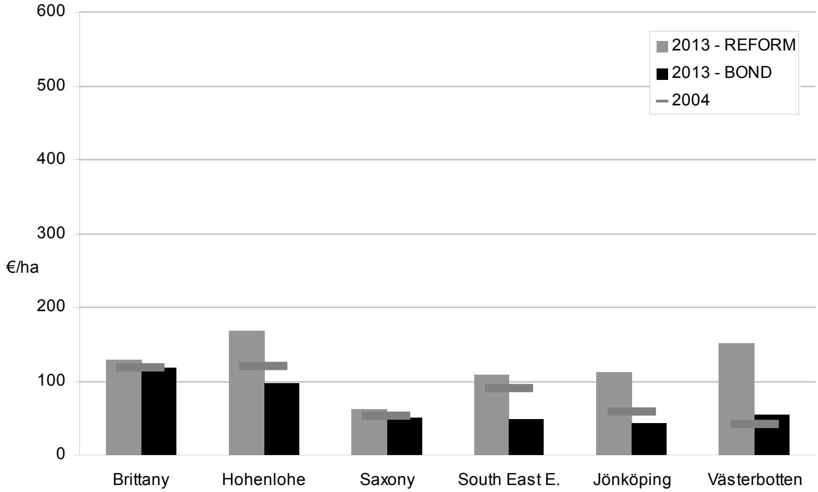
Figure 4-10: Average rental price for arable land in 2004 and 2013 in the REFORM and BOND scenario



Source: Own calculations.

The development of rental prices for grassland is different. Under AGENDA conditions no subsidies were directly paid for grassland. Only a small share of payments for cattle was indirectly linked to grassland via fodder production. Thus, the capitalisation of payments in rental prices for grassland is weaker. This becomes particularly evident regarding the development of rental prices for grassland in Brittany and Saxony. There, rental prices show no significant decline. In Västerbotten, rental prices for grassland are not affected in the BOND scenario, because the national grassland payments of 206 Euros/ha are still coupled. In Hohenlohe, South East England and Jönköping, a significant decline in rental prices for grassland is observable in the BOND scenario. On the contrary, Figure 4-11 shows that the introduction of a regional payment for grassland in the hybrid decoupling schemes in Germany, England and Sweden (REFORM) leads to the capitalisation of these payments into the rental price for grassland.

Figure 4-11: Average rental price for grassland in 2004 and 2013 in the REFORM and BOND scenario

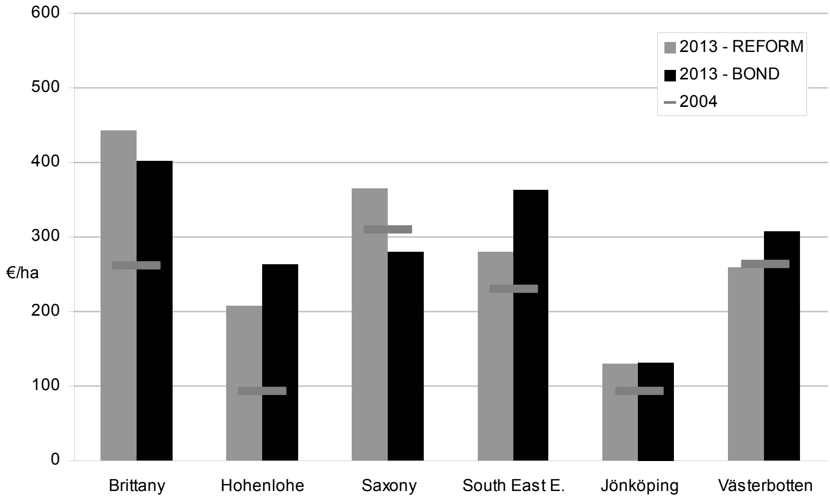


Source: Own calculations.

4.4.3 Farm income in the BOND scenario

One would expect that in the BOND scenario profits per hectare would decline because payments leave the agricultural sector together with leaving farms. However, Figure 4-12 shows that the loss of payments could be compensated in the Hohenlohe, South East England, Jönköping and Västerbotten regions by lower rental prices and the realisation of economies of scale due to a significant increase in farm sizes. In Brittany and Saxony, the average profit is lower in the BOND scenario compared to the REFORM scenario. This is due to the modest decline of rental prices after the introduction of the BOND scenario (Figure 4-10 and Figure 4-11). In Saxony, the average profit per hectare even declines compared to 2004, because farms are already quite large and have already realised economies of scale.

Figure 4-12: Average profit/ha minus imputed costs for own labour in 2004 and 2013 in the REFORM and BOND scenarios



Source: Own calculations.

Table 4-11 compares the share of farms quitting agriculture in the BOND scenario in 2005 with the share of payments leaving agriculture along with farms quitting agriculture. Only in Hohenlohe and Jönköping does the share of payments withdrawn from agriculture by quitting farms appear higher than the share of farms quitting agriculture. In Jönköping, abandoned farms are on average larger than farms which stay in agriculture, and at the same time abandoned farms receive more payments per hectare. In Hohenlohe, abandoned farms are slightly smaller than continuing farms, but receive more payments per hectare as well. In all other regions, abandoned farms are significantly smaller than continuing farms. Thus, the share of payments withdrawn from agriculture is smaller than the share of farms quitting agriculture because of the policy change.

Table 4-11: Decline in number of farms and transfers into agriculture in 2005 due to introduction of a BOND scheme

	Brittany	Hohenlohe	Saxony	South East E.	Jönköping	Västerbotten
Farms	-21%	-22%	-55%	-58%	-46%	-46%
Payments	-10%	-28%	-22%	-33%	-53%	-16%

Source: Own calculations.

It may be criticised that in the BOND scenario many payments are immediately withdrawn from agriculture, but on the other hand the share of payments withdrawn from agriculture due to the capitalisation of payments into rental prices observed in the other policy scenarios should be considered. Assuming that farmers would share 50% of their payments with land owners, then the same amount of payments would be withdrawn in the BOND scenario only in Jönköping. In all other regions, less payments would be withdrawn from agriculture in the BOND scenario.

4.5 Conclusions

The CAP reform of 2003 aimed at breaking the link between subsidies and agricultural production. The desired outcome was to make EU farmers more competitive and market-orientated while at the same time providing income stability. To avoid abandoning production activities that are highly dependent on public support, member states were given the option to keep specific shares of subsidies coupled to production. Depending on the specific situations of farmers in the EU (e.g. age, capital endowments, specialisation, land fragmentation, site-specific factors), individual farmers' adjustments to policy changes are expected to differ. Therefore, the impacts of decoupling direct payments on structural change in six case study regions were analysed. The study regions are located in Sweden, Germany, England and France. The agent-based simulation model AgriPoliS was used to elicit policy impacts at the regional scale, which are generated by the individual actions of a large number of individual and heterogeneous farms. The chosen methodology explicitly links the individual actions of a large number of farms with effects at the regional level.

The objectives of this study were i) to assess the impact of decoupling direct payments on structural change, farm income and land markets; ii) to find out whether the impacts of the MTR are region-specific; iii) to test whether the MTR reduces farm exit rates because farms' become more market-oriented and thus more efficient, and iv) to analyse the impacts of also decoupling payments from land input.

Four policy scenarios were considered. The reference scenario is a continuation of the Agenda 2000 policy after 2004. In addition to simulating the impact of the actually implemented decoupling scheme (scenario REFORM) in each region, two alternative decoupling regimes were considered: a decoupled single farm payment (SFP) with payment entitlements attached to the land and no partial coupling options; and a kind of bond scheme (BOND) where payments are also decoupled from land input (BOND).[59] The target year of the simulations is 2013. For the decoupling scenarios, price increases caused by expected declines in cereal

[59] At this point, it should be stressed that the obtained results are limited by the assumptions on which AgriPoliS, the underlying data and the analysis methods are based. As stated in OECD (1994), "Any assessment of the implications of policy reforms will be complicated by the multitude of conflicting and contrasting forces that can be expected to exert adjustment pressures, particularly the overall state of the economy, changes in tastes and demographics changes".

and beef production are considered in the simulations. The price changes are taken from similar simulations with the partial equilibrium model ESIM.

The analysis reflects the results of other studies, namely that the MTR reduces production effects and that farmers become more market-oriented (OECD 2001b and DEWBRE et al. 2001). In particular, livestock production declines in the simulations because of decoupling livestock payments (c.f EUROPEAN COMMISSION 2003a, FRANDSEN et al. 2003, KÜPKER et al. 2006 and BALKHAUSEN et al. 2008). Rather, farmers maintain their grassland in GAEC by cutting it once per year. The possibility of adjusting production according to market signals enables farmers to achieve higher incomes in 2013, because it would have been possible with the continuation of Agenda 2000. Additional simulations confirm that in 2013, farm incomes will also be higher in the REFORM and the SFP scenario compared to Agenda 2000, when no price increases are considered in these scenarios. Only in Saxony is the decline in cattle keeping so strong that the profit per hectare declines in the decoupling scenarios without price changes. In the northern Swedish region Västerbotten, incomes are expected to decline until 2013, but the decline is slower in the decoupling scenarios than in the AGENDA scenario. Nevertheless, higher incomes than in the AGENDA scenario lead to a reduction in farm exits. Thus, the simulations approve the assumption that the MTR would reduce the farm exit rate. Most farms that do not exit in the decoupling scenarios are small, have a high share of grassland and kept cattle before the MTR. After the MTR, they stop keeping cattle and simply maintain their grassland in GAEC, which reduces costs and therefore helps farms not to exit.

The comparison of the REFORM scenario with the SFP scenario only shows significant differences in the development of income for the Västerbotten and Jönköping regions. In the REFORM scenario, farms benefit from the partially decoupled cattle payments, whereas in the SFP scenario, all payments are decoupled. However, this difference in the income development only slightly influences the farm exit rate. The only region where a significant difference in the farm exit rate can be observed is Saxony. Here, the redistribution of payments among farms in the REFORM scenario leads to a stronger farm exit rate than in the SFP scenario, where no payments are redistributed. That there are only small differences between both scenarios can be explained by the assumption that payments will be capitalised into rental prices in both scenarios. Otherwise, the differences should be bigger.

The impacts of the MTR on rental prices differ among regions. On the one hand, this depends on regulations, for instance in Brittany, where the simulation results do not show any significant difference between the REFORM, SFP and AGENDA scenarios. In Brittany, rental prices are controlled by SAFER, which explains why almost no change can be observed in the three scenarios compared to 2004. On the other hand, the different impacts on rental prices depend on the respective agricultural structures. As it is assumed that payments are capitalised into rental prices, the development of rental prices depends on the production structure of a region. In Saxony and South East England, less cattle is kept, therefore payments paid per hectare of arable land do not change as much with the MTR, and consequently rental prices for arable land are almost similar in all three scenarios. In Hohenlohe, Jönköping and Västerbotten, more cattle is kept and more payments are redistributed from cattle to arable land, which explains why rental prices for arable land are increasing.

One can conclude that some impacts of the MTR, such as the increase in farm income and the lower farm exit rate, are more or less independent of regional structures. There are only differences in the strength of these impacts, not in their general direction. Impacts on other indicators like the decline in cattle keeping and changes in rental prices are region-specific. But regional characteristics are not the only factors that lead to different results. The comparison of the actually implemented policies (REFORM) with the policy initially suggested by the EU Commission (SFP) shows that both scenarios have different impacts, e.g. in the Swedish REFORM scenario, the farm incomes are higher because cattle payments are partially decoupled. Furthermore, the development of rental prices depends on the redistribution of payments among farmers in the respective scenarios.

In particular, the capitalisation of payments into rental prices was one reason to simulate the impacts of the bond scheme (BOND) as an alternative policy scenario, where the linkage of payments with land is cut. The results of these simulations are surprising. One would expect that the incomes of farms remaining in the sector decline because exiting farms withdraw payments from agriculture. But this does not happen, despite a strong and abrupt decrease in the number of farms after the policy change. Compared to the REFORM scenario, farm incomes would only be lower in Brittany and Saxony. In Hohenlohe, South East England, Västerbotten and Jönköping, income losses caused by the withdrawal of payments by exiting farms can be compensated by declining rental prices and the realisation of economies of scale. This was not possible in Brittany and Saxony, because in both regions rental prices are quite low and in Saxony, farms are already large and therefore have already realised economies of scale.

5 INCOME AND DISTRIBUTIONAL EFFECTS OF POLICY CHANGES: THE ROLE OF STRUCTURAL CHANGE[60]

5.1 Introduction

Agricultural policy analyses usually focus on either the sectoral level or on single farms. However, policy reforms are also supposed to affect structural change. We claim that by adopting a meso-level and dynamic perspective, important additional farm-specific, as well as aggregate effects, can be considered for policy debates and refinement.

In general, changing policy measures may lead to different adjustment reactions at the farm level. Some farms may be forced to leave agriculture due to financial problems or they may decide to leave agriculture because off-farm job opportunities become more favourable. Farms that remain in the sector may benefit from the exit of other farms or begin to specialise or diversify themselves in reaction to the policy changes. Considering such dynamic aspects when analysing farmers' benefits or losses caused by policy changes seems important – particularly because policy debates often give the impression that farmers, the public and policy-makers prefer policies which avoid a loss of income and which slow structural change. However, such policies can be problematic in the long run. On the one hand, misled farms may become dependent on the continuation of policy support, and on the other hand, farms with growth potential suffer from the additional competition on inelastic input and output markets – particularly on markets for land and production quotas. The MTR of the EU's CAP was at least partly motivated by this insight, as it was explicitly "*geared towards consumers' and taxpayers' interests while continuing to assist farmers*" by "*helping EU farmers to become more market-oriented, and competitive on EU and world markets, while receiving reasonable income suppo*rt," (EUROPEAN COMMISSION 2003b).

Taking this as a starting point, this paper aims to analyse the impacts of various decoupling schemes on structural change and household incomes of individual farms. Thereby, we intend to identify interrelationships between structural change and household incomes and possible winners and losers of decoupling

[60] This chapter is based on SAHRBACHER, C., KELLERMANN, K., and BALMANN, A. (2008): Winners and losers of policy reforms – What is the role of structural change? Presented at the 107th EAAE Seminar on the "Modelling of Agricultural and Rural Development Policies", Seville, Spain, January 29th to February 1st, 2008. Konrad Kellermann was intensively involved in the discussion about the model extension and did the programming. Both co-authors contributed to the discussion of the results and particularly Alfons Balmann contributed to the analysis of the results.

subsidies. This is accomplished by utilising simulations with the agent-based model AgriPoliS. AgriPoliS (HAPPE 2004, HAPPE et al. 2006 and KELLERMANN et al. 2008) simulates the evolution of agricultural regions by considering the actions and interactions of farms within the region. Exiting farmers receive income for hiring out household-owned labour, capital and land resources. In order to analyse the social and distributional impacts of policy reforms, this contribution explicitly considers and compares, for several policy scenarios, the situation of exiting farm households with the financial situation of those farmers staying in the sector. The chosen policy scenarios are: the continuation of the Agenda 2000 policy as a reference scenario; the actual German decoupling scheme; a pure single-farm payment scheme; and finally, a bond scheme.

The paper is structured as follows. In Section 5.2, the agent-based model AgriPoliS is described and its main assumptions and parameters are explained. The necessary model extensions are documented in Section 5.3. Section 0 includes an overview on the study region Hohenlohe, and in Section 5.5 the simulated policy scenarios are described. We present our results in Section 5.6, and discuss them in Section 5.7.

5.2 Methodology (Basic assumptions and key parameters)

The methodological basis of this contribution is the agent-based model AgriPoliS, which is a normative spatial and dynamic model for simulating structural change in an agricultural region developed by HAPPE et al. (2006) and based on BALMANN (1997). Further developments are documented in KELLERMANN et al. (2008)[61]. The main purpose of AgriPoliS is to understand how farm structures evolve in rural areas, particularly in response to various policies. To accomplish this, AgriPoliS represents an agricultural region as a system of interacting heterogeneous farm agents. Structural change in AgriPoliS is not exogenously given, but results from within the model. AgriPoliS maps the key components of regional agricultural structures thusly: heterogeneous farm enterprises and households; space; markets for products; and production factors. These are all embedded in a technical and political environment. For the base period, the model is calibrated to the empirical data of a study region.

The main entities in AgriPoliS are the farm agents and the landscape in which the farms are embedded. The internal state of a farm is organised as a balance sheet that keeps track of factor endowments (land, labour, capital and quota), farmer's age, and expectations about future prices, along with a number of financial indicators. The landscape consists of plots of equal size but varying qualities (arable land, grass land, non-agricultural land), with some of the plots serving as farmsteads for the spatially-distributed farms.

[61] HAPPE et al. (2006) is an online publication with a detailed description of AgriPoliS. In KELLERMANN et al. (2008), the model description is extended by the documentation of further developments since the online publication. For this paper, especially the expectation formation of the farm agents has been revised, which will be described in the following section.

Farms act autonomously in order to maximise their household income, and farms' actions are derived from a mathematical programming approach. Farm agents can engage in production activities, labour allocation, land rental activities, production quotas, and manure disposal rights. To finance farm activities, farm agents can take on long-term and/or short-term credit. Liquid capital not used on the farm earns interest in the bank. Simultaneous to the production planning, farms select from a set of investment alternatives. For investments, scale effects are considered. Furthermore, we assume investment costs to be sunk. A farm exits the sector either if it is illiquid or if opportunity costs of farm-owned production factors (family labour, capital and owned land) are higher than the expected agricultural income. Interactions between farms are defined via markets for factor inputs and products. For products, capital and labour, prices are determined via an exogenous price function. The land market, which plays a central role in AgriPoliS, is modelled as an auction, where farms directly compete for available land plots.

To detail what drives the simulation, we provide a brief overview of the main assumptions (a more detailed description of these assumptions can be found in SAHRBACHER et al. (2007)):

Generational change: We assume that individual farms are handed over to the next generation every 25 years. Because education and training are specific and irreversible investments, for generational change it is assumed that the potential successor expects a 25% higher labour income from off-farm employment than a farmer who had previously decided to continue farming. If the successor decides to remain in agriculture, opportunity costs for labour are set back to the level prior to the generation change.

Land rental contracts: Land rental contracts run for a fixed period of time, which is set randomly between 5 and 18 years. Whenever a rental contract terminates, the land is released to the land market and available for renting to all farms.

Farm heterogeneity: Farms are differentiated according to managerial abilities by assuming a 10% variation of variable production costs between farms.

Interest rates: Interest rates are differentiated into long-term borrowed (i_{bc} = 5.5%) and short-term borrowed capital (i_{sbc} = 8.0%) as well as equity capital (i_{ec} = 4.0%).

Labour costs: Wages for hired labour and off-farm employment are assumed to increase annually by 0.5%.

Off-farm employment: Family labour can be employed off-farm without restrictions. I.e., the risk of unemployment is ignored.

Output prices: Farms are assumed to be price-takers. For decoupling scenarios, output price changes according to simulations with the partial equilibrium model ESIM (European Simulation Model, (BALKHAUSEN and BANSE 2005)) for the corresponding scenarios (see BALKHAUSEN and BANSE 2007). Accordingly, the price increase for beef is 6%, for cereals 4%, and for rapeseed 3%, respectively. The price increases correspond to the price differences in 2009 between the ESIM Agenda scenario and the ESIM scenario with the actually implemented policy. The year 2009 was chosen to consider medium-term effects. Price changes are introduced in AgriPoliS in one step in 2005 because farms in AgriPoliS react abruptly to policy changes.

5.3 Model extensions

For the purpose of this contribution, AgriPoliS was mainly extended in two directions. *First*, the farms' expectation formation in the case of policy changes concerning the decision whether to quit agriculture was revised. *Second*, we introduced the possibility of keeping track of farms that had already quit farming.

After each period, every farm decides whether to stay in agriculture. This decision is based on the comparison of the expected farm-household income and the opportunity costs for land, family labour and capital. The expected farm-household income is calculated for the next period by calculating the total gross margin from agriculture with a mixed integer programming model (MIP) based on the farm's current factor endowment. Thereby, increasing costs for hired labour and price changes for agricultural outputs caused by policy changes are considered (see model assumptions above). The total gross margin is then, amongst others, reduced by rent expenditures (RE) and transport costs (TC) of the farm (for details see Table 5-1).

Table 5-1: Calculation of expected income and opportunity costs

Expected farm-household income	**Opportunity costs**	
	Input factor	Valued at
total gross margin agriculture	family labour	off-farm income
+ interest on liquid capital at bank	+ liquid capital	long-term savings rate
+ off-farm income	+ owned land	average regional rent
+ subsidies	+ milk quota	quota leasing price
- interest on long-term debts	- interest on long-term debts	
- depreciation of fixed assets	- depreciation of fixed assets	
- wages paid		
- transport costs to plots		
- expected rent expenditures		

Source: Based on HAPPE (2004).

As opportunity costs for family labour we take the costs for hired labour and for liquid capital the long-term savings rate, which is assumed to be equal to the long-term interest costs (i_{bc} = 5.5%). The milk quota is valued at the quota leasing price, and owned land (OL) at the average rental price $(\overline{R})$ of the simulated region, which is endogenously determined. Because the average rental prices change over time, future trends are considered in the calculation of the opportunity costs for owned land. To include the development of rental prices in the calculation of expected household income, the so-called expected rent expenditures (REE) are calculated. The expected rent expenditures (equation (5.1)) are the average of the average rent expenditures $(\overline{R}E)$ of a farm and the average regional rental price $(\overline{R})$ multiplied by the rented land (RL) of a specific soil type (s)[62]. In the case of structural breaks caused by policy changes, the expected rent expenditures, as well as the opportunity costs for land (OC_{OL}) are adjusted by the factor π.

$$REE = \sum_{s=1}^{S}\left[RL_s \cdot (\overline{R}E_s + \overline{R}_s)/2 \cdot \pi_s\right], \text{ with } \pi = 1 \text{ if no policy change.} \qquad (5.1)$$

The values of π for various soil types are based on the simulation experiments of HAPPE (2004) (chapter 8). To update and automate this procedure, the adjustment factors are now calculated in AgriPoliS. Therefore, the year of the policy change (tp) is simulated in advance and the average rental prices of the year in which the policy change takes place (Rs, tp) is divided by the average rental price in the year prior to the policy change $(Rs, tp-1)$. This provides the adjustment factor π for the rental prices in the expectation formation (see equation (5.2)). The same period is again simulated considering the adjustment factor. Equation (5.3) shows the calculation of the opportunity costs for owned land (OC_{OL}) with the adjustment factor π for the year of policy change:

$$\pi_s = \overline{R}_{s,tp} / \overline{R}_{s,tp-1} \qquad (5.2)$$

$$OC_{OL} = \sum_{s=1}^{S}\left[OL_s \cdot \overline{R}_s \cdot \pi_s\right], \text{ with } \pi = 1 \text{ if no policy change.} \qquad (5.3)$$

Though this revision is a further elaboration of the decision rule according to which farms quit farming or not, the decision routine still has to be understood as myopic and to some extent biased towards the continuation of marginal farms. The bias arises due to steadily increasing non-agricultural income opportunities, as well as the missing anticipation of the consequences of endogenous structural change. These issues are related to each other in the sense that in the long run, structural change should lead to equal income opportunities inside and outside of agriculture, and in general, one could expect that it is sufficient to compare actual income opportunities. I.e., if a farm is profitable, the farm could be expected to be profitable in the future as well. However, the consequences of endogenous structural change are more complex. *First*, since structural change is affected by frictions like sunk costs, the frictions and their impacts would have to be understood by the farmers/agents. For instance, it matters how far the system

62 Here we differentiate between two soil types, arable land and grassland.

is away from its long-run equilibrium. *Second*, if the system's state is not in equilibrium, farms have to make strategic decisions and there is room for strategic behaviour by the farms/agents. Many farms may at the same time be in a situation which offers opportunities either to grow or to exit, while the success of each option depends on the strategies chosen by neighbouring farms – which themselves have to form expectations and make decisions. This can result in situations similar to the Game of Chicken or Hawk-Dove Game (FUDENBERG and TIROLE 1991 and WEIBULL 1995) for which no general decision rule exists. In respect thereof, further research is surely necessary. But at least the persistence of functional income disparities (i.e. discrepancies between market prices and shadow values of factors) often found for Western European agriculture provides empirical evidence that farmers' expectations are probably similarly biased (e.g. BALMANN et al. 2006 and COELLI et al. 2006).

To determine whether leaving farms are winners or losers, we also analyse the accounting and financial situation of exiting farms by considering payments for land, labour and liquid capital. For their owned land, leaving farmers receive the rent paid by the leaseholder. Wages for labour are based on the off-farm wages of surviving farms and increase annually by 0.5%. In case a farm closes during generational transition, the successor receives a 25% higher wage during the rest of the simulation time. Liquid capital can be saved at an interest rate (i_{bc}) of 5.5%, because we assume that the leaving farms can invest their money long-term. These payments are reduced by depreciations and interest costs for still-existing agricultural buildings and machinery. The remaining income is reduced by minimum expenditures covering the costs for the basic requirements of each family member. This minimum level is equal to the minimum withdrawal (WD_{min}) of the surviving farms. Further details about the calculation of the household income of surviving and leaving farms can be found in Table 5-2.

Table 5-2: Calculation of the household income

Indicator	Calculation for surviving farms	Calculation for leaving farms
household income =	total gross margin agriculture + off-farm income + interest on working capital + subsidies - rent expenditures - depreciation - interest costs - current upkeep of machinery and equipment - farming overheads - transport costs - wages paid	total gross margin agriculture + off-farm income + interest on working capital + subsidies + rent received - depreciation - interest costs
equity capital change =	household income (Y) - withdrawal (WD)	household income (Y) - expenditures (WD)
withdrawal =	$WD_{\min} + (Y - WD_{\min}) \cdot \varepsilon$ with $0 < \varepsilon \leq 1$ and $Y \triangleright WD_{\min}$	

Source: Based on HAPPE (2004).

