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

Amanda Sahrbacher

Impacts of CAP reforms on farm structures and performance disparities

An agent-based approach

LEIBNIZ-INSTITUT FÜR AGRARENTWICKLUNG
IN MITTEL- UND OSTEUROPA

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ZUSAMMENFASSUNG

Ziel der Arbeit ist es zu untersuchen, wie die Direktzahlungen der Gemeinsamen Agrarpolitik (GAP) die Entwicklung der Betriebsstrukturen und dadurch Leistungs- und Einkommensdisparitäten zwischen den Betrieben beeinflusst. Der Schwerpunkt dieser Arbeit liegt im Vergleich der Auswirkungen der Verteilung der Direktzahlungen auf die Landwirtschaft. Dabei werden folgende drei Politikmaßnahmen betrachtet: 1) die Art der Entkopplung der Direktzahlungen im Rahmen der Fischler Reform, d.h. Regionalmodel, Betriebsmodel bzw. Hybridmodel; 2) das Niveau und die Ausgestaltung der Modulation, d.h. die Kürzung der Direktzahlungen in Abhängigkeit der Betriebsgröße bzw. unabhängig davon und 3) eine schrittweise Reduzierung der Direktzahlungen (1. Säule) ab 2013 für alle Betriebe parallel zu einer Aufstockung der Zahlungen der zweiten Säule. In der Analyse dieser Politiken werden insbesondere die Auswirkungen auf die Betriebsstrukturen, die Landnutzung, den Bodenmarkt und die Produktion berücksichtigt. Des Weiteren werden Auswirkungen auf die Verteilung der Direktzahlungen und Einkommen zwischen den Betrieben untersucht. Die durchgeführten Untersuchungen geben somit einen Überblick über die Auswirkungen der letzten GAP-Reformen auf die Landwirtschaft.

Die Auswirkungen dieser Politikmaßnahmen wurden mit Hilfe des agentenbasierten Models AgriPoliS (Agricultural Policy Simulator) untersucht. AgriPoliS ermöglicht es, das Zusammenspiel und die Entwicklung heterogener und untereinander vernetzter Betriebe zu beobachten. Insbesondere ist es möglich, die Reaktionen einzelner Betriebe auf politische Reformen zu beobachten. Im Rahmen dieser Arbeit wurde AgriPoliS an die Region Ostprignitz-Ruppin (OPR) in Brandenburg angepasst. Bei der Modellierung der Region wurde besondere Wert auf die Abbildung der natürlichen Gegebenheiten gelegt. Dabei wurden die Produktionsverfahren für insgesamt fünf unterschiedliche Bodentypen differenziert. Zusätzlich wurde neben der Abbildung verschiedener Entkopplungsvarianten die Agrarumweltmaßnahme "gesamtbetriebliche *extensive Grünland*-Bewirtschaftung" aus der zweiten Säule modelliert. Dabei bekommen die Landwirte für die extensive Nutzung der gesamten Grünlandfläche ihres Betriebes eine Agrarumweltzahlung. OPR ist eine Region mit marginalen Standorten in der neben kleineren Familienbetrieben große Personengesellschaften und Juristische Personen existieren. Des Weiteren wirtschaften die Betriebe in OPR mit einem hohen Pachtflächenanteil und sind stark von Fremdarbeitskräften abhängig. Gleichzeitig ist die Landwirtschaft in dieser Region einer der wichtigsten Arbeitgeber, weshalb die Entwicklung der Betriebe in Anbetracht der hohen Arbeitslosigkeit in der Region von besonderer Bedeutung ist. Auf Grund dieser strukturellen Besonderheiten

wirken sich die in den letzten Jahren beschlossenen Politikmaßnahmen in besondere Weise auf die Region aus.

In einer *ersten Reihe von Simulationsexperimenten* werden die Auswirkungen der drei in 2005 eingeführten Entkopplungsoptionen 1) Betriebsmodel, 2) Regionalmodel und 3) das in Deutschland angewandte Hybridmodel untersucht. Die Ergebnisse zeigen, dass das Regionalmodel im Vergleich zu den beiden anderen Entkopplungsoptionen zu einem Rückgang der Betriebsaufgaben führt. Im Hybridmodell hören dagegen schon mehr Betriebe auf und im Betriebsmodel die meisten. Gleichzeitig steigt durch die Entkopplung der Pachtflächenanteil in der Region. Kleinere und mittlere Betriebe scheiden aus der Landwirtschaft aus und verpachten ihre Eigentumsflächen an größere Betriebe. Das stärkste Wachstum können auf Markfruchtbau spezialisierte Einzelbetriebe verzeichnen, die insbesondere im Regionalmodel verfügbares Grünland hinzupachten, dies aber nach guter landwirtschaftlicher Praxis nur minimal nutzen. Die minimale Nutzungsweise ist in allen Entkopplungsmodellen auch auf Ackerstandorten von geringer Qualität zu beobachten, was zu einer Konzentration der Produktion auf besseren Böden führt. Des Weiteren führt die Entkopplung der Direktzahlungen zu einem Rückgang der Rinderhaltung in der Region und somit auch zu einem Rückgang der Beschäftigung in der Landwirtschaft.

In allen Entkopplungsmodellen steigt der Anteil der Direktzahlungen am Faktoreinkommen bis 2013. Der Anstieg der Ungleichheit in den Faktoreinkommen zwischen 2004 und 2013 sowie die zunehmende Ungleichheit der Verteilung der Direktzahlungen zeigt, dass keines der Entkopplungsmodelle die Ungleichheit zwischen den Betrieben reduziert. Im Falle des Betriebsmodels gewinnen Futterbaubetriebe bei einer *betrieblichen Betrachtung* mehr Direktzahlungen als in den anderen Entkopplungsmodellen. Dies gilt jedoch nicht bei einer *Betrachtung pro Arbeitskraft*. Die Ergebnisse zeigen, dass die Direktzahlungen pro Arbeitskraft von Futterbaubetrieben 2013 niedriger sind als in 2004. Ackerbaubetriebe, insbesondere einzelbetrieblich organisierte, haben durch die Entkopplung deutlich gewonnen. Dies gilt in besonderem Maße für das Hybridmodel, bei dem Ackerbaubetriebe den Umfang der Direktzahlungen pro Arbeitskraft im Vergleich zu 2004 nahezu verdreifachen können. Dieser starke Anstieg ist durch die Zupacht von bisher nicht genutztem Grünland und der minimalen Nutzung dieser Flächen als auch der minimalen Nutzung von niedwertigen Ackerland möglich. Dadurch verringert sich die Arbeitsintensität und die Direktzahlungen werden auf weniger Arbeitskräfte verteilt. Insoweit kommt es im Hybridmodel zu einer Umverteilung der Direktzahlungen von intensiv wirtschaftenden Rindermastbetrieben hin zu extensiver wirtschaftenden Betrieben. Im Hybridszenario werden zwar auf kurze Sicht Gewinnverluste durch die schrittweise Prämienumverteilung vermieden, aber langfristig verringert sich dadurch nicht die Abhängigkeit von den Direktzahlungen. Dadurch reduziert sich der Spielraum für weitere Anpassungen der

Agrarpolitik, wodurch zukünftige Verhandlungsrunden für GAP-Reformen komplizierter werden.

In einer *zweiten Reihe von Simulationsexperimenten* werden zwei Modulationsvarianten für die Zeit zwischen 2009 und 2013 verglichen. Zum einen wird eine mit der Betriebsgröße zunehmende Modulation (progressiv) modelliert, wobei die Modulationsraten wie im Health Check beschlossen ab 2009 jährlich ansteigen. In der zweiten Modulationsvariante wird für Betriebe mit mehr als 5.000 Euro Prämie von einer einheitlichen Modulationsrate ausgegangen. Wie in der ersten Modulationsvariante nimmt auch hier die Modulation von 2009 bis 2013 zu. Die Simulationsergebnisse zeigen, dass durch die Modulation mehr Betriebe aus der Landwirtschaft ausscheiden. Dabei handelt es sich insbesondere um kleinere Einzelbetriebe. Dies widerspricht der im Rahmen des Health Checks getroffenen Annahme, dass eher Großbetriebe von der Modulation in ihrer Existenz bedroht wären. Betriebe mit mehr als 300.000 Euro Direktzahlungen pro Hektar verlieren zwar zwischen 2008 und 2013 Fläche, jedoch hört keiner dieser Betriebe auf. Bei einer einheitlichen Modulation können mittelgroße Betriebe mit 200.000 bis 300.000 Euro Prämie Fläche gewinnen. Verbleibende "kleinere" Betriebe mit weniger als 200.000 Euro Direktzahlungen (< 600 ha) in 2013 sind nur wenig von der Modulation betroffen. Die Modulation hat aber nicht nur einen Einfluss auf die Betriebsgrößen, sondern auch auf die Verteilung der Direktzahlungen. So nimmt die Ungleichverteilung durch die Modulation zwischen 2008 und 2013 zu. Allerdings nähme die Ungleichverteilung im Falle einer einheitlichen Modulation weniger stark zu. Darüber hinaus hat die Modulation keinen Einfluss auf die Teilnahme bei der Agrarumweltmaßnahme "extensives Grünland". Somit liegt der Erfolg der Modulation eher in der Reduzierung exorbitant hoher Direktzahlungen einzelner Betriebe, wie sie von der Öffentlichkeit kritisiert werden, als in einer vernünftigen Umverteilung zwischen der ersten und der zweiten Säule der Agrarpolitik.

In einer *dritten und letzten Reihe von Simulationsexperimenten* werden die Direktzahlungen zwischen 2013 und 2020 schrittweise auf 100 Euro pro Hektar gekürzt. Parallel dazu steigen die Zahlungen für die Agrarumweltmaßnahme "extensives Grünland" (zweite Säule). Die Kürzung der Direktzahlungen führt schon im ersten Jahr zu einem deutlichen Anstieg der Betriebsaufgaben. Insbesondere sind davon kleinere Einzelbetriebe betroffen. Nur Betriebe bei denen der Anteil der Direktzahlungen am Faktoreinkommen unter 30 % liegt, verbleiben bis 2020 in der Landwirtschaft. Personengesellschaften und Juristische Personen erweisen sich als weniger anfällig gegenüber Direktzahlungskürzungen. Durch die Direktzahlungskürzung sinkt auch die Anzahl der in der Landwirtschaft Beschäftigten bis 2020 gegenüber 2013 auf 75 %. Die Pachtpreise für Ackerland sinken um 19 % und Ackerland von geringer Qualität fällt entweder brach oder wird nur noch gepflegt und nicht mehr für die Produktion genutzt. Die Ergebnisse zeigen, dass der schrittweise Anstieg der Zahlungen für "extensive Grünlandnutzung" zu steigenden

Pachtpreisen für Grünland führt. Jedoch lässt sich durch den Anstieg der Zahlungen für "extensive Grünlandnutzung" weder der Strukturwandel bremsen, noch lässt sich vermeiden, dass 50 % des Grünlandes in der Region brach fällt. Die Höhe der Zahlungen reicht jedoch aus, dass immerhin 40 % des genutzten Grünlandes extensiv bewirtschaftet werden. Bis 2020 konnten tierhaltende Betriebe ihre Fläche auf Grund der steigenden Zahlungen für "extensive Grünlandnutzung" im Vergleich zum Szenario mit konstanten Zahlungen für "extensive Grünlandnutzung" sogar ausdehnen.

Die Simulationsexperimente zeigen, dass jeglicher Eingriff durch die öffentliche Hand Einfluss auf die Einkommensverteilung und die Betriebsstrukturen hat. Mit Hilfe agentenbasierter Modellierung ist es im Vergleich zu anderen Ansätzen möglich, das Anpassungsvermögen von Landwirten in einer dynamischen Umwelt zu berücksichtigen und somit zusätzliche Erkenntnisse über die Auswirkungen politischer Maßnahmen zu gewinnen. Darüber hinaus ermöglicht die individuelle Modellierung der Betriebe einer Region eine gezielte und flexible Auswahl der Untersuchungseinheiten. Dies erleichtert die Identifikation der Hauptnutznießer der öffentlichen Stützungsmaßnahmen sowie die Folgenabschätzung der Direktzahlungsverteilung auf das Investitionsverhalten der Betriebe. Die agentenbasierte Modellierung ist folglich ein geeigneter Ansatz mit dem sich Auswirkungen von Politikmaßnahmen auf eine stark differenzierte Population in einer heterogenen Struktur untersuchen lassen. Dabei lässt sich insbesondere das Ausmaß von Moral Hazard und adverser Selektion von potentiellen freiwilligen Maßnahmen, die im Rahmen der zweiten Säule eingeführt werden könnten, untersuchen. Demzufolge lässt sich durch eine bessere Einschätzung der Teilnahme an Maßnahmen der zweiten Säule das Phänomen leerer bzw. voller Kassen vermeiden. Da jedoch der Erfolg nicht ohne eine klare Festlegung der auf regionaler Ebene zu erreichenden Ziele möglich ist, ist es wichtig, im ersten Schritt bisher erfolgreiche Maßnahmen und lokales Wissen zu berücksichtigen. Dabei kann agentenbasierte Modellierung nicht nur für die Folgenabschätzung von Politikmaßnahmen ein hilfreiches Werkzeug sein, sondern auch bei der politischen Entscheidungsfindung.

SUMMARY

The objective of this work is to investigate how Common Agricultural Policy's (CAP) direct payments influence the development of farm structures and therefore performance and income disparities between farms. In this study the focus is put on the comparison of impacts of changes in direct payments distribution on the agricultural sector considering 1) the decoupling model, i.e. either a regional area payment, a historic payment or a hybrid payment system from 2005; 2) the level and design of modulation, i.e. cuts in Pillar I payments relative or not to farm size and; 3) yearly cuts in Pillar I payments for all farms from 2013 parallel to increases in Pillar II payments. Outcomes of policy changes are analysed regarding their impact on farm structures, land use, land markets and agricultural production. Distributive effects of direct payments and agricultural incomes among farms are compared. The analyses performed in this study provide a panorama of impacts of CAP reforms on the agricultural sector.

The approach chosen is the agent-based model AgriPoliS (Agricultural Policy Simulator). This model allows considering very heterogeneous farm structures. It allows as well the observation of individual decisions consecutive to political reforms in a dynamic and complex network. The model has been adapted to the Eastern German region Ostprignitz-Ruppin (OPR) in the Federal State of Brandenburg. In order to improve the representation of OPR's natural conditions in the model, production activities have been differentiated for five soil types. In addition to this, the Pillar II agri-environmental measure (AEM) "extensive grassland" has been modelled and provides an agri-environmental payment (AEP) to farmers for converting their whole grassland into extensive grassland. OPR is a marginal region where family farms cohabit with large farms organised as legal entities or partnerships. Farm structures in OPR are characterised by a high share of rented land and many farms rely on hired labour in a region where unemployment's rate would otherwise be higher than it already is. This specific farming and ownership structure in OPR can make recent political decisions quite a sensitive topic at the time.

In a *first series of experiments* three decoupling modalities, 1) a historic payment, 2) a regional payment and 3) the actual German hybrid dynamic decoupled payment, are implemented from 2005. Results show that the introduction of the regional payment is inhibiting structural change in the sense that less farms close down compared to the two other decoupling scenarios. On the contrary, least farms survive after 2005 with the introduction of a historic payment. In all scenarios the proportion of rented land increases. Land transfers occur from small or medium farms owning most of their land to larger farm units renting most of it. The

highest increases in farm size are observed by individual farms oriented in field crop farming which expand by renting available grassland especially in the case of a regional payment. In all scenarios low quality arable land is kept in Good Agricultural and Environmental Conditions (GAEC) and is therefore not used for production anymore. This leads to a concentration of productive activities on better soils whereas poor soils are minimally used. The introduction of decoupling plays an important role in the decrease of employment in agriculture. This decrease is linked to the lower attractiveness of ruminant productions. Family workers allocate more time to jobs outside agriculture and the number of agricultural employees is reduced.

An important share of farms' agricultural factor income is made of direct payments in 2013. The increase in overall inequality in agricultural factor incomes between 2004 and 2013 as well as the increase in the contribution of Pillar I payments to this overall inequality show that none of the decoupling scheme does really change distributive inequalities observed between farms. In the historic model intensive beef fattening and intensive milk production would have gained more payments *per farm* compared to the two other decoupling models. This is not the case anymore if Pillar I payments are calculated *per annual working unit (AWU)*. Results show that Pillar I payments for grazing livestock farms in 2013 are lower than in 2004. Field crop farming, mostly operated by individual farms, has gained a lot with decoupling, especially with the actual hybrid payment. Actually in this latter scenario these farms could almost triple the amount of Pillar I payments per AWU compared to 2004. This increase is due to large expansions by renting formerly unused grassland and keeping it in GAEC, as well as low quality arable land. Therefore labour intensity at the farm level is reduced. To this extent there is a redistribution of Pillar I payments in favour of extensive farming at the expense of intensive cattle farms with the hybrid payment. In this scenario, even though profit losses are avoided in a short term perspective, it does not help farms to be less dependent on direct payments than they already were before 2005. This reduces potential room for manoeuvre and therefore will complicate future CAP reform negotiations.

In a *second series of experiments*, two modulation modalities between 2009 and 2013 have been compared. First, a modulation increasing with farm size (or "progressive" modulation), was introduced in the model. The same modulation rates than those introduced in 2009 consecutively to the Health Check of the CAP have been used. Second, a homogenous modulation with rates increasing between 2009 and 2013 was implemented for all farms receiving more than 5,000 Euros of Pillar I payments. Compared to the situation without cuts in Pillar I payments, simulation results show that more farms close down in both modulation scenarios. Farms closing are mainly small individual farms. This may contradict expectations made during CAP's Health Check predicting that very large farms would be threatened in their existence by drastic cuts, causing further job losses in already

economically underdeveloped areas. Large farms (receiving more than 300,000 Euros of Pillar I payments) lose acreage and downsize with the actual hybrid payment between 2008 and 2013. However, none of them closes down with modulation. Results show that medium-large farms (receiving between 200,000 and 300,000 Euros of Pillar I payments in 2013) gain some acreage in case of a homogenous modulation. "Smaller" farms (receiving less than 200,000 Euros of Pillar I payments and smaller than 600 ha) still remaining in the region in 2013 only suffer moderately from the introduction of modulation. Results show that with or without modulation, inequality in the distribution of Pillar I payments increases between 2008 and 2013. However, inequality increases less in case of a homogenous modulation compared to the other scenarios. Moreover, modulation has no influence in the participation of farms in the AEM "extensive grassland". Therefore, modulation rather succeeded more in limiting visible excesses pointed out by public opinion than being a sensible redistributive tool between Pillar I and Pillar II.

In the *third and last series of experiments* yearly cuts in Pillar I payments are introduced from 2013 onwards parallel to increases in the AEP for the conversion of grassland into extensive grassland (Pillar II). Impacts on farm structures are substantial and visible from the first year of payments' cuts. Structural change is substantially accelerated and among those farms closing the huge majority is constituted of individual farms, which are the smallest farms in the region as well. Only farms for which Pillar I payments contribute to less than 30% of their agricultural factor income in 2013 still remain in the region in 2020. Partnerships and legal entities show a higher resilience towards strong Pillar I payment reductions than individual farms. Total employment in agriculture decreases to 75% of its 2013 level. Arable land has lost 19% of its value and if not abandoned, low quality arable land is massively turned into land kept in GAEC but not used for production. Results show that the yearly increase in the AEP after 2013 exerts a pressure on rental prices for grassland through the indirect support of land-based animal productions. However, it is neither enough to slow down structural change nor to prevent the abandonment of more than 50% of available grasslands. But it is enough for farms to keep 40% of the remaining used grassland as "extensive grassland". In 2020 grazing livestock farming even gained some acreage compared to cuts in Pillar I payments without redistribution to Pillar II.

The simulation experiments show that any public intervention has consequences on farm structures. As agent-based modelling is able to consider farms' adaptive capabilities in a dynamic framework, it can provide additional insights on policy impacts compared to other approaches. Moreover, analyses performed at the very individual level allow a precise targeting of study groups. This facilitates the identification of main beneficiaries of public support as well as the impact assessment of payments' distributional patterns on farms' investment decisions. Agent-based modelling is therefore an appropriate tool which allows depicting impacts of a policy on a highly differentiated population placed on a heterogeneous landscape.

Especially when considering a portfolio of voluntary programmes as mostly implemented in the current Pillar II of the CAP, agent-based modelling could help investigating the extent of moral hazard and adverse selection of potential new measures. Consequently a better assessment of required resources would prevent empty or full cashbox phenomena in public expenses. However, as no success can be guaranteed without any clear setting of objectives to be reached at the regional level, it is important at the first place to consider past successes and local knowledge. Therefore agent-based modelling could constitute a helpful tool not only for policy impact assessment, but for policy decision making as well.

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LIST OF ABBREVIATIONS

AgriPoliS	Agricultural Policy Simulator
AEM	Agri-Environmental Measure
AEP	Agri-Environmental Payment
AWU	Annual Working Unit
AZ	Ackerzahl (German index of soil quality)
BMELV	German Federal Ministry of Food, Agriculture and Consumer Protection
CAP	Common Agricultural Policy of the European Union
CEEC	Central and Eastern European Countries
CGE	Computable General Equilibrium
COP	Cereals, Oilseeds and Protein plants
dt	Deciton
€	Euros
EAGGF	European Agricultural Guidance and Guarantee Fund
EEC	European Economic Community
EU	European Union
FADN	Farm Accountancy Data Network
FNVA	Farm Net Value Added
GAEC	Good Agricultural and Environmental Conditions
GATT	General Agreement on Tariffs and Trade
GDR	German Democratic Republic
GE	Generalised Entropy
ha	hectare
HC	Health Check
hh income	Household income
IBM	Individual Based Models
InVeKos	Integrated administration and control system
KTBL	Kuratorium für Technik und Bauwesen in der Landwirtschaft

LEADER	Liaisons Entre Actions de Développement de l'Economie Rurale
LFA	Least Favoured Area
LU	Livestock unit
MIP	Mixed-integer programme
MJ ME	Mega Joule of Metabolic Energy
MLD	Mean Logarithmic Deviation
MLUV	Ministry for Agriculture, Environment and Consumer Protection (Brandenburg)
MTR	Mid-term review
NEL	Net Energy of Lactation
OECD	Organisation for Economic Co-operation and Development
OPR	Ostprignitz-Ruppin
RD	Rural Development
SAP	Single Area Payment
SFP	Single Farm Payment
SPS	Single Payment Scheme
UAA	Utilized agricultural area
UK	United Kingdom
USA	United States of America
WTO	World Trade Organization

INTRODUCTION

Problem definition

The European agricultural sector is in constant evolution. At the basis of agricultural activities are farms, which diversity and heterogeneous capacities shape the European agriculture. Individual farms or legal entities, part-time of full-time businesses, farms' activities provide commodities for agricultural markets, jobs in rural areas, shape landscapes and interact deeply with the environment. They are rewarded by an income they get from their way of managing the combination of resources they dispose of. This potential income differs widely depending on farm's location, size and type of farming among other factors of variability. Above these factors, one important driver determining farm income is the Common Agricultural Policy (CAP). From the very first years of its creation, this policy serves as framework common to all agricultural and most rural activities, and all farms registered as such see their activities ruled by the CAP in some way. This policy clearly state one of its main objective "to ensure a fair standard of living for the agricultural community, in particular by increasing the individual earnings of persons engaged in agriculture" (Article 33 of the Treaty of Rome, 1957). Income support was a fundamental objective in other "industrialised capitalist market economies as a group" (HILL, 2000) as well as in OECD (Organisation for Economic Co-operation and Development) countries in general, where "the maintenance of farm incomes [was] probably the major objective of agricultural policy" (WINTERS, 1988). There are hardly other sectors in industrialised economies where such an emphasis on income has been made than in the agricultural sector. In the case of CAP, the income objective, combined with the other articles of the Treaty and following reforms were aiming at implementing the following: through restructuring and modernisation, the productivity of agriculture should be enhanced and therefore earnings coming from agriculture increase. The CAP's role was to provide measures and instruments helping the farming sector to fulfil necessary steps to reach those goals set for the sector.

The bulk of the support provided by the CAP has long been "invisible" to the society. Provided through price policies performed within each European Common Market Organisation until 1992, it has afterwards been delivered through direct payments. Payments progressively increased to compensate farmers for the loss of income provoked by the decrease of European Union's (EU) internal agricultural prices while these prices progressively decreased to reach the level of world prices.

Times have changed a lot since the creation of the CAP and many reforms and corrections occurred since then. In particular the last reform, the so-called "Fishler reform", marked deeply the modalities of intervention of the CAP. Direct payments (also called Pillar I payments) have been decoupled from production for most agricultural sectors and are now distributed independently from farmers' production decisions; EU member states had the choice to implement either a regional payment, a historic payment or a hybrid payment system. Additionnally, landscape, environment and food quality as well as rural viability are being tackled by the Rural Development policy (RD policy), also called Pillar II of the CAP. Although the provisions for Pillar II are much inferior than those devoted to the first pillar of the CAP, instruments and measures designed in the second pillar are aiming at inciting farmers to better care for the environment and related issues as well as rewarding them for any behavioural change towards the improvement of environment and waters, the maintenance of landscapes and biodiversity as well as for initiatives towards the sustainability of rural areas. The provision of these non commodity goods is rewarded by payments in the framework of bilateral contracts between the farmer and the administration. Beyond the environmental benefits, these payments may constitute a good balance for those farms located in less favoured European zones in terms of soil fertility and other agronomic constraints as well as in terms of socio-economic contexts. Therefore they may play a complementary role to Pillar I payments.

Since the recent publication of the amounts of direct payments farm operators receive from the EU budget, the question of their distribution or redistribution as well as the potential consequences on farm structures and their incomes is quite challenging and investigated in this study. The relevance and appropriateness of public action implemented in the CAP by means of these payments on farms and their decisions constitutes a legitimate concern expressed by the rest of society; any change in policy has consequences on main agricultural actors' decisions indeed, and therefore on markets, trade, production of course, but on landscapes, environment, food quality and rural areas as well.

Research objective

The objective of this work is to investigate how public action in agriculture, and CAP's direct payments in particular, influences the development of farm structures and performance disparities between farms. Why is it important to investigate this? Public support and the resulting income distribution deal with the distribution of economic resources: this is a social phenomenon which engages civil society and policymakers. Therefore it seems legitimate to assess impacts of policies through the magnifying glass of distributional aspects. How far can public action change distributional inequalities between heterogeneous actors? How does initial factor allocation influence income distribution among heterogeneous agents in a dynamic framework? In such a complicated and multifaceted activity like agriculture, which are the impacts to be expected when comparing policy scenarios implementing different distribution patterns?

In this study the focus is put on the consequences of changes in direct payments distribution on the agricultural sector considering 1) the decoupling modality, i.e. the introduction of either a regional area payment, a historic payment or a hybrid payment system; 2) the level and design of modulation, i.e. modalities of Pillar I payment cuts relative to farm size and; 3) the decrease in Pillar I payments, i.e. cuts in direct payments for all farms after 2013. Distributional issues are important in the sense that decoupling modalities differ between EU member states since 2005 and a progressive transition from historic payment systems to a regional payment had been evoked in the recent "Health Check" of the CAP. The role of Pillar II, even though limited in terms of allocated funds, and beyond this the multifunctional role of agriculture may lead to increasing support in other fields related to agriculture. The temporal component is important as well: while CAP instruments and measures will stay relatively fixed until 2013, it is not clear yet how the future European policy for agriculture will look like and which instruments, new or renewed, will be kept. However, financial constraints are expected to enter the balance on future decisions in any case, current discussions do not plead for a radical reform from 2013 and the income objective, in times where market orientation of farms confront the sector with price volatility, may again stay in good place in future reforms of the CAP.

This study investigates impacts of a common policy on a heterogeneous landscape of farms. In Western Europe agricultural production is mostly carried out by family farms often owning their production means, among which labour they certainly dispose of, and for which agricultural activities may only be one way to remunerate those factors apart from off-farm activities and financial resources. However, those family farms, or individual farms, in Eastern Germany and the New Member States of the EU often cohabit with other farm structures which organisation and goals noticeably differ from theirs. This heterogeneous and dual farm population constitutes the main target of agricultural policy in this study.

Based on empirical data from an Eastern German region (Ostprignitz-Ruppin, or "OPR", in the Federal State of Brandenburg), several hypothetical decoupling schemes as implemented in the framework of the Fischler reform are tested, including the actual German hybrid dynamic decoupling scheme. In addition, recent discussions and decisions about modulation of Pillar I payments and their eventual future decrease are implemented as well, allowing tackling redistributive impacts and structural consequences these decisions involve. These issues are important in OPR in the sense that this region is neither the most fertile nor the wealthiest in Germany. Farms mostly rent their land and many rely on hired labour in a region where unemployment’s rate would otherwise be higher than it already is. Analyses of outcomes as regards land use, land markets, agricultural production and financial aspects give a panorama on comparative impacts of policy on the agricultural sector in a region which farming and ownership structure make recent political decisions quite a sensitive topic at the time. On top of this, comparative analyses on the redistribution of direct payments between scevnarios tested in the study provide a detailed panorama of actual groups or agricultural productions benefiting from recent CAP changes.

Most studies on income disparities and inequalities are either performed in a static framework or consider some important causes for disparities like heterogeneity of economic agents, asset accumulation, and access to credit etc. separately. The approach chosen for this study, the agent-based model AgriPoliS (Agricultural Policy Simulator), allows simultaneously considering a large panel of factors determining heterogeneities between farms and confronting political reforms to individual decisions performed in a complex network of actors.

Therefore, both the choice of the case study region as well as the method chosen to assess political impacts will allow investigating how far political discourses and corresponding measures can hold their promises like for instance caring for more equitable redistribution of payments between farms. How far are political assumptions about the reaching of predefined goals really plausible in a modelling framework used as a test tube, which resulting regional outcomes are the result of individual decisions made at the farm level? This study will aim at tackling these issues thanks an artificial world made of boundedly rational economic agents which reactions to the systematically tested political measures provide an additional insight on policy assessment.

Organisation of the study

The study is organised as follows. The first chapter provides an overview on income distribution analysis and theories elaborated in the framework of this topic so far; most used indicators of inequalities and income disparities are presented in the section as well. The second chapter firstly introduces the topic of public action; afterwards comments and reviews on policy making in the field of agriculture as well as on impact studies on general issues related to public action are provided. The main historical features of the CAP are then presented, followed by more extensive description of current issues linked to the last decoupling reforms and redistributive issues which are to be tackled in a future European agricultural policy. The third chapter presents the method used to investigate impacts of policies in this study, the agent-based model AgriPoliS. This description is followed by the presentation of the case study region selected, the region Ostprignitz-Ruppin in the German Federal State of Brandenburg. The description of the calibration steps to be fulfilled in order to well represent the region in the model as well as main innovations introduced for the simulation experiments close the third chapter. The fourth chapter deals with the practical simulation experiments. First, policy scenarios tested in the simulation experiments are described. Then, results on main impacts on farm structures of the three decoupling scenarios tested (a regional payment, a historic payment and a hybrid dynamic decoupled payment) are compared and commented. In the fifth chapter the focus is put on distributional issues while comparing impacts of policy scenarios; additionally to the impact analyses of the three decoupling scenarios, modulation schemes between 2009 and 2013 as well as cuts in Pillar I payments after 2013 are tested in the model and their consequences on farm structures analysed as well. A conclusion on main outcomes closes each subchapter. In the sixth and last chapter, a general discussion on the whole study is provided as regards the consequences of the policy experiments performed. Questions raised by modelling outcomes as well as future challenges for research in the study of CAP's impacts are commented and close the study.

1 INCOME DISTRIBUTION, INCOME INEQUALITY AND FARM INCOME

"There are many branches of economics where it is quite helpful to assume that the economic agents involved are well informed and act rationally so as to achieve well-understood objectives as effectively as possible. [...] But in the branch of economic study [of inequality and income distribution], the fictional figure of economic man is, in many respects, useless. For as soon as one turns from the strategy and tactics of finance, trade and production to the struggle to divide up the spoils, rational behaviour is replaced by instinctive animal reactions and the sway of crude primitive passions such as envy, greed and loyalty to the pack, compassion for the weak and the urge to rally round in an emergency. The methods used to change the distribution to one's advantage include threatening gestures and the extensive use of bluff: economic man is replaced by a group of monkeys grimacing and chattering at a rival group." CHAMPERNOWNE and COWELL (1998), Preface to the Handbook Economic inequality and income distribution, p. xvii.

This way of introducing the present chapter may appear quite rude to the reader, but actually Champernowne and Cowell's words clearly show what the income distribution topic is about in reality. Where one expects economic agents with given or acquired resources to maximise their individual outcome whatever its form, any attempt to eventually remove resources from the wealthy (which could supposedly do as good with less) to those in need, no matter how strong the underlying reasons for redistributing are, is no simple political exercise. In comparison the task devoted to the economist may appear much easier indeed. This is unfortunately not the case and this chapter aims at describing the foundations of the study of income distribution and redistribution, progresses in the field and challenges as well as difficulties in the measurement of disparities, inequalities and the comparison of social states.

1.1 What does one mean when it comes to income distribution?

Income distribution is already long a widely explored topic in economics. To design models which can ideally explain the development and causes of income disparities and help to understand their dynamics may be important for policy makers, as public intervention consists in redistributing resources among economics agents where imperfect markets can supposedly not do it.

1.1.1 Theoretical background

There is no unique theory of income distribution. Through the last decades various fields have been explored but there has not been any unique proposition of a unifying theory of income distribution to bind these fields together. Instead, different directions of research have been taken to tackle this issue, somewhat overlapping to grasp the maximum aspects possible.

1.1.1.1 Static approaches: Factor share theories and income distribution

To have an idea of the theoretical and methodological problems economics encounters in the field one can start by considering a static model in a competitive Walrasian framework[1]. *I* individual agents are endowed with a vector of *M* productive factors characterised by a vector of prices *w*. These factors are for instance labour, capital, but skills or personal abilities can enter the model too. There are *K* firms endowed with fixed factors of production and able to produce goods with a given technology. If we assume a complete private ownership of the firms by individual agents and if we let θ_{ik} be the share of individual *i* in firm *k* which delivers a profit π_k, the primary income of an individual *i* is given by:

$$y_i = \sum_m a_{im} w_{im} + \sum_k \theta_{ik} \pi_{ik}$$

The distribution of income $Y = (y_1, y_2, \ldots, y_I)$ results then from a combination of the multidimensional distribution of endowments, the matrix $A=(a_{11}, a_{12}, \ldots, a_{1M}; a_{21}, a_{22}, \ldots, a_{2M}; \ldots; a_{I1}, a_{I2}, \ldots, a_{IM})$, the return per unit of these endowments *w* and the distribution of wealth represented by the matrix Θ. The distribution of income depends on how the factors are rewarded, i.e. how do vectors for prices and profits look like. Once these are determined, demand and supply of goods and factors are equilibrated and it is possible to close the competitive equilibrium model. The distribution of income Y is the function of the distribution of endowments *A*, of wealth Θ and of technological factors characterised by the distribution *F* of fixed factors among firms.

$$Y = H(A, \Theta, F).$$

Both this general equilibrium equation and the partial counterpart above are "the heart of the theory of income distribution and the basis for policy analysis in that field" (ATKINSON and BOURGUIGNON, 2000). However, this approach has some limitation. First, the larger the matrices, the more complicated it is to compute and interpret. Then, it does not answer why the rewards for factors are like they are: why are researchers better paid than bus drivers although both may possess capital and endowments in the same proportions? Linked to this, investments in human capital raising productivity, like education or training, should be included in such a theory. Moreover, agents may receive earnings from other sources like interest rates or rents. Finally, there is no consideration for institutions in this framework, like the state for instance, which retains parts of agents' earnings for redistributive purposes. All these issues have consequences on the relation between factor returns and income distribution.

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[1] Most, if not all, of this part is adapted from the extensive theoretical review found in ATKINSON and BOURGUIGNON (2000).

The former framework has been used to investigate the observed widening gap of wages among workers (TINBERGEN, 1975). This gap can be explained by the "race" between technical change and the supply of highly skilled workers: technological development creates a bias towards skilled labour in production and as long as enough highly skilled workers are not educated, wage dispersion will grow. Introducing even more complexity in the framework by extending the matrices of factors and rewards lead to the CGE (for Computable General Equilibrium) tradition which has considered distinct labour markets (urban vs. rural) for differently skilled labour as well as the scale of land uses. By modifying the private ownership rule a socialist redistribution system can be considered for inequality measurement compared to a pure capitalist system.

However, this static approach misses many aspects ruling income inequality by considering it as exogenous, as well as heterogeneity in the distribution of assets. The dynamic aspects of income distribution have to be considered, and two approaches dominate: the factor accumulation approach and the labour market approach.

1.1.1.2 Dynamic approaches: Factor accumulation and labour market theories

Using the former framework and making it dynamic, the first "factor accumulation" approach considers decisions made by individual agents as regards accumulation of assets and shares in the *K* firms and those made by firms as regards fixed factors. As individuals and firms aim at maximising incomes and profit returns, their decisions depend on current and future factor rewards and prices. Completed by equilibrium prices for factors, assets and firm shares, one can get a full dynamic representation of the economy, grounding a dynamic general equilibrium model. However this model is too complicated in a general framework and only simplified forms have been investigated. Let $A_{i,t}$ be the level of assets owned by person *i* at time *t*, ρ and *a* two positive constants and $\varepsilon_{i,t}$ a random term representing exogenous processes[2] (with $E(\varepsilon)=0$ and $V(\varepsilon)=\sigma^2$), a simple model can be written as follows:

$$A_{i,t} = \rho A_{i,t-1} + a + \varepsilon_{i,t} \qquad (1.1)$$

One can consider *A* being the wealth of an individual, comprising financial wealth and human capital. From this starting point several theories try to explain income distribution.

Stochastic theories consider ρ equal to unity, *a* equal to zero and emphasize the role of ε. *A* stands for the logarithm of wealth and follows a random walk. In this model the distribution of wealth tends towards a limit and depends on the characteristics of the distribution of ρ and ε. Where $\rho<1$, the process converges to $\sigma^2/(1-\rho^2)$, the smaller ρ the faster it converges. Where $\rho>1$ the process leads in

[2] These exogenous processes can be considered as shocks, distributed independently across the individuals, introducing heterogeneity between individuals.

infinite time to a degenerate situation of maximal inequality, where the share of total wealth of the richest tends to unity. The problem remains however the same than in the static case: the distribution of assets is exogenous. Moreover, one has to grasp mechanisms which determine ρ (which can be considered as an accumulation factor) and whether it is bigger or smaller than unity.

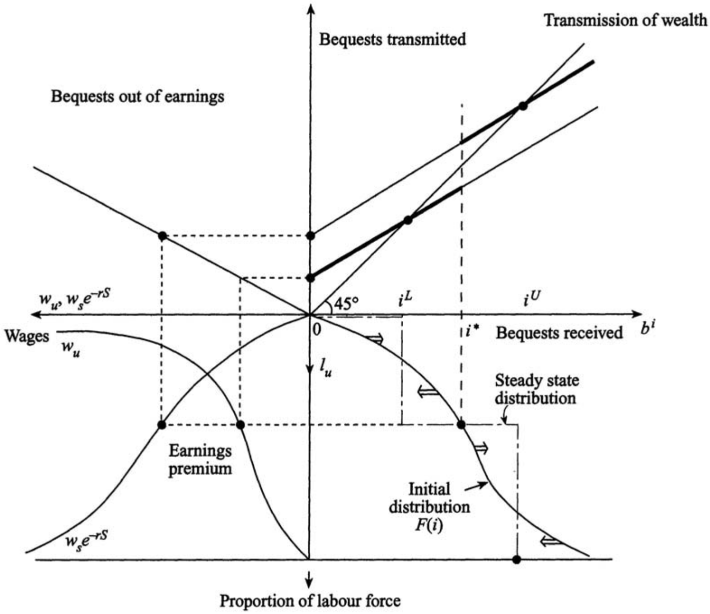
The dynastic model considers that individuals are altruistic in the sense that they care for their descendants. In Equation (1.1) ρ is replaced by (1+r) where r is the rate of return; a is replaced by c_t which holds for the consumption of the individual at period t. Under some classical conditions the optimal consumption at each point of time equals the income flow from wealth; wealth, income and consumption follow a random walk and thus their variance increase with time. While this theory may stand for an intra-generational theory of income and wealth distribution, the form of altruism modelled may not be satisfactory to explain the cases of intergenerational transmission of inequality; the variance of wealth does not seem to increase between generations. Other factors like fertility (the larger the family, the more rapidly wealth is divided) as well as social and legal norms are important to consider in this sort of bequest model.

Not only stochastic heterogeneity due to external shocks (here mimicked by ε) has to be considered, but individual preferences, tastes and risk aversion are important to understand the development of income distribution. This grounds the theory of human capital which roughly states that the total human capital asset owned over the lifetime of an individual is determined by the equalization of the individual specific marginal return and marginal cost, i.e. wage and interest rates.

Still in the field of human capital, setting a dependency between the accumulation factor ρ and the former level of wealth A introduces new possibilities for analysis of income distribution (consider $\rho(A)$ rather than simply ρ in Equation (1.1), which becomes a nonlinear equation). This dependency may occur in reality because of capital market imperfections, for instance people can lend at a rate of interest but can only borrow against collateral. It means that people with low initial level of wealth will not be able to borrow against future incomes, or only at interest rates negatively correlated to their level of wealth. They can stay locked in the low wealth level over generations, where individuals starting from higher wealth levels will probably not see their descendants switch to the low wealth category as they will grow in favourable conditions.

Figure 1 illustrates what this would imply in a bequest model with imperfect capital market following GALOR and ZEIRA (1993). Each individual here has one only descendant and transmits him a part of its accumulated wealth through a bequest. Individuals are identical except their level of education, allowing them to sell their labour on the market for skilled or unskilled labour. Earnings of skilled persons are higher than of those unskilled. The descendant of each individual knows the level of bequest he will receive, which will serve him as collateral. On this basis he decides whether he will invest in his own education to enter the skilled labour market knowing that during the training, there is a minimal level of consumption he will have to finance and which grows at the exponential rate *r*. Under a critical level of bequest, unskilled individuals will rather take the decision not to invest in their education because they will not be able to finance their consumption until they are on the market for skilled persons. This level is represented on the figure by *i**, and the proportion of unskilled labour by l_u. Wages are represented by w_u (wage for unskilled labour) and $w_s e^{-rS}$ (wage for skilled labour) where S is the period of training.

Figure 1: Distribution of income with imperfect capital market



Source: ATKINSON (1997).

The figure shows that, under the illustrated conditions, people starting with a level of bequest under *i** (which is an unsteady state in this case), i.e. belonging to the lower part of the distribution *F(i)*, can not afford their training and chose an unskilled labour. Therefore their bequest is lower than otherwise and their descendant is in the same situation as they were before. In a dynamic perspective, from generation to generation, the transmitted bequest in this part of the distribution converges to i^L. Similarly, people receiving a bequest above *i** can invest in their training and in a dynamic perspective an equilibrium in the transmission of bequest settles at i^U. The steady state distribution is illustrated by the dashed and dotted line. Two classes establish: one is composed of skilled people, the other of unskilled people. If no external shock happen (no change in the interest rate *r*, no technical change changing the aspect of curves in the bottom left hand quadrant or no intervention lowering i^*), inequalities perpetuate.

The former framework assumed the interest rate *r* to be exogenously given. But if a dynamic general equilibrium framework is to be considered, all variables should closely depend on each other. It is then incorrect to assume *r* being exogenously given; the personal distribution of assets, the price vector as well as the distribution of fixed factors should all depend on each other, and thus deliver the rate of return *r* endogenously. The most recent research on income distribution and the understanding of mechanisms ruling its development is focusing on the interdependence of these complex matters and how they influence each other.

Last but not least, human capital theory opens the possibility to consider the issue of income distribution and inequality under the light of other factors like natural talents or abilities, sense of effort or motivation. These are not directly observable characteristics, however not homogeneously distributed among the population, and which easily lead the researcher to ask whether "economic mechanisms are responsible for the transformation of the natural distribution of talents and abilities into a distribution of earnings which is more or less skewed" (ATKINSON, 2000), or the contrary. With skewness it is meant that observed density functions of earning distributions in large populations are asymmetric and have a long "fat" tail, i.e. there are more persons getting very high earnings than in a normal distribution of earnings (also the mean income is superior to the median income). However, as COWELL and JENKINS (1995) mention it is commonly supposed that "personal attributes and labour market status are major determinants of interpersonal income differences"[3]. The nature and completeness of labour markets plays here the central role on the outcomes and several theories and models have been developed to tackle these issues[4].

This theoretical review showed that the issue of income distribution is far from being completely understood in all its components. The first static framework evoked already lead to complex analyses and results and extending it into a dynamic perspective did not make the task easier. It showed that interactions between growth, factors and assets distributions, the vectors of prices on simultaneous markets embedded in a global multilateral game on international markets are complex; however they all play a significant role in the dynamics of income distribution.

3 This assertion was shown empirically unfounded by the authors in the case of inequalities in the USA.

4 For an extended review on the literature see NEAL and ROSEN (2000).

1.1.2 Redistribution

1.1.2.1 Why redistribute?

As BOADWAY and KEEN (2000) mention it, "one good reason for being interested in the distribution of income […], is because one might want to change it." Why would one like to change income distribution? As once again mentioned in the former quoted review, three reasons can be found: one would like to redistribute considering criteria of social justice, or considering mutual advantageous efficiency gains or redistribute to express the coercive power of the state. Behind the second reason, i.e. assuming that redistribution will induce efficiency gains and provoke mutual advantages by "losers" and "winners" of the redistributive process, the notion of efficiency is to be defined. Whether these efficiency gains qualify a Pareto improvement, a potential Pareto improvement if appropriate compensation is to be paid or an increase in total output of a good or of a total level of activity with the same amount of resources, methods and conclusions of the study will differ. However, even though efficiency gains (under any of its meanings) are to be expected through a redistributive process, some trade-off and leakages have to be expected in the end.

Take the decision to redistribute resources belongs to the policy maker and understanding the modalities and motives for redistribution the "principal task of political economy" (BOADWAY and KEEN, 2000). Motives guiding public action can find their roots in the search for efficiency gains as mentioned above. Beside this, political self-interests (motivated by the perspective of future elections) or lobbying activities of interest groups present at the political level can constitute other reasons explaining why and how redistributive processes occur. A part of this question was already the object of another chapter in this study and no further comment on this topic will be made in this section. This includes comments on the political structure of the power in place taking the decision to redistribute resources which will as well be set aside.

In the field of welfare economics, policymakers would have the possibility to reallocate resources along the first-best utility frontier. This frontier is made of Pareto-efficient utility combinations among economic agents where the only constraints are the resources available and the technologies to convert resources into goods and services. Following the second fundamental theorem of welfare economics, any Pareto-efficient allocation of resources can be achieved through a suitable reallocation of endowments (i.e. lump sum incomes) among households in a competitive economy. The policy maker wanting to achieve an optimal allocation of resources has to choose a pattern of lump-sum transfers which will lead him to the desired reallocation. However, constraints linked to the knowledge at the disposal of policy makers as well as their own preferences and the availability of efficient redistribution instruments limit the success of any redistributive measure if not even question the existence of an ideal redistributive measure.

1.1.2.2 Constraints on redistribution

1.1.2.2.1 Obstacles to a first-best redistribution of resources

If we attach a utility function to each household (meaning as well that each can produce goods and services, i.e. generate income and this at different levels corresponding to individual abilities), then the first obstacle to an optimal redistribution of resources lies in the fact that the policy maker does not know which utility function is linked to each household. Depending on the "rewarding" criteria considered for redistributing resources, each household will tend to deliver information leading it to maximise what it can get from the redistributive policy. If one considers a tax used to be redistributed among the population it means that due to these informational leakages, the implementation of either a progressive or a lump-sum tax may have the same result, i.e. both not being as efficient as expected. As policymakers cannot directly distinguish the better-offs from the worse-offs, i.e. they lack information to heavenly redistribute resources, they choose to implement distorting taxes (price distorting taxes on some goods for example) which, even though they violate the second theorem of welfare economics in a first-best world, have at least the advantage to induce agents to reveal their true type. Indeed, if one assumes income as an approximation for the ability of a person, the introduction of a tax will force taxpayers to choose the combination of consumption/income, i.e. the level of tax which they find the most appropriate for themselves instead of a combination appropriate for other ability types. They thus reveal their true ability through the choice of an appropriate level of taxes for them. However this "self-selection" process may not hold at the edge of equality (in the sense of equality in utilities). At some point higher-ability persons may prefer a lower combination of consumption/income: they then mimic lower-ability persons and further redistribution becomes impossible. Theoretically, even in a static framework not considering the accumulation of assets, homogeneous households and all this without uncertainty, to find an optimal non linear taxation system coupled to a redistribution system requires assumptions as regards preferences, distribution of abilities and elasticity of labour supply. The adoption of a linear taxation system presents a disadvantage as well: possibilities of Pareto improving redistributions cannot be fully exploited because of the self-selection constraint. The remaining redistribution potential can thus not be used completely.

Actually, it is once informational asymmetries are considered that welfare analysis quits the first-best world to enter the second-best one. PUTTERMAN et al. (1998) describe these two paradigms which differ considering the constraints applied to the set of feasible allocations. The first paradigm, the neoclassical paradigm, only considers aggregate resources and technology constraints to define the set of feasible allocations, i.e. redistributive possibilities. In this world, lump sum transfers are feasible and guarantee a Pareto-improvement among the agents. Whereas the information paradigm considers that as soon as private information on individuals (characteristics, actions) is missing, lump sum transfers are not possible anymore because they violate the informational and incentive constraints partially evoked in this section. Thus usually policy action and impact analysis of political decisions are performed in a second-best world. Adding more constraints than those present in a first-best world immediately shifts the problem in this second-best perspective. If lump sum transfers are not possible in a second-best world, how much room is left for policies which could at the same time keep efficiency at its higher level and enhance equality?

1.1.2.2.2 The equality-efficiency trade-off

Since the 70's, economists try to find and discuss redistributive processes leading to a joint improvement of equality (or equity) and efficiency. This objective may be considered important for political action and have long been challenged by economics analysts, at least since Okun's concept of "leaky bucket"[5] (OKUN, 1975). BLANK (2002) mentions that there is substantial evidence that "government transfers, designed to create greater equity, can lead to inefficiencies". She evokes a series of experiments in the 70's in the USA aiming at testing the effects of welfare program design on labour supply and well-being of recipients: in general the government had to spend almost twice more than the actual increase in family incomes, i.e. the leaky bucket lost half of its content during the transfer, reducing from that much the efficiency of this redistributive method in the real world.

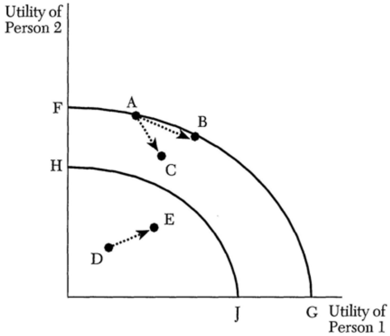
But is there really no room for any mutual gains in equality and efficiency? Do these two notions inevitably have to conflict with each other?

Coming back to PUTTERMAN et al. (1998), with reference to the two paradigms listed before namely neoclassical and information paradigms, it is worth looking more precisely on what former statements imply when we consider utility sets. Consider a two-person economy with two utility possibility sets (Figure 2). The FG frontier corresponds to the neoclassical utility possibility set, while the HJ frontier to the information one. Starting from point A located on the utility possibility frontier (therefore economically efficient) let us assume that society decides that person 1 receives too little. Lump sum transfers could help to reach point B, still economically efficient. But if we assume that lump sum transfers are not possible, and that the improvement of person's 1 utility implies a decrease in person's 2 utility (point C), then we quit the utility possibility frontier and there are efficiency losses. However, this can not hold. First, if point B is not reachable, it means that the utility possibility set is smaller than the neoclassical one. Then, if absolutely no transfer instrument is available or used ("laissez-faire" situation), then it could be that even point D is reached. And this ultimately would mean

5 Any dollar transferred from a richer individual to a poorer individual will result in less than a dollar increase in income for the recipient. These leakages are due to administrative costs of redistribution, changes in work effort, savings and investment as well as attitudes caused by redistribution.

that it should be possible, starting from D, to find a way which would lead to E where efficiency and equality can be improved at the same time.

Figure 2: Equality-efficiency trade-offs in the neoclassical and information paradigms



Source: PUTTERMAN et al. (1998).

1.1.2.2.3 By the way, equality of what?

The word "equality" used in the above section is worth being commented. Literature on this topic being quite well furnished this section only aims at shortly evoke points which could give the reader some more insights on the roots of the equality problem.

First, what exactly should be "equal"? Should it be the level of welfare across individuals? Should utility be the central concept for this purpose? In his lecture "Equality of What?" SEN (1980) comments the difficulties linked to the definition of equality as well as contradictions linked to the three at that time existing proposals to reach it.

The first approach of equality, utilitarian equality, requires maximising the sum-total of utility irrespective of distribution. But for that the marginal utility of everyone has to be equal as well the size of the "cake" to be shared among the individuals. Actually, problems appear when the size of resources to share (the "cake") varies and this not independently from its distribution. Moreover, added to the fact that marginal utility is a counter-factual concept quite difficult even impossible to really measure, there is also the problem of different tastes among individuals. If we consider two persons where one has cheap tastes and the other expensive ones, then try to equalise their respective welfares could lead to transfer resources from the person with the cheapest tastes to the one with the expensive ones.

This problem also appears in the second approach of equality, which aims at reaching the equality of total utility. Even though this approach presents the advantage to consider direct observations rather than hypothetical ones, it can not say a lot on how much preferable is a distribution of utility over another. The objective heads for the case of absolute equality whatever (and that is a central criticism to this approach) the intensity of individual needs. It is however possible to compare two distributions within this approach of equality by comparing the levels of utility of the two worst-off, then of the second worst-off if the worst-off's levels of utility were identical, and so on. If all utilities along the two distributions match pair wise, then they are equally good. This is called the *leximin* rule in the social choice theory.

However, the fact that utilitarian equality and total equality approaches are neither interested in interpersonal priorities nor intensity of needs constitutes one of the central criticisms on welfarism made by Rawls by stating his principles. To his view, "two principles of justice" characterise the need for equality in terms of "primary social goods". While the first principle, the principle of liberty, requires each person to have an equal right to the most extensive basic liberty and this holding for other persons too, the second principle demands efficiency and equality using an index of primary goods. This principle includes the so-called "Difference Principle" setting priority to increasing the interests of the worst-off; this is also called the *maximin* rule. Among the primary social goods, one can find money of course, but some other things not measurable in pecuniary terms, like "rights, liberties and opportunities […] and the social bases of self-respect" (SEN, 1980). However, following SEN (1980), the difficulty is to find an index allowing interpersonal comparison for such heterogeneous bundles of good and rights as well considering that not all people need the same kind of goods or opportunities to be satisfied.

On top of this, SEN (1980) criticises the "fetishist" side of Rawls' conception of equality through these primary goods, because following him Rawls omits the relation that links goods to individuals there. Instead of this Rawls considers income and wealth as material goods, not considering their capacity to produce happiness and satisfaction by individuals independently of the nature of these goods. Moreover, the maximin rule does not care about which minimal size should worst-offs' gains have and how much loss one could reasonably tolerate by the better-offs' for the corresponding gain by the worst-offs. Thus SEN (2000) develops the concept of capabilities which clearly distinguishes accomplished things (buy a house, a car and so on) from the possibility of accomplishing them (independently from the nature of goods, which is specific to individuals' preferences). Levels of *functionings* have to be equalised, where these are observable doings and beings (being healthy, well nourished, moving freely, etc.) on which individuals depend to reach a certain quality of life. This way of describing individual claims allows then to get rid of the necessity of considering means, goods or any material objects not all individuals would wish for their own use.

This section revealed how complicated inequality matters can become when it deals with comparing different individuals' needs, preferences and performances. If one should retain the notion of utility comparison, income may constitute a default indicator to begin with. Although imperfect in the sense that it does not contain all information needed to properly estimate individual states, it may however be a good proxy where other indicators do not exist or fail in providing solid information. The next section may focus on the measurement of income disparities as a proxy for the measurement of inequality.

1.2 Measurement of income disparities and inequalities

1.2.1 Introduction

There lies undoubtedly something tricky and dangerous in simply declaring that one would like to measure inequality. For that the meaning of the sole word inequality (or equality) directly depends on some intellectual positions we tried to discuss in the preceding section. As its measurement deals with the comparison of distributions by means of criteria derived from sophisticated methods or simple intuition, rather classical concepts to characterise and describe a distribution will be firstly presented here beforehand.

However, measuring overall income dispersion and inequality among individuals may only give some general information on the general features of the distribution. But the interpretation and the search for the sources of dispersion often implies to group individuals considering some possibly explanatory criteria. This is an important issue in the sense that depending on the groups chosen (aside from the question: why is one grouping wealthier than another?), this would affect the understanding of economical and social factors contributing to inequality, and thus potential proposals for the design of policies for redistribution.

1.2.2 Indicators of dispersion and inequality

1.2.2.1 First step: Grasp the main features of a distribution and compare it to another

1.2.2.1.1 Conventional dispersion indicators

One of the first step in the analysis of dispersion or inequality in a distribution is to grasp its general features by looking at straightforward statistics (mean, variance, standard deviation) as shown in Figure 3(a). These statistics are calculated based on the sample of farms contained in the Farm Accountancy Data Network (FADN) for the years 2002 and 2004 for the Federal State of Brandenburg in Germany. The variables displayed in the figures are calculated based on the variable "Farm Net Value Added" (FNVA) of the FADN database. This variable is an indicator of the level of remuneration of fixed factors used on-farm[6].