5.4 Data

The simulations are based on data taken from the study region Hohenlohe for 2001. The agricultural structure of Hohenlohe is virtually represented in AgriPoliS by weighted replications of selected individual farms to cover regional characteristics such as number of farms specialised in field crops, milk production, pig or poultry, etc., number of farms of different size classes, number of animals in respective size classes, etc. Therefore, individual farms are derived from FADN-data. On the farm level, the production structure and behaviour of the selected farms is represented by a mixed integer programming model, as described in Section 5.2.

The Hohenlohe region is situated in south-west Germany and has a utilised agricultural area (UAA) of 73,439 ha (STATISTISCHES LANDESAMT BADEN-WÜRTTEMBERG 1999). In general, agriculture in Hohenlohe is small-scale structured, with an average farm size of 26 ha and approximately half of the 2,869 farms being part-time. These farms have less than one AWU, or their total standard gross margin is lower than 16 ESU[63] (19,200 Euros). Part-time farms use approximately 22% of the total UAA. Farms in Hohenlohe are mostly specialised in pig and poultry production (34%) or grazing livestock (32%). A detailed description of the virtual representation of a region can be found in SAHRBACHER and HAPPE (2008).

63 ESU = European Size Unit, equivalent to 1,200 Euros. Farms with a total standard gross margin of less than 8 ESU are not considered in the FADN in Germany (EUROPEAN COMMISSION 2002b).

Further information about the input data and the Hohenlohe region can be found in SAHRBACHER et al. (2005).[64]

5.5 Policy scenarios

Four different policy scenarios have been defined (Table 5-3). In the first scenario, the Agenda 2000 will be continued. This scenario is called AGENDA and serves as a baseline for analysing the impacts of decoupling. In addition to the baseline scenario, three different decoupling scenarios are considered.

The first decoupling scenario is called REFORM, because here we consider Germany's implementation of the MTR (Germany has chosen a hybrid dynamic decoupling scheme, which leads to a regional payment by 2013). Payment entitlements are calculated as follows[65] (BMELV 2006):

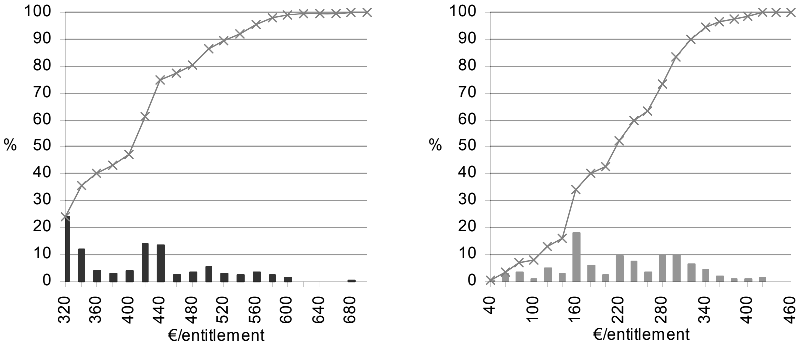
- COP-payments are transferred into a regional payment for arable land in each federal state;
- Slaughtering payments for cattle, additional payments for cattle and 50% of extensification payments for cattle are distributed on the grassland of each federal state;
- Payments for milk, suckler cows, special payments for male cattle, slaughtering payments for calves, ewe payments and 50% of the extensification payments for cattle are distributed on the agricultural land of individual farms.

Finally, the farm-specific payments and the hectare payment for arable land or grassland are put together in one payment entitlement per hectare. Figure 4-1 shows the distribution of the payment entitlements for the regional adaptation of AgriPoliS for Hohenlohe in 2005. The payments presented here are calculated in AgriPoliS based on the production in a three-year reference period. As they are based on the production structure taken from AgriPoliS and not upon reality, they differ slightly from the real payments in the observed regions.

[64] The model specification, calibration and data collection, as well as further analysis, have been carried out within the EU-project IDEMA.

[65] This is only a short description of the decoupling scheme in Germany. We described here only those parts which are important for modelling the regions.

Figure 5-1: Distribution and cumulative distribution of arable land (left) and grassland (right) payment entitlements among the total UAA in Hohenlohe in 2005



Source: Own calculations based on AgriPoliS simulation results.

The value of payment entitlements for arable land varies between 323 and 700 Euros. As the regional payment for arable land is 323 Euros/ha, one can see that in Hohenlohe, 26% of the payment entitlements for arable land are not increased by farm-specific payments. The majority (90%) of payment entitlements for arable land have a value of between 323 and 520 Euros. The value of payment entitlements for grassland is much lower than for arable land, which is caused by the lower regional payment for grassland; it varies between 54 and 440 Euros. Figure 4-1 also shows that 90% of the grassland payment entitlements have a value of more than 100 Euros.

From 2010, the difference between the value of payment entitlements and the final regional payment of 2013 will be stepwise reduced by 10, 30, 60 and 100% in a way that there will only be one payment level for each hectare of arable land and grassland.

Table 5-3: Policy scenarios

Name	Description
AGENDA	- Continuation of Agenda 2000
REFORM	- Hybrid dynamic decoupling - Payment entitlements consist of a region-specific and a farm-specific portion - Value of payment entitlements differs at the beginning of decoupling - Differences between payment entitlements will be stepwise reduced after 2010 till 2013
SFP	- Farm-specific decoupling - Calculation of payment entitlements per hectare depending on a farm's production - Value of payment entitlements is different depending on farmers' production
BOND	- Full decoupling, i.e. farmers receive the payment independent of whether they produce - Payments will be also paid after farms exit - Calculation of the payment is based on a three-year reference period

Source: Own presentation.

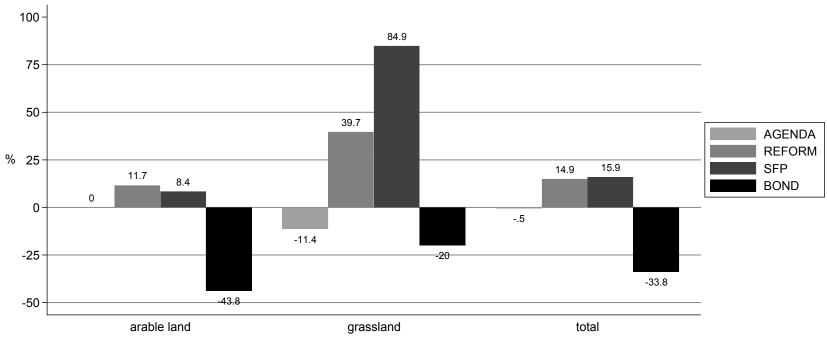
Since the European Commission initially suggested that direct payments should be decoupled towards a pure single farm payment (SFP), we also simulate this policy to compare it with the hybrid dynamic decoupling scheme in Germany. The implemented single farm payment is without any coupling rates for specific products.

Since payments in the REFORM and the SFP scenarios are still coupled to the use of land, the problem of capitalising payments into rental prices is not resolved. Thus, the fourth scenario (BOND) considers payments that are fully decoupled from the land used by a farm, in the sense of the "Bond scheme" suggested by KOESTER and TANGERMANN (1977), TANGERMANN (1991) and SWINBANK and TRANTER (2004). This means that in AgriPoliS farmers receive a payment based on a reference period of three years independent of whether they produce anything, that is to say they receive the payment even if they quit agriculture. The duration of these payments is fixed as the simulations do not run more than 20 periods after the policy change. The payments are also not transferred into a tradable bond.

5.6 Results

As rental prices affect amongst others the farm household income, we first present how they develop during the simulations. Figure 5-2 shows the relative difference of arable land and grassland rental prices between 2004 and 2013. One can see that total rental prices (grassland and arable land) are relatively stable in the AGENDA scenario, while for grassland they even decline till 2013. By contrast, the rental prices increase in the REFORM and SFP scenarios. This happens because in these scenarios land rents increase as a result of farmers' increasing flexibility due to the decoupling of direct payments. The difference between the REFORM and the SFP scenario is caused by the different calculation of the payment entitlements in both scenarios, which results in different payment levels per hectare for arable land and grassland and finally in different rental prices. In the SFP scenario, all payments of a farm are divided by the total UAA of the farm to calculate the payment entitlements per hectare. This leads to a redistribution of payments from arable land to grassland and in the whole region to an average payment for arable land of 348 Euros/ha. As already mentioned in the scenario description, the payments for arable land consist of a regional portion and a farm-specific portion in the REFORM scenario. The regional part of the arable payment is calculated by dividing the sum of all payments for COPs by the total arable land in the region and is 325 Euros/ha. The farm-specific top-up depends on the livestock husbandry of each farm and as shown in Figure 4-1, varies between zero and 355 Euros/ha in 2005. Considering this, the average payment for arable land in Hohenlohe in the REFORM scenario is 376 Euros/ha for 2005, which is 30 Euros/ha more than in the SFP scenario. The opposite is the case for the payment entitlements for grassland. In the REFORM scenario, their average value is 233 Euros/ha in 2005 and in the SFP scenario 383 Euros/ha. Thus, rental prices for grassland increase more in the SFP scenario than in the REFORM scenario. On the other hand, rental prices for arable land increase more in the REFORM scenario, as Figure 5-2 shows. In total, the average rental expenditures for arable land and grassland show a similar increase in the REFORM and SFP scenarios. For the BOND scenario, we observe a decline of the total rental price of 34%, which is caused by decoupling the payments from land use.

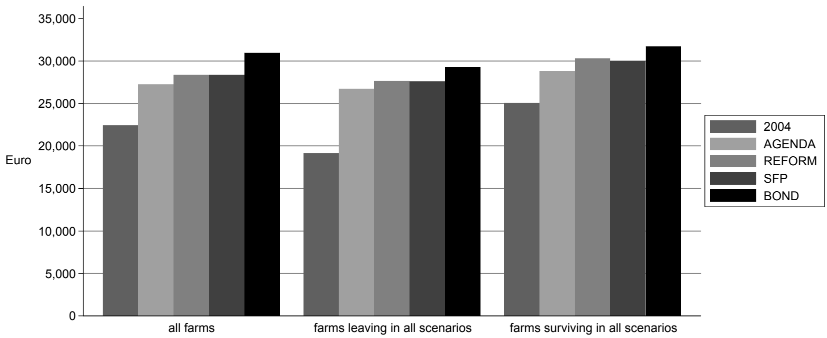
Figure 5-2: Relative rental price changes from 2004 to 2013



Source: Own calculations.

In order to identify the winners and losers of the MTR, household incomes of individual farms are analysed. As indicator, we have chosen the household income per family annual work unit (FAWU). The household income includes all incomes of the farmers' families, as well as off-farm incomes. To provide a brief overview, we first examine the average household income in all scenarios in 2004, the year before decoupling, and in 2013, when there is only a regional payment in the REFORM scenario (Figure 5-3). We differentiate between farms surviving in all scenarios, leaving in all scenarios and all farms. The first bars of each group show the household income in 2004, whereas the other bars show the household income of the different scenarios in 2013. It is obvious that leaving farms have a smaller household income per AWU than surviving farms. But not only is the household income smaller, their average farm size and initial wealth are, too. Farms leaving agriculture in all scenarios have an average size of 19 ha in 2004 and surviving farms have, at the same time, an average size of 42 ha. Furthermore, Figure 5-3 shows that the difference between household incomes of surviving and leaving farms diminishes over time; in 2004 the difference is approximately 5,900 Euros, and in 2013 in the AGENDA scenario, approximately 2,100 Euros. The reason for the reduction of this difference over time is that leaving farmers can earn more money outside agriculture and can thus catch up to the surviving farms. Comparing the different scenarios, one can see that in the REFORM and SFP scenarios, household incomes are similar and higher than in the AGENDA scenario, which can be explained by the increasing flexibility in production decisions due to decoupling. Somewhat surprisingly, the highest income increase can be observed in the BOND scenario. On the one hand this is unexpected, because payments are fully decoupled and farmers can take them out of agriculture by quitting farming. But on the other hand, as we have seen in Figure 5-2, rental prices strongly decline in the BOND scenario.

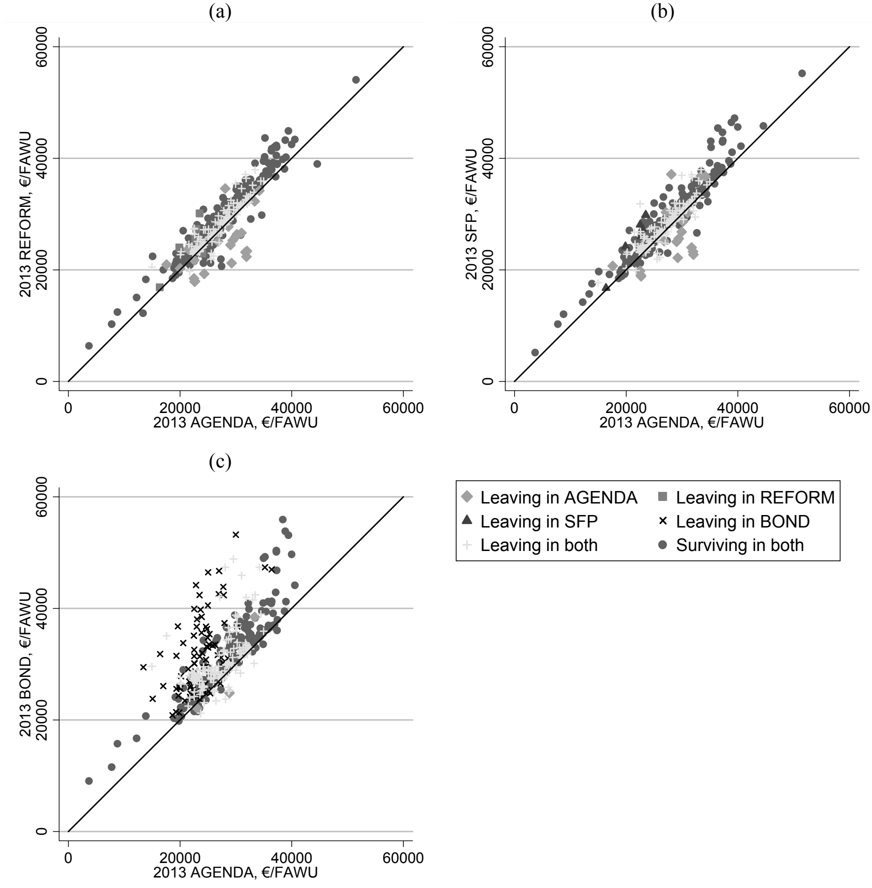
Figure 5-3: Average household income per FAWU for different policy scenarios in 2013 compared to 2004



Source: Own calculations.

Returning to the initial question of "Who are the winners and losers of the MTR," Figure 5-4 shows the relation of the household income for the surviving farms, as well as for leaving farms in the AGENDA scenario, to one of the other policy scenarios for the year 2013. Figure 5-4 denotes which farms leave in just one, or in both, policy scenarios, and also shows which farms survive in both scenarios. Dots on the bisecting line represent farms whose household income development is independent of the policy. Accordingly, farms surviving in both scenarios (presented in a graph of Figure 5-4) develop better in the decoupling scenarios (REFORM, SFP and BOND) than in the AGENDA scenario.

Figure 5-4: Household income per family work unit (FAWU) for leaving and surviving farms in 2013 under various policy scenarios



Source: Own calculations.

In the REFORM and SFP scenarios, the decoupling of direct payments slows structural change compared to the AGENDA scenario. In Figure 5-4 it can be seen that less farms leave in the REFORM or SFP scenarios than in the AGENDA scenario. The figures in Table 4 confirm this observation. This slow-down in structural change is a result of lower demands for receiving payments after decoupling. For example, maintenance of grassland is no longer guaranteed by payments for ruminants but rather by a grassland payment, which stipulates only that the grassland must be maintained, not how it should be done. Maintaining grassland can easily be done by mulching the land once a year, which requires less labour input than keeping ruminants. Thus, mainly small farms reduce their labour input in agriculture and increase off-farm employment. Thereby, they become part-time farms instead of leaving agriculture. In the BOND scenario, farmers have the best opportunity to use their payments which leads to the strongest structural change as well as to the highest incomes.

Table 5-4: Decline in number of farms between 2004 and 2013

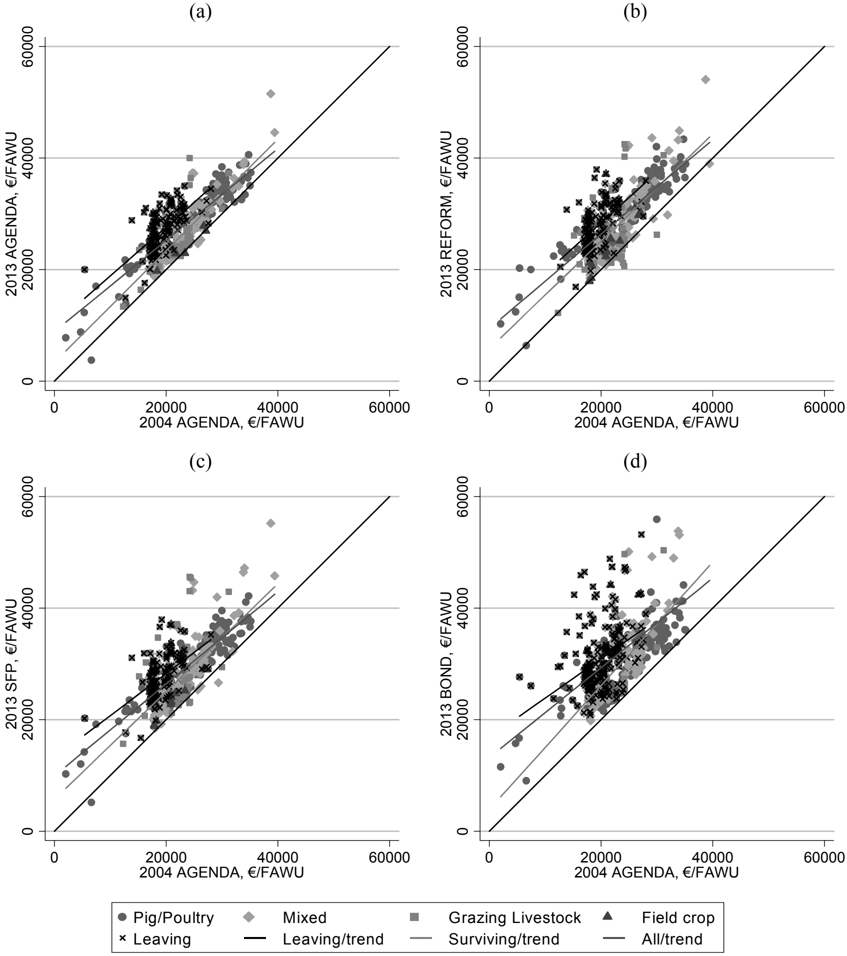
Scenario	Average annual decline	Total decline
AGENDA	4.5%	34%
REFORM	3.9%	30%
SFP	4.0%	31%
BOND	7.8%	52%

Source: Own calculations.

Furthermore, Figure 5-4a/b show that some farms which are leaving in the AGENDA scenario survive in the REFORM and SFP scenarios. However, these farms have a lower household income in the REFORM and SFP scenarios than in the AGENDA scenario. Such farms may be called "willing to leave farms" and can be counted as losers of the MTR because of their lower household income in the REFORM and SFP scenarios. The same result appears when comparing the BOND and the AGENDA scenario (Figure 5-4c). In the more liberal BOND scenario, even more farms are leaving and achieve, in comparison to the AGENDA scenario, higher incomes in 2013. As mentioned above, the expectation that the household income of the remaining farms will decline due to payments leaving the sector together with the leaving farms cannot be confirmed for two reasons. *First*, there is no longer a connection between payments and land with coupling the payments to the farmer. Thus, payments are no longer capitalised into the rental price and rental prices are declining. *Second*, with the exit of a large number of farms, much land is available for the remaining farms to increase their size. These remaining farms can thereby realise economies of scale.

From Figure 5-4 it is not possible to draw conclusions over whether the development of individual farms household income from 2004 till 2013 was positive or not. Therefore, in Figure 5-5 we compare the household income per FAWU for surviving and leaving farms in 2004 and 2013. The regression line over all farms shows – similar to Figure 5-3 – that the average household income of all farms increases in all policy scenarios till 2013. Nevertheless, several grazing livestock farms must accept losses in income in the REFORM and SFP scenarios. Other grazing livestock farms can achieve only small income increases. Furthermore, the regression line over all farms shows that farms with a lower household income per FAWU prior to decoupling benefit more than farms with an initially higher household income per FAWU. The household incomes in the first group increase more in absolute values than those of farms with an initially higher household income per FAWU. An explanation for this is that farms with an initially low household income can gain a lot by leaving agriculture.

Figure 5-5: Household income per family work unit (FAWU) for leaving and surviving farms comparing 2004 and 2013 under different policy scenarios



Source: Own calculations.

As mentioned before, mainly farms with a small household income per FAWU leave the sector in all scenarios. Though some of these farms stay in agriculture, they cannot achieve the same income increase as those farms which left agriculture. Thus, it is evident that it would be better for these small farms to leave agriculture than to stay in the sector. The persistence of these farms results from the model's assumption that farms look only one year ahead to decide whether they leave agriculture or not. This kind of persistence seems to be observable in reality as well, where farms also probably care more about their current situation than about other possibilities.

A further outcome of the analysis is that leaving farms (marked with a cross in Figure 5-5) cannot be called losers. As we already mentioned, their income increase is stronger than if they would stay in agriculture. However, it has to be considered that all family members working in agriculture are assumed to find off-farm employment – which is probably a restrictive assumption.

5.7 Conclusion

The goal of this paper was to discover which farms benefit and which suffer from different decoupling scenarios. To accomplish this goal, we applied the agent-based model AgriPoliS to the Hohenlohe region in south-west Germany. The analysis included the hypothetical development of farm households leaving agriculture, and as a consequence AgriPoliS was extended and improved in two directions: 1) the formulation of expectations regarding the decision of whether a farm should continue or not, and 2) the financial accounting of farms that choose to leave. To answer the question: "Who are the winners and losers of decoupling," the household incomes of individual farms in three different decoupling scenarios were compared to a continuation of the Agenda 2000. *First* was the hybrid dynamic decoupling scheme currently being implemented in Germany. *Second* was the EU’s originally planned pure farm-specific decoupling scheme, and *third*, as an alternative, was a simplification of the Bond scheme suggested by TANGERMANN (1991) and SWINBANK and TRANTER (2004).

The analysis showed that the average income increases from 2004 till 2013 are stronger in the decoupling scenarios than in the continuation of the Agenda 2000 policy because of farmers’ higher flexibility concerning their production decisions in these scenarios. However, structural change in the hybrid dynamic (REFORM) and farm-specific decoupling scheme (SFP) is slower than in the AGENDA scenario. Rather than leaving the sector, more small farms become part-time farms in these scenarios. This means that structural change in terms of changes in the production structure towards a stronger market orientation can compensate for losses in economies of scale due to less increase in farm size, as it happens in the REFORM and SFP decoupling scenarios. However, according to the simulations, this kind of structural change makes losers of those farms that would leave agriculture under Agenda conditions but continue under decoupling because they would achieve a higher household income by 2013 if they were to exit. The comparison of the income development of similar farms - leaving agriculture and not leaving - shows that leaving farms can increase their income more than the remaining farms. Hence, leaving farms cannot be counted as losers if they leave due to opportunity costs. To summarise, we argue that in the long run, leaving farms should not be considered as losers in general, at least regarding their financial situation, if there are adequate off-farm job opportunities.

Furthermore, the analysis reveals that farms exhibit a kind of persistence to stay in the sector. Probably similar to reality, a significant number of farms do not leave agriculture in AgriPoliS despite the fact that it would be more profitable for them in the long run. This persistence likely stems from the assumption that farms in AgriPoliS are more oriented upon their current situation than upon future options; farms in AgriPoliS look only one year ahead when they decide to leave farming or not. Thus, structural change might be underestimated in AgriPoliS. However, the persistent and very large functional income disparities in West German agriculture may be understood in the way that similar mechanisms exist in reality. Moreover, the differences between policy scenarios should be the same.

The analysis shows that from an efficiency and a social point of view, the BOND scenario can be seen as a promising alternative to the REFORM and SFP scenarios because it makes it easier for marginal farms to leave. It thus improves the development perspectives of surviving farms by fostering structural change. Leaving farms benefit from the payments, and the remaining farms benefit from declining rental prices and realising economies of scale.

6 PAST AND FUTURE EFFECTS OF THE COMMON AGRICULTURAL POLICY IN THE CZECH REPUBLIC[66]

6.1 Introduction

The accession of 10 Central and Eastern European countries (CEECs) in 2004, and two in 2007, marked a big change for their respective agriculture sectors due to a strong increase in payments and the high number of new regulations. Even though the acceding countries at first received just 25% of the payments paid in the OMS per hectare or head of livestock, this led, for example in the Czech Republic, to an 80% increase in agricultural subsidies. During the phasing-in period, till 2013, payments will increase further until they reach 100% of the level in the OMS. It seems likely that such an increase in aid will affect agriculture strongly. For example, farmers' incomes will grow and this might influence their decision to stay in agriculture or not. But not all money ends up in farmers' pockets; landlords and owners of other production factors also benefit from subsidies for agriculture (LENCE and MISHRA 2003, ROBERTS et al. 2003 and LATRUFFE et al. 2008).