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[6] Farm Net Value Added: "Remuneration to the fixed factors of production (work, land and capital), whether they be external or family factors. As a result, holdings can be compared irrespective of their family/non-family nature of the factors of production employed. This indicator is sensitive, however, to the production methods employed: the ratio (intermediate consumption + depreciation)/fixed factors may vary and therefore influence the FNVA level.

As shown in Figure 3(a) these basic characteristics on the distribution do not say much about the dispersion of the variable between its extreme values. Some more information can then be delivered by the box plot technique (Figure 3(b)), also called box-and-whisker plot. This representation is a convenient way of graphically depicting groups of numerical data through five numbers: the smallest observation (sample minimum), the lower quartile (Q1), the median (Q2), the upper quartile (Q3), and the largest observation (sample maximum). A box plot may also indicate which observations, if any, might be considered outliers. The value Q3 minus Q1 defines the interquartile range. The horizontal lines (the "whiskers") extend to at most 1.5 times the interquartile range from either or both ends of the box. They must end at an observed value, thus connecting all the values outside the box that are not more than 1.5 times the box width away from the box. In our example many outliers for both years are to be found beyond the upper whisker, only one observation in 2002 is found below the low whisker. The two distributions are positively skewed: most observations are found beyond the median value. This representation is quite useful to display the main differences between two distributions like in our example.

Histograms and Kernel densities are ways to represent an approximation of the underlying density function (Figure 3, (c) and (d) respectively). Histogram is the simplest non-parametric density estimator and the one that is most frequently encountered. The interval covered by data values is divided into so-called "bins" which are limited by end points. However the difficulty lies in the choice of a proper bin width able to deliver the maximum information in still a readable manner. This is due to the properties of histograms: they are not smooth, and their accuracy depends on the size of the bins as well as their end points. Figure 3 (c) illustrates the histogram built upon values of FNVA for farms in Brandenburg in 2002. There the bin width is of 100,000 Euros and the first bin is centred on the origin. Would this first bin has been centred on 50,000 Euros the overall picture would have been slightly different in the range of values between 1,000,000 and 1,500,000 Euros. The problems encountered with histograms can be alleviated by using Kernel estimators. The bins are centred on data values themselves instead of having to deal with end points. Each point of the dataset is replaced by a suitable density function, usually the normal distribution. A standard deviation is calculated, which has neither to be too small nor too big ("h Opt" in Figure 3 (d)). The separated curves are then added together to give an overall density function: therefore the area under the Kernel curve is equal to unity. The choice of an appropriate standard deviation is determinant to get an optimally smoothed Kernel curve, which should be neither over- (standard deviation too big, obscured structure of the data) nor

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For example, in the livestock sector, if production is mostly without the use of land (purchased feed) or extensive (purchase and renting of forage land)", *Definition of variables used in FADN standard results*, RI/CC 882 Rev. 7.0, Community Committee for the Farm Accountancy Data Network (FADN), DG AGRI G.3, 10th October 2002.

under-smoothed (standard deviation too small, showing an undue fine structure of the data). Figure 3 (d) illustrates Kernel densities calculated for the FNVA among farms in the Brandenburg sample for both years 2002 and 2004. Similarities with the histogram on the left for the 2002 Kernel curve can be easily identified and the gain in fineness through the Kernel representation acknowledged.

This short overview on possible methods to represent the dispersion of data primary aimed at showing that basic knowledge on a distribution is a preliminary to further analyses. The more accurate the knowledge on data (and the most appropriate the choice of the representation method and of respective calibration parameters) the better the chances to deliver right and accurate interpretation of their development and behaviour through time or in comparison with other variables.

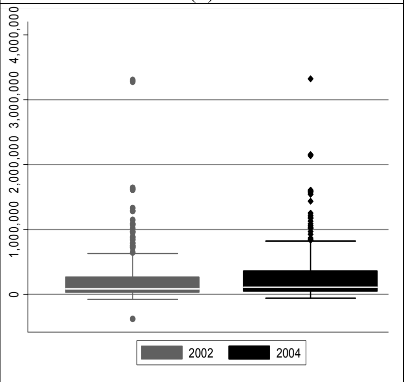
Figure 3: Some representations of descriptive methods to investigate a distribution

(a)

	Number of farms	Mean	Standard deviation	Min	Max
2002	259	241,236	418,873	-380,409	3,301,155
2004	259	282,002	423,262	-55,417	3,321,973

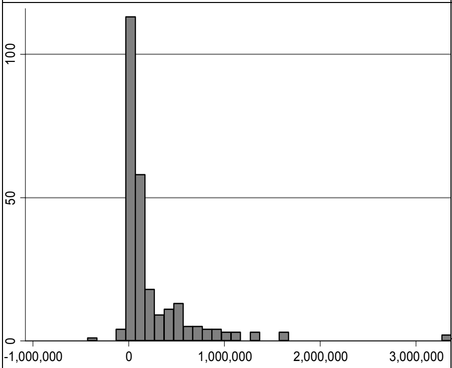
Statistics on the FADN variable Farm Net Value Added in the years 2002 and 2004 (Euros)

(b)



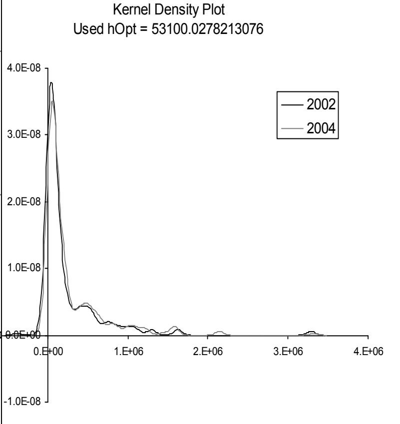
Box plot of Farm Net Value Added in 2002 and 2004 (Euros)

(c)



Farm Net Value Added 2002, bandwidth 100,000 Euros

(d)



Kernel densities Farm Net Value Added 2002 and 2004

(a) (b)

Source: Own figure, adapted from the FADN database for Brandenburg (2002, 2004), using Stata 10.1 and the Kernel 1.0 Add-in for Excel 2003 for Figure 3 (d).

The relative advantages of each representation method are compared in Table 1 below. These first explorative methods help getting a first picture of the dispersion of data values. They are to be used as first indicators of comparison between several distributions. However, they do not give any clue on *how much* two distributions differ from one another and which one would be *preferable*: these concepts actually bring into the topic of inequality discussed below.

Table 1: Advantages and disadvantages of techniques to describe a distribution

	Advantages	Disadvantages
Basic statistics: Mean, standard deviation	First rough picture on the distribution. More properties can be illustrated in a box-and-whisker plot.	Rough statistics do not help to depict irregularities inside the distribution
Frequency distribution (histograms)	Estimate of the underlying density function. Deliver information on the structure of data.	Subdivisions have not to be coarse. Problems in the choice of the right variable of income.
Kernel densities	In comparison to histograms, delivers a smooth picture of data structure.	Choose the right standard deviation.

Source: Own figure.

There are some more descriptive analyses which can give clue for further analysis of the dispersion of a variable. Adding some more dimensions by introducing classes of individuals or categories (like for instance in our example farm size classes or technical orientation) reveals how the FNVA is distributed among these categories.

Table 2 illustrates the frequency distribution of farms in 2002 and 2004 in a bivariate way, crossing the values of FNVA per hectare with farms' total Utilized Agricultural Area (UAA). Each cell contains the number of farms belonging to the corresponding crossed categories and the extreme columns deliver the averages either of farms' total UAA per FNVA per hectare (ha) category or the average FNVA per ha per farm size class. The "extreme" average values of FNVA per ha found in 2002 and 2004 in the size category under 100 ha are due to the presence of farms technical oriented towards horticulture (market garden cropping and flowers): this technical orientation delivers extremely high values added per hectare on very small areas. This explains reversely the low average size of farms found in the category above 1,000 Euros per ha of FNVA. On the other hand, these types of farms can make big losses which can be seen in the average size of farms producing negative FNVA per ha in both years.

Table 2: Bivariate frequency distribution of farms considering their Farm Net Value Added per hectare of Utilized Agricultural Area (UAA) and total UAA in 2002 and 2004

2002		Range of farm total UAA in ha						*Average UAA in each range*
		< 100	100-300	300-500	500-1,000	1,000-2,500	> 2,500	
Range of FNVA per UAA in €/ha	<0	6	8	1				*153*
	0-100	6	7	1			1	*334*
	100-300	9	32	19	9	8	1	*499*
	300-500	10	23	16	10	17	4	*737*
	500-1,000	17	14	4	10	9	3	*820*
	>1,000	18	3		1	2		*180*
Average FNVA/UAA in each range		*22,835*	*320*	*314*	*450*	*444*	*420*	

2004		Range of farm total UAA in ha						*Average UAA in each range*
		< 100	100-300	300-500	500-1,000	1,000-2,500	> 2,500	
Range of FNVA per UAA in €/ha	<0	6						*46*
	0-100	2	6	1			1	*443*
	100-300	8	28	11	6	3		*356*
	300-500	9	33	16	14	13	1	*538*
	500-1,000	15	25	11	13	22	3	*828*
	>1,000	2	7	2		1		*157*
Average FNVA/UAA in each range		*6,271*	*480*	*470*	*465*	*550*	*521*	

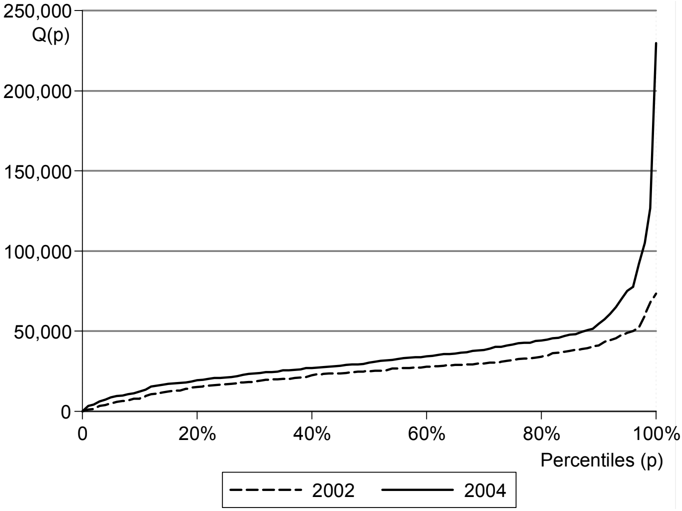
Source: Own figure, adapted from the FADN database for Brandenburg (2002, 2004).

1.2.2.1.2 The concept of dominance

The preceding section has presented basic tools to investigate a distribution in its roughest aspects. Now it would be convenient to use tools helping to get a better idea of the way distributions are spread and allowing ranking them, or ordering them with respect to some comparison criteria. An intuitive approach to this could be to look at the development of gaps between two extremes of the distribution. For instance the difference between the top and the bottom deciles could be an indicator of inequality. It is possible to give this intuitive approach a solid theoretical foundation by using the concept of social welfare function; however we will keep sticking on more applied aspects here.

For instance let us use the story of the Parade introduced by PEN (1971): imagine a "parade of dwarfs and a few giants" where each person's income is represented by his physical height, you get a sort of income profile when the parade passes by. Consider now two "parades", or two distributions or vectors of incomes $X_1 = (x_1, x_2, ..., x_n)$ and $X_2 = (x_1, x_2, ..., x_m)$ as well as their corresponding distribution functions $F(X_1)$ and $F(X_2)$. Then if $F(X_1)$ lies nowhere above and at least somewhere below $F(X_2)$ then X_2 *first-order dominates*, or *first-dominates* X_1 in the sense of a first-order stochastic dominance. Then in the distribution X_2 there are no more individuals with income less than a given income level than in distribution X_1 for all levels of incomes. This is illustrated in the Figure 4 below for the two distributions of FNVA per Annual Working Unit (AWU) in 2002 and 2004. Here, as graphically the 2004 distribution seems to be nowhere below than the 2002 distribution one can conclude that the 2004 distribution first-dominates the 2002 distribution. The "Pen's parades" for these two distributions reveal an increase in FNVA per AWU values between 2002 and 2004. It reveals some "anomalies" in 2004 where very high values of FNVA per AWU are to be found in the upper tail of the distribution.

Figure 4: Quantile curves for Farm Net Value Added per Annual Working Unit in 2002 and 2004 among farms in the FADN sample for Brandenburg



Source: Own figure adapted from the FADN database for Brandenburg (2002, 2004), using the DASP Version 1.4 in Stata 10.1

However, quite often neither distribution first-dominates the other. Moreover transfers between individuals in the same distribution cannot be taken into account using this tool.

Another kind of stochastic dominance has to be introduced here. Let us note G_X[7] the integral of the cumulative distribution function F_X corresponding to the vector of incomes X, then namely:

$$G_X = \int_0^u F_X(t)dt, \quad 0 \le u \le 1$$

If one would consider another vector of incomes Y characterised by a deficit function G_Y then if G_X lays nowhere above and somewhere below G_Y then distribution X *second-order dominates*, or *second-dominates* distribution Y.

The dual of the function G is actually the *generalised Lorenz curve* (or absolute Lorenz curve, or concentration curve, (SHORROCKS, 1983) corresponding to a given vector of incomes, for instance X in this case. It is formally defined as follows:

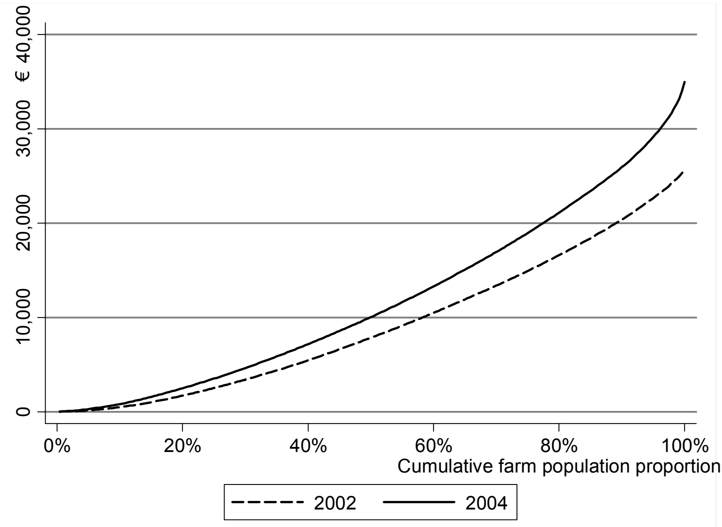
$$GL_X = \int_0^q x\,dF(x)\text{, with } 0 \le q \le 1$$

7 G_X can be named "deficit function" of the distribution X.

The generalised Lorenz curve is non-decreasing, continuous and convex, with $GL_X(0) = 0$ and $GL_X(1) = \mu$ where μ is the mean of incomes calculated throughout the distribution. The generalised Lorenz curve plots cumulative income shares scaled by the mean of the distribution against cumulative population. If we pick a point $q*$ along the cumulative population axis then the slope of the generalised Lorenz curve at this place indicates the mean of incomes over the individuals to be found below this limit.

We plotted generalised Lorenz curves for the FNVA per AWU over the two years 2002 and 2004. One can see that for both distributions $GL(1)$ equals the mean calculated for each distribution (25,602 € in 2002, 35,009 € in 2004). As the 2004 FNVA distribution is nowhere to be found under the 2002 FNVA distribution, then the 2004 FNVA distribution second-order dominates the 2002 one.

Figure 5: Generalised Lorenz curves for values of Farm Net Value Added per Annual Working Unit in 2002 and 2004 in Brandenburg



Source: Own figure adapted from the FADN database for Brandenburg (2002, 2004), using the module clorenz in Stata 10.1 (ARAAR, 2005).

The two preceding tools find their roots in the social welfare theory and helped drawing conclusions about welfare based on individual income data. Actually, second-order stochastic dominance implies that any social welfare function that is increasing and concave in income will record higher levels of welfare in the dominant distribution than in the dominated, here in the 2004 distribution rather than the 2002.

Another tool of distributional analysis can be used to rank distributions in terms of inequality alone. This quite known way to illustrate how inequality is spread over a distribution is delivered by plotting Lorenz curves, also called relative Lorenz curves. Formally, given a sample of n ordered individuals with $x_i^{'}$ the size of individual i and $x_1^{'} < x_2^{'} < ... < x_n^{'}$, the Lorenz curve is the polygon joining the points $(h/n, L_h/L_n)$, where $h = 0,1,2,...,n$, $L_0 = 0$ and $L_h = \sum_{i=1}^{h} x_i^{'}$. Alternatively, the Lorenz curve can be expressed as:

$$L(y) = \frac{\int_0^y x\,dF(x)}{\mu},$$

where $F(Y)$ is the cumulative distribution function of ordered individuals and μ is the average size among individuals. It is easy to see that the Lorenz curve is the mean-normalised generalised Lorenz curve already seen above. This may affect the interpretation on the position of these curves we will evoke below.

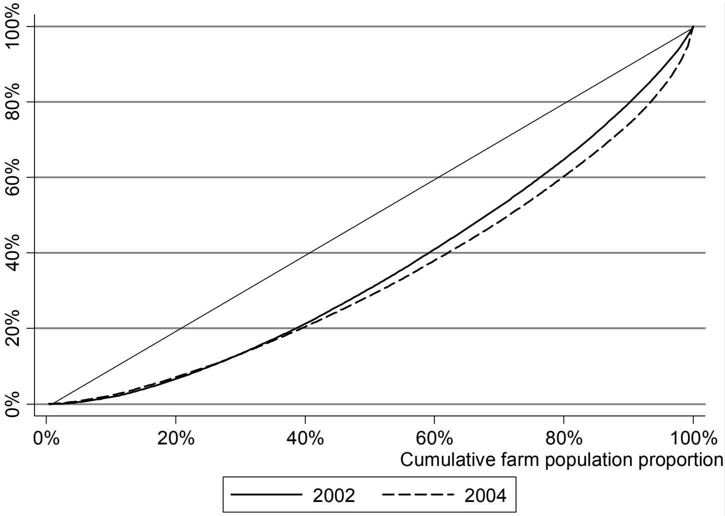
If the vector $(x_1^{'}, x_2^{'}, ..., x_n^{'})$ is constituted only of positive values, then the Lorenz curve has the following properties: it is continuous, increasing and convex.

In these conditions it can neither rise above the perfect equality line nor sink below the perfect inequality borders. However, the Lorenz curve will be located *under* the line of perfect equality in case the mean over the sample is *positive* and *above* the line of perfect equality in case the mean is *negative*[8].

We have plotted below in Figure 6 two Lorenz curves corresponding two the already displayed above values of FNVA for farms in the FADN of Brandenburg in the years 2002 and 2004. Interpreting such a curve is quite straightforward: the situation in 2004 reveals that 80 % of the farms in the sample produced less than 60 % of the total FNVA per AWU; in 2002 80 % of farms produced less than 65 % of the total FNVA per AWU. A straight line has been drawn as well. This line is the line of "perfect equality". If a distribution were to strictly follow this line, it would mean that all values among the distribution are equal: in our case all farms would produce the same FNVA per AWU.

[8] If the mean over a distribution is positive then the presence of negative values is not much a problem for the building of relative Lorenz curve. In case of negative means among the distributions, it is advised to draw generalised Lorenz curves (COWELL, 2000).

Figure 6: Lorenz curve for Farm Net Value Added per AWU in 2002 and 2004 among farms in the FADN sample for Brandenburg



Source: Own figure, adapted from the FADN database for Brandenburg (2002, 2004), using the module glcurve in Stata 10.1 (JENKINS and VAN KERM, 2004).

Building Lorenz curves for one or more distribution delivers interesting information. It can help comparing how these distributions are discarded from the perfect equality line, as well as comparing how these distributions are placed one against the other. This permits to introduce the concept of Lorenz dominance[9]. Consider two distributions $X_1 = (x_1, x_2, ..., x_n)$ and $X_2 = (x_1, x_2, ..., x_m)$ to each of which corresponds a Lorenz curve $L_1(u)$ and $L_2(u)$ for all $u \subset [0,1]$ respectively. The random variable X_1 is said to be at least as unequal as X_2 in the Lorenz sense if $L_1(u) \leq L_2(u)$, which can be written:

$$X_1 \geq_L X_2 \quad \Leftrightarrow \quad L_1 \leq L_2$$

The distribution X_2 is said to be *Lorenz-dominant* over distribution X_1.

The expression above reveals that the Lorenz curve is a partial order. Therefore the situation where two Lorenz curves *intersect* becomes problematic to interpret: which is the most "equally" spread distribution then? Which distribution should one "prefer" then? This is exactly the problem we encounter in Figure 6. This representation is a relative comparison of distributions and to say that distribution A "Lorenz-dominates" distribution B implies that the Lorenz curve for distribution A is located between the perfect equality line and the Lorenz curve for distribution

9 Lorenz dominance is also called mean-normalised second-order stochastic dominance.

B along the *whole* x-axis of the Lorenz curve. If two Lorenz curves intersect then difficulties arise as regards the choice of a proper interpretation. One alternative is to use unambiguous indicators of inequality. Another one might be to plot generalised Lorenz curves as we already did in Figure 5.

Actually, the generalised version of the Lorenz curve has interesting properties as regards the conclusion it allows to draw as regards stochastic dominance. It overcomes the problem where, with relative Lorenz curves, it is difficult to declare one distribution Lorenz-dominant over another in case the curves intersect. Based on ATKINSON (1970), STARK and YITZHAKI (1988) show that a necessary condition for distribution A to dominate distribution B in the absolute sense is that $E(A) \geq E(B)$ [10]. Actually if the means are equal, then to declare that distribution A (relative) Lorenz-dominates distribution B requires that the two (relative) Lorenz curves do not intersect. But if $E(A) > E(B)$, then it is possible that the relative Lorenz curve intersect, without that distribution A loses its dominance over distribution B: the generalized Lorenz curves do not intersect though.

Thus, as regard the two distributions of FNVA per AWU, knowing that their respective means are of 25,602 € in 2002 and 35,009 € in 2004 as already mentioned above, the distribution of values of FNVA per AWU in 2004 first- and second-order dominates the distribution of values of FNVA per AWU in 2002 in the absolute sense. It means that, if we were to consider FNVA per AWU as a satisfactory evaluation function of individual incomes, then social welfare has increased between 2002 and 2004 among farm population. As the Lorenz curves intersect as shown in Figure 6, no conclusion can be drawn as regards the Lorenz dominance of the 2004 distribution over the 2002 one and vice versa. However, Lorenz curves graphically show that inequality has certainly not decreased between 2002 and 2004; the 2002 Lorenz curve is closer to the perfect equality line than the 2004 does. Inequalities may have risen between 2002 and 2004 while social welfare has increased.

This general section presenting some methods to investigate basic properties aimed at showing that the interpretation of the dispersion of data has to consider the advantages and disadvantages of the method used to illustrate this dispersion. It provided first insights of the study of disparities and inequalities as well. The question of the right interpretation of figures and indicators of dispersion and inequalities is central when one looks at these. The next section will introduce the topic of the measurement of inequalities and disparities, where we may not be able to avoid this central issue to welfare economics: which distribution of income, wealth or any other welfare indicator is preferable to the other? How far is it possible to

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[10] In their paper, STARK and YITZHAKI (1988) mean stochastic dominance which differs from distributional dominance where a complete ranking of distributions is generated as used in COWELL (2000).

trust the rightness of one indicator and on which theory and/or assumptions is it built upon?

1.2.2.2 The challenge of inequality measurement[11]

1.2.2.2.1 Foreword and grounding axioms

The preceding section provided a first overview on methods to investigate a distribution of data. It introduces the concept of first-order and second-order stochastic dominance which constitutes an alternative approach to the one presented below.

However, a preliminary question would be worth asking: why not simply comparing means, variance and standard deviations corresponding to these distributions and attribute the "preference" to the distribution with the highest mean or the lowest standard deviation? Find a "good" summary measure satisfying properties one would expect this measure to have is not that easy though. ATKINSON (1970) uses findings made in the framework of the theory of decision-making under uncertainty to depict the properties an ideal inequality measure should possess. For instance, one would expect the inequality measure to be invariant with respect to linear transformation: if all incomes are multiplied by a (a>0), then the inequality measure should not move. Similarly, the measure should take into account the fact that equal additions to incomes will raise the concern on inequality. The general sensitivity of the indicator would have to be taken into account, as well as its easy computation, easy interpretation, its behaviour in a defined range of variation and its completeness over the whole distribution. And in the end, the measure should take transfers into account, i.e. if lump-sum transfers would be possible from higher incomes to lower ones, then the inequality measure should be consequently lower. Atkinson suggests rejecting all measures he proposed to investigate in his paper (including variance, standard deviation, relative mean deviation, coefficient of variation, Gini coefficient – on which we may come back later – and standard deviation of logarithms) because of the disputable assumptions each of these measures imply on the form of the underlying social welfare function.

We can summarise and extend the above list of desirable properties an inequality measure should have in an axiomatic way. This measure should respect the following principles:

- *Anonymity* (or *symmetry*): This principle requires the measure to be independent of any characteristics of the individuals other than their income (or any variable considered as indicator for income),

[11] This section has benefited a lot from the following sources: COWELL (2000), CHAMPERNOWNE and COWELL (1998), ATKINSON (1970), COWELL and JENKINS (1995) and LITCHFIELD (1999).

- *Income scale independence*: As evoked above, the measure shall be invariant to uniform proportional changes. The variance for instance would not pass this test: it would be quadrupled by doubling all incomes!
- *Principle of population* (DALTON, 1920): Merging two identical populations should not change the inequality measure,
- *Pigou-Dalton transfer principle* (PIGOU, 1920, DALTON, 1920): The inequality measure should rise (or at least not fall) in response to a mean-preserving spread. An income transfer from a poorer to a richer person should be register as a rise (or at least not as a fall) in inequality and the contrary should hold as well. Most measure satisfy this principle (Generalized Entropy, Atkinson and Gini coefficients),
- *Decomposability*: If the initial distribution is to be divided into groups and if inequality rises inside each group then the inequality measure for the whole distribution is expected to rise as well. This appeals the decomposability of an inequality measure into a within-groups and between-groups inequality. The Generalized Entropy class of measures is such that $I_{total}=I_{between}+I_{within}$. The Atkinson measures are decomposable but the sum of the within and between components of inequality do not equal the overall inequality[12]. The Gini coefficient is only decomposable when the partitions are not overlapping.

The last axiom one would wish an inequality measure to respect is a very interesting one when partitions of a distribution are made in a meaningful sense. This property reminds us of the multivariate approach presented in 1.2.2.1.1. If the grouping of individuals is properly made, the development of the inequality measure respecting the decomposability principle can help understanding and depicting some determinants of the development of heterogeneities among incomes.

So far the class of Generalised Entropy measures would respect all axioms listed above. The description and properties of these and other inequality measures are to be found right below.

1.2.2.2.2 Some indicators of inequality

The Gini index is a measure of inequality which is much appreciated and has played an important role in the inequality literature. One of the reasons for this may be its link to the Lorenz curve: actually, it is calculated based on the ratio of the area trapped between the Lorenz curve and the diagonal line of perfect equality over the proportion of the whole area of the triangle. Therefore, it varies between 0 and 1, where 0 holds for perfect equality and 1 for perfect inequality.

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[12] As shown in COWELL and JENKINS (1995), let A be the Atkinson measure for inequality, then $A_{total}=A_{within}+A_{betwenn}- A_{within}x\ A_{betwenn}$.

Formally, following COWELL (2000), the Gini index can be expressed at least in three different ways:

$$Gini = \frac{1}{2\mu(F)}\int\int |x - x'|\, dF(x)\, dF(x')$$

$$= \int x\,\kappa(x)\, dF(x)$$

$$= 1 - 2\int_0^1 L(y)\, dy$$

$$= \frac{1}{2n^2\,\overline{y}}\sum_{i=1}^{n}\sum_{j=1}^{n}\left|y_i - y_j\right|$$

where $L(y) = \frac{\int_0^y x\, dF(x)}{\mu}$, $\kappa(x) = 2F(x) - 1/\mu(F)$ and in the discrete case n the size of the population and $\overline{y}$ the arithmetic mean income.

The first expression reveals that the Gini index measures the average distance between incomes in the population; it is the normalised average absolute difference between all pairs of income in the population. The second expression reveals that this index is the weighted sum of all the incomes in the population where the weights $\kappa(x)$ depend on the rank of the income-receiving unit of the distribution $F(x)$.

The third expression of the Gini index reveals its formal link with the Lorenz curve. The convenience represented by the possibility to graphically "see" inequality among a distribution is one of the explanations for the success of the Gini index since decades. The last expression is the Gini index calculated in the discrete case.

However, this index has to be considered with caution. First, although only one Gini index can be calculated for a specific Lorenz curve, the reverse is not true. Actually, to each Gini index could correspond infinity of Lorenz curve, which quite restrains the enthusiasm one could experience with this index. Second, although it fulfils the four first axioms quoted above, the Gini index will not satisfy the fifth one if the sub-vectors of income in the studied population overlap; the Gini indexes calculated over the groups are not that easily appealing.

Nonetheless the Gini index is quite a pragmatic tool and its notoriety in the literature makes it a good candidate for inequality comparisons.

Actually, inequality measures satisfying all five axioms listed above belong to the class of Generalised Entropy measures (GE measures). These measures are derived from the work of THEIL (1967) using the entropy concept in information theory. In the discrete case they can be formally expressed as following:

$$GE_{\alpha}(y) = \frac{1}{\alpha^2 - \alpha}\left[\frac{1}{n}\sum_{i=1}^{n}\left(\frac{y_i}{\bar{y}}\right)^{\alpha} - 1\right]$$

where $\alpha \in (-\infty;+\infty)$. This measure varies between 0 and $+\infty$ where a GE value of 0 means perfect income equality and higher values higher levels of inequality. What is interesting here is the role played by the parameter α. It captures the sensitivity of the GE index to particular parts of the income distribution; for lower or negative values of α the GE measure is more sensitive to changes in the lower tail of the distribution while higher values of α makes the GE measure more sensitive to changes in the upper tail of the distribution. The most common values for α are 0, 1 and 2. Thus for α=0, more weight is given to distances between incomes in the lower tail of the distribution. For α=1, the weight is equal throughout the distribution. For α=2 gaps between incomes in the upper tail of the distribution influence the value of the GE measure. For these three values of α corresponds an inequality measure among which two have been defined by Theil and expressed as follows:

In the case where α=1, the GE measure becomes the Theil index or Theil's T and:

$$GE_1(y) = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{y_i}{\bar{y}}\right)\ln\left(\frac{y_i}{\bar{y}}\right)$$

In the case where or α=0, the GE measure is the mean logarithmic deviation (MLD) index, or Theil's L, and:

$$GE_0(y) = \frac{1}{n}\sum_{i=1}^{n}\ln\left(\frac{y_i}{\bar{y}}\right)$$

In the case where α=2, the GE measure becomes the coefficient of variation, the variance if squared.

Table 3 illustrates the differences between values of the classical indexes mentioned above for FNVA per hectare calculated for farms belonging to the FADN database for the years 2002 and 2004.

Table 3: Some inequality measures calculated using the FNVA per ha of farms in the FADN sample for Brandenburg in 2002 and 2004

	FNVA/ha in 2002	FNVA/ha in 2004
Relative mean deviation	0.6616355	0.6060713
Gini coefficient	0.8183519	0.7177935
Theil's L (α =0) or MLD	2.1277331	1.7707811
Theil's T (α =1)	1.0138259	0.97812202
Coefficient of variation (α =2)	5.0394413	4.3776224

Source: Own figure adapted from the FADN database for Brandenburg (2002, 2004), using the DASP Version 1.4 in Stata 10.1

All indicators in the table testify a decrease in inequality among the sample of farms between 2002 and 2004. However, Theil's general entropy measures and the possibility to vary the weight given to different parts of the distribution give an additional possibility to depict "where" inequality has decreased. By calculating the ratio between Theil's indexes over both study years one can state that inequality has decreased a bit sharper at the lower extreme of the income distribution (α =0) than at the top income level (α =2).

Where the creation of GE measures has benefited from information theory the next index finds its roots in the field of individual choice under uncertainty. Attitudes towards risk are "transformed" into attitudes towards inequality; the formulation of riskiness and the concept of risk aversion have been translated to the fields of inequality measurement and social evaluation of income distribution and keep on doing so. It delivered a practical tool for distributional analysis based on the idea of *equally-distributed equivalent* level of income closely related to the concept of risk premium or certainty equivalent (ATKINSON, 1970). The equally-distributed equivalent can be defined as a money-metric of social welfare and the corresponding level of income is that income which, if distributed to each individual along the distribution, would yield the same level of social welfare as the actual income distribution considered. In a two-person world the corresponding measure of inequality would be expressed as follows:

$$I = 1 - \frac{EDE}{\mu},$$

where EDE is the equally-distributed level of income and μ the actual mean of income over the two persons. The higher the index (the closer to unity), the less equal the distribution; however assumptions on a social welfare function as well as the definition of inequality aversion may play an important role in the value of the index.

Finding a practical tool to be implemented in an n-individuals economy requires the definition of a proper index, of the nature of "inequality aversion" and of a social welfare function. The Atkinson index would be the right candidate for that:

$$I_A^{\varepsilon} = 1 - \left[\frac{1}{n} \left[\sum_{i=1}^{n} \frac{y_i}{\bar{y}} \right]^{1-\varepsilon} \right]^{1/(1-\varepsilon)},$$

where $\varepsilon \in (0; +\infty)$ is a parameter defining relative inequality aversion. The higher its value, the more society is concerned about inequality. Note that for $\alpha = 1 - \varepsilon$ the Atkinson class of measures are ordinally equivalent to the GE ones.

Table 4 illustrates the variation of the Atkinson index while varying the value of ε. The higher the value of ε, the "more concerned" expressed by society over a rise in inequality. This concern translated into an increase of the Atkinson index as well.

Table 4: Atkinson measures calculated using the FNVA per ha of farms in the FADN sample for Brandenburg in 2002 and 2004

	FNVA/ha in 2002	FNVA/ha in 2004
ε=0.1	0.1551634	0.1561984
ε=0.5	0.5606416	0.5052654
ε=1	0.6371718	0.6239834

Source: Own figure adapted from the FADN database for Brandenburg (2002, 2004), using the DASP Version 1.4 in Stata 10.1.

The best-known indexes of inequality have been presented so far. They allow comparing overall inequality throughout whole distributions. However, as mentioned where required, there is no perfect index as the underlying assumptions on which their definition is based can always be discussed; see the inequality aversion of the Atkinson index/the sensitivity of the GE measures where one could ask: which value *should* I choose?. Their performances as regards the five grounding axioms are questionable as well. Among those the decomposability axiom is particularly appealing for the analysis of possible sources of inequality; this is the topic of the next section.

1.2.2.3 Decomposing inequality

There are two main types of decomposition one would like to perform in order to better understand the structure of inequality:

- decomposition by groups of the population, where the relationship between inequality as a whole and inequality within and between groups. The distribution may be divided for instance with respect to the location of individuals or to some common characteristics,

- decomposition by income sources, or any component which could determine the development of inequality in the population.

These decompositions can help depicting the structure and the dynamics of inequality, where global indexes may fail to reveal important facets.

As regards the decomposition by groups, this assumes that the indicator can be divided into two components: inequality "within" and the one "between" groups. Then there are two aspects of interest: 1) how do inequalities within and between these groups look like, and 2) how do they evolve dynamically over time?

The static decomposition evoked in 1) can be achieved with the Atkinson index and the GE measures. If GE measures are to be used, the "within" group component of inequality can be expressed as follows:

$$I_w = \sum_{j=1}^{k} w_j GE(\alpha)_j \qquad \text{with } w_j = v_j^{\alpha} f_j^{1-\alpha} \text{ and } j = 0,1,...,k ,$$

where f_j is the population share of the group j and v_j the income share of the group j. As regard the "between" group component, it is calculated by assigning the mean income of each group to each of its member:

$$I_b = \frac{1}{\alpha^2 - \alpha}\left[\sum_{j=1}^{k} f_j \left(\frac{\overline{y_j}}{\overline{y}}\right)^{\alpha} - 1\right]$$

In this case, the overall inequality can be simply expressed as:

$$I = I_w + I_b$$

It means also that it is possible to calculate which "amount of inequality" is due to income differences between groups classified by a given characteristic or set of characteristics. Following COWELL and JENKINS (1995), let us define the ratio $R_b = I_b / I$, then the closer this ratio to 1, the more relevant the characteristic chosen to build groups to explain overall inequality. As shown by COWELL and JENKINS (1995), the use of a specific inequality indicator as well as the choice of the parameter α in the case of GE measures (or its equivalent ε in the case of the Atkinson family of measures) is decisive as regards final results.

Table 5 illustrates this issue using the database already used above. The farm population has been divided into distinct groups considering the technical orientation of farms for the years investigated. One can see that the "between" groups component of inequality is dominant from far compared to its counterpart, the "within" groups component. However, the latter component tends to gain more importance in the calculation of inequality between the two study years, which denotes growing income heterogeneity within the predefined groups between these two time snapshots.

Table 5: Decomposition of the Generalized Entropy index (α =0) for the FNVA per ha in between and within components of inequality

	Absolute contribution		Relative contribution	
	2002	2004	2002	2004
Within	0.186328	0.237328	0.160295	0.235426
Between	1.119847	0.776004	0.963385	0.769786

Source: Own figure adapted from the FADN database for Brandenburg (2002, 2004), using the DASP Version 1.4 in Stata 10.1.

To investigate the dynamic change of inequality between and within groups over time evoked in point 2), three aspects have to be considered (marked in the equation below):

- a "pure" inequality effect due to changes in inequality within groups (1).
- an "allocation" effect due to the size change of groups (2),
- an "income" effect due to changes in relative mean incomes between groups (3),

For the GE class of measure with $\alpha = 0$ the decomposition of inequality between periods t and t+1 would be expressed as follows[13]:

$$\Delta GE(0) = GE_{t+1}(0) - GE_t(0)$$

$$= \left[\underbrace{\sum_{j=1}^{k} \overline{f_j}\, \Delta GE(0)}_{(1)} + \underbrace{\sum_{j=1}^{k} \overline{GE(0)_j}\, \Delta f + \sum_{j=1}^{k} \left[\overline{\lambda_j} - \overline{\log(\lambda_j)} \right] \Delta f_j}_{(2)} + \underbrace{\sum_{j=1}^{k} \left(\overline{v_j} - \overline{f_j} \right) \Delta \log(\mu(y_j))}_{(3)} \right]^{14}$$

where y is income, Δ the difference operator and the bars above the variables indicates an average of values between periods t and t+1. λ_j represents group's j mean income relative to the population mean and v_j is the group's j share of total population income.

The development of inequality can be investigated under the light of income sources as well (JENKINS, 1995). The decomposition considers each income source *f* as having a specific contribution S_f to overall inequality such as:

$$I = \sum_f S_f$$

[13] Based on former research from MOOKHERJEE and SHORROCKS (1982), this formula is an approximation.
[14] JENKINS (1995).

If the income source f provides an "equalizing effect then S_f will tend to be negative, whereas if not then it would be positive. Therefore the absolute contribution s_f of income source f would be:

$$s_f = S_f / I$$

JENKINS (1995) uses one of the measures belonging to the GE class with α =2 to state that:

$$S_f = s_f GE(2) = \rho_f \chi_f \sqrt{GE(2) \cdot GE(2)_f}$$

and thus, in a dynamic perspective:

$$\begin{aligned}\Delta GE(2) &= GE_{t+1}(2) - GE_t(2) \\ &= \sum_f \Delta S_f \\ &= \sum_f \Delta\left[\rho_f \chi_f \sqrt{GE(2) \cdot GE(2)_f}\right]\end{aligned}$$

with ρ_f the correlation between income source f and total income and $\chi_f = \mu_f / \mu$ which is the ratio between the mean of factor f among the population and the total income mean.

For both decompositions the proportion of variation of inequality can be obtained by dividing the expression of the decomposition by subgroups by $GE_t(0)$ and by $GE_t(2)$ in the expression of the decomposition of inequality by income sources.

Decomposing inequality helps in a decisive way. Having in mind potential causes or influence factors for income inequality, one is provided with precise and objective measures of the influence of each of these factors in the development of inequality. The decomposition by subgroups can be used to check which amount of inequality can be explained by population characteristics. The decomposition by income sources helps identifying the most influential sources of inequality.

These possibilities offered to decompose inequality over either subgroups or income sources open a wide range of analyses. In agriculture, where farmers' population is clearly "physically" decomposable over farm size or technical orientation for instance, the use of decomposed inequality indicators and the analysis of their development can give useful clues on the precise impacts of policies on each of these subgroups.

However, particularly as regards the CAP and the quite recent political will expressed over the EU to keep the budget for agriculture constant and even decreasing in the future, a redistribution of direct payments between Member States and eventually farm groups seems unavoidable and is already taking place through the modulation of Pillar I payments to the benefit of Pillar II. The red-hot question of redistribution of payments through modulation or other political tools implies the development of inequality not be independent of the group characteristics anymore. Actually, the progressive modulation of Pillar I payments and their redistribution through Pillar II may lead to the situation where benefits for some groups are done at the expense of other groups. Therefore even though general indicators of inequality would display a more equal resource or income distribution, they would not be able to reflect this win-lose situation over the farm population. Farmers' expectations on future policy designs and the fact that some homogeneous and/or influential subgroups may win/lose public support often put the acceptance and therefore the success of the planned policy into question. The border-line may even lead to an open conflict between/within subgroups of farms or even between farms and the rest of the society. Nowadays, the CAP may cause some unrest by planning a redistribution of credits throughout the farm population without any further global increase in general. This new pragmatic paradigm may provide the concept of polarization with some interesting properties for this study.

The next section may shed some light on this issue.

1.2.3 Polarization

In few words, to say that a group or a society is polarized means that one can define groups or "clusters", "such that each cluster is very "similar" in terms of the attributes of its members, but different clusters have members with very "dissimilar" attributes" (ESTEBAN and RAY, 1994)[15]. In a sense, the idea could be compared to cut the population into subgroups as has been exposed in the section before, therefore to decompose inequality measures should suffice to get a quite precise picture of heterogeneities in the studied population. However, Esteban and Ray specify that even though polarization would be high in a society (meaning intra-group homogeneity be high as well as inter-group heterogeneity), "measured inequality in such a society may be low". With the help of simple examples they illustrate the fact that the presence of "local means" among a distribution may not be properly grasped by measured inequality. This is linked to a growing identification phenomenon within the groups gathered around these local means, such as described in DUCLOS et al. (2004): "local equalizations of income differences at two different ranges of the income distribution will most likely lead to two better-defined groups-each with a clearer sense of itself and the other. In this case inequality will have come down but polarization may be on the rise". Moreover, the size of the considered groups in a polarized distribution may play a role in the overall picture on redistribution of resources. Therefore, altogether number and size of groups, "distance" between them and the volume of income or whatever resource distributed among the population as well as the direction and strength of redistribution

[15] Following DUCLOS et al. (2004), "polarization is related to the alienation that individuals and groups feel from one another, but such alienation is fuelled by notions of within-group identity". Therefore polarization takes place in a so-called identity-alienation framework which can determine social and political divisions throughout a population. ESTEBAN and RAY (1994) even mention that "the phenomenon of polarization is closely linked to the generation of tensions, to the possibilities of articulated rebellion and revolt, and to the existence of social unrest in general".

of resources overtime play a simultaneous role in the calculation of polarization. These considerations may complicate the study of income and resources distribution a bit and open a quite different way to consider disparities throughout a population.

Similarly to inequality measurement, an axiomatic approach has been used by DUCLOS et al. (2004) to depict properties a polarization measure should possess. The axioms are listed for distributions which can be described by density functions:

- Axiom 1: "if a distribution is composed of a single basic density, then a squeeze of that density cannot increase polarization." In other words, as polarization relies on the presence of at least two distinct groups gathered around local means, the compression of the distribution around one unique mean does not influence polarization;
- Axiom 2: "if a symmetric distribution is composed of three basic densities with the same root and mutually disjoint supports, then a symmetric squeeze of the side densities cannot reduce polarization." If one imagines three "hills" summing the population along the axis of income distribution, then the compression of the two corner hills does not change polarization. In the contrary, inequality in this case will undoubtedly rise.
- Axiom 3: like in Axiom 1, consider a symmetric distribution but composed of four basic densities this time. In this case if you slide each of the two middle densities to opposite sides, then polarization must go up. The four distinct groups merge stepwise to two "extreme" groups.
- Axiom 4: any positive identical scaling of two populations leaves the corresponding polarization measures unchanged.

These axioms are satisfied by the following polarization measure:

$$P_\alpha(F) \equiv \iint f(x)^{1+\alpha} f(y)|y-x|\,dy\,dx\,,$$

where $\alpha \in [0.25,1]$, f is the density function of the population for income levels x and y.

Following the definition of the identification-alienation framework explained by DUCLOS et al. (2004) as well as another expression of polarization they use in their paper, the index may be considered as the product of "average alienation, average identification, and (one plus) the mean-normalized covariance between these two variables". To explain the "identification" factor, let us say that for the individuals becoming the income x, the more other individuals become the same income, the strongest the "feeling" for them all to belong to this specific group distinct from the others. Similarly, as regards the "alienation" factor, the more distant the other incomes are from the income x of an individual, the strongest the "feeling" for this individual not to belong to the other income groups.[16]

There are some comments to be made on the parameter α though. First, if its value is 0, the polarization measure becomes the Gini coefficient. However, it can never take this value in the axiomatic framework defined above without violating the Axiom 2. Similarly, it can not be too high without violating Axiom 1, therefore the bounds.

In the discrete case the polarization measure is as follows (ESTEBAN and RAY, 1994):

$$P^*(\pi, y) \equiv K \sum_{i=1}^{n} \sum_{j=1}^{n} \pi_i^{1+\alpha} \pi_j \left| y_i - y_j \right|,$$

Where K>0, $\alpha \in [0, \alpha^*]$ and $\alpha^* \approx 1.6$ and where $(\pi, y) = (\pi_1, ..., \pi_n; y_1, ..., y_n)$ is a distribution of a range of incomes y distributed over a population constituted of π groups.

Deduced from the expressions above, it is to specify that the lowest the index, the lowest the polarization.

Table 6 provides polarization values for the set of data illustrating this chapter. One can see that the farm population has become less "polarized" between 2002 and 2004, where inequality indicators have shown the same patterns as well.

Table 6: Duclos, Esteban and Ray (DER) index of polarization (α=0.5) for FNVA/ha in Brandenburg in 2002 and 2004

	Estimate	STD	Lower Bound	Upper Bound
2002	0.543774	0.122101	0.303099	0.784450
2004	0.513418	0.122094	0.272758	0.754078
Difference	-0.030356	0.066354	-0.160407	0.099695

Source: Own figure adapted from the FADN database for Brandenburg (2002, 2004), using the DASP Version 1.4 in Stata 10.1.

The concept of polarization has gained and is still gaining resonance in the literature. Its relevance for the study of topics centred on social conflicts and the assessment of acceptance of political decisions makes it an interesting issue to focus on. It widens the already large perspectives opened in the field of income inequality and enriches it.

16 As specified in DUCLOS et al. (2004), the "approach is fundamentally based on the view that the interpersonal alienation fuels a polarized society, as does inequality." And "such alienation must also be complemented by a sense of identification. This combination of the two forces generates a class of measures that are sensitive (in the same direction) to both elements of inequality and equality, depending on where these changes are located in the overall distribution."

The two first subchapters above aimed at providing an overview of existing theories and indicators in the field of inequality and polarization. This will be useful for the overall appreciation of income disparities and their development considering the implementation of differential policy scenarios.

1.3 Contribution of inequality literature to the understanding of income issues in agricultural economics

1.3.1 Farm income, farm household income, agricultural profit and wealth

1.3.1.1 Some issues to be clarified

Agricultural activities are based on three main groups of factors: land, labour and capital. Farm's production system is constituted of a combination of these factors. This allows the farm operator to reach a profit from its activities of which a proportion will be reinvested in the maintenance and improvement of the production system. This process occurs dynamically and economic results of a farm highly depend on its current environment and future expectations as well. There are two interpretations of farm income.

The first defines farm income as returns to the farm entrepreneur for the use of agricultural resources to generate goods and services. HILL (2000) mentions that usually an indicator for the amount of value-added remaining to farmers and their families (or to farmers and their spouses by charging unpaid labour from other family members) is used to estimates the return for using the factors of production that they own (owned land and capital, labour and managerial efforts). This concept is close to business profit to some extent.

The second interpretation of income implies talking about farmer households rather than individuals; incomes and expenditures of farmers are usually pooled. In this approach personal incomes are considered, covering the broader flow of resources to farmers that can be spent or saved. The focus here concerns the way that farm households acquire and/or rent and use resources and make decisions on how they use them to get a living. As labour can be used on- and off-farm (including therefore farming, other income-generating activities, household tasks and leisure), decisions on how members of a household will allocate this time are object for study. The choice among activities and time spent on different items depends on on-farm and off-farm labour opportunities. A household occupied in farming is likely to have one or more members who have income from earnings in other occupations, from on-farm (like farm tourism), off-farm (employee, self employed business man/woman or professional) investments, pensions or other transfer payments. These other sources of income are of great significance in Europe. They reduce the degree of dependence on farming for households' livelihoods and may even constitute the major source of revenues. They may protect farm families against the inherent instability of their income from farming.

However, farm household incomes pose a problem to the policy maker. As most farms are organised as family owned and operated farms and family members have off-farm employment, farm households derive their income both from agricultural and non-agricultural occupations. The consequence is a more or less significant underestimation of the situation of agricultural households when income is measured only in terms of agricultural production. This is not to mention capital and fixed assets (buildings, land) which in some cases could make consider farmers as a wealthy population category.

When it comes to comparisons with other income earners in the society difficulties arise for policy makers in defining appropriate agricultural policies. The systematic gap between farm incomes and incomes in the rest of the economy is partly due to the fact that the total income of agricultural households does not only come from the production of agricultural goods, but considerably depends on off-farm activities performed by family members.

1.3.1.2 Why caring for farm incomes at all?

Although agricultural activities provide goods which are of first importance for the whole human mankind, it has long been considered, in opposition to industry and services, as a backward activity. In France, agriculture was long thought to be devoted to people who could not get any better position in administration or industry (BERTHELOT, 2001). Supporting this activity, which operators' incomes were reputed to systematically lag behind those in other sectors of the economy, is confirmed by the following citation from Hill that "there seems to be general agreement among academics and commentators working in the policy area that income support is now the fundamental objective of agricultural policy in contemporary western Europe and in industrialised capitalist market economies as a group" (HILL, 2000). In Japan, for instance and until recently, enabling farmers to enjoy equal standards of living with workers in other industries through increased farm income was described as the main objective of agricultural policy (MOREDDU et al., 2003). In Turkey, rural development projects have to "increase farmers' income". Canadian policies emphasize the protection of the incomes of efficient producers from market price instability, whereas in Australia and New Zealand the government is expected to "protect incomes from sharp and unexpected decreases, as with disaster relief measures". The presence of risk in agricultural activities due to their climate depending nature sensible to weather conditions (floods, droughts, pests, etc.) as well as the provision of public goods, both not necessarily well covered by markets, may justify the intervention of governments in the sector. Moreover, the permanent adjustments farmers have to operate parallel to the tendency for farms to get larger loads of work on farm family members, as hired labour becomes more expensive to employ. Especially for small farms which can not generate enough income from agricultural activities to operate at a full time basis, the harsh economic climate forcing them either to exit or to farm more intensively and look for alternative income sources can be perceived as unfair; those farm groups may claim assistance from policy makers.

Based on the perceptions various stakeholders have from policy there are three broad concerns identified by HILL (2000):

- the level of incomes in agriculture compared with earnings in other sectors, or the parity issue
- the low levels of incomes in some regions or farm sizes, or the poverty issue
- the variation of income over time, or the instability issue.

These concerns reflect the components of the "farm problem"[17] summarised by GARDNER (1992). They are either explicitly mentioned, or at least indirectly expressed, through policy objectives and underlying beliefs.

However, especially regarding households getting an off-farm income, "supporting the income from farming is unlikely to have much impact on the total income of these households, yet it will greatly raise the income of the larger producers" (HILL, 2000). This means that income support policies may have mitigated impacts on most farms, as a large part of them (over half the number of holdings in the EU in 2000, HILL (2000) do not exclusively rely on farming activities.

1.3.1.3 What are income disparities due to?

There are many causes to income disparities between farms, some of them being relatively straightforward.

A first reason is of "physical" order: the location of the farm. Agronomical potentials, and thus the maximal receipts the farm can get from its agricultural activities depends on the quality of the soils the farm is managing, the access to water or at least the possibility to irrigate the land if necessary and the climatic conditions imposed by the location of the farm.

Economical reasons for disparities are closely linked to the way the farm is structurally organised. Farm size, the types of production the farm operator has chosen to invest in and the combination of productive factors selected to reach the maximal profit are some decisive factors determining farm performance. This is the result of decisions made by the farm operator, may it be a unique owner leading a family farm or a legal entity constituted of shareholders. Among the economical reasons for disparities, the political framework should be included. Indeed, public

[17] The farm problem qualifies structural adjustments and outflow of labour caused by inelastic demand and the "technological treadmill"; the combination of growth in non agricultural sectors and decreasing prices in the agricultural sector accelerates this outflow. Moreover, it requires technological progress sufficient to generate only a slightly larger rate of increase of supply compared to demand to cause prices to fall a lot, and relatively small transitory output or demand shocks to cause substantial price fluctuations. In the end, there is a constant depression on farm incomes in the sector in general.

support directly provided through the CAP until 2003 to some sectors (cereals, oilseeds, ruminants) rather than others (pig and poultry) played a non negligible role in farmer's investment and production decisions across the EU. The actual decoupling of CAP direct payments does not correct these public support disparities, as these payments were in most EU countries until now only directly distributed to the farm operator at their previous level. This point may rather be extensively discussed later.

1.3.2 Income inequality issues in agricultural economics

1.3.2.1 A short literature overview

The OECD agricultural ministers (ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT have identified equity and targeting as operational criteria for policy evaluation (OECD, 1998). However, the impact of farm support programmes on the distribution of income among farmers has not received much explicit consideration. Although the topic of income inequality has long been addressed, the literature in agricultural economics is not that extended regarding income inequality among farm households. Von WITZKE (1979) has initiated works to explore some explanations of income distribution in Europe, taking in his study the example of impacts of CAP price policy on the distribution of incomes in the West German agriculture. By mean of a neoclassical model, he finds that in the long run, agricultural support price policy would contribute to a greater concentration of income within agriculture. Stating that farmers with high incomes benefit relatively more from higher prices than low income farmers, he rather suggests the use of other instruments to conduct a more appropriate income policy. In the USA, GARDNER (1969) finds significant differences among states as regards farm family income inequality. Later, AHEARN et al. (1985) find a higher inequality in the distribution of total farm household income in 1984 than in 1966, as well as that any increase in US government payments and household farm income would decrease income inequality, without any regional distinction though.

Further studies mentioned in MISHRA et al. (2009) focus on the impact of off-farm employment in the development of farm income inequality and conclude that any increase/decrease in inequality depends on the region considered. Additionally other studies point the importance of off-farm employment in reducing income inequality among farm families, hence the importance of rural development policies aimed at promoting better off-farm opportunities.

These studies all used the "classical" Gini coefficient to illustrate and justify their results as regards income inequality development. This might be problematic in the sense that a quite common occurrence in the agricultural sector (especially when public support is not included in the income variable used) is the presence of negative incomes in the distribution. Some of the studies cited above based their results on incomes considered as being equal to zero when being negative in reality, which underestimates inequality. The difficulty of measuring inequality in the presence of negative incomes as well as possible solutions to overcome this problem will be evoked in the following section.

1.3.2.2 Negative farm incomes and suitable inequality measures

As mentioned in AMIEL et al. (1996), "the possibility that some 'income' observations may be negative raises some awkward issues in the measurement of economic inequality". Although the standard ranking tools of inequality measurement such as quartiles and shares are well defined for all incomes, may they be negative or positive, other tools are more problematic in their use.

Many standard aggregative inequality measures are undefined for negative incomes, and a substantial class of these measures will not work even for zero incomes, in the sense that they are either undefined, or are unbounded, or attain their maximum value at any income distribution that has one or more zero incomes. The reason for this is that many standard measures can be expressed as transforms of the average value of an 'income evaluation function' evaluated over the distribution, and that for many commonly used measures this function has a singularity at 0. General entropy measures (therefore including all Theil indexes), except the coefficient of variation, enter the category of non usable inequality measures in case of negative incomes.

There are several alternatives to this. Either one could simply delete all negative incomes appearing in a distribution, or replace them by zeros, or use some adjusted measures of inequality. In the first two cases, there is no doubt that, if taking for instance the Gini coefficient, results will of course differ depending on which alternative will be chosen. Table 7 below illustrates the gaps to be expected between Gini coefficients if income distributions were to be modified due to negative incomes.

Table 7: Gini coefficient calculated using the FNVA per AWU of farms in the FADN sample for Brandenburg in 2002

	Estimated Gini	Standard deviation	Lower Bound	Upper Bound
All incomes	0.360273	0.024764	0.311508	0.409038
Negatives set to 0*	0.330315	0.017742	0.295377	0.365252
Negatives deleted*	0.289146	0.015308	0.258993	0.319298

Source: Own figure adapted from the FADN database for Brandenburg (2002), using the DASP Version 2.1 in Stata 11.0. *: 15 negative values over 259 observations.

Inequality as displayed above by considering all incomes in the distribution (mean positive: 25,602 Euros per AWU) is found to be the lowest one in the case were negative incomes are simply deleted, which makes sense knowing the nature of the Gini coefficient. However, one can see that setting negatives to zero underestimates inequality as already mentioned in KINSEY (1985) in response to the article published by AHEARN et al. (1985) who have used this technique to overcome difficulties linked to the presence of negative incomes in the calculation of Gini coefficient.