Another issue is the upcoming redistribution of payments among farms due to a change in the CAP. Along with the accession of 8 CEECs as well as Malta and Cyprus in 2004, the EU changed its agricultural policy from 2005 on. Direct payments distributed within the Agenda 2000 policy per hectare of specific crops or heads of livestock have been decoupled in the OMS and are now a farm-specific payment or a single area payment. In both cases farmers are paid for the use of agricultural land independent of what they produce. The level of payments to each farm depends on a three-year past average. In 2004 the aceding CEECs did not have the same payment system as the EU, so it was not possible for them to already introduce decoupled payments in 2005. Thus, these New Member States could either implement the old Agenda 2000 policy or the so-called single area payment scheme (SAPS) before they fully implement the new decoupling policy. The SAPS is a mixture of the Agenda 2000 policy and the

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66 This chapter is a version of the article "Past and future effects of the Common Agricultural Policy in the Czech Republic" (SAHRBACHER, C., JELINEK, L., KELLERMANN, K., MEDONOS, T. 2009) published in: *Post-Communist Economies* 21 (4): 495-511. Post-Communist Economies is available online at: http://www.informaworld.com/smpp/and the article is available at: http://www.informaworld.com/smpp/content~db=all~content=a917406470~frm=titlelink Ladislav Jelinek and Tomas Medonos provided the empirical data and data for the model input. Konrad Kellermann especially contributed to the structure of the paper. All co-authors contributed to the discussion of the results.

new decoupling policy; it contains a uniform decoupled area payment[67] similar to the decoupling scheme planned for the OMS, and it is also possible for the acceding countries to pay additional subsidies, so-called complementary national direct payments or top-ups (EUROPEAN COMMISSION 2003c), which are coupled to certain products. Aside from Malta and Slovenia, all countries acceding to the EU in 2004 opted for the SAPS (AGRA Informa 2008). Independent of the policy chosen by the acceding countries, it was initially planned that they would switch to the new EU decoupling policy in 2009 (COUNCIL REGULATION (EC) No 1782/2003, Article 154a. 87 p.). However, the European Commission postponed this deadline to 2011 and in the recent Health Check proposal, they suggested further postponing it to 2013 (AGRA informa). Now, acceded countries have to decide whether they will introduce a farm-specific or a single area payment. In countries like the Czech Republic, which introduced top-ups, decoupling towards a single area payment will lead to a redistribution of top-ups among farms. In the case of farm-specific decoupling, payments will not be redistributed.

The goal of this paper is, *first,* to analyse the impacts of accession on structural change and farmers' income based on empirical data from 2001 to 2007. The empirical data are simultaneously used to validate simulations conducted with the agent-based model AgriPoliS (Agricultural Policy Simulator) for the same period. *Second*, the impacts of the upcoming decoupling of top-ups on structural change, farm income and payment redistribution will be simulated with AgriPoliS. Thereby, both decoupling options – the farm-specific and the pure area payment – will be analysed and compared with the impacts expected were the current policy to be continued.

The employed model, AgriPoliS, is a normative spatial and dynamic agent-based model developed by HAPPE (2004). AgriPoliS represents an agricultural region like Vysočina, Czech Republic, as an agent-based system, i.e., a system of interacting heterogeneous agents. Changes, e.g. in farm income or rental prices in a modelled region result from within the model. The agent-based approach allows us to consider dynamics such as farm growth and to observe simultaneously the adjustment reactions of individual farms to policy changes. The simulations start in 2001. In 2004 the accession policy with SAPS payments and top-ups is introduced and in 2009 top-ups will be decoupled either to a farm-specific or a single area payment.

The paper is structured as follows. In the following section we give a short description of AgriPoliS, its key assumptions and the data we used. The next section describes the policy scenarios simulated with AgriPoliS. Then results from the *ex post* and the *ex ante* analysis are shown. The paper closes with a concluding section.

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[67] In the following, we refer to these payments as "SAPS payments".

6.2 Methodological approach, key assumptions and data

As stated above, one important goal of this paper is to project CAP effects in a selected region in the Czech Republic. The AgriPoliS model is used as a framework for this projection. AgriPoliS is a spatial and dynamic agent-based simulation model of structural change in agriculture developed by HAPPE et al. (2006) and based on BALMANN (1997). Further developments are documented in KELLERMANN et al. (2008)[68]. The main purpose of the model is to understand and project how farm structures change in rural areas, particularly in response to various policies. For this purpose, AgriPoliS maps the key components of regional agricultural structures: heterogeneous farm enterprises and households, space, markets for products and production factors. These are all embedded in a technical and political environment. For the base period, the model is calibrated to the empirical data of the study region.

The main entities in AgriPoliS are the farm agents and the landscape in which the farms are embedded. The internal state of a farm is organised as a balance sheet that keeps track of factor endowments (land, labour, capital and milk quota), farm age, and expectations about future prices, along with a number of financial indicators. The landscape is constituted by cells of equal size but varying qualities (arable land, grassland, non-agricultural land), with some of the plots serving as farmsteads for the spatially-distributed farms.

Farms act autonomously in order to maximise their household income, or their profit in the case of corporate farms. The farms' actions are derived from a mathematical programming approach. Farm agents can engage in production activities, labour allocation, rental activities for land, production quotas, and manure disposal rights. To finance farm activities, farm agents can take on long-term and/or short-term credit. Liquid assets not used on the farm can bear interest at the bank. Simultaneous to production, farms select from a set of investment alternatives, for which scale effects are considered. Furthermore, we assume investment costs to be sunk. A farm exits the simulation if it is illiquid, or if the opportunity costs of farm-owned production factors are not covered.

Interactions between farms are defined via markets for factor inputs and products. For products, capital and labour, prices are determined via an exogenous price function. The land market, which plays a central role in AgriPoliS, is modelled as an auction, where the farms directly compete for available land plots.

[68] HAPPE et al., (2006) is an online publication. The annex of this publication includes a detailed description of AgriPoliS. In KELLERMANN et al., (2008), the model description is extended by the documentation of further developments since HAPPE et al., (2006).

To provide an idea about what drives the simulation results, we give a brief overview of some main assumptions. A more detailed description of these assumptions can be found in Sahrbacher et al., 2007.

Generation change: We assume that individual farms are handed over to the next generation every 25 years. If a farm is handed over to the next generation, opportunity costs for the successor's labour force are assumed to be 25% higher. This reflects a potential successor's choice to work off farm or on the farm. If the successor decides to stay in agriculture, then opportunity costs are set back to the level prior to the generation change.

Opportunity costs of farm family labour: We assume that it is mostly the younger, better educated farm family members who are able to work off-farm. Considering that one farming generation is 25 years, opportunity costs of older farm family members are 50% of the original level (10-20 years after taking over the farm) or zero (20-25 years after taking over the farm), respectively, which reflects their (in)ability to find off-farm jobs.

Legal form: The legal forms "individual farm" (IF) and "corporate farm" (CF) are differentiated based on initialisation data. Farms cannot switch their legal form during the simulation time. Corporate farms are not confronted with the problem of generation change or age-dependent opportunity costs because they have no family labour.

Land rental contracts: Land rental contracts run for a fixed period of time, which we set between 5 and 18 years. Whenever a rental contract terminates, the land is released to the land market and available for rent to other farms.

Heterogeneity of farms: As in reality, farms are differentiated by their managers' various managerial abilities, which cause differences in economic performance. Thus, we assume a 10% variation of production costs between farms.

Output prices: Farms are assumed to be price takers. For decoupling scenarios SAP2009 and SFP2009, we consider output price changes. These are taken from simulations with ESIM for the corresponding scenarios (see BALKHAUSEN and BANSE 2007). Accordingly, the price increase for beef in both scenarios is 5%.

Data for the *ex post* analysis about factor and output prices, agricultural subsidies and farm income are from the "Green Report" published by the MINISTRY OF AGRICULTURE (2001 - 2007). Structural data are from the CZECH STATISTICAL OFFICE (2008). All *ex post* data are for the entire Czech Republic.

The *ex ante* analysis, on the other hand, is based on simulations of development in the case study region Vysočina. The agricultural structure of Vysočina in 2001 was virtually represented by weighting selected individual farms to cover regional characteristics such as: number of farms specialised in field crops; milk production; pig or poultry, etc.; number of farms in different size classes; number of animals in respective size classes, etc. Therefore, individual farms are derived from FADN-data. The production structure and behaviour of the selected farms is then represented with a mixed integer programming model as described above.

As the FADN sample for Vysočina includes few farms smaller than 10 ha, these were not considered in the virtual region. Thus, from 3,443 farms larger than 1 ha, we consider only 1,872 in the virtual region. The utilised agricultural area is thus reduced from 393,726 to 385,713 ha. A detailed description of the virtual representation of a region can be found in SAHRBACHER and HAPPE 2008. Further information about the input data can be found in SAHRBACHER et al. (2005). JELINEK et al. (2007) includes a section with further simulation results. The latter two publications also contain a detailed description of the region.

6.3 Policy scenarios

For the *ex ante* analysis with AgriPoliS, we implemented four policy scenarios for which we simulated structural changes from 2001 to 2013. Until 2004, we considered the policy applied before EU-accession. In 2004, we implemented the accession policy in three of these four scenarios, whereas in the fourth scenario, the PRE-ACCESSION policy was continued. This allows us to analyse the effects of accession. The second scenario, ACCESSION, reflects the actual implemented policy with SAPS payments and coupled top-ups till 2013. In the third (SAP2009) and fourth (SFP2009) scenarios, payments are decoupled in different ways in 2009. In the following, the analysed scenarios are described in more detail.

PRE-ACCESSION: As the payments before accession slightly differ in 2002 and 2003, we calculated the average of both years. The payment for arable land is only paid if farms set aside at least 5% of their arable land. For the land set aside, farmers receive 179 Euros/ha on average in the years before accession. However, they can set aside a maximum of 10% of their arable land. For grassland, we take into account the payments for less favoured areas (LFA). For dairy cows, farmers received a compensatory payment for milk quota, which amounts, in the years before accession, to an average of 24 Euros per dairy cow.

Table 6-1: Pre-accession payments (average coupled premiums of 2002 and 2003)

Production activity:	Ø – Premium (€/ha, €/cow)
Arable land	10
Set-aside	179
Grassland LFA	65
Dairy cows	24

Note: Payment for dairy cows is the compensatory payment for milk quota: in 2002, this was 3.24 Cent/l, and in 2003, 4.4 Cent/l. The annual milk yield is 6,175 kg (JUŘICA et al. 2004).

Source: MINISTRY OF AGRICULTURE 2001-2004 and own calculations.

<u>ACCESSION:</u> In 2004 the pre-accession policy is replaced by SAPS payments and coupled top-ups for ruminants, cereals, oilseeds and protein crops (COPs), flax, hop and starch potatoes. Additionally, a coupled agri-environmental payment of 110 Euros/ha for grassland is introduced. The SAPS payment is paid for each hectare of utilised agricultural land, whereas land has to be kept in good agricultural and environmental conditions (GAEC). SAPS payments are phased in stepwise, which can be seen in Table 6-2. The payments start in 2004 at 25% of their final level in 2013. In the following years, they increase to 30, 35, 40, 50, 60, 70, 80 and 90%, respectively, of the full 2013 amount. After 2009, top-ups are reduced, because in the modelled region the total payment consisting of SAPS payments and top-ups reach the target level of payments granted in 2013. Hence, in 2013 this scenario automatically ends in a decoupled single area payment (SAP).

Table 6-2: Payments in the ACCESSION scenario

	Unit	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
SAPS	€/ha	57	70	85	98	122	146	171	195	220	244
Top-ups EA()	€/ha	46	80	82	80	80	80	73	49	24	0
Ruminants	€/LU	69	69	91	91	91	63	35	23	12	0
Agri-env. payment	€/ha	110	110	110	110	110	110	110	110	110	110

Note: EA = eligible area of COP, flax, hop and starch potatoes.

Source: Payments for 2004 to 2006 are from MINISTRY OF AGRICULTURE (2005), SBÍRKA ZÁKONŮ (2006); SAPS payments after 2006 are calculated based on phasing in rates; top-ups for arable land and ruminants are, in our simulations, kept at the same level as in 2006, until they reach, together with the SAPS payments, the target level of 2013, when they have to be reduced. The payments are based on model calculations and can differ from the actual development.

<u>SAP2009:</u> Until 2008, the ACCESSION policy is applied. In 2009, top-ups and SAPS payments are transferred into one SAP for arable land and grassland. In

our simulations there is no further increase in the SAP, because SAPS payments and top-ups already reach, prior to decoupling in 2009, the target level of 2013. This scenario leads to an abrupt reallocation of payments among farmers. Although smoother, this reallocation also appears in the ACCESSION scenario because of the stepwise reduction of the top-ups prior to 2013. The agri-environmental payment for grassland remains coupled.

Table 6-3: Payments in the SAP2009 scenario

	Unit	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
SAPS, SAP	€/ha	57	70	85	98	122	244	244	244	244	244
Top-ups (EA)	€/ha	46	80	82	80	80	0	0	0	0	0
Ruminants	€/LU	69	69	91	91	91	0	0	0	0	0
Agri-env. payment	€/ha	110	110	110	110	110	110	110	110	110	110

Source: See Table 6-2, the SAP introduced in 2009 is equal to the level of SAPS payments that should be reached in 2013.

<u>SFP2009:</u> In 2009 top-ups are decoupled and a single farm payment is introduced. Thereby the value of payment entitlements depending on a farm's production is calculated, i.e., the total amount of payments a farm receives in 2008 is divided by the total area of the farm in 2008. The value of the payment entitlements varies among farms depending on their production structure before decoupling. In this scenario no reallocation of payments among farms takes place. If land moves from one farmer to another, the payment entitlement of the land moves as well. Again, the agri-environmental payment will not be decoupled as shown in Table 6-4.

Table 6-4: Payments in the SFP2009 scenario

	Unit	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
SAPS	€/ha	57	70	85	98	122	SFP	SFP	SFP	SFP	SFP
Top-ups (EA)	€/ha	46	80	82	80	80	SFP	SFP	SFP	SFP	SFP
Ruminants	€/LU	69	69	91	91	91	SFP	SFP	SFP	SFP	SFP
Agri-env. payment	€/ha	110	110	110	110	110	110	110	110	110	110

Source: See Table 6-2.

6.4 Results

As mentioned above, we conducted both an *ex post* and an *ex ante* analysis. In the *ex post* analysis, we examine accession's impact on structural change, farm income and input prices – especially land rents based on empirical data. To test the reliability of simulation results from AgriPoliS for the *ex ante* analysis, the simulation results are compared with *ex post* data. Based on the simulation experiments, the focus of the *ex ante* analysis is the impact of decoupling top-ups in 2009 on structural change and the redistribution of payments among individual and corporate farms and among different farm types.

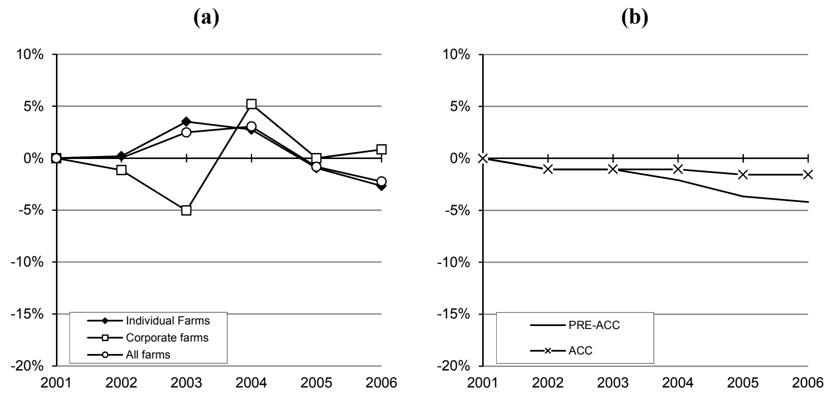
6.4.1 Ex-post analysis and comparison of model results and real data

Structural change

Here we focus on the development of the number of farms as one indicator for structural change. The differentiation of farms according to their legal type shows that the transformation process is ongoing Figure 6-1 (a). Corporate farms are undergoing a restructuring process where they split into smaller units and are converting their legal form from cooperatives into business companies (DOUCHA and DIVILA 2001). At the same time, individual farms are growing and changing their legal form. Thus, the number of corporate farms fluctuates (see Figure 6-1 (a). A similar effect can be observed for individual farms between 2002 and 2005. But here the increase in number of farms in 2003 is caused by the Czech Republic's EU accession. Many landowners who used their land without being registered as a farmer have registered themselves in order to be eligible for receiving payments. From 2004 to 2005, the number of individual farms drops almost by 4%, because the Czech government introduced the minimum tax for non-corporate enterprises – meaning that individual farms had to pay a minimum tax threshold regardless of whether they operated at a profit or loss.

The simulation results for the study region Vysočina (Figure 6-1 (b) are not differentiated by farm type, as the split of corporate farms and the change of legal type are not implemented in AgriPoliS. Thus, AgriPoliS cannot exactly represent the real developmental process. Nevertheless, the simulation results are in line with the empirical observation that the Czech Republic's EU accession slows down structural change. In the simulations, less individual farms (especially small farms) decide to quit agriculture because the payments increase from an average of 38 Euros/ha in 2003 to 148 Euros/ha in 2004, and reach 234 Euros/ha in 2007. The reason why farmers stay in agriculture or new farmers enter it is that farm incomes increase together with subsidies, which will be analysed in the following.

Figure 6-1: Relative development of number of farms in reality (a) and in simulations (b)



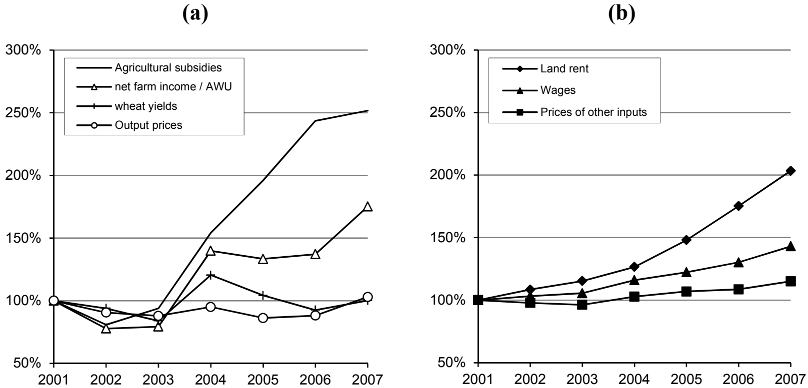
Note: Real data are for the entire Czech Republic and farms >5ha.

Source: CZECH STATISTICAL OFFICE (2008) and own calculations.

Development of farm income

Figure 6-2 (a) shows the development of wheat yields, output prices, net farm income per annual working unit (NFI/AWU) and the development of subsidies between 2001 and 2007. One can see that the development of NFI/AWU is correlated with the development of output prices and subsidies. In general, net farm income follows output prices. In 2004, 2006 and 2007 farm incomes are increasing, as are output prices, and in 2005 they are declining. However, in 2004 and 2007 the increase in farm incomes is much stronger than the increase in output prices – farm incomes follow the increase of subsidies.

Figure 6-2: (a) Development of subsidies, farm income, wheat yields and output prices relative to 2001 (b) Development of prices for land labour and other input factors relative to 2001



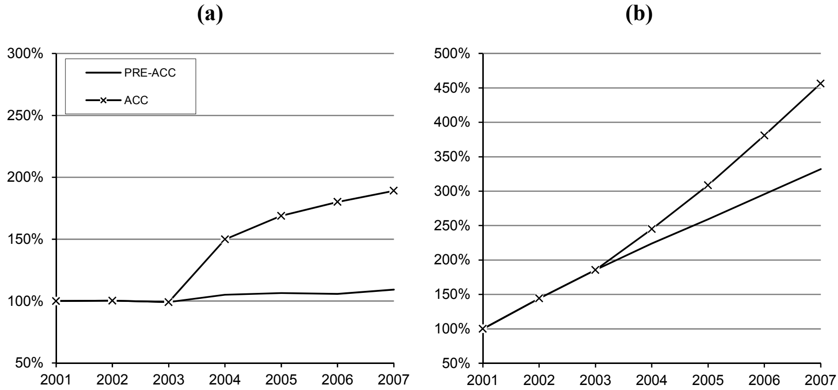
Source: Own calculations based on MINISTRY OF AGRICULTURE 2001-2007.

But not all subsidies end up in farmers' pockets, otherwise farm incomes should also increase in 2005 and 2006. So what happened to the increasing subsidies? One can see in Figure 6-2 (b) that they were partially transferred to the wages for hired labour, land and other input factors like agri-services, seeds, fertiliser, energy, plant protection, fodder, etc. Costs for these factors constantly increased. Thus, one can conclude that accession to the EU had a positive effect on farm incomes. However, this comparison shows that subsidies were rather quickly capitalised in other production factors like land and current assets. Rental prices increased by 203% from 2001 (19 Euros/ha) to 2007 (47 Euros/ha).

Similar developments can be seen in the simulation results (Figure 6-3). There, the net farm income also follows the increase of subsidies, but here the development is more or less constant as we assume constant output prices. Rental prices are increasing in the simulations as well, but much stronger than in reality because the version of AgriPoliS we used does not cover the specific conditions of land markets in CEECs[69]. Based on studies by DALE and BALDWIN (2000), LERMAN CSAKI and FEDER (2004), SWINNEN et al. (2006) and PROSTERMAN and HANSTAD (1999), CIAIAN and SWINNEN (2006) mention the following market imperfections for CEECs: the market power of large farms, co-ownership of land, unknown boundaries or unknown owners.

[69] In KELLERMANN et al. (2006) we extended AgriPoliS to consider the market imperfections mentioned by CIAIAN and SWINNEN (2006).

Figure 6-3: Development of net farm income (a) and rental prices (b) relative to 2001



Source: Own calculations.

6.4.2 Ex-ante analysis

In the *ex ante* analysis we determine how decoupling top-ups affects structural change, i.e., we analyse the decline in number of farms and how it affects the redistribution of payments among farms. Concerning the latter issue, we show the development of profits and payments of individual and corporate farms and the level of payments in different farm groups according to their specialisation. Table 6-5 shows the farm structure of the model region in 2008. One can see that corporate farms dominate production, using most of the land (76%) and keeping most of the livestock, with 1.02 livestock units (LU) per hectare. As they keep more ruminants than individual farms, their share of grassland in total utilised agricultural area (UAA) is higher, too. The differentiation of farms into production groups also shows that 58% of the corporate farms are mixed farms which keep ruminants.

Table 6-5: Structural characteristics of the model region in 2008

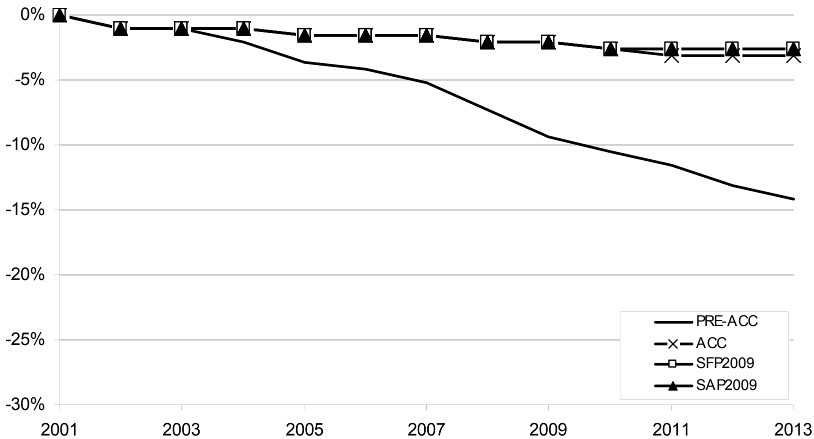
	Individual farms	Corporate farms	Total
Share of number of farms	86%	14%	100%
Share of land used by	24%	76%	100%
Pig/poultry farms	-	15%	2%
Field crop farms	77%	27%	70%
Mixed farms	23%	58%	28%
Livestock density [LU/ha]	0.34	1.02	0.86
Grassland in total UAA	14%	22%	20%

Source: Own calculations.

Structural change

In the previous section we described the development of farm structures in the Czech Republic during the transformation and accession period prior to 2007. Empirical data as well as simulation results showed that the strong increase in connection with EU-accession in 2004 slowed structural change. Figure 6-4 shows that this development continues until 2013. If the Czech Republic had not entered the EU (PRE-ACCESSION), 14% of the farms would have left agriculture in the study region Vysočina during that time. This is an annual average decline of 1.1%, whereas in ACCESSION the annual average decline is only 0.3%. Looking at the impacts of decoupling top-ups in 2009 (SAP2009 and SFP2009), one can see a tendency for the decline in number of farms to slow down, but this tendency is not as strong as in the OMS, where decoupling of payments slowed down structural change significantly (SAHRBACHER et al. 2007). It seems that this impact of decoupling, observed in the OMS, is overlaid in the Czech Republic by the strong increase in payments due to accession.

Figure 6-4: Relative change in number of farms

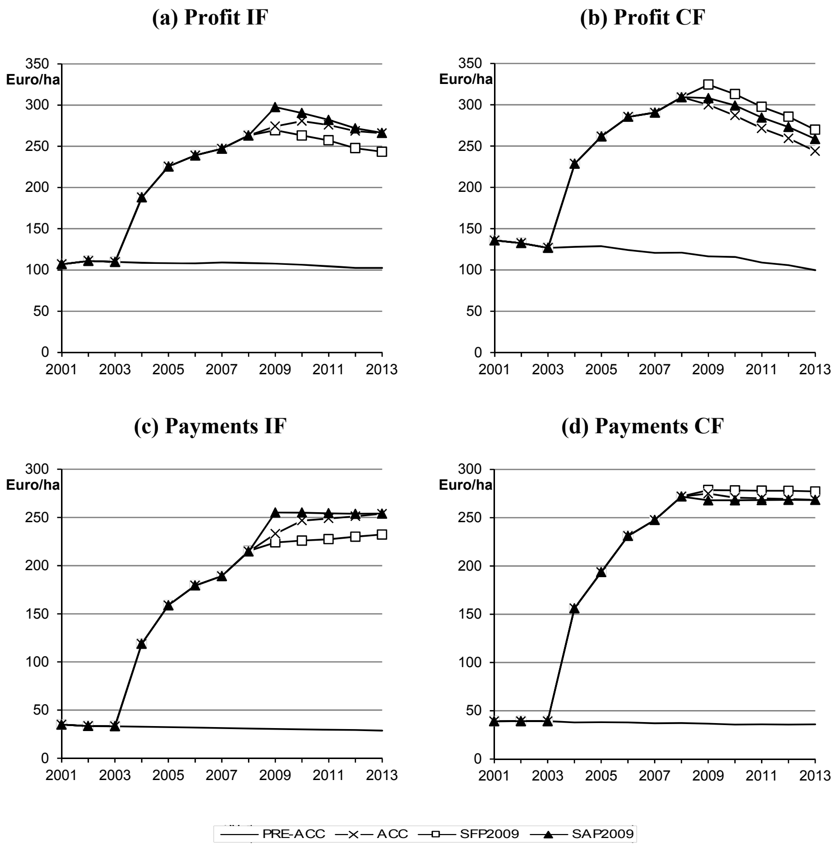


Source: Own calculations.