Another alternative as mentioned above would consist in the use of measures which calculation is based on absolute differences which may be normalized in order to be invariant under scale transformations of income and which would be able to cope with negative incomes. MISHRA et al. (2009) mention some studies (BOISVERT and RANNEY, 1990) using a so called "adjusted" Gini index noted G* (CHEN et al., 1982; BERREBI and SILBER, 1985). This measure has a lower bound of 0 and an upper bound of 1. When applied to farm household income, a Gini value of 0 indicates perfect equality while a value of 1 indicates perfect inequality. The benefit of using this index rather than the "classical" Gini coefficient (G) is its ability to mitigate the possibility of overstating inequality when the data contain a large number of observations. It is calculated as follows:

$$G^* = \frac{(2/n)\sum_{j=1}^{n} j\,y_j - \frac{n+1}{n}}{\left[1 + (2/n)\sum_{j=1}^{m} j\,y_j\right] + (1/n)\sum_{j=1}^{m} y_j \left[\frac{\sum_{j=1}^{m} y_j}{y_{m+1}} - (1+2m)\right]}$$

With $y_j = Y_j / n\overline{Y}$ and $\overline{Y} = \sum_{j=1}^{n} Y_j / n > 0$.

In the above equation defining G*, n is the total number of households, y_j is the income share of the j^{th} household, Y_j is the household's total income where $Y_1 \leq \ldots \leq Y_n$ with some $Y_j < 0$, and m is the size of the subset of the households whose combined income is zero with $Y_1 \leq \ldots \leq Y_m$. For computational purposes, m is determined where the sum of incomes over the first m households is negative and the first m + 1 households is positive. In the absence of negative incomes and if data are not grouped, G and G* are identical. The advantage of using the "adjusted" Gini is that it allows for the same geometric interpretation as with the conventional Gini.

However, it has some limitations. For instance, it does not allow for an accurate decomposition of income inequality by source. Moreover, it makes the derivation of elasticity of income source[18] without using simulation techniques difficult. Generally, it has to be recalled that the use of the Gini coefficient, classical or adjusted, does not provide information on how a distribution is skewed or who won and who lost, which is a central issue for policy makers.

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[18] The income elasticity measure allows showing how income inequality changes due to a marginal change in the income from a specific source.

A rather satisfying choice is made by EL-OSTA et al. (1995) in their paper aiming at measuring the role of off-farm income and other income sources in the size distribution of farm operator households' total personal income. Actually, after assessing pros and cons of both G and G*, they decide to use both for different purposes as negative incomes are present in the distributions they investigate. Therefore, the classical Gini coefficient is used to measure income inequality of each source of income by region and to measure the importance of each income source in the total income inequality. It is used as well to provide qualitative policy implications to changes in each source of income in terms of their effect on total income inequality. Then, the "adjusted" Gini is used for comparing households based on their production region.

An additional illustration in form of Kernel densities could bring some more insight on distributive issues in the sense that it would allow to get a rough idea on patterns characterising the distribution of a variable. This representation also has the advantage to not being affected by negative incomes as it only provides information on how many households/individuals/farms are situated along the x-axis of incomes, whatever the value affected to income.

Gini coefficients and other "classical" inequality measurement tools provide information on the development of inequalities between households or individuals. However, as already mentioned before, an important policy relevant issue when thinking of farm incomes is to see to which extent these incomes are spread along the income ladder and especially if some heterogeneity in the distribution of incomes has appeared. Therefore the use of polarization indexes might be relevant to investigate these issues. However, like for the Gini coefficient, the DER polarization index strongly depends on the value of the mean over a distribution. It means that in the presence of negative incomes, results provided by polarization indexes might be manipulated with the same caution as when using the Gini coefficient.

The next section will now rather shortly focus on redistributive impacts of public action as regards their impact on incomes.

1.3.3 Redistributive aspects of agricultural policies

The presence of horizontal inequalities between incomes without, or before, political intervention as well as vertical inequalities in the distribution of support is an important point to be considered for the evaluation of policies. The mainstream literature on the redistributive effects of agricultural policy has focused on the optimal choice of instruments to transfer surplus from consumers and taxpayers to producers that is, on efficiency rather than equity issues.

The difficulties for the policymaker to ideally redistribute resources have already been evoked in the subchapter 1.1.2. To introduce "ideal" lump-sum transfers, and thus implement a redistribution of resources considered as optimal in a first-best world, is nearly impossible because of lack of information on individuals' characteristics.

Therefore only redistribution schemes based on observable characteristics (for instance educational attainment, occupation, social class and wealth holding) as suggested by ROBERTS (1984) can be used for both implementation and analysis of policies in a second-best world.

In a theoretical study, ROBERTS (1984) showed that, in a world of imperfect information, there is no mechanism which could be expected to do better than a tax system, i.e. a redistribution scheme based on income levels. There are classically two types of inequalities which can be caused, or at least not corrected, by the tax system:

- horizontal inequality, or "unequal tax treatment of equals" (KAKWANI and LAMBERT, 1999): for some reason two "similar" individuals regarding their income are not paying the same level of taxes;
- vertical inequality: individuals with different incomes do not proportionally pay the same level of taxes.

Those inequalities can be transposed in the practical case of the CAP. The introduction of direct payments in 1992 followed by their decoupling in 2005 has, for the most, congealed their pattern of distribution throughout Europe, as well as throughout farms as regards size and technical orientation. As mentioned in SINABELL et al. (2008), "usually, the political rationale of distributive policies is to improve the income distribution by transferring money from richer to poorer households in order to correct market outcomes according to politically determined equity objectives". In two studies ALLANSON (2007 and 2008) analyses the redistributive effect of "horizontal inequity", being the differences between the level of support received by farms of a given type and the level of pre-support income, taking for example the Scottish agriculture. The author finds that whereas between farm-type horizontal inequity arises from systematic differences in support levels between commodity regimes, within farm-type horizontal inequity is associated with differences in the level of support received by farms of a given type and level of pre-support income. In the end the overall redistributive effect of horizontal inequity in Scottish agriculture is shown to be substantial, though systematic discrimination between farm types proves not to be the major cause: by implication, agricultural policy is unsuited to targeting support to those farms capable of generating only low levels of income. In another study on Tuscany (Italy), ALLANSON and ROCCHI (2007) find that the provision of support increases absolute income inequality within the agricultural community because the distribution of transfers was both vertically and horizontally inequitable. There are only a small number of studies which lead to other conclusions. One example is the study of Irish agriculture based on individual farm records made by KEENEY (2000), where the author demonstrates that direct payment of the MacSharry reform induced a more equal distribution of family farm incomes. However, with hardly any exceptions, studies looking at distributional effects of the CAP reveal that the current instruments of this policy do not prevent a substantial part of farmers from being among the poorest citizens of EU member states. At the same time, direct payments to high-income farm units and regions contribute to pronounced income inequalities in this sector.

2 PUBLIC ACTION IN AGRICULTURE AND THE COMMON AGRICULTURAL POLICY: GOALS, SUCCESSES AND FAILURES IN REDISTRIBUTING RESOURCES

"What, for instance, would be the budgetary costs of catering for the additional urban or sub-urban dwellers produced by accelerated rural desertification? Would an end of the CAP result, would it not, in contradictory policies by the member states possibly causing the collapse of the internal market? Or would it reduce European farm production to such an extent as to have a major impact on (higher) world prices with serious humanitarian, economic and political consequences, in particular for food importing developing countries? And could reduced production of European food end up benefiting mainly the 'latifundistas' (large land-owners) of Latin America and elsewhere, who invest their profits on Wall Street? The CAP scrappers did not seem to care about the answers." Corrado Pirzio-Biroli, Chef de Cabinet of Franz Fischler, PIRZIO-BIROLI (2008).

2.1 Public action and impacts on farm incomes: Modalities and efficiency

Following HILL (2000), a policy can be divided into a number of distinct components:

- a background, i.e. a set of values that the society holds,
- a set of myths, i.e. beliefs about the way in which the real world operates,
- concrete objectives, i.e. the translation of myths into clear intentions,
- policy instruments (or mechanisms, or measures), i.e. concrete initiatives to achieve objectives,
- monitoring, consisting in assessing the effectiveness of instruments implemented.

Therefore, the notion of policy applies to the whole process described above. However, the rest of the study will rather focus on the coherence between objectives, instruments used to reach these objectives and outcomes, therefore restricting policy to its most observable features.

2.1.1 Policy making and impacts of public action: Generalities

Policy making is a multi-level, multi-bargaining and inter-temporal process. This process is easy to consider as a game, and like STIGLITZ (1998) mentions, "the awareness of the dynamic nature of the bargaining game has further repercussions. Legislation can help crystallize some groups, and attenuate the strength of others. It affects the coalitions which are formed, and thereby the outcomes of political processes. Participants in the political game today realize this, and hence actions which in the short run might look like a Pareto improvement can look far riskier from a long-term, dynamic perspective." The notion of "success" of a policy is in this sense closely linked to the expectations of policy makers, economic agents and the civil society, and the actual fulfilment of these expectations for each "player".

Why are public choices like they are? This is rather a question belonging to the fields of political economy and rationale. Applied to agricultural economics, the corresponding rich literature (see a review in de GORTER and SWINNEN, 2002) using political economy models adapted to agricultural policies reports studies and models investigating the impacts of four key elements in decision making at the policy level: individual preferences of citizens, collective action by lobby groups, preferences of politicians and existence and nature of political institutions. Reforms and political decisions are the result of a complex, interactive and iterative process because it involves periodically the same groups around the table.

The case of agricultural policies, especially those of the U.S. and the EU, from early stages of a reform process to consequences in the long run, were always and still are ideal objects for study. The representatives of these particularly strong policies, long having applied high tariffs to isolate agricultural activities from world markets, keep on claiming, among others, that one of their central, recurrent objectives is the maintenance of farm incomes.

However, the relative restricted freedom of action for policy makers makes it hard to propose, and then to impose, radical policy reforms. Failures in reforming are absolutely not specific to agriculture however examples of aborted successes or half successes are abundant. The Mansholt Plan proposed in 1968 for the CAP by the Agriculture Commissioner at that time provoked massive contestations from farmers unions because of the radical structural changes it would imply and redistributive aspects to the detriment (already) of very large farms (STEAD, 2007). GARZON (2006) comments manifold aspects preventing any kind of meaningful reform at the policy level as regards the CAP: inertia is the main characteristic of a more than fifty years-old policy, now implemented (and negotiated) among 27 Member States.

This section briefly reviews which kind of instruments have been implemented in the field of agricultural policy and which are the scientific contributions as regards their efficiency to redistribute resources in agriculture.

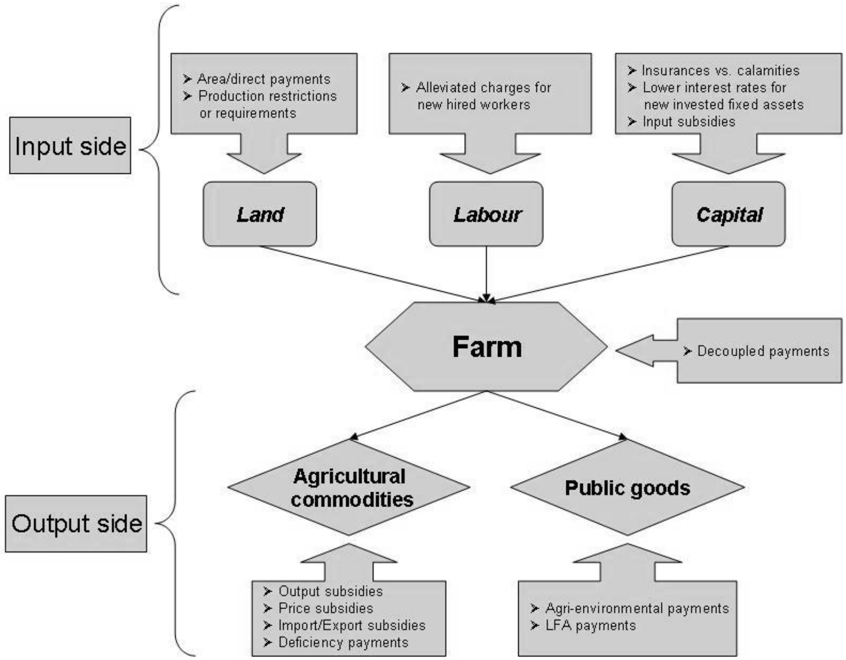
2.1.2 Instruments available for public action

Public support to farm incomes can be distributed in numerous different ways and many instruments are theoretically at disposal for analysis. The variety and number of instruments potentially usable by policy makers is thus much extended. Figure 7 illustrates some of these instruments regarding the level of the agricultural production chain they are targeting.

Policy instruments can be either input-, or output-oriented, considering that they either provide support to the farm through the factors it uses to produce, or support farm end products. In the category of input oriented instruments, one can first cite the whole group of input subsidies supporting the use of a specific factor, for instance subsidies for the use of variable factors like pesticides, herbicides or diesel. Other instruments can also be used to support fixed factors like buildings and machinery, as well as provide financial facilities to the farm in the form of insurances or lower interest rates and labour costs alleviations. Market price supports, either linked to farm outputs or in the form of deficiency payments[19] belong to output oriented instruments. Import tariffs applied for agricultural goods constitute an indirect support to farmer as well, artificially increasing prices of imported goods and therefore protecting local agricultural producers. Though not directly linked to the production processes, additional forms of support linked to the provision of public goods rather than to agricultural commodities are to be considered. These are linked to services and products jointly delivered by the agricultural sector and which are not included in any market like landscape and nature conservation, extensification of production and protection of cultural inheritage. Payments aiming at compensating farmers for the additional costs involved for producing in less favoured zones can be classified in this section, as they indirectly reward the farmer for going on in agriculture, indirectly contributing to the maintenance of rural population and rural activities.

[19] The idea of a deficiency payment (or a target payment) came initially from US President Truman's secretary for agriculture, Charles Brannan, in early 1949. He proposed a plan aiming, among others, at increasing food production without reducing profitability by paying farmers directly the difference between the market price and the price needed to yield a fair profit, thus guaranteeing farmers an income in any case and letting prices fluctuate. This payment would have comprised a ceiling above which farms would not have had access to the payment, thus privileging a family-sized farm model. After much debates, his plan was ultimately rejected in July 1949.

Figure 7: Examples of policy instruments used in the agricultural sector



Source: Own figure.

There are of course other instruments which can possibly be used; for instance social safety nets provided by social policies or labour opportunities favoured by structural and tax policies were not considered in this general picture. Instruments described above are as well susceptible of having the strongest impact on farm incomes; some of them were specially designed to reach this objective, by either stabilising or providing a minimal level of income. For instance US deficiency payments guarantee a compensation for famers during output prices decreasing periods, or EU decoupled payments provide a sort of safety net to farmers without any production restrictions but some minimal requirements.

2.1.3 Efficiency of agricultural policies in maintaining and/or redistributing incomes: Contribution of models in agricultural economics

The question whether a government's policy is "efficient" or not is a central point in the analysis of the consequences of any economical policy. This question encloses the following corollary: why do policy makers often make the use of inefficient instruments to reach farm income goals?

2.1.3.1 Do policies reach the targeted recipients and do the latter benefit from the whole support transferred?

The success of policies explicitly aiming at maintaining farm incomes, or at reducing disparities in incomes between different farm classes, is logically to be assessed considering the actual impact on these incomes of the policies implemented. Even in the case of a proper targeting, supposed and actual recipients may not completely correspond to each other and it is to expect that a one to one, i.e. a perfectly efficient transfer of support may not occur. DE GORTER and SWINNEN (2002) mention that in the long run, benefits of public action are to be found on factor markets rather than on product markets, and by already established farmers rather than by newcomers.

In the case of agricultural support in the form of income support, there are two sources of transfer losses that limit the income transfer efficiency[20] of policy measures (MOREDDU et al., 2003). These are economic costs and distributive leakages.

Economic costs while transferring support are due to distortions directly involved by the nature of the support. Let us consider for instance a farm operator producing suckler cows. For some reason, for instance good opportunities for off-farm labour on the market, or a relative low competitiveness in comparison to his neighbours, this farmer would like to turn his system into a more extensive one and spend more time off-farm. If then, a premium per head of suckle cow is introduced by the policy maker, this might influence the end choice of this farmer. Depending on the level of this premium and farmer's opportunity costs for other factors, the farmer may be encouraged to maintain a less efficient conventional production of suckler cows instead of rather switching to a part-time farming activity and a possibly efficient extensive production of suckle cows, or quit agriculture at all. This leads to economic costs in the form of:

- a misuse of resources, here labour and land belonging to the farmer
- wrong signals to the market in the form of an overproduction of suckle cows
- trade distortions if the overproduction leads to additional provisions of meat on world markets
- price distortions if these additional export are subsidised by the exporting land.

In this first case of transfer losses, it is not obvious that the farmer is better off (i.e. see his income increase) while maintaining his production of suckle cows than if he had partially abandoned this production to spend more time off-farm in

[20] Transfer efficiency is here defined as the ratio of income gain of the targeted beneficiaries (here farm households) and the sum of the associated government expenditures and consumer costs (1995). The objective is this analysis is to relate the net benefits that famers receive from support to the costs incurred by consumers and taxpayers in providing that support.

case there would not have been any premium introduced. It is to note that these costs can not be directly observed in the reality. In the above example, one would have to compare the income benefits the farmer gets from keeping his whole herd of cows with those where he gives up a part of his agricultural activities to get a job off-farm. An alternative to calculate these costs can be provided by modelling tools which can tackle the actions and reactions of farmers under different policy conditions, "with" or "without" the investigated premium or chosen form of support.

Distributive leakages include administrative costs and payments farmers indirectly have to pay to other actors in the agricultural chain, may they belong to upstream industries providing inputs to farms (fertilisers, chemicals, machinery and equipment, buildings and financial services) or to downstream industries involved in the processing and distribution of farm commodities. Administrative costs are to be considered as almost inevitable for any new instrument or policy to be implemented. They include the costs induced by the production, collection and processing of information on farmers and/or recipients of support and the costs of controls. Of course the level of these costs depends on the complexity of the measure implemented. Then, for any measure implemented to support farm incomes there is a percentage, varying from instrument to instrument, which is captured by other economic actors in the supply chain than the farmers. In case for instance of an input-oriented support, there is a high probability that prices of inputs will be consequently set at a higher price at the disposal of the farmers, meaning that input suppliers retain a part of the support. Another case with the distribution of an area payment conditioned to the minimal use of land leads to the capitalization of a portion of this payment leading to higher rental prices. A part of the payment is here captured by the land owner, may it be the farmer himself when he owns all or parts of the land he uses any other non-farm actor. This phenomenon has already been analysed for different products and support modalities as well as with different methods. Believing the summary made by BARNARD et al. (1997) as regards former studies published on the impact of US support programs, the share of government payments was estimated between 7 % and 38 % of cropland values. For some support programs in the US, the immediate financial benefit for the farmer is not the only aspect to consider in the rise of rental prices. Actually, benefiting from support today means that there are good chances, if the support program lasts, that the farmer will be benefiting from this program in the future except if a policy reform is considered (HERRIGES et al., 1992). Thereby public support can constitute a form of insurance which has an implicit value, having an indirect impact on land rental prices. This can be included in the whole set of expectations motivating farmers' decisions, including expectations on future real returns and interest rates (FEATHERSTONE and BAKER, 1988) as well as expectations on market prices and technological change (BURT, 1986). Similarly, even though public support were to be removed, BARNARD et al. (1997) suggest that rental prices may not follow the same decreasing trend than support, but rather that farmers would hope for alternative support scheme and thus not necessarily let land. Other factors are of course to be considered, like urbanisation or an increase in export demand which are occurrences capable of maintaining a pressure on rental prices.

Designing and implementing a policy among others aiming at supporting farm incomes imply losses, direct or indirect, which are hardly avoidable. However, these costs are closely to the nature of the policy instrument implemented.

2.1.3.2 The efficiency of redistribution of resources through agricultural policies

2.1.3.2.1 The welfare approach and the supply-demand models

WALLACE (1962) and NERLOVE (1958) have initiated a literature on the evaluation of income redistribution and deadweight losses of farm programs in the U.S.A. WALLACE (1962) compared three different agricultural programs: a production quota ("the Cochrane[21] proposal"), a price subsidy ("the Brannan Plan") and an input restriction program for reducing agricultural output. He provided a method to approximately calculate redistributed surpluses based on price wedges created by policies and elasticity of supply and demand. As the production of commodities is limited in the case of a quota, the success of this measure is conditioned by the substitutability of these commodities by other commodities, for the farms to reallocate resources freed by the limiting production quota somewhere else. Similarly, a price subsidy for a limited number of commodities may incite more and more farmers to produce one of these covered commodities, fixing resources like land to the exclusive production of these crops, thus indirectly increasing social costs. However, GARDNER (1992) criticises this analysis for the reason that it considers the agricultural sector as a whole without making differences between commodity markets. Following this, he lists other studies continuing in the direction of supply/demand global equilibrium models to calculate monetary transfers from taxpayers and/or consumers to producers. Many of them are empirical studies of the U.S. farm programs over the last decades estimating the gains and losses of these programs, as well as the deadweight losses for the whole society, with more or less success. These studies report estimated amounts of credits transferred to farmers through agricultural programs, but not to which extent these credits have been transmitted to farm incomes indeed.

This is the objective of the study published by the OECD (MOREDDU et al., 2003), based on a cost-benefit analysis using OECD's partial equilibrium model. This study provides estimations of transfer losses of different instruments and therefore the actual percentage of support actually transmitted to farm household incomes through the sum of gains in quasi-rents earned by farm households in supplying factors they own, supposedly here land and farm labour. This percentage varies from 17 % for an input subsidy to 48 % for an area payment under the

[21] COCHRANE (1959).

made assumptions (both measures targeting the input side of agricultural production). Two other instruments, related to the output side of agricultural production, were tested in the form of a market price support policy and a deficiency payment, recording an actual transfer of support to farm income of 24 % and 25 % respectively. Although these values are to be taken carefully in absolute terms (assumptions on elasticities, fixed demand, factor shares, one output and two inputs, etc.) they provide a reference in the comparison of the effectiveness of four different policy instruments commonly used in agriculture. Area payments seem to be the most efficient way to transfer income to farm households, in addition to what they seem to be the least trade distorting in comparison to other instruments (DEWBRE et al., 2001). This especially holds if those area payments are distributed irrespective to how the farmer uses it. In general, DEWBRE et al. (2001) suggest that "those support measures causing the greatest distortion to production and trade (per dollar transferred to farmers from consumers and taxpayers) are also the least efficient in providing income benefits to farm households and vice versa. Following this work, GUYOMARD et al. (2004) test the impacts of an output subsidy, a land subsidy and a decoupled payment (with and without mandatory production) on multiple policy goals, of which income support, by mean of a partial equilibrium model with three markets, for land, output and for entry/exit of farms. They find decoupled income transfers without mandatory production to be superior to the other instruments tested as regards the support of farm incomes and the fact that they produce less trade distortions. However, their analysis reveal that the three goals they investigate (income support, maintenance of a maximum number of farmers and reduction of negative externalities arising from non-land input use) are subject to trade-offs. Therefore their advice for future policies postulating multifunctionality in agriculture is to consider non-food benefits of agriculture separately by means of specific instruments directly linked to the provision of public goods and positive externalities.

These works focused on the transfer of support from consumers and/or taxpayers to the whole farm sector, without special distinction between farms as regards their size, their technical orientation or their social role in rural regions. In the end, results, conclusions and recommendations in these supply-demand models are strongly linked to assumptions on demand and supply functions (i.e. elasticities). Another problem highlighted by GARDNER (1992) is the lack of factor markets in the modelling frameworks, especially for labour as actually, general factor market conditions in the economy condition farm adjustments as regard labour and investments.

2.1.3.2.2 The contribution of political economy models to understand agricultural policy

Parallel to the above listed works rooted in welfare economics and generally based on the maximisation of a social welfare function, a stream of recent research in agricultural economics has emerged using findings in the field of political economy to understand why governments do what they do in agriculture, and whether they are efficient in doing it, intentionally or not. De GORTER and SWINNEN (2002) identify three major approaches in the field: the collective action by lobby groups approach as defined in OLSON (1971)[22]; the interaction between politicians and citizens approach extending the political-voter interaction model of DOWNS (1957); and the revealed preference approach initiated by ZUSMAN (1976)[23]. These approaches consider policy-making process like any other economic activity, but rather than dividing society into taxpayers, consumers and producers, they consider economic agents being politicians, voters and pressure groups. Each of these agents acts rationally and aims at maximising its own objective function. Pressure groups are constituted of individuals who share characteristics like occupation, income level, geographical location etc.: the group uses its influence to gain political favour and competes with other pressure groups, an equilibrium of taxes and subsidies being the result of this multi -actors, -interests, -outcomes game.

In a seminal article, developing Olson's framework, BECKER (1983) presents a theory of the political redistribution of income considering the pressure power of groups to gain favourable decision from policy makers, where "political equilibrium depends on the efficiency of each group in producing pressure, the effect of additional pressure on their influence, the number of persons in different groups, and the deadweight costs of taxes and subsidies". In this framework, BULLOCK (1995) cites GARDNER (1983) who defines what an efficient redistribution is, namely "the use of the most efficient methods available to transfer income among political pressure groups, minimizing deadweight costs, given the amount of transfer called for by the political process" In other words, an efficient policy is a policy rewarding the most competitive pressure groups at the lowest social costs, without necessarily being an efficient policy in the "classical" sense (redistributing resources with consideration of marginal costs and individual performances). This approach grounds the so-called "efficient redistribution hypothesis" where equilibrium is actually found in the real world when a hypothetical not revealed political preference function is using resources as efficiently as possible considering surrounding interest groups' pressures. It would similarly mean that if interest groups[24] would know of a policy which could make all groups better off they would all undoubtedly support it: the actual policy implemented is therefore the Pareto superior one.

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22 One central finding of this approach is that small interest group are more successful in their lobbying activities because they are better able to control free-riding among their own members, meaning that they can better lead their joint action.

23 The name of this approach is explicit: "The policy maker maximizes a weighted objective function reflecting the welfare of lobbying groups and ***reveals*** his preferences through the weights he attributes to the different objectives." BEGHIN (1990).

24 One could argue that the two expressions "interest groups" or "pressure groups" may differ (for instance, members of a group can share the same interests without necessarily exerting any pressure at the policy level), they are considered to have the same meaning here.

SALHOFER (1997) uses this framework to investigate the efficiency of the Austrian bread grain policy to redistribute incomes at the lowest social costs. Concluding on the inefficiency of the policy implemented (i.e. the government could have applied a policy improving the welfare of non-bread-grains farmers without harming the welfare of bread grains farmers), SALHOFER (1997) evokes three possible reasons for this to have happened: (1) a not well enough specified model, (2) the presence of uncertainty at the political level as well as an imperfect knowledge on the impacts of the policy on the agricultural sector, (3) or a discrepancy between displayed goal of policy makers and hypothetical "hidden" goals like favouring upstream or downstream industries, or some specific interest groups among farmers.

As regards the first reason cited above, BULLOCK (1995) proposed a test to challenge the efficient redistribution hypothesis for m groups and n policy instruments by way of a vector maximisation problem. His statistical tests aims at showing whether observed policy outcomes lay on the Pareto frontier defining the set of efficient policies, i.e. whether no other policy could make at least one of the interest group better off. BULLOCK (1995) comes to the conclusion that the result of the test strongly depends on the accuracy and the correctness of the pressure groups defined and on the policy instruments tested, i.e. the way the true political economy is represented.

Actually, the choice of economically efficient policies does not systematically happen in the reality, and income redistribution policies favouring the most successful pressure groups are rather passed to the detriment of less visible or powerful groups. Why then? Why, even though an economically and politically reasonable reform is proposed, it often has no chance to be adopted? This lies on the nature imperfections in the policy-making process. DIXIT and LONDREGAN (1994) argue for instance that "political process often compensates the losers from technical change or international competition in an economically inefficient way, namely by subsidizing or protecting declining industries instead of encouraging the movement of resources to other more productive uses", meaning that inefficient agents benefit from political transfers based on their political characteristics, not based on their economic performance. This has to do both with the length of electoral cycles (too short to reward economically efficient choices; too short to record gains and/or losses due to political decisions), imperfect information and competition and the interaction between political and economical dynamics. As regards this latter issue STIGLITZ (1998) bases his analysis of political failures on properties of perfect economic markets to find the reasons why policies are inefficient. First, one reason lies in the nature of the policy-making process: it occurs dynamically, and even though improvements (in the Pareto sense) would be keen to happen for all pressure groups in the short term, this is less obvious in the long run. In this case, pressure groups have a broader and better view of consequences political decisions can have on the welfare of their members than policy makers. They are able to anticipate. If some of these groups consider they can be worse off in the long run if a reform happens, they will oppose it, even though it is a Pareto improvement for all groups in the short term. Then, imperfect information in the bargaining process of policy-making leads to suboptimal outcomes: Pareto improvements are here less attainable than if information was perfect. Third, there are often cases of destructive competition in policy games; these are specific cases of imperfect competition. It means that interest groups will handle in the way that what they gain is a cost for others. This happens in cases of zero sum policies, typically where a "constant cake" has to be shared among economic agents. Finally, STIGLITZ (1998) states that even though a policy would involve mutual benefits for all groups (i.e. a policy which would create "a bigger cake" to share), scepticism between interest groups would nevertheless hinder the adoption of the policy. To illustrate this it would mean that if an adversary group supports a political reform, other groups may think that it supports it because it would be at their expense. This is a case of asymmetric information ("the intentions of the adversary group are not clear" or the implementation of the supported reform would necessary represent costs for the others) as well as simple imperfect information: consequences of a reform proposal are not understood or evaluated correctly by the interest groups.

The fact that, since sixty years, in industrialised countries, most farmers left the sector or turned out to part-time farming while other few produced the majority of agricultural outputs can as well explain the relative inefficiency of some implemented agricultural programs which were based on production rather than on actual needs on farm households (needs which would even include support to exit farming at lower costs rather than keeping farmers in the sector at any price). However, incomes are and remain central to the foundations of agricultural policies in developed countries. The gap between farm incomes and those of the rest of society on the one hand and income disparities within the agricultural sector on the other hand are aimed, ambitiously, at being tackled simultaneously by agricultural policies.

The next sections do not aim at covering very precisely all features which characterised the CAP since its creation. This policy made of instruments addressed to all sectors of agriculture can not be that easily summarised in few pages. After a general introduction on the foundations of this policy, the focus is put on instruments which will be used in the modelling framework for impact assessment.

2.2 The CAP: A short historical perspective

The current CAP is the result of decades of negotiations between actors and stakeholders of the agricultural sector in Europe and the world. This policy, one of the first built within the European Economic Community (EEC), lies at the crossroads of a multi-level and multi-actor game. Thus, behind the word "policy", there is not only a combination of economic instruments aiming at reaching one or more objective, but it qualifies a whole process from the values setting the cultural background of a society to the practical monitoring of policy mechanisms aiming at reaching predefined objectives. However in this chapter the focus will be less put on the deep analysis of reasons behind the choice of each policy instrument rather than on which ones have been used within the CAP and how effective they were to reach the maintenance of agricultural incomes throughout Europe.

2.2.1 Foundations of the CAP

2.2.1.1 First years of agricultural integration

The CAP has got its roots in the post World War II world. In the early 1950's consumption levels had fallen below those of pre-war period. The spectres of starvation and food shortages were still present few years after the end of the war, and encouraging more agricultural outputs to reach self-sufficiency was felt like a necessity in Europe. Governments had at the same time to face unfavoured balances of payments and agriculture was seen as a means of, partially, aiding their restoring. Eventually could surpluses, if any, be exported and help refuel the amount of foreign currency (FENNELL, 2002).

Concerning the six first member states (Germany, France, Belgium, Luxembourg, The Netherlands and Italy), adopted in 1957, the Treaty of Rome states the objectives of CAP in its Article 39. This article mentions that:

"The objectives of the common agricultural policy shall be:

(a) to increase agricultural productivity by promoting technical progress and by ensuring the rational development of agricultural production and the optimum utilisation of the factors of production, in particular labour;

(b) thus to ensure a fair standard of living for the agricultural community, in particular by increasing the individual earnings of persons engaged in agriculture;

(c) to stabilise markets;

(d) to assure the availability of supplies;

(e) to ensure that supplies reach consumers at reasonable prices."

The establishment of market unity, community preference and financial solidarity constituted the core of the CAP and administered prices the Common market in the Member States insured farmers a guaranteed outlet for their products. The point (b) above reveals the strong concern policy makers had at that time on insuring farm households a minimal living standard compared to the rest of the society. Since then, this concern was always present, at least in policy speeches (even though the term "standard of living" would never have been further explained at this point and later). For instance, in 1984, a document published by the Commission specifies that: "Although they are not the only factor in an assessment of the economic and social situation in agriculture, agricultural incomes are obviously of key importance. The improvement in the individual incomes of those working in agriculture is indeed, under Article 39 of the Treaty of Rome, one of the fundamental objectives of the Common Agricultural Policy" (CEC, 1984). One year later, the Commission highlights again the same concerns by specifying in a document that "the challenge for the Community is to reconcile the success of the CAP in achieving its economical objectives with the need to continue to fulfil the social objective of assuring a fair standard of living for the agricultural population" (CEC, 1985). From this date, the Commission then referred explicitly to a bimodal system where income support especially for small farms would be combined to a CAP reoriented towards the market. Then, income concerns began to be rather considered as a social issue to be linked to situations of need. Some documents of the Commission even highlighted the fact that those claiming that CAP should be a compulsory way to support agricultural incomes may be the most reluctant to any serious and deep reform of this policy (CEC, 1988). FENNELL (2002) criticises quite strongly the choices made at the European level to go for price support and market protection after World War II, "despite their known and obvious deficiencies as a means of improving income levels" (FENNELL, 2002). The choice of undifferentiated unit level of support for selected outputs neither linked to farm size nor to farm marginal returns had for direct and logical consequence to reward large business units rather than the smaller ones. May it had been due to the will to provide support at the lowest administration costs, to an efficient lobbying from big farmers unions or to alternative solutions found by small farmers to get on with the political context, it seems clear that the income objective invoked in the Rome Treaty has not been seriously targeted until the MacSharry reform, and afterwards.

2.2.1.2 The limits of market price support

However, mechanisms imagined to achieve the main objectives of the CAP implied a constant increase of expenses (LOYAT and PETIT, 1999). This lead to first adjustments as proposed in the Mansholt Plan in 1968. Rather than staying exclusively centred on prices, the CAP should include a structural section as well. Even though the bulk of the Mansholt Plan had to be abandoned after massive protestation and consecutive loss of political support, measures like early retirement schemes or financial support for young farmers were first introduced at that time. From the end of the 60's, speculation movements on monetary markets endangered the relative balances of European currencies based on which exchanges on the Common market were made. Devaluation/re-evaluation movements created distortions between Members of the Community and the complicated mechanisms created at that time to keep markets in place were definitely abandoned only in 1999 with the introduction of the Euro. Meanwhile, the 80's were marked by a constant increase of expenses of the CAP budget, however not helping agricultural incomes to stay at a reasonable level as well as reducing disparities between countries and production systems. The introduction of Maximum Guaranteed Quantities (MGQ) for rapeseed, sunflower and then for cereals as well as the continuation of the quota policy for the milk sector were supplemented by the introduction of set-aside, granted by annual direct payments. This was not enough. Still excessive expenses of the policy and the coming of the Uruguay Round negotiations in the framework of the General Agreement on Tariffs and Trade (GATT) made it urgent to deeply rethink the CAP.

The scientific community had already laid the foundations for a future reform of the CAP in the Wageningen Memorandum (1973). Pointing the failures and lacks of the CAP at that time, i.e.:

- the lack of consideration of structural changes in agriculture in particular labour mobility,
- the inability to contain surplus production,
- the failure to tackle low incomes (as "the distribution of human skills and physical assets is unequal in all European countries", an "administered price system benefits most those who have more to sell")
- and the low ability of the CAP as it is to cope with future enlargement,

the signatories list some propositions to better tackle these issues. Among them, the necessity to better match resources to market requirements, the need to change relative prices between altogether commodities and currencies and the necessity to revise the trade policy.

But on top of this, two other propositions are listed which will be implemented later in the real world. First, as in the "process of agricultural adjustment some income disparities both within agriculture and between agriculture and other sectors are unavoidable" and as "proposals for a policy for farmers in those poorer areas in which farming is necessary for the purpose of maintaining a minimum population level and conserving the countryside", the signatories of the Memorandum saw a need to create an income support system for those European areas which "cannot benefit from price system". Therefore a structural policy, integrated with the regional policies of the Community should "improve the economic opportunities of those who wish to leave agriculture and, also, with those policies arising out of the desire for environmental conservation and the exploitation of the growing demand for recreational amenities". Some of these aspects have been integrated since then in the Rural Development (RD) policy of the CAP as well as in the EU structural and regional policies.

Second, as instruments used at that time had proven their limits as regards issues to be solved, the Wageningen community suggested the use of new instruments, of which an "import-levy price-supplement scheme"; "individual farm contracts" providing an income subsidy for 1) the guarantee not to increase production, 2) the appropriate production of commodities considering market demand, 3) the delivery of the farm to regional restructuring after termination of the contract and, 4) the satisfaction of environmental amenities; "direct compensation payments" paid to farmers "as part of a move towards a lower price level" and "transferable only under certain conditions consistent with structural aims".

This Memorandum reveals that the idea to introduce some direct payments to support income (at least in case of lower support prices) was already present in economists' works from the 1970's (FENNELL, 2002). Why have such ideas not been adopted earlier? There are numerous explanations for this of which at least two of them can be mentioned. Actually, in practice, policy makers "tend to tinker with what exists already and rarely make bold innovations."(FENNELL, 2002). Moreover political decisions "tend to be based on short-term considerations" (Wageningen Memorandum, 1973). Most policy instruments which have been used in the CAP had already been tried in the countries of the Community. Therefore the range of potentially acceptable policy instruments is limited in reality and their future implementation rely on both their past implementation in a country and the potential outcomes to be expected out of them.

As regards the specific case of the introduction of direct payments, there was a strategic problem for farmers in agreeing on such a system; it may explain the reluctance of policy makers to adopt them earlier than what happened in reality as well. Actually, transferring support from an opaque and complicated market price system to a direct payment system implies that the real costs of agriculture become more visible for taxpayers which take the place of consumers as new creditor of the CAP. Therefore amounts and distribution patterns are disposed to discussions, critics – making distributive issues as well as the nature of direct payments quite sensible politically – and eventually, reductions as mentioned in de GORTER and SWINNEN (2002).

2.2.2 The need for reforms

Performing a Delphi survey performed over a panel relatively closely involved in the making-process of the last reforms, CUNHA and SWINBANK (2009) conclude that the most influential factors in the CAP policy-making process are: 1) the role of the Commission and particularly of its Commissioner for Agriculture, 2) the GATT/WTO (World Trade Organisation) negotiations as major motivating source, 3) enlargements (1999 and 2003) and the need to curb CAP surpluses (1992) and the budget, 4) pressures from environmental groups, media and public opinion and 5) political feasibility, of which the consensus-building methods, the presence of a precedent and the fear of no decision if no compromise shall emerge from the discussions. Surely did part or all of these factors play an effective role in the reforms to come; however the objective here is not to try to weight them precisely but to shortly overview their expected and actual outcomes.

2.2.2.1 The MacSharry reform and the Agenda 2000 policy

As regards the precise genesis of this first "big" reform, SWINBANK (2004) reports two different opinions on who exactly initiated the first brainstorming sessions. KAY (1998) suggests that between 1989 and 1992, Ray MacSharry lead some (almost secret) meetings which resulted, already in 1989/90, in the formulation of reform proposals which would be kept in the final agreement. Believing Ross' opinion (ROSS, 1995), it is more Jacques Delors, at that time Commission' President who, by drawing first lines of thought, definitely helped their conceptualisation before the end of the year 1990. However, SWINBANK (2004) concludes that without external pressures exerted by the GATT negotiations, "it seems unlikely that the 1992 reforms would have been approved by Farm Ministers" (pp. 7). Strategically, from the EU's negotiators point of view, it has been more advantageous to come to the GATT table with first reform proposals than with nothing, in which case external arguments would have been a little bit harder to discuss.

On the other hand, MOEHLER (2008) considers that this reform was "more the result of the domestic dynamics of the CAP and the internal reactions it triggered". Actually, with 23 billions Ecus expenses in 1987 (the double of expenses in the year 1980) the EU was at the edge of bankruptcy. Market price support had urgently to be kept under control and the reform should allow controlling cereal and meat production surpluses as well as make EU products more competitive. The 1988 budget reform finally saved EU finances and the MacSharry reform in 1992 cared for surpluses and competitiveness aspects.

The surplus production problem would be tackled by reducing support prices for cereals, oilseeds and proteins over three years starting in 1993/94. These reductions would be accompanied by compensatory payments per hectare on the crops (subject to set-aside a proportion of arable land) and per head of ruminants. These direct payments were thought from the beginning to compensate the potential loss of income due to the decrease of administrative prices. Actually, MacSharry "simply wanted the money spent to arrive at the farmer's door and not to land in the pockets of exporters, traders, storage holders and other intermediaries. Thus, farmers could be persuaded to accept direct income support instead of market price support" (MOEHLER, 2008). However, incomes disparities inherited for the ancient support system were known by the Commission, which observed that 80 percent of the support provided went to 20 percent of farms, even though occupying the greater part of agricultural land indeed. The reaching of a political compromise graved any try to implement an extensive redistributive system within the "biggest" CAP reform since its creation. The choice of the word "compensatory" to name these payments progressively increasing over three years parallel to the decrease of administrative prices, does not really illustrates their actually permanent nature, as acknowledge by the Commission which, about this reform, says that it is "the introduction of a system of permanent compensatory aid to neutralize the negative effect on incomes caused by the decision to lower prices in the cereals, oilseeds and beef and veal sectors" (EUROPEAN COMMUNITIES, 1993).

On the other hand, multifunctionality entered the scene with the introduction of a rural development policy aside the more classical agricultural measures. Environmental challenges could be tackled by adopting "accompanying measures" as incentives to switch towards agriculture more protective for the environment. The first agri-environmental programmes and agri-environmental measures (AEM) appeared in the framework of the MacSharry reform. Together with the introduction of compulsory set-aside, all these initiatives gave a new hint to help farmers in adopting environmentally friendly production methods or in taking care of landscapes and moving towards less intensive agriculture.

The continuation of the 1992 policy in its main lines was confirmed by the adoption of the Agenda 2000 policy in 1999, "with a view to stimulating European competitiveness, taking great account of environmental considerations, ensuring fair income for farmers, simplifying legislation and decentralising the application of legislation" (EU COMMISSION, 1999). Beside this overall goal, the will to control expenses in expectation of the integration of Central and Eastern European Countries (CEEC) set up clear limits to future agricultural support. The now distinct Rural Development policy (RD policy) was reinforced, brightening the range of accessible measures favouring environment protection, structural and rural development programmes, animal welfare and food quality based on the experience with the former AEM. Therefore the Agenda 2000 policy introduced a separation between first and second pillars of the CAP; the first pillar would be devoted to economic measures while the second would rather be orientated towards environmental and social issues joint to the strict production of agricultural commodities. Moreover, the possibility to cut part of direct payments to finance the AEM or similar environmental programmes was let to the appreciation of each Member State; the notion of "modulation" was born. Whereas The MacSharry reform permitted to better respond to society's expectations by eliminating surplus production, putting emphasis on rural development and promoting protection of environment, the Agenda 2000 policy went one step beyond by allocating those joint issues to agricultural production a specific policy, the RD policy or second pillar of the CAP.

2.2.2.2 The role of the second pillar

2.2.2.2.1 A "new" paradigm within the Agenda 2000: Multifunctionality of agriculture and the creation of a rural development policy

From 1992, but especially from 1999 within the Agenda 2000 policy, RD policy appeared beside market mechanisms of the CAP. The "second pillar" (or Pillar II) includes all measures targeted on other concerns than market ones which belong to Pillar I.

The RD policy has got its roots in the early 70's, where the first measures introduced dealt with the modernisation of farms and the enhancement of the cessation of farming, as well as socio-economic guidance and occupational training for farmers. In 1975, a directive on mountain and hill farming and less-favoured areas was added. In 1985, those four directives were replaced by Council Regulation No 797/85 on improving the efficiency of agricultural structures, which introduced measures to promote investment in agricultural holdings, installation of young farmers, forestation, land use planning and support for mountain and hill farming and less-favoured areas (LFA). All those measures were to be financed jointly by the Community European Agricultural Guidance and Guarantee Fund (EAGGF) and the Member States.

For now, the future RD policy, as set for the period 2007-2013, will focus on three areas in line with the "three axes" of measures laid down in the new Rural Development Regulation:

- Improvement of competitiveness for farming and forestry,
- Protection of environment and countryside,
- Improvement of quality of life and diversification of the rural economy.

A fourth axis based on experience with the LEADER programme introduces possibilities for locally-based bottom-up approaches of rural development. The Health Check outcomes mention some more challenges to tackle for the RD policy, namely climate change, renewable energy, water management, biodiversity and some measures related to the dairy sector.

2.2.2.2.2 Antagonisms and compatibilities with the first pillar

The strengthening of EU rural development policy has become an overall EU priority (EUROPEAN COMMUNITIES, 2008). The conclusions of the Göteborg European Council of June 2001 made this clear, stating that: "During recent years, European agricultural policy has given less emphasis to market mechanisms and through targeted support measures become more oriented towards satisfying the general public's growing demands regarding food safety, food quality, product differentiation, animal welfare, environmental quality and the conservation of nature and the countryside". Therefore the RD policy aims at tackling the multiple roles of farming in society after having mostly been oriented towards structural problems at days of its creation.

However, to some extent the constraints imposed by cross compliance already include concerns expressed by society as regards environment and quality for Pillar I payments to be distributed to eligible farmers. Since Agenda 2000 cross compliance includes for instance adherence to maximum stocking rates for cattle or sheep, compliance with specific conditions for the cultivation of sloping land, respect of maximum permitted volumes of fertilisers per hectare and compliance with specific rules concerning the use of plant protection products. Since the 2003 reform, cross compliance has been reinforced in the sense that standard sanctioning approach are applied to selected statutory requirements in the field of the environment, food safety, plant and animal health, and animal welfare. In addition, cross-compliance applies to the obligation of farmers to keep their land in good agricultural and environmental conditions (GAEC). The CAP reforms included the basic principle that Member States shall take environmental measures they consider to be appropriate in view of the situation of the agricultural land used or the production concerned.

2.2.3 Premises for a new reform

Based on former proposals by TANGERMANN (1991), SWINBANK and TANGERMANN (2001) suggest the implementation of a "Bond Scheme" as next design for the CAP for the following reasons:

- the sustainability of direct payments and their justification in front of the society is put into question, in times where the integration of former CEEC in the EU is being discussed,
- direct payments do not encourage profitability and competitiveness in farm holdings, where sometimes the only motivation to produce animals or crops is the payment linked to it: the economic value of payments is reduced and inefficient business keep on running,
- the distribution of direct payments linked to volume to compensate price cuts for some products leads to absurd situation when there are surpluses on the market (i.e. during the Bovine Spongiform Encephalopathy (BSE) crisis, where payments where still distributed to farmers for beef cattle, encouraging production, causing surpluses to be destroyed at the cost of the tax payer),
- such decoupled payments could be easily be transferred in the Green box at the WTO,
- orientate the funds towards rural areas and other European economical sectors.

This proposal for a Bond Scheme advocated six steps to do in one in order to switch from a system of acreage and per head payments to a system where after a complete decoupling of these payments from production, they can be distributed directly to farm operator without any obligation of production. The authors even evoked the possibility for farmers to claim their complete payment due in order to invest in objects for agricultural activities of for a reconversion somewhere else in the economy.

Even though the next reform after the Agenda 2000, the so-called Fischler reform, went quite far towards an innovative design for the CAP, some aspects wished and proposed by SWINBANK and TANGERMANN (2001) have not been retained. However, this reform was to be the "most radical reform since the inception of the CAP (OLPER, 2008). Above all for the first time the new reform involved consumers who entered the CAP "game" after foot and mouth disease and BSE crises, expressing more concern for environment and animal welfare through their agricultural ministers involved in the negotiations (Green Party ministers in Germany and Italy).

This reform took place under two main constraints, one internal to the EU and the other one external. The external constraint was due to international pressures; the EU had to strengthen its position before further negotiations at the WTO, which had classified direct payments distributed since 1992 to EU farmers in the "red box", i.e. payments distorting international trade because directly linked to production. The internal constraint was the EU budget devoted to agriculture; it was wished to keep it into acceptable limits knowing the future accession of the first ten CEEC in the EU. However, the negotiations to come to a compromise between the Member States at that time revealed the ability of Agricultural Commissioner Franz Fischler to "take advantage of a very complex political environment, in which budget pressures and enlargement mattered" (OLPER, 2008). Moreover, "the low redistributive power of the reform package, which only marginally affects the pre-reform political economy equilibrium" (OLPER, 2008) despite the innovative design of the reform, conditioned its success in the end, at least in the sense that all Member States had no objection to adopt the reform and fit its rules to national issues. Indeed, a certain degree of freedom was provided to the Member States through the possibility of maintaining a percentage of payments coupled to production as well as the possibility to choose which decoupled model would be applied. This has let quite a lot of free room for national adaptations.

At the end of the mid-term review of the CAP in Luxemburg, on the 26th of June in 2003, the EU Ministers of Agriculture agreed on a reform of the CAP for the next programming period. The main internal goals of this reform were to better connect agricultural production to markets and to encourage consumer orientated agriculture by supporting the production of healthier and environmentally-friendly agricultural commodities.

2.3 The Fischler reform and decoupling modalities

The key innovation and main instrument to reach reform's goals was the decoupling of direct payments from production ("Single Payment Scheme" or SPS), i.e. the distribution of direct payments independently of farmers' production decisions conditioned to "the respect of environmental, food safety, animal and plant health and animal welfare standards, as well as the requirement to keep all farmland in good agricultural and environmental condition ("cross-compliance")"[25] (EU COMMISSION, 2003a). However, each Member State had the possibility to maintain subsidies coupled to some commodities in sectors where it was considered that a complete decoupling of payments would have strong negative impacts (abandonment of production, disturbance to agricultural markets). Finally, modulation already introduced as an option in the framework of the former Agenda 2000 policy became compulsory and should take place in each Member State from 2005.

[25] We will use the abbreviation GAEC to designate land kept in Good Agricultural and Environmental Conditions to satisfy the cross-compliance requirements.

Modulation refers to the shift of funds to rural development policies, i.e. from Pillar I to Pillar II. The implementation of the SPS had to come into effect from 2005 until 2007 at the latest.

Member States have had the choice between three decoupling approaches:

- basic (historic) approach
- regional (flat rate) approach
- mixed (hybrid) models

Each of these approaches will be shortly described below, as their main features will be modelled with AgriPoliS later in the study. In all three models farmers are provided with payment entitlements calculated for a reference period (2000-2002). These payment entitlements are activated if the farmer uses the matching amount of eligible land. Payment entitlements can be sold or leased and are, in principle, not linked to particular parcels of land: it means that payment entitlements remain linked to a farm, not to land, which leads to relative complicated outcomes related to compatibility with national legislations, value development considering initial regional structures and future owner in case the initial owner quits agriculture. Initially the flat rate approach would not have made possible that entitlements "move out" of the region from where they had been emitted.

2.3.1 Decoupling models chosen among the old Member States

In the historical model each farmer is granted with entitlements corresponding to the payments he received during the reference period and the number of hectares he was farming during the reference period and which gave right to direct payments in the reference period. This model has been chosen by a vast number of old Member States (EU COMMISSION, 2008c): Belgium, Ireland, Greece, Spain, France, Italy, Netherlands, Austria, Wales and Scotland in the United Kingdom (UK) and Portugal.

In the regional model reference amounts are not calculated at the individual level but at the regional level. Regional reference amounts are calculated by dividing the sum of payments received by all the farmers in the region concerned during the reference period by the number of eligible hectares declared by the farmers of the region in the year of SPS introduction; the value of a single entitlement is thus the same one across the whole region. Finally, each farmer receives a number of (flat rate) entitlements equal to the number of eligible hectares declared in the year of SPS introduction. Therefore this approach entails some redistribution of payments between farmers. It is to note that none of old Member States has fully implemented this model.

Finally "hybrid" models have encountered a wide success by old Member States. These models allow mixing historical and regional approaches. Such hybrid systems can further vary over the period between first application of the SPS and full implementation, giving rise to dynamic as well as to static hybrid systems. Luxemburg, Sweden and Northern Ireland in the UK have adopted the static hybrid approach for decoupling direct payments, i.e. both historic and regional payments at one time and onwards. Denmark, Germany, Finland and the other regions of the UK not cited above have rather decided to introduce a dynamic hybrid scheme moving towards a regional payment.

2.3.2 Expected and actual impacts of the SPS scheme

Numerous impacts analyses have been executed to know which consequences the Fischler reform would have on the European agricultural sector. Therefore the aim of this section is less to provide an extensive review of the rich scientific literature on this topic (ex ante assessments, model-based experiments or theoretical studies) than trying to depict which were the political expectations of this reform on agriculture in general and agricultural incomes in particular.

Impact analyses published by the EU Commission's Directorate-General for Agriculture (EU COMMISSION, 2003b) compared expected outcomes of the CAP reform with those of the continuation of Agenda 2000 policy. For the EU-15 they conclude that the reform would imply a decrease in total cereal production due to the increase in UAA used for the production of energy crops, the rise in voluntary set-aside and changes in support level in the sector. As regards animal production, the SPS would favour the extensification of production systems. In particular, beef production would fall and would involve a rise in prices and a decline in exports. The rise in beef prices would boost pork and poultry sectors which could benefit from an expanded demand for their products. As regards dairy production the increase in milk production quota would cause an increase in milk production as well; due to a cut in support and the rise in production of fats due to the increase in milk production, butter production would decrease to the contrary of cheese and fresh dairy products benefiting from a growing demand and the additional quantities of milk at disposal.

As regards farm incomes, the impact of the reform would be very limited, causing a slight decrease in incomes in comparison to the continuation of Agenda 2000 policy in 2009 (-0.1 %) but incomes would still be higher than in 2001 (8.5 % in real term and par work unit). This analysis includes projections on prices. Actually, a decrease in incomes right after the implementation of the reform would be implied by decreases in cereal, meat and milk prices. This trend should however be reversed later with the rise in cereal and meat prices.

Impacts should diverge between regions and commodity sectors. In the dairy sector the combination of additional price cuts and quota increase should have a negative, but nevertheless marginal impact on incomes. On the opposite the meat sector (beef, sheep, pig and poultry) should benefit from price increases largely compensating "the combined impact of the fall in production and of the degression[26]" (EU COMMISSION, 2003b).

In the end the report, therefore the EU Commission itself, acknowledges that the Fischler reform was not expected to cause major income changes for agricultural producers and for the overall redistribution between EU Member States. The level and structure of tariff protection would rather play a more important role in those matters[27].

OLPER (2008) concludes that "overall, the Fischler reforms have contributed to a strong redirection of the CAP towards the marketplace, by reducing the gap between internal and world prices". By providing the farmer with market signals rather than administered prices the reform increased the efficiency of supporting farm incomes. By making these payments more transparent to the taxpayer; by strengthening the RD policy, the CAP has become more defensible politically.

2.3.3 The German approach

2.3.3.1 Main features

Germany has chosen a dynamic hybrid approach for decoupling direct payments. This model is implemented overall in the country including in the Federal State of Brandenburg where the study region OPR is located.

From the year 2005, direct payments distributed to farms and calculated over the 2000-2002 reference period are composed of:

- a farm specific component
- a regional component.

The farm specific component of the payment is composed of parts of former direct payments for animals among other payments, for instance the suckler cow premium (for a detailed description of all premium included in the farm component as well as some specific issues see MLUV, 2004). This component is distributed only to farms which received these payments before the reform, mostly farms oriented towards grazing livestock, dairy and mixed farming.

The regional component is distributed per hectare of UAA, but differs between grassland and arable land as well as from Federal State to Federal State. To calculate the regional grassland payment, the average of the remaining (i.e. not included in the farm specific component) of animal premiums distributed over the reference period is divided by the number of hectares of grassland in the region.

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26 Degression is to be understood here as cuts in first pillar payments.

27 OLPER (2008) provides a simplified example on the impacts of cross-compliance rules combined to tariff policy on demand and supply in the EU for an exemplary product). It reveals some shortcomings of the Fischler reform reasoning where farm incomes may become more sensitive to border protection, restricting the level of action of EU negotiators in future WTO rounds.

As regards the regional payment for arable land, the average of all Cereal and Oil Plants (COP) premiums is divided by the regional number of hectares of arable land. In 2005, in the Federal State of Brandenburg, the regional payment per hectare grassland was of 70 Euros while the regional payment for arable land reached 274 Euros per hectare. For comparison purposes, these payments reached 89 Euros and 299 Euros respectively in Bavaria and 79 Euros and 301 Euros respectively over the whole country (BSLF, 2004).

From 2010, the hybrid model will progressively switch from its current form to a "pure" regional model in 2013. Practically, the farm specific component will be stepwise transferred to the regional payment which will be homogenised between arable land and grassland as well. In 2013, 292 Euros per hectare UAA will be distributed in the framework of the German regional model for Brandenburg. Table 8 displays the most important changes as regards the distribution of direct payments in the framework of the dynamic hybrid model in the Federal State of Brandenburg.