Redistribution of payments and income among individual and corporate farms

In Figure 6-5 (a) and (b) we illustrate, as an indicator of the income development of individual and corporate farms, the average profit per hectare. Costs for family labour are subtracted to ensure comparability between individual and corporate farms. Simulation results show that income situation in the study region tends to improve due to EU accession. For PRE-ACCESSION, the projected profit per hectare declines at a constant rate because of the decline in livestock production. The comparison of individual and corporate farms' profitability shows that corporate farms achieve a higher profit per hectare than individual farms. On the one hand, this can be explained by the fact that they realise economies of scale. The average farm size of corporate farms in AgriPoliS in 2001 is 1,055 ha, whereas the average size of individual farms is 47 ha. On the other hand, corporate farms' profit is higher because they are more specialised in the processing of crops by fattening beef cattle or keeping dairy cows. In Table 6-5 one can see that their livestock density is higher than that of individual farms. In PRE-ACCESSION, the difference in income between individual and corporate farms diminishes with the decline in livestock production on corporate farms.

Figure 6-5: Profit per ha of utilized agricultural land for individual (a) and corporate farms (b) and payments per ha of individual (c) and corporate farms (d)



Source: Own calculations.

In the accession scenarios (ACCESSION, SFP and SAP), profits are mainly increasing due to the increase in payments (Figure 6-5: c) and d)). But when payments reach their maximum level in 2009, profits start to decline. This is due to the ongoing capitalisation of payments into land rental prices. However, corporate farms' profits decline more intensively than individual farms' because the effect of capitalisation is much stronger for corporate farms. They own, on average, only 1% of the land they cultivate, whereas individual farms can keep a larger share of the payments because they owned, on average in 2001, 31% of the land which they cultivated. However, this share declines to 25% in 2013, as in AgriPoliS growing farms increase their acreage by renting additional land.

Examining the level of payments per hectare after 2009 shows different developments depending on the scenario. In SFP2009, only small changes can be observed because decoupling is based on the past production of farms. All farm payments are transferred into payment entitlements per hectare. The value of payment entitlements varies among farms depending on their historical production. Corporate farms' payment entitlements have, on average, a higher value than individual farms', because they keep more beef cattle and thus receive more top-ups prior to decoupling. The slow increase of the average payment per hectare of individual farms indicates that individual farms can gain land from corporate farms with high payment entitlements. But the gap in profits compared to corporate farms cannot be closed in that way.

In ACCESSION and SAP2009, one can see that individual farms gain payments from corporate farms due to the decoupling of top-ups for ruminants towards an area payment. This is due to the different production structure of individual and corporate farms. As Table 6-5 shows, 58% of the corporate farms are mixed farms keeping ruminants, and 77% of the individual farms are specialised in field crops. The difference between ACCESSION and SAP2009 is that in the first scenario, payments are redistributed stepwise, whereas in the latter scenario redistribution takes place in one step in 2009 Figure 6-5 c) and d)[70]).

Even if the different payment schemes implemented in ACCESSION and SAP2009 lead to the same result in 2013 – a single area payment – they have different impacts on the income development of corporate and individual farms. In both scenarios, individual farms achieve the same profit in 2013, which is not the case for corporate farms. Here the situation is specific. A number of corporate farms still have some capacities to fatten beef cattle or suckler cows. Due to the specific payment structure in ACCESSION, where top-ups are phased-out stepwise, it is more profitable at the beginning of this phasing-out to invest in beef cattle than in suckler cows. Later on, suckler cow production becomes more and more

[70] The small difference of 13 Euros/ha between the payments per hectare of corporate and individual farms results from the fact that corporate farms have more grassland and thus receive more agri-environmental payments.

competitive. For farms which had previously decided upon beef cattle, it is possible but difficult to change production. Farms are probably misled in their production decision due to the stepwise decoupling, and thus their profit is lower than in case of an abrupt decoupling as in SAP2009.

Redistribution of payments among farm types

So far we have seen the volume of payment redistribution among individual and corporate farms. As initially shown, this redistribution is caused by the different specialisation of individual and corporate farms. Now we will have a closer look at the redistribution of payments among various farm types. In AgriPoliS, farms change their farm type depending on their production. Thus, (in Table 6-6) we select only farms which survive in all three scenarios (ACCESSION, SFP2009 and SAP2009) and do not change their farm type to compare payment redistribution among farms types.

Table 6-6 shows that the variation of payments per hectare among farms due to top-ups is 53 Euros in 2008. In 2009, top-ups are decoupled from production in SAP2009 towards a single area payment and in SFP2009 towards a farm-specific payment where the per hectare payment is different depending on the production of a farm before decoupling. In ACCESSION, top-ups are stepwise reduced due to the phasing in of SAPS payments, which means they are stepwise decoupled till 2013. With decoupling, the obligation to produce a specific product to receive a specific payment falls and payments are granted even for a minimum use of land, meaning that land has to be kept in GAEC. Thus, the obligation to receive payments is the same for all farms independent of their former specialisation. One can argue that all farms should receive the same payment per hectare, which is the case in SAP2009. However, in SFP2009 this does not happen and in ACCESSION it happens stepwise till 2013. Table 6-6 shows that in ACCESSION, the variation of payments per hectare between different farm types declines to zero by 2013. In SFP2009, the variation of payments per hectare between farmers declines as well, but not to zero. In 2009, this figure is 50 Euros/ha and in 2013 just 39 Euros. This redistribution in SFP2009 does not result from policy change, but rather from structural change within the region. Land with high payment entitlements is moving from mixed farms to field crop and pig and poultry farms.

Comparing the two decoupling options SFP2009 and SAP2009 in 2013, one can say that in the case of SAP2009 with an area payment of 244 Euros/ha, pig and poultry farms would gain 28 Euros/ha and field crop farms 16 Euros/ha, whereas mixed farms would lose 11 Euros/ha. However, in SAP2009 this redistribution of payments happens abruptly and farms' can probably not react as fast to this change. Thus, the "stepwise decoupling" through continuing ACCESSION seems to be a reasonable option because farms have more time to adapt to decoupling top-ups if the preferred policy is a single area payment. This would be similar to the hybrid dynamic decoupling policy implemented in the UK and Germany, where the idea was to give farms some time to adjust to future area payment.

Table 6-6: Payments per hectare by various farm types and different policies (in Euros/ha)

Farm type	Scenario	2008	2009	2013
ACCESSION	Pig/poultry	198	222	244
	Field crop	214	230	244
	Mixed	251	251	244
	Variation	**53**	**29**	**0**
SFP	Pig/poultry	198	208	216
	Field crop	214	222	228
	Mixed	251	258	255
	Variation	**53**	**50**	**39**
Average		237	244	244

Source: Own calculations.

6.5 Conclusions

The goal of this paper was to show the impacts of EU accession on structural change and income development in agriculture in an *ex post* analysis in the Czech Republic. Furthermore, an *ex ante* analysis with the agent-based model AgriPoliS has been conducted to determine how the upcoming decoupling of top-up payments affects structural change, farm income and the allocation of payments. In this analysis, the decoupling of top-ups is assumed to take place in 2009. Even though decoupling of top-ups has been postponed until 2013 by the European Commission, this analysis can provide insight into future changes.

The *ex post* analysis shows that the development in number of farms in the NMS is still influenced by the transformation process. Nevertheless, empirical data show an increase in number of farms due to the Czech Republic's accession to the EU. This supports the assumption that strongly increasing subsidies slow down structural change and verifies the simulation results, which also show a slower structural change. Another issue that can be observed in reality and in the simulations is the capitalisation of payments into rental prices and prices of other production factors.

Concerning income development, model results are confirmed by the empirical findings. Both analyses show that accession leads to a strong increase in agricultural incomes. One can assume that the results of the *ex ante* analysis are reliable and impacts of further decoupling might be estimated in the proper way, even if the model results are based on only one region and the development of the payments might differ in reality. Based on the ex ante analysis, we can conclude that in contrast to the OMS, decoupling does not strongly affect structural change in the NMS because it is overlaid by accession effects. In NMS, the strong increase in payments and the relatively low share of coupled top-ups buffers possible changes in the development of the number of farms. However, farm incomes might decline if land mobility and thereby the capitalisation of payments into rental prices increases.

As the total level of payments in the NMS will not change due to decoupling, the more interesting question is how the allocation of payments among farmers will change depending on the manner of decoupling. Simulations show that the continuation of the accession policy (ACCESSION) will in every case lead to a decoupled policy in 2013, which does not differ from decoupling to an SAP in 2009. In the case of farm-specific decoupling (SFP2009), payments are unequally distributed among farmers depending on their production before decoupling. Some farmers would receive more payments by fulfilling the same requirements (keeping land in GAEC) than would other farmers. Thus, a single area payment seems reasonable because all farmers have to fulfil the same requirements to receive the payments, and in future it will become increasingly difficult to explain the difference in payments per hectare in the case of farm-specific decoupling.

7 DISCUSSION AND CONCLUSION

The impacts of the MTR on production have been analysed by several studies with various methods and models (EUROPEAN COMMISSION 2003a, FRANDSEN et al. 2003, BINFIELD et al. 2004, GOHIN 2006 and KÜPKER et al. 2006). The goal of this study was to complement the existing studies by analysing the impact of the MTR on farm incomes and income distribution, the farm exit rate and farm growth, as well as the associated interactions among farms on the land market. Moreover, the agent-based model AgriPoliS has been extended by adapting it to six agricultural regions in the OMS and one region in the NMS.[71] This will provide the basis for analysing future policy scenarios in further studies. The analysis of the MTR additionally served as a validation of the model and provides an indication of whether results for a specific region can be generalised or not.

7.1 Methodological findings and conclusions

Agent-based modelling was first used within agricultural economics by BALMANN (1995, 1997). The advantage of agent-based modelling is the bottom-up approach. General and partial equilibrium models (GTAP, ESIM, CAPRI[72]), as well as farm group models (FARMIS, CAPRI) represent very well the whole agricultural sector in terms of production and/or price effects. But they cannot avoid aggregation errors. Agent-based modelling solves this issue because farms are modelled explicitly and farm activities are based on the farm's financial capacities, managerial abilities and location. The farms' scope for decision-making in AgriPoliS comprises, aside from the planning of production, investments into new production activities, renting land or offering land on the land rental market, as well as finishing production and exiting from agriculture. Compared to the abovementioned farm group models, this affects the farms' flexibility and opportunities to react to policy changes. Furthermore, this approach allows a detailed analysis of structural change.

In the current work, the application of AgriPoliS to several case studies showed that the quality of the regional representation strongly depends on the availability of data. There are three types of data necessary: i) regional data about the agricultural structure of a study region; ii) a pool of farms with complementary

[71] The regions are: Brittany (France), South East England, Hohenlohe (Southwest Germany), Central Saxonian Loess Region (East Germany), Jönköping and Västerbotten (Sweden), and Vysočina (Czech Republic).

[72] CAPRI consists of two parts. On the one hand, the supply of agricultural products of in EU- countries is determined by a programming model, and on the other hand, the supply of Non-EU-countries and the demand is determined with a partial equilibrium model.

farm-level structural data which characterise regional agricultural structure; and iii) economic data about the farms, their production activities and investments. The first two types of data are necessary to represent the structure of a region. The economic data is needed to represent the farms' production. The regional data used here is in some regions from different sources, which led to inconsistencies in the data. These inconsistencies have been eliminated based on own assumptions before the representation of the respective region. To avoid such adjustments it is preferable to use IACS data, or if national Statistical Offices agree, to carry out special calculations. In both cases it is possible to recalculate the data of each regional characteristic (e.g. total UAA, number of livestock, number of farms by legal form) if some farm groups like horticulture, vine or permanent crop farms don't have to be considered. However, this procedure was only possible for representing the Central Saxonian Loess Region.

IACS data is also a good source for deriving a pool of farms which can be used for the representation of a region. Another source is FADN data. Both the regional data and the farm data were put into a matrix to select and weight farms such that the structure of an agricultural region can be represented as best as possible. In the applied optimisation problem, the quadratic deviation between the sum of weighted farm characteristics and the respective regional characteristics were minimised. The accuracy of the regional representation obtained through this method was satisfying. In some regions larger deviations between some upscaled characteristics and the respective real characteristics occurred, but these deviations are caused by the lack of data and not by the method applied.

The representation of selected farms' production also caused some problems. *First*, IACS data do not include the relevant financial and economic data necessary to represent the production. This was solved by using data from FADN accountancy results about specific farm groups. Data of farm groups with similar characteristics (farm size, specialisation, legal form) have been assigned to the selected farms. A *second* problem was the availability of economic data about production activities in Czech Republic. These data were derived from FADN data by regional experts. Afterwards, the data were calibrated as all production data of all regions were, in collaboration with regional experts. The goal of the calibration was to represent production in the base year as best as possible.

Thereafter, initial simulations of the continuation of the Agenda 2000 (AGENDA) were carried out and it was determined whether the results were in line with past developments. The AGENDA scenario is the reference point for the comparison of different decoupling scenarios. *First*, a pure Single Farm Payment (SFP) as initially suggested by the European Commission has been modelled for all regions. *Second*, in the REFORM scenario the decoupling model chosen by each member state within the MTR has been modelled. *Third*, a kind of bond scheme (BOND) has been modelled. All simulations start in 2001 with the Agenda policy. In 2005 the policy change takes place and the simulations end in 2013.

The explicit modelling of the hybrid dynamic decoupling scheme applied in Germany and England is one of several improvements to AgriPoliS undertaken in this thesis. A *second* improvement of AgriPoliS is that the income of farm households that left agriculture can now be simulated and analysed. This improvement has shown that the myopic behaviour of the farms in the simulations misleads some of them to stay in agriculture in the REFORM scenario. If they were to leave agriculture as they had done in the AGENDA scenario, they would prosper more. Such behaviour might explain the persistent and very large functional income disparities in West German agriculture.

Third, the expectation formation about the rental price development in the case of decoupling direct payments has been improved. Depending on the decoupling policy, rental prices can be expected to change.[73] For example, grassland rental prices increase due to the redistribution of payments from beef cattle or arable land to grassland; or rental prices decrease in the case of decoupling payments from land use (BOND). As changes in rental prices affect the farms' opportunity costs, such changes have to be considered in their expectation formation because they might influence their exit decision. In previous studies farmers' expectations about rental prices after decoupling direct payments were adjusted by a factor that has been calculated in test simulations conducted by HAPPE (2004) for the Hohenlohe region. As the impacts of decoupling on rental prices vary among the various study regions, AgriPoliS has been improved in a way that this factor is now calculated endogenously by simulating the period of the policy change twice. The first simulation is used for calculating the factor to change the price expectation for rental prices. In the second simulation of the same period, this information is given to the farmers for their decision to stay or exit agriculture.

7.2 Policy related findings and conclusions

The goal of the policy analysis was to identify the impacts of the MTR on farm structures, farm income and the land rental market. Therefore, the following indicators have been compared for six study regions in the OMS: farm exit rate and average farm size, livestock density, profit per hectare and rental prices for arable and grassland. This analysis answered the questions of whether the MTR reduces the farm exit rate and whether the impacts of the MTR are region-specific. The results will now be discussed based on the theoretical considerations presented in section 2 and on results of other studies. First, structural indicators

[73] C.f. ISERMEYER (2003), KILIAN and SALHOFER (2008), COURLEUX et al. (2008), CIAIAN et al. (2008) and KILIAN et al. (2008).

such as the farm exit rate and changes in the production structure are discussed, followed by economic indicators such as rental prices and farm incomes.

The assumption that the farm exit rate declines with the MTR has been confirmed by the simulations. Farmers have more freedom in their production decision and reduce non-profitable farm activities or become part-time farms. SWINNEN et al. (2008) found some empirical evidence for this development. The MTR reduced farm exit rate in Belgium, Finland, Sweden and UK. Furthermore, these authors cannot identify a significant difference in the impact on farm exit between the hybrid and the historical model. That the farm exit rate is also reduced in the historical model is contradictory to HENNING'S (2003) first assumption, that the historical model would increase the farm exit rate, because it allows inefficient farms to sell their payment entitlements to efficient farms and then use this money as compensation for leaving agriculture.[74] In the hybrid model this option is not given, because payments are capitalised into rental prices, and thus the prices for payment entitlements are too low to sell, leading farms to leave agriculture. SWINNEN et al. (2008) explain the reduction of the farm exit rate in the historical model in a way similar to HENNING (2003), by imperfections on the market for payment entitlements.[75] That is, there might be a regional surplus of payment entitlements, which leads to a capitalisation of the payments into rental prices. Another reason for the capitalisation of payments in the historical model is that agricultural land for the activation of payment entitlements becomes scarce because of the loss of land for settlements (ISERMEYER 2003).

In livestock production, the number of dairy cows and beef cattle strongly decline in the historical and in the hybrid models in AgriPoliS. This is in line with expectations for decoupling cattle payments. However, compared to other models (EUROPEAN COMMISSION 2004, FRANDSEN et al. 2003, KÜPKER et al. 2006 and BALKHAUSEN et al. 2008), the decline in cattle keeping might be a bit too strong in our simulations. With the decline in cattle, keeping less arable land is necessary

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[74] In the historical model payment entitlements are normally scarce, because not all land is eligible for payments. Thus, prices for payment entitlements are high and rental prices for land will be low. In the regional and in the hybrid models, the number of payment entitlements are higher than the area., meaning that farmers are willing to pay higher rental prices for land to activate their entitlements, and payments become capitalized into rental prices.

[75] Imperfections in the entitlement market are also caused by EU regulations and national governments. Tassos Haniotis, Director of Economic Analysis, Perspectives and Evaluations at the Directorate-General for Agriculture and Rural Development of the European Commission, mentioned during his presentation, "The CAP reform process in perspective: issues of the post-2013 debate", at IAMO Forum 2010, that for the European Commission, it was an explicit goal for the MTR and the decoupling strategy to avoid a devaluation of land prices. The main reason behind this was to avoid a devaluation of the farms' equity capital and thus ensure the farms' financial stability. Keeping rental prices stable was also an argument made by the German government when they decided for the hybrid model (HENNING et al. 2004, p. 41).

for forage maize, and thus the production of crops such as wheat and barley is slightly extended in AgriPoliS.

Rental prices in AgriPoliS increase independently of the chosen decoupling option (historical or hybrid), as we assume a surplus of payment entitlements for both decoupling options in the long-term because agricultural land will be used for settlements. The analysis of empirical data by SWINNEN et al. (2008) supports this finding for countries that implemented the hybrid model, but they show a stagnation of rental prices in countries with the historical model. However, a stagnation of rental prices in the countries applying the historical model does not mean that payments are not capitalised into rental prices. Prior to the MTR, coupled direct payments were already capitalised into rental prices (KILIAN et al. 2008). If capitalisation is stopped in the historical model, rental prices should rather decline, as BERTELSMEIER (2005) and HENNING et al. (2004) assume in their analysis. SWINNEN et al. (2008) also argue that the capitalisation of payments in land values with the historical model is more difficult to identify than with the hybrid model. In the latter, payments are redistributed between farmers and regions. SWINNEN et al. (2008) also mention that the impact of the MTR on rental prices is the most visible in marginal, less fertile lands where other drivers of rental prices are less important. In the historical model, payments are not redistributed and thus it is more difficult to identify capitalisation.

Looking at farm incomes, AgriPoliS, as well as the EUROPEAN COMMISSION (2003a), predict an increase with the continuation of the Agenda 2000 policy. For the historical model, AgriPoliS predicts a stronger income increase compared to the continuation of the Agenda 2000 (AGENDA). This is still in line with the results of other models (BERTELSMEIER 2005, EUROPEAN COMMISSION 2003a and HENNING et al. 2004). However, AgriPoliS also predicts a stronger income increase for the hybrid model, whereas BERTELSMEIER (2005) and HENNING et al. (2004) predict even a decrease in farm incomes compared to the AGENDA scenario.[76] To explain these differences, one has to go more into detail. BERTELSMEIER (2005) and HENNING et al. (2004) assume in their models that in the case of the historical model, payments will not be capitalised into land rents. Thus, land rents decline and farm incomes go up because of lower costs for rented land. For the regional model, these authors assume that rental prices become more capitalised into land rents than in the AGENDA scenario. The increasing costs for renting land negatively affect the farm income. The assumption that payments become capitalised into land rents holds in AgriPoliS for both the historical and the regional models. [77] However, farms can increase

[76] The EUROPEAN COMMISSION study (2003a) does not analyse the impact of the hybrid dynamic model.

[77] Indeed, we do not present results for the regional model, but the impacts of the regional model on rental prices are comparable to the hybrid model that was analysed in this study.

their profits in AgriPoliS despite the higher land costs. The single farms modelled in AgriPoliS are more flexible than the farm groups in FARMIS or the model utilised by HENNING et al. (2004). Thus they can, like farms in reality, better adjust to policy changes. In AgriPoliS these adjustments result in a higher total gross margin on one hand, and in lower costs for maintenance, depreciation, interests, wages, etc., on the other. These cost reductions and the higher total gross margin overcompensate for the increase in rental prices in AgriPoliS (c.f. appendix A.10). The stronger increase in the total gross margin compared to FARMIS can be explained through the slight increase of wheat and barley production in the decoupling scenarios in AgriPoliS. Additionally, the reduction of the total gross margin due to the decline in cattle has at least been compensated in Hohenlohe and Brittany by an increase in breeding sows and fattening pigs.

The comparison of six OMS regions showed that the impacts of the MTR in one region can only partially be generalised. Some results, such as the reduction of the farm exit rate and the increase in farm income, are generalisable in that they have the same direction but not always the same strength. On the other hand, the AgriPoliS simulations showed that the impacts of the MTR on rental prices are region-specific. In the studied beef and milk production regions of Brittany, Hohenlohe, Jönköping and Västerbotten, rental prices for arable land are higher in the case of the MTR than in the Agenda 2000 because cattle payments have been redistributed from cattle to arable land due to the MTR. Drawing a conclusion from this result, one may propose adjustments of the MTR to avoid these regional-specific impacts. But the different development of the rental prices does not influence farm incomes enough to justify an adjustment. Furthermore, the differences in payment level between different regions within the EU Member States, and between them, are more important than the inequalities arising from the regional-specific impact of the MTR on rental prices. For example, in marginal regions and in the New Member States, payments per hectare are lower, because within the MacSharry reform and the Agenda 2000, payments have been a compensation for income losses due to the reduction of market support. Thus, they have been determined by the yields achieved in a region or country, as well as by the prevailing type of production. These regional differences will be reduced in Member States which implement the hybrid or the hybrid dynamic models by 2013. However, the differences between the EU Member States may continue if no further fundamental reforms are adopted. Since the MTR direct payments are no longer seen as compensation for reductions in market support, but rather as compensation for fulfilling Cross Compliance, it would be consequent to adjust their level between the EU Member States and to reduce them to the real costs of Cross Compliance. Such a reduction would further reduce inequality between

One also has to consider that we modelled a hybrid dynamic model for South East England and the German regions, i.e. they end in a regional payment.

farms because only farms with their own land fully benefit from direct payments, and farms with rented land pass on a certain share of the direct payments to the land owners.

The analysis of the Bond scheme as an alternative to the historical and regional models has revealed European agriculture's enormous structural deficits. In the BOND scenario, payments are also decoupled from land input, i.e. farmers can exit agriculture and still receive the payments. Thus, many small farms decide to exit agriculture in the simulations, and the average farm size increases. However, this increase in farm size is not so strong that super-large farms are created. For example, in Hohenlohe and Brittany the surviving farms in the BOND scenario gain, on average, only around 10 ha compared to the REFORM scenario, and reach an average size of around 60 ha, which is far beyond the average farm size of Saxony in the BOND scenario (941 ha). There, the surviving farms grow by 450 ha. If, in reality, the market for payment entitlements would be perfect in regions with the historical model, entitlements would be scarce compared to land. Further, if the commitment problem described by HENNING (2003) did not exist, then a similar development to the BOND scenario could be observed. Inefficient farms would sell their payment entitlements and exit agriculture (HENNING 2003). Thus, the results of the BOND scenario show the impacts that have been theoretically discussed for the historical model. Rental prices also significantly decline in the BOND scenario as predicted by BERTELSMEIER (2005). However, in reality this has thus far not been observed in regions with the historical model. From another perspective, the results of the BOND scenario can provide insights for a possible future bisection of direct payments. The results show that a high share of farms will quit agriculture. This offers the remaining farms the opportunity to become more competitive by realising economies of scale. However, the effects are limited in regions with small farm structures such as Hohenlohe or Brittany. There, farm size increases are not as strong in absolute figures. Thus, environmental impacts are also not as strong. Despite a strong increase in farm sizes, environmental impacts are also not as strong in regions with large farm structures like Saxony because there, small farms utilise only a small share of the agricultural land.

The in-depth analyses of the German region Hohenlohe and of Vysočina in Czech Republic reveal the potential of AgriPoliS to provide simulated accountancy data for each model farm. Thereby, the development of each farm can be analysed. In the study on Hohenlohe, the development of farm households exiting agriculture has also been calculated. The comparison of each farm household's income between the Agenda 2000 and the hybrid decoupling model implemented in Germany show that some farms are misled by the MTR. For example, there are some farms which stay in the sector in the hybrid model, but which leave in the Agenda 2000. Comparing the results showed that exiting agri-culture is the more profitable option for these farms.

For the Vysočina region, farm-level simulation data has been analysed according to the legal form and farm type regarding the redistribution of payments and incomes among these groups of farms depending on the decoupling option. The comparison of farm incomes between individual and corporate farms showed that corporate farms are more affected by rental price increases than individual farms because of their higher share of rented land. However, an important result of this in-depth analysis was that in the NMS, the impacts of accession on farm incomes, the farm exit rate, and rental prices are stronger than the impact of decoupling the granted top-ups for cattle in 2009. Comparing the AgriPoliS results for the accession scenario with empirical data confirmed this result. The phasing-in of payments within accession leads to an increase of farm incomes. However, farm incomes do not increase with the same speed as do the subsidies because input prices, in particular rental prices, also increase. For the upcoming decoupling in the New Member States, the results suggest that the New Member States should use the option, provided by the European Commission within the Health Check, of postponing the decoupling of top ups till 2013. Simulation of this scenario showed that this would automatically lead to a regional payment in 2013, because top ups have to be reduced stepwise due to the phasing-in of the SAPS payments. The introduction of the historical model has the disadvantage that some farmers would receive more payments by fulfilling the same requirements (keeping land in GAEC) than other farmers. In future it will become increasingly difficult to explain the difference in payments per hectare. On the other hand, the "stepwise" introduction of a regional payment has the advantage that farmers have more time to adapt to the new situation.

7.3 Further research

The adaptation of AgriPoliS to several study regions has facilitated a more comprehensive analysis of structural change in agriculture than prior to this study. However, it has to be stressed that the representation of a region in AgriPoliS cannot be used indefinitely because the economic framework changes over time, and gross margins and technical coefficients of production activities, as well as the representation of the real farm structure, have to be updated after a few years. Such adaptations result in a time-consuming recalibration of the regional representation. Thus, the automation and simplification of the calibration process would be very useful and time-saving. On the other hand, new empirical data about the regional structures offer the possibility of validating the simulation results based on this data.

Further tasks also arise from the model development. For example, for the evaluation of profit development it would be useful to calculate the total gross margin of different strands of production (plant, livestock production) or even of production activities (dairy, fattening pigs, etc.). This would help to reveal the impact of the farm's investment and disinvestment behaviour on farm profits. Simultaneously, the transparency of the results would be improved. Furthermore, analysing the development of single farms, i.e. analysing their investment behaviour and how they change their specialisation, would help to trace their behaviour. Such an analysis goes in the direction of the subproject, "Between path dependence and path creation – The impact of farmers' behavior and policies on structural change in agriculture", from the DFG Research Unit "Structural change in agriculture". In this subproject, experiments will be undertaken where a real person replaces one computer farm agent in AgriPoliS and competes with the other computer agents. In these experiments, the behaviour of the real persons should be identified. Based on these observations, the behavioural rules of the computer agents will be changed or extended.

With respect to improving the agent's behavioural rules, the results of HÜTTEL and MARGARIAN (2009) could be a starting point. These authors formulated several hypotheses about strategic behaviour of farms on the land market depending on the structure of a region. By applying an empirical model they confirmed the following hypotheses. *First*, farms react with lower demand towards anticipated rising demand of others, because a higher demand raises land prices. If land is equally distributed among farms, symmetric expectations can be assumed and the outcome would be a Cournot equilibrium. Thus, farms grow more slowly in regions where land is equally distributed. *Second*, farm growth is slower in regions characterised by a capital-intensive production because sunk costs and high capital intensities raise the rents of the status quo. *Third*, in regions where farms are heterogeneous, a Stackelberg equilibrium arises where one farm follows the strategy of quantity leadership and the followers assume an inelastic reaction of the quantity leader. Thus, they reduce their demand stronger than in the case of a Cournot equilibrium. Then, the large farms can grow faster and the smaller farms grow even less.

Another interesting aspect is the variation of managerial ability. So far the managerial ability varies among farmers randomly within a specific range. This means that a farmer can handle one production activity as good or as bad as any other activity. But it can be assumed that in reality, farmers have preferences for specific production activities or at least their skills and knowledge varies among different production activities. If this would be considered in AgriPoliS, the aggregated adjustment reactions would be less strong. For example, a farmer who is very good at milk production would be able to continue keeping dairy cows even if the economic or political conditions worsen. However, such a change is connected with two problems. *First*, data for such a specification of the managerial ability should be available. *Second*, the interpretation of the results may be more difficult. Basically, which additional variables should be implemented into the model should be well thought out. Considering only variables with a strong impact on the results may allow the model to be kept simple. However, there could also be interrelations between different variables which cause a stronger impact than one would expect from the sum of impacts of the individual variables. If additional variables like the variation of the managerial ability according to production activities should be implemented, then additional studies have to be used or data have to be collected. An example is the survey of farmer's age and the existence of a successor and their willingness to take over the farm conducted within the EU-funded project SCARLED (Structural change in agriculture and rural livelihoods).

A further issue is the analysis of the impact of the Bond scheme, or of an abrupt stop in subsidising agriculture on structural change. Both scenarios would cause similar effects, thus the findings about the impacts of the BOND scenario in this study already provide some insights on the possible future abrupt stoppage of subsidising agriculture. For example, the simulation results for the BOND scenario and considerations about the impact of a Bond scheme on rental prices (section 4.4.2 and 7.2) show that these prices would significantly decline. However, in AgriPoliS it is not considered that land values, which are part of the farms' equity capital, can also be expected to decline. Such a development could affect farmers' investment behaviour because land is an important collateral for credits. However, in recent years factors other than subsidies also had a significant impact on land values. For example, SWINNEN et al. (2008) provide a list of drivers of sales and rental prices of agricultural land. These authors identified agricultural commodity prices as one main driving factor for the price development of agricultural land. This means that price reductions of agricultural land caused by payment reductions could be, to some extent, compensated by an increase of commodity prices. This again has to be considered if one wants to analyse the problem that collaterals for credits will be reduced in the case of a payment reduction. Other important drivers of land values are urban pressure, infrastructural expansion and farm size (SWINNEN et al. 2008). Analysing the impacts of these drivers with AgriPoliS would open a new and interesting field of research.

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APPENDIX

A.1 AgriPoliS data output

Table A-1: Data output at the farm and sector level (selection of key data)

Farm level	Unit
Structure	
Farm size	ha
Economic size	ESU
Farm type	
Main income source	Professional/ non-prof.
Production	
Output in quantities	ha, LU
Output in value	€
Costs	
Overheads	€
Maintenance	€
Depreciation*	€
Wages paid*	€
Rent paid*	€
Interest paid*	€
Annualised average costs of fixed capital	€
Variable costs	€/unit
Subsidies	
Direct payments*	€
Land	
Economic land rent	€/ha
Rent paid per soil type*	€/ha
Owned land*	ha
Rented land per soil type*	ha
Balance sheet	
Total assets	€
Total fixed assets	€
Total land assets*	€
Liquidity*	€
Borrowed capital*	€
Short-term borrowed capital	€

Sector level	Unit
Production	
Region totals	ha, head
Inputs	
Total land input	ha
Total capital input	€
Total labour	h
Investment	
Investment expenditure	€
Sector totals of farm level data	various units

Farm level	Unit
Financial situation	
Profit*	
Equity capital*	€
Change in equity	€
Net investments	€
Income and labour	€
Labour input*	h
Family labour*	h
Farm net value added*	€
Total household income*	€
Off-farm income*	€

Note: * Farm level data also aggregated on sector level.

Source: Based on HAPPE (2004).

A.2 Farms selected to represent the study regions

Table A-2: Selected farms in Västerbotten, Sweden

Legal form	Farm No.	Farm type[a]	Weight	Total UAA	Arable land	Grassland	Beef cattle	Dairy cows	Suckler cows
Individual farms	**1**	FC	122	35	35	-	< 10	-	-
	2	FC	44	126	126	-	-	-	-
	3	FC	527	18	18	-	-	-	-
	4	D	181	78	78	-	10 - 24	25 - 49	-
	5	D	13	189	189	-	-	75 - 150	-
	6	D	97	54	54	-	-	25 - 49	-
	7	D	50	207	206	1	25 - 49	50 - 74	-
	8	D	120	57	47	10	< 10	10 - 24	-
	9	D	248	29	24	5	< 10	10 - 24	-
	10	GL	20	130	130	-	-	-	50 - 74
	11	M	47	35	35	-	10 - 24	< 10	-

Notes: [a] FC: Field crop farms; D: Dairy farms; GL: Grazing livestock farms; M: Mixed farms.

Source: Derived of FADN-data by regional partners.

Table A-3: Selected farms in South East England, UK

Legal form	Farm No.	Farm type[a)]	Weight	Total UAA	Arable land	Grassland	Suckler cows	Beef cattle	Dairy cows	Sheep
Individual farms	**1**	FC	460	28	20	8	-	-	-	-
	2	FC	609	348	338	10	-	-	-	< 50
	3	D	148	60	10	50	-	-	< 100	-
	4	D	59	230	113	117	-	-	> 200	-
	5	D	91	275	230	45	-	-	100 - 200	< 50
	8	GL	353	18	10	8	-	-	-	< 50
	6	GL	322	103	-	103	< 25	25 - 50	-	200 - 500
	7	GL	170	110	50	60	-	100 - 150	-	-
	9	M	343	110	15	95	25 - 50	< 25	-	100 - 200
	10	M	7	158	43	115	25 - 50	< 25	-	> 1,000
	11	M	199	225	-	225	> 50	< 25	-	500 – 1,000
	12	M	52	900	683	217	-	-	100 - 200	> 1,000

Notes: [a)] FC: Field crop farms; D: Dairy farms; GL: Grazing livestock farms; M: Mixed farms.

Source: Derived of FADN-data by regional partners.

Table A-4: Selected farms in the Saxonian Loess Region, Germany – Part 1

Legal form	Farm No.	Farm type[a]	Weight	Total UAA	Arable land	Grass-land	Beef cattle[1]	Dairy cows	Suckler cows	Sows[2]	Fattened pigs[3]
Individual farms	**1**	FC	14	80	60	20	-	-	< 25	< 100	-
	2	FC	264	90	90	-	-	-	-	-	-
	3	FC	46	110	110	-	-	-	-	< 100	< 50
	4	FC	77	185	180	5	< 25	-	-	-	-
	5	FC	164	270	270	-	-	-	-	-	-
Legal entities	**6**	FC	20	90	70	20	-	-	-	-	-
	7	FC	72	560	560	-	-	-	-	-	-
	8	FC	8	885	805	80	25 - 50	-	100 - 200	200 - 500	500 - 1,000
	9	FC	47	1,195	1,195	-	-	-	-	-	-
	10	D	88	145	110	35	-	< 50	-	-	-
	11	D	10	1,460	1,060	400	-	500 - 1,000	-	-	1,000 - 2,500
	12	P	7	45	45	-	-	-	-	-	-
	13	P	14	135	135	-	-	-	-	210 - 220	< 50
	14	GL	44	150	90	60	25 - 50	50 - 150	-	-	-
	15	GL	21	925	780	145	-	-	-	-	50 - 200

Notes: [a] FC: Field crop farms; D: Dairy farms; P: Pig and poultry farms; GL: Grazing livestock farms.
[1] Beef cattle older than one year.
[2] Sows after the first mating.
[3] Fattened pigs with more than 50 kg.
Because of confidentiality only herd size groups are showed.

Source: Derived of FADN-data by regional partners.

Table A-4: Selected farms in the Saxonian Loess Region, Germany – Part 2

Legal form	Farm No.	Farm type[a]	Weight	Total UAA	Arable land	Grass-land	Beef cattle[1]	Dairy cows	Suckler cows	Sows[2]	Fattened pigs[3]
Legal entities	**16**	FC	11	465	395	70	-	-	-	-	-
	17	FC	8	4,690	3,790	900	250 - 500	1,000 - 2,000	-	100 - 200	500 – 1,000
	18	D	10	2,415	1,965	450	-	1,000 - 2,000	< 25	-	-
	19	D	5	3,260	2,725	535	-	1,000 - 2,000	-	-	200 - 500
	20	D	8	3,400	2,700	700	-	1,000 - 2,000	-	-	< 2,500
	21	M	4	820	725	95	-	150 - 250	-	500 - 1,000	-
	22	M	6	1,840	1,620	220	-	250 - 500	-	1,000 - 3,000	-
	23	M	12	1,040	820	220	-	250 - 500	-	-	-
Part time farms	**24**	FC	466	35	25	10	< 25	-	< 25	-	-
	25	GL	187	15	5	10	-	-	< 25	-	-
Partnerships	**26**	FC	53	380	315	65	-	50 - 150	-	-	-
	27	FC	26	1,430	1,220	210	-	250 - 500	-	-	-
	28	D	24	495	370	125	-	150 - 250	-	-	-
	29	D	4	895	645	250	-	250 - 500	-	-	-
	30	GL	115	20	10	10	-	-	< 25	-	-

Notes: [a] FC: Field crop farms; D: Dairy farms; GL: Grazing livestock farms; M: Mixed farms.
[1] Beef cattle older than one year.
[2] Sows after the first mating.
[3] Fattened pigs with more than 50 kg.

Source: Derived of FADN-data by regional partners.

Table A-5: Selected farms in Hohenlohe, Germany

Legal form	Farm No.	Farm type[a)]	Weight	Total UAA	Arable land	Grass-land	Dairy cows	Sows	Fattened pigs	Turkeys
Full time farms	**1**	D	140	30	13	17	20 - 29	-	-	-
	2	D	111	33	10	23	40 - 59	-	-	-
	3	D	101	38	10	28	30 - 39	-	-	-
	4	D	41	90	57	33	> 60	-	-	-
	5	P	94	15	15	-	-	50 - 99	-	-
	6	P	178	20	20	-	-	30 - 49	-	-
	7	P	67	33	33	-	-	100 - 200	-	-
	8	P	13	35	35	-	-	50 - 99	-	-
	9	P	42	35	35	-	-	100 - 200	100 - 199	-
	10	P	83	50	50	-	-	100 - 200	200 - 399	~ 5,500
	11	P	49	55	55	-	-	100 - 200	> 600	-
	12	P	72	55	55	-	-	100 - 200	< 100	-
	13	GL	122	15	10	5	< 20	-	-	-
	14	FC	20	30	30	-	-	-	100 - 199	-
	15	FC	52	78	78	-	-	50 - 99	-	-
	16	P	110	20	20	-	-	100 - 200	-	-
	17	GL	63	30	22	8	< 20	< 30	-	-
	18	M	109	43	28	15	-	50 - 99	< 100	-
	19	M	140	50	50	-	-	70 - 75	-	-
Part time farms	**20**	FC	449	10	10	-	-	-	-	-
	21	FC	52	78	78	-	-	50 - 99	-	-
	22	P	183	18	18	-	-	< 30	< 100	-
	23	P	59	25	25	-	-	-	400 - 599	< 100
	24	GL	295	15	10	5	-	-	-	-

Notes: [a)] FC: Field crop farms; P: Pig and poultry farms; GL: Grazing livestock farms; M: Mixed farms.

Source: Derived of FADN-data by regional partners.

Table A-6: Selected farms in Brittany, France – Part 1

Legal form	Farm No.	Farm type[a)]	Weight	Total UAA	Arable land	Grass-land	Beef cattle[1)]	Dairy cows	Suckler cows	Sows[2)]	Fattened pigs[3)]	Hens	Chicken male
Individual farms	**1**	FC	5,111	2.5	2.5	-	-	-	-	-	-	-	-
	2	D	4,094	13	8	5	-	< 20	-	-	-	-	-
	3	D	2,338	33	33	-	< 25	20 - 29	-	-	-	-	-
	4	D	3,224	40	25	14	-	20 - 29	< 25	-	-	-	-
	5	D	2,092	70	52	18	< 25	20 - 29	-	-	-	-	-
	6	P	4,350	5	5	-	25 - 49	40 - 49	-	-	-	5,000 - 10,000	-
	7	P	421	40	40	-	-	-	-	-	-	-	~ 120,000
	8	P	2,441	93	90	3	25 - 49	-	-	-	1,000 - 2,000	-	-
	9	GL	57	25	25	-	< 25	> 50	-	-	-	-	-
	10	GL	312	73	33	40	< 25	> 50	-	-	-	-	-
	11	M	3,561	13	13	-	-	-	-	100 - 199	-	-	-
	12	M	1,877	40	40	-	-	-	-	> 200	-	-	-
	13	M	742	48	45	3	-	-	-	-	100 - 499	-	5,000 - 10,000
	14	M	1,815	60	40	20	< 25	-	25 - 49	20 - 99	-	-	-

Notes: a) FC: Field crop farms; D: Dairy farms; P: Pig and poultry farms; GL: Grazing livestock farms; M: Mixed farms.
1) Beef cattle older than one year.
2) Sows after the first mating.
3) Fattened pigs with more than 50 kg.

Source: Derived of FADN-data by regional partners.

Table A-6: Selected farms in Brittany, France – Part 2

Legal Form	Farm No.	Farm type [a]	Weight	Total UAA	Arable land	Grass-land	Beef cattle [1]	Dairy cows	Suckler cows	Sows [2]	Fattened pigs [3]	Hens	Chicken male
	15	FC	1,147	30	25	5	-	-	< 25	-	-	-	-
	16	FC	1,082	55	55	-	-	-	-	-	-	-	-
Legal	**17**	FC	323	180	180	-	-	-	-	-	-	-	-
entities	**18**	D	915	75	70	5	< 25	40 - 49	-	< 20	-	-	-
(EARL)	**19**	P	1,297	-	-	-	25 - 49	30 - 39	-	-	-	5,000 - 10,000	-
	20	M	450	75	75	-	50 - 99	-	-	-	500 - 999	-	-
	21	M	1,062	88	88	-	-	-	-	20 - 99	-	-	-
Partner	**22**	D	1,084	73	65	8	25 - 49	30 - 39	-	-	< 100	-	-
ships	**23**	D	1,088	73	70	3	25 - 49	> 50	-	-	-	-	-
(GEAC)	**24**	D	1,209	113	95	18	< 25	30 - 39	< 25	-	-	-	-
	25	M	416	140	140	-	-	30 - 39	-	-	-	-	-
Other	**26**	D	274	85	85	-	25 - 49	40 - 49	-	-	-	-	-
legal	**27**	P	507	43	43	-	-	-	-	-	> 2,000	-	-
entities	**28**	P	530	55	55	-	-	-	-	20 - 99	1,000 - 2,000	-	5,000 - 10,000

Notes: [a] FC: Field crop farms; D: Dairy farms; P: Pig and poultry farms; M: Mixed farms.
[1] Beef cattle older than one year.
[2] Sows after the first mating.
[3] Fattened pigs with more than 50 kg.

Source: Derived of FADN-data by regional partners.

Table A-7: Selected farms in Vysočina, Czech Republic – Part 1

Legal Form	Farm No.	Farm type [a]	Weight	Total UAA	Arable land	Grass-land	Beef cattle [1]	Dairy cows	Sows [2]	Fattened pigs [3]	Suckler cows
Individual farms	**1**	FC	202	22.5	22.5	-	-	-	< 100	< 50	-
	2	FC	105	32.5	32.5	-	-	-	-	0	-
	3	FC	60	72.5	72.5	-	-	-	< 100	< 50	-
	4	FC	128	82.5	82.5	-	-	-	-	< 50	-
	5	FC	32	102.5	102.5	-	-	-	-	< 50	-
	6	D	100	27.5	17.5	10	-	< 50	-	0	-
	7	D	63	152.5	110	42.5	-	50 - 99	-	< 50	-
	8	GL	67	37.5	20	17.5	-	< 50	-	< 50	-
	9	GL	95	47.5	32.5	15	-	-	-	0	< 25
	10	P	24	2.5	2.5	-	-	-	< 100	50 - 200	-
	11	P	59	220	220	-	-	-	< 100	1,000 - 2,500	-
	12	M	392	17.5	7.5	10	-	< 50	-	0	-
	13	M	258	32.5	22.5	10	-	< 50	-	0	-
	14	M	49	72.5	72.5	-	-	-	-	50 - 200	-

Notes: [a] FC: Field crop farms; D: Dairy farms; P: Pig and poultry farms; GL: Grazing livestock farms; M: Mixed farms.
[1] Beef cattle older than one year.
[2] Breeding sows of 50 kg or more.
[3] Fattened pigs of 20 kg or more.

Source: Derived of FADN-data by regional partners.

Table A-7: Selected farms in Vysočina, Czech Republic – Part 2

Legal Form	Farm No.	Farm type a)	Weight	Total UAA	Arable land	Grass-land	Beef cattle[1)]	Dairy cows	Sows2)	Fattened pigs3)	Suckler cows
	15	FC	11	1,498	1,228	270	150 - 250	50 - 150	150 - 250	-	150 - 250
	16	P	30	3	3	-	-	-	-	2500 - 5000	-
	17	P	12	3	3	-	-	-	-	2500 - 5000	-
	18	P	6	2,5	3	-	-	-	-	> 5000	-
	19	GL	25	435	435	-	-	-	-	500 - 1000	-
	20	GL	34	625	518	108	50 - 150	150 - 250	-	250 - 500	-
Legal entities	**21**	GL	15	970	800	170	250 - 500	150 - 250	-	-	-
	22	GL	31	993	933	60	< 50	50 - 150	-	500 - 1000	-
	23	GL	12	1,333	1,130	203	150 - 250	250 - 500	-	< 50	-
	24	GL	41	1,543	1,068	475	50 - 150	250 - 500	-	250 - 500	-
	25	GL	12	1,890	1,583	308	150 - 250	250 - 500	< 50	-	< 50
	26	GL	21	2,185	1,758	428	50 - 150	> 500	-	50 - 150	-
	27	GL	24	2,555	1,795	760	150 - 250	> 500	< 50	-	< 50

Notes: [a)] FC: Field crop farms; D: Dairy farms; P: Pig and poultry farms; GL: Grazing livestock farms; M: Mixed farms.
[1)] Beef cattle older than one year.
[2)] Sows after the first mating.
[3)] Fattened pigs with more than 50 kg.

Source: Derived of FADN-data by regional partners.

A.3 Results of the regional representation

Table A-8: Representation of the Swedish region Västerbotten in AgriPoliS

General characteristics	Regional data	Consid-ered and adjusted data	Virtual region	Deviation to consid-ered data [1-(4)/(3)]	Coverage of the regional data [(4)/(2)]
(1)	(2)	(3)	(4)	(5)	(6)
Number of farms	2,506	**1,500**[1)]	1,469	-2%	59%
Utilised agricultural area (UAA; ha)	74,414	**68,032**[2)]	69,740	3%	94%
Number of beef cattle older than 1 year	7,297	7,297	7,199	-1%	47%
Number of dairy cows	15,526	15,526	16,519	6%	106%
Number of suckler cows	1,130	1,130	1,140	1%	101%
Number of ewes and rams	3,857				
Sows after the first mating	2,322				
Fattening pigs	15,039				
Structural characteristics					
Area (ha)					
Arable land	70,269	**64,423**[3)]	66,950	4%	95%
Grassland	4,145	**3,609**[3)]	2,790	-23%	67%
Total	74,414	**68,032**[3)]	69,740		
Number of farms specialised in[5)]					
Field crop farms (13, 14, 60)	1,807				
Grazing livestock (41, 42, 43, 44)	745				
Pig and poultry (50)	21				
Mixed farms (71, 72, 81, 82)	544				
Total	3,117				
Number of farms per size class					
2-10 ha	1,006				
10-20 ha	516	516	527	2%	102%
20-30 ha	250	250	248	-1%	99%
30-50 ha	283	283	289	2%	102%
50-100 ha	328	328	278	-15%	85%
More than 100 ha	123	123	127	3%	103%
Total	2,506	1,500	1,469		
Number of dairy cows per herd size class					
1-9	299	**332**[4)]	329	-1%	110%
10-24	3,593	**3,992**[4)]	4,640	16%	129%
25-49	6,926	**7,696**[4)]	8,049	5%	116%
50-74	2,240	**2,489**[4)]	2,500	0%	112%
More than 74	915	**1,017**[4)]	1,001	-2%	109%
Total	13,973	15,526	16,519		

Note: 1) Farms with less than 10 ha are not considered.
2) The regional expert Mark Brady reduced the total UAA, by 6.3 ha for each of the 1,006 farms not considered.
3) The area of arable and grassland is reduced according to the total UAA by keeping the relation of arable and grassland.
4) There is a small difference in the total number of dairy cows and in the sum of dairy cows by herd size, thus the number of each herd size is adjusted to the total number of dairy cows.

Source: STATISTICS SWEDEN (2003); 5) REGIONAL DATA (2002).