Table 8: Main features of the 2003 Fischler Reform in the Federal State of Brandenburg

			Unit	2000-2004	2005-2009	2010	2011	2012	2013 +
Regional component	PLANT PRODUCTIONS	Cereals, set aside [1)2)]	€/ha	285	274	276	280	285	292
		Arable fodder crops, potatoes, sugar beets	€/ha	0	274	271	266	257	292
		Grassland	€/ha	0	70	92	137	203	292
	ANIMAL PRODUCTIONS	Dairy cows	€/head	35	0	0	0	0	0
		Suckler cows	€/head	218	0	0	0	0	0
		Fattening bulls	€/head	207	0	0	0	0	0
Farm specific component			€/farm	None	Farm specific payment (yearly)	Progressive reduction of the farm specific payment at the level of:			
						10%	30%	60%	100%

Source: Payments for Agenda 2000 policy (2002-2004) from LANDESANSTALT FÜR LANDWIRTSCHAFT (2001); payments afterwards from MLUV (2004).

Notes: [1)] no compulsory set-aside (minimum 10 % of UAA) from 2009 (EU COMMISSION, 2008b); [2)] additional premium of 55.57 €/ha for protein plants (BMELV, 2006).

Other features completing the indicative table above can be found in the explicative brochure published by the Ministry for Agriculture of Brandenburg (MLUV, 2004).

2.3.3.2 Some explanations for this political choice

To some extent the German decoupling model is as an intermediate between a "pure" historical model and a "pure" regional model. Neither an abrupt introduction of a flat-rate payment, uniform for each hectare of UAA over the country (or at least over each Federal State), nor a historical model were wished by the decision makers at the time of the negotiations for the Fischler reform. However, as soon as the principle of decoupling was accepted, the choice of the one or the other model was a pure *political problem*, where little had to do with economic logic.

The choice for the hybrid model seems to be partly due to the German political constellation at the time of negotiations on the CAP reform. Actually, at that time the German Federal Minister for Consumer Protection, Food and Agriculture was Renate Künast, member of the German Green Party. "Commissioner Fischler knew he had an ally in Künast" (SYRRAKOS, 2008) in the sense that she was favourable for going into the reform negotiations. Her declarations at the very beginning of the actual negotiations in 2001 revealed she was favourable to modulation, stricter rules in cross-compliance, as well as moving "German agriculture away from quantity and cheap prices towards quality and sustainability". Her Ministry already suggested in 2002 the introduction of a single flat-rate area payment covering all sectors as a long term objective for agriculture (SYRRAKOS, 2008). This largely oriented the future German decoupling model towards the regional payment direction, which was supposed to favour extensive and organic farming system more than conventional intensive production systems.

As regards the possibility to keep some payments coupled as some other member states chose to do, a study of the Federal Institute for Agricultural Research (FAL) published in 2003 reported some arguments pleading for a full decoupling of payments in any case (ISERMEYER, 2003):

- Keeping payments partially coupled may keep farm incomes lower as they may provide wrong signals to farmers, preventing them from using their resources for more lucrative activities,
- The increase in farm competitiveness would be limited through a delay in investment decisions and therefore production costs' decrease in the sector slowed down,
- Administrative costs would increase through the management of both coupled and decoupled systems,
- Strong price decreases should not take place because of different reasons, which deactivates one of the most widespread fears among decoupling criticisers; even though some movements would be observed, other policy instruments (of which Pillar II measures) should be able to tackle eventual problems.

In the end, the combination of both a regional model and a historic model has been chosen in Germany. As argued in ISERMEYER (2003), this combination of models was planned to avoid too strong over- or undercompensations among farmers, which would have been politically hard to defend, as well as the perpetuation of unevenly distributed payments as calculated in a historic model. The smooth switch to a regional payment in 2013 would therefore help avoiding potential income losses in a short term perspective.

2.4 The redistributive issues in the last CAP reform

It is often argued that direct payments were and still are unevenly distributed: 20 % of the beneficiaries would get 80 % of the total support in the form of direct payments (VELAZQUEZ, 2008, based on data from 2006). Therefore each CAP reform constitutes a challenge for countries and stakeholders in negotiating in a sense which may either keep things like they are or help getting a more favourable agreement for one's side. However, in the case of Fischler reform, even though the decoupling of direct payments may be considered as a quite big change in itself, the distribution pattern has not been fundamentally changed though. OLPER (2008) mentions that actually "the redistributive power of the [Fischler] reform is very low, leaving the money distribution largely unchanged". Total farm support was only marginally affected by the reforms and remained at the same level as before. Moreover, the allocation of money across countries and among famers did not really change, "fixing privileges and positions", as well as the balance between the two pillars of the CAP. BUREAU et al. (2007) mention that the distribution of payments remained highly uneven even after the implementation of the SPS, stating that given the regional or historical references used for the provision of the SPS, "the largest share of the CAP payments go to larger farmers, often in the most fertile areas". In the end, although the reform seemed quite radical in its implementation, it did more reveal the ability of the EU Commission and of its head at that time to conceive a reform which "gives something to everyone and generally avoids taking anything away from anyone, at least until 2013" (OLPER, 2008).

However it is interesting to investigate whether distinct impacts of a regional area payment in comparison to those of a historical payment have been expected in the sense of support distribution, i.e. which farm groups or agricultural sectors may benefit the most from the one or the other model. After that some "corrective" instruments in the form of degression, capping of payments or modulation will be shortly introduced, as they have played an important role in the recent Health Check negotiations and outcomes; and probably will be part of future discussion rounds for the design of the CAP after 2013.

2.4.1 Single farm payment or single area payment: How does each model behave as regards redistribution of resources?

2.4.1.1 Expectations on impacts of both models: Comparison of before and after the reform

Either historic or regional, the introduction of the SPS decoupling first pillar payments from production was expected to overthrow the EU agricultural sector in a tempered way though as mentioned in a preceding section. As regards the differential impacts of the one or the other model, one important issue to consider was the land market because it could be source of potential transfer losses. In his study on the impacts of the separate models on German agriculture, ISERMEYER (2003) mentions that in the long term differences in rental prices observed between the two models[28] should progressively be smoothened, which would place all farmers who rent land in the same position in both cases. But impacts of the one or the other model should differ depending on the distribution of incomes between farm types. Actually, the sudden introduction of a regional payment may immediately lead to either over- or under compensation which the author estimates could reach the level of 100 Euros per hectare on 20 percent of the UAA. There would be no much redistribution of payments in the case of the historical model. Moreover, the trade of payment entitlements may systematically lead in both models to the keeping of low quality land in GAEC and therefore concentrate agricultural production on better soils. Therefore if clear geographical limits were not set for the trade of entitlements regions with low quality soils would massively be removed from production. However, none of both models would play a role (or if then, a minimal one) in farmers' production decisions which would mostly depend on world market prices, costs and eventually signals coming from Pillar II. In the end, ISERMEYER (2003) clearly expects that as soon as decoupling was accepted, the choice of the regional model or the historic one would only depends on political preferences in redistributing resources considering which parts of the farm population policy makers would rather favour at the expense of the others.

2.4.1.2 Expectations on impacts between both models: Comparison of both models after the reform

As regards redistribution differences between both models after the reform, they are mostly due to movements on land markets as regards rental prices as already mentioned in the former section. VELAZQUEZ (2008) argues that in the regional model land values may be more affected than in the historic where possibly not all land would have be eligible for receiving entitlements, limiting the transfer of

[28] In a short-term perspective rental prices should decrease in the case of the historical model; they should stay high in the case of a regional payment. This difference lies in the modalities of attribution of payment entitlements from 2005 and the possibility for owners of these entitlements (farm managers) not to "give them back" to the land owner after their rental contracts for land come to an end.

payments for land only kept in GAEC. Whereas in the regional model all UAA is eligible for premium after reform, rental prices may be kept high and therefore transfer efficiency lower than in the historic model: premiums would be capitalised in rents and not necessary used for active production but kept in GAEC while non-farming landowners of land would benefit from it at the expense of land managers. The regional ownership structure may play an important role in those matters.

VELAZQUEZ (2008) notes that before the reform, payments differed a lot between EU countries in 2003, varying from a bit less than 100 Euros per hectare in Latvia to more than 500 Euros per hectare in Greece (around 300 Euros per hectare in the EU-15 in average). Therefore one could argue that comparisons of distributive consequences of either a historic payment or a regional one would be difficult to establish and would depend on countries' past specific production structures.

For the specific case of Germany, KLEINHANß (2007) compared the outcomes of a hypothetical historic model to those of the actual German hybrid dynamic model (in both years 2007 and 2013) as regards the distribution of entitlements levels based on the German FADN dataset for 2005/2006. The analysis showed that in the historic model, entitlement levels would be below 200 €/ha and above 500 €/ha for about 10 percent of the UAA each and high entitlement levels would be mainly distributed to farms with intensive beef fattening and intensive milk production. In the case of the hybrid dynamic model, the distribution would not change much more than in the historic model in 2007, because the most important premiums would be paid according to individual reference amounts. However fully implemented regional payments from 2013 would induce significant redistributions in favour of extensive farms and less-favoured areas, while intensive cattle farms would be negatively affected. For instance, whereas extensive bull fattening farms would not be much affected by a regional payment, farms with more than 3 bulls per hectare of roughage would loose almost half of direct payments. This tendency would also hold for dairy farms but in a less pronounced manner. Farms with suckler cows would be positively affected on average, because this is typically an extensive production system.

2.4.1.3 Future of the SPS

The round of discussions on the developments and expectations around the future of the CAP until the end of the programming period 2007-2013 have begun at the end of 2007 with first proposals from the EU Commission: this was the so-called "Health Check" of the CAP. Among the numerous points evoked as regards the modernisation and simplification of the CAP one concerned the future of direct payments due to the implementation of SPS. The Agricultural Commissioner's Fischer Boel speech on the 6th of December 2007[29] at the conference

[29] http://europa.eu/rapid/pressReleasesAction.do?reference=SPEECH/07/791&format=HTML&aged=0&language=EN&guiLanguage=en.

organised by the EU Commission's DG-AGRI about the Health Check proved the lasting Commission's concern to reduce "differences between individual farmers' decoupled payments within their territory", suggesting the implementation of a "flatter rate" of direct payments for "fairness" and "public acceptance" reasons. It suggests as well the progressive switch from a historical payment in the Member States where it has been implemented to a regional payment, justified by the fact that after some time, payments based on historical performances as measured between 2000 and 2002 may find no valid and politically defendable explanation anymore. Outcomes of Health Check negotiations show that Member States benefited from some alternative proposals in switching from their SPS model into a flat-rate until 2013, which would address the societal concern about the unequal distribution of payments among farmers (EU COMMISSION, 2009). Direct payments could be therefore considered in the future as "remuneration of public goods, or as compensation for costs incurred in the generation of positive externalities demanded by consumers and citizens" (BUREAU et al., 2007).

The alternatives to reach a flat-rate of payments have been analysed by DG AGRI. VELAZQUEZ (2008) compares different modalities in switching from either a historical model or a hybrid static/dynamic model to three possible flat rate models[30]. The study compares the switch to: an EU-wide flat rate scheme; a Single Area Payment Scheme (SAPS) for all Member States; a flat rate scheme with equal payments per hectare within Member States; and a regional flat rate scheme with equal payments per entitlement. Redistributions between member states on the one hand and farm groups on the other hand are considered.

Whether an EU-wide flat rate payment would improve the distributional equity of the SPS is a hypothesis rejected by the study. An equal payment per hectare across all EU member states would imply a very significant redistribution between countries, as this payment would be linked to land and land is not equally distributed among EU countries. There would be redistribution among economic size classes of farms: payments per hectare and income per annual work unit would decrease in the largest farms and increase in the lower size classes and among various farm types, at the benefit or grazing livestock, granivore and horticulture farms and at the expense of dairy and crop farms.

Based on the accession policy implemented in the new member states, a possible switch from SPS to SAPS is analysed. However, as the SAPS and the corresponding payment calculation are based on a varying area reference, it would not be compatible with the fixed entitlements reference as defined in the EU-15 countries. Moreover, the degree of capitalisation of payment in land values would be high, therefore decreasing transfer efficiency of support at the benefit of landowners.

Conclusions drawn if a regional flat rate payment should be chosen are similar to those already mentioned in the case of an EU-wide flat rate payment. Direct

[30] Simulations performed by DG AGRI based on individual farms of the FADN.

support would be reallocated towards smaller farms and may benefit grazing livestock, granivore and horticulture farms rather than dairy and permanent crop farms. However the calculation of this payment (per entitlement or per eligible hectare) as well as the definition of regions may have different consequences for rental prices and therefore transfer efficiency of support.

In the end, the definition or reinforcement of other redistributive instruments notably through Pillar II did play a role until 2013. Actually, the presence of heavy weighted measures within the RD policy providing a possibility to support a certain kind of investment or products (therefore "re-coupling" to some extent) could influence future discussions on budget reviews from 2013. The future role of Pillar II will therefore have to be thoroughsly debated taking impact assessment studies into account.

2.4.2 Progressive modulation, basic modulation and capping of first pillar payments: Suitable redistributive instruments?

The idea of modulating direct payments actually came to politicians' minds much earlier than Agenda 2000 reform. During the first steps of MacSharry reform, "there were plans to introduce forms of "modulation", in effect achieving a somewhat more equitable distribution of financial support by scaling down the amounts that large farmers would receive" (HILL, 2000). The will was then clearly to redistribute, more "equally", payments considered as unevenly distributed. These plans did not survive the end proposal. What was meant by modulation at that time was somewhat similar to what it means since the Agenda 2000 policy. Actually, with the introduction of an area payments for crops the first proposals dealt with decreasing the compensation rate with the farm's area[31]. Obviously the goal was to limit payments for larger farms. However, these ideas did not get it through the reform process and the last Commission's proposals mentioned no word about it. In the end, farmers got the full compensation on all their crop area independently of their size, including the set aside area (for which limitations plans were as well discussed at that time). The same phenomenon happened between the first proposals for the Agenda 2000 reform (1997) and the agreement on the final package of the reform in 1999, but somewhat a tempered way. Modulation remained mentioned in the final agreement, but was to be optional at the national level; however any mention to a capping of higher payments was simply dropped. Modulation has been reintroduced in the political agenda with the implementation of the Agenda 2000. The aim at transferring financial means from the first to the second pillar of the CAP was explicitly mentioned. Optional for EU member states from 1999, this possibility of transferring resources had not been widely used. However, modulation has become compulsory since 2005 and both its level and future use of resources it

[31] SWINBANK (2004) reports that " compensation would only be paid in full on the first 30 hectares of claims, at 75% on the next 50 hectares, and at 65% of the full rate on the remainder".

released for Pillar II or other matters are currently discussed and will obviously be in the future.

In the past years and especially since the negotiations on the "Health Check" of the CAP (2007-2009) words like degression or ‘degressivity’, capping, cuts and modulation have been mentioned several times in official documents as well as in numerous papers related to the CAP. For the sake of the whole study it is time now to choose precise definitions for these words which meaning however remains mostly political following the terms used in the Health Check final outcomes (EU COMMISSION, 2009). Therefore, in the following, modulation (or basic modulation) will qualify the transfer of resources from Pillar I to Pillar II, i.e. the action of transferring resources from a group of farms or from the whole farm population based on predefined criteria to a group of farms of the whole farm population based on the fulfilment of other predefined criteria. Capping will be used to describe the action of cutting Pillar I payments with no consideration of where the resources are transferred. Finally progressive modulation or degression will be used to qualify the differential cutting of Pillar I payments for farms considering size criteria, for instance additional cuts in payments for farms receiving more than 100,000, 200,000 or 300,000 Euros.

2.4.2.1 At the EU level, the search for a compromise on capping Pillar I payments and potential consequences for Germany

At the time of negotiations during the Mid-Term Review in 2003 it became clear that with the planned accession of the CEEC, which agreement had been made at the Copenhagen conference in the end of 2002, the EU budget would be quite highly requested after integration of the first 10 CEEC in 2004. Believing OLPER (2008), "in their January 2003 final MTR proposal, the Commission introduced ‘degressivity’ [in the sense of progressive modulation]: a cut in direct payments from 1 % in 2007 to 12.5 % or 19 % in 2013, depending on the farm size, to account for new Pillar I expenditures (e.g. dairy reform), a new rural development fund (modulation) and implicitly for the enlargement". In the end a compromise on the level of a compulsory modulation was found at a level of "only" 5 % from 2005 for the benefit of Pillar II and the mechanism called "financial discipline" should ensure to keep CAP expenditures under the budget ceiling as defined in 2002. However, as CAP expenditures should increase until 2016, especially at the end of the transition period where the CEEC should be fully integrated (i.e. farmers in the CEEC should get the same level of Pillar I payments than those in the old member states), further cuts were to be expected before 2009 (OLPER, 2008); this is exactly what happened with the Health Check of the CAP which was launched in 2007.

The Commission Communication "Preparing the Health Check of the CAP reform" (EU COMMISSION, 2007) published on November 20th 2007 aimed at assessing the implementation of the 2003 CAP reform, in particular the introduction of the Single Payment Scheme. Among the list of adjustments to the reform process that "are deemed necessary in order to further simplify the policy, to allow it to grasp new market opportunities and to prepare it for facing new challenges such as climate change, water management and bio-energy" (EU COMMISSION, 2008b), the so called "progressive modulation" opened a Pandora box in Europe and in Germany particularly. The first proposal (EU COMMISSION, 2007), actually a simple footnote, however considered as an outcome plausible enough to be immediately tackled by critics overall in Europe) for a future basic and progressive modulation dealt with strong cuts in direct payments at the benefit of Pillar II, even until 45 % for the biggest farmers[32]. This exemplary proposal provoked a general outcry among Member States and actors of the agricultural sector. On the other hand BUREAU et al. (2007) consider these cuts, among others, would only have filled the RD cashbox at the level of 3.3 billion Euros, roughly "equivalent to the extra revenue generated by a 1 percent increase in agricultural prices. However, after numerous consultations with stakeholders across Europe the EU Commission published another proposal in May 2008. Stating that Member States have "budget needs beyond their financial possibilities" for RD, but conscious of the farmers' sensitivity about modulation, the Commission finally proposed to increase basic modulation by 2 % annually from 2009 until it reaches 13 % in 2012 as shown in Table 9, as well as to introduce a progressive element depending on the level of farm direct payments, and thus on farm size (EU COMMISSION, 2008a). As mentioned in BUREAU et al. (2007), the amount of money transferred to Pillar II under this mechanism in the member states affected would be less than 0.5 billion Euros, of which about 70 % would be collected in Germany (due to the farm structure in East Germany), another 10 % in the UK.

Table 9: Modulation percentages to be applied following the Commission's proposal (EU COMMISSION, 2008a)

Payment (€)	Until 2004	2005	2006	2007-08	2009	2010	2011	2012+
1 to 5,000	0	0	0	0	0	0	0	0
5,000 to 99,999	0%	3%	4%	5%	5%+**2%**	5%+**4%**	5%+**6%**	5%+**8%**
100,000 to 199,999	0%	3%	4%	5%	5%+**5%**	5%+**7%**	5%+**9%**	5%+**11%**
200,000 to 299,999	0%	3%	4%	5%	5%+**8%**	5%+**10%**	5%+**12%**	5%+**14%**
Above 300,000	0%	3%	4%	5%	5%+**11%**	5%+**13%**	5%+**15%**	5%+**17%**

Source: Adapted from EU COMMISSION (2008a).

32 This proposal suggested the reduction of payments above 100,000 Euros by 10%, above 200,000 Euros by 25% and above 300,000 Euros by 45%.

Although compared to November 2007, the Commission had softened its initial proposal the German position was clearly against any further increase of modulation of direct payments above the 5 % initially planned until 2013[33]. That Germany is one of the most affected Member States in the EU as regards progressive modulation becomes obvious if one looks at the distribution of direct payments by size classes in Germany compared to EU-25 as displayed in Table 10.

Table 10: Distribution of direct payments by size class in Germany and EU-25

Size class of payments (€)	% of total amount		% of total beneficiaries	
	DE	EU-25	DE	EU-25
< 5,000	6.52	15.55	50.96	82.12
5,000-100,000	65.05	71.09	47.7	17.57
100,000-200,000	6.84	6.85	0.66	0.23
200,000-300,000	4.55	2.13	0.25	0.04
> 300,000	17.03	4.38	0.42	0.03

Source: KELLERMANN et al. (2009).

Hence, there were many motives for Germany to avoid any further cut in direct payments, whereas these arguments are of particular relevance in Eastern Germany where due to the specific structural conditions very large farms could loose more then one fifth of their payments in 2013. One was the fear that especially these farms would be threatened in their existence due to the drastic cuts which could cause further job losses in some anyway economically underdeveloped areas. Another reason invoked against an increase in modulation is the limited co-financing possibilities of the Federal States. One projection estimated the cut to 638 million due to the increased modulation in Germany, of which 45.5 % in Eastern Germany (STEFFENS, 2008). If the co-financing rate was to be kept at 60 % (85 % in objective 1 regions, EC no. 1783/2003), some Federal States would have expected budget restrictions limiting the use of the modulation funds. Moreover, for the German Minister of Agriculture, at the national level, the net-payer position of Germany seemed incompatible with any cut in direct payments (SEEHOFER, 2008). Sharing these opinions or some of them, other EU Member States[34] had joined the German position and claimed the abandonment of any increase in modulation (AGRA-EUROPE 2008).

Several months long, farm representatives, politicians and stakeholders led intensive discussions and get prepared to counter with the Commissions proposal. In the

[33] See "Legislativvorschläge der Europäische Kommission zum "Gesundheitsüberprüfung der Gemeinsamen Politik" [KOM (2008) 306 endg.; Ratsdok: 9656/08 vom 20. Mai 2008] – Positionierung Deutschlands für die Verhandlungen im EU-Agrarministerrat". http://www.agrarministerkonferenz.de/uploads/endgueltiges_Ergebnisprotokoll_Sonder-AMK_17_edd.pdf

[34] Great Britain, Sweden, Czech Republic, Hungary, Romania and Slovakia.

end a compromise was reached for the question of modulation in November 2008 (EU COMMISSION, 2008b), as shown in Table 11. As illustrated in this table, an increasing basic modulation is applied from 2009 until 2013 starting from 7 % in 2009 and increasing up to 10 % in 2013 for all direct payments higher than 5,000 Euros. Farms getting payments exceeding 300,000 Euros would have to count with additional 4 % of progressive modulation on top of the basic modulation.

Table 11: Modulation percentages to be applied following Health Check's compromise on modulation (EU COMMISSION, 2008b)

Payment (€)	Until 2004	2005	2006	2007-08	2009	2010	2011	2012+
1 to 5,000	0	0	0	0	0	0	0	0
5,000 to 99,999	0%	3%	4%	5%	5%+**2%**	5%+**3%**	5%+**4%**	5%+**5%**
100,000 to 199,999	0%	3%	4%	5%	5%+**2%**	5%+**3%**	5%+**4%**	5%+**5%**
200,000 to 299,999	0%	3%	4%	5%	5%+**2%**	5%+**3%**	5%+**4%**	5%+**5%**
Above 300,000	0%	3%	4%	5%	5%+**6%**	5%+**7%**	5%+**8%**	5%+**9%**

Source: Adapted from EU COMMISSION (2008b).

Practically, in Germany alone, basic modulation will amount 242 Million Euros; 19 Million will be collected through progressive modulation of which the total remains in the region where it was collected[35]. In the Federal State of Brandenburg, there are 371 farms falling under progressive modulation in 2008. They may only represent 6 % of farm population but occupy 50 % of total UAA in Brandenburg, hire 41 % of total labour in agriculture and own 60 % of dairy stables (MLUV, 2008). These farms would however provide 54 % of the total credits coming from modulation (i.e. including basic and progressive). Between 2009 and 2013 modulation should release 86.9 Million Euros; those farms undergoing progressive modulation would lose 145,000 Euros in total between 2009 and 2013, i.e. 86 Euros per hectare.

It is worth considering the reasons invoked for capping and progressive modulation. BUREAU et al (2007) mention the assumption that "public funds should aim at correcting inequalities by supporting those who derive fewer advantages from the market organizations". However, while such an instrument might be desirable in the short term, it "does not provide a sound basis for the allocation of public support". It should not aim at replacing a consistent social policy; however it succeeds quite well in limiting visible excesses pointed out by public opinion.

35 Interview of Ilse Aigner, *Bauernzeitung, 2009, 13. Woche,* p.14.

However, the progressive cutting of payments on the basis of farm size is described by affected farmers as being discriminatory against those who have to face it. Actually it is hard to justify such cuts both in their design and extent. Especially in Eastern Germany where farming structures inherited from the former regime tend to be very large in average, progressive modulation continues to be actively discussed despite the compromise agreed on at the EU level and therefore undersigned by the German authorities. Recently the German farmers' associations Union (Genossenschaftsverband) has even registered a complaint against basic and progressive modulation as implemented since 2003 for it being a violation of the principle of protection for reliance on existing law (AGRA EUROPE, 2009). Therefore the issue may be discussed again, during negotiations of the CAP after 2013 at the latest.

2.4.2.2 At the regional level, an uncertain future as regards resources devoted to Pillar II through modulation

There were both scepticism and resilience on the stakeholders' side from the beginning of discussions about the transfer of resources from Pillar I to Pillar II.

Already during the Fischler reform's negotiations, the change this transfer could have represented has been immediately tempered by the effective planned financial contributions for Pillar II. Actually, before the Health Check round, the amount of resources planned to be shifted to Pillar II from 2008 to 2013 was not of more than 3 % of the total, "too poor a contribution to consider this element of the reforms a radical change" (OLPER, 2008). Moreover, the agreement of the Brussels European Council of October 2002, engineered by the French President Chirac with the support of German Chancellor Schröder lead to the compromise that the budget for Pillar I would not be cut before 2013 (PIRZIO-BIROLI, 2008): only Pillar II expenditures would be cut if necessary. On this point, SWINNEN (2008) amusingly notes that "despite all of Fischler's emphasis on rural development, the budget for Pillar II was lower at the end of his tenure than it was before the 2003 MTR".

However, Health Check outcomes in 2009 specified that funds cut from Pillar I through modulation should be allocated to additional challenges, on top of the "old" three Axis (plus LEADER) already defined in the RD policy, focused on the following issues: climate change, renewable resources, water management, biodiversity and, newly added to the list, support of the dairy sector (EU COMMISSION, 2009). From member states' side it was criticised that those resources freed through modulation (basic and progressive) as agreed after the Health Check may not compulsory "come back" to agriculture and in the region where it was taken from to properly tackle the challenges listed before. The definition of new co-financing rates to be set at the levels of 75 % (90 % in convergence regions) should enlighten local finances compared to the initial Commission proposal (50 %). For instance the Ministry of Agriculture of the Federal State of Brandenburg would use those additional resources for supporting farm investment with the goals to increase competitiveness and local employment (with focus on the dairy sector), as well as increase payments for less favoured zones (MLUV, 2008). The setting of such priorities in Brandenburg clearly reveals that to some extent environmental goals do not necessarily prevail in a short term perspective. The currently difficult situation in the dairy sector and the generally unfavourable economic situation in this German state quite mitigate future prospects towards political engagement for the improvement of environment's quality and other non economic objectives.

Therefore as regards the effectiveness and efficiency of the use of modulation resources there are some remarks to be made. First, believing the Commission, "Rural Development" measures should be the best way to meet the challenges cited above. However, BUREAU et al. (2007) report that, even though in some case targeted Pillar II measures may constitute an appropriate response (in the field of water management for instance), overall competences of the second pillar are rather vague and lack a long-term vision in those matters.

Then, it is difficult to tailor idealised nature conservation measures which reach goals like reducing externalities and compensating farmers for the effort they concede mostly because of adverse selection and moral hazard. Actually, both farm specific costs to commit in AEM and relevant farm groups to subscribe to those measures are unknown to the policy maker. Therefore, the extent to which some AEM may sound is difficult to foresee, therefore putting the adequate use of resources into question (empty or full cashbox for some measures). Moreover, costs of implementation and monitoring of environmental schemes may appear quite high with regard to actual outcomes, especially if new measures should be implemented

Therefore "the difficulties to make an efficient use of the money devoted to environmental programmes are formidable" mention BUREAU et al. (2007). It gives the necessity to look at past successful AEM an utmost importance in order to (re)distribute resources efficiently in the future.

So far programs and instruments remain untouched until 2013. However, this deadline comes closer; it is therefore to be questioned whether the measures adopted until 2013 will prepare or in the contrary spread confusion about future reforms to come after this date.

2.4.3 Future of the CAP: What comes after 2013?

Health Check conclusions have more consisted in adjustments of the current CAP so far and have crystallized CAP instruments designs until 2013. Discussions about long-term visions for the CAP as well as resulting budget issues have unfortunately not begun during the Health Check; nevertheless proposals and reflections have been emerging from various European think tanks (BUREAU et al., 2007; BUREAU and MAHÉ, 2008; ZAHRNT, 2009 to cite some recent works) as regards long term visions for the CAP and should help policy makers to shape the next policy from 2013 based on economic expertise.

2.4.3.1 Where does CAP stand?

Although lots of problems, created since its creation, have partly been solved thereafter, the CAP still has some huge challenges to overcome. Following BUREAU et al. (2007) and despite the outcomes of the last discussion round during the Health Check, a list of "plagues" inherent to the current policy can be empanelled: the cost of the CAP which will amount 43 % of the whole EU budget between 2007 and 2013; the poor transfer efficiency of the policy where rich farmers get the bulk of the support and leakages allow asset owners to get their share as well; a poor environmental record with lots of negative externalities due to agricultural activities; a lacking ambition as regards productivity support; a fading justification for support as "compensation" of farmers for reform; uneven distributive effects where "the largest share of the CAP payments go to larger farmers, often in the most fertile areas"; a brake to harmonious international relations and; last but not least, uneven contributions to and benefits from the CAP across the member states. As regards these issues, it is to mention that national envelopes are largely determined by past payments rather than on some criteria reflecting CAP's objectives. Especially "first-pillar measures of the CAP – which account for most of the budget – do not contribute much to the cohesion objectives, given their uneven benefits across countries, regions and sectors" (BUREAU and MAHÉ, 2008).

The following current and expected international and EU internal contexts drawn in BUREAU and MAHÉ (2008) are listed as delimiting milestones where the future CAP should be defined. First, they mention the high probability that agricultural prices may not drop down anymore but remain higher in the next years; this may constitute an opportunity for further reforms. Then, an agreement in the WTO could prevent the EU from further internal conflicts and put an end to export subsidies. Actually, as mentioned in OLPER (2008), an agreement on market issues at the WTO would only be possible with further CAP reforms solving interest conflicts within the EU as regards tariffs; again, redistributive aspects across member states shall be tackled by future CAP reforms. The consideration of consumers' and European citizens' demands implies the provision of a wide range of food and non food products, fulfilling safety and quality standards for the best price. This contains the conservation of biodiversity and traditional landscapes as well. All these demands may however interfere with each other or with competitiveness requirements. Moreover, the CAP may not fulfil general EU policy objectives: EU competition policy lets some agricultural sectors more sheltered than others; poor consumers have not been considered much by the CAP so far, although being an objective of the Treaty of Rome; collusions in retail sectors and food industry might be tolerated while those between farmers to regulate markets in geographical indications not and; as mentioned above, unevenly distributed first pillar payments contradicts the cohesion objectives. Finally, adding the budget considerations, interests conflicts between member states might complicate negotiations for the definition of the future CAP.

2.4.3.2 Where could CAP's direct payments head for?

Believing ZAHRNT (2009) this overall question of distribution of CAP resources among member states should be put into question; through the replacement and progressive elimination of the SPS by a "discretionary" pillar and the replacement of the second Pillar Into a "public goods" pillar, the author suggests a provision of national envelopes thanks calculations based on objective criteria (UAA, forest area, Natura 2000 and area used in organic farming) to roughly determine the overall distribution of public support. Without evoking the question of national envelopes and somehow less provocative, BUREAU and MAHÉ (2008) nevertheless promote the creation of new pillars as well. They suggest the creation of a general contractual scheme somewhat in coherence with current two pillars. Basic husbandry payments "subject to few but observable commitments regarding rural farming landscape, biodiversity and natural resources", natural handicap payments "targeting farms in rural zones with natural handicaps" and green points payments "prescribed for portions of rural territory which are environmentally sensitive or endowed with assets of high natural value" should advantageously replace a complex set of current payments, "bringing simplification and coherence to the overall system of farm support" (BUREAU and MAHÉ, 2008).

The risk in designing future direct payments is to "re-couple" them again somewhat to agricultural productions through diverse requirements and services. BUREAU et al. (2007) mention however in a quite provocative way that "for basic maintenance of open landscape in some regions payments for suckler cows or sheep could provide a more efficient instrument for administrative reasons than a complex payment scheme based on output in terms of additional biodiversity". This highlights the difficulties to come in finding the right balance between provision of services from farmers, the consequent value obtained by the society and the nature and quality of agricultural commodities produced. Moreover, if direct payments were to be renewed, they would have to cope, as they already had to in the past, with the double heterogeneity characterising the European agriculture: heterogeneous farm structures across the continent (full- or part-time family farms and legal entities in different proportions, farm specialisations, sizes and technical endowments) and heterogeneous farming conditions. However, both BUREAU and MAHÉ (2008) and ZAHRNT (2009) suggest the progressive removal of the SFP as it currently is. This would save financial resources to be transferred to programs mandated by the Lisbon agenda and therefore be rather invested, efficiently if possible, in the provision of public goods.

As regards Pillar II and in particular agri-environmental measures, there are some issues of importance which have to be solved in sight of future negotiations. First, the trade-off between costs of (some) AEM (monitoring, inspection and control) and actual provision of public goods may be negative: increasing budget beyond certain limits may either imply a risk of corruption or excessive costs. Moreover, the number of applicants may be overlooked in many cases. Then, as far as Pillar II measures provide non-tradable goods produced at a local level (therefore non market distorting), it is to question whether the EU level is the right competence level to monitor those measures. As regards past experiences in allocating Pillar II resources between member states, GLEBE and SALHOFER (2007) find that until recent reforms (Agenda 2000 and Fischler reform) the largest panels of Pillar II programs were chosen by countries which contributed the least to the EU budget, revealing a "restaurant table effect". Despite fixed allocations of EU funds to member countries (forcing them to choose a "common meal") the calculation of national allocations is based on historical spending; past restaurant table effects may still rule. Finally, and this may particularly make sense for the case study region chosen here, if the EU level is chosen as competent for the management of AEM then these should be integrated in a broader regional policy (BUREAU et al., 2007); considering the ongoing structural trend of a declining number of farms, there is no reason for RD policy to target agriculture more than other sectors in the line of territorial coherence.

The relatively limited number of instruments used at the political level as well as various constraints consisting in internal and external pressures drastically restricts the range of feasible reforms, therefore political choices as regards the CAP. Moreover, path dependency created at each step of political decisions restricts future choices and options at the disposal of policy makers. For applied research in the field of which this study would be classified, this restricts as well the range of politically relevant experiments. By chance, the number, focus, quality and scope of tools and methods to investigate impacts of policy changes do not follow the same path. The tool used in this study, AgriPoliS, belongs to methods which enable a deeper understanding of policy impacts through the possibility to observe patterns and reactions of farm population at the very individual level. These reactions and patterns as regards production and investment choices can be aggregated to provide a fine picture of potential policy outcomes. Harmless for the real farm sector AgriPoliS enables to simulate as much policy scenarios the user would like. Therefore the comparison of relative changes in individual patterns between scenarios enables both scientists and policy makers to better grasp potential implications of political decisions for the farm sector. The next section provides an overview on AgriPoliS as well as on the case study region used as "guinea-pig" for some exemplary experiments analysed in this study.

3 MODEL-BASED ASSESSMENT OF REDISTRIBUTIVE ASPECTS OF POLICY SCHEMES ON FARM STRUCTURES

"The simulation of agents and their interactions is known by several names, including agent-based modeling, bottom-up modeling, and artificial social systems. Whatever name is used, the purpose of agent-based modeling is to understand properties of complex social systems through the analysis of simulations. This method of doing science can be contrasted with the two standard methods of induction and deduction. Induction is the discovery of patterns in empirical data. Deduction, on the other hand, involves specifying a set of axioms and proving consequences that can be derived from those assumptions. The discovery of equilibrium results in game theory using rational-choice axioms is a good example of deduction. Agent-based modeling is a third way of doing science. Like deduction, it starts with a set of explicit assumptions. But unlike deduction, it does not prove theorems. Instead, an agent-based model generates simulated data that can be analyzed inductively. Unlike typical induction, however, the simulated data come from a rigorously specified set of rules rather than direct measurement of the real world. Whereas the purpose of induction is to find patterns in data and that of deduction is to find consequences of assumptions, the purpose of agent-based modeling is to aid intuition." Introduction to the Handbook The Complexity of Cooperation: agent-based models of competition and collaboration AXELROD (1997).

3.1 The use of agent-based modelling to explore impacts of public action

3.1.1 Why using agent-based modelling to explore impacts of public action on farm structures and inequalities in agriculture

3.1.1.1 Generalities

Although first examples of computer simulations date from the 60's, simulation began to be widely used in the 90's. Simulation introduces the possibility of a "new way of thinking" (AXELROD, 1997) about processes, based on the idea that complex behaviour can emerge from relatively simple activities. Like for other models used in econometrics for instance, the researcher builds his model based on assumptions on economic and social processes. This grounds the difference with a statistical model: while the latter reproduces the pattern of correlations among measured variables, agent-based models are concerned with processes and are therefore able to model the mechanisms which are underlying the relationships measures by means of statistics. Rather than on equations the agent-based model relies on computer programs. Different tools have been developed among which multi-agents models allow to "create programs which interact 'intelligently' with their environment" (GILBERT and TROITZSCH, 2002). These programs are named 'agents' and are able to control their own actions, independently from others', having direct control of their internal actions and state, based on their perceptions of their operating environment. A way to program those agents is to use an 'object-oriented' language: objects are program structures which hold both data and procedures for operating on those data. Once the proper modelling architecture is built, the next step consists in verifying whether the model runs at all. Complex models can easily produce lots of trouble and this debugging part of the modelling process may be laborious and difficult. When the model is able to produce results, the next task is to check whether they make sense at all. This constitutes the validation part of the modelling work. Validation is concerned with the question of whether the simulation is a good a suitable representation of the target (HAPPE, 2004). Some calibration of initial data or of internal properties of the model may be necessary. However, phenomena like random factors, path dependency, non reproducibility of past processes ('retrodiction') and incorrect data undoubtedly play a role in this validation steps and have consequences on the final model outcomes (GILBERT and TROITZSCH, 2002).

3.1.1.2 Contribution of agent-based modelling to the studied topic

As agent-based models are considering a certain numbers of formalised independent agents, they enable the researcher to experiment complexity which is characterising economic, social and environmental worlds. Complexity can arise from the panel of possible activities defined for agents as well as from the heterogeneity which can be introduced between those agents. In many fields the consideration of heterogeneities, may they be spatial, economic or environmental is crucial to depict possible, and plausible, trajectories a social system can take.

The possibility to let autonomous agents acting on their environment, reacting to changes as well as interacting with others agents allows showing how patterns at a higher level can emerge from a series of actions, reactions and interactions at the lower level. These aspects can not be grasped by static models, which allow agent-based models to provide an original view in addition to what static models provide.

Although embedded in a sometimes complex network of assumptions as regards their structure, the behavioural rules defined for agents as well as the initial state of simulations, agent-based model can produce results which can be used for explanation and/or prediction purposes. Especially as regards policy analysis, agent-based simulations enable to experiment policy measures without harming either people or the environment and constitutes an interesting economic laboratory where any scenario can be tried like in a test tube.

Therefore, agent-based models provide the possibility to introduce diversity between agents from the beginning of the simulations, which is of utmost interest in the present study. Actually, performance and income disparities between farmers and their development through time and policy reforms highly depend on initial heterogeneities between those farms at the "beginning". In other words, it is somewhat necessary to consider inequalities in initial endowments in capital, land and labour as well as spatial locations between farms in the initial step of the modelling.

Following CHAMPERNOWNE and COWELL (1998), inequality can endorse the two following forms:

- inequality of outcomes[36], depending on the fitness of farmers to run their business, against which farmers can choose the best production mix possible,
- inequality of opportunity: depending on the mix of soil types, the ownership structure of the farm, all characteristics attributed to farms at the beginning of the simulation.

Agent-based modelling allows taking part of these inequalities into account: outcomes of agricultural policies are indeed dependent of the specific regional structure considered.

There is an important point evoked by GARDNER (1992) which could demonstrate the marginal contribution and decisive relevance of agent-based modelling for the study of impact of agricultural policies on farm incomes. It is worth referring to the complete text passage where GARDNER (1992) states how econometrics may not necessarily provide satisfactory answers on the influence of policy programs on the agricultural sector[37]: "The question of how commodity programs affect farm income' should be answerable using straightforward econometrics. We have data on farm income and on government intervention, so a regression model explaining the former in terms of the latter looks feasible. But no direct econometric answer (as opposed to simulated answer) on the effect of farm programs on farm income has appeared in the literature. What insurmountable problem has this research agenda confronted? The main difficulty seems to be that for a given set of legislated price supports, the amount redistributed automatically increases when commodity markets weaken and market-generated income falls. On the other hand, during the periods in which farm income is highest, such as during World War II or the 1972-75 period […], the commodity programs are inactive. Therefore, ***a regression explaining farm income by program variables would indicate that more intervention reduces income***. In principle, appropriate exogenous instruments or a fuller model that explains both farm programs and market outcomes simultaneously could permit identification of the structural effect of farm programs on income, but the data do not seem friendly to this project." Such a quotation contributes to justify the use of agent-based models in addition to those tools already available in econometrics to investigate the outcomes of policies on agricultural structures and farm incomes. Moreover, the possibility to introduce new conditions (institutions, behavioural strategies, market structures) during the modelling process

[36] CHAMPERNOWNE and COWELL (1998) describe it as the part of inequality which is attributed to the fault or merit of the affected persons themselves, in opposition to inequality of opportunity against which persons can not do anything.

[37] The text written in bold between the quotation marks has been highlighted by the author of this study.

provides the modeller with new insights on their consequences in a complex and dynamic framework.

Agent-based models are a way to complete the methodological panel available for agricultural economics; however their use and recognition is often problematic.

3.1.1.3 Limitations

Using agent-based models, like using any other modelling method, contains some limitations as regards what these models are able to provide the researcher and the rest of society, especially policy makers in the case of policy experiments and the analysis of their outcomes.

The initial calibration of the model will highly determine the outcomes of the simulations, and consequently the political analyses to be made. This means that if the agent-based model aims at giving a quite realistic picture of reality, a careful attention will have to be paid at the initial state, i.e. the start conditions of the modelling. However it has to be kept in mind that a model, as sophisticated as it can be, remains a model, i.e. a simplification of reality based on the understanding the researcher or the model designer has from it. It explains why the "retrodiction" evokes in the subchapter above may not necessarily be a method to properly validate the capability of a model: there are and will always be some features of reality which will never be possible to entirely integrate in a modelling framework.

It is quite difficult to properly communicate results and capabilities of agent-based models because of the relative complexity of their structure and the amount of assumptions made to build them. This burden makes it difficult for the agent-based modeller to rely on spontaneous acceptability of his tool, even though these models, from the most theoretical to the more applied ones, are often built following some strict and well defined rules rooted in the discipline of research they aim to contribute to. Whereas analytical models, formulated in the general language of mathematics, can be described quite precisely and therefore are more accessible to the reader, "published descriptions of IBMs[38] are often hard to read, incomplete, ambiguous, and therefore less accessible" (GRIMM et al., 2006). This difficulty has not created a positive and sound ground for agent-based models but this situation is improving with the attempts to create and develop standardised description protocols.

Linked to the communication lack, the difficulty to reproduce what other modellers have created in a classical scientific reviewing approach has not been completely solved though. Both because of the complexity of the task (technical competence in agent-based language as a prerequisite for the reviewer, high probability not to get any results because of bugs) and because of confidentiality and intellectual property problems (restricted use of raw data, restricted share of source codes), the review of publications involving agent-based models is often laborious if not

[38] Individual Based Models.

impossible. Papers using these methods are relatively scarce in high ranked journals and therefore, because of constraints mentioned above and not necessarily because of the substance and relevance of the agent-based methods, the scientific credibility of those models is often put into question.

This is not a fatality and tends to change over time. Model descriptions gain in being concise and the use of the language of mathematics may help the reader to understand the model "from the inside". GRIMM et al. (2006) report some studies whose clear and precise description of model processes in equations has done a lot for the understanding and reproducibility of results, therefore improving resonance and use of these models.

3.1.2 AgriPoliS, an agent-based model of structural change in agriculture

3.1.2.1 Introduction

AgriPoliS is one of the leading agent-based models in the field of agricultural economics. Structure of the model as well results it has produced have been, or parts of it, already published in referred journals and AgriPoliS has been already used in important EU projects[39] in recent years. Although complex and highly applied, its rules and assumptions are rooted in the neoclassical producer theory. As a foreword to the chapter devoted to the exploration of the model, we shall list the grounding assumptions made on the central characteristics of an agricultural system. These assumptions ground the existence of the model and are listed by BALMANN (1995) as following:

- The evolution of agricultural structures follows a dynamic process
- Agricultural structures are path dependent, i.e., the history of the system significantly determines its present state and certain events are irreversible.
- For the most part, decision-making follows goal-oriented economic considerations.
- Certain activities, decisions and actions are indivisible.
- There are feedback mechanisms, particularly at the local scale, between the actions of individuals and between the results of individual actions.

In addition to this there are assumptions that are model-specific and are necessary to make the model operational and to keep it tractable and clear. Particularly, these assumptions concern farm behaviour, expectation formation, the definition of the planning period, the representation of markets and interaction with other sectors.

[39] EU projects "MEA-Scope" (SSPE-CT-2004-501516) and "IDEMA" (SSPE-CT-2003-502171) between 2004 and 2008 within the Sixth Framework Programme for Research, Technological Development and Demonstration Activities, for the Specific Targeted Research Projects.

3.1.2.2 ODD protocol for AgriPoliS

As mentioned above, the gain in complexity in some well established agent-based models is unfortunately often counterbalanced by a loss of visibility of what the model really can or can not. Therefore the following description of AgriPoliS is established following the ODD protocol (for Overview, Design concepts and Details) as described in GRIMM et al. (2006). Most AgriPoliS features are fully and admirably described in other documents available to the reader, especially in HAPPE (2004) where the first complete description of AgriPoliS (as it is used in this study: adapted to a real region) is available and in KELLERMANN et al. (2008) where the reader could find the very last version of the model including recent major advances and options.

3.1.2.2.1 Overview

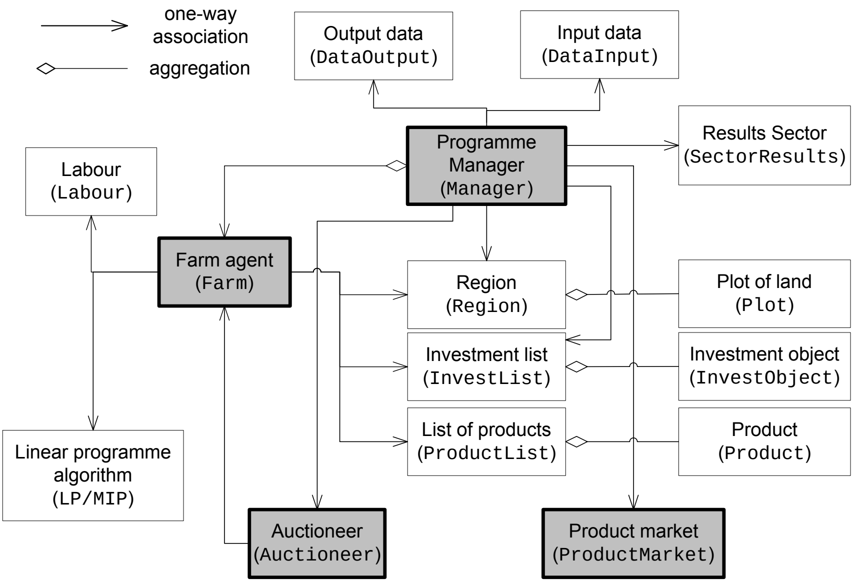
Purpose. AgriPoliS is a spatial and dynamic agent-based simulation model of structural change in agriculture (KELLERMANN et al., 2008; HAPPE et al., 2006; HAPPE, 2004). The main purpose of the model is to understand how farm structures change in rural areas, particular in response to different policies. AgriPoliS maps the key components of regional agricultural structures: heterogeneous farm enterprises and households, space, markets for products and production factors. These are embedded in the technical and political environment. While this environment is common to all farms, the diversity introduced between farms at the beginning of the simulation allows getting differentiated results among the population as regards policy impacts, thus permitting to temper and mitigate policy expectations made a priori. Finally, land markets play a crucial role in agricultural structural change. Because the dynamics on land markets are mainly determined by the interactions between individual farms, an agent-based approach offers many advantages for creating an endogenous land market.[40]

State variables and scales. The model comprises different hierarchical levels: farm agents, plots[41], regions, farm population, and political environment. Farm agents are characterised by state variables such as age, factor endowments (land, capital, labour), ownership structure, location in space, technical orientation, managerial ability, full time or part-time farm. In order to produce, farm agents utilise different production factors of different types and capacities, i.e. stables for cows or other animals or machines. Farm agents comprise the population of all agents in the region. Figure 8 illustrates the model's structure and resolution.

40 The first version of the land market presented here dates back to the works of BALMANN (1997), HAPPE (2004) and HAPPE et al. (2006). A literature review reveals few similar attempts. For example, the model by BERGER (2001) includes a land market which is of a similar structure to the approach presented here, and is also based on BALMANN (1997).

41 What we name "plots" are individual equally-sized cells in the artificial region. All plots joined together constitute the artificial region, like fields constitute specific landscapes in the reality.

Figure 8: Static class-diagram of AgriPoliS



Source: HAPPE (2004).

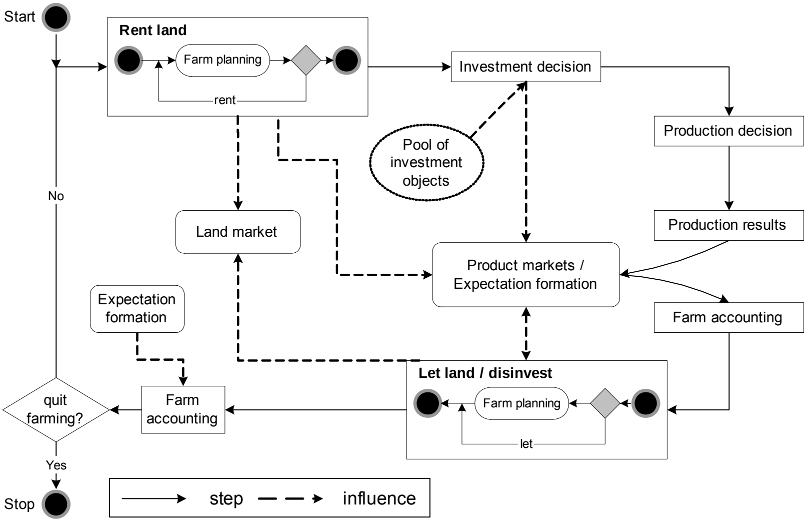
Note: Names in brackets denote the class names used in AgriPoliS' C++ programme code. For clarity, the figure does not show attributes and methods. The grey shaded classes are agent classes.

Considering space is important to obtain a realistic model of structural development and its impacts on the agricultural landscape. Plots represent physical land units or cells, each of which is 1 ha in OPR. Together, plots form the artificial region. Plots exist in different forms: owned/rented, arable and grassland of different quality (low, medium-low and medium high for arable land, extensive or intensive for grasslands), distance to farmstead, non-agricultural land[42]. This artificial region is built upon real data (size of the case study in hectares, of which arable land and grasslands in which different proportions of soil types are introduced). Rather than producing an exact replication of the real landscape, a model of the real landscape is created. Distance costs to the fields are considered in farms' internal calculations therefore making AgriPoliS an abstract spatial model of the agricultural landscape.

[42] These are features not directly related to agriculture are not specifically considered, like roads, rivers, lakes, etc. The assumption made is that agricultural policies may only cause changes on agricultural lands and thus leaving all other features of the landscape unchanged. For this study the ratio of non-agricultural land over the total regional area has been set at 10 %.

Process overview and scheduling. The model proceeds in annual time steps or periods. Each "year" the following steps are processed for each farm: set policy, land auction, investment, production, update product markets, and assess period results, exit decision. Figure 9 shows how the model organises farms' actions in one time period.

Figure 9: Course of events in one planning period for one farm agent



Source: KELLERMANN et al. (2008) based on BALMANN (1995).

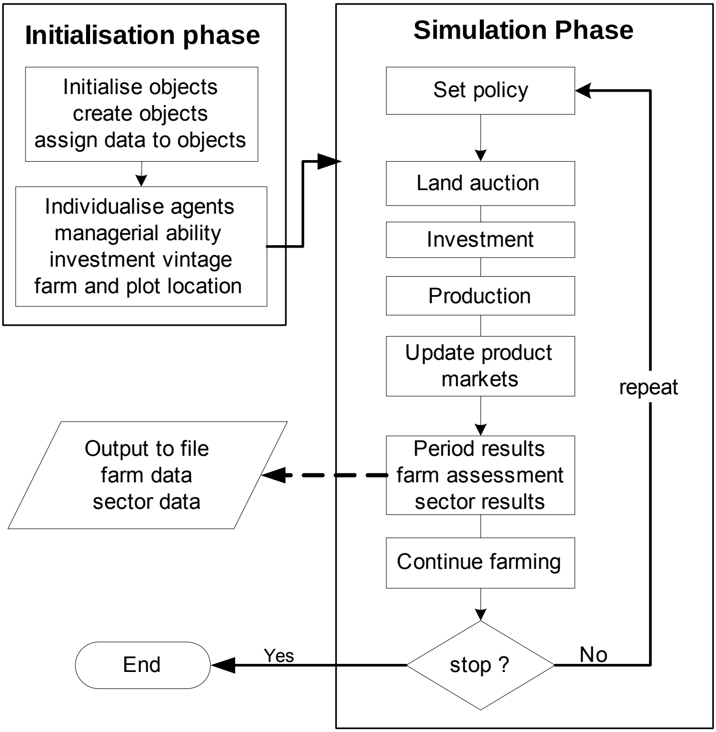
The political environment is delineated by the predominant agricultural policy setting which affects farm agents by way of direct payments, agri-environmental programmes or limits on stocking density. This political environment and any policy change can therefore be introduced as a payment distributed in junction with farms' production of agricultural commodities[43] or as a constraint in the internal calculus made by farms in each time period[44].

The scheduling of the model's processes is the task of the Manager objects. The Manager coordinates the initialisation and simulation phases as shown in Figure 10.

[43] For instance direct payments coupled to hectares of COP –cereals, oilseeds, protein plants- or animal heads as distributed by the CAP before the decoupling reform in 2005

[44] A limit on stocking densities inside the farm will introduce an internal constraint in farm's calculations. In this study the limit has been set at the level of 2 livestock units per hectare, whereby the definition of 1 livestock unit corresponds to 500 kg live weight. Agri-environmental payment schemes, as modelled in this study, will condition the distribution of the payment to the adoption of environmentally-friendly activities, including a constraint on livestock density among others.

Figure 10: Model dynamics as implemented in the Manager class



Source: HAPPE (2004).

At the end of each period, farm agents assess their economic performance during the past period. Based on this assessment and the given future policy changes, farm agents form expectations about the next production period and decide on whether to continue or stop farming. They take all possible adjustment options into account such as off-farm labour opportunities, selling excess quota, and terminating land rental contracts. Fixed assets cannot be disinvested due to the sunk cost assumption made in the model. Results for each individual farm agent and the sector as a whole are written to an output file. The simulation terminates when the number of specified time steps is reached or if farms have all stopped farming.

3.1.2.2.2 Design concepts

Behaviour: Farm agents maximise farm income. To derive the farms' actions, a mathematical programming approach is used as a means of combining various farm production activities and investment choices given the farm's resource constraints. This approach is a Mixed Integer Programme (MIP) which mixes continuous activities (hire employees on an hour basis, grow crops on a certain proportion of farmland, borrow credits, etc.) with integer ones (build a stable and not 0.89, hire an employee on a yearly-basis – and not 1.27). The MIP is the programme which rules economic decisions of farms; the mix and definition of available activities (costs, labour requirements, revenue, premium, depreciation of investments, etc.) is defined considering statistical data, if possible real observed data at the regional level for the case study area of interest.

Adaptation: Farm agents adapt to changing conditions on markets and to policy changes by changing the combination of their activities. Farm agents can produce a selection of goods. In order to produce, farm agents use buildings, machinery and facilities of various types and capacities. Accordingly, AgriPoliS implements economies of size: when the level of production increases, investment costs per unit decrease. Moreover, labour is assumed to be used more effectively with increasing size. Farm agents can engage in production activities, labour allocation, land renting, production quotas, and manure disposal rights. Labour can be hired on a yearly or hourly basis; farm family members can work off-farm. To finance farm activities farm agents can take up long-term and/or short-term credit. Liquid assets not used on the farm can be invested. A farm agent leaves the sector if it is illiquid or if the opportunity costs of farm-owned production factors are not covered. A potential successor takes over the farm only if the expected farm income is at least as high as the comparable industry salary, which is assumed to be 25 % higher than the regular off-farm income.

Prediction: Farm agents form expectations about future prices based on adaptive expectations. They anticipate the impact of major policy changes one period in advance. A farm agent does not act strategically. It does not know what his neighbours are producing and neither do they.

Sensing: Farm agents are assumed to know their own state and endowments so that they can apply their behavioural rule. They take into account expected prices for products as well as the future political settings one year ahead. Farm agents sense the state of all plots in the region, and hence can determine which additional plot they wish to rent.