Table A-9: Representation of the region South East England in AgriPoliS

General characteristics	Regional data	Consid-ered and adjusted data	Virtual region	Deviation to consid-ered data [1-(4)/(3)]	Coverage of the regional data [(4)/(2)]
(1)	(2)	(3)	(4)	(5)	(6)
Number of farms	11,214	**2,526**[1)]	2,813	11%	79%
Utilised agricultural area (UAA; ha)	530,696	**445,973**[2)]	460,043	3%	103%
Beef cows	34,467	34,467	31,371	-9%	91%
Beef fatteners	46,479	46,479	44,561	-4%	96%
Dairy cows	58,362	58,362	57,790	-1%	99%
Breeding sheep	430,528	430,528	397,155	-8%	92%
Fattening pigs	27,860				
Structural characteristics					
Area (ha)					
Arable land (Crops, fallow and temporary grassland)	259,485	259,485	296,748	14%	114%
Grassland (permanent and rough grazing)	186,488	186,488	163,295	-12%	88%
Total	445,973	445,973	460,043		
Number of farms bigger than 8 ESU specialised in					
Field crop farms (13)	1,111	1,111	1,069	-4%	96%
Specialist fruit (32)	294				
Specialist glass (20)	269				
Other horticulture (20)	195				
Specialist Hardy Nursery Stock (20)	119				
Pig and poultry (50)	139				
Dairy (41)	276	276	298	8%	108%
Grazing livestock (42, 43, 44)	708	708	845	19%	119%
Mixed farms (71, 72, 81, 82)	431	431	601	39%	139%
Total	3,542	2,526	2,813		
Number of breeding sheep per herd size class					
Below 100	49,389	49,389	20,480	-59%	41%
100-200	49,124	49,124	38,073	-22%	78%
200-500	124,648	124,648	132,342	6%	106%
500-1000	119,747	119,747	120,793	1%	101%
More than 1000	87,620	87,620	85,467	-2%	98%
Total	430,528	430,528	397,155		
Number of dairy cows per herd size class					
Below 100	12,911	12,911	12,580	-3%	97%
100-200	26,010	26,010	25,740	-1%	99%
More than 200	19,441	19,441	19,470	0%	100%
Total	58,362	58,362	57,790		

Notes: 1) Farm specialization is only calculated for farms bigger than 8 ESU, thus we considered only these farms. Horticulture and permanent crop farms are also subtracted.
2) The total UAA is adjusted to the sum of arable and grassland.

Source: DEFRA (2002), data from 2001 and 2002.

Table A-10: Representation of the Saxonian Loess Region (Germany) in AgriPoliS – Part 1

General characteristics	Regional data	Consid-ered and adjusted data	Virtual region	Deviation to consid-ered data [1-(4)/(3)]	Coverage of the regional data [(4)/(2)]
(1)	(2)	(3)	(4)	(5)	(6)
Number of farms	2,858	**1,852**	1,835	-1%	64%
Utilised agricultural area (UAA; ha)	496,451	**479,100**	483,145	1%	97%
Number of beef cattle older than 1 year	8,197	**7,451**	7,500	1%	91%
Number of dairy cows	96,705	**96,272**	96,119	0%	99%
Number of breeding sows	27,479	**26,574**	26,546	0%	97%
Number of fattened pigs	69,602	**67,944**	68,045	0%	98%
Number of suckler cows	12,079	**10,500**	10,500	0%	87%
Structural characteristics					
Area (ha)					
Arable land	425,185	**417,530**	423,290	1%	100%
Grassland	64,418	**61,570**	59,855	-3%	93%
Total					
Number of farms by legal form					
Legal entities	278	**234**	222	-5%	80%
Partnerships	221	**208**	222	7%	100%
Individual farms - full time	881	**761**	738	-3%	84%
Individual farms - part time	1,478	**649**	653	1%	44%
Number of farms specialised in					
Field crop (13, 14, 60)	1,625	**1,288**	1,298	1%	80%
Dairy (41) and grazing livestock (42, 43, 44)	921	**526**	498	-5%	54%
Pig and poultry (50)	33	**21**	21	0%	64%
Mixed (71, 72, 81, 82)	67	**17**	18	6%	27%
Others (20, 31 - 34)	209				
Total	2,855				
UAA of pig and poultry farms	2,223	**2,155**	2,205	2%	99%
UAA of legal entities specialised in					
Field crop	170,733	**170,665**	166,195	-3%	97%
Dairy and grazing livestock	80,273	**80,145**	90,765	13%	113%
Mixed	23,422	**23,295**	20,160	-13%	86%
Others[1)]	4,601				
UAA of partnerships specialised in					
Field crop	57,567	**57,580**	57,320	0%	100%
Dairy and grazing livestock	17,434	**17,390**	17,760	2%	102%
Others[1)]	2,048				
UAA of full time farms specialised in					
Field crop	88,850	**88,785**	90,265	2%	102%
Dairy and grazing livestock	21,020	**20,915**	19,360	-7%	92%
Mixed	896				
Others[1)]	2,140				
UAA of part time farms specialised in					
Field crop	16,953	**15,495**	16,310	5%	96%
Dairy and grazing livestock	4,203	**2,675**	2,805	5%	67%
Mixed	417				
Others[1)]	3,669				

Table A-10: Representation of the Saxonian Loess Region (Germany) in AgriPoliS – Part 2

Structural characteristics	Regional data	Consid-ered and adjusted data	Virtual region	Deviation to consid-ered data [1-(4)/(3)]	Coverage of the regional data [(4)/(2)]
(1)	(2)	(3)	(4)	(5)	(6)
Number of farms per size class					
2 - 10 ha	888				
10 - 50 ha	904	**797**	775	-3%	86%
50 - 100 ha	292	**293**	298	2%	102%
100 - 200 ha	274	**273**	269	-1%	98%
200 - 500 ha	260	**249**	253	2%	97%
500 - 1000 ha	111	**111**	113	2%	102%
1000 - 2500 ha	105	**104**	104	0%	99%
More than 2500 ha	24	**24**	23	-4%	96%
Total	2,858	**1,851**	1,835		
Number of dairy cows per herd size class					
Less than 50	4,460	**4,187**	4,224	1%	95%
50-150	11,840	**11,680**	11,600	-1%	98%
150-250	6,979	**6,979**	7,000	0%	100%
250-500	24,010	**24,010**	23,095	-4%	96%
500-1000	21,227	**21,227**	21,000	-1%	99%
More than 1000	28,189	**28,189**	29,200	4%	104%
Total	96,705	**96,272**	96,119		
Number of breeding sows per herd size class					
Less than 100	1,271	**1,021**	1,026	0%	81%
100-200	1,474	**1,474**	1,480	0%	100%
200-500	5,478	**5,478**	5,480	0%	100%
500-1000	8,025	**7,370**	7,360	0%	92%
More than 1000	11,231	**11,231**	11,200	0%	100%
Total	27,479	**26,574**	26,546		
Number of fattened pigs per herd size class					
Less than 50	2)	**1,619**	1,660	3%	
50-199	2)	**3,250**	3,255	0%	
200-499	2)	**4,753**	4,750	0%	
500-1000	2)	**10,250**	10,280	0%	
1000-2500	2)	**22,620**	22,600	0%	
More than 2500	2)	**25452**	25,500	0%	
Total	69,602	**67,944**	68,045		98%

Notes: Considered are only farms bigger than 10 ha, because smaller farms are of minor importance, they utilize only 3% of the total UAA. Full and part-time farms specialised in pig and poultry and mixed production are not considered too.
1) Wine, other permanent crops, horticulture and other farms.
2) These data were not required in the first query.

Source: Based on data from (LfL Sachsen 2002) out of applications for agricultural subsidies 2002 and own calculations.

Table A-11: Representation of the German region Hohenlohe in AgriPoliS – Part 1

General characteristics	Regional data	Considered and adjusted data	Virtual region	Deviation to considered data [1-(4)/(3)]	Coverage of the regional data [(4)/(2)]
(1)	(2)	(3)	(4)	(5)	(6)
Number of farms[1)]	2,869	2,869	2,857	0%	100%
Utilised agricultural area (UAA; ha) [1)]	73,439	73,439	73,587	0%	100%
Number of beef cattle older than 1 year[2)]	50,902	50,902	48,006	-6%	94%
Number of dairy cows[2)]	17,667	17,667	17,562	-1%	99%
Number of breeding sows[2)]	101,122	101,122	99,785	-1%	99%
Number of fattened pigs[2)]	106,008	106,008	106,074	0%	100%
Number of turkeys[2)]	450,000	450,000	457,664		
Structural characteristics					
Area (ha) [2)]					
Arable land	59,974	**57,468**[a)]	59,034	3%	98%
Grassland	16,667	**15,971**[a)]	14,553	-9%	87%
Total	76,641	73,439			
Number of farms in different organisational forms[1)]					
Full time farms	1,553	1,553	1,607	3%	103%
Part time farms	1,316	1,316	1,250	-5%	95%
UAA of farms in different organisational forms[1)]					
Full time farms	57,321	57,321	57,350	0%	100%
Part time farms	16,117	16,117	16,237	1%	101%
Number of farms specialised in[1)]					
Field crop (13, 14, 60)	459	459	521	14%	114%
Dairy (41) and grazing livestock (42, 43 44)	906	906	873	-4%	96%
Pig and poultry (50)	988	988	951	-4%	96%
Mixed (71, 72, 81, 82)	516	516	512	-1%	99%
UAA of farms specialised in[1)]					
Field crop	9,569	9,569	9,143	-4%	96%
Dairy and grazing livestock	21,683	21,683	23,408	8%	108%
Pig and poultry	27,766	27,766	26,774	-4%	96%
Mixed	14,421	14,421	14,261	-1%	99%
Total	73,439	73,439	73,856		
Number of farms per size class[2)]					
2 - 10 ha	817	828	712	-14%	87%
10 -30 ha	968	981	1,042	6%	108%
30 - 50 ha	622	630	666	6%	107%
More than 50 ha	424	430	437	2%	103%
Total	2,831	2,869	2,857		
Number of dairy cows per herd size class [3)]					
Less than 20	23%	4,063	3,942	-3%	97%
20-29	20%	3,533	3,502	-1%	99%
30-39	17%	3,003	3,032	1%	101%
40-59	25%	4,417	4,445	1%	101%
More than 59	15%	2,650	2,641	0%	100%
Total	17,667	17,666	17,562		

Notes: [a)] The shares of arable and grassland are adjusted to the total UAA.

Table A-11: Representation of the German region Hohenlohe in AgriPoliS – Part 2

Structural characteristics	Regional data	Consid-ered and adjusted data	Virtual region	Deviation to consid-ered data [1-(4)/(3)]	Coverage of the regional data [(4)/(2)]
(1)	(2)	(3)	(4)	(5)	(6)
Number of breeding sows per herd size class [3)]					
Less than 30	6%	6,067	5,976	-1%	99%
30-49	8%	8,090	8,022	-1%	99%
50-99	25%	25,281	24,740	-2%	98%
More than 99	61%	61,684	61,047	-1%	99%
Total	101,022	101,022	99,785		
Number of fattened pigs per herd size class [3)]					
Less than 100	9%	9,541	10,007	5%	105%
100-199	9%	9,541	9,519	0%	100%
200-399	21%	22,262	21,635	-3%	97%
400-599	24%	25,442	25,531	0%	100%
More than 599	37%	39,223	39,382	0%	100%
Total	106,008	106,009	106,074		

Source: [1)] STATISTISCHES LANDESAMT BADEN-WÜRTTEMBERG (1999).
[2)] STATISTISCHES LANDESAMT BADEN-WÜRTTEMBERG (2003).
[3)] The region Hohenlohe is not congruent with the administrative boarders of the county Hohenlohe. Thus, except for herd size all data are the sum of the data from the municipalities in the region Hohenlohe. Data about herd size are not available why we applied the distribution of herd size from the counties Hohenlohe and Schwäbisch-Hall to the total number of livestock in the region Hohenlohe STATISTISCHES LANDESAMT BADEN-WÜRTTEMBERG (2001).

Table A-12: Representation of the French region Brittany in AgriPoliS – Part 1

General characteristics[1)]	Regional data	Consid-ered and adjusted data	Virtual region	Deviation to consid-ered data [1-(4)/(3)]	Coverage of the regional data [(4)/(2)]
(1)	(2)	(3)	(4)	(5)	(6)
Number of farms	51,219	**45,176**[a)]	43,967	-3%	86%
Utilised agricultural area (UAA; ha)	1,701,568	**1,669,031**[a)]	1,693,698	1%	100%
Number of beef cattle older than 1 year	634,500	634,500	513,179	-19%	81%
Number of dairy cows	779,400	**771,936**[b)]	840,748	9%	108%
Number of suckler cows	142,200	142,200	150,124	6%	106%
Sows after the first mating	550,000	550,000	563,635	2%	102%
Fattened pigs with more than 50 kg	3,171,500	3,171,500	3,359,765	6%	106%
Table type chicken [1000]	39,540	39,540	39,900	1%	101%
Hens [1000]	23,340	23,340	22,443	-4%	96%
Structural characteristics					
Number of farms by legal form[1)]					
Individual farms	37,906	**33,434**[c)]	32,676	-2%	86%
Partnerships (GAEC = **G**roupement **A**gricole d'**E**xploitation en **C**ommun)	4,525	**3,991**[c)]	3,797	-5%	84%
Legal entities (EARL = **E**xploitation **A**gricole à **R**esponsabilité **L**imitée)	6,927	**6,110**[c)]	6,199	1%	89%
Other legal entities	1,861	**1,641**[c)]	1,295	-21%	70%
Total	51,252	45,176	43,967		
UAA of farms (ha)[1)]					
Individual farms	928,437	**910,685**[c)]	929,605	2%	100%
Partnerships (GEAC)	359,097	**352,231**[c)]	351,523	0%	98%
Legal entities (EARL)	345,060	**338,462**[c)]	338,305	0%	98%
Other legal entities	68,972	**67,653**[c)]	74,265	10%	108%
Total	1,701,566	1,669,031	1,693,698		
Area (ha)[1)]					
Arable land	1,559,879	**1,444,072**[d)]	1,495,298	4%	96%
Grassland	243,000	**224,959**[d)]	198,400	-12%	82%
Total	1,802,879	1,669,031	1,693,698		
Number of farms specialised in[2)]					
Field crops (13, 14)	7,240	7,240	7,551	4%	104%
Horticulture (20)	955				
Permanent crops (32, 33, 34)	522				
Milk (41)	16,201	16,201	16,208	0%	100%
Grazing livestock (42, 43)	5,098	5,098	4,974	-2%	98%
Sheep farms (44)	4,355				
Pig and poultry (50)	4,853	4,853	5,146	6%	106%
Mixed (60, 71, 72, 81, 82)	11,784	11,784	10,088	-14%	86%
Others (non classified)	211				
Total	51,219	45,176	43,967		

Notes: [a)] Horticulture, permanent crop, sheep and other farms are not considered. The total UAA is reduced by the area used by these farm types.
[b)] Adjusted to the sum of dairy cows by herd size.
[c)] The number of farms and the UAA by legal form is reduced by keeping the shares of each legal form.
.

Table A-12: Representation of the French region Brittany in AgriPoliS – Part 2

Structural characteristics	Regional data	Consid-ered and adjusted data	Virtual region	Deviation to consid-ered data [1-(4)/(3)]	Coverage of the regional data [(4)/(2)]
(1)	(2)	(3)	(4)	(5)	(6)
UAA of farms specialised in (ha)[2)]					
Field crops	172,587	172,587	167,593	-3%	97%
Horticulture	5,383				
Permanent crops	3,693				
Milk	766,096	766,096	781,113	2%	102%
Grazing livestock	135,134	135,134	133,328	-1%	99%
Sheep farms	23,411				
Pig and poultry	104,708	104,708	95,318	-9%	91%
Mixed (crops and livestock)	490,506	490,506	516,348	5%	105%
Others	46				
Total	1,701,564	1,669,031	1,693,698		
Number of farms per size class[3)]					
1 - 5 ha	12,719	**6,676**[e)]	6,499	-3%	51%
5 - 20 ha	8,842	8,842	8,374	-5%	95%
20 - 35 ha	8,140	8,140	8,023	-1%	99%
35 - 50 ha	8,298	8,298	7,888	-5%	95%
50 - 75 ha	8,140	8,140	8,186	1%	101%
75 - 100 ha	3,138	3,138	3,055	-3%	97%
100 - 125 ha	1,205	1,205	1,204	0%	100%
125 - 150 ha	417	417	416	0%	100%
More than 150 ha	320	320	322	1%	101%
Total	51,219	45,176	43,967		
Number of fattened pigs per herd size class[4)]					
Les than 100	2%	**53,915**[f)]	54,650	1%	58%
100-499	13%	**415,466**[f)]	453,852	8%	62%
500-999	20%	**624,785**[f)]	640,668	3%	58%
1000-1999	32%	**1,021,223**[f)]	1,101,123	8%	61%
More than 1999	33%	**1,056,110**[f)]	1,109,472	5%	60%
Total		3,171,500	3,359,765		
Number of sows per herd size class[4)]					
Les than 20	2%	**10,450**[f)]	10,131	-3%	6%
20-99	26%	**141,900**[f)]	145,190	2%	7%
100-199	36%	**196,900**[f)]	206,690	5%	7%
More than 199	37%	**200,750**[f)]	201,624	0%	7%
Total		550,000	563,635		
Number of dairy cows per herd size class[5)]					
Les than 20	46,563	46,563	49,620	7%	107%
20-29	106,403	106,403	111,737	5%	105%
30-39	175,406	175,406	191,954	9%	109%
40-49	142,307	142,307	158,039	11%	111%
More than 49	301,257	301,257	329,398	9%	109%
Total	771,936	771,936	840,748		

Notes: [d)] The area of arable and grassland are reduced according to the area of the considered farm types by keeping the relation of arable and grassland.
[e)] The average size of the horticulture, permanent crop, sheep and other farms is 5.4 ha. Thus, we reduced the number of farms smaller than 5 ha by the number of not

considered horticulture, permanent crop, sheep and other farms.
f) Data about herd size for breeding sows and fattening pigs are not available for Brittany, why we applied the distribution of herd size for whole France. This is reasonable, because 57% of the French pork meat is produced in Brittany (SCHNICKE 2005).

Source: [1] AGRESTE BRETAGNE (2003).
[2] AGRESTE (2000)
[3] AGRESTE BRETAGNE (2001).
[4] INSTITUT TECHNIQUE DU PORC (2003), these are national data. The respective shares in each size class are adjusted to the regional values.
[5] INSTITUT DE L`ELEVAGE (2003).

Table A-13: Representation of the Czech region Vysočina in AgriPoliS – Part 1

Structural characteristics	Regional data	Consid-ered and adjusted data	Virtual region	Deviation to consid-ered data [1-(4)/(3)]	Coverage of the regional data [(4)/(2)]
(1)	(2)	(3)	(4)	(5)	(6)
Number of farms	3,433	**1,872**[1)]	1,908	2%	56%
Utilised agricultural area (UAA; ha)	393,726	**385,713**[2)]	380,520	-1%	97%
Number of beef cattle older than 1 year	60,560	29,304	30,353	4%	104%
Number of dairy cows	82,466	**81,666**[3)]	82,352	1%	100%
Number of suckler cows	73,430	4,289	4,285	0%	100%
Breeding sows of 50 kg or more	47,703	47,703	47,411	-1%	99%
Fattened pigs with more than 20 kg	412,672	412,672	406,248	-2%	98%
Structural characteristics					
Area (ha)					
Arable land	309,913	**304,913**[4)]	304108	0%	98%
Grassland	82,800	**80,800**[4)]	76,413	-5%	92%
Total	392,713	385,713	380,520	-1%	97%
Number of farms by legal form					
Individual farms	3,159	**1,599**[5)]	1,634	2%	52%
Legal entities	274	**273**[5)]	274	0%	100%
Total	3,433	**1872**[5)]	1,908		
Number of farms specialised in					
Field crops (13, 14, 60)	1,733		538		
Horticulture (20)	23				
Permanent crops (32, 33, 34)	12				
Milk (41)	163	163	163	0%	100%
Grazing livestock (42, 43, 44)	162	162	162	0%	100%
Pig and poultry (50)	132	132	131	-1%	99%
Mixed (71, 72, 81, 82)	1,208		914		
Total	3,433		1,908		
Number of farms per size class					
1 - 10 ha	1,561				
10 - 50 ha	1,257	1,257	1,219	-3%	97%
50 - 100 ha	238	238	237	0%	100%
100 - 200 ha	95	95	95	0%	100%
200 - 500 ha	80	80	84	5%	105%
500 - 1000 ha	78	78	80	3%	103%
1000 - 2500 ha	100	100	97	-3%	97%
More than 2500 ha	24	24	24	0%	100%
Total	3,433	1,872	1,836		
Number of fattened pigs per herd size class					
Less than 50	18,942	18,942	18,961	0%	100%
50-200	12,883	12,883	12,914	0%	100%
200-500	22,425	22,425	23,166	3%	103%
500-1000	45,082	45,082	43,507	-3%	97%
1000-2500	100,615	100,615	97,586	-3%	97%
More than 2500	212,725	212,725	210,114	-1%	99%
Total	412,672	412,672	406,248		

Notes: [1)] Farms bigger than 1 ha and smaller than 10 ha are not considered.
[2)] The total UAA is reduced by assuming the 1,561 farms bigger than 1 ha and smaller than 10 ha have an average size of 5 ha.

Table A-13: Representation of the Czech region Vysočina in AgriPoliS – Part 2

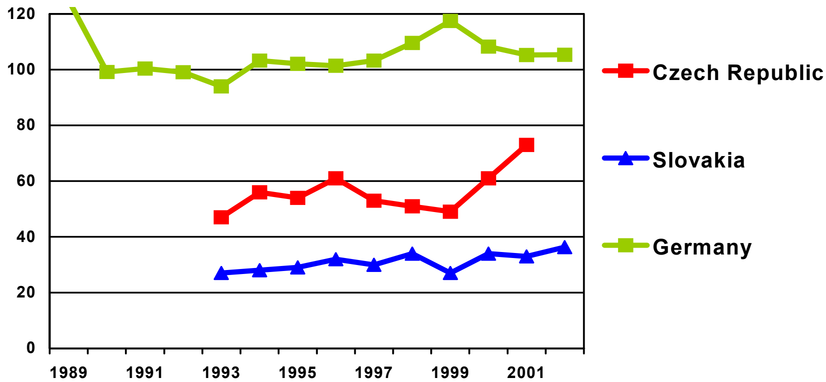
Structural characteristics	Regional data	Consid-ered and adjusted data	Virtual region	Deviation to consid-ered data [1-(4)/(3)]	Coverage of the regional data [(4)/(2)]
(1)	(2)	(3)	(4)	(5)	(6)
Number of sows per herd size class					
Less than 100	8,431	8,431	8,451	0%	100%
100-200	6,964	6,964	6,875	-1%	99%
200-500	9,615	9,615	9,753	1%	101%
More than 500	22,693	22,693	22,332	-2%	98%
Total	47,703	47,703	47,411		
Number of dairy cows per herd size class					
Less than 50	7,877	**7,077**[3)]	7,112	0%	90%
50-150	8,037	8,037	8,097	1%	101%
150-250	10,376	10,376	10,022	-3%	97%
250-500	25,459	25,459	25,723	1%	101%
More than 500	30,717	30,717	31,398	2%	102%
Total	82,466	81,666	82,352		

Notes: [3)] It is assumed that the farms bigger than 1 ha and smaller than 10 ha keep in average 1.3 dairy cows
[4)] The area of arable and grassland is reduced according to the total UAA by keeping the relation of arable and grassland.
[5)] In the FADN data of Vysočina was one corporate farm (legal entity) smaller than 10 ha all other not considered farms are assumed to be individual farms.

Source: CZECH STATISTICAL OFFICE (2004).

A.4 Nitrogen input in OMS and NMS

Figure A-1: N-fertilization in kg/ha



Source: FAOSTAT (2004).

A.5 Economical data for the production activities in the case study regions

Table A-14: Economical data for wheat

Region	Yield in	Price	Revenue	Variable costs	Gross margin	Premium
	t/ha	€/t	€/ha	€/ha	€/ha	€/ha
South ast E. E	8.0	109	875	339	535	355
Hohenlohe	6.5	134	870	510	360	324
Saxony	7.2	106	766	416	350	392
Brittany	7.3	110	803	352	451	355
Vysočina	5.8	100	616	311	305	10

Note: No value means that no data was available.

Sources:
- Sweden: AGRIWISE (2004). Prices are based on actual levels for 2003.
- South East E.: NIX (2003) and calculations by Paul Webster, Wye Campus, Imperial College London.
- Hohenlohe: SAHRBACHER (2003) based on REGIERUNGSBEZIRK MITTELFRANKEN (2000).
- Saxony: LFL SACHSEN (2003).
- Brittany: Price for peas and yields of field crops except rape seed are from TEYSSIER (2002); yield for rape seed and prices of field crops except peas are from AGRESTE BRETAGNE (2003).
- Vysočina: Yields and prices from KAVKA et al. (2000); variable costs from JUŘICA et al. (2004) and calculated by Zdeněk Louda, UZEI in Prague, Department "Centre for Economic Modelling" and Jana Poláčková, UZEI in Prague, Division of Structural and Economic Development of Agriculture.

Table A-15: Economical data for triticale production

Region	Yield	Price	Revenue	Variable costs	Gross margin	Premium
	t/ha	€/t	€/ha	€/ha	€/ha	€/ha
Jönköping	4.0	99	395	293	102	186
Brittany	7.3	100	730	350	380	355

Source: See Table A-14.

Table A-16: Economical data for oats

Region	Yield	Price	Revenue	Variable costs	Gross margin	Premium
	t/ha	€/t	€/ha	€/ha	€/ha	€/ha
Jönköping	3.3	83	275	268	7	186
South East E.	6.8	100	678	241	437	355

Source: See Table A-14.

Table A-17: Economical data for rape seed

Region	Yield	Price	Revenue	Variable costs	Gross margin	Premium
	t/ha	€/t	€/ha	€/ha	€/ha	€/ha
South ast E. E	3.2	234	746	317	429	355
Hohenlohe	3.5	219	767	537	230	324
Saxony	3.0	225	675	403	272	392
Brittany	3.8	220	836	447	389	355
Vysočina	3.0	200	631	352	279	10

Source: See Table A-14.

Table A-18: Economical data for potatoes

Region	Yield	Price	Revenue	Variable costs	Gross margin	Premium
	t/ha	€/t	€/ha	€/ha	€/ha	€/ha
South East E.	33.1	113	3,742	1,447	2,295	0
Vysočina	19.0	118	2,360	1,386	974	10

Source: See Table A-14.