Interaction: In AgriPoliS, farm agents interact indirectly via markets for production factors land, labour and capital, and on product markets. The population of farm agents is derived from FADN data in a reference year. Farm agents are further individualised with respect to production costs, location, age, and the age of the assets. Technical coefficients and gross margins of production activities are based on standard indicator sets. Markets for products, capital and labour are coordinated via a simple price function with an exogenously given price elasticity and a price trend for each product[45]. The land market used in AgriPoliS serves as institutional

[45] It is differentiated between interest rates for long-term borrowed (5.5%) and short-term borrowed capital (8%) and for equity capital (4%; all values DEUTSCHE BUNDESBANK, 2003).

framework for exchanging land between farm agents. Although farms are initialised with both owned and rented land, transactions on the land market take exclusively place via renting activities. Free land is distributed to farms following first-price auction rules. Land is available either because 1) it was not used by any other farm agent before, 2) or the rental contract attached to the plot has ended or has been terminated by the farm manager 3) or a farm agent hast quitted the sector and therefore freed its land. The auction is sequential, i.e. it is possible to bid only for one plot at a time, and it is repeated until there are no plots available anymore or if there are no more positive bids. Each farm calculates a bid for the plot it considers as most valuable; the farm making the highest valuation for a plot receives it. Rental contracts have a fixed duration[46]. The contract length is randomly drawn from a uniform distribution with a minimum and maximum contract length. The contract length is binding for the duration of the contract, and neither the land owner nor the land manager can terminate or renegotiate the rental contract during the contractual period. In other words, and this is important to keep in mind for the understanding of presented model results later in this study, as long as the rental contract is still valid for a plot, the farm has to keep it and pay the rent.

<u>Observation</u>: The model produces results at the sector level as well as for each individual farm at each time step on economic indicators, production, and investment.

3.1.2.2.3 Details

<u>Initialisation</u>: Coming back to Figure 10, the Manager objects control the programme's flow. It controls and implements the initialisation first and the simulation phase afterwards. First, the model's structure is created, including 1) the creation of objects based on class definition, and 2) the assignment of values to the attributes of the various objects. As regards the Product Market class of objects, data on products and investments come from regional statistics for the base year considered[47]. As regards the class of farm agents, values are for the most coming from individual empirical data[48]: technical orientation[49], size in hectares – including

For hired labour we assume an annual increase of 0.5% for costs for hired labour. In these simulation experiments we assumed output prices to stay constant.

46 There is another type of rental contracts introduced in AgriPoliS. There plots can be "renegotiated" at the end of each production period. At the end of a production period for each rented plot, a farm decides to either keep the plot or to release it. The decision rule itself is based on the expected revenue of a plot in the next production period (KELLERMANN et al., 2008).

47 Datensammlung für die Betriebsplannung und die betriebswirtschaftliche Bewertung landwirtschaftlicher Produktionsverfahren im Land Brandenburg, Landesanstalt für Landwirtschaft, 3. überarbeitete Auflage, Land Brandenburg, Band 2, 2001; KTBL (2002): Taschenbuch Landwirtschaft 2002/03. 21. Auflage, Münster-Hiltrup: Landwirtschaftsverlag GmbH.

48 FADN Brandenburg 2002.

49 We may use the expression "farm type" as well. This designation is derived from the variable used in the FADN database where the farm type is determined considering the dominant

hectares of arable land and grassland, proportion of rented land, number and type of animals, labour input, net worth and land assets. Farms are then further randomly differentiated by the Manager as regards their location in the region, the age and the fitness of the farmer, the vintage of assets and the proportion of land belonging to different quality classes the farm owns or rents at the beginning of the simulation (low, medium-low and medium high quality for arable land, extensive or intensive for grassland).

Input: Two files are compiled together in the initialisation phase. The first file or "Input" file is a collection of table sheets containing all necessary information about farms, products, investments, decision rules and other general settings specific for the region modelled needed for the model to run. The second file, the "policy settings" file, reports policy changes which will occur through the simulation and this for each period. This file is read at the beginning of each period as shown in Figure 9 and the information it contains is crucial for farm agents to build their expectations for the year to come and make decisions which will maximise their expected income. Both of the mentioned files are built before the simulations, read by the program and can not be changed during the simulation, i.e. it is not possible to introduce any change in these files without having to rerun the complete model.

Submodels: Following the ODD protocol, this section aims at providing a full model description, especially in the form of mathematical equations and rules in order for the reader to fully understand the what's and how's constituting the inside of the model. All this material can be found in KELLERMANN et al. (2008) accessible online[50].

Now that the main features of the method have been presented, it is the turn of the case study region to be shortly described in its main aspects.

3.2 Description of the case study region

The administrative district Ostprignitz-Ruppin (OPR) gives boundaries to the "Rhinluch" case study area. Ostprignitz-Ruppin is located in the federal state of Brandenburg in Germany, 100 km in the North-West of Berlin (Figure 11). The district covers 2,511 km^2 and is area-wise the third biggest district of Brandenburg.

technical orientation in the calculation of the total farm's gross margin (EU COMMISSION, 2002). For instance, if most of the total gross margin comes from dairying activities, farm's type will be classified as "dairy", digit code 41--.

[50] http://www.agripolis.de/documentation/agripolis_v2-1.pdf.

Figure 11: Location of the case study area (in dark grey)

Source: Wikipedia (http://de.wikipedia.org/wiki/Landkreis_Ostprignitz-Ruppin).

Brandenburg belongs to the North German Lowland which is a part of the Great European Plain that sweeps across Europe from the Pyrénées in France to the Ural Mountains in Russia. Hills in the lowlands only rarely reach 200 meters in height, and most of the Ostprignitz-Ruppin district is well under 100 meters above sea level. Lowlands slope almost imperceptibly toward the Baltic Sea. A varied nature and culture landscape with numerous avenues, forests, lakes, historical villages and settlement structures shapes the OPR district. An average of 520mm of precipitations per year was observed over the past 20 years.

Land use

The total UAA in 2003 was of more than 126,000 ha (Table 12), of which almost 30 % of grassland.

Table 12: Land use in OPR in 2002

Land use	Area	in%
Arable land	*89,566*	*71.0*
Of which low quality (AZ 25)	3,073	2.4
Of which medium-low quality (AZ 38)	83,773	66.4
Of which medium-high quality (AZ 50)	1,660	1.3
Grassland	*36,659*	*29.0*
Of which extensive grassland	9,472	7.5
Of which intensive grassland	22,979	18.2
Total Utilised Agricultural Area	***126,162***	***100.0***

Source: GIS information for OPR (2005).

Note: "AZ" stands for "Ackerzahl" which is a German index of soil quality comprised between 7 (soils hardly usable for agricultural purposes) and 100 (best suited soils for agriculture). An index of 50 roughly means that yields on these soils are half those reached on soils having an index of 100.

The two thirds of the grassland area can be potentially used intensively to produce food and roughage for animals, as it is spread on relatively good quality soils for this purpose. The rest is constituted of low yield pastures and grasslands, of which some wetlands. As regards arable land, Germany classifies soils as regards their potential agricultural yields in a range starting from 0 (extreme low yields) to 100 (maximal agricultural yields). Almost all arable land in OPR is constituted of medium-low quality and rather sandy land, which, combined to relatively low precipitations, do not offer the best conditions to expect the highest yields.

Farming structure

561 farms were performing their activity in OPR in 2002. Although 60 % of the farms are smaller than 50 ha (Table 13), the average farm in OPR covers 225 ha, of which 160 ha of arable land and 65 ha of grassland. This is due to the presence of big structures inherited from the socialist era and which legal form has been converted to private legal entities after the fall of the Berlin wall. But mostly, related to the number of farms, farms in OPR are, for the majority, small-medium-scaled individual family farms.

Table 13: Farming structure in OPR in 2002

Size class	Number	%
1-50 ha	332	59.2
50-200 ha	92	16.4
200-500 ha	65	11.5
500-1,000 ha	33	5.9
1,000-2,500 ha	28	5.0
> 2,500 ha	11	2.0
Total	*561*	*100.0*

Source: Landesbetrieb für Datenverarbeitung und Statistik, Land Brandenburg, 2003.

In OPR, field crop and grazing livestock farming are the dominant technical orientations: most of the UAA is occupied by these two types of farming (Table 14). The average farm size for these two types is slightly above the regional average.

Table 14: Technical orientations of farms in Ostprignitz-Ruppin in 2002

Farm type	Share among all farms (%)	Percentage in total UAA (ha)	Average farm size (ha)
Field crop farms	40.5	61,715	271.9
Grazing livestock farms	41.7	58,092	248.3
Dairy farms	11.6	1,294	19.9
Mixed farms	3.9	4,465	203.0
Others	2.3	596	67.7

Source: Landesbetrieb für Datenverarbeitung und Statistik, Land Brandenburg, 2003.

As regards potential yields in OPR compared to the rest of Germany, we can take the example of winter barley in 2001, which was the most cultivated crop in OPR at that time (24,250 ha[51]). Average yields reached 51.7 dt/ha in OPR compared to 61.5 dt/ha, average value for the whole country[52]. Figure 12 below shows the evolution of yields over 4 years for cereals in general (without maize and corn-cob mix) in OPR and Germany: yields in OPR are generally inferior to the average in Germany. This is due to the dominance of medium-low quality lands in OPR as shown in Table 12.

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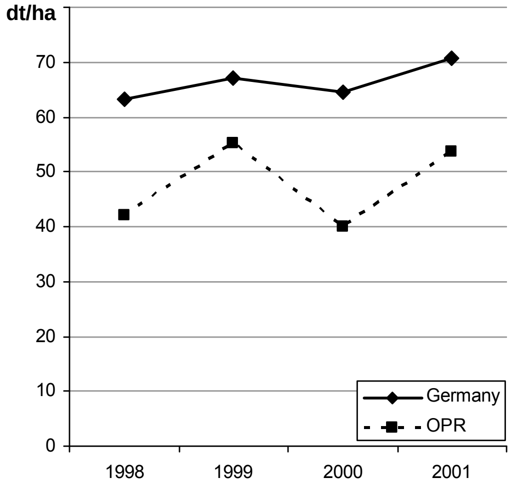
51 ANTRAG AUF AGRARFÖRDERUNG (2001), Brandenburg.

52 BMVEL (2001).

Figure 12: Development of yields for cereals in OPR compared to Germany



Source: BMVEL (2001): Statistisches Jahrbuch über Ernährung, Landwirtschaft und Forsten 2001: Deutschland (02/309); Antrag auf Agrarförderung 2001, Brandenburg.

Ruminants and other animal activities like fattening pigs or breeding sows in OPR are presented in the Table 15 below.

Table 15: Animal production in OPR in 2002

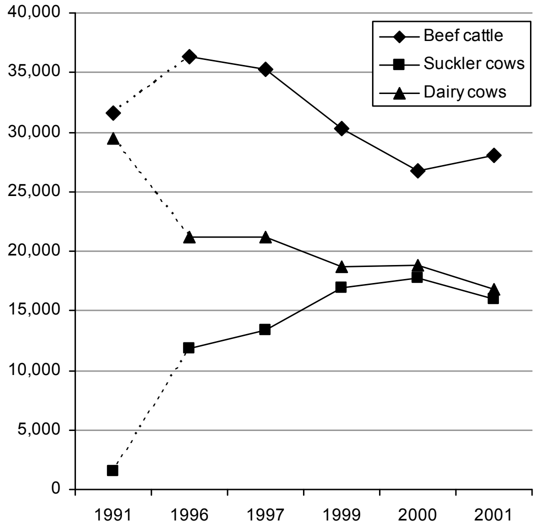
	Number of heads
Beef cattle 1-2 years old	27,991
Dairy cows	15,989
Suckler cows	15,969
Breeding sows of more than 50kg	4,729
Pigs for fattening of more than 20kg	9,903

Source: Landesbetrieb für Datenverarbeitung und Statistik, Land Brandenburg 2003.

The three herbivores productions have known quite different trajectories since the fall of the Berlin Wall (Figure 13). Particularly suckler cow production has increased from the 1991 production level until 2001. In the opposite beef cattle and dairy productions have undergone a decline since 1996. In the case of dairy production, even though the absolute number of dairy cows has been decreasing, the total production of milk has remained constant because of constant increases in milk yields per dairy cow (6,728 kg of milk per cow in 1999; 7,905 kg in 2002[53]).

[53] Wirtschafts- und Landwirtschaftsbericht für Ostprignitz-Ruppin (2002).

Figure 13: Development of animal production in OPR between 1991 and 2001



Source: Wirtschafts- und Landwirtschaftsbericht, Landkreis Ostprignitz-Ruppin (2002).

Economical and environmental issues

Although population is constantly decreasing in OPR, this decrease is relatively inferior to other districts near Berlin: "only" 8 % less people lived in OPR in 2004 than in 1990[54]. However, forecast studies plan the lost of 12,000 people in 2020, in other words a decrease in population of 12 % in comparison to 2002. One important brake to further development believing local experts[55] is the lack of infrastructures in the district: there are only 34 km of roads for 100 km^2 (43 km for whole Brandenburg) despite the crossing of the district by the highway A42 (Berlin-Hamburg/Rostock).

The second concern deals with the quality of environment which is linked to the increase of tourism in OPR, particularly in its North-Eastern parts. These zones are occupied by forests and clear waters, very appreciated by visitors. But actually, agricultural lands are for the most located in the Western and Southern parts of the districts. While ground moraines plateau parts of OPR are dominated by arable farming, the lowest parts of the lands near the river Dosse or by the Rhinluch are animal oriented zones with lots of grasslands. These zones would be particularly sensitive to any intensive or extensive trend in agricultural activities.

[54] LANDESAMT FÜR BAUEN UND VERKEHR (2006).

[55] Series of Reports of the FP6 Research Project MEA-Scope: Vol. 6 (http://project1.zalf.de/meascope/documents/MEA-ScopeD6.3.pdf).

In a region where the unemployment rate was of 19.6 % in 2002[56], the agricultural sector plays an important role: 8 % of the active population was employed in this sector in 2004, the double than the average in Brandenburg[57]. A decline in farming activities would then represent a risk for future rural viability, rural employment, and occupation of land. As regards farming structure, OPR has inherited a rather dual structure as regards farm sizes like in other ex-GDR federal states. Lots of smaller family farms cohabit with very large farms which were collectivized farms in former times. Due to their sizes and production structures, these big farms are keen to be concerned by modulation or capping policies through the reduction of their direct payments.

3.3 Adaptation of the model to the OPR region

The adaptation of the starting conditions is done in two steps.

The first step is to represent the structure of the study region based on a number of "typical" farms. By typical, we mean single farms which are closely related to empirically observed farms in the region (BALMANN et al., 1998). Typical farms for a specific region can be defined according to real farm data, official statistics or expert knowledge. A useful data source for identifying typical farms is the Farm Accountancy Data Network; FADN data for Brandenburg are actually the data used for this study.

The second step is to represent the internal organisation of typical farms, that is to say, their specialisation, main production activities, assets and capital endowments. Suitable data sources for the second step are standard farm management norms as provided, for example by KTBL and other data sources in Germany.

3.3.1 Selection of typical farms and reconstruction of the OPR region

The main idea behind the selection of typical farms is to create an input data set to initialise AgriPoliS with a virtual farming structure that provides a close approximation of the observed real farming structure in a base year. This requires representing the region's key structural indicators such as the number of farms, farm size distribution, farm specialisation and herds' structures.

To create the initial virtual farm structure based on a set of 10 to 30 typical farms, an approach developed by BALMANN et al. (1998) and further developed by KLEINGARN (2002) and SAHRBACHER (2003) is used. Because typical farms only represent a fraction of the observed farm structure and are not necessarily representative for that structure, a particular aggregation scheme is necessary. This scheme considers regional weights, or scaling factors, for each typical farm. The vector of weights is calculated by applying a least squares estimation technique. The goal is to minimise the squared deviation between the observed goal criteria

[56] WIRTSCHAFTS- UND LANDWIRTSCHAFTSBERICHT, 2002.
[57] LANDESAMT FÜR BAUEN UND VERKEHR, 2006.

from agricultural statistics and the numbers calculated from the "artificial" farm structure which is defined by the assigned weights to typical farms. These weights artificially rebuild the regional farm structure. This particular approach requires two kinds of data: first, data about the region listing aggregate regional capacities (usually number of hectares of arable land and grassland, number of animals and size of herds) and farm structure (number of farms classified in groups relative to their size and technical orientation) and second the same data but at the very individual level. Table 16 provides partial results regarding the selection of typical farms for OPR and their main physical characteristics.

Table 16: Characteristics of typical farms selected for adaptation in the model

Farm name	Weight	Total UAA (ha)	Arable land (ha)	Grass-land (ha)	Dairy cows	Suck-ler cows	Beef cattle	Pigs for fat-tening	Bree-ding sows
IF-FC1	130	15	11	4	0	6	2	12	0
IF-M2	46	19	15	4	0	2	0	0	19
IF-M3	44	24	10	14	0	17	0	0	39
IF-M4	45	49	14	25	0	25	0	0	0
IF-GL5	53	76	60	16	0	47	24	43	0
P-D6	1	102	36	56	99	0	0	0	0
IF-GL7	55	114	48	66	0	52	46	0	0
P-D8	20	207	198	9	114	0	36	0	0
IF-FC9	7	294	283	11	0	0	0	0	0
O-GL10	15	311	2	309	0	261	0	0	0
O-GL11	18	334	17	317	0	195	10	0	0
IF-FC12	9	357	235	122	0	56	10	0	0
P-M13	1	413	212	201	0	174	0	0	0
O-M14	2	606	606	0	75	0	0	0	513
P-FC15	21	757	624	133	88	0	1	0	0
O-M16	4	856	756	50	169	0	0	1,687	232
O-M17	5	953	710	243	172	0	98	0	0
O-M18	8	1,145	916	229	193	0	72	0	0
O-FC19	12	1,622	1,622	0	0	0	0	0	0
O-M20	15	2,519	1,835	684	735	0	689	0	0

Source: FADN Brandenburg, 2002. For confidentiality reasons data have been modified.

Note: In the first column, composing farm's name: IF stand for individual farm, P for partnership and O for other legal form (mostly legal entity); FC stands for field crop, GL for grazing livestock, D for dairy and M for mixed.

Then, there are 130 copies of the first farm "IF-FC1" in the artificial OPR, each operating on 11 ha of arable land and 4 ha of grassland. However, as mentioned above in section 3.1.2.2.3, these copies are randomly differentiated during the initialisation phase in AgriPoliS. Additional economic data like available family labour and net worth are used inside the model as right-hand sides in the Mixed Integer Programme (MIP) introduced below.

3.3.2 Building the Mixed Integer Program (MIP) for AgriPoliS

The MIP is at the roots of farm's behaviour in AgriPoliS. Each farm's goal is to maximise farm income by ideally combining available activities presented below considering their own constraints and capacities. All data used for production activities introduced in AgriPoliS for OPR can be found in Appendix 1.

3.3.2.1 Production activities

Typical production activities were defined for the case study region. Table 17 shows plant production activities in Ostprignitz-Ruppin. In most cases, all activities can be performed on all soil qualities like for instance most winter crops. Though, the definition of production activities with respect to factor demand differs per soil type. Cereal production dominates and in particular wheat and barley production. Ruminant fodder activities could be differentiated (e.g. lupine, lucerne grass mixture).

Table 17: Variations of gross margins for plant production activities in OPR (medium-low soil quality AZ 38=100) for each production activity

	Low quality (AZ 25)	Medium-high quality (AZ 50)
Winter wheat	75	122
Winter barley	46	110
Winter rye	63	106
Winter rapeseed	19	140
Triticale	46	113
Oat	60	108
Spring wheat	5	153
Spring barley	49	116
Sunflower*	45	200
Potato	73	112
Sugar beet	81	119
Maize silage*	118	94
Lucerne grass mixture*	108	96
Linseed	986	300
Peas**	–	149
Lupine	4	90
Set aside	100	100
Idle land	100	100

Source: Own calculations based on LANDESANSTALT FÜR LANDWIRTSCHAFT (2001).

Notes: *: Negative gross margins for all soil types.

**: Negative gross margin on low quality soil type.

Regarding livestock production activities, breeding sows, pigs for fattening, beef cattle, suckler cows and dairy cows have been considered. As regards breeding sows, piglet production is included. The activity "suckler cows" includes the cow as well as the suckling calves. Also the activity "dairy cows" includes heifers.

For each activity mentioned above, data on variable costs, revenues, and factor demand (capital, labour) were collected, for each soil type regarding plant production when available. Where production activities could not be differentiated according to soil types, factor demand, costs, and revenues relative to the most productive soil type were estimated. In general, all data is extracted from general gross margin data sources. Table 18 shows an exemplary definition of the production activity "winter wheat" in Ostprignitz-Ruppin. Revenue and labour demand vary by soil type.

Table 18: Winter wheat in Ostprignitz-Ruppin per year

Soil quality	Revenue (€/ha)	Variable costs (€/ha)	Pillar I payment before 2004 (€/ha)	Labour demand (h/ha)
Low (AZ 25)	340	340	285	4.4
Medium-low (AZ 38)	609	398	285	5.1
Medium-high (AZ 50)	798	483	285	5.9

Source: LANDESANSTALT FÜR LANDWIRTSCHAFT (2001).

3.3.2.2 Investment options

Farms in AgriPoliS have the option to invest to replace depreciated operations or to open new lines of production. Data about typical investment options is thus required. Table 19 lists typical livestock investment options in Ostprignitz-Ruppin.

Table 19: Livestock production investment options, average investment costs per place, and useful life of operations in Ostprignitz-Ruppin

Investment	Capacity (place, ha)	Average investment costs[1)]	Useful life (years)
Breeding sows	1,580; 800; 672; 336; 252;170; 128; 64; 40	2,148	20
Pigs for fattening	10,800; 5,400; 2,000; 1,000; 600; 400; 200; 100	402	20
Beef cattle	500; 200; 100; 40	2,313	25
Dairy cows	480; 240; 120; 60; 30	4,578	25
Suckler cows	100; 40; 10	1,900	25

Note: [1)] Average investment costs over all capacities. For individual operation sizes, costs per place decrease with operation size.

For each line of production, investment options of different sizes (=capacities) are considered. We assume economies of scale, reflected in lower investment costs per place and lower labour demand per unit of the activity produced with the investment.

3.3.2.3 Specific model parameters and assumptions

For the purpose of the study, a number of model assumptions needed to be decided upon. In addition to defining production activities, investment options, and the set of "global" model parameters the assumptions relate to key components of the modelling framework such as interest rates and labour costs.[58] The parameters directly influence farmers' decision making by defining institutional and/or spatial framework conditions and are documented in detail in Appendix 2.

3.3.2.4 Innovations introduced in the model for the study

To introduce the "inequality of opportunity" as meant by CHAMPERNOWNE and COWELL (1998), the five soil types mentioned above found in OPR have been introduced in the model. These soil types have been distributed randomly by the programme to each farm in the model at the beginning of the simulation, in total leading to the overall distributional picture as illustrated in Table 20 below. Discrepancies are relatively low between real GIS data and soil type distributions as initialised in AgriPoliS. The last column of the table provides information on the proportion of rented land at the regional level.

Table 20: Soil distributions calculated in AgriPoliS compared to real data

	GIS data for OPR		Distributed in AgriPoliS		
	UAA (ha)	% of UAA	UAA (ha)	% of UAA	Of which rented in 2001
Arable land	***88,506***	***73.2***	***93,743***	***72.7***	***90.8%***
Low (AZ 25)	3,073	2.5	5,235	4.1	56%
Medium-low (AZ 38)	83,773	69.3	79,964	62.0	96%
Medium-high (AZ 50)	1,660	1.4	8,544	6.6	65%
Grassland	***32,451***	***26.8***	***35,036***	***27.2***	***88.1%***
Extensive	9,472	7.8	11,606	9.0	82%
Intensive	22,979	19.0	23,430	18.2	91%
Total UAA	**120,957**	**100.0**	**128,977**	**100.0**	**90.1%**

Source: GIS information for OPR, 2005.

[58] Details about the implications of certain assumptions can be found in AgriPoliS documentations (e.g. HAPPE et al. 2006, KELLERMANN et al. 2008).

Another innovation has been introduced for the purpose of this study, namely the possibility to use grassland extensively in the framework of the agri-environmental measure (AEM) "extensive grassland" in place in OPR (see Section 4.1.1.2). Shortly, farms choosing to participate in this measure have to use all their grassland extensively to be eligible to an agri-environmental payment (AEP) of 130 Euros per hectare of converted grassland; if they do not fulfil all conditions required by the measure they will not receive the payment. Table 21 reports the features of the programmed AEM in the farm model. The switch is represented by the column "AEP_or not" which conditions the participation of the farm to the AEM. This activity is defined as an integer and can only take two values, 0 or 1. If the switch "AEP_or not" takes the value 0, the activity "AEM_Total_Area" is freed; the farmer chose to use all of his grassland extensively (activities "AEM_on_Grassland_INT" and "AEM_on_Grassland_EXT") and the grassland is therefore eligible for the corresponding AEP of 130 Euros per hectare. If the switcher takes the value 1, then the farm chose to manage his grassland conventionally (activities "Grassland_INT activity" and "Grassland_INT activity"); he may use some of his grassland in the framework of the AEM, but he will not get the AEP for it.

Table 21: Introduction of the AEM "Extensive grassland" in the MIP for OPR

	Grassland_EXT activity	Grassland_INT activity	PREMIUM_AEM	AEM_on_Grassland_EXT	AEM_on_Grassland_INT	AEM_Total_Area	AEP_or not	
Obj. function	GM	GM	1	GM	GM	0	0	<=*RHS*
Grassland_EXT	1			1				X
Grassland_INT		1			1			Y
Max LU/ha	-2	-2		-1.4	-1.4			0
AEP_switch						0.000,001	1	1
100% GL ha in AEM	1	1					-5,000,000	0
Get AEP				-1	-1	1		0
Value AEP			1			-130		0
Activity level	discrete	discrete	discrete	discrete	discrete	discrete	integer	

Source: Own figure.

The option to participate to the AEM is always open for all simulation experiments. The only feature of this AEM which may be varied is the AEP distributed per hectare. If this should occur it will be specified at the right place in this study. More details and features of this AEM are provided below in section 4.1.1.2

4 DEVELOPMENT OF FARM STRUCTURES IN OPR AND IMPACTS OF THREE DECOUPLING POLICIES

4.1 Policy scenarios

In this section the successive policy scenarios which results will be analysed later are described. The aim is to provide the reader with detailed information about the policy changes introduced in AgriPoliS.

4.1.1 Initial policy situation: The Agenda 2000 action plan as a policy

As the model has been calibrated and initialised with OPR data for the year 2001, the corresponding policy at that time had to be introduced. The policy in place at that time was the one defined within the so-called Agenda 2000 policy. The framework established by this policy was defined for the period from 2000 to 2005 therefore relevant for the OPR case study region from 2001. As mentioned above, the will to encourage commitments to protect the environment and enhance rural viability among other issues involved by agricultural activities has been translated into the reinforcement of a specific RD policy, therefore creating two pillars, the first being devoted to market policy and the second to environmental and rural development policy.

4.1.1.1 Direct payments as first pillar of the CAP in OPR

Table 22 reports the payments distributed from the initialisation year 2001 at the beginning of the simulation. These payments are distributed each year until the introduction of the decoupling schemes in 2005.

Table 22: Payments per hectare or head distributed in the Agenda 2000 policy

Unit	Cereals	Protein plants	Grassland	Dairy cows	Beef cattle	Suckler cows
€/ha or €/head	285	328	0	35	207	218

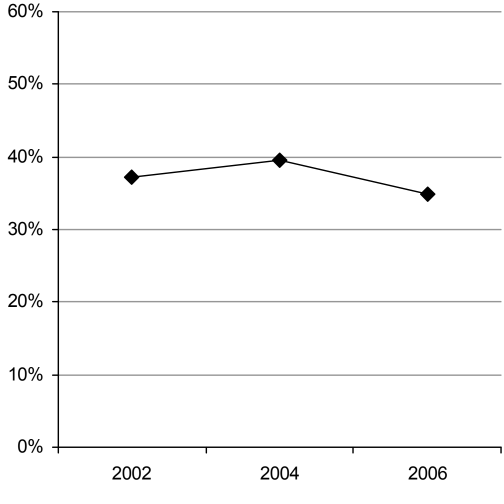
Source: LANDESANSTALT FÜR LANDWIRTSCHAFT (2001).

The choice to start the simulations in 2001 is not only due to the higher availability (generally) of older data rather than newer ones, but to the possibility for the model to internally calculate decoupled payments from 2005 individually. Actually, as farm agents get individual characteristics in the initialisation phase (soil types, managerial ability, age, vintage of machinery and stables) and as their structural development partly depend on these initial settings, each farm belonging to a set of typical farms will develop differently than its "clones". It means that attributing a decoupled payment from 2005 and onwards to each typical farm as mentioned in the FADN database for the corresponding year (if possible at all) would not only be an approximation but an error as well; it would either over- or underestimate the "right" payment each farm agent should receive considering its own past development in the model.

4.1.1.2 Agri-environmental measures (AEM) in the second pillar of the CAP for OPR

Already introduced optionally from 1992, agri-environmental measures (AEM) have been continued in the framework of the Agenda 2000 policy. Therefore we introduced in the model a similar AEM to the real "Extensive grassland" measure implemented in OPR. This measure implies that the farmer signs an agreement in which he commits to respect his obligations five years long (see below). As shown in Figure 14 this AEM is relatively successful as it covered more than one third of the area of grasslands in OPR, with a small decrease between 2004 and 2006.

Figure 14: Percentage of total grassland in OPR used extensively in the framework of the AEM "Extensive grassland"



Source: INVEKOS BRANDENBURG.

In the RD plan 2000-2006 for the Federal State of Brandenburg (MLUV, 2005), this AEM (measure A1 "Extensive Grünlandnutzung") provided a payment of 130 Euros per hectare of grassland converted into extensive grassland if:

- the livestock density was comprised between 0.3 and 1.4 LU/ha,
- no chemicals and synthetic fertiliser was used,
- the grassland was mowed once a year,
- the farm used at least 30 % of its UAA as grassland.

Therefore, this measure mostly targeted farms managing a quite high percentage of grassland, i.e. mostly grazing livestock farms. The 30 % constraint has been deleted from 2003 onwards and replaced by the obligation for the farm to convert all its grassland into extensive grassland to be eligible, without any minimal percentage of grassland to be managed at the signature of the agreement. The measure A1 was explicitly relevant for grazing livestock farms as it provided an income compensation for continuing grazing livestock production whereas simply mulching the grassland would have been an economically viable solution as well (MLUV, 2007, Appendix 17.3). The current RD plan 2007-2013 keeps this measure as it was in the former programme, except that the payment is reduced to 120 Euros per hectare from 2007[59].

To keep things simple and easily computable, the AEM has been introduced in the model with the following properties:

- payment are delivered only if all grassland is used as specified in the "Extensive grassland" AEM rules, therefore there is no payment if some grassland of the farm is used conventionally,
- costs, revenues and energy deliveries for animals have been set at the same level as hay extensively used: no pesticides, no herbicides, low requirements of labour and machinery and therefore lower deliveries of fodder per hectare for ruminants
- maximum livestock density of 1.4 LU/ha
- the participation of farmers is optional, each farm decides each year whether it wants to use all its grassland as extensive grassland or not, therefore the 5-years length of contract is not modelled.
- 130 Euros per hectare until the introduction of the policy change in 2005.

The level of the payment remains constant throughout the entire AGENDA 2000 policy simulation, to the contrary of the other decoupling scenarios; comments will be provided in the section 4.1.4 below.

An important aspect of the AEM could not be captured in the model though. As mentioned above farmers commit in the AEM for five years. This feature could not be modelled in AgriPoliS, as farms in the model only have a one-year sight. This means that some discrepancies between real results and simulation results are unavoidable.

4.1.2 Decoupling scenarios from 2005: "Pure" and hybrid dynamic decoupling schemes

The main features of decoupling policies have been introduced in the model from 2005. First, the actual hybrid dynamic decoupling scheme as implemented in Germany will be described followed by the description of the Single Area Payment

[59] See MLUV (2007), Appendix 17.3, p. 6 for more explanation.

(SAP) policy also named regional payment policy. The main features characterising the Single Farm Payment (SFP) policy (or historic payment) will be introduced afterwards.

4.1.2.1 Reform scenario: The German hybrid dynamic decoupling scheme

As explained above, Germany chose a dynamic hybrid decoupling scheme from 2005, combining a regional payment and a farm specific payment which is progressively removed between 2010 and 2013.

This policy has been introduced in its main features as illustrated in Table 23. Unlike in the reality, the average payment to be distributed to farms after the reform in 2005 in the model has not been calculated based on payments received between 2000 and 2002 (the model has been calibrated based on data from 2001), but on payments received between 2002 and 2004.

Table 23: Payments distributed in the hybrid dynamic decoupling scenario in AgriPoliS

			Unit	2001-2004	2005-2009	2010	2011	2012	2013 +
Regional component	PLANT PRODUCTIONS	Cereals, set aside 1)2)3)	€/ha	285	274	271	266	257	246
		Arable fodder crops, potatoes, sugar beets	€/ha	0	274	271	266	257	246
		Grassland	€/ha	0	34	55	98	161	246
	ANIMAL PRODUCTIONS	Dairy cows	€/head	35	0	0	0	0	0
		Suckler cows	€/head	218	0	0	0	0	0
		Fattening bulls	€/head	207	0	0	0	0	0
Farm specific component			€/farm	None	Farm specific payment (yearly)	Progressive reduction of the farm specific payment at the level of: 10 %	30 %	60 %	100 %

Source: Payments for 2004: LANDESBETRIEB FÜR DATENVERARBEITUNG UND STATISTIK (2003); payments after 2005 are calculated based on AgriPoliS results between the years 2002 and 2004.

Notes: 1) Same payment level for all soil types; 2) no compulsory set-aside (minimum 10 % of UAA) from 2009 (EU COMMISSION, 2008b); 3) additional premium of 55.57 €/ha for protein plants (BMELV, 2006).

The values of direct payments are however worth receiving some comments. Between 2005 and 2009, their calculated value per hectare of arable land is identical to the value observed in reality (274 Euros per hectare, see Table 8 in section 2.3.3.1). However, in the case of grassland, they differ from the real premiums actually distributed in Brandenburg (70 Euros per hectare). This is due to free grassland in the region with the introduction of decoupling in 2005; actually, simulations have been performed considering OPR as an isolated region and payment calculations ignore the other districts constituting the Federal State of Brandenburg as it is the case in reality. The area payment to be distributed from 2013 in the model being the quotient of all payments distributed in OPR in 2001 (animal plus crop payments) over the total UAA in OPR, it has been calculated integrating all potentially usable lands in the modelled region, therefore including free grassland. This payment, instead of increasing for arable land from 274 to 292 Euros per hectare like in Brandenburg, decreases to 246 Euros per hectare from 2013; this is however a sharp increase in the case of grassland though (34 to 246 Euros per hectare). Financial discipline is therefore respected at the OPR level in the model throughout the whole simulation[60].

4.1.2.2 SAP scenario: Introduction of a regional area payment

In the regional model as proposed to EU Member States as decoupling design, reference amounts are not calculated at the individual level but at the regional level. Regional reference amounts are calculated by dividing the sum of payments received by all the farmers in the region concerned during the reference period by the number of eligible hectares declared by the farmers of the region in the year of SPS introduction; the value of a single entitlement is thus the same one across the whole region. Finally, each farmer receives a number of (flat rate) entitlements equal to the number of eligible hectares declared in the year of SPS introduction. Therefore this approach entails some redistribution of payments between farmers. It is to note that none of old Member States has fully implemented this model.

In AgriPoliS the implementation from 2005 of the regional payment per hectare strictly respects the real proposal made to EU Member States at the time of decoupling, with two major differences though; 1) entitlements stay linked to the land and are not tradable, 2) the model calculates the regional payment considering all available agricultural land, therefore including land not used by farms before decoupling (mostly grassland). Assuming a sudden attractiveness of grasslands left idle before decoupling right after the introduction of the regional payment, this payment has been calibrated from 2005. It helped to prevent a brutal increase

[60] Simulations have been performed based on payments of 74 Euros per hectare of grassland and 274 Euros per hectare of arable land from 2005, increasing to 290 Euros per hectare between 2009 and 2013. Results showed an increase of 4.9% in budget expenses from the year of the reform introduction in 2005. In 2013 the level of expenses reached 21.3% of their 2005 level due to the progressive transfer of farm specific payments towards the regional payment over the total UAA available in the region.

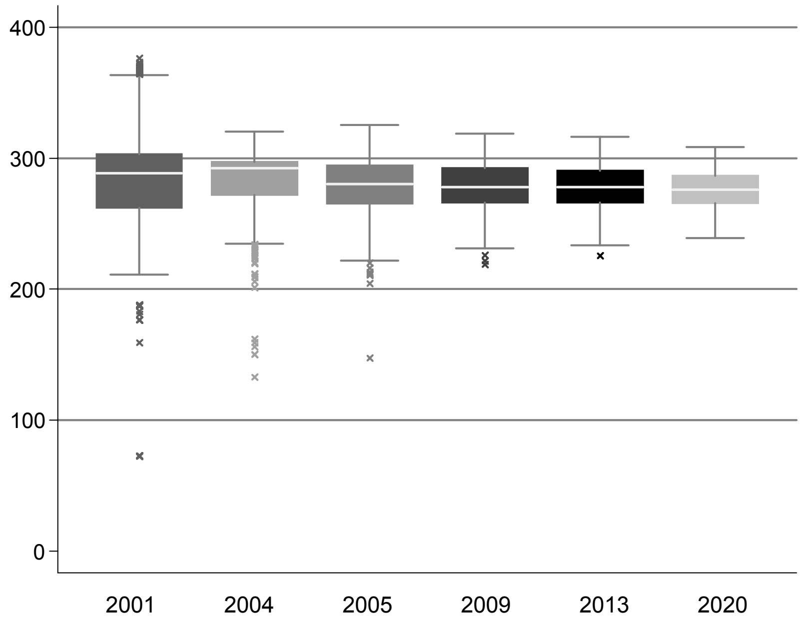
in public expenses from 2005 and keep the same volume of payments distributed over the region before and after decoupling. The regional payment was therefore set in the model at a lower level after decoupling than the average Pillar I payments received by farms between 2002 and 2004 (290 Euros per ha). The regional payment reaches 246 Euros per hectare from 2005.

4.1.2.3 SFP scenario: Introduction of a farm specific payment

In the historical model each farmer is granted with entitlements corresponding to the payments he received and the number of hectares he was farming during the reference period and which gave right to direct payments in this reference period. Like in the former case, in AgriPoliS, payment entitlements are not tradable and remain linked to the land.

As payments are further distributed after 2005 considering past levels of payments for each farm, payment entitlements diverge from one piece of land to the other considering to which farm it is "linked" to after the introduction of the reform in 2005 as shown in Figure 15.

Figure 15: Distribution of payments per hectare received by farms in OPR in all scenarios until 2004 and then in the SFP scenario from 2005 (in Euros/ha)



Source: Own figure.

In 2005, right after the introduction of the single farm payment, direct payments vary from 147 to 325 Euros per hectare (in average 279 Euros per hectare). After 2005 the gap between extreme values of direct payments per hectare tends to get reduced in the SFP scenario; this is due to the progressive abandonment of land parcels which will not find any interested farmer to rent it.

4.1.3 Basic and progressive modulation

The other important feature mimicked by the model is the modulation implemented from 2005. Both basic and progressive modulations have been modelled in the Reform scenario as illustrated in Table 24. The possibility to cut Pillar I payments considering farm size has been introduced in AgriPoliS as described in KELLERMANN et al. (2009).

Table 24: Modulation percentages applied in the default Reform scenario following Health Check's final outcomes (EU Commission, 2008b)

Payment (€)	Until 2004	2005	2006	2007-08	2009	2010	2011	2012 and onwards
1 to 5,000	0%	0%	0%	0%	0%	0%	0%	0%
5,000 to 99,999	0%	3%	4%	5%	7%	8%	9%	10%
100,000 to 199,999	0%	3%	4%	5%	7%	8%	9%	10%
200,000 to 299,999	0%	3%	4%	5%	7%	8%	9%	10%
Above 300,000	0%	3%	4%	5%	11%	12%	13%	14%

Source: Own figure, adapted from EU COMMISSION (2008a).

Other modulation percentages shown in Table 25 have been tested as well on top of the basic settings implemented in the hybrid dynamic decoupling scenario Reform (see Table 23) or in the other tested scenarios presented in this study.

For the scenarios AGENDA, SAP, SFP and Ref0Mod, no modulation has been introduced at any time as the focus was rather put on the comparison of different decoupling modalities.

Table 25: Overview of modulation percentages implemented in scenarios of this study

Name of scenarios	Payment (€)	Until 2004	2005	2006	2007-08	2009	2010	2011-12-13	2014 and onwards
AGENDA, Ref0Mod SAP SFP	1 to 5,000	0%	0%	0%	0%	0%	0%	0%	0%
	5,000 to 99,999	0%	0%	0%	0%	0%	0%	0%	0%
	100,000 to 199,999	0%	0%	0%	0%	0%	0%	0%	0%
	200,000 to 299,999	0%	0%	0%	0%	0%	0%	0%	0%
	Above 300,000	0%	0%	0%	0%	0%	0%	0%	0%
Reform	1 to 5,000	0%	0%	0%	0%	0%	0%	0%	0%
	5,000 to 99,999	0%	3%	4%	5%	7%	8%	9 -– 10 - 10%	10%
	100,000 to 199,999	0%	3%	4%	5%	7%	8%	9 – 10 - 10%	10%
	200,000 to 299,999	0%	3%	4%	5%	7%	8%	9 – 10 - 10%	10%
	Above 300,000	0%	3%	4%	5%	11%	12%	13 – 14 - 14%	14%
RefIDMod	1 to 5,000	0%	0%	0%	0%	0%	0%	0%	0%
	5,000 to 99,999	0%	3%	4%	5%	7.5%	8.4%	9.4 - 10.4 - 10.3%	10.3%
	100,000 to 199,999	0%	3%	4%	5%	7.5%	8.4%	9.4 - 10.4 - 10.3%	10.3%
	200,000 to 299,999	0%	3%	4%	5%	7.5%	8.4%	9.4 - 10.4 - 10.3%	10.3%
	Above 300,000	0%	3%	4%	5%	7.5%	8.4%	9.4 - 10.4 - 10.3%	10.3%
Ref0Mod_2013 Capping_2013 Mod_2013	1 to 5,000	0%	0%	0%	0%	0%	0%	0%	0%
	5,000 to 99,999	0%	3%	4%	5%	7%	8%	9 – 10 - 10%	0%
	100,000 to 199,999	0%	3%	4%	5%	7%	8%	9 – 10 - 10%	0%
	200,000 to 299,999	0%	3%	4%	5%	7%	8%	9 – 10 - 10%	0%
	Above 300,000	0%	3%	4%	5%	11%	12%	13 – 14 - 14%	0%

Source: Own figure.

In the scenario RefIDMod, the hypothesis of an equal modulation degree for all farms receiving more than 5,000 Euros of direct payments has been tested. The levels of modulation calculated for the years between 2009 and 2013 have been obtained by using the results of the Reform scenario for each of these years: each year the total amount of direct payments cut through modulation has been summed up over the whole farm population and divided by the total not modulated amount of direct payments which could have been potentially distributed without modulation. The ratio obtained has then been retained as average modulation percentage over all farms receiving more than 5,000 Euros and implemented in the RefIDMod scenario as shown in Table 25.

The last three scenarios, Ref0Mod_2013, Capping_2013 and Mod_2013 do not contain any modulation after 2013. Therefore, this removal implied to recalibrate the payment per hectare paid for arable land and grassland after 2013. As shown in Table 23 above, the regional direct payment reached 246 Euros per hectare in the Reform scenario. From 2014, in the three last scenarios mentioned in Table 25, this regional payment will only reach 220 Euros per hectare to take the removal of modulation into account in the sense that financial discipline is respected.

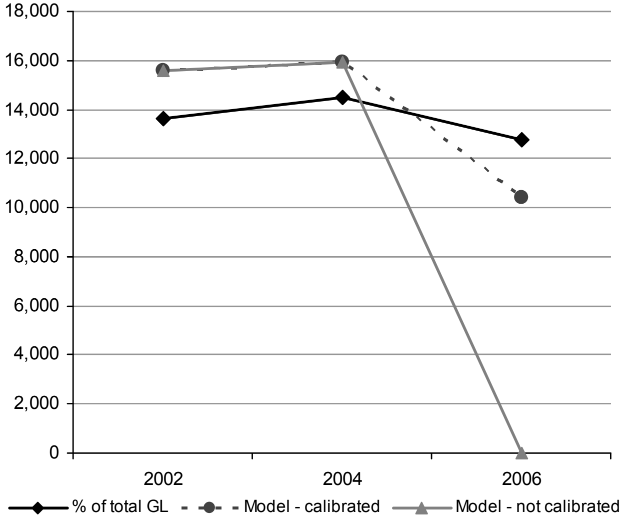
4.1.4 Calibration of the AEM "extensive grassland" in all decoupling scenarios

The introduction of decoupled payments in 2005 induced a quite strong shock especially on the relative attractiveness of grasslands for a classical use as fodder for ruminants. The possibility to keep land in GAEC introduced in the model with the reform provoked a strong decrease in the use of grasslands as such; they would not be uses for production and therefore only kept in GAEC. As the decision to participate to the AEM "extensive grassland" is closely linked in the model to the attractiveness and the continuation of herbivores production for the farmer, the rate of participation after the introduction of the decoupling reform (in whatever form) strongly decreased and the total area used under the AEM was almost 0 hectare at the regional level right after the reform.

Therefore, in order to provide a realistic picture of the region as regards the use of grasslands in the framework of the AEM "extensive grassland" we chose to increase the AEP so that it reaches 230 Euros per hectare after 2005 instead of 130 Euros per hectare until 2004.

Figure 16 shows the development of grassland used extensively in OPR between 2004 and 2006 in the framework of the AEM "Extensive grassland" 1) in reality (line "Real"), 2) without any increase of the AEP from 2005 and onwards (line "Model – not calibrated") and 3) with a 100 Euros increase of the AEP from 2005 (line "Model – calibrated").

Figure 16: Area of grassland in OPR used as extensive grassland in the framework of the AEM A1 "Extensive grassland"



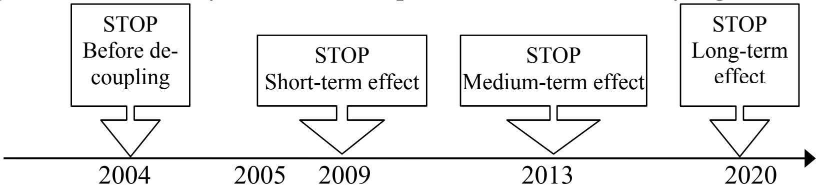
Source: InVeKos Brandenburg; own figure.

As illustrated above model results better correspond to the real development of areas under the AEM between 2002 and 2006 when the AEP is increased from 2005 as when it is not. Therefore the change in the AEP level from 2005 is kept and maintained as such throughout the simulations made in this study except if explicitly mentioned.

4.1.5 Summary: Overview of the policy scenarios implemented

Figure 17 summarises the main features of each scenario tested in this study. For more clarity, some parts of this figure will be recalled at the appropriate place to allow a better understanding of analyses.

Figure 17: Summary of simulation experiments in the case study region OPR



AGENDA	Agenda 2000 policy: > Full first pillar payments for crops and animals from 2002 to 2004 > AEP for extensive grassland > Set-aside: minimum 10%, maximum 33% > No cross-compliance	POLICY SWITCH: DECOUPLING OF PILLAR I PAYMENTS	Continuation of Agenda 2000 policy
SAP			Single area payment: > Regional payment, homogeneous over the whole area > Subject to continuation of farming > Calibrated AEP for extensive grassland > No min and max constraint for set-aside from 2009 onwards > No modulation introduced at any time > Payments subject to cross compliance: used land in 2004 has to be maintained at least in GAEC
SFP			Farm specific decoupled payment: > Farm specific payment calculated on a historical basis > Subject to continuation of farming > Calibrated AEP for extensive grassland > No min and max constraint for set-aside from 2009 onwards > No modulation introduced at any time > Payments subject to cross compliance: used land in 2004 has to be maintained at least in GAEC
Reform			Hybrid dynamic decoupling scheme: > Progressive switch to a unique regional area payment in 2013, kept constant onwards > Farm specific payment, decreasing from 2010 until 2013 > Subject to continuation of farming > Calibrated AEP for extensive grassland > No min and max constraint for set-aside from 2009 onwards > Modulation from 2005, progressive from 2009 until 2013; 2013 values kept onwards > Payments subject to cross compliance: used land in 2004 has to be maintained at least in GAEC
Ref0Mod			Same as Reform except: > No modulation introduced at any time
RefIDMod			Same as Reform except: > Same level of modulation between 2009 and 2013 for farms receiving more than 5,000€; 2013 modulation rates kept onwards
Ref0Mod_2013			Same as Reform but: > Modulation abolished for all farms from 2014 > Direct payments calibrated in 2014 (decrease of 10.6% per hectare) to consider removal of modulation > Direct payments constant from 2014
Capping_2013			Same as Ref0Mod_2013 but: > Direct payments per hectare decreasing from 2015 until 2020 (20 Euros/ha less per year)
Mod_2013			Same as Capping_2013 but: > AEP per hectare increasing from 2015 until 2020 (10 Euros/ha more per year)

Source: Own figure.

4.2 Analysis framework

4.2.1 Presentation and comparison of results

In a first part of the results section scenarios will be compared through the light their impacts on a multifunctional agriculture and to do this, they will be classified for each indicator, as regards the value they reach on a range from "low" to "high", from the lowest value to the highest one for the corresponding indicator. This is a relative scale and aims at helping the reader getting a fast overview on results of simulations. For instance, comparisons signs are used between scenarios and give the possibility to compare to which extent two values are different one from the other. The equal sign can as well be used if two values are same or if the difference is negligible. Figure 18 delivers an overview on the strategy chosen to present the large range of results obtained thanks simulations. For instance, if one considers indicator 2, its value is the highest one under scenario 2, and the lowest under scenario 3. However, the values reached under scenarios 1 and 4 are equal or very similar: an equal sign is then drawn between these scenarios. On the opposite, the indicator’s values present a very big difference between scenarios 2 and 3 for indicator 1, and this leads to draw a double bigger than sign. As the difference is not big but significant between scenarios 3 and 4, a simple bigger than sign is drawn. This synthetic way to illustrates results will help to draw stories from the positions of the scenarios investigated. Additionally, more graphs will be punctually provided to support and better understand results.

Figure 18: An illustrative way to compare scenarios

Indicators		High						Low
Indicator 1	[unit]	Scenario 1	>>	Scenario 2	>>	Scenario 3	>	Scenario 4
Indicator 2	[unit]	Scenario 2	>	Scenario 1	=	Scenario 4	>	Scenario 3
Indicator 3	[unit]	Scenario 4	>>	Scenario 3	>>	Scenario 2	>	Scenario 1
Indicator 4	[unit]	Scenario 3	>	Scenario 1	>	Scenario 4	>	Scenario 2
etc.								

Legend: ">": higher value than; ">>" much higher value than; "=": equal values.

Source: Own figure.

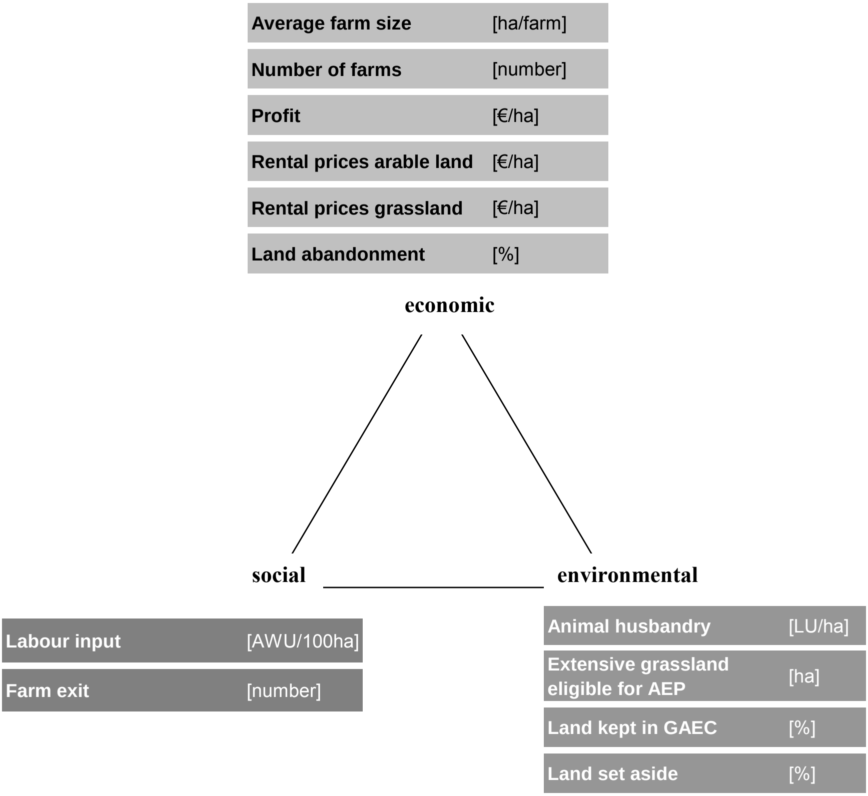
Following the classical differentiation into economic, ecological, and social functions, the indicators have been assigned to these three categories:

- **economic indicators**: indicators referring to agricultural structures, profits from agricultural activities, farm sizes or technical orientations and land rents,
- **environmental indicators**: they refer for instance to land abandonment and conversion of land into extensive production activities,

- **social indicators**: any structural development in the sense of abandonment of farming, or the development of part-time farming for instance, have consequences on rural viability.

Figure 19 illustrates which category a chosen set of indicators delivered by AgriPoliS belong to.

Figure 19: Classification of indicators relatively to the multifunctionality concept



Legend: GAEC: Land kept in Good Agricultural and Environmental conditions.
AEP: Agri-Environmental Payments.

Source: Own figure.

The exact meaning of each indicator in the model is provided in Appendix 3.

4.2.2 Variables of economic performance calculated in AgriPoliS

Regarding economic indicators, several income intermediates are made available at the individual level by the model. Table 26 details the content of the most important income intermediates used later in the study.

Table 26: Calculation of income intermediates in AgriPoliS

Indicator (end of period t)	Calculation
Profit (farm income) (t) =	Gross margin + Interest on working capital + Subsidies – Rent paid – Current upkeep of machinery and equipment – Depreciation – Farming overheads – Transport costs – Interest paid – Wages paid
Household income (t) =	Profit + Off-farm income
Farm net value added (t) =	Profit + Rent paid + Interest paid + Wages paid
Equity capital (t) =	Equity capital (t-1) + (Household income – Withdrawal)

Source: HAPPE (2004).

Profit represents what the farm actually gets from agricultural activities once labour, capital and land are remunerated in the form of wages, interests and rents respectively. If those three factors are not substracted, the intermediate obtained is the farm net value added. Adding off-farm income to profit is relevant for farms owning all or some of the labour employed on-farm; if not all family labour is used on the farm, it is assumed that family members can get additional income from off-farm activities. Therefore household income considers both incomes from agricultural and non agricultural activities. Once withdrawals necessary for family supply from household income are removed, the remaining is added to (or substracted from) farm's equity capital which can somehow be considered as an indicator of farm's wealth. All these variables are available at the farm level for all years of the tested simulations.

4.3 General impacts of policy changes at the regional level

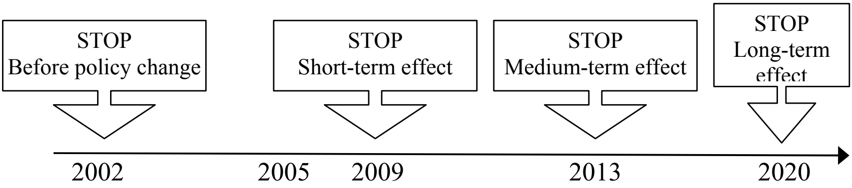
4.3.1 Introduction

The objective of this section is twofold. The first goal is to grasp the main impacts of policy changes in OPR as regards the development of indicators reflecting agricultural multifunctionality. Second, the observation and analysis of these impacts will constitute ways of investigating the behaviour and responses of the model as consequences of policy changes introduced. These outcomes will be compared to those expected and described in section 2.3.2. Three decoupling scenarios are compared: the actual hybrid dynamic decoupling scheme[61] (Ref0Mod), a historic payment (SFP) and a regional payment (SAP). They are compared at three points in time, namely few years after the introduction of decoupling in 2005 (year 2009), then in a mid-term perspective (2013) and finally in an hypothetical long-term perspective 15 years after the introduction of the reform (2020).

Figure 20 summarises the main features of the scenarios tested in this specific section.

[61] The actual decoupling scenario implemented here does not consider modulation, as the objective is to investigate distributive issues related to different decoupling schemes. Introducing modulation in the three scenarios would have complicated outcomes' interpretation.