Table A-19: Economical data for sugar beets

Region	Yield	Price	Revenue	Variable costs	Gross margin	Premium
	t/ha	€/t	€/ha	€/ha	€/ha	€/ha
Saxony	52	47	2,482	960	1,522	0
Hohenlohe	60	54	3,252	1,094	2,158	0

Source: See Table A-14.

Table A-20: Economical data for protein plants

Region		Yield	Price	Revenue	Variable costs	Gross margin	Premium
		t/ha	€/t	€/ha	€/ha	€/ha	€/ha
South East E.	Winter Beans	3.8	132	498	181	317	407
Hohenlohe	Field ean b	3.5	111	390	470	80	384
Saxony	Peas	4.0	115	460	322	138	452
Brittany	Peas	5.5	130	715	410	305	409

Source: See Table A-14.

Table A-21: Economical data for breeding sows

Region	Piglets per year	Price per piglet	Revenue[1)]	Variable costs	Gross margin
		€	€/year	€/year	€/year
South East E.	21.0	41	915	544	371
Hohenlohe	17.4	61	1,151	683	468
Saxony	21.6	49	1,098	754	344
Brittany	19.5	52	1,087	657	430
Vysočina	15.3	26	402	238	164

Note: [1)] Including yields for selling the old breeding sow.

Sources: South East E.: NIX (2003) and calculations by Paul Webster, Wye Campus, Imperial College London.
Hohenlohe: SAHRBACHER (2003) based on REGIERUNGSBEZIRK MITTELFRANKEN (2000).
Saxony: LFL SACHSEN (2003).
Brittany: TEYSSIER (2002).
Vysočina: KAVKA et al. (2000); variable costs same source as for plant production, see Table A-14.

Table A-22: Economical data for sheep

Region	Lambs per ewe and year	Carcass weight	Price	Revenue	Variable costs	Gross margin	Premium
		kg	€/kg	€/year	€/year	€/year	€/year
Västerbotten	1.70	18.5	3.4	95	57	38	21
Jönköping	1.70	18.5	3.4	95	31	64	21
South ast E. E	1.60		54.4	60	17	43	20

Note: No value means that no data was available.

Sources: Sweden: AGRIWISE (2004). Prices are based on actual levels for 2003.
South East E.: NIX (2003) and calculations by Paul Webster, Wye Campus, Imperial College London.

Table A-23: Economical data for suckler cows

Region	Revenue	Variable costs	Gross margin	Premium
	€/year	€/year	€/year	€/year
Västerbotten	489	141	348	300
Jönköping	489	135	354	300
South ast E.	E338	148	190	238
Hohenlohe	635	265	370	360
Saxony	493	227	266	313
Brittany	661	200	461	388
Vysočina	500	237	263	-

Sources: Sweden: AGRIWISE (2004). Prices are based on actual levels for 2003.
South East E.: NIX (2003) and calculations by Paul Webster, Wye Campus, Imperial College London.
Hohenlohe: SAHRBACHER (2003) based on REGIERUNGSBEZIRK MITTELFRANKEN (2000).
Saxony: LFL SACHSEN (2003).
Brittany: TEYSSIER (2002).
Vysočina: JUŘICA et al. (2004) and calculations by Zdeněk Louda, UZEI in Prague, Department "Centre for Economic Modelling" and Jana Poláčková, UZEI in Prague, Division of Structural and Economic Development of Agriculture.

Table A-24: Economical data for dairy cows

Region	Milk yield	Milk price	Revenue	Variable costs	Gross margin	Premium
	kg	€/kg	€/year	€/year	€/year	€/year
Västerbotten	9,000	0.32	2,914	1,018	1,896	810[1)]
Jönköping	9,000	0.31	2,816	939	1,877	109[1)]
South ast E. E	6,300	0.27	1,737	547	1,190	114[1)]
Hohenlohe	5,700	0.33	2,300	920	1,380	104[1)]
Saxony	7,260	0.30	2,383	1,123	1,260	131[1)]
Brittany	6,323[3)]	0.32[4)]	2,355	929	1,426	114[1)]
Vysočina	6,175[5)]	0.25[5)]	1,330	723	607	24[2)]

Notes: [1)] In 2004 0.0181 € have been paid per kilogram milk. As Västerbotten is a Nordic region an dditional national payment of 701 €/dairy cow is paid.
[2)] Average of payments in 2002 0.00324 €/l and in 2003 0.0044 €/l.

Sources: Sweden: AGRIWISE (2004). Prices are based on actual levels for 2003.
South East E.: NIX (2003) and calculations by Paul Webster, Wye Campus, Imperial College London.
Hohenlohe: SAHRBACHER (2003) based on REGIERUNGSBEZIRK MITTELFRANKEN (2000).
Saxony: LFL SACHSEN (2003).
Brittany: [3)] TEYSSIER (2002), [4)] AGRESTE BRETAGNE (2003).
Vysočina: [5)] JUŘICA et al. (2004); variable costs same source as for plant production, see Table A-14.

Table A-25: Economical data for fattening pigs

Region	Weight at the beginning	Weight at the end	Fattening period	Turn over	Daily weight gain	Carcass weight	Price per kg carcass weight	Revenue	Variable costs	Gross margin
	kg	kg	days	Pigs/year	kg/day	kg	€/kg	€/year	€/year	€/year
South East E.	30	95	100	3.7	0.70	71	1.36	333	305	28
Hohenlohe	28	117	127	2.9	0.70	94	1.46	370	314	56
Saxony	27	115	121	3.0	0.75	92	1.46	378	336	42
Brittany	27[1)]	110[1)]	120[1)]	3.0	0.75	88[1)]	1.40[2)]	332	260	72
Vysočina	15	110	158	2.3	0.60		1.18	281	162	119

Note: No value means that no data was available.

Sources: South East E.: NIX (2003) and calculations by Paul Webster, Wye Campus, Imperial College London.
Hohenlohe: SAHRBACHER (2003) based on REGIERUNGSBEZIRK MITTELFRANKEN (2000).
Saxony: LFL SACHSEN (2003).
Brittany: 1) TEYSSIER (2002), 2) AGRESTE BRETAGNE (2003).
Vysočina: KAVKA et al. (2000); variable costs same source as for plant production, see Table A-14.

Table A-26: Economical data for beef cattle

Region	Weight at the beginning	Weight at the end	Fattening period	Daily weight gain	Carcass weight	Price	Revenue	Variable costs[1)]	Gross margin	Premium
	kg	kg	days	kg/day	kg	€/kg	€/year	€/year	€/year	€/year
Västerbotten	75	570	488	1.01	300	2.37	356	289	67	200
Jönköping	75	570	488	1.01	300	2.37	356	244	112	200
South East E.	230	500	260	1.04		1.44	387	166	221	151
Hohenlohe	90	660	500	1.14	376	3.16	868	600	268	212
Saxony	50	600	500	1.10	336	2.50	560	337	223	206
Brittany	275[2)]	710[2)]	365[2)]	1.19	426[2)]	2.60[3)]	1,108	920	188	290
Vysočina	353	590[4)]	635[4)]	0.87		1.13[5)]	564	250	314	0

Notes: No value means that no data was available.
[1)] Costs for heifers are included in all regions.

Sources: Sweden: AGRIWISE (2004). Prices are based on actual levels for 2003.
South East E.: NIX (2003) and calculations by Paul Webster, Wye Campus, Imperial College London.
Hohenlohe: SAHRBACHER (2003) based on REGIERUNGSBEZIRK MITTELFRANKEN (2000).
Saxony: LFL SACHSEN (2003).
Brittany: [2)] TEYSSIER (2002), [3)] AGRESTE BRETAGNE (2003).
Vysočina: [4)] Qualified estimation for livestock production for year 2004 by Mr. Kopecek UZEI in Prague – Department "Centre for Economic Modelling". [5)] JUŘICA et al. (2004); variable costs same source as for plant production, see Table A-14.

Table A-27: Economical data for beef cattle activities in Sweden

Region	Weight at the beginning	Weight at the end	Fattening period	Bulls per year[1)]	Daily weight gain	Carcass weight	Price	Revenue	Variable costs[2)]	Gross margin	Premium
	kg	kg	days		kg/day	kg	€/kg	€/year	€/year	€/year	€/year
Västerbotten											
Bull dairy	75	570	488	0.75	1.01	300	2.37	356	289	67	200
Bullock dairy	75	560	702	0.52	0.69	280	2.33	326	180	146	295
Bull suckler	300	600	214	1.71	1.40	350	2.55	891	853	38	400
Jönköping											
Bull dairy	75	570	488	0.75	1.01	300	2.37	356	244	112	200
Bullock dairy	75	560	702	0.52	0.69	280	2.33	326	170	156	295
Bull suckler	300	600	214	1.00	1.40	350	2.55	891	787	104	400

Notes: [1)] These figures are maximum values based on the fattening period. In reality not all stable places are used during the whole year. Only a half bull dairy or bullock dairy are fattened per year. Farms also fatten only one bull suckler per year. The revenue and variable costs are based on this turnover.
[2)] Costs for heifers are included.

Sources: Sweden: AGRIWISE (2004). Prices are based on actual levels for 2003.

A.6 Investment options of the study regions

Table A-28: Investment options for Jönköping

No.	Investment type	Unit	Capacity	Investment costs	Useful life	Additional labour[1)]
			Unit	€/unit	years	h/unit
1	Cattle barn 1	Places	20	2,085	25	7.90
2	Cattle barn 2	Places	50	1,565	25	3.00
3	Cattle barn 3	Places	100	1,416	25	2.00
4	Cattle barn 4	Places	200	1,367	25	0.70
5	Cattle barn 5	Places	300	1,314	25	0.00
6	Suckler cows 1	Places	20	2,720	25	8.70
7	Suckler cows 2	Places	50	2,536	25	4.60
8	Suckler cows 3	Places	100	2,623	25	1.70
9	Suckler cows 4	Places	200	2,355	25	0.30
10	Suckler cows 5	Places	300	2,192	25	0.00
11	Dairy barn 1	Places	30	8,163	22	15.00
12	Dairy barn 2	Places	60	7,336	22	8.00
13	Dairy barn 3	Places	120	6,851	22	5.00
14	Dairy barn 4	Places	200	6,196	22	3.00
15	Dairy barn 5	Places	400	5,294	22	0.00
16	Ewe 1	Places	50	461	25	3.00
17	Ewe 2	Places	100	384	25	2.00
18	Ewe 3	Places	200	346	25	1.00
19	Ewe 4	Places	400	315	25	0.00
20	Machinery 1	ha	15	2,800	18	1.00
21	Machinery 2	ha	30	1,907	18	0.50
22	Machinery 3	ha	50	1,894	15	0.00
23	Machinery 4	ha	75	1,796	15	-1.00
24	Machinery 5	ha	100	1,347	12	-1.00
25	Machinery 6	ha	200	908	12	-1.50
26	Machinery 7	ha	300	765	12	-1.70

Note: [1)] Additional labour demand per unit relative to the labour demand of the largest investment option.

Source: SLI (2004).

Table A-29: Investment options for Västerbotten

No.	Investment type	Unit	Capacity	Investment costs	Useful life	Additional labour[1)]
			Unit	€/unit	years	h/unit
1	Cattle barn 1	Places	20	2,085	25	7.90
2	Cattle barn 2	Places	50	1,565	25	3.00
3	Cattle barn 3	Places	100	1,142	25	2.00
4	Cattle barn 4	Places	200	1,026	25	0.70
5	Cattle barn 5	Places	300	1,019	25	0.00
6	Suckler cows 1	Places	20	2,433	25	8.70
7	Suckler cows 2	Places	50	2,069	25	4.60
8	Suckler cows 3	Places	100	1,970	25	1.70
9	Suckler cows 4	Places	200	1,855	25	0.30
10	Suckler cows 5	Places	300	1,765	25	0.00
11	Dairy barn 1	Places	30	12,000	22	15.00
12	Dairy barn 2	Places	60	8,000	22	8.00
13	Dairy barn 3	Places	120	5,580	22	5.00
14	Dairy barn 4	Places	200	5,121	22	3.00
15	Dairy barn 5	Places	400	4,426	22	0.00
16	Ewe 1	Places	50	428	25	3.00
17	Ewe 2	Places	100	357	25	2.00
18	Ewe 3	Places	200	303	25	1.00
19	Ewe 4	Places	400	258	25	0.00
20	Machinery 1	ha	15	3,396	18	1.00
21	Machinery 2	ha	30	1,698	18	0.50
22	Machinery 3	ha	50	1,605	15	0.00
23	Machinery 4	ha	75	1,456	15	-1.00
24	Machinery 5	ha	100	1,092	12	-1.00
25	Machinery 6	ha	200	701	12	-1.50
26	Machinery 7	ha	300	574	12	-1.70

Note: [1)] Additional labour demand per unit relative to the labour demand of the largest investment option.

Source: SLI (2004).

Table A-30: Investment options for South East England

No.	Investment type	Unit	Capacity	Investment costs	Useful life	Additional labour[1)]
			Unit	€/unit	years	h/unit
1	Sow housing 1	Places	100	1,658	20	3.00
2	Sow housing 2	Places	200	1,583	20	2.50
3	Sow housing 3	Places	300	1,508	20	2.00
4	Sow housing 4	Places	400	1,477	20	1.50
5	Sow housing 5	Places	500	1,447	20	1.00
6	Sow housing 6	Places	1,000	1,432	20	0.50
7	Sow housing 7	Places	1,500	1,417	20	0.00
8	Fatt. pig sty 1	Places	500	271	20	0.60
9	Fatt. pig sty 2	Places	1,000	256	20	0.40
10	Fatt. pig sty 3	Places	2,000	241	20	0.24
11	Fatt. pig sty 4	Places	5,000	226	20	0.10
12	Fatt. pig sty 5	Places	10,000	211	20	0.00
13	Cattle barn 1	Places	40	965	25	2.90
14	Cattle barn 2	Places	100	935	25	2.40
15	Cattle barn 3	Places	200	905	25	1.70
16	Cattle barn 4	Places	500	874	25	0.00
17	Suckler cows 1	Places	10	1,244	25	1.90
18	Suckler cows 2	Places	40	1,169	25	0.70
19	Suckler cows 3	Places	100	1,131	25	0.00
20	Dairy barn 1	Places	60	3,460	25	9.00
21	Dairy barn 2	Places	120	3,234	25	3.00
22	Dairy barn 3	Places	240	3,008	25	1.00
23	Dairy barn 4	Places	480	2,782	25	0.00
24	Machinery 1	ha	15	2,200	12	5.00
25	Machinery 2	ha	30	1,600	12	5.00
26	Machinery 3	ha	50	1,400	12	4.00
27	Machinery 4	ha	100	1,200	12	3.00
28	Machinery 5	ha	200	1,000	12	2.20
29	Machinery 6	ha	500	800	12	1.00
30	Machinery 7	ha	1,000	700	12	0.00

Note: [1)] Additional labour demand per unit relative to the labour demand of the largest investment option.

Source: IMPERIAL (2004).

Table A-31: Investment options for Hohenlohe

No.	Investment type	Unit	Capacity	Investment costs	Useful life	Additional labour[1)]
			Unit	€/unit	years	h/unit
1	Sow housing 1	Places	40	2,659	20	3.80
2	Sow housing 2	Places	64	2,556	20	2.90
3	Sow housing 3	Places	128	2,352	20	1.30
4	Sow housing 4	Places	170	2,250	20	0.40
5	Sow housing 5	Places	252	2,147	20	0.00
6	Fatt. pig sty 1	Places	100	573	20	0.30
7	Fatt. pig sty 2	Places	200	522	20	0.20
8	Fatt. pig sty 3	Places	400	429	20	0.10
9	Fatt. pig sty 4	Places	600	368	20	0.02
10	Fatt. Pig sty 5	Places	1,000	358	20	0.00
11	Cattle barn 1	Places	40	2,659	25	8.00
12	Cattle barn 2	Places	100	2,454	25	3.00
13	Cattle barn 3	Places	200	2,147	25	0.00
14	Suckler cows 1	Places	10	1,053	25	5.00
15	Suckler cows 2	Places	40	820	25	0.00
16	Turkey house 1	Places	5,000	58	20	0.007
17	Turkey house 2	Places	10,000	57	20	0.002
18	Turkey house 3	Places	15,000	54	20	0.00
19	Dairy barn 1	Places	30	5,931	25	27.00
20	Dairy barn 2	Places	60	5,594	25	14.00
21	Dairy barn 3	Places	120	4,254	25	6.00
22	Dairy barn 4	Places	240	3,865	25	3.00
13	Dairy barn 5	Places	480	3,763	25	0.00
24	Machinery 1	ha	15	2,107	12	2.00
25	Machinery 2	ha	30	1,527	12	0.67
26	Machinery 3	ha	55	1,302	12	0.00
27	Machinery 4	ha	85	1,239	12	-1.18
28	Machinery 5	ha	150	1,106	12	-1.33
29	Machinery 6	ha	350	771	12	-1.40

Note: [1)] Additional labour demand per unit relative to the labour demand of the largest investment option.

Source: SAHRBACHER (2003) based on KLEINGARN (2002), KTBL (2001, 2002), ALLB ILSHOFEN (2001).

Table A-32: Investment options for Saxony

No.	Investment type	Unit	Capacity	Investment costs	Useful life	Additional labour[1)]
			Unit	€/unit	years	h/unit
1	Sow housing 1	Places	40	2,600	20	6.50
2	Sow housing 2	Places	64	2,500	20	4.50
3	Sow housing 3	Places	128	2,300	20	2.50
4	Sow housing 4	Places	170	2,200	20	1.00
5	Sow housing 5	Places	252	2,100	20	0.70
6	Sow housing 6	Places	336	1,930	20	0.50
7	Sow housing 7	Places	672	1,915	20	0.30
8	Sow housing 8	Places	800	1,900	20	0.10
9	Sow housing 9	Places	1,580	1,890	20	0.00
10	Fatt. pig sty 1	Places	100	560	20	1.57
11	Fatt. pig sty 2	Places	200	510	20	0.80
12	Fatt. pig sty 3	Places	400	420	20	0.40
13	Fatt. pig sty 4	Places	600	360	20	0.30
14	Fatt. pig sty 5	Places	1,000	357	20	0.21
15	Fatt. pig sty 6	Places	2,000	343	20	0.10
16	Fatt. pig sty 7	Places	5,400	335	20	0.03
17	Fatt. pig sty 8	Places	10,800	330	20	0.00
18	Cattle barn 1	Places	40	2,600	25	10.70
19	Cattle barn 2	Places	100	2,400	25	6.00
20	Cattle barn 3	Places	200	2,150	25	1.50
21	Cattle barn 4	Places	500	2,100	25	0.00
22	Suckler cows 1	Places	10	2,000	25	5.00
23	Suckler cows 2	Places	40	1,900	25	4.00
24	Suckler cows 3	Places	100	1,800	25	0.00
25	Dairy barn 1	Places	30	5,800	25	17.00
26	Dairy barn 2	Places	60	5,470	25	12.00
27	Dairy barn 3	Places	120	4,160	25	9.00
28	Dairy barn 4	Places	240	3,780	25	3.00
29	Dairy barn 5	Places	480	3,680	25	0.00
30	Machinery 1	ha	15	2,200	12	6.66
31	Machinery 2	ha	30	1,600	12	6.66
32	Machinery 3	ha	50	1,400	12	6.66
33	Machinery 4	ha	100	1,200	12	3.64
34	Machinery 5	ha	200	1,000	12	1.50
35	Machinery 6	ha	500	800	12	0.00
36	Machinery 7	ha	1,000	700	12	-1.00

Note: [1)] Additional labour demand per unit relative to the labour demand of the largest investment option.

Source: LFLSACHSEN (2003), KTBL (2001, 2002).

Table A-33: Investment options for France

No.	Investment type	Unit	Capacity	Investment costs	Useful life	Additional labour[1)]
			Unit	€/unit	years	h/unit
1	Hens 1	Places	40,000	23	20	0.02
2	Hens 2	Places	55,000	21	20	0.01
3	Hens 3	Places	70,000	20	20	0.00
4	Poultry_Chicken 1	Places	400	135	20	0.20
5	Poultry_Chicken 2	Places	1,000	120	20	0.00
6	Fatt. pig sty 1	Places	100	560	20	1.54
7	Fatt. pig sty 2	Places	200	510	20	0.77
8	Fatt. pig sty 3	Places	400	420	20	0.37
9	Fatt. pig sty 4	Places	600	390	20	0.27
10	Fatt. pig sty 5	Places	1,000	375	20	0.18
11	Fatt. pig sty 6	Places	2,000	350	20	0.07
12	Fatt. pig sty 7	Places	5,400	340	20	0.00
13	Sow housing 1	Places	30	2,600	20	7.50
14	Sow housing 2	Places	72	2,300	20	3.50
15	Sow housing 3	Places	144	2,100	20	1.50
16	Sow housing 4	Places	336	2,000	20	0.50
17	Sow housing 5	Places	672	1,980	20	0.30
18	Sow housing 6	Places	800	1,960	20	0.10
19	Sow housing 7	Places	1,580	1,950	20	0.00
20	Cattle barn 1	Places	30	2,407	25	6.00
21	Cattle barn 2	Places	60	2,237	25	3.00
22	Cattle barn 3	Places	100	2,190	25	1.50
23	Cattle barn 4	Places	200	2,000	25	0.00
24	Suckler cows 1	Places	30	3,092	25	5.00
25	Suckler cows 2	Places	60	2,225	25	2.00
26	Suckler cows 3	Places	90	2,057	25	0.00
27	Dairy barn 1	Places	30	5,400	25	13.00
28	Dairy barn 2	Places	60	4,600	25	8.00
29	Dairy barn 3	Places	90	4,200	25	6.50
30	Dairy barn 4	Places	120	4,000	25	5.00
31	Dairy barn 5	Places	240	3,850	25	2.00
32	Dairy barn 6	Places	480	3,750	25	0.00
33	Machinery 1	ha	15	2,200	12	6.66
34	Machinery 2	ha	30	1,600	12	6.66
35	Machinery 3	ha	50	1,400	12	6.66
36	Machinery 4	ha	100	1,200	12	3.64
37	Machinery 5	ha	200	1,000	12	1.50
38	Machinery 6	ha	500	800	12	0.00
39	Machinery 7	ha	1,000	700	12	-1.00

Note: [1)] Additional labour demand per unit relative to the labour demand of the largest investment option.

Source: SCHNICKE (2005) based on TEYSSIER (2002).

Table A-34: Investment options for Vysočina

No.	Investment type	Unit	Capacity	Investment costs	Useful life	Additional labour[1)]
			Unit	€/unit	years	h/unit
1	Sow housing 1	Places	30	1,456	20	10.05
2	Sow housing 2	Places	50	1,365	20	7.50
3	Sow housing 3	Places	80	1,283	20	5.38
4	Sow housing 4	Places	120	1,212	20	3.25
5	Sow housing 5	Places	200	1,157	20	1.55
6	Sow housing 6	Places	300	1,109	20	0.70
7	Sow housing 7	Places	500	1,078	20	0.28
8	Sow housing 8	Places	1,000	1,056	20	0.00
9	Fatt. pig sty 1	Places	50	455	20	1.74
10	Fatt. pig sty 2	Places	80	428	20	1.39
11	Fatt. pig sty 3	Places	150	402	20	1.09
12	Fatt. pig sty 4	Places	300	379	20	0.74
13	Fatt. pig sty 5	Places	500	359	20	0.44
14	Fatt. pig sty 6	Places	700	344	20	0.24
15	Fatt. pig sty 7	Places	1,000	334	20	0.14
16	Fatt. pig sty 8	Places	1,500	324	20	0.06
17	Fatt. pig sty 9	Places	3,000	316	20	0.00
18	Cattle barn 1	Places	80	1,541	25	6.50
19	Cattle barn 2	Places	150	1,300	25	3.50
20	Cattle barn 3	Places	300	1,200	25	1.50
21	Cattle barn 4	Places	500	1,150	25	0.00
22	Suckler cows 1	Places	60	730	25	3.50
23	Suckler cows 2	Places	90	700	25	1.50
24	Suckler cows 3	Places	150	680	25	0.50
25	Suckler cows 4	Places	250	670	25	0.00
26	Dairy barn 1	Places	50	3,296	25	14.50
27	Dairy barn 2	Places	90	3,105	25	10.50
28	Dairy barn 3	Places	150	2,914	25	8.50
29	Dairy barn 4	Places	300	2,675	25	2.50
30	Dairy barn 5	Places	600	2,516	25	0.50
31	Dairy barn 6	Places	1,000	2,420	25	0.00
32	Machinery 1	ha	15	1,500	12	8.00
33	Machinery 2	ha	30	700	12	7.00
34	Machinery 3	ha	50	530	12	6.00
35	Machinery 4	ha	100	420	12	4.00
36	Machinery 5	ha	200	370	12	2.00
37	Machinery 6	ha	500	330	12	0.00
38	Machinery 7	ha	1,000	300	12	-1.00

Note: [1)] Additional labour demand per unit relative to the labour demand of the largest investment option.

Source: UZEI (2004).

A.7 Calibrated economical data and technical coefficients of production activities[1]

Table A-35: Calibrated economical data and technical coefficients for wheat

Region	Gross margin	Premium	Labour requirement	Machinery requirement	Max. N-uptake	Crop rotation limit	
	€/ha	€/ha	h/ha	ha	kg N/ha	% UAA	
South East E.	535	355	4.8	1.00	170	max 60	
Saxony	350	392	4.8	1.00	170	max 40	
Hohenlohe	360	324	10.0	1.00	170	max 5	7
Brittany	451	355	10.0	1.00	170	max 6	3
Vysočina	305	**10**	6.8	1.00	170	max 50	

Sources: Sweden: AGRIWISE (2004). Prices are based on actual levels for 2003.
South East E.: NIX (2003) and calculations by Paul Webster, Wye Campus, Imperial College London.
Hohenlohe: SAHRBACHER (2003) based on REGIERUNGSBEZIRK MITTELFRANKEN (2000).
Saxony: LFL SACHSEN (2003).
Brittany: Price for peas and yields of field crops except rape seed are from TEYSSIER (2002); yield for rape seed and prices of field crops except for peas are from AGRESTE BRETAGNE (2003).
Vysočina: Yields and prices from KAVKA et al. (2000); variable costs from JUŘICA et al. (2004) and calculated by Zdeněk Louda, UZEI in Prague, Department "Centre for Economic Modelling" and Jana Poláčková, UZEI in Prague, Division of Structural and Economic Development of Agriculture.