Figure 20: Summary of experiments testing the implementation of different SPS in OPR



AGENDA	Agenda 2000 policy : > Full first pillar payments for crops and animals from 2002 to 2004 > AEP for extensive grassland > Set-aside: minimum 10%, maximum 33% > No cross-compliance	POLICY SWITCH	Continuation of Agenda 2000 policy
Ref0Mod			Hybrid dynamic decoupling scheme: > **Progressive switch to a unique regional area payment** > **Farm specific payment, decreasing from 2010 until 2013** > Subject to continuation of farming > Calibrated AEP for extensive grassland > No min and max constraint for set-aside from 2009 onwards > No modulation introduced at any time > Payments subject to cross compliance: used land in 2004 has to be maintained at least in GAEC
SFP			Farm specific decoupled payment: > **Farm specific payment calculated on a historical basis** > Subject to continuation of farming > Calibrated AEP for extensive grassland > No min and max constraint for set-aside from 2009 onwards > No modulation introduced at any time > Payments subject to cross compliance: used land in 2004 has to be maintained at least in GAEC
SAP			Single area payment: > **Regional payment, homogeneous over the whole area** > Subject to continuation of farming > Calibrated AEP for extensive grassland > No min and max constraint for set-aside from 2009 onwards > No modulation introduced at any time > Payments subject to cross compliance: used land in 2004 has to be maintained at least in GAEC

Source: Own figure.

The main issue investigated in this very first section is the general impact of different decoupling scenarios from 2005 on regional indicators with the following questions in mind: what are the main differentiated impacts of a regional payment, a historic payment or a mix of both on regional structures in OPR? Are modelling results consistent with former expectations already formulated by scientists or policy makers? Which additional features are observable with the current modeling method?

4.3.2 Impacts on economic indicators

4.3.2.1 Regional farm structure

As regards the development in the number of farms, one preliminary remark has to be made; right after the introduction of the reform in 2005 the decrease in the number of farms is the highest in the SAP scenario compared to the other scenarios

(6 % less surviving farms). However, as shown in Figure 21 below, the decreasing trend is afterwards less accentuated in the SAP scenario than in the other scenarios; from 2009 there are the least number of farms in the AGENDA scenario, followed by the SFP and the Ref0Mod scenario (respectively 7 %, 4 % and 3 % less farms in 2020 than in the SAP scenario).

Figure 21: First set of economic indicators for scenarios in 2009, 2013 and 2020

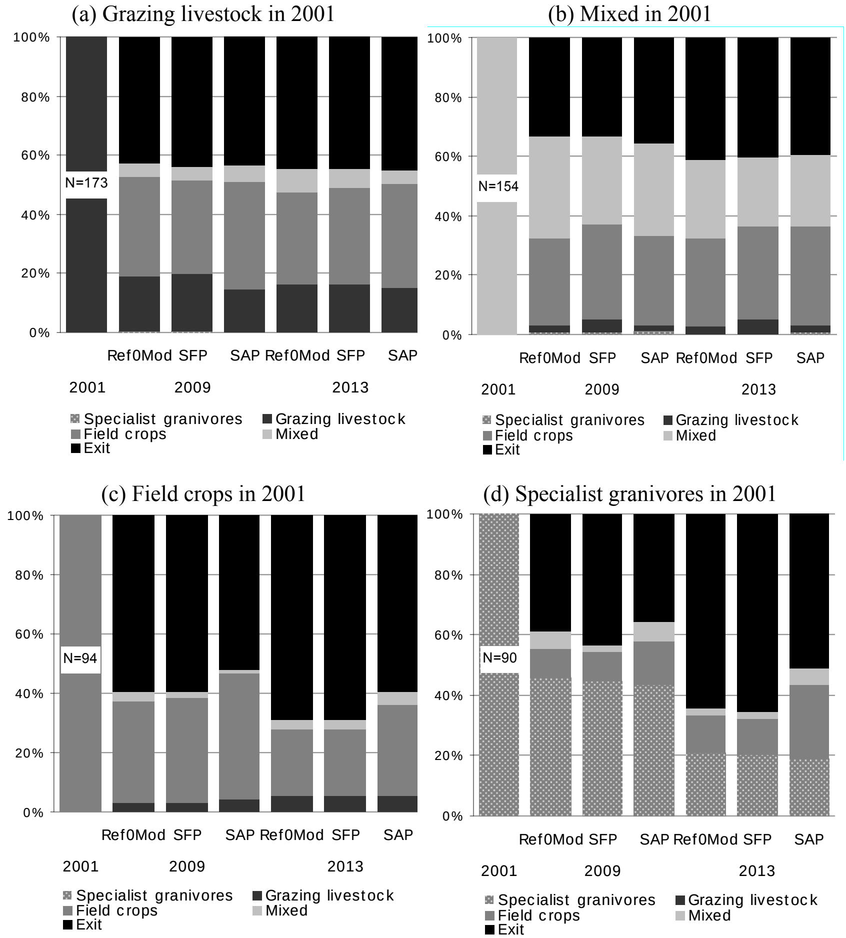
2009	**Average farm size**	[ha/farm]	SAP	>	SFP	=	Agenda	=	Ref0Mod
	Number of farms	[number]	SAP	>	Ref0Mod	>	SFP	=	Agenda
	Profit	[€/ha]	Agenda	>	SFP	=	Ref0Mod	>>	SAP
2013	**Average farm size**	[ha/farm]	Ref0Mod	>	SAP	>	SFP	=	Agenda
	Number of farms	[number]	SAP	>	Ref0Mod	=	SFP	>	Agenda
	Profit	[€/ha]	SFP	>	Agenda	>>	Ref0Mod	>	SAP
2020	**Average farm size**	[ha/farm]	Ref0Mod	>	SAP	>	Agenda	>	SFP
	Number of farms	[number]	SAP	>	Ref0Mod	>	SFP	>	Agenda
	Profit	[€/ha]	SFP	>	Agenda	>>	Ref0Mod	>	SAP

Source: Own figure.

The average farm size is the highest in the SAP scenario, but only until 2012; actually, after the complete transfer of farm specific payments to the regional payment in the Ref0Mod scenario, farm size is thereafter the highest among the four scenarios until the end of the simulation. In this case it results from an increased use of formerly abandoned grasslands and a slightly higher decrease in the number of farms between 2011 and 2012 compared to past years in this scenario.

Figure 22 goes beyond the former statement by providing a clear illustration of the development of farm structures as regards their technical orientation in OPR in all scenarios in 2009 and 2013. For all scenarios, the exit rate in 2009 and 2013 is the highest among farms classified as field crop farms in 2001 (see Figure 22 (c)). The huge majority of those remaining farms continue field crop farming though, while some of them convert to grazing livestock and mixed farming. Mixed farms are the ones which "resist" the best among farm types; almost the half of the remaining farms stays in mixed farming while most of the rest converts to field crops farming.

Figure 22: Development of the number of farms as regards their technical orientation in each scenario in 2009 and 2013



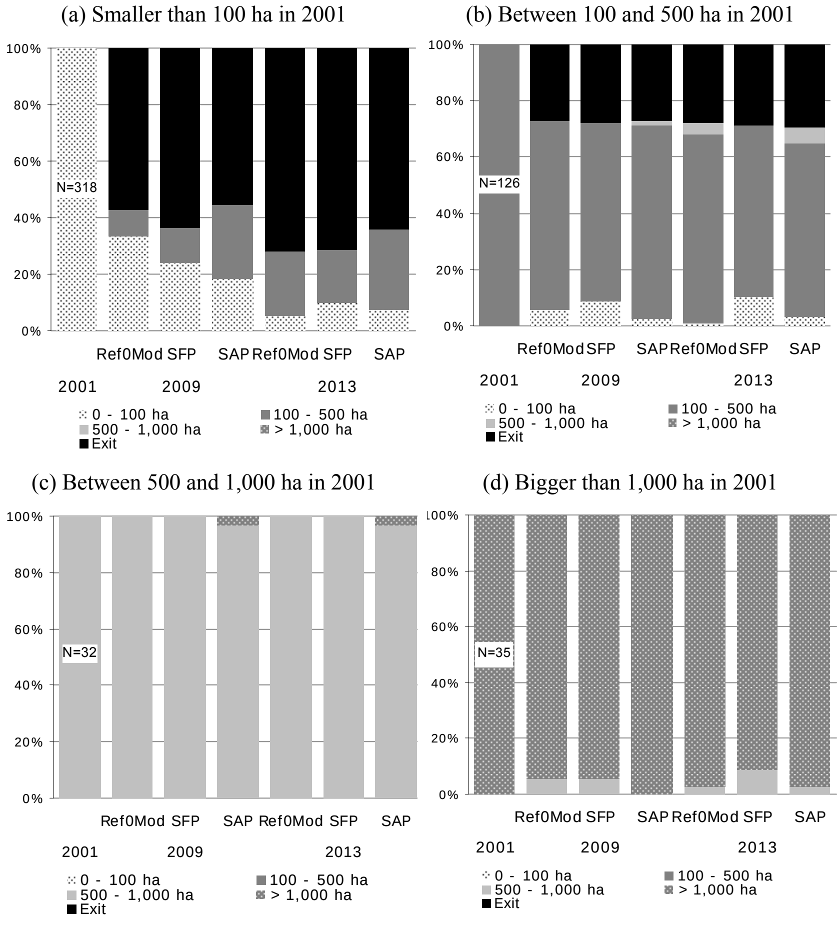
Source: Own figure.

Notes: In AgriPoliS farms are classified in one farm types category (among grazing livestock, specialist granivores or field crops) if farm standard gross margin of the most important production line exceeds two thirds of the total production; otherwise the farm is classified as "mixed".

The development of farms' technical orientations looks relatively similar between the two scenarios SFP and Ref0Mod as regards the rate of farm exit and the proportion of farms orientated towards different production systems. However, the SAP scenario sees the slowest structural change in terms of number of farms closing as already mentioned above. Especially farms orientated towards field crop and specialist granivores farming perform better when a regional payment is implemented than when a farm specific payment or a mixture of farm payment/regional payment are implemented.

Figure 23 below shows the evolution of farm structures as regards their size in the three decoupling scenarios. It shows that the huge majority of farms closing in all scenarios are farms smaller than 100 hectares, as shown in Figure 23 (a).

Figure 23: Development of farms considering their size in each scenario in 2009 and 2013



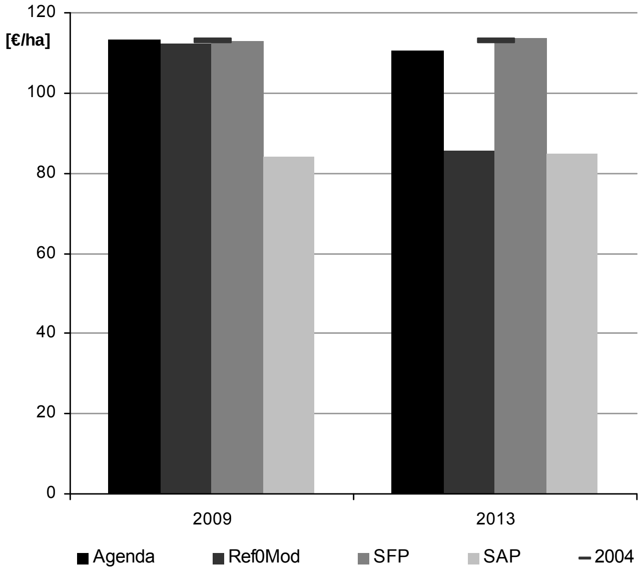
Source: Own figure.

However, the best chances are offered to those farms in the SAP scenario to continue farming and to grow to a large extent, about 80 % of surviving farms smaller than 100 ha in 2001 reaching a bigger size (until 500 ha) in 2013 in this scenario. In the case of SFP and Ref0Mod, the closing rate for farms smaller than 100 ha is of about 73 % in 2013 for both scenarios, while in the SAP scenario this rate "only" reaches 63 %. The worst chances of growth for those farms are found in the SFP scenario. The closing rate of 27-30 % for middle-sized farms (between 100 and 500 ha) is comparable in 2009 and 2013 between the three scenarios, with maybe a higher rate in the SAP scenario in 2013 than in the other scenarios. Again, the implementation of a regional payment like in the SAP scenario offers the best opportunities for those farms to grow throughout the simulation; to the contrary, the SFP scenario sees some of those farms downsize until 2013 and join the category of farms smaller than 100 ha. This phenomenon of downsizing farms in the case of a farm specific payment has already been observed in HAPPE et al. (2006). None of the large (between 500 and 1,000 ha) and very large farms (bigger than 1,000 ha) in 2001 close down during the simulation; as regards size changes some comments can be made. Large farms stay in the same size category in both scenarios Ref0Mod and SFP during the whole simulation. However again in the SAP scenario some of them find the opportunity to expand. In the very large farms category (more than 1,000 ha) some farms downsize in the three scenarios, more in the SFP and Ref0Mod scenarios than in the SAP scenario.

4.3.2.2 Profit and income

The sharp decline in the number of farms right after the introduction of the regional payment in the SAP scenario is directly linked to the sharp decrease in direct payments per hectare from 2004 to 2005 in this scenario; while in average 290 Euros of direct payments are distributed per used hectare in 2004, the average direct payment falls to 246 Euros per hectare from 2005 in the SAP scenario causing a gap in farm profit calculation at the regional level (Figure 24). As already mentioned in Section 4.1.2.2 above, the lower payment in the SAP scenario from 2005 is calculated considering free grassland; therefore the average payment including free grassland is lower than an average payment only considering land actually used before decoupling. This decrease in Pillar I payment occurs in the Ref0Mod scenario as well from 2010, the regional payment calibrated at the same level than in the SAP scenario (decreasing to 246 Euros per hectare between 2010 and 2013 parallel to the decrease of the farm specific component) being lower than the one distributed between 2005 and 2009 (274 Euros per hectare of arable land plus farm specific payment, see Table 23). However, despite the persistence of regional lower profits compared to the other scenarios, the SAP scenario conserves the highest number of farms throughout the simulation.

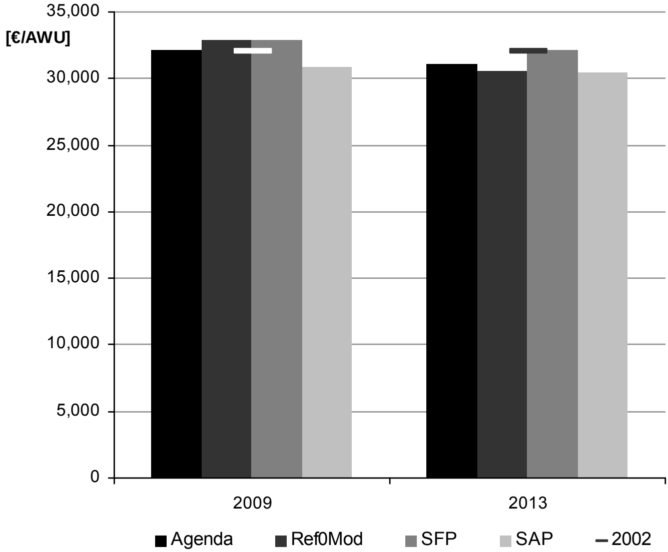
Figure 24: Profit per hectare in each scenario in 2009 and 2013 (black line: 2004)



Source: Own figure.

As regards farm incomes, as mentioned in the section 2.3.2, EU Commission's DG AGRI expected a limited impact of the introduction of the SPS scheme, causing a slight decrease in incomes in comparison to the continuation of AGENDA 2000 policy in 2009 (-0.1 %) but incomes would still be higher than in 2001 (8.5 % in real term and per work unit). The results of our simulations confirm the increase of incomes per AWU in 2009 in the Ref0Mod and SFP scenarios compared to 2001, however not in the SAP scenario where a decrease is observed due, as explained above, to the brutal decrease in average of direct payments per hectare from 2005 (Figure 25). Incomes decrease in average as well in 2013 in the Ref0Mod scenario to almost reach the level of average incomes in the SAP scenario; this is due to the progressive switch to a pure regional payment from 2013 set at a lower average level per hectare than in 2010.

Figure 25: Average income per AWU in each scenario in 2009 and 2013 (black line: 2002)



Source: Own figure.

The DG AGRI analysis includes projections on prices. Actually, a decrease in incomes right after the implementation of the reform would be implied by decreases in cereal, meat and milk prices. This trend should however be reversed later with the rise in cereal and meat prices. As simulations performed here do not consider any changes in prices it is difficult to confront present results to DG AGRI's ex-ante analysis. However, the next sections may reveal some global impacts of the three tested decoupling scenarios on OPR's regional structure.

4.3.2.3 Rental prices and land use

One important property of AgriPoliS is its capacity to model rental markets internally and to provide rental prices as endogenous variables. Therefore, these are the result of an internal auction occurring between farms as competitors for free plots of land in the OPR region. The following analyses are interesting for regions like OPR, where renting land is a much more widespread tenure form than owning it. Figure 26 summarizes impacts of policy scenarios on rental prices for arable land and grassland as well as on the proportion of land abandoned throughout the region as indicator for the relative attractiveness of land-based agricultural activities. It shows that regarding rental prices for arable land and land abandonment the AGENDA scenario registers the highest scores compared to the three decouplings scenarios, of which the SFP almost always reaches the second best scores for these indicators. The lowest rental prices for arable land as well as the lowest land abandonment rates are found in the SAP scenario, joined for this latter indicator by the scenario Ref0Mod in 2013 and 2020.

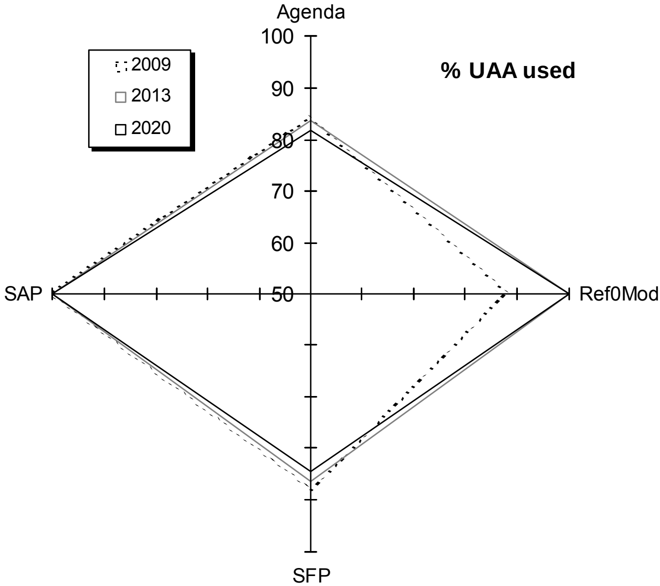
Figure 26: Second set of indicators for tested scenarios in 2009, 2013 and 2020

2009	**Rental prices arable land**	[€/ha]	Agenda	>	Ref0Mod	>	SFP	>	SAP
	Rental prices grassland	[€/ha]	SAP	>	SFP	>	Ref0Mod	>	Agenda
	Land abandonment	[%]	Agenda	>	SFP	=	Ref0Mod	>>	SAP
2013	**Rental prices arable land**	[€/ha]	Agenda	>	Ref0Mod	>	SFP	>	SAP
	Rental prices grassland	[€/ha]	SFP	>	SAP	>>	Agenda	>	Ref0Mod
	Land abandonment	[%]	Agenda	>	SFP	>>	SAP	=	Ref0Mod
2020	**Rental prices arable land**	[€/ha]	Agenda	>	SFP	>	Ref0Mod	>	SAP
	Rental prices grassland	[€/ha]	SFP	>>	SAP	>	Agenda	>>	Ref0Mod
	Land abandonment	[%]	Agenda	>	SFP	>>	SAP	=	Ref0Mod

Source: Own figure.

As regards land abandonment, Figure 27 shows that results obtained in the SAP scenario differentiate themselves from those in the two other decoupling policies. All available land is fully used already from 2005, while in the two scenarios Ref0Mod and SFP land is used at a level of 88 % in 2009. After that land is being further abandoned in the SFP scenario to reach only 84 % of land used in 2020 while it is fully used again in the Ref0Mod scenario from 2013. In the reference scenario AGENDA, land abandonment increases progressively and equals 18 % of the UAA in 2020.

Figure 27: Proportion of land used in all scenarios in 2009, 2013 and 2020



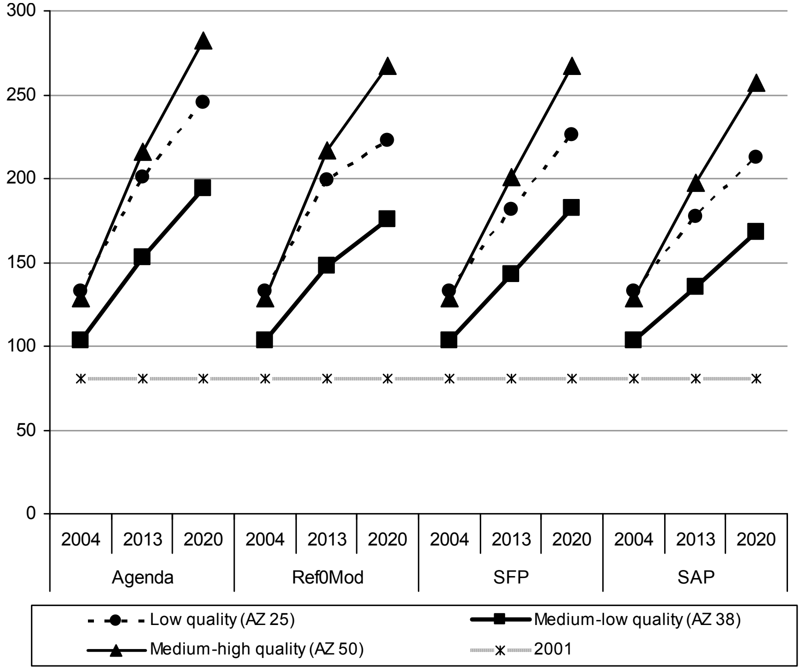
Source: Own figure.

Not all types of lands are equally abandoned in those scenarios SFP and AGENDA, as well as in Ref0Mod in 2009. This mainly concerns grasslands whereas arable land, whatever its quality, is fully used in all scenarios during the whole simulation.

Comparing the development of rental prices for arable land throughout the simulation in the four scenarios (Figure 28), one can see that in all scenarios, rental prices for arable land tend to increase consequently. From their initial level in 2001 (81 Euros/ha62) they reach between 104 and 133 Euros per hectare in 2004 before the introduction of decoupling, to increase then in relatively similar proportions in all scenarios.

[62] A unique rental price has been introduced in the model for all arable land whatever its quality.

Figure 28: Change in rental prices for arable land in OPR (in Euros/ha)



Source: Own figure.

Increases are the strongest in the reference scenario AGENDA, where rental prices are multiplied by almost three and a half between 2001 and 2020. As direct payments remain linked to acreage or animals heads, as long as those activities linked to the use of arable land are worth rental prices will increase in this scenario. The increasing trend in the decoupling scenarios is comparable to the one observed in the AGENDA scenario63. Increase patterns for all soil qualities look quite similar in the SAP and the SFP scenarios (with a les accentuated increase in the SAP scenario), whereas those increases in rental prices are similar in the Ref0Mod

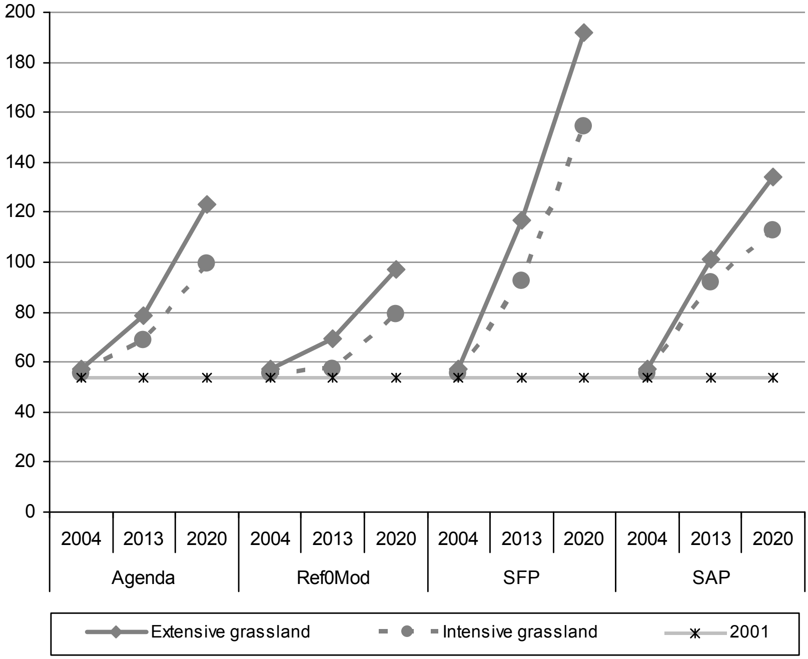
[63] In AGENDA, at the regional level, farms set their low quality land aside as far as they can (maximum 33% of total COP area), set aside the required 10% of medium-low quality land and try to use the maximum of the best medium-high quality soils for productive agricultural productions. Therefore the conjunction of set aside requirements and the presence of neutrally distributed direct payments lead to the most important increase in rental prices for arable land among the four scenarios. This is fully in line with FRASER (2009), who says that in case of "set-aside premiums established with reference to average levels of production income foregone, heterogeneous land quality means that it is farmers' best interests to set aside the lowest quality land in terms of production income, which results in policy 'slippage' in terms of output control".

scenario and in the AGENDA scenario between 2004 and 2013. Rental price increases are less pronounced in the two other decoupling scenarios SAP and SFP. However, as regards land use, instead of setting land aside, which is not compulsory anymore from 2009 in the three decoupling scenarios, farms massively keep land in GAEC, especially low quality arable land. For this soil quality almost all arable land is kept in GAEC in 2009[64] which coincides as well with the removal of compulsory set aside. As low quality arable land is, as far as possible, not used for productive purposes, both level and increase in rental prices for those soils are resulting from direct payments distribution modalities and requirements; this constitutes an illustration of capitalization of direct payments in rental prices as mentioned in SWINNEN et al. (2008).

Whereas arable land is fully used and not abandoned during the whole simulation in all four scenarios, it is not the case for grassland. Figure 29 show that for grassland the four scenarios show quite different increasing rental prices patterns for intensive and extensive grassland. This is due to several factors combined together: the possibility to participate in the AEM extensive grassland and get an additional premium for that; the introduction of a direct payment per hectare of grassland from 2005 in the three decoupling scenarios; the relative (un)attractiveness of ruminant productions and; the differential variable costs and labour requirements between the two grassland qualities.

64 This is, again, in line with FRASER (2009), who uses a static analysis to conclude that in case of local land heterogeneity, "a uniform payment means that the provision of environmental goods and services will be concentrated in parts of the region where the agricultural value of land is below average". This is shown by the results of the simulations where mostly low quality arable land is kept in GAEC.

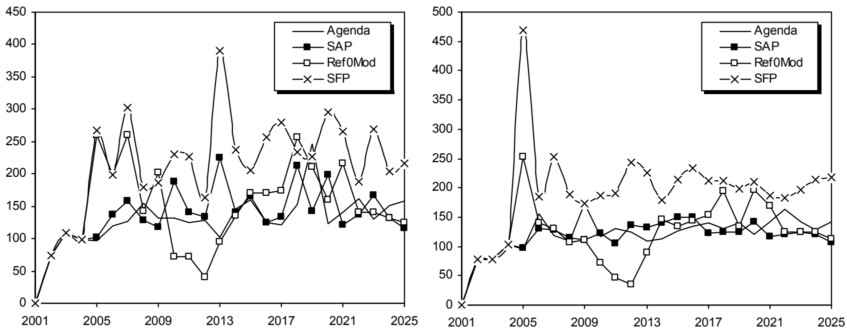
Figure 29: Change in rental prices for grassland in OPR (in Euros/ha)



Source: Own figure.

During the whole simulation in the AGENDA scenario and until 2004 in the decoupling scenarios no direct payment is linked to the use of grassland except in the framework of the AEM extensive grassland and through ruminant production. Therefore, the use of grassland depends on the attractiveness of ruminant activities and on the presence and attractiveness of public support linked to its use. In the AGENDA scenario the attractiveness of suckler cows and beef cattle productions combined to farms' participation in the AEM extensive grassland mostly drive increases in rental prices for grassland. In the SFP scenario, high increases in rental prices are due to high payment entitlements distributed to grasslands with decoupling in 2005; farms rather try to rent those fields eligible for high direct payments which are located near the farmstead, increasing local demand for specific plots and therefore exerting a pressure on rental prices. Between 2004 and 2013, rental prices for grassland do not increase very much in the Ref0Mod scenario compared to the two other scenarios. All other things being equal, this is due to the relatively low direct payment per hectare introduced from 2005 in the Ref0Mod scenario (34 Euros per hectare) compared to SFP and SAP (in average 272 Euros per hectare and 246 Euros per hectare respectively). The light increase between 2013 and 2020 in Ref0Mod results from the progressive transfer of farm specific payment to the regional payment for all land in the region. However, even though the payment per hectare of grassland reaches 246 Euros per hectare in this scenario from 2013, increases in rental prices are not that accentuated than in the SAP scenario until 2020. This means that transfer efficiency of direct payments per hectare is improved in the Ref0Mod scenario compared to the two other decoupling scenarios as regards rental prices for grassland. Actually, the transfer of payments at the benefit of landowners is limited and land managers see less public support get capitalised into rental prices. In the opposite direct payments are at the most capitalised in rental prices in the SFP scenario; rental prices are three to four times higher in 2020 than in 2004 for intensive and extensive grassland respectively. This is at the opposite of what VELAZQUEZ (2008) expected by confronting regional and historic model (similar to SAP and SFP respectively), predicting a lower transfer efficiency in the regional model than in the historical one. Actually, in AgriPoliS, there is a higher pressure carried out by farms for getting plots of grassland freed by neighbouring closing or downsizing farms. Bids on "new" freed grassland are set higher than end rental prices in general (calculated as arithmetic mean throughout the region after all farm bids are done) and are at their highest levels in the SFP scenario as shown in Figure 30.

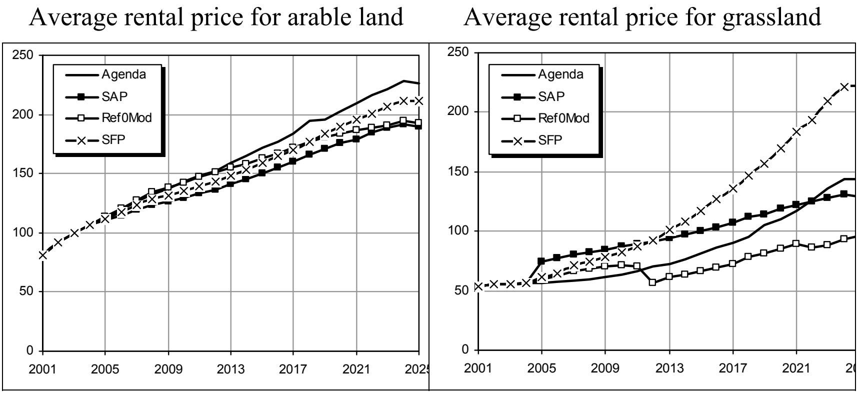
Figure 30: Average bids for free plots of extensive (left) and intensive (right) grassland (in Euros per hectare)



Source: Own figure.

To conclude, Figure 31 illustrates the average development of rental prices for both arable land and grassland. Confronting what those simulations deliver to what ISERMEYER (2003) expected (see section 2.4.1.1), there is actually a stabilisation of rental prices observed in the long term. But gaps deepened during the simulation do not get reduced between the regional and the historic models, respectively SAP and SFP. At the most, one can observe a rapprochement between rental prices for arable land in Ref0Mod and SAP in the long term. However, looking at the strong increase in rental prices for grassland between 2004 and 2005 in the SAP scenario suggests that there should be at least an over compensation on some pieces of land as expected by ISERMEYER (2003).

Figure 31: Development of rental prices for arable land (left) and grassland (right) in average over the four scenarios (in Euros per hectare)



Source Own figure.

Moreover, there is no decrease in rental prices observed in the historical model as represented in the SFP scenario after 2005; on the contrary, increases in rental prices show a progressive trend for grassland. A decreasing trend in rental prices for grassland is observed in the Ref0Mod scenario between 2011 and 2012; this coincides with the complete transfer of farm specific payment to the regional payment and the loss of attractiveness of the AEM extensive grassland compared to the "simple" keeping of land in GAEC. Land use changes regarding grassland activities will be commented in the next section more in detail.

Going beyond classical studies based on average rental prices for arable land and grassland, AgriPoliS allows a differential analysis of the development of rental prices based on soil qualities observed in the present case study area as well as based on the establishment of new rental contracts. This enables to refine analyses as regards the specific regional distribution of soil qualities and allows a deeper understanding of differential developments of prices on rental markets in the model. Rational farm renting activities as implemented in the model confirm expectations formulated by ISERMEYER (2003) and FRASER (2009), namely that 1) the implementation of a regional payment actually seems to provoke at least overcompensation visible at the regional level as regards grassland and 2) extensive uses of land tend to concern lower quality lands.

4.3.3 Impacts on environmental indicators

4.3.3.1 Cattle husbandry

As shown in Figure 32, the keeping of cattle, therefore the productive use of grassland to feed those animals is at its highest level in the AGENDA scenario. The attractiveness of ruminant production, linked to the direct payment distributed per head of beef cattle or suckler cow in this scenario, increases the attractiveness of the AEM extensive grassland on used grassland.

Figure 32: Environmental indicators for tested scenarios in 2009, 2013 and 2020

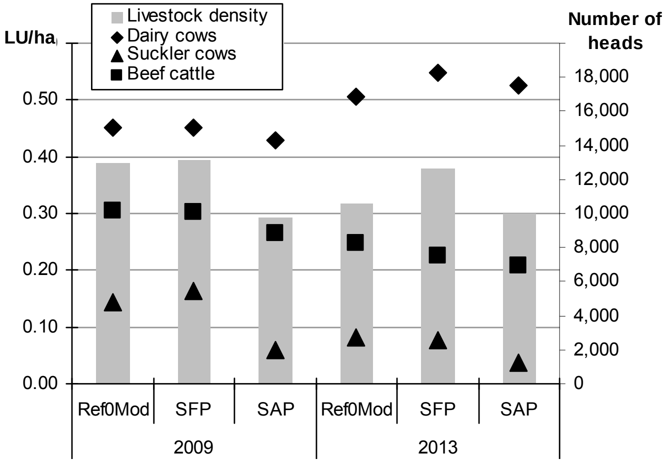
2009	Animal husbandry	[LU/ha]	Agenda	>>	Ref0Mod	=	SFP	>>	SAP
	Extensive grassland eligible for AEP	[ha]	Agenda	>>	SFP	>	Ref0Mod	>	SAP
	Land kept in GAEC	[%]	SAP	>>	Ref0Mod	>	SFP		
	Land set aside	[%]	Agenda						
2013	Animal husbandry	[LU/ha]	Agenda	>>	SFP	>	Ref0Mod	>	SAP
	Extensive grassland eligible for AEP	[ha]	Agenda	>>	Ref0Mod	>	SFP	>	SAP
	Land kept in GAEC	[%]	Ref0Mod	>	SAP	>>	SFP		
	Land set aside	[%]	Agenda						
2020	Animal husbandry	[LU/ha]	Agenda	>>	SFP	>	Ref0Mod	>	SAP
	Extensive grassland eligible for AEP	[ha]	Agenda	>>	SFP	>	Ref0Mod	>	SAP
	Land kept in GAEC	[%]	Ref0Mod	>	SAP	>>	SFP		
	Land set aside	[%]	Agenda						

Source: Own figure.

The DG-AGRI analyses mentioned in section 2.3.2 expected an extensification of production systems with the introduction of the SPS. Although these analyses include expectations on prices and trade, which is not the case in our simulations, Figure 33 illustrates the decrease in the average livestock density per hectare at the regional level in the three decoupling scenarios in 2009 and 2013 (0.5 LU/ha in 2004). The number of suckler cows is the lowest in the SAP scenario in both years compared to SFP and Ref0Mod; in the three scenarios suckler cows and beef cattle productions decrease over time. However, dairy production increases from 10,000 heads in 2001 to 14,000-15,000 heads in the three scenarios in 2009. It finally reaches between 16,000 and 18,000 heads in 2013 in the three scenarios.

Pigs and sow productions have been modelled as well. Although those productions are relatively independent from policy changes because formerly not directly supported in the framework of the AGENDA 200 policy, their development after decoupling strongly depends on their compared attractiveness with other animal production as well as on maximal livestock density constraints set at the farm level in the model.

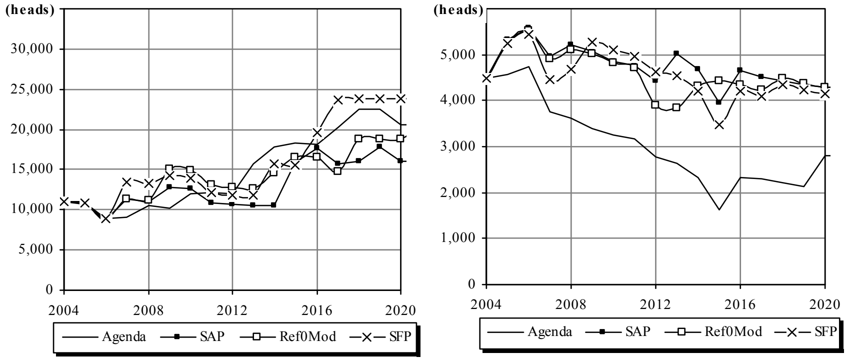
Figure 33: Development of ruminant production in the decoupling scenarios in 2009 and 2013



Source: Own figure.

As shown in Figure 34, pigs and sow productions have not evolved exactly similarly after 2004 in the three decoupling scenarios. However, the trend is a general increase in pig production from 2004 to 2020 which is observed in the reference scenario AGENDA as well. In the case of sow production the number of heads decreases in all scenarios, more sharply in the AGENDA scenario than in the decoupling scenarios though. To the contrary of pig production, there is a sharp decrease in investments in stable places for sows right after the introduction of decoupling in 2005 in the three corresponding scenarios SFP, SAP and Ref0Mod as well as in AGENDA. The number of head decreases more or less heavenly afterwards in those scenarios to reach slightly less sows at the regional level in 2020 compared to 2004 whereas only two thirds remain in the AGENDA scenario.

Figure 34: Development of pig (left) and sow (right) productions between 2004 and 2020



Source: Own figure.

Animal production is closely linked to the use of land in the model. Whereas land is used for fodder production and spreading manure by grazing livestock farms, it is only used for spreading manure by granivore farms. Therefore those farms have to own or rent enough land to spread manure produced by pig and sow productions. Arising environmental problems linked to intensive farming activities pushed policy makers in the recent years to favour schemes and measures favouring extensive land uses. The next section focuses on some of them as introduced in the model.

4.3.3.2 Extensive land uses

Whereas the possibility to participate in the AEM extensive grassland is open in the four scenarios AGENDA, SAP, SFP and Ref0Mod, this is not the case for the setting aside of arable land[65] and the keeping of land in GAEC (see Figure 32). Actually, the activity "set aside" is removed from the model from 2009 in the three decoupling scenarios but remains in the model during the whole simulation in the AGENDA scenario. Similarly, as the keeping of land in GAEC has been introduced with the implementation of decoupling policies, this activity can not be chosen by farmers in the AGENDA scenario but only in the three decoupling scenarios SAP, SFP and Ref0Mod from 2005.

However, the comparison of decoupling scenarios together on the one hand and to the scenario AGENDA on the other hand as regards farmers' choice can reveal the relative attractiveness of the AEM extensive grassland compared to keeping land in GAEC in the case of grassland after the decoupling reform; in the case of

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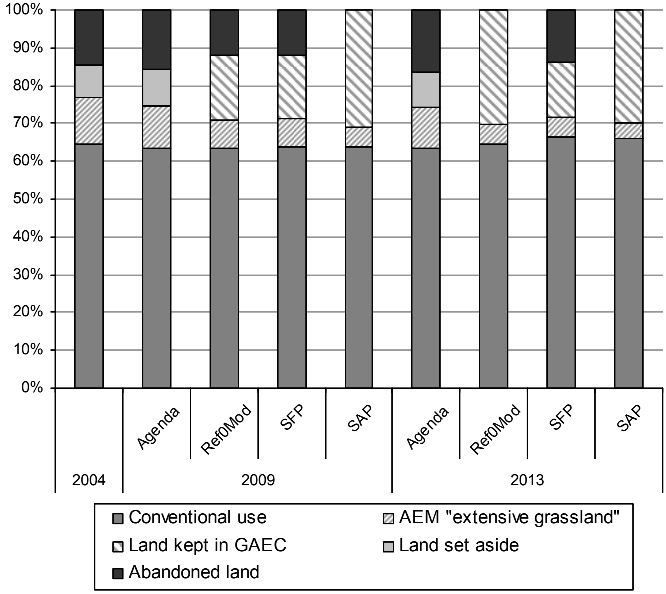
[65] Set aside is not properly an extensive way to use land but rather a policy measure aiming at controlling agricultural outputs. However, it is considered here as extensive land in the sense that it is not used ifor the conventional production of agricultural commodities.

arable land, the possibility to keep land in GAEC after decoupling follows set aside as non productive use of land.

Figure 35: Land use in OPR in each scenario in 2004, 2009 and 2013 (% of total UAA)



Source: Own figure.

As shown in Figure 35, before the reform in 2004, 20 % of the UAA used extensively in OPR was either grassland used as extensive grassland in the framework of the AEM (12 %) or arable land set aside (8 %). Whereas set aside constraints were modelled such that 10 % of farm's total area in COP should compulsory be set aside (but not more than 33 %), the participation in the AEM remains completely optional. In the AGENDA scenario, the totality of grassland used during the simulation is managed extensively by farmers in the framework of the AEM "extensive grassland", therefore leading to the distribution of AEP for each hectare of grassland used as such. It means that none of the grassland in OPR in this scenario is used "classically", i.e. not in the framework of the AEM or intensively; all farmers who manage grassland find it interesting to participate in the AEM. In the three decoupling scenarios, the participation of farmers in the AEM shows a clear decrease after the introduction of the reform in 2005. Not all farmers managing grassland will participate in the AEM, but rather keep parts of their grassland in GAEC. In 2009 Ref0Mod and SFP show very similar extensive land use distributions: in both scenarios 16 % of initial land -actually grassland- is still abandoned, about the half of used grassland is kept in GAEC, between 30 and 40 % is used in the AEM and the rest is used to produce hay (grassland not eligible for AEP). As regards arable land, in 2009 in the three decoupling scenarios, almost all low quality arable lands are only kept in GAEC as well as nearly 10 % of medium-low quality arable land. From 2013, land use patterns observed in Ref0Mod tend to join those observed in the SAP scenario, however never reaching exactly the same results. Grassland put in production again in Ref0Mod with the increase of grassland area payment (full rate from 2013) is kept in GAEC and the proportion of grassland used in the AEM decreases throughout the simulation. Until the end of the simulation there is a bit less grassland kept in GAEC and a bit more grassland in the AEM in the Ref0Mod than in the SAP scenario.

This is due to differential opportunities offered to and taken by farmers between the two scenarios until 2013. Therefore structural developments which occurred due to these different opportunities lead each year to different contexts offered to farmers which took different decisions in the past and which relative competitive position compared to other farmers will condition potential future decisions.

4.3.4 Impacts on social indicators

4.3.4.1 Labour

Although farm exit rate is the highest, or at least among the highest, in the AGENDA scenario as shown in Figure 36, this is at the same time the scenario where labour input in agriculture, from family or hired workers, is the highest among the four scenarios. This is linked to cattle husbandry in the AGENDA scenario where the number of suckler cows and beef cattle only decreases very progressively compared to the three decoupling scenarios.

Figure 36: Social indicators for tested scenarios in 2009, 2013 and 2020

2009	Labour input	[AWU/100ha]	Agenda	>>	Ref0Mod	>	SFP	>>	SAP
	Farm exit	[number]	Agenda	=	SFP	>	Ref0Mod	>	SAP
2013	Labour input	[AWU/100ha]	Agenda	>>	SFP	>>	SAP	>	Ref0Mod
	Farm exit	[number]	Agenda	>	SFP	=	Ref0Mod	>	SAP
2020	Labour input	[AWU/100ha]	Agenda	>>	SFP	>>	Ref0Mod	>	SAP
	Farm exit	[number]	Agenda	>	SFP	>	Ref0Mod	>	SAP

Source: Own figure.

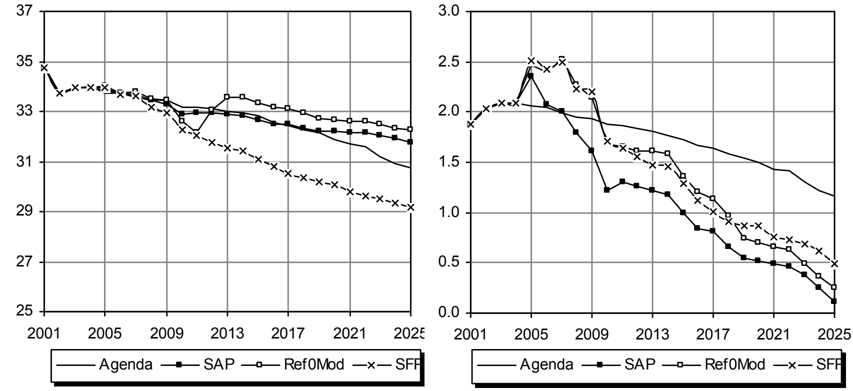
As those activities require a lot of labour per year compared to "classical" field crop activities, their maintenance therefore keeps agricultural employment at levels comparable to those observed between 2001 and 2004, i.e. comprised between 0.7 and 0.8 AWU/100 ha. Similarly, the massive conversion of grasslands in land just kept in GAEC from 2005 in the SAP scenario combined to the partial abandonment of ruminant production leads to the decrease in total labour input in agriculture observed in this scenario. From 2012, labour input observed in Ref0Mod decreases almost to the level observed in the SAP scenario (0.58 AWU/100 ha), but remains at a slightly higher level until the end of the simulation. In 2020, labour input in the SFP scenario is of 0.70 AWU/100 ha while it is of 0.77 AWU/100 ha in the AGENDA scenario; in Ref0Mod it reaches 0.63 AWU/100 ha while this value only reaches 0.59 AWU/100 ha in the SAP scenario. The difference in labour input between the scenarios Ref0Mod and SAP, although land use looks relatively similar, is due to a higher number of dairy cows (2,000 heads more than in all other scenarios) as well as of beef cattle (1,200 more than in the SAP scenario); as already mentioned before, these are labour intensive activities compared to other field crop activities.

The share of family labour in total labour used in agriculture is of 32 % in 2004. Afterwards, it declines progressively to the level of 22 % in 2020 in the reference scenario AGENDA. In the three decoupling scenarios it follows the same trend than in AGENDA from 2011; however, right after the introduction of decoupling in 2005, family labour input declines at 84 % of its level right before the reform (91 % for total labour input). This is explained by the simultaneous increase in off-farm labour observed in the three decoupling scenarios certainly due to freed family labour thanks the possibility to kept land in GAEC as well as the partial abandonment of animal production, therefore contributing to the decline in family labour used for agricultural activities.

4.3.4.2 Public expenses

An important justification for decoupling direct payments in 2005 lied in the goal for the EU to control public expenses for agriculture. It should have provided the EU budget devoted to agriculture with a ceiling set at the level of expenses reached before the decoupling reform.

Figure 37: Public expenses (in Mio Euros) in total (left) of which second pillar expenses (right). ***Please mind the Y-axes***



Source: Own figure.

Figure 37 illustrates the development of public expenses in the four scenarios in total (left) and only regarding expenses linked to the second pillar (right) constituted of AEP distributed per hectare of grassland used in the framework of the AEM extensive grassland. On the right side of the figure, it can be stated that second pillar expenses 1) never represent more than 7.4 % of public expenses as simulated here and 2) except an increase in 2005 in the three decoupling scenarios due to the calibration of the AEP (see section 4.1.4) the expenses are rather rapidly decreasing to a very low level in 2020 in those scenarios (between 500,000 and 900,000 Euros at the regional level). The bulk of public expenses are therefore, like in the reality, constituted of first pillar payments which distribution modalities throughout the simulations and regional structural change condition patterns observed on the left side of the figure.

The three decoupling scenarios noticeably differ in terms of development of total public expenses. While from 2013 the trend in expenses in SFP, SAP and Ref0Mod is decreasing, the difference between SFP expenses and those in the two other scenarios grows until the end of the simulation, as decrease in expenses in SFP is stronger than in SAP and Ref0Mod. In SFP public expenses have decreased from 34 Million Euros in 2005 to 30 Million Euros in 2020, while expenses reach 32.2 Million and 32.6 Million in 2020 in SAP and Ref0Mod respectively. However, expenses in the Ref0Mod scenario do not follow a constant decreasing trend as shown in the figure above. Between 2011 and 2013 expenses grow from 32.2 to 33.6 Million Euros; the explanation lies in the combined increases in direct payments for grassland and in the use of formerly abandoned grassland by farms which are thereafter mostly kept in GAEC.

These results regarding public expenses were provided at the regional level and delivered insights in an aggregated way. However the next chapter will intensively focus on payments at the very individual level and therefore it will be possible to see which farm groups are favoured by each scenario compared to others.

4.3.5 Conclusion

Table 27 below summarizes the main preceding findings in a synthetised way.

Table 27: Summary of general impacts of the three tested decoupling scenarios at the regional level

	Ref0Mod	SFP	SAP
Regional farm structure	Field crop farming is the production system where most farms close down after decoupling both in 2009 and 2013		
	Similar development of farming systems in both scenarios		
		– Farms' downsize – Lowest number of farms after 2005	– Best farm growth opportunities – Structural change slowed down – Highest number of farms
Profit and income	Decrease in incomes per AWU and profits per hectare to almost reach those of the SAP scenario in 2013		Lowest profits after 2005
Arable land uses	Potential activities strongly influenced by modalities of distribution of direct payments and therefore: – payments influence the development of rental prices; – have a direct impact on dairy and beef productions; – have a direct impact on extensive use of land.		
	– Large parts of low quality arable land kept in GAEC, therefore taken out of agricultural productive activities – Concentration of productive arable land activities on better soils		
Grassland uses	Use of grassland (for either productive or non productive purposes) conditioned by the modality of distribution of direct payments as well as by their level. Three possible uses: – standard productive use for animal fodder, – AEM "extensive grassland" – non productive use (grassland kept in GAEC)		
	Large parts of grassland taken out of production to be kept in GAEC in all decoupling scenarios		
	High attractiveness for grassland from 2013	Loss of attractiveness for grassland from 2005	High attractiveness for grassland from 2005
Employment in agriculture	– Important role of cross-compliance in the decrease in livestock density and therefore in the decrease in employment in agriculture – Freed time used by family workers to occupy a job outside the farm		

Source: Own figure.

The general picture provided in this chapter hopefully helped to depict the main impacts in AgriPoliS of the three decoupling scenarios as implemented in the EU (except the abrupt introduction of a regional payment – SAP scenario – which *could* have been introduced), notwithstanding some local specificities (in particular regarding the keeping of coupled subsidies).

The next chapter will rather focus on distributional issues. Productive factors at the basis of farming activities, the extent to which they are distributed in the farm population as well as the development of this distribution induced by policy changes will be investigated.

The overall objective being the following: taking the practical example of OPR, is it fair to announce that such policy design is necessarily better than the other in terms of distributional aspects? How far do distributive patterns of direct payments provoked by policy changes really impact the development of farm structures and therefore the evolution of income inequalities? Finally, what would the "less first pillar payments after 2013" current debate potentially mean for farms, agricultural factors and rural viability?

5 REDISTRIBUTIVE ASPECTS OF CAP SCENARIOS

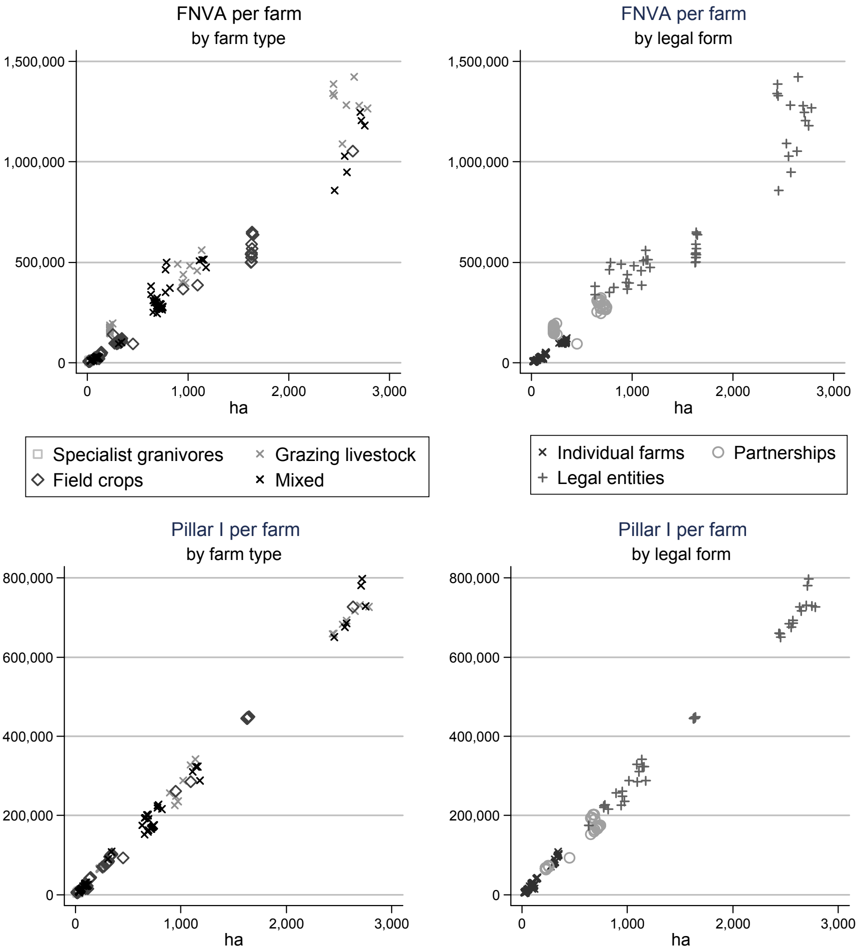
The following analyses are divided in several sections. First, as all simulations outcomes are identical until 2005, section 5.1 focuses on the situation for farms in OPR before any reform occurs, namely in 2004. This enables an overview on farms' financial situation and subsidies' share before the decoupling reform considering farms' legal form or technical orientation. Afterwards, section 5.2 provides detailed analyses on the distributive impacts of the three decoupling schemes tested (a historic payment, a regional payment and a hybrid dynamic payment) at the very individual level in 2009, 2013 and 2020. Following this, section 5.3 investigates consequences on farms' development of either the actual progressive modulation or a homogeneous one between 2009 and 2013. Finally, section 5.4 focuses on the consequences of capping Pillar I payments after 2013 and analyses mostly focus on farms' situation in 2020.

5.1 Disparities in payments and performance disparities before decoupling

The agricultural structure in the modelled OPR region is quite heterogeneous; individual farms (or farm households) neighbouring legal entities, crop production oriented systems sharing regional available land with livestock farms, share of owned land varying between farms, vintage of assets, management abilities,… all these very individual characteristics provide each farm a specific combination of advantages and disadvantages constituting a panel of opportunities with which it will have to compete with neighbouring farms.

In current simulations the development of each farm has strictly followed the same pattern over the tested scenarios between 2001 and 2004. From 2005 though, policy changes are introduced and each farm has to take advantage of the new policy framework to continue farming activities in indirect competition for land with the neighbouring farms. Figure 38 illustrates the dispersion in farm net value added (FNVA) as well as in Pillar I payments between farms regarding either their legal form or their technical orientation.

Figure 38: Farm net value added (top) and Pillar I payments (bottom) per farm in 2004 (in Euros)



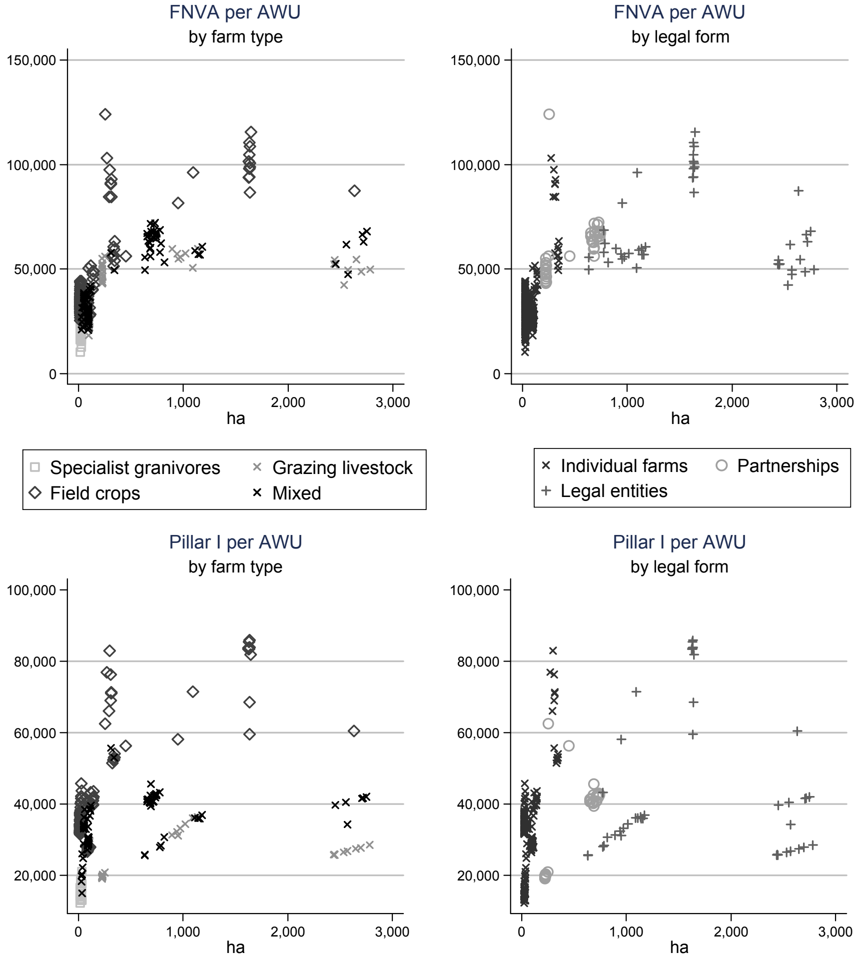
Source: Own figure.