1 Data which have been calibrated are bold written.

Table A-36: Calibrated economical data and technical coefficients for barley

Region	Gross margin	Premium	Labour requirement	Machinery requirement	Max. N-uptake	Crop rotation limit
	€/ha	€/ha	h/ha	ha	kg N/ha	% UAA
Jönköping	**32**	186	4.5	1.00	60	min 33
Västerbotten l	**-67**	273	4.5	1.00	36	min 33
Västerbotten h	2	273	4.5	1.00	60	min 33
South East E.	362	355	4.8	1.00	170	max 60
Saxony	257	392	4.8	1.00	170	max 66
Brittany	**339**	355	10.0	1.00	170	max 20
Vysočina	194	**10**	7.1	1.00	170	max 66

Note: In Västerbotten we differentiated between two soil types with low and high quality.

Sources: See Table A-35.

Table A-37: Calibrated economical data and technical coefficients for triticale

Region	Gross margin	Premium	Labour requirement	Machinery requirement	Max. N-uptake	Crop rotation limit
	€/ha	€/ha	h/ha	ha	kg N/ha	% UAA
Jönköping	**33**	186	5.5	1.00	70	min 50
Brittany	380	355	10.0	1.00	170	max 0 2

Sources: See Table A-35.

Table A-38: Calibrated economical data and technical coefficients for oats

Region	Gross margin	Premium	Labour requirement	Machinery requirement	Max. N-uptake	Crop rotation limit
	€/ha	€/ha	h/ha	ha	kg N/ha	% UAA
Jönköping	**30**	186	4.4	1.00	56	min 33
South East E.	437	355	4.8	1.00	170	max 60

Sources: See Table A-35.

Table A-39: Calibrated economical data and technical coefficients for rape seed

Region	Gross margin	Premium	Labour requirement	Machinery requirement	Max. N-uptake	Crop rotation limit
	€/ha	€/ha	h/ha	ha	kg N/ha	% UAA
South East E.	429	355	4.7	1.00	170	max 60
Saxony	272	392	4.8	1.00	170	max 30
Hohenlohe	230	324	8.5	1.00	170	max 30
Brittany	389	355	8.5	0.88	170	max 25
Vysočina	279	**10**	8.4	1.00	170	max 30

Sources: See Table A-35.

Table A-40: Calibrated economical data and technical coefficients for protein plants

Region	Gross margin	Premium	Labour requirement	Machinery requirement	Max. N-uptake	Crop rotation limit
	€/ha	€/ha	h/ha	ha	kg N/ha	% UAA
South East E.	**317**	407	7.6	1.00	170	max 60
Saxony	138	452	4.7	0.88	170	max 20
Hohenlohe	**57**	384	8.8	0.88	170	max 5
Brittany	305	409	9.2	0.88	170	-

Sources: See Table A-35.

Table A-41: Calibrated economical data and technical coefficients for potatoes

Region	Gross margin	Premium	Labour requirement	Machinery requirement	Max. N-uptake	Crop rotation limit
	€/ha	€/ha	h/ha	ha	kg N/ha	% UAA
South East E.	**1,017**	0	15.0	1.5	100	max 5
Vysočina	974	**10**	28.7	1.2	170	max 5

Sources: See Table A-35.

Table A-42: Calibrated economical data and technical coefficients for sugar beets

Region	Gross margin	Premium	Labour requirement	Machinery requirement	Max. N-uptake	Crop rotation limit
	€/ha	€/ha	h/ha	ha	kg N/ha	% UAA
Saxony	1,522	0	15.0	1.20	170	max 2.0
Hohenlohe	2,158	0	12.0	1.20	170	max 2.4

Sources: See Table A-35.

Table A-43: Calibrated economical data and technical coefficients for set aside

Region	Variable costs	Premium	Labour requirement	Machinery requirement	Crop rotation limit
	€/ha	€/ha	h/ha	ha	% AA U
Västerbotten l	0	168	4.35	0.1	max 50
Västerbotten h	0	168	2.40	0.1	max 50
Jönköping	0	186	2.40	0.1	max 50
South East E.	-16	407	2.30	0.3	max 60
Saxony	-31	392	4.00	0.3	max 33
Hohenlohe	-31	333	4.00	0.3	max 33
Brittany	-31	355	4.00	0.3	max 33
Vysočina	-39	179	1.90	0.3	max 10

Note: In Västerbotten we differentiated between two soil types with low and high quality.

Sources: See Table A-35.

Table A-44: Calibrated economical data and technical coefficients for breeding sows

Region	Gross margin	Labour requirement	Nitrogen excretion
	€/year	h/year	kg/year
South East E.	**206**	16.5	30
Hohenlohe	**452**	18.7	30
Saxony	**337**	13.5	30
Brittany	**365**	15.0	30
Vysočina	**115**	13.8	30

Sources: South East E.: NIX (2003) and calculations by Paul Webster, Wye Campus, Imperial College London.
Hohenlohe: SAHRBACHER (2003) based on REGIERUNGSBEZIRK MITTELFRANKEN (2000).
Saxony: LFL SACHSEN (2003).
Brittany: TEYSSIER (2002).
Vysočina: Gross margin is calculated from yields and prices: KAVKA et al. (2000) and variable costs: JUŘICA et al. (2004) and calculated by Zdeněk Louda, UZEI in Prague, Department "Centre for Economic Modelling" and Jana Poláčková, UZEI in Prague, Division of Structural and Economic Development of Agriculture.

Table A-45: Calibrated economical data and technical coefficients for sheep

Region	Gross margin	Premium	Labour requirement	Nitrogen excretion
	€/year	€/year	h/year	kg/year
Västerbotten	**97**	21	4.0	12
Jönköping	**106**	21	4.0	12
South East E.	**48**	20	3.1	6

Sources: Sweden: AGRIWISE (2004). Prices are based on actual levels for 2003.
South East E.: NIX (2003) and calculations by Paul Webster, Wye Campus, Imperial College London.

Table A-46: Calibrated economical data and technical coefficients for fattening pigs

Region	Gross margin	Labour requirement	Nitrogen excretion
	€/year	h/year	kg/year
South East E.	**37**	1.44	10
Hohenlohe	**57**	2.00	10
Saxony	**45**	1.00	10
Brittany	**57**	1.21	10
Vysočina	**28**	1.16	10

Sources: South East E.: NIX (2003) and calculations by Paul Webster, Wye Campus, Imperial College London.
Hohenlohe: SAHRBACHER (2003) based on REGIERUNGSBEZIRK MITTELFRANKEN (2000).
Saxony: LFL SACHSEN (2003).
Brittany: TEYSSIER (2002), AGRESTE BRETAGNE (2003).
Vysočina: Gross margin is calculated from yields and prices: KAVKA et al. (2000) and variable costs: JUŘICA et al. (2004) and calculated by Zdeněk Louda, UZEI in Prague, Department "Centre for Economic Modelling" and Jana Poláčková, UZEI in Prague, Division of Structural and Economic Development of Agriculture.

Table A-47: Calibrated economical data and technical coefficients for suckler cows

Region	Gross margin	Premium	Labour requirement	Nitrogen excretion
	€/year	€/year	h/year	kg/year
Västerbotten	**16**	300	6.3	63
South East E.	**172**	238	7.2	50
Hohenlohe	**312**	360	28.0	50
Saxony	**218**	313	20.0	50
Brittany	461	388	22.0	110
Vysočina	**278**	-	18.5	50

Sources: Sweden: AGRIWISE (2004). Prices are based on actual levels for 2003.
South East E.: NIX (2003) and calculations by Paul Webster, Wye Campus, Imperial College London.
Hohenlohe: SAHRBACHER (2003) based on REGIERUNGSBEZIRK MITTELFRANKEN (2000).
Saxony: LFL SACHSEN (2003).
Brittany: TEYSSIER (2002).
Vysočina: JUŘICA et al. (2004) and calculations by Zdeněk Louda, UZEI in Prague, Department "Centre for Economic Modelling" and Jana Poláčková, UZEI in Prague, Division of Structural and Economic Development of Agriculture.

Table A-48: Calibrated economical data and technical coefficients for dairy cows

Region	Gross margin	Premium	Labour requirement	Nitrogen excretion
	€/year	€/year	h/year	kg/year
Västerbotten	**2,335**	810	23.4	128
Jönköping	**2,321**	109	23.4	128
South East E.	**1,170**	114	28.0	100
Hohenlohe	1,380	104	28.0	100
Saxony	1,260	131	28.0	100
Brittany	**1,470**	114	37.0	100
Vysočina	**550**	24	27.5	100

Sources: Sweden: AGRIWISE (2004). Prices are based on actual levels for 2003.
South East E.: NIX (2003) and calculations by Paul Webster, Wye Campus, Imperial College London.
Hohenlohe: SAHRBACHER (2003) based on REGIERUNGSBEZIRK MITTELFRANKEN (2000).
Saxony: LFL SACHSEN (2003).
Brittany: TEYSSIER (2002), AGRESTE BRETAGNE (2003).
Vysočina: Gross margin is calculated from milk yield and price: JUŘICA et al. (2004) and from variable costs JUŘICA et al. (2004) and calculated by Zdeněk Louda, UZEI in Prague, Department "Centre for Economic Modelling" and Jana Poláčková, UZEI in Prague, Division of Structural and Economic Development of Agriculture.

Table A-49: Calibrated economical data and technical coefficients for beef cattle

Region	Gross margin	Premium	Labour requirement	Nitrogen excretion
	€/year	€/year	h/year	kg/year
Västerbotten[1)]	67	200	8.7	34
Jönköping[1)]	112	200	8.7	34
South East E.	**169**	151	8.4	50
Hohenlohe	268	212	12.0	50
Saxony	223	206	8.5	50
Brittany	**270**	290	11.5	50
Vysočina	**233**	0	8.5	50

Note: 1) Refers to "bull dairy".

Sources: Sweden: AGRIWISE (2004). Prices are based on actual levels for 2003.
South East E.: NIX (2003) and calculations by Paul Webster, Wye Campus, Imperial College London.
Hohenlohe: SAHRBACHER (2003) based on REGIERUNGSBEZIRK MITTELFRANKEN (2000).
Saxony: LFL SACHSEN (2003).
Brittany: TEYSSIER (2002), AGRESTE BRETAGNE (2003).
Vysočina: Gross margin is calculated from price and carcass weight JUŘICA et al. (2004) and from variable costs: JUŘICA et al. (2004) and calculated by Zdeněk Louda, UZEI in Prague, Department "Centre for Economic Modelling" and Jana Poláčková, UZEI in Prague, Division of Structural and Economic Development of Agriculture.

Table A-50: Calibrated economical data and technical coefficients for beef activities in Jönköping and Västerbotten

Region	Gross margin Jönköping	Gross margin Västerbotten	Premium	Labour requirement	Nitrogen excretion
	€/year	€/year	€/year	h/year	kg/year
Bull_dairy	112	**87**	200	8.7	34
Bullock_dairy	**151**	**142**	295	11.0	42
Bull_suckler	**84**	**80**	400	6.5	34

Sources: Sweden: AGRIWISE (2004). Prices are based on actual levels for 2003.

A.8 Decoupling scheme in the Sweden

Table A-51: Decoupling scheme for livestock payments in Jönköping and Västerbotten

Livestock	Total Premium	Direct Pay.		Slaugh. Prem.		Ext. Pay.	
	(€/ha)	(€/ha)		(€/ha)		(€/ha)	
Bullock dairy	295	150	25% to regional payment 75% coupled till 2009, then decoupled into the regional payment	45	60% to regional payment 40% to farm payment	100	50% to regional payment 50% to farm payment
Bull dairy	200	105		45		50	
Bull suckler	400	210		90		100	
Ext Bullock suckler	295	150		45		100	
Heifer suckler	200	200	50% to regional payment; 50% to farm payment				
Suckler cow	300	200				100	
Ewe	21	21	100% in regional payment				
Dairy cow	701	National support (only Västerbotten)			701	Not decoupled	

Source: SLI (2004).

Table A-52: Decoupling scheme for plant production in Jönköping

Production Activity	Total Premium	Direct Pay.		Env. subs 1		Env. subs 2		Comp. Pay.	
	(€/ha)	(€/ha)		(€/ha)		(€/ha)		(€/ha)	
Cereals	186	186	decoupled into regional payment		not decoupled		not decoupled		not decoupled
Set aside	186	186							
Reserve grass	192	93		44				55	
Grass silage	192	93		44				55	
Arable pasture	99			44				55	
Seminat grazing	242			110		77		55	

Source: SLI (2004).

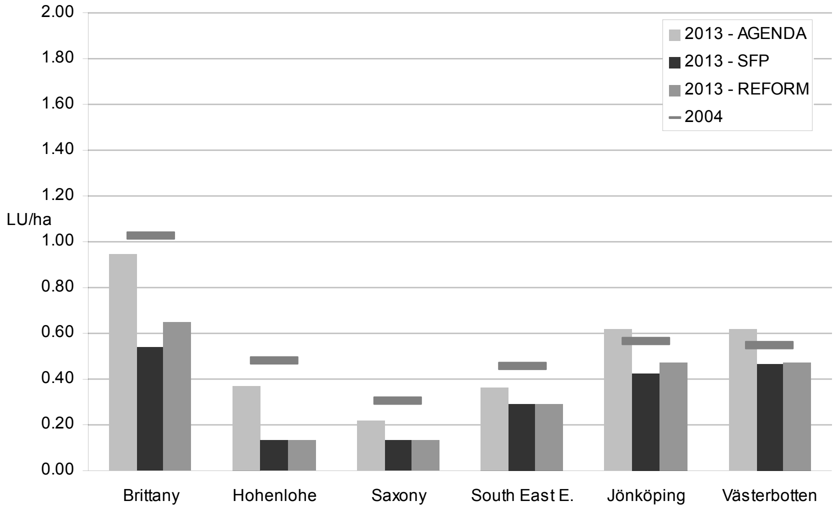
Table A-53: Decoupling scheme for plant production in Västerbotten

<table>
<tr><th>Production Activity</th><th>Total Premium</th><th>Direct Pay.</th><th></th><th>Env. Subs 1</th><th></th><th>Comp. Pay.</th><th></th><th>Drying Aid</th><th></th></tr>
<tr><td></td><td>(€/ha)</td><td>(€/ha)</td><td></td><td>(€/ha)</td><td></td><td>(€/ha)</td><td></td><td>(€/ha)</td><td></td></tr>
<tr><td>Cereals</td><td>273</td><td>168</td><td rowspan="4">decoupled into regional payment</td><td></td><td rowspan="6">not decoupled</td><td>55</td><td rowspan="6">not decoupled</td><td>50</td><td rowspan="6">decoupled into farm payment</td></tr>
<tr><td>Set aside</td><td>168</td><td>168</td><td></td><td>0</td><td></td></tr>
<tr><td>Reserve grass</td><td>405</td><td>84</td><td>225</td><td>96</td><td></td></tr>
<tr><td>Grass silage</td><td>405</td><td>84</td><td>225</td><td>96</td><td></td></tr>
<tr><td>Arable pasture</td><td>321</td><td></td><td></td><td>225</td><td>96</td><td></td></tr>
<tr><td>Seminat grazing</td><td>206</td><td></td><td></td><td>110</td><td>96</td><td></td></tr>
</table>

Source: SLI (2004).

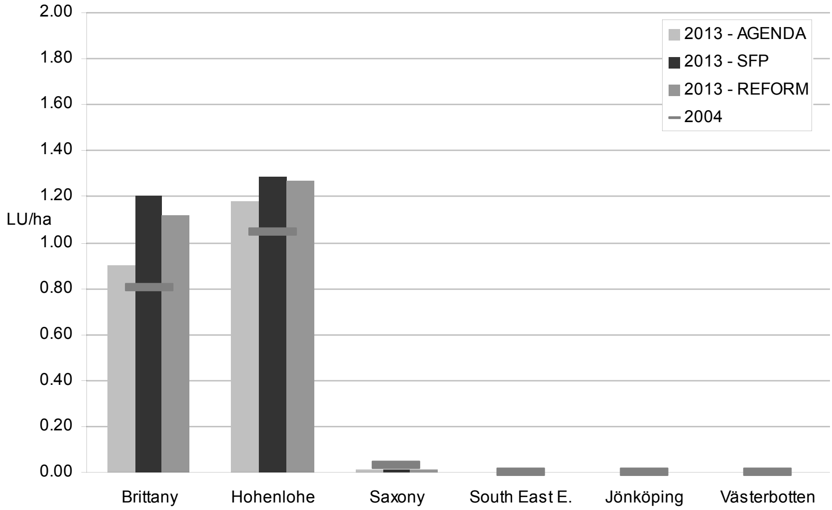
A.9 Development of Livestock density and labour input

Figure A-2: Average livestock density of ruminants in 2004 and 2013 depending on policy



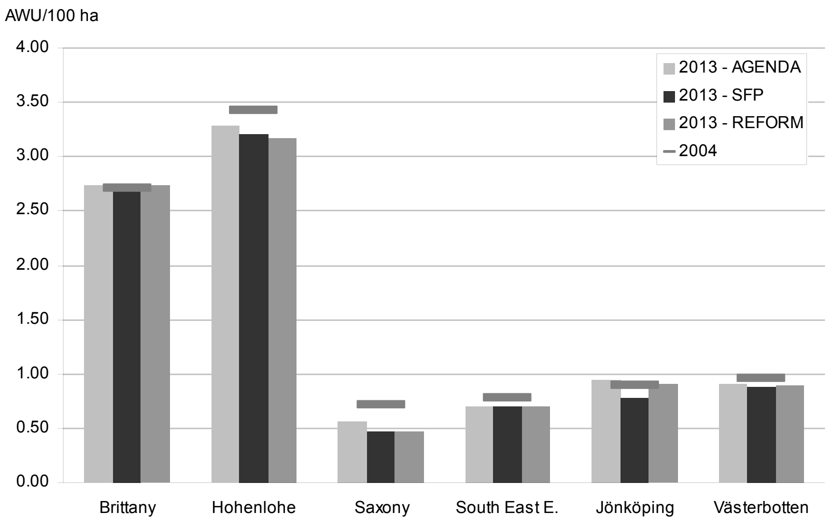
Source: Own calculations.

Figure A-3: Average livestock density of non-ruminants in 2004 and 2013 depending on policy



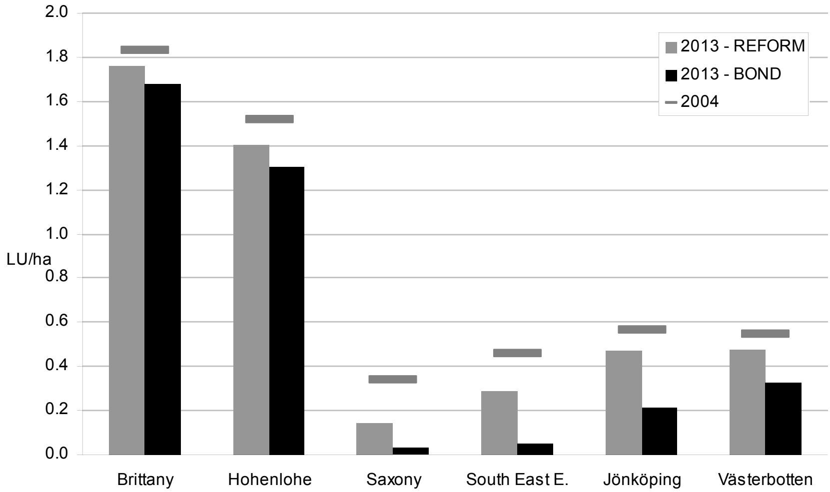
Source: Own calculations.

Figure A-4: Average labour input per 100 hectare in 2004 and 2013 depending on policy



Source: Own calculations.

Figure A-5: Average livestock density in 2004 and 2013 in the REFORM and BOND scenario



Source: Own calculations.

A.10 Impact of the different policy scenarios on profit per hectare in each region

Table A-54: Profit calculation Brittany

Year	***2004***	**2013**	**2013**	**2013**
Scenario	***AGENDA***	**AGENDA**	**SFP**	**REFORM**
			Difference to AGENDA	
	€/ha	**€/ha**	**€/ha**	**€/ha**
Gross margin	***1,064***	**1,090**	**104**	**76**
+ Interest on working capital	*13*	24	6	6
+ Subsidies	*463*	489	24	38
- Rent paid	*128*	134	-2	-2
- Maintenance charges	*110*	97	2	1
- Depreciation	*398*	371	5	1
- Farming overheads	*15*	15	1	1
- Interest paid	*130*	130	5	4
- Wages paid	*63*	80	-10	-6
- Transport costs	*11*	12	0	0
Profit	***684***	**763**	**134**	**121**
- Imputed costs own labour	*422*	436	5	5
Profit-costs own labour	***262***	**327**	**130**	**117**

Source: Own calculations.

Table A-55: Profit calculation Hohenlohe

Year	***2004***	**2013**	**2013**	**2013**
Scenario	***AGENDA***	**AGENDA**	**SFP**	**REFORM**
			Difference to AGENDA	
	€/ha	**€/ha**	**€/ha**	**€/ha**
Gross margin	***1,516***	**1,576**	**34**	**9**
+ Interest on working capital	*19*	28	3	4
+ Subsidies	*342*	346	0	0
- Rent paid	*163*	202	25	22
- Maintenance charges	*119*	104	0	0
- Depreciation	*509*	516	-9	-20
- Farming overheads	*18*	18	0	0
- Interest paid	*195*	167	7	1
- Wages paid	*122*	178	-15	-24
- Transport costs	*12*	17	-2	-2
Profit	***740***	**748**	**31**	**36**
- Imputed costs own labour	*648*	589	-16	-13
Profit-costs own labour	***93***	**159**	**47**	**49**

Source: Own calculations.

Table A-56: Profit calculation Saxony

Year	***2004***	**2013**	**2013**	**2013**
Scenario	***AGENDA***	**AGENDA**	**SFP**	**REFORM**
			Difference to AGENDA	
	€/ha	**€/ha**	**€/ha**	**€/ha**
Gross margin	***544***	**504**	**-48**	**-56**
+ Interest on working capital	*17*	59	1	0
+ Subsidies	*384*	402	-6	-9
- Rent paid	*136*	193	-1	-3
- Maintenance charges	*47*	38	-2	-2
- Depreciation	*221*	177	-29	-32
- Farming overheads	*8*	8	0	0
- Interest paid	*46*	36	-6	-6
- Wages paid	*105*	86	-20	-20
- Transport costs	*20*	20	-1	0
Profit	***362***	**405**	**6**	**0**
- Imputed costs own labour	*52*	45	-5	-6
Profit-costs own labour	***310***	**359**	**10**	**6**

Source: Own calculations.

Table A-57: Profit calculation South East England

Year	***2004***	**2013**	**2013**	**2013**
Scenario	***AGENDA***	**AGENDA**	**SFP**	**REFORM**
			Difference to AGENDA	
	€/ha	**€/ha**	**€/ha**	**€/ha**
Gross margin	***491***	**432**	**39**	**38**
+ Interest on working capital	*15*	53	3	2
+ Subsidies	*285*	291	6	6
- Rent paid	*143*	176	11	11
- Maintenance charges	*38*	33	1	1
- Depreciation	*146*	106	3	1
- Farming overheads	*7*	7	0	0
- Interest paid	*39*	31	0	0
- Wages paid	*64*	46	3	1
- Transport costs	*23*	24	0	0
Profit	***330***	**354**	**29**	**32**
- Imputed costs own labour	*101*	108	-3	6
Profit-costs own labour	***230***	**246**	**33**	**25**

Source: Own calculations.

Table A-58: Profit calculation Jönköping

Year	***2004***	**2013**	**2013**	**2013**
Scenario	***AGENDA***	**AGENDA**	**SFP**	**REFORM**
			Difference to AGENDA	
	€/ha	**€/ha**	**€/ha**	**€/ha**
Gross margin	***456***	**431**	**-87**	**-29**
+ Interest on working capital	*65*	76	17	20
+ Subsidies	*313*	364	-12	9
- Rent paid	*58*	88	23	18
- Maintenance charges	*74*	66	-15	-10
- Depreciation	*169*	148	-26	-20
- Farming overheads	*8*	8	-1	0
- Interest paid	*71*	74	-23	-16
- Wages paid	*1*	19	-15	-5
- Transport costs	*38*	47	-3	-4
Profit	***416***	**421**	**-24**	**39**
- Imputed costs own labour	*324*	337	-49	-7
Profit-costs own labour	***92***	**84**	**25**	**46**

Source: Own calculations.

Table A-59: Profit calculation Västerbotten

Year	***2004***	**2013**	**2013**	**2013**
Scenario	***AGENDA***	**AGENDA**	**SFP**	**REFORM**
			Difference to AGENDA	
	€/ha	**€/ha**	**€/ha**	**€/ha**
Gross margin	***414***	**265**	**39**	**59**
+ Interest on working capital	*71*	73	20	21
+ Subsidies	*656*	721	-4	-12
- Rent paid	*56*	118	25	18
- Maintenance charges	*97*	71	2	2
- Depreciation	*243*	187	11	14
- Farming overheads	*11*	10	0	0
- Interest paid	*91*	75	0	2
- Wages paid	*33*	54	-5	-3
- Transport costs	*32*	38	-4	-4
Profit	***579***	**507**	**26**	**39**
- Imputed costs own labour	*315*	292	-6	-4
Profit-costs own labour	***263***	**215**	**32**	**43**

Source: Own calculations.

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