First, it is to state that farms classified as legal entities belong to the largest farms in the region in 2004 (over 700 ha), followed by partnerships (between 200 and 850 ha) and individual farms which are to be found among the smallest production units (less than 300 ha). Then, the correlation between size of the farm and amount of Pillar I payment might be relatively high looking at the graphs, this is not the case when looking for instance at the FNVA per farm on the graphs at the top: the biggest farms do not all achieve comparable performances (see farms larger than 2,500 ha) and the FNVA per farm can even vary from the simple to almost the double (between 850,000 and 1,450,000 Euros).

Therefore, when one looks at farm performance disparities using an indicator comparable across all farms, differences in profits generated are not so obviously linked to size or legal form anymore. Figure 39 displays individual farm results as regards the net value added generated per annual working unit employed in agriculture[66] as well as the amount of Pillar I payments received per annual working unit employed in agriculture.

[66] Therefore labour employed outside agriculture is not considered here: individual farms are thus more easily comparable to other legal forms as regards their agricultural performance.

Figure 39: Farm net value added (top) and Pillar I payments (bottom) per AWU in 200-4 (in Euros)



Source: Own figure.

It is to state that the boundaries and the range of variation of FNVA per AWU for farms larger than 300 ha are similar for all legal forms. Reversely, FNVA per AWU varies between much lower boundaries for farms smaller than 300 ha. The largest farms (legal entities oriented towards grazing livestock and mixed farming) are not necessary those showing the highest FNVA and Pillar I payments per AWU.

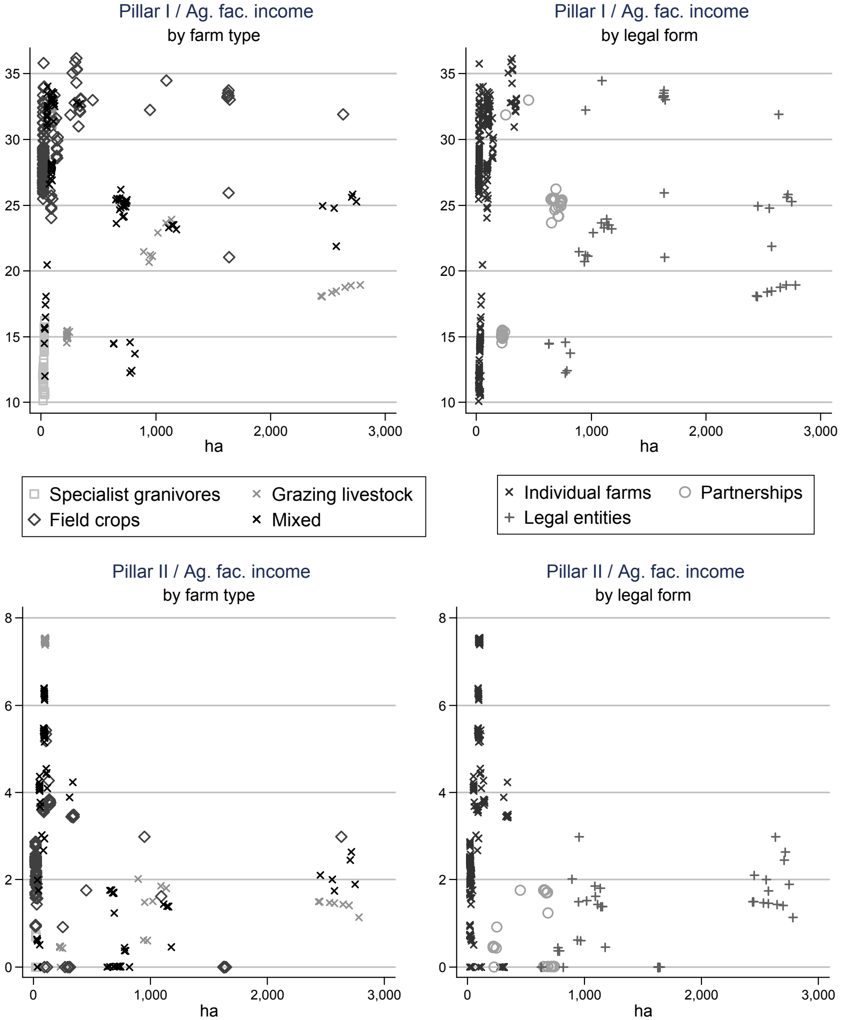
The figures above illustrate the following additional points observed right before the decoupling policy change:

- as regards the FNVA per AWU:
  - o the highest farm net value added per annual working unit (more than 70,000 Euros per AWU) are to be found in field crop farming and this whatever farm's size (from 250 to almost 3,000 ha),
  - o at the other end of the distribution, the lowest FNVA per AWU (less than 25,000 Euros per AWU) exclusively concern individual farms oriented in pig and sow production, followed by mixed and field crop production systems,
  - o even though the majority of individual farms does not score the best FNVA per AWU, some of them are successful or even very successful,
  - o legal entities and partnerships score more than 50,000 Euros of FNVA per AWU whatever their size and technical orientation,
- as regards the amount of Pillar I payment per AWU:
  - o the range of Pillar I payments received per farm is quite large, namely between 10,000 and 87,000 Euros per AWU,
  - o most farms receive between 20,000 and 40,000 Euros per AWU in all size classes. All farms oriented towards grazing livestock farming and a large part of farms oriented towards mixed farming are to be found in this tranch,
  - o most farms receiving more than 50,000 Euros of Pillar I payments are oriented towards field crops farming,
  - o farms oriented towards granivore production all receive the least Pillar I payments per AWU.

Figure 40 allows looking more deeply at farms' dependency towards direct payments. It illustrates the ratio of direct payments (from Pillar I or II) over agricultural receipts[67] and therefore provides an additional view on the share of public support in agricultural farm income.

[67] In an online document made by the EU Commission agricultural receipts are also named agricultural factor income, constituting the most suitable farm income intermediate to be compared across Member States (http://ec.europa.eu/agriculture/cap-post-2013/graphs/graph4_en.pdf)

Figure 40: Proportion of Pillar I (top) and Pillar II payments (bottom) in agricultural farm income in 2004 (in %) – *Please mind the y-axes*



Source: Own figure.

The ratio of Pillar I payments varies from 10 % to a bit more than 35 % for farms smaller than 100 hectares. These are mostly individual farms of all technical orientations, whereas farms in granivore production show the smallest ratios relative to the other production systems. Partnerships and legal entities are less dependent to Pillar I payments compared to individual farms. However, the range of variation is large as for individual farms.

Regarding Pillar II payments, their share in farms' economic results depends on whether the farm owns or rents grassland at all and if yes, if it considers that the conversion to an extensive production of grassland eligible for AEP would be worth it. Therefore, some farms not participating into the second pillar measure introduced in the model logically show a share of 0 % of Pillar II payments of their agricultural income. Mostly small scaled individual farms see a significant share of their agricultural income supported through the second pillar. However, the share of Pillar II payments maximally reaches until 7.5 % of the agricultural income and the highest shares concern farms oriented in grazing livestock and mixed farming. Other small individual farms oriented in field crops and granivore farming have chosen to convert their grassland into extensive grassland as well. The incentive for this seems to be interesting enough for those farms not necessarily exclusively producing ruminants. For farms larger than 300 hectares, the share of Pillar II payments never exceeds 5 % of agricultural income, making the contribution of the Pillar II measure to the economic performance of the farm relatively marginal.

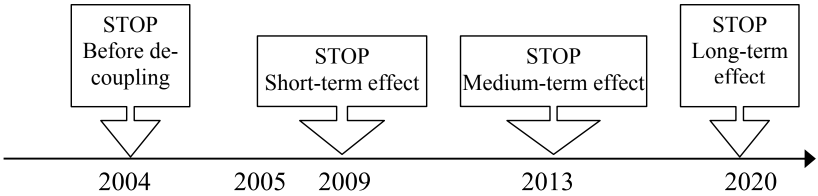
This section has provided a short overview of farms' creation of net value added in the OPR region as modelled in AgriPoliS, the distribution of Pillar I payments among those farms and their dependency to direct payments before any policy change in the year 2004. The necessity to consider a comparable indicator across all farms (here FNVA per AWU or direct payments per AWU) led to the production of results looking quite different compared to those produced if considered per farm. Whereas the level of Pillar I payments per farm seemed to be quite proportional to farm's size (Figure 38), this is not the case anymore when considering Pillar I payments per AWU; a 300 ha field crop farm can become as much Pillar I payments per AWU than a 1,700 ha one (Figure 39). Reversely, large farms do not necessarily become more Pillar I payments than small farms when calculated per AWU. Similarly when considering FNVA per farm, those farms creating most value added (legal entities in grazing livestock and mixed farming larger than 2,000 ha, see top of Figure 38) considering this criteria are to be found in the lower half of the distribution when considering the creation of value added *per AWU* (Figure 39, top). The preceding remarks plead for the necessity to carefully choose suitable indicators when comparing farms together. Finally, Figure 40 showed wide variations in farms' dependency to Pillar I payments; still, for the majority of farms 20 to 35 % of their agricultural income was constituted of Pillar I payments, especially by field crop and mixed farms in general and by individual farms smaller than 300 ha in particular. It can be assumed that those farms will be the most sensitive to future policy changes regarding Pillar I payments. Due to their optional nature, Pillar II payments' share in farms' agricultural factor income is not expected to increase much except in case of a high increase in the AEP.

The next section compares the development of farm performance and inequalities between the three decoupling scenarios tested few years after decoupling. Some features obtained above will be used again for comparing those scenarios and the relative gains or losses farms may have made throughout the policy simulations.

5.2 Which decoupling strategy for which impacts at the regional and individual levels?

It is useful at this point to summarise the main features of the tested decoupling scenarios in this section (Figure 41). As shown in the figure below, the three main decoupling scenarios implemented over EU Member States are tested on our study region Ostprignitz-Ruppin. Particularly their impacts on aspects regarding direct payments, income inequalities and land redistribution will be investigated in the next subsections.

Figure 41: Summary of experiments testing the implementation of different SPS in OPR



Ref0Mod	Agenda 2000 policy: > Full first pillar payments for crops and animals from 2002 to 2004 > AEP for extensive grassland > Set-aside: minimum 10%, maximum 33% > No cross-compliance	POLICY SWITCH: DECOUPLING OF PILLAR I PAYMENTS	Hybrid dynamic decoupling scheme: > Progressive switch to a unique regional area payment > Farm specific payment, decreasing from 2010 until 2013 > Calibrated AEP for extensive grassland > No min and max constraint for set-aside from 2009 onwards > No modulation introduced at any time > Payments subject to cross compliance: used land in 2004 has to be maintained at least in GAEC
SFP			Farm specific decoupled payment: > Farm specific payment calculated on a historical basis > Subject to continuation of farming > Calibrated AEP for extensive grassland > No min and max constraint for set-aside from 2009 onwards > No modulation introduced at any time > Payments subject to cross compliance: used land in 2004 has to be maintained at least in GAEC
SAP			Single area payment: > Regional payment, homogeneous over the whole area > Subject to continuation of farming > Calibrated AEP for extensive grassland > No min and max constraint for set-aside from 2009 onwards > No modulation introduced at any time > Payments subject to cross compliance: used land in 2004 has to be maintained at least in GAEC

Source: Own figure.

5.2.1 Redistributive aspects of the decoupling scenarios

This subchapter is divided in three parts. First, disparities in Pillar I payments' distribution between 2004 and 2013 as well as between the decoupling scenarios among farm groups are investigated. Then the contribution of main income components to the development of inequalities among farms is assessed. Finally, an overview of direct payments' impacts on the development of individual farms in a region where most of agricultural land is managed by legal entities is provided.

5.2.1.1 How do Pillar I direct payments redistribution look like in the three scenarios?

One of the central questions investigated in this section is namely: where does actually public support go few years after decoupling? Which farm types and farm legal forms have the most benefited from each decoupling scenario simulated with the model in a medium-term after the policy change? The two tables reporting payments' concentration among farms provide a first overview. They display results regarding Pillar I payments and population shares per farm type and legal form. It is possible to observe the relative gains and losses of Pillar I payments between farm groups. For instance, in 2004 granivore farms representing 15.36 % of total farm population receive 1.17 % of total Pillar I payments which ratio corresponds to a score of 0.08. The increase in this ratio in all scenarios therefore means that granivore farms have relatively gained from decoupling in terms of Pillar I payments compared to 2004. However, this gain concerns granivore farms still operating in the region in 2013 which is only half their 2004 population.

Table 28: Pillar I payments movements between 2004 and 2013 considering farm types

	Population share (1)	Pillar I share (2)	(2)/(1)
Granivores			
2004	*0.1536*	*0.0117*	*0.08*
SFP	0.0726	0.0086	0.12
SAP	0.0667	0.0128	0.19
Ref0Mod	0.0766	0.0216	0.28
Grazing livestock			
2004	*0.2083*	*0.3167*	*1.52*
SFP	0.1653	0.3224	1.95
SAP	0.1296	0.2544	1.96
Ref0Mod	0.1492	0.2551	1.71
Field crops			
2004	*0.3724*	*0.2876*	*0.77*
SFP	0.5524	0.3576	0.65
SAP	0.6037	0.3952	0.65
Ref0Mod	0.5323	0.4028	0.76
Mixed			
2004	*0.2656*	*0.3840*	*1.45*
SFP	0.2097	0.3115	1.49
SAP	0.2000	0.3376	1.69
Ref0Mod	0.2419	0.3206	1.33

Source: Own figure.

Table 28 shows that, *in total*, the absolute share of Pillar I payments by field crop farms increased in all scenarios since 2004 but not as fast as the population share of this farm group, meaning that field crop farms have lost Pillar I payments relatively to 2004 except in the Ref0Mod scenario. Grazing livestock and mixed farms are the technical orientations getting more Pillar I payments than their population share in 2004. In 2013 those technical orientations are the most favoured in the SAP scenario in the sense that the score reached by dividing their Pillar I payments share over population share is the highest among the three decoupling scenarios; in this sense Ref0Mod rather favours granivore and field crop farms and the SFP scenario grazing livestock farms.

Table 29: Pillar I payments movements between 2004 and 2013 considering legal forms

	Population share (1)	Pillar I share (2)	(2)/(1)
Individual farms			
2004	*0.7708*	*0.1803*	*0.23*
SFP	0.6452	0.2204	0.34
SAP	0.6741	0.2683	0.40
Ref0Mod	0.6452	0.2728	0.42
Partnerships			
2004	*0.1094*	*0.1639*	*1.50*
SFP	0.1694	0.1563	0.92
SAP	0.1556	0.1547	0.99
Ref0Mod	0.1694	0.1597	0.94
Legal entities			
2004	*0.1198*	*0.6558*	*5.47*
SFP	0.1855	0.6233	3.36
SAP	0.1704	0.5770	3.39
Ref0Mod	0.1855	0.5675	3.06

Source: Own figure.

Table 29 illustrates the relative gain of Pillar I payments for individual farms between 2004 and 2013, in particular in the Ref0Mod scenario. Partnerships and legal entities lose least payments in the SAP scenario compared to 2004. Results show as well that individual farms are the most numerous whereas the bulk of Pillar I payments are received by legal entities. However, it is not because legal entities get most of Pillar I payments in absolute terms that they necessarily get *more* payments than the other two legal forms as already seen in the preceding section 5.1. Therefore, although it is interesting to investigate how Pillar I payments are distributed among the farm population in absolute terms another indicator allowing for more comparability between very different farm systems has to be selected.

The indicator chosen in the following to investigate the redistribution of Pillar I payments is its level per Annual Working Unit employed in agriculture (i.e. family plus hired). There were several reasons not to consider any other indicator.

First, considering Pillar I payments per farm sometimes displaying huge amounts may have overlooked the fact that those payments were determined by farms' size and technical orientation in 2005. Then, considering Pillar I payments per hectare may have hardly made any sense especially from 2013 in the Ref0Mod and SAP scenarios as the regional area payment will be fully introduced at the same levels for arable and grassland overall in the region. To ensure some comparability between those very different farm structures characterising OPR in AgriPoliS, Pillar I payments per AWU was the best indicator to reflect the real contribution of those payments to, among other things, support employment in OPR as well as reflect which production systems and farm groups those payments actually support the most.

To illustrate the former point, Table 30 below compares the flow of Pillar I payments if calculated per farm or per AWU between the three decoupling scenarios and compared to 2004 as well. Farms have been grouped regarding their legal form or technical orientation.

Table 30: Pillar I payments per farm and per AWU (in Euros) considering farms' legal form and technical orientation in 2013 in each decoupling scenario and compared to 2004

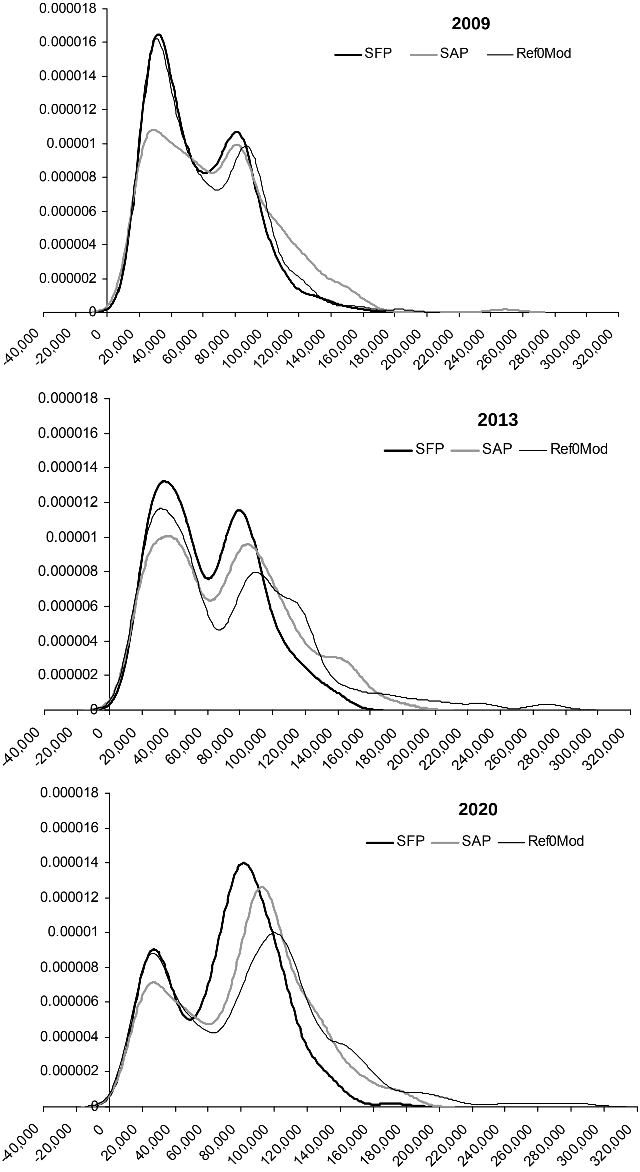
	Number of farms	Mean (€/farm)	**2013/2004**	Mean (€/AWU)	**2013/2004**
Individual farms					
2004	*296*	*19,410*		*30,544*	
SFP	160	41,450	**214%**	72,169	**236%**
SAP	182	46,687	**241%**	86,568	**283%**
Ref0Mod	160	54,531	**281%**	90,371	**296%**
Partnerships					
2004	*42*	*124,355*		*32,538*	
SFP	42	112,015	**90%**	40,616	**125%**
SAP	42	116,639	**94%**	42,298	**130%**
Ref0Mod	42	121,611	**98%**	44,513	**137%**
Legal entities					
2004	*46*	*454,263*		*47,252*	
SFP	46	407,710	**90%**	41,650	**88%**
SAP	46	397,268	**87%**	41,908	**89%**
Ref0Mod	46	394,605	**87%**	43,981	**93%**
Granivores					
2004	*59*	*6,320*		*15,347*	
SFP	18	14,298	**226%**	44,147	**288%**
SAP	18	22,557	**357%**	55,482	**362%**
Ref0Mod	19	36,382	**576%**	75,235	**490%**
Grazing livestock					
2004	*80*	*126,149*		*26,922*	
SFP	41	236,591	**188%**	26,050	**97%**
SAP	35	230,201	**182%**	25,825	**96%**
Ref0Mod	37	220,486	**175%**	27,215	**101%**
Field crops					
2004	*143*	*64,082*		*42,399*	
SFP	137	78,539	**123%**	81,983	**193%**
SAP	163	76,786	**120%**	94,018	**222%**
Ref0Mod	132	97,589	**152%**	102,504	**242%**
Mixed					
2004	*102*	*119,960*		*33,911*	
SFP	52	180,268	**150%**	39,894	**118%**
SAP	54	197,980	**165%**	41,335	**122%**
Ref0Mod	60	170,890	**142%**	39,752	**117%**

Source: Own figure.

When considering Pillar I payments per farm differences between individual farms, partnerships and legal entities seem to be huge; however, they are for the most due to farm's size. Individual farms are mostly small farms, partnerships middle-sized farms and legal entities are rather large systems. Some results may be misleading depending if Pillar I payments are considered per farm or per AWU; in 2004 the levels of Pillar I payments per AWU are quite comparable between individual farms and partnerships whereas legal entities do not seem to receive considerably more than other farms anymore. Similarly, even though decoupling seems to have well benefited to grazing livestock and mixed farms, conclusions are somewhat mitigated when looking at Pillar I payments per AWU; compared to 2004 grazing livestock farms almost get exactly the same amount of payments whereas the increase is not that strong for mixed farms anymore. The contrary is observed for field crop farms; the increase in Pillar I payments with decoupling is much stronger when calculated per AWU than in average per farm. Absolute amounts per farm make some values appear huge because of farms' size and productive structure, for instance when looking at payments received by legal entities. However, when calculated per AWU, legal entities lost payments with decoupling to the contrary of individual farms (still operating in the region) which saw their direct payments per AWU almost triple in 2013 compared to 2004. Therefore looking at Pillar I payments per AWU may better reflect their real impacts on the farming sector and distributive patterns may somehow be different if related to actual agricultural employment in the model.

Figure 42 illustrates the distribution of Pillar I payments per AWU in the three decoupling scenarios in a rather short (2009), a medium (2013) and a long term (2020) after the introduction of the policy change. In 2009 the distribution of payments is relatively similar in both scenarios SFP and Ref0Mod with two peaks in the number of farms getting around 37,000 Euros and 80,000 Euros (90,000 Euros in the Ref0Mod scenario), the first peak being by far the highest. These two peaks exist in the SAP scenario as well but show the same height. In 2013, both peaks observed in 2009 display a quite similar height in each of the scenarios SFP and SAP, meaning that less farms get around 30,000 Euros in 2013 compared to 2009. However the width of this peak has increased in all scenarios. In Ref0Mod the two peaks are very dissimilar. While the first around 30,000 Euros is contained between the ones of the two other decoupling scenarios, the other one at 90,000 Euros tend to skew to the right to highest values of Pillar I payments per AWU.

Figure 42: Kernel densities for Pillar I payments per AWU in scenarios SFP, SAP and Ref0Mod in 2009 (hOpt=8290.0916), 2013 (hOpt=9007.6267) and 2020 (hOpt=9767.6129)



Source: Own figure.

In a longer term there is a translation of Pillar I payments per AWU to highest values than before in all decoupling scenarios, meaning that on the one hand farms belonging to the former 30,000 Euros peak may have progressively closed down and on the other hand those remaining in the sector gained more payments and for some of them reached the second peak. The second peak is around 100,000 Euros in the Ref0Mod scenario, followed by the SAP peak at around 95,000 Euros and the SFP one at 80,000 Euros.

Looking at those two (even two and a half in 2009 in the SAP and Ref0Mod scenarios) peaks leads to the following question: has the polarization of the farm population increased between 2004 and after decoupling and if yes, to which extent in which scenario? Table 31 reports the values for the DER index of polarization in 2004 then 2009, 2013 and 2020 in all decoupling scenarios.

Table 31: Duclos, Esteban and Ray (DER) index of polarization (α =0.5) for Pillar I payments per AWU in 2004, 2009, 2013 and 2020 (highest scores in bold)

		Estimate	Standard deviation	Lower bound	Upper bound
2004		0.176298	0.006999	0.162536	0.19006
2009	SFP	0.208647	0.005153	0.198504	0.218789
	SAP	0.208151	0.005818	0.196701	0.219602
	Ref0Mod	**0.215522**	0.005333	0.205026	0.226018
2013	SFP	0.205189	0.005708	0.193946	0.216431
	SAP	0.211138	0.006164	0.199003	0.223273
	Ref0Mod	**0.225795**	0.00639	0.21321	0.23838
2020	SFP	0.196623	0.008485	0.179901	0.213345
	SAP	0.197772	0.007837	0.182335	0.213209
	Ref0Mod	**0.215091**	0.007873	0.19958	0.230603

Source: Own calculations using the DASP module in Stata 11.0.

In all decoupling scenarios the polarization index has increased in 2009 compared to 2004. Being relatively similar between SFP and SAP, its value is somewhat higher in the Ref0Mod scenario. The same statement holds in 2020 if the three scenarios were to be kept unchanged. The index is always the highest in the Ref0Mod scenario compared to SAP and SFP for all years 2009, 2013 and 2020. In 2013, it can be observed that the distribution is the most polarized in the Ref0Mod scenario followed by SAP and SFP which display different values in this case. Thanks to Figure 42 above it is to state that polarization in Ref0Mod has mostly increased due to the translation of the second peak at around 100,000 Euros of Pillar I payments per AWU; some farms have therefore benefited from higher Pillar I payments in this scenario compared to the other decoupling scenarios, digging a larger gap between them and farms receiving 30,000 Euros per AWU.

The results shown below illustrate the actual contribution of each farm group to inequality in Pillar I payments in 2013 in each decoupling scenario using the decomposed Gini coefficient (Table 32). Over the whole farm population (bottom of the table) the results confirm those already observed using the polarization index for 2013, namely that inequality in the distribution of Pillar I payments per AWU is the highest in the Ref0Mod scenario, followed by SAP and then SFP. The rest of the table focuses on the contribution of each farm group, relative to their technical orientation or legal form, to overall inequality in each scenario. For instance, total inequality in 2013 in the SAP scenario reaches a score of 0.3066 which is higher than the 2004 score, meaning that inequality has increased. It is among mixed farms that inequality is the highest (score of 0.2461) but this result shall be relativised by the fact that farms belonging to this group represent 20 % of total farm population in the region receiving 11.47 % of total Pillar I payments (calculated per AWU). Field crop farms are more numerous (60.37 %) and get most Pillar I payments per AWU (78.75 %).

Table 32: Gini index for Pillar I payments per AWU decomposed by farm groups considering technical orientation and legal form in 2013

Scenario	Groups	Gini index	Population share	Pillar I share	Absolute contribution	Relative contribution
SFP	Sp. granivores	**0.1980**	0.0726	0.0524	0.0008	0.27%
	Gr. livestock	0.1211	0.1653	0.0704	0.0014	0.51%
	Field crop	0.1526	0.5524	0.7404	0.0624	22.40%
	Mixed	0.1751	0.2097	0.1368	0.0050	1.80%
SAP	Sp. granivores	0.1999	0.0667	0.0513	0.0007	0.22%
	Gr. livestock	0.2022	0.1296	0.0464	0.0012	0.40%
	Field crop	0.1862	0.6037	0.7875	0.0885	28.87%
	Mixed	**0.2461**	0.2000	0.1147	0.0056	0.00%
Ref0Mod	Sp. granivores	**0.2502**	0.0766	0.0779	0.0015	0.43%
	Gr. livestock	0.2191	0.1492	0.0549	0.0018	0.52%
	Field crop	0.2233	0.5323	0.7373	0.0876	25.31%
	Mixed	0.2085	0.2419	0.1300	0.0066	1.89%
Within farm types	SFP				0.0696	24.98%
	SAP				0.0961	31.33%
	Ref0Mod				0.0975	28.15%
Between farm types	SFP				0.2005	**72.34%**
	SAP				0.1956	**71.95%**
	Ref0Mod				0.2274	**63.79%**
SFP	Ind. farms	0.2250	0.6452	0.7612	0.1105	39.66%
	Partnerships	**0.2930**	0.1694	0.1125	0.0056	1.10%
	Legal entities	0.2594	0.1855	0.1263	0.0061	1.66%
SAP	Ind. farms	0.2390	0.6741	0.8096	0.1305	42.55%
	Partnerships	**0.3360**	0.1556	0.0913	0.0048	2.00%
	Legal entities	0.2753	0.1704	0.0991	0.0046	2.39%
Ref0Mod	Ind. farms	0.2954	0.6452	0.7879	0.1502	43.38%
	Partnerships	**0.3336**	0.1694	0.1019	0.0058	1.56%
	Legal entities	0.2782	0.1855	0.1102	0.0057	2.18%
Within legal forms	SFP				0.1222	**43.84%**
	SAP				0.1399	**45.63%**
	Ref0Mod				0.1616	**46.68%**
Between legal forms	SFP				0.1166	41.85%
	SAP				0.1357	44.27%
	Ref0Mod				0.1430	41.30%
Population	**2004**	**0.2153**	1.0000	1.0000	0.2153	1.0000
	SFP	**0.2786**	1.0000	1.0000	0.2786	1.0000
	SAP	**0.3066**	1.0000	1.0000	0.3066	1.0000
	Ref0Mod	**0.3462**	1.0000	1.0000	0.3462	1.0000

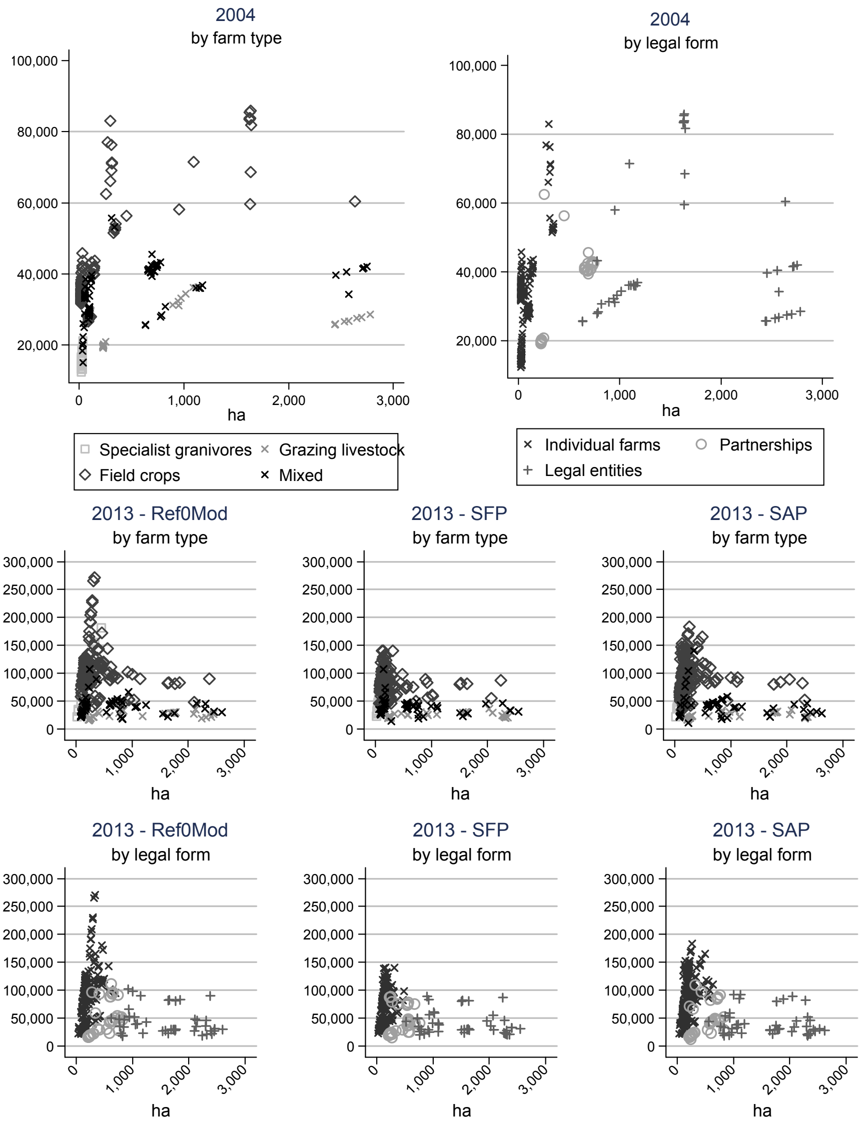
Source: Own calculations using the DASP extension for Stata 11.0 (ARAAR and DUCLOS, 2007).

Note: The highest scores by farm group and by scenario for in-between groups are marked in bold.

Results show than regarding inequality decomposed by farm groups relatively to their technical orientation, field crop farming is the most widespread farm type getting most of Pillar I payments per AWU as reported by the two columns "Population share" and "Pillar I share". Its contribution to inequality is the highest in the SAP scenario and the lowest in the SFP scenario. However, most inequality is due to between groups inequality, representing at least 64 % of total inequality (in Ref0Mod), increasing until 72 % (in SFP). This means that Pillar I payments per AWU distributions corresponding to each farm group are relatively different from one another and that average levels of Pillar I payments per AWU are quite distant between groups as already observed in Table 30.

In all scenarios, inequality is higher within groups classified relatively to their legal forms than within groups classified relatively to their technical orientation. This means that even though average levels of Pillar I payments per AWU between legal forms are similar, the corresponding distributions look quite different though. The higher overlap values than in the preceding case confirm that distributions somehow intersect in this case. The highest within group inequality score is found among partnerships in the three scenarios. However individual farms being the dominant legal form in terms of number of farms and share of Pillar I payments per AWU, their influence on overall inequality is therefore the strongest. Their contribution to overall inequality is the highest in the Ref0Mod scenario. Here within group inequality as regards legal forms represents between 44 % (in SFP) and 47 % (in Ref0Mod) of total inequality which is for all scenarios no much more than inter-group inequality. Figure 43 below provides an illustration of how Pillar I payments per AWU distributions differ from one another considering those two preceding farm groups and the three decoupling scenarios. The figure provides an additional information by spreading farms' coordinates relatively to their size on the x-axis.

Figure 43: Pillar I payments per AWU (family plus hired) in 2004 (in Euros) and in 2013 for each decoupling scenario



Source: Own figure.

The first striking statement is the visible partial increase between 2004 and 2013 of direct payments per AWU whatever the decoupling scenario considered; whereas no farm could reach 90,000 Euros of Pillar I payments per AWU in 2004, many of them, especially individual farms oriented towards field crop farming, get more (sometimes even much more, look at the Ref0Mod scenario) than 50,000 Euros per AWU of Pillar I payments in 2013 in all decoupling scenarios. The presence of numerous outliers, especially in the Ref0Mod scenario, attests the capability of some farm managers to get the most possible out of public support made available through decoupling. Most of them have adapted their production systems of which farm orientation by rather abandoning labour intensive activities on-farm (for instance ruminant productions) therefore reducing labour load. At the same time, those farms have been able to seek for more land but this expansion was rather "payment-oriented" as most seeked land is then kept in GAEC (which is an activity only requiring very low levels of labour) but eligible to the same Pillar I payment than agricultural land used for production purposes.

The tables below extend the above analyses and focus on how much Pillar I payments per AWU have changed between farm groups considering their legal form and their technical orientation; results already observed in Table 30 above are therefore decomposed so far. First, looking at legal entities, one can state that differences are not that huge both between 2004 and 2013 as well as between decoupling scenarios (Table 33). Legal entities mostly lost payments with decoupling whatever the technical orientation they belong to.

Table 33: Pillar I payments per AWU (in Euros) received by legal entities in 2004 and in 2013 in each decoupling scenario

	Number of farms	Mean	Standard deviation	Minimum	Maximum	2013/2004
Granivores						
2004	0					
SFP	0					
SAP	0					
Ref0Mod	0					
Grazing livestock						
2004	15	29,991	3,826	25,793	36,428	
SFP	17	27,293	4,258	20,508	36,384	91%
SAP	16	27,684	4,543	19,324	33,954	92%
Ref0Mod	14	27,393	4,693	19,001	35,214	91%
Field crops						
2004	15	77,129	10,410	58,110	85,952	
SFP	12	72,135	14,437	50,385	88,674	94%
SAP	10	78,908	15,200	50,879	92,318	102%
Ref0Mod	14	72,030	20,719	46,997	101,904	93%
Mixed						
2004	16	35,425	6,044	25,601	43,241	
SFP	17	34,487	9,032	19,629	49,272	97%
SAP	20	34,788	11,280	18,623	58,679	98%
Ref0Mod	18	35,066	12,250	18,419	66,312	99%

Source: Own figure.

Those legal entities oriented towards mixed farming lose the least through decoupling compared to the other farm orientations as illustrated in the last right column of the table. Field crops farms lose the least in the SAP scenario, Pillar I payments per AWU even increasing of 2 % compared to 2004, whereas they would lose at least 6 % in the other two scenarios. Grazing livestock orientated farms lose between 8 and 9 % of Pillar I payments and mixed farms between 1 and 3 %; however the sizes of these two groups have grown in these two orientations, which is not the case when considering partnerships and individual farms (see tables below). Moreover, the size of the field crop group is decreasing here, again to the contrary of the two other legal forms investigated below.

As regards the situation for partnerships, they were divided in two groups in 2004, one getting around 20,000 Euros per AWU for an UAA of 100 ha and the other around 40,000 Euros for an UAA of 600 ha with some outliers around 60,000 Euros between 100 ha and 300 ha big. In general partnerships have both grown in size and amount of Pillar I per AWU between 2004 and 2013 in the three scenarios (Table 34).

Table 34: Pillar I payments per AWU (in Euros) received by partnerships in 2004 and in 2013 in each decoupling scenario

	Number of farms	Mean	Standard deviation	Minimum	Maximum	2013/2004
Granivores						
2004	0					
SFP	0					
SAP	0					
Ref0Mod	0					
Grazing livestock						
2004	19	19,698	405	19,107	20,897	
SFP	18	22,063	2,936	18,828	28,634	112%
SAP	17	19,493	3,765	15,877	28,903	99%
Ref0Mod	18	20,425	4,728	15,917	30,860	104%
Field crops						
2004	2	59,443	4,342	56,373	62,513	
SFP	9	78,386	5,560	73,053	88,437	132%
SAP	9	85,994	12,887	65,742	109,099	145%
Ref0Mod	9	90,636	13,781	58,842	111,200	152%
Mixed						
2004	21	41,593	1,393	39,384	45,595	
SFP	15	40,217	8,084	14,597	47,586	97%
SAP	16	41,948	9,587	11,645	52,528	101%
Ref0Mod	15	45,746	5,628	29,863	53,777	110%

Source: Own figure.

Differences between scenarios are to be observed here in contrast to legal entities. In all farm types, partnerships gain Pillar I payments per AWU in the Ref0Mod scenario compared to 2004, even about 50 % more in average when considering field crop farms. They win nearly the same in the SAP scenario though (plus 45 %) but the other farm orientations do not gain much otherwise in this scenario. Except for mixed farming where partnerships have to concede 3 % of their 2004 Pillar I payments, the SFP scenario allows for increased public support in grazing livestock (plus 12 %) and field crop farming (plus 32 %) compared to 2004.

Looking now at the situation for individual farms, it reveals quite surprising scores especially regarding the extents of their change between 2004 and 2013 in all farm orientations (Table 35).

Table 35: Pillar I per AWU (in Euros) received by individual farms in 2004 and in 2013 in each decoupling scenario

	Number of farms	Mean	Standard deviation	Minimum	Maximum	2013/2004
Granivores						
2004	59	15,347	1,698	12,330	21,155	
SFP	18	44,147	16,034	23,187	78,736	288%
SAP	18	55,482	23,109	21,709	128,085	362%
Ref0Mod	19	75,235	38,362	22,496	181,006	490%
Grazing livestock						
2004	46	28,905	454	28,192	29,704	
SFP	6	34,487	6,931	27,416	47,033	119%
SAP	2	64,768	49,138	30,022	99,514	224%
Ref0Mod	5	51,165	35,838	28,257	114,757	177%
Field crops						
2004	126	37,994	10,281	26,639	83,038	
SFP	116	83,281	23,857	39,033	140,488	219%
SAP	144	95,569	32,667	34,186	183,571	252%
Ref0Mod	109	107,398	46,111	34,324	271,144	283%
Mixed						
2004	65	31,057	6,245	15,062	55,727	
SFP	20	44,247	19,837	25,460	106,851	142%
SAP	18	48,066	33,931	21,552	140,764	155%
Ref0Mod	27	39,545	21,327	21,671	107,417	127%

Source: Own figure.

Whereas in 2004 most of them received between 10,000 and 43,000 Euros per AWU with some outliers to be found between 50,000 and 83,000 Euros per AWU, in all decoupling scenarios individual farms have clearly gained public support, sometimes a lot and the span of Pillar I payments is very bright *whereas individual farms' UAA never exceeds 800 ha*. However, their number has decreased in all technical orientation (except field crop farms in the SAP scenario) which should be considered to buffer those results.

Now beyond the absolute consideration of how much public support each farm group becomes, one of the last questions to be investigated in this section is the relative dependency of farms in OPR to Pillar I payments some time after the policy change in 2013. Believing a document produced by the DG AGRI of the EU Commission, in average in Germany direct payments (supposedly equivalent to Pillar I payments considered here) represents 40 % of total agricultural factor income[68] (27 % in the EU), almost 50 % if all subsidies are considered[69].

[68] The agricultural factor income represents the income generated by the farming activities which is used to remunerate (1) borrowed/rented production factors (capital investment, wages for salaries and rented land), and (2) its own production factors (work and/or enterprise, own capital and owned land). Source: http://ec.europa.eu/agriculture/cap-post-2013/graphs/graph4_en.pdf.

[69] As a reference for comparison, in the Ref0Mod scenario Pillar I payments in 2006-2008 count for 34.7 % of agricultural factor income.

Table 36: Proportion of Pillar I, Pillar II and total direct payments in agricultural factor income generated by farming activities in 2013

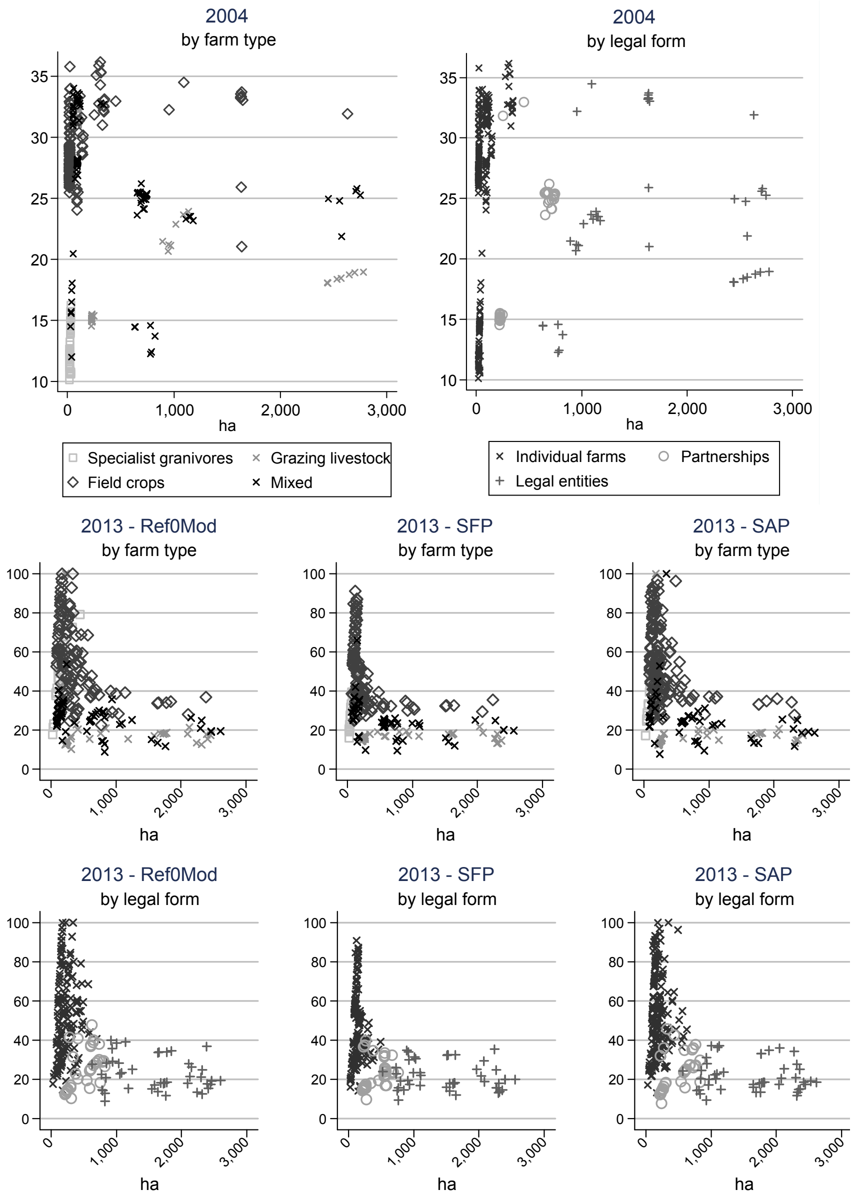
		Number of farms	Mean	Standard deviation	Minimum	Maximum
Pillar I	2004	384	25.4	7.32	10.13	36.15
	SFP	248	36.9	18.28	9.47	91.05
	SAP	270	43.3	22.37	7.79	100.00
	Ref0Mod	248	42.6	22.59	8.99	100.00
Pillar II	2004	384	2.8	2.35	0.00	7.55
	SFP	248	1.4	3.16	0.00	12.78
	SAP	270	1.0	2.57	0.00	12.52
	Ref0Mod	248	1.7	3.51	0.00	13.46
Total subsidies	2004	384	28.2	8.84	10.13	40.21
	SFP	248	38.4	18.08	9.47	91.05
	SAP	270	44.2	21.82	7.79	100.00
	Ref0Mod	248	44.3	21.85	8.99	100.00

Source: Own calculations.

Table 36 reports the results for OPR in 2013. In average, the proportion of Pillar I payments in agricultural factor income is the highest in the SAP scenario with 43.3 %. It is immediately followed by Ref0Mod with 42.6 % and finally by SFP with 36.9 %. Including Pillar II payments as introduced in the model in the form of payments for extensive grassland, SAP and Ref0Mod are almost strictly similar regarding the proportion of direct payments in agricultural factor income (44.2 % and 44.3 % respectively). SFP follows with 38.4 %. Even though only one Pillar II measure could be introduced in the model, it remains that it still constitutes for some farms (not all farms have to participate in the AEM introduced in the model) an appreciated additional source of support for continuing agricultural activities. The other conclusion is that decoupling Pillar I payments from agricultural production does not reduce farms' dependency to those payments compared to before the policy change in 2004; in the contrary, from the introduction of decoupling and, among others, the possibility to keep land in GAEC and the consecutive general decrease in agricultural production, the ratio of payments over the value of agricultural outputs increased of at least ten points in percentage.

Stating this, which are the technical orientations for which this dependency is the most important? Figure 44 illustrates this dependency at the very individual level in the three decoupling scenarios considering farms regarding their type or legal form.

Figure 44: Ratio of Pillar I payments over agricultural factor income (in %) in 2004 and in 2013 in each decoupling scenario



Source: Own figure.

The figures observed recall those already seen in Figure 43. Individual farms especially oriented towards field crop farming present the widest standard deviation in the proportion of Pillar I payments in agricultural factor income in all scenarios. Whereas the ratio varies between almost 10 % and 45 % by partnerships, and almost 10 % and 40 % by legal entities, the scope of variation by individual farms is much larger and comprised between 17 % and 100 % (except in SFP where the maximum is of 91 %). Between 2004 and 2013, it seems quite clear that decoupling payments from field crop and animal production (but keeping them "coupled" to, at least, a minimal use of land) has tremendously, if not favoured, at least supported, the emergence and maintenance of a group of farms highly dependent to Pillar I payments (superior to 40 %, almost only individual farms in field crop farming - and granivore production in Ref0Mod) for the continuation of farming. This has been provoked by reactions of farms like converting productive land into land kept in GAEC, renting more land when possible in a competitive environment and setting livestock production aside to use labour force outside the farm in the case of individual farms; all this allowing farms to survive and take advantage of the new political deal.

5.2.1.2 Which income components cause the most inequalities?

Farm income relies on several sources: receipts from agricultural activities, direct payments and other public support mechanisms (including social transfers), interests received from load of money at the bank or other financial products, etc. The variable for farm income used here is the total agricultural income per AWU; sources of receipts (calculated per AWU as well) constituting this income are receipts from agricultural activities, Pillar I and Pillar II payments and interest received from farms' bank accounts. Table 37 displays the extent to which each of these income components participates to the reduction or the increase of the Gini coefficient for the total agricultural income per AWU in 2013 and 2020. This decomposition is useful in the sense that it helps going beyond the single value of the Gini coefficient as mentioned in the table as well, value which is found to be relatively similar for all three scenarios but in all cases superior to the value calculated for 2004.

First it can be observed that the concentration index for Pillar II payments is negative, which deserves some explanation. The concentration index plots the individuals ranked regarding their total agricultural income along the x-axis by Pillar II payments corresponding values along the y-axis. It can take values between -1 and 1. Negative concentration values for Pillar II payments indicate that the concentration curve (equivalent of the Lorenz curve for a Gini coefficient) lies "above the diagonal". In other words those getting the most Pillar II payments per AWU are those scoring the lowests total agricultural incomes in the farm population and one can conclude that this variable would contribute to lower the Gini coefficient and therefore inequality.

Table 37: Gini coefficient decomposed by income sources for total agricultural income per AWU in 2004 and 2013 for each decoupling scenario

Year	Income components	Scenario	Income share	Concentration index	Absolute contribution	Relative contribution
2004	Receipts		0.4903	0.0609	0.0298	14.97%
	Pillar I		0.1241	0.1498	0.0186	9.33%
	Pillar II		0.0117	-0.0875	-0.0010	-0.51%
	Interest rec.		0.3739	0.4066	0.1520	76.22%
	Total		1.0000	---	**0.1994***	100.00%
2013	Receipts	SFP	0.4562	0.0875	0.0399	15.69%
		SAP	0.4695	0.0945	0.0444	17.84%
		Ref0Mod	0.4627	0.1132	0.0524	**20.22%**
	Pillar I	SFP	0.1646	0.2266	0.0373	14.66%
		SAP	0.2014	0.2246	0.0452	18.18%
		Ref0Mod	0.1999	0.2721	0.0544	**21.01%**
	Pillar II	SFP	0.0049	-0.4750	-0.0023	-0.92%
		SAP	0.0033	-0.6150	-0.0020	-0.82%
		Ref0Mod	0.0055	-0.5638	-0.0031	**-1.19%**
	Interest received	SFP	0.3743	0.4797	0.1795	**70.56%**
		SAP	0.3258	0.4948	0.1612	64.80%
		Ref0Mod	0.3319	0.4676	0.1552	59.96%
	Total	**SFP**	1.0000	---	**0.2544***	100.00%
		SAP	1.0000	---	**0.2488***	100.00%
		Ref0Mod	1.0000	---	**0.2589***	100.00%

Source: Own calculations using the DASP extension for Stata 11.0 (ARAAR and DUCLOS, 2007).

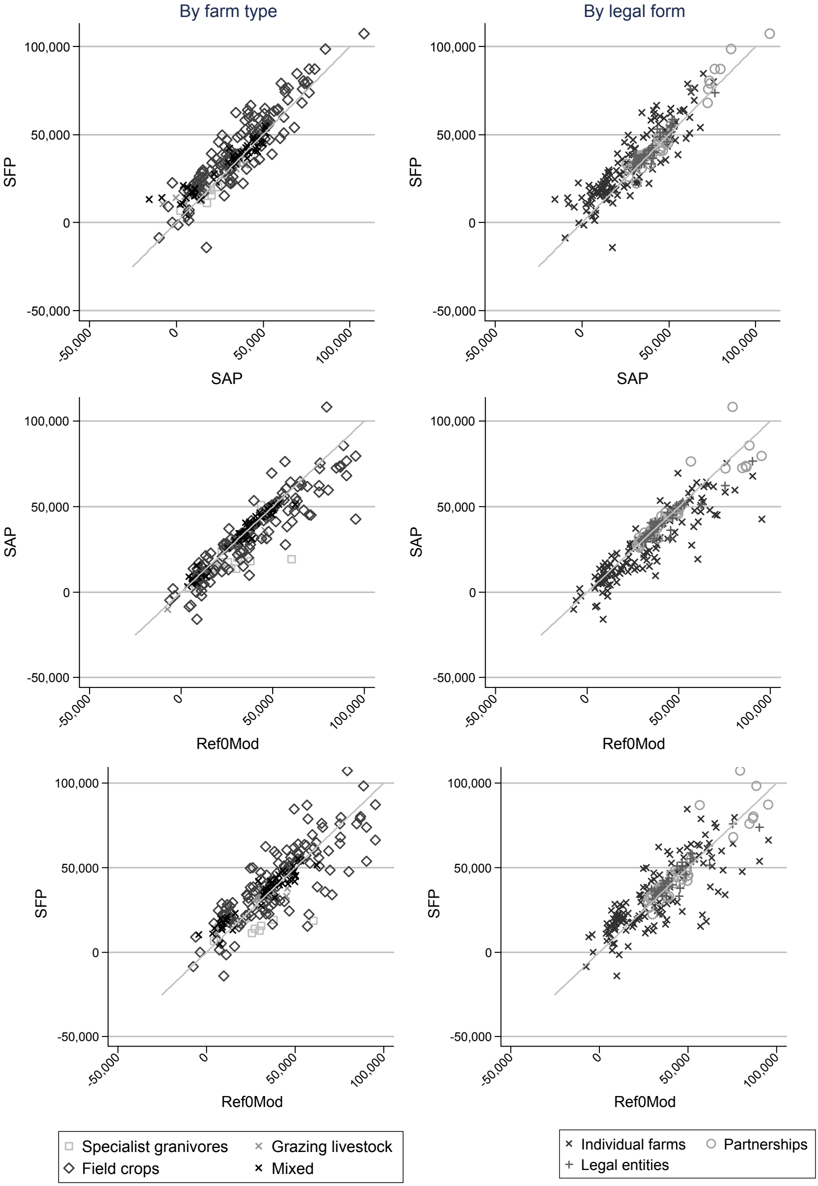
Note: Cells marked with a * indicate the Gini coefficient for agricultural income per AWU for the corresponding years and scenarios.

Looking at income shares of the four variables in Table 37 indicates that agricultural receipts contribute the most to the level of agricultural income, however in a lesser extent in all scenarios compared to 2004. Pillar II payments only contribute marginally to this income. Therefore its contribution to the calculation of the overall Gini coefficient is quite marginal as well but worth commenting; actually, looking at the last column of the table, one sees that Pillar II payments contribute to their modest extent to the *decrease* of the Gini coefficient as their relative contribution is negative. In other words, if those payments were removed from agricultural incomes throughout the region, *inequality would increase* in a very modest extent as the relative contributions are extremely low. This means as well that those Pillar II payments rather go to farms reaching among the lowests agricultural incomes.

In the contrary, interests received would participate to a very high extent to the decrease of the inequality index if they were to be removed from agricultural income. This denotes the highly heterogeneous financial situation of farms in OPR where rents received from equity capital placed in the bank perturb gaps already observed between farms regarding their performances. In 2013, it is in Ref0Mod that the contribution of both agricultural receipts and Pillar I payments to the increase of the Gini coefficient is the highest; among the three scenarios the contribution observed in SFP for these components is the lowest. However, the reverse is true for the contribution of interests received: the highest is observed in SFP, the lowest in Ref0Mod.

The next figure illustrates in a more classical manner the differential consequences of decoupling scenarios on agricultural profits per farm in 2013 (Figure 45). Labour costs (in the form of wages paid) have been included back in the variable for profit used to allow for the comparison of results among all legal forms. Decoupling scenarios are compared one against the other. The first comparison between SAP and Ref0Mod reveals that more farms would have been better off in the Ref0Mod than in SAP. It particularly holds for individual farms in granivore and field crop production. Comparing now SFP and Ref0Mod reveals that SFP would have been more favourable to mixed and grazing livestock farms whereas Ref0Mod would have, again favoured granivore and field crop farms like in the preceding case and this to a quite high extent. Finally, SFP would have been more favourable to more farms belonging to almost all farm types than SAP would have.

Figure 45: Comparison of profits per AWU (all labour costs included) in 2013 (in Euros)



Source: Own figure.

As a conclusion, Ref0Mod leaves more farms (sometimes much) better off that the two other scenarios, followed by SFP and then SAP. It is however not exact to say that the two other scenarios are necessary worse that Ref0Mod, in the contrary, they favour other farms which could be able to better take advantage of the specific political settings than their neighbours.

In the two preceding subchapters, specificities linked to individual farms have not been put into relief. Actually, when considering labour employed in agriculture, there has been no difference made between hired labour and family labour force which actually has to be remunerated as well. Moreover, this factor, namely family labour, can be employed either on the farm or off-farm, bringing in this case some additional income to the farm household. The next section may shed some light on issues specific to this category of farms cohabiting with legal entities and partnerships (using owned labour full-time on the farm in our case) in OPR.

5.2.1.3 Is the farm household model put more in danger with hybrid dynamic decoupling than with the other decoupling models?

One reason explaining the presence of this section in this study comes from recent discussions and debates at the European level about the justification of sometimes very high direct payments for some farms. The indignation of European societies when direct payments received per farm have been made publicly available has partly provoked the political response from EU’s side consisting in the increase of modulation of direct payments combined to a degression of those payments linked to the size of the farm. As, notably in most parts of the EU, the largest farms are legal entities and partnerships, such outcries regarding the absolute levels of direct payments and the political decisions made consecutively to respond to it maybe had the advantage to rather favour the position of individual family farms. Aspects directly linked to modulation and its consequences will be investigated later; in this part the focus is put on the following question; although high absolute levels of direct payments after decoupling are (logically) distributed to larger farms and among them especially legal entities and partnerships, are there good arguments to think that farm households have "suffered" from decoupling and if yes, which decoupling model may have caused the most damage?

Figure 46 shows the average composition of farm household income in 2004 and 2013 in all decoupling scenarios. First, it is to recall that the SAP scenario is the scenario where most individual farms stay in the agricultural sector throughout the whole simulation. Therefore, beyond all other considerations, it is the scenario offering the best surviving chances in agriculture to family farms. Total household income has increased by at least 42 % between 2004 and 2013. Most of this increase is due to the increase in farm profits during the simulations. There is a gap at the advantage of the Ref0Mod scenario regarding farm profits compared to the two other scenarios. Off-farm income is at its highest level in SFP scenario.

Figure 46: Decomposition of farm household income per family AWU for individual farms in 2004, 2009, 2013 and 2020 in the three decoupling scenarios

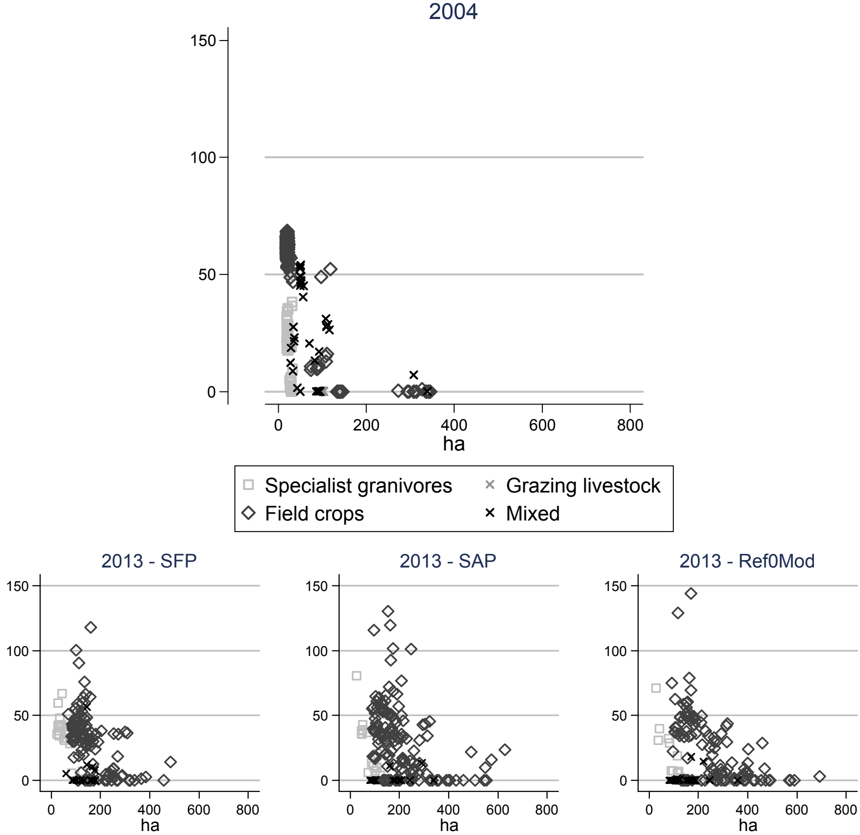
Year	Income	Scenario	Number of farms.	Mean	Standard deviation	Min	Max
2004	Total household income		296	15,852	8,992	2,849	69,902
	Off-farm income		296	4,169	4,385	0	11,072
	Farm profit		296	11,683	9,961	2,674	69,852
2013	Total household income	SFP	160	24,019	12,078	769	69,029
		SAP	182	22,495	12,691	-5,086	65,203
		Ref0Mod	160	**25,427**	17,124	608	77,573
	Off-farm income	SFP	160	**5,407**	4,481	0	11,983
		SAP	182	5,072	4,378	0	11,924
		Ref0Mod	160	4,252	4,712	0	12,219
	Farm profit	SFP	160	18,613	12,362	-8,728	69,029
		SAP	182	17,423	13,357	-10,592	65,203
		Ref0Mod	160	**21,175**	17,635	-3,789	77,573

Source: Own calculations.

There are several points to notice namely that 1) Ref0Mod offers the best chances to reach a high farm profit inside agriculture for family farms; 2) individual farms resort the most to off-farm labour in the SFP scenario; 3) 12 % more individual farms remain in the sector in the SAP scenario compared to the two other decoupling models.

Figure 47 brings an additional view completing the table above. It illustrates the extent to which farm households use their labour to work off-farm at the individual level depending on farms' size and technical orientation.

Figure 47: Percentage of off-farm income on total household income (in %) for individual farms in 2004 and 2013

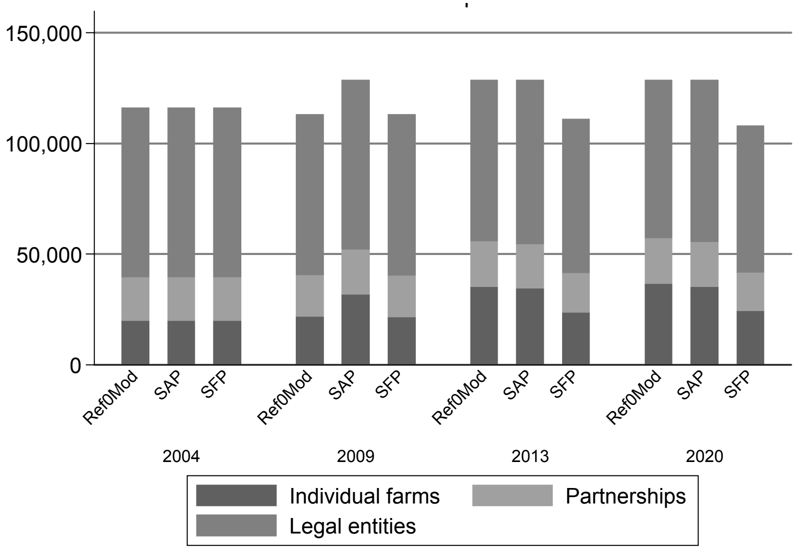


Source: Own figure.

Beyond the consideration of means and averages, the figure above shows that in 2004 most farms were getting less than 50 % of their total farm income out of off-farm work. Actually the figure indicates that the smaller the farm, the higher the proportion of off-farm income in total household income, for all technical orientations, whereas grazing livestock farms are rather fully employing family workforce. This situation has changed in 2013 in the three decoupling scenarios, namely the ratio off-farm income over total household income seems to have "exploded" for some farms reaching far more than 50 % or even 100 % and beyond, even for middle-sized individual farms managing between 100 and 200 hectares. This concerns mostly farms oriented towards granivore and field crop productions, whereas mixed and grazing livestock farms rather use their whole own workforce on-farm. Patterns are relatively similar between the three scenarios except in the case where no family labour is used off-farm; in SAP and Ref0Mod much more farms do not use any family labour off-farm than in SFP.

Figure 48 may eventually provide some more elements about the situation of individual farms on land markets in the three decoupling scenarios. On the figure it can be clearly seen that individual farms is the only legal form renting some more land throughout the simulation compared to the two other legal forms. Actually, individual farms already grasp the chance to rent out all the available land in OPR in 2009 with the introduction of the regional payment in the SAP scenario, as in this scenario Pillar I payments are fully transferred to agricultural land from 2005. This phenomenon only happens somewhat later in 2013 in the Ref0Mod scenario; while no tremendous change in individual farms' land occupation can be observed in the SFP scenario.

Figure 48: Land occupation by legal form and scenarios in 2004, 2009, 2013 and 2020 (in number of hectares used in agriculture)

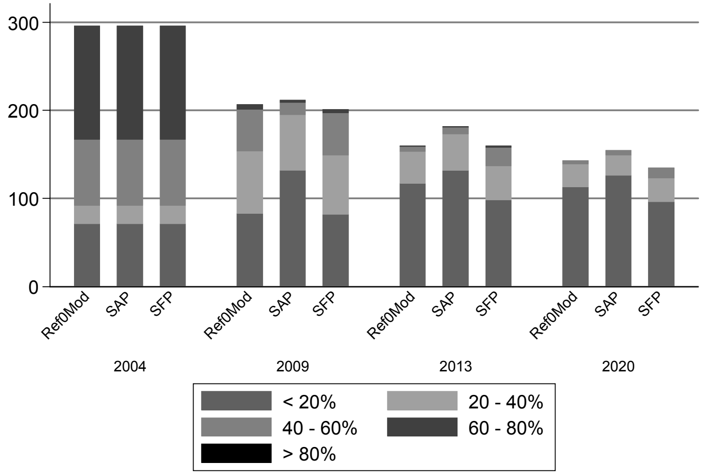


Source: Own figure.

This is an interesting feature explaining why Pillar I payments rather go to individual farms oriented towards field crop farming as seen above in section 5.2.1.1; they have taken the chance to expand at the expenses of other legal forms (especially legal entities) thanks to the redistribution of payments on each hectare of land from 2005 in SAP and in a full extent from 2013 in Ref0Mod. In the contrary the figures for the SFP scenario reveal a decrease in land use even though coupled to a light increase in land managed by individual farms from 2009 to 2020.

Figure 49 provides an additional view on the ownership structure of individual farms continuing farming in the simulations. The first statement is the brutal decrease in the number of individual farms between 2004 and 2009 in all scenarios, in the SAP scenario to a lower extent than in the two other scenarios though. Surviving individual farms own their land to a lesser extent throughout the simulations; farms owning less than 40 % of their land, especially less than 20 %, are the most widespread among surviving individual farms from 2009.

Figure 49: Number of individual farms classified relatively to the percentage of owned land in 2004, 2009, 2013 and 2020 in each decoupling scenario



Source: Own figure.

Moreover, it is to note that almost all farms owning most of their land (more than 60 %) "disappear" between 2004 and 2009; where "have they gone"? Table 38 illustrates the path followed by farms owning between 60 and 80 % of their land in 2004 as well as the path of farms owning a bit less, namely between 40 and 60 %.

Table 38: Number of individual farms switching from their 2004 ownership category to another one in 2009 in each decoupling scenario

2004	2009	< 20%	20-40%	40-60%	60-80%	Total	Closed 2004-09
60-80%	SFP	4	22	24	4	54	75
	SAP	**33**	20	3	3	59	70
	Ref0Mod	3	23	23	6	55	74
40-60%	SFP	4	39	23	0	66	9
	SAP	**23**	36	11	0	70	5
	Ref0Mod	5	40	23	0	68	7

Source: Own calculations.

Whereas similar movements between categories between 2004 and 2009 are observed in SFP and Ref0Mod, one can see a net switch of individual farms from both 2004 ownership categories into the "less than 20 % of owned land" category in the SAP scenario, meaning in other word that those (surviving) farms which owned between 40 and 80 % of their land in 2004 have tremendously expanded in 2009 consecutively to the introduction of the regional payment as implemented in SAP. This expansion happens right from 2005; farms choosing to expand do it by mean of renting available grassland. This phenomenon only happens progressively between 2009 and 2013 in the Ref0Mod scenario with the transfer of all Pillar I payments to arable land and grassland.

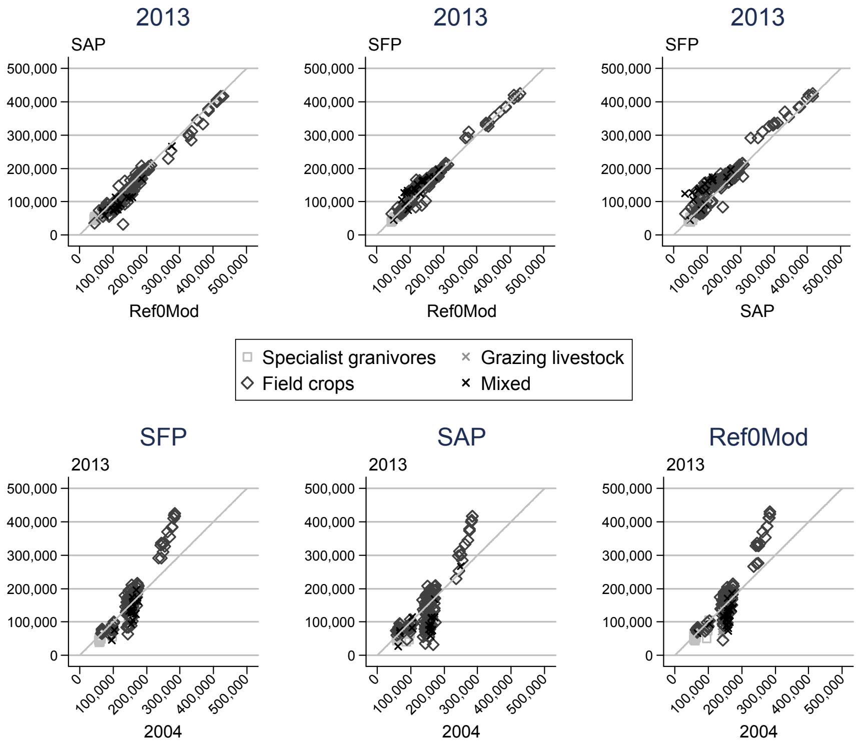
The last figure of this chapter illustrates the following question: would individual farms have gone poorer with decoupling and if yes, in which model did they have to undergo the worst losses?

Believing MISHRA et al. (2002) (p. 14), farm household wealth is the sum of farm net worth (farm assets minus farm debt) and nonfarm net worth (nonfarm assets minus nonfarm debts). As AgriPoliS only allows estimating net worth coming from farming activities, farm household wealth will be approximated as being farm net worth made of the difference between:

- farm assets, of which land and buildings, farm equipment, financial assets and other farm assets and,
- farm debt, of which real estate debt, non-real estate debt, short-term debt and long term debt.

Equity capital is therefore a good estimator of farm wealth. In Figure 50, the comparison of farms' situation between 2004 and 2013 in all scenarios (bottom of the figure) shows that most individual farms oriented in field crop farming and still remaining in the sector in 2013 have seen their wealth increased, especially for those owning more than 200,000 Euros of equity capital in 2004. It is not the case for the other farm types whose equity capital decreased between 2004 and 2013 in all decoupling scenarios. Farms' situation seems identical in both scenarios SFP and Ref0Mod in 2013 compared to 2004 whereas more losses in equity capital are to be stated in the SAP scenario especially by mixed farms. Comparing further the three decoupling scenarios together in 2013 (top of the figure) confirms a higher general level of wealth in SFP followed by Ref0Mod and finally SAP. SFP seems to offer better chances for farms, especially mixed farms, to increase their own capital compared to the two other scenarios.

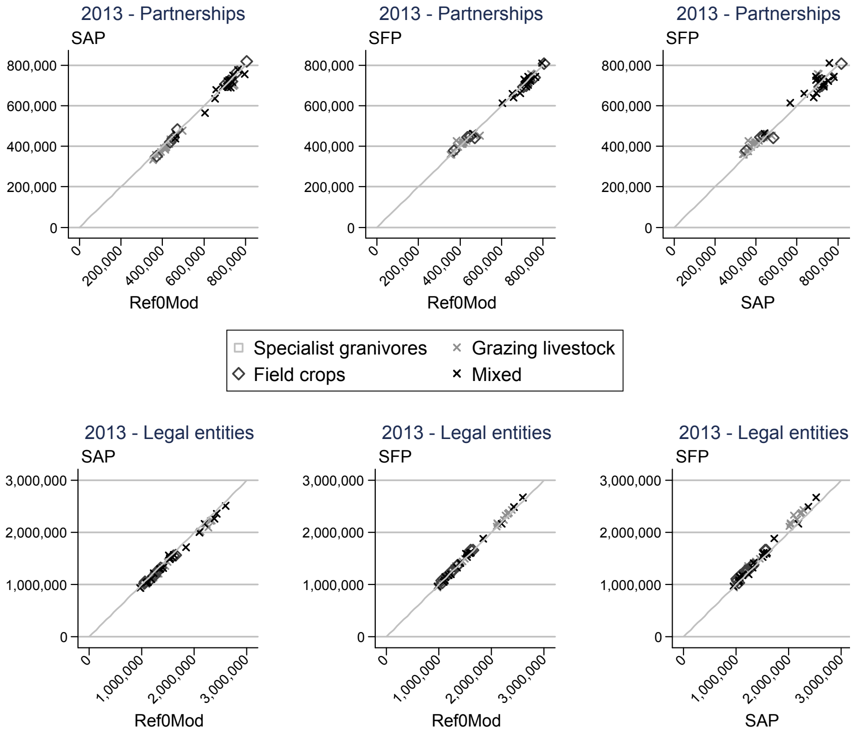
Figure 50: Comparison of equity capital (in Euros) between scenarios in 2013 (top) and development of equity capital between 2004 and 2013 in each decoupling scenario (bottom)



Source: Own figure.

Staying in 2013, Figure 51 provides similar figures than the one built above for individual farms, but this time for the two other legal forms namely partnerships and legal entities. For those two legal forms, there is no clear dominance of any decoupling scenario over the others regarding the variation in equity capital.

Figure 51: Comparison of equity capital per AWU employed in agriculture (in Euros) between scenarios in 2013 for partnerships (top) and legal entities (bottom)



Source: Own figure.

To briefly conclude this section on individual farms, the very first statement is that it is the legal form in which most of the farms closed down during the simulation. However, the extensification possibilities offered by the three decoupling scenarios have permitted those surviving individual farms to both expand their size and permit family members to work more off-farm. Compared to legal entities and partnerships, individual farms have been offered the best chances for expansion above all in the SAP scenario right after the policy switch and then later in the simulation in the Ref0Mod scenario.

5.2.2 Conclusion: Which decoupling strategy for which impacts on farm structures?

The former analyses revealed the wide variety of individual decisions following the change of the agricultural political frame in three decoupling cases. Table 39 below summarizes and synthesizes the distributive consequences of each decoupling scenario with focus on 2013.

Table 39: Summary of distributive effects of decoupling scenarios in 2013

		SFP	SAP	Ref0Mod
Pillar I payments per AWU	Kernel densities	– Two "peaks" of distribution at around 30,000 (Peak 1) and 80,000 Euros (Peak 2) – Peak 2 growing in terms of number of farms between 2009 and 2020		
		Peak 2 at 80,000 Euros in 2013	Peak 2 at 95,000 Euros in 2013	Peak 2 at 100,000 Euros in 2013
	Polarization index	Index increasing in all scenarios between 2004 and 2013		
		Index decreasing between 2009 and 2013	Index slightly increasing between 2009 and 2013	– Highest polarization index observed for all years – Highest increase between 2009 and 2013
	Inequality index	– Increase in all scenarios between 2004 and 2013; highest increase in Ref0Mod – Inequality between farm types predominant; inequality within legal forms predominant		
	Distributive aspects	– Visible increase of payments for most farms between 2004 and 2013 – Gain for field crops and granivore farms + individual farms; loss for grazing livestock and mixed farms + legal entities, partnerships – Increase in the number of legal entities oriented towards mixed and grazing livestock farming		
				Most outliers observed (more than 150,000 Euros per AWU)
	Average Pillar I payments per AWU	Most favourable to: – partnerships in grazing livestock farming Least favourable to: – individual farms in granivore, grazing livestock and field crop farming – partnerships in field crop and mixed farming – legal entities in grazing livestock and mixed farming	Most favourable to: – individual farms in grazing livestock and mixed farming – legal entities in grazing livestock and field crop farming; Least favourable to: – partnerships in grazing livestock farming	Most favourable to: – individual farms in granivore and field crop farming; – partnerships in field crop and mixed farming; – legal entities in mixed farming; Least favourable to: – individual farms in mixed farming – legal entities in field crop farming
Farm dependency to direct payments	Direct payments/agricultural factor income	– General increase between 2004 and 2013 (between 12 and 18%) – Creation of a highly to very highly Pillar I payments dependent class of farms, mostly individual farms oriented towards field crop farming (plus some in granivore and mixed farming) – No legal entities found beyond the 40% ratio		
	In average		Highest dependency to Pillar I payments alone	Highest dependency to Pillar II payments and to direct payments in general
	Per group	Lowest variation in dependency		– Highest variation in dependency – Most partnerships beyond 40% compared to SFP and SAP

		SFP	SAP	Ref0Mod
Income components	Gini index by income source	– Increase in the Gini index between 2004 and 2013 for total agricultural income per AWU – Increase in the contribution of receipts and Pillar I payments to total inequality; decrease in the contribution of interests received – Contribution of Pillar II payments to the decrease of inequality		
		– Highest contribution of interests received to the increase of overall income inequality – Lowest contribution of receipts and Pillar I payments to the increase of overall income inequality;	– Lowest contribution of Pillar II payments to the decrease of overall income inequality	– Highest contribution of receipts and Pillar I payments to the increase of overall income inequality; – Highest contribution of Pillar II payments to the decrease of overall income inequality
	Profits per AWU	– Compared to Ref0Mod: more farms better off in mixed and grazing livestock farming – Compared to SAP: more farms better off	See other scenarios	– Compared to SAP: more farms better off (individual farms in field crops and granivore farming) – Compared to SFP: more farms better off in granivore and field crop farming
Individual farms	In average	More than 30% increase in total household income, mostly due to increase in farm profits		
		Highest off-farm income	Most individual farms surviving	Highest total household income and farm profit
	Ratio off-farm income/total hh income	– "Explosion" of the ratio in 2009 compared to 2004, comparable situations in 2013 – Field crop and granivore farms have recourse for the most to off-farm jobs; much less for mixed and grazing livestock farms		
		Most farms using labour off-farm		
	Land occupation	Small increase in total land occupied by individual farms	Massive increase in land occupied by individual farms by renting available land (predominantly grassland) from 2005	Progressive renting of available land by individual farms between 2005 and 2013
	Ownership structure	Between 2004 and 2009, farms owning more than 60% of their land literally "disappear" from the region		
			Farms owning more than 40% of their land in 2004 to be found in the "less than 20% owned land" category	
Farm wealth	Individual farms	Compared to 2004, improvement of the financial situation for surviving farms in field crop farming (especially with more than 200,000 Euros of EC); worsening for all other farm types		
		– Best situation for farms compared to 2004 – Best chances for mixed farms compared to the other scenarios		

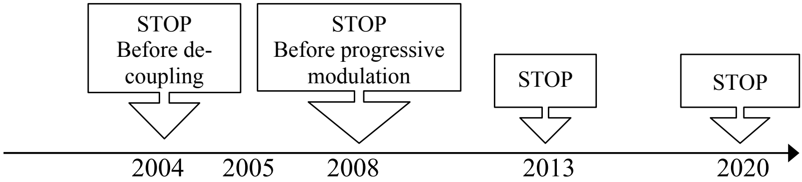
Source: Own figure.

5.3 Modulation of direct payments and distributive impacts of first pillar cuts until 2013

This section aims at investigating the consequences of the introduction of modulation as decided during CAP's Health Check negotiations. For this purpose, Ref0Mod will now be compared to two other scenarios, namely Reform, which considers modulation as actually implemented in Germany on top of the hybrid dynamic decoupling model already considered in Ref0Mod, and RefIDMod, in which equal modulation rates are implemented from 2009 to all farms getting more than 5,000 Euros of Pillar I payments. Figure 52 describes the main features of the three scenarios to be compared in the following.

The impacts of modulation of Pillar I payments on farm structures have already been investigated with AgriPoliS, first in OSUCH et al. (2008) where very first indicative modulation rates proposed by the EU Commission have been tested (EU COMMISSION, 2007a). Later in KELLERMANN et al. (2009) modulation rates as actually implemented since 2009 have been considered (EU COMMISSION, 2008b). In this section we consider an additional situation with the scenario RefIDMod where modulation rates are the same ones for all farms receiving more than 5,000 Euros direct payments, i.e. modulation rates do not increase with farm size.

Figure 52: Summary of experiments testing the implementation of different modulation rates in OPR



Ref0Mod	Agenda 2000 policy: > Full first pillar payments for crops and animals from 2002 to 2004 > AEP for extensive grassland > Set-aside: minimum 10%, maximum 33% > No cross-compliance	INTRODUCTION OF MODULAITON	Hybrid dynamic decoupling scheme: > Progressive switch to a unique regional area payment > Farm specific payment, decreasing from 2010 until 2013 > Calibrated AEP for extensive grassland > No min and max constraint for set-aside from 2009 onwards > No modulation introduced at any time > Payments subject to cross compliance: used land in 2004 has to be maintained at least in GAEC
Reform			Hybrid dynamic decoupling scheme: > Progressive switch to a unique regional area payment in 2013, kept constant onwards > Farm specific payment, decreasing from 2010 until 2013 > Calibrated AEP for extensive grassland > No min and max constraint for set-aside from 2009 onwards > Modulation from 2005, progressive from 2009 until 2013; 2013 values kept onwards > Payments subject to cross compliance: used land in 2004 has to be maintained at least in GAEC
RefIDMod			Same as Reform except: > Same level of modulation between 2009 and 2013 for farms receiving more than 5,000€; 2013 modulation rates kept onwards

Source: Own figure.

As modulation rates practised from 2005 differentiates the three above scenarios, Table 40 below reminds the development of these rates throughout the simulations (see section 4.1.3 for an explanation on the calculation of modulation rates in RefIDMod).

Table 40: Overview of modulations rates implemented in Ref0Mod, Reform and RefIDMod

Name of scenarios	Payment (€)	Until 2004	2005	2006	2007-08	2009	2010	2011-12-13	2014 and onwards
Ref0Mod	1 to 5,000	0%	0%	0%	0%	0%	0%	0%	0%
	5,000 to 99,999	0%	0%	0%	0%	0%	0%	0%	0%
	100,000 to 199,999	0%	0%	0%	0%	0%	0%	0%	0%
	200,000 to 299,999	0%	0%	0%	0%	0%	0%	0%	0%
	Above 300,000	0%	0%	0%	0%	0%	0%	0%	0%
Reform	1 to 5,000	0%	0%	0%	0%	0%	0%	0%	0%
	5,000 to 99,999	0%	3%	4%	5%	7%	8%	9 – 10 - 10%	10%
	100,000 to 199,999	0%	3%	4%	5%	7%	8%	9 – 10 - 10%	10%
	200,000 to 299,999	0%	3%	4%	5%	7%	8%	9 – 10 - 10%	10%
	Above 300,000	0%	3%	4%	5%	11%	12%	13 – 14 - 14%	14%
RefIDMod	1 to 5,000	0%	0%	0%	0%	0%	0%	0%	0%
	5,000 to 99,999	0%	3%	4%	5%	7.5%	8.4%	9.4 - 10.4 - 10.3%	10.3%
	100,000 to 199,999	0%	3%	4%	5%	7.5%	8.4%	9.4 - 10.4 - 10.3%	10.3%
	200,000 to 299,999	0%	3%	4%	5%	7.5%	8.4%	9.4 - 10.4 - 10.3%	10.3%
	Above 300,000	0%	3%	4%	5%	7.5%	8.4%	9.4 - 10.4 - 10.3%	10.3%

Source: Own figure.

In the actual hybrid dynamic decoupling scheme as implemented in Germany since 2005 and reproduced in the Reform scenario, those farms getting the most Pillar I payments (above 300,000 Euros) are the most penalised through progressive modulation from 2009 (14 %). Compared to Ref0Mod, it is therefore worth looking at some consequences for farm structures in the following. On the other hand, if one would have wanted to implement a more "egalitarian" modulation like implemented in RefIDMod, would it have changed anything for farms and if yes, for which ones exactly?

5.3.1 At the regional level, only minor differences, especially between the two modulation scenarios

Table 41 below reports differences at the regional level between the three tested scenarios between 2004 and 2020.

Table 41: Development of farm structures and rental prices in the three tested scenarios in 2004 and afterwards

Year	Scenario	Number of farms	Average farm size (ha/farm)	Average rental price arable land (Euros/ha)	Average rental price grassland (Euros/ha)
2004	All	384	303	106	56
2008	Ref0Mod	321	355	134	68
	Δ Reform	-3	+3	-2	+3
	Δ RefIDMod	-3	+3	-2	+3
2013	Ref0Mod	248	519	155	61
	Δ Reform	-10	+22	-6	+5
	Δ RefIDMod	-11	+24	-6	+3
2020	Ref0Mod	231	557	184	85
	Δ Reform	-17	+5	-16	-2
	Δ RefIDMod	-17	+5	-15	-3

Source: Own calculations. "Δ[name scenario]" provides values compared to those calculated in Ref0Mod.

As a foreword it is to mention that from 2008 all farms still operating in OPR have to overcome modulation as no farm receiving less than 5,000 Euros Pillar I payments is operating in the region anymore.

Whereas results slightly differ between Ref0Mod and the two other decoupling scenarios, differences between Reform (actual modulation) and RefIDMod (same modulation rate over all farms getting more than 5,000 Euros) can not be considered as such. There are several features to be noticed though. First there are more farms closing down during the simulation in the scenarios with modulation (Reform and RefIDMod) than in the scenario without modulation (Ref0Mod). Parallel to this, average farm size increases less rapidly in the scenario without modulation than in the scenarios with modulation. This denotes that modulation penalises more farms than a situation without modulation as already observed in KELLERMANN et al. (2009). Land left after the abandonment of those closing farms is overtaken by surviving farms; this explains the higher average farm size in scenarios with modulation compared to Ref0Mod.

Second, average rental prices for arable land are slightly lower in the scenarios Reform and RefIDMod with modulation than in Ref0Mod without modulation. Looking back at Table 40, one can see that all farms have to expect lower Pillar I payments linked to any additional rented piece of arable land. Therefore bids coming from each farm for any piece of arable land made available on the land market are lower in average than they would have been without modulation as observed in the scenario Ref0Mod. Moreover, the almost no existing difference in rental prices for arable land between Reform and RefIDMod can be explained by the actually very marginal impact at the regional level of the progressive modulation on farm structures as modelled in Reform compared to a uniform modulation as modelled in RefIDMod. In 2013, all farms getting more than 100,000 Euros of Pillar I payments are modulated at the level of roughly 10 %, which is 25 Euros per ha in our simulations; farms getting more than 300,000 Euros"only" lose 9 Euros per hectare in Reform compared to other farms.

Finally, slightly higher rental prices for grassland are observed in the scenarios with modulation Reform and RefIDMod compared to Ref0Mod. Available grassland is more rapidly rented by farms in Ref0Mod than in the two other modulation scenarios between 2010 and 2012. This is linked to lower rental prices in this scenario; higher prices with modulation are driven by farms able to bid more than other farms for these pieces of land, i.e. farms more competitive on the land market even after considering cuts in Pillar I payments due to modulation. With or without modulation grassland newly rented by farms is immediately kept in GAEC, i.e. not for productive activities especially linked to ruminant production. However, grassland can also be used in the framework of the AEM "extensive grassland". Results show that there is hardly any difference observed as regards the participation in the AEM extensive grassland between the three scenarios as shown in Table 42. As regards the proportion of used grasslands in the framework of this programme differences between the three scenarios are minor.

Table 42: Percentages of extensive or intensive grassland used in the AEM "extensive grassland"

Year	Scenario	Extensive grassland	Intensive grassland
2008	Ref0Mod	38.2	32.1
	RefIDMod	36.8	29.8
	Reform	36.8	29.8
2013	Ref0Mod	20.1	11.0
	RefIDMod	20.0	11.0
	Reform	19.8	10.9
2020	Ref0Mod	9.1	4.7
	RefIDMod	7.8	4.0
	Reform	8.8	4.6

Source: Own calculations.

As a summary, modulation exerts a pressure on farms such that some of them close down during the simulations. In 2020, there are a bit more than 7 % less surviving farms when modulation is applied. In this latter situation average farms size follows the reverse trend and is therefore higher when no modulation is applied. Rental prices reflect the pressure of modulation on farms' bids for arable land and are lower in the scenarios with modulation. Differences in rental prices between the three scenarios are tiny and it is the progressive transfer of farm payments to agricultural land which drives rental prices in this case; modulation hardly has any decisive impact on them.

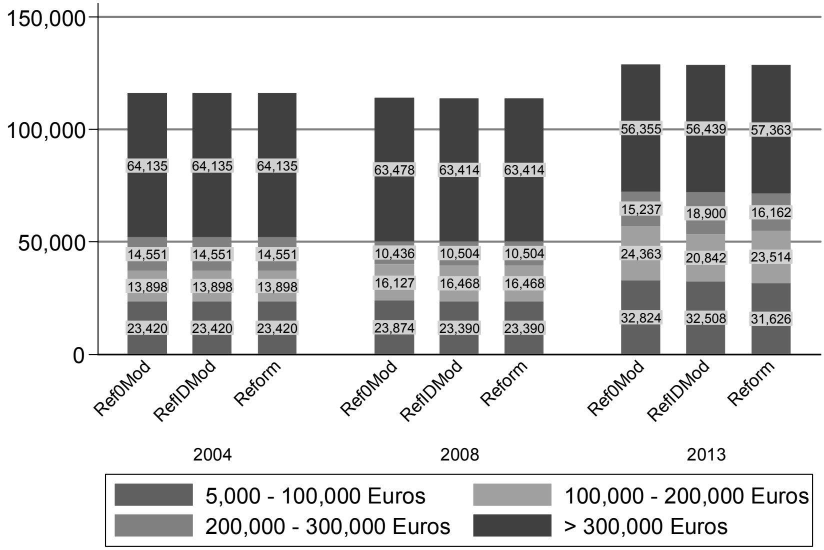
Strong differences between the two modulation scenarios can not be observed at the regional level; this would mean that progressive modulation with farm size does not necessarily endangers the survival of farms getting more than 300,000 Euros of Pillar I payments much more than homogeneous cut in Pillar I payments among the whole farm population. The next section goes beyond regional analyses and provides insights on impacts of the two modulation scenarios at the farm group and individual levels.

5.3.2 At the individual level, some unexpected outcomes

One indicator for farm success or failure in AgriPoliS is the size of the farm. If a farm is successful, it expands by leasing agricultural land, invests in new productive activities and therefore creates jobs. The next figure (Figure 53) illustrates the expansion of farms considering the modulation group they belong to (farms attributed to each group before the implementation of modulation; see Table 40 for the modulation rates). Differences between Ref0Mod and the two other scenarios RefIDMod and Reform between 2004 and 2008 are due to the progressive introduction of modulation reaching 5 % of Pillar I payments from 2007 onwards. Compared to 2004, in 2008, farms receiving between 200,000 and 300,000 Euros lost acreage to the benefit of farms belonging to the other groups. No significant difference can otherwise be observed between the three scenarios at this point of the simulation.

In 2013, compared to 2008, large farms (more than 300,000 Euros of Pillar I payments) have lost significant shares of land to the benefit of the three other modulation groups. This is due to the fact that some of them have downsized between 2008 and 2013 to join the group of farms receiving between 200,000 and 300,000 Euros of Pillar I payments. On the other hand farms receiving less than 200,000 Euros of Pillar I payments in 2008 have expanded in 2013; this has been done thanks to land freed by closing or downsizing farms. The introduction of modulation has not had much impact on the overall distribution of land between the four modulation groups. However, the introduction of a homogenous modulation in the RefIDMod scenario seems to have disadvantaged farms receiving between 100,000 and 200,000 Euros of Pillar I payments, as they occupy a lower share of UAA in the RefIDmod scenario than in the two other scenarios. Have they downsized? It might be possible, but they could have expanded compared to Reform and Ref0Mod to join the upper group of farms receiving between 200,000 and 300,000 Euros of Pillar I payments as well.

Figure 53: Acreage shares considering the modulation group



Source: Own figure.

To go more in detail in comparing the impacts of the three tested scenarios, the following tables display some information on farms not only considering their modulation group but their legal form in 2013 as well. The tables provide additional information compared to Figure 53 regarding movements of farms between modulation groups.

Table 43 shows that among individual farms which belonged to the first modulation group in 2004 (receiving less than 5,000 Euros of Pillar I payments – not modulated) none remain in this group in 2013 in any of the three scenarios. Actually, they have all closed down during the simulation. Among the four individual farms which belonged to the group of farms receiving between 100,000 and 200,000 Euros, two have remained in this group in RefIDMod and Reform and three in Ref0Mod while the other farms have downsized and are to be found in the 5,000-100,000 Euros group. Other farms which belonged to the 5,000-100,000 Euros group in 2004 have expanded their size and entered the 100,000-200,000 Euros group in 2013. To summarize, individual farms dramatically expand their acreage between 2004 and 2013 in the three scenarios. Individual farms which have closed down between 2004 and 2013 in the three scenarios were farms receiving less than 100,000 Euros of Pillar I payments. Modulation has forced some more ten farms in Reform and eleven farms in RefIDMod to close down compared to the situation without modulation like in Ref0Mod; all these farms were prone to modulation but received less than 100,000 Euros of Pillar I payments. Surviving farms remaining in the region and receiving less than 100,000 Euros in 2013 have seen their average size slightly increase with modulation (see average farm sizes); some belonging to this group in 2004 have expanded and joined the upper sized group receiving more than 100,000 Euros. All in all modulation rather prevented individual farms to rent more land than without modulation (see total land occupied for all farms).

Table 43: Distribution of individual farms in each modulation group and average farm size (in ha) in 2013

	Number of farms	Average farm size (ha/farm)	Standard deviation	Minimum	Maximum	Total UAA occupied (ha)
Not modulated						
2004	10	24	5	19	31	240
Ref0Mod	0	0	0	0	0	0
RefIDMod	0	0	0	0	0	0
Reform	0	0	0	0	0	0
5,000-100,000 €						
2004	282	65	64	19	341	18,432
Ref0Mod	146	194	90	27	401	28,346
RefIDMod	135	201	89	28	403	27,196
Reform	135	197	87	27	404	26,626
100,000-200,000 €						
2004	4	342	4	338	346	1,369
Ref0Mod	14	497	80	402	692	6,956
RefIDMod	14	494	101	408	794	6,911
Reform	15	492	89	412	742	7,373
All						
2004	296	68	71	19	346	20,038
Ref0Mod	160	221	124	27	692	35,302
RefIDMod	149	229	124	28	794	34,107
Reform	150	227	124	27	742	33,999

Source: Own calculations. Between 2004 and 2013, 136 farms have closed down in Ref0Mod, 147 in RefIDMod and 146 in Reform.

Regarding partnerships (Table 44) and legal entities (Table 45), it is first to mention that no farm belonging to these two legal forms has closed down between 2004 and 2013.

By partnerships (Table 44) there is a slight expansion to be observed between 2004 and 2013 and even additional expansions when modulation is introduced (see average farm sizes and total UAA occupied for all farms).

Table 44: Distribution of partnerships in each modulation group and average farm size (in ha) in 2013

	Number of farms	Average farm size	Standard deviation	Minimum	Maximum	Total UAA occupied (ha)
5,000-100,000 €						
2004	21	238	50	222	453	4,988
Ref0Mod	17	263	49	217	383	4,478
RefIDMod	19	280	61	217	405	5,312
Reform	18	278	60	217	388	5,000
100,000-200,000 €						
2004	16	704	34	651	745	11,267
Ref0Mod	23	628	92	412	793	14,438
RefIDMod	18	650	62	545	790	11,707
Reform	20	656	75	520	792	13,128
200,000-300,000 €						
2004	5	681	3	677	683	3,405
Ref0Mod	2	817	14	807	827	1,634
RefIDMod	5	855	45	821	931	4,274
Reform	4	856	56	813	939	3,424
All						
2004	42	468	237	222	745	19,660
Ref0Mod	42	489	206	217	827	20,550
RefIDMod	42	507	226	217	931	21,293
Reform	42	513	224	217	939	21,552

Source: Own calculations. Between 2004 and 2013, no farms have closed down.

Table 45 illustrates the differences between scenarios for legal entities. In all scenarios the average farm size and total acreage occupied by legal entities has decreased between 2004 and 2013. It is actually by the largest farms (receiving more than 300,000 Euros direct payments) that acreage has decreased the most. However, here again regarding legal entities, modulation causes a slight expansion in average farm size and total UAA occupied.

Table 45: Distribution of legal entities in each modulation group and average farm size (in ha) in 2013

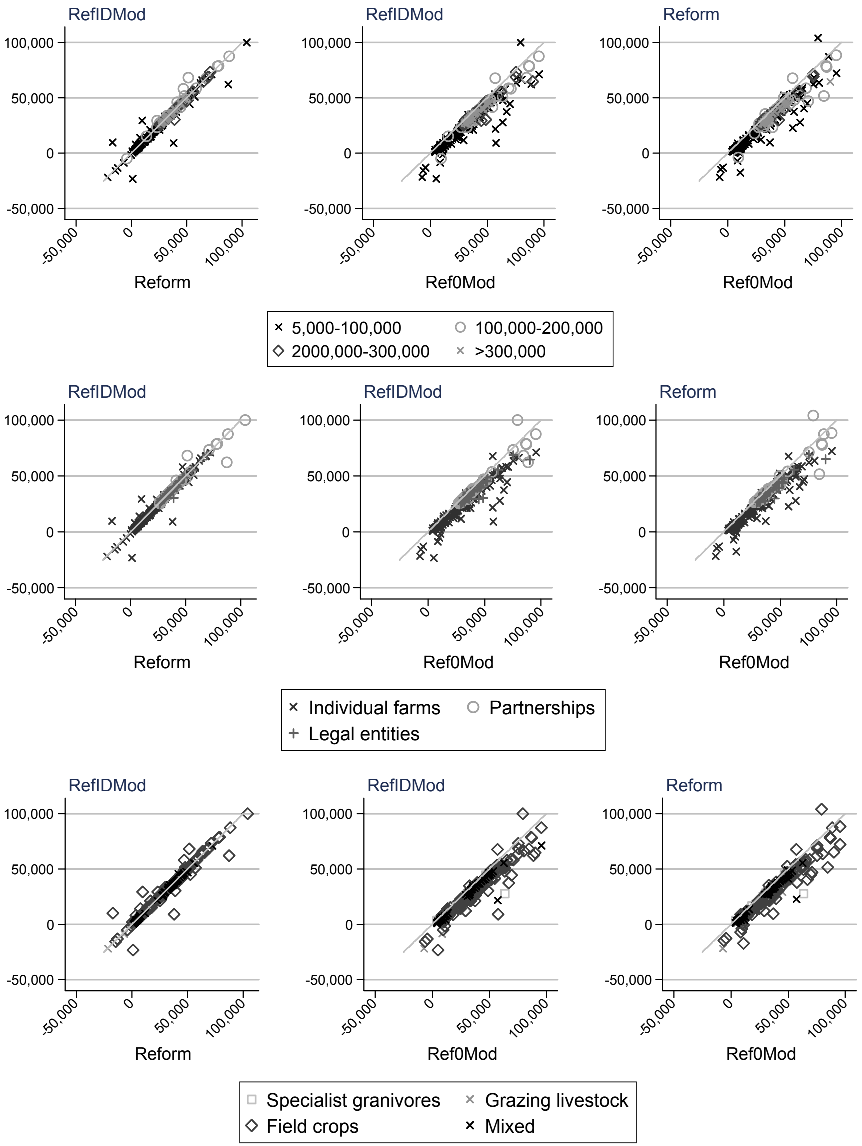
	Number of farms	Average farm size	Standard deviation	Minimum	Maximum	Total UAA occupied (ha)
100,000-200,000 €						
2004	2	631	1	630	632	1,262
Ref0Mod	4	742	76	629	793	2,969
RefIDMod	3	741	76	654	794	2,224
Reform	4	753	68	653	797	3,013
200,000-300,000 €						
2004	12	929	128	775	1,176	11,146
Ref0Mod	14	972	117	826	1,184	13,603
RefIDMod	15	975	120	804	1,199	14,626
Reform	13	980	111	824	1,163	12,738
>300,000 €						
2004	32	2,004	594	1,087	2,779	64,135
Ref0Mod	28	2,013	365	1,242	2,600	56,355
RefIDMod	28	2,016	359	1,240	2,491	56,439
Reform	29	1,978	388	1,204	2,490	57,363
All						
2004	46	1664	722	630	2,779	76,543
Ref0Mod	46	1585	615	629	2,600	72,927
RefIDMod	46	1593	607	654	2,491	73,289
Reform	46	1589	604	653	2,490	73,114

Source: Own calculations. Between 2004 and 2013, no farms have closed down.

Differences between the two modulation scenarios RefIDMod and Reform are pretty marginal what concerns farm size for all legal forms.

One of the sensitive questions raised by the introduction of modulation was the loss of income for concerned farms, especially those farms receiving more than 300,000 Euros of direct payments (simulated in Reform here). These farms are modulated at the level of 14 % while all other farms see their direct payments only cut at the level of 10 %. Figure 54 illustrates the comparison of profits per AWU including all labour costs in the three tested scenarios by modulation group (top), legal form (middle) and technical orientation (bottom).

Figure 54: Comparison of profits per AWU (in Euros, all labour costs included) in 2013 by modulation group (top), legal form (middle) and technical orientation (bottom)



Source: Own calculations.

Comparing the figures confronting the two scenarios with modulation (Reform and RefIDMod) to the scenario without modulation (Ref0Mod), one has to state that profits per AWU globally decrease for all farms still operating in the region in 2013. For some farms this decrease is quite high especially individual farms receiving between 5,000 and 100,000 Euros of direct payments and mostly oriented towards field crop farming. In both scenarios with modulation field crop farms are those having undergone the highest losses in profit per AWU with modulation whereas mixed farms only have to put up with minor losses. Looking at the top figures (per modulation group) it is not by the largest farms (receiving more than 200,000 Euros of Pillar I payments) that the highest losses in profits per AWU are reported but rather by smaller farms. It is the case as well in the Reform scenario where farms modulated at the level of 14 % (group receiving more than 300,000 Euros of Pillar I payments) do not register any high loss in profits as one could have expected. Comparing the two modulation scenarios RefIDMod and Reform, there is no remarkable difference in profits to be stated, rather the presence of few outliers oriented towards field crop farming getting out while the going is good in each scenario.

To conclude this section, Table 46 reports Gini values for Pillar I payments per AWU in 2013 among farms considering either their legal form or their technical orientation. One may have expected the introduction of modulation, either homogeneous or progressive, to have lowered the Gini coefficient compared to the situation without modulation like in Ref0Mod. Actually, this might be the case if we would have displayed this coefficient per hectare. But per AWU, modulation as no significant impact on Gini values taken as a whole (see bottom of the table); still its highest value is to be found in Reform, followed by Ref0Mod and lastly by RefIDMod. Total inequality is mostly constituted of inequalities between farm groups concerning technical orientation; these inequalities are the lowest in the RefIDMod scenario. Regarding the values of Gini coefficient by legal form and technical orientation, it is in RefIDMod that inequality is the highest among grazing livestock and mixed farms. Then, it is in Ref0Mod that the highest inequality is registered among graniore, field crop and individual farms, and so it is as well among legal entities and partnerships in Reform.

Table 46: Gini index for Pillar I payments per AWU decomposed by farm groups considering technical orientation and legal form in the three modulation scenarios in 2013 (highest scores by farm group and by scenario and within or between groups in bold)

Scenario	Groups	Gini index	Population share	Pillar I share	Absolute contribution	Relative contribution
Granivores	Ref0Mod	**0.2502**	0.0766	0.0779	0.0015	0.43%
	RefIDMod	0.2055	0.0591	0.0641	0.0008	0.23%
	Reform	0.2229	0.0630	0.0651	0.0009	0.26%
Gr. livestock	Ref0Mod	0.2191	0.1492	0.0549	0.0018	0.52%
	RefIDMod	**0.2962**	0.1646	0.0670	0.0033	0.96%
	Reform	0.2066	0.1597	0.0553	0.0018	0.52%
Field crops	Ref0Mod	**0.2233**	0.5323	0.7373	0.0876	25.31%
	RefIDMod	0.2051	0.5359	0.7194	0.0791	23.29%
	Reform	0.2119	0.5336	0.7448	0.0842	24.21%
Mixed	Ref0Mod	0.2085	0.2419	0.1300	0.0066	1.89%
	RefIDMod	**0.3054**	0.2405	0.1495	0.0110	3.24%
	Reform	0.2452	0.2437	0.1348	0.0081	2.32%
Within farm types	Ref0Mod				0.0975	28.15%
	RefIDMod				0.0941	27.72%
	Reform				0.0950	27.31%
Between farm types	Ref0Mod				0.2274	**65.70%**
	RefIDMod				0.2052	**60.46%**
	Reform				0.2335	**67.12%**
Ind. farms	Ref0Mod	**0.2954**	0.6452	0.7879	0.1502	43.38%
	RefIDMod	0.2687	0.6287	0.7842	0.1325	39.03%
	Reform	0.2819	0.6303	0.7819	0.1389	39.94%
Partnerships	Ref0Mod	0.3336	0.1694	0.1019	0.0058	1.66%
	RefIDMod	0.3453	0.1772	0.1065	0.0065	1.92%
	Reform	**0.3556**	0.1765	0.1092	0.0069	1.97%
Legal entities	Ref0Mod	0.2782	0.1855	0.1102	0.0057	1.64%
	RefIDMod	0.2792	0.1941	0.1093	0.0059	1.74%
	Reform	**0.2895**	0.1933	0.1089	0.0061	1.75%
Within legal forms	Ref0Mod				0.1616	46.68%
	RefIDMod				0.1449	42.70%
	Reform				0.1519	43.66%
Between legal forms	Ref0Mod				0.1430	41.30%
	RefIDMod				0.1568	46.20%
	Reform				0.1536	44.15%
Population	**2008**	**0.2640***	1.0000	1.0000	0.2640	1.0000
	Ref0Mod	**0.3462**	1.0000	1.0000	0.3462	1.0000
	RefIDMod	**0.3395**	1.0000	1.0000	0.3395	1.0000
	Reform	**0.3478**	1.0000	1.0000	0.3478	1.0000

Source: Own figure.:

Note: * 0.2659 in Ref0Mod.

Finally, the progressive modulation has not necessary lead to the reduction of inequality in the distribution of Pillar I payments when considered per AWU in our simulations. It means that somehow the deviation from the mean has increased when introducing the progressive modulation like in Reform, and decreased with the homogeneous modulation of RefIDMod.

5.3.3 Conclusion: Is modulation a threat for farm structures?

The former analyses have revealed the impacts of two modulation strategies (among them the actual one) on the development of farm structures in the modelled region OPR. Table 47 below summarises main policy outcomes.

Table 47: Summary of impact of modulation in the case study region OPR in 2013

		Reform	RefIDMod	Ref0Mod
Regional level				
	Farm structures	– General decrease in the number of farms in the region; 65% of farms compared to 2004 still operate		
		– 4% more farms close down compared to Ref0Mod – Increase of 4.2% in average farm sizes		
	Land markets	– Increase in rental prices compared to 2004		
		– Increasingly lower rental prices for arable land between 2004 and 2020 – Slightly higher rental prices for grassland		
	Land use	– All grassland fully used again in all scenarios in 2013 – 20% of grassland used in the framework of the AEM "extensive grassland" in 2013; the rest is kept in GAEC – Twice as much extensive grassland (20%) used in the AEM as intensive grassland (11%)		
Individual level				
Acreage shares	General	– Large farms (more than 300,000 Euros of direct payments) have lost significant shares of land because to the benefit of the three other modulation groups between 2004 and 2013: they downised and/or swith to the lower modulation group (between 200,000 and 300,000 Euros of Pillar I payments) – Land available (abandoned land or freed by downsizing or closing farms) between 2004 and 2013 massively rented by individual farms receiving between 5,000 and 100,000 Euros of Pillar I payments		
		Large farms (>300,000 Euros Pillar I payments) keep the highest share of UAA compared to the two other scnearios	Favours growth of farms which were medium-small farms (100,000-200,000 Euros Pillar I payments) in 2004 and become medium-large farms (between 200,000 and 300,000 Euros of Pillar I payments) in 2013	Most favourable to smaller farms (less than 200,000 Euros of Pillar I payments)
	Individual farms	– In average high acreage increase between 2004 and 2013 – Individual farms which have closed down between 2004 and 2013 received less than 100,000 Euros of Pillar I payments		
		– Slight increase in average size of farms receiving less than 100,000 Euros – In total modulation rather prevents individual farms to rent more land		
Acreage shares	Individual farms	– 10 more farms close down compared to Ref0Mod; belonged to the 5,000-100,000 Euros modulation group	– 11 more farms close down compared to Ref0Mod; belonged to the 5,000-100,000 Euros modulation group	
Acreage shares	Partnerships	– No partnership closed down since 2004 – Slight expansion observed between 2004 and 2013		
		– Additional size increase (in average and in total)		

		Reform	RefIDMod	Ref0Mod
	Legal entities	– In all scenarios average farm size and total acreage decreased between 2004 and 2013 – Highest decrease by the largest farms (>300,000 Euros Pillar I payments)		
		– Slight expansion in average farm size and total UAA occupied		
Profits per AWU		– Global decrease for all farms still operating in the region in 2013 – High decrease for individual farms receiving between 5,000 and 100,000 Euros of Pillar I payments oriented in field crop farming – Highest losses by field crop farms; lowest losses by mixed farms – Among modulation groups highest losses in profits per AWU by smaller farms (less than 200,000 Euros Pillar I payments)		
		– No high losses by farms receiving more than 300,000 Euros of Pillar I payments – Some outliers oriented towards field crop farming doing better than in the other modulation scenario	– Some outliers oriented towards field crop farming doing better than in the other modulation scenario	
Gini coefficient	Pillar I payments per AWU	– In all scenarios increase in the Gini coefficient between 2008 and 2013 – Total inequality mostly constituted of inequalities between farm groups regarding technical orientation		
		– Highest total inequality – Highest inequality among legal entities and partnerships	–.Lowest total inequality – Highest inequality among grazing livestock and mixed farms	– Highest inequality among granivore, field crop and individual farms

Source: Own figure.

5.4 Decreasing direct payments after 2013: Which consequences for farm structures?

Present simulations consider the partial removal of Pillar I payments as the core issue of this section. As those payments constitute the bulk of direct support, it is interesting to investigate to which extent their decrease could drive structural change in a region such as OPR. Figure 55 summarises the experiments which results will be analysed in this section

Figure 55: Overview of simulation experiments for after-2013

Reform		Hybrid dynamic decoupling scheme: > Progressive switch to a unique regional area payment in 2013, kept constant onwards > Farm specific payment, decreasing from 2010 until 2013 > Calibrated AEP for extensive grassland > No min and max constraint for set-aside from 2009 onwards > Modulation from 2005, progressive from 2009 until 2013; 2013 values kept onwards > Payments subject to cross compliance: used land has to be maintained at least in GAEC
Ref0Mod_2013	DECREASE IN PILLAR I PAYMENTS?...	Same as Reform but: > Modulation abolished for all farms from 2014 > Direct payments calibrated in 2014 (decrease of 10.6% per hectare) to consider removal of modulation > Direct payments constant from 2014
Decrease_2013		Same as Ref0Mod_2013 but: > Direct payments per hectare decreasing from 2015 until 2020 (20 Euros per hectare less per year)
Mod_2013		Same as Decrease_2013 but: > AEP per hectare increasing from 2015 until 2020 (10 Euros per hectare more per year)

Source: Own figure.

On top of the reference scenario Reform (continuation of the current policy until 2020), the other experiments integrate a removal of modulation from 2014 and the keeping of two distinct pillars (i.e. the four scenarios above are identical until 2013). The removal of modulation is "translated" in form of a calibration of Pillar I payments from 2014. The potential reinforcement of the second pillar of CAP is mimicked as the increase in Pillar II payments in the Mod_2013 scenario after 2013. Table 48 reports the main information regarding direct payments in the region as implemented in the model from 2013 in Mod_2013; this scenario combines all changes introduced in the model simultaneously after 2013 indeed.

Table 48: Main policy settings implemented in the scenario Mod_2013

	Direct payments per hectare			Modulation rates of direct payments for farms belonging to one of these groups:			
	Pillar I (Euros/ha)	Protein plants	Pillar II (Euros/ha)	5,000-100,000€	100,000-200,000€	200,000-300,000€	>300,000€
2013	246	302	230	0.1	0.1	0.1	0.14
2014	220	276	256	0	0	0	0
2015	200	256	270	0	0	0	0
2016	180	236	280	0	0	0	0
2017	160	216	290	0	0	0	0
2018	140	196	300	0	0	0	0
2019	120	176	310	0	0	0	0
2020	100	156	320	0	0	0	0

Source: Own figure.

Therefore, from 2013, Ref0Mod_2013 will only consider the removal of modulation and the continuation of the distribution of calibrated Pillar I payments from 2014 (220 Euros per hectare). This decrease in Pillar I payments has been introduced here in order to take budget constraints into account. The next scenario Decrease_2013 considers the yearly decrease in Pillar I payments as detailed in the first column of Table 48. Finally, Pillar II payments are yearly increased in the scenario Mod_2013 parallel to the decrease of Pillar I payments between 2013 and 2020.

5.4.1 Immediate visible changes

5.4.1.1 A fast(er) structural change

As a preamble it would be useful to look back again at Figure 44 at the end of section 5.2.1.1. This figure illustrated to which extent farms, especially individual farms, were dependent on Pillar I payments for the constitution of their agricultural factor income. Therefore, one may expect a substantial yearly decrease in Pillar I payments to have more serious consequences on farm accounts than those observed in the previous section with the introduction of modulation. Table 49 below confirms the drastic consequences of Pillar I payments cuts applied after 2013 in the modelled region.

Table 49: Development of farm structures and rental prices between 2013 and 2020

Year	Scenario	Number of farms	Average farm size (ha/farm)	Average rental price arable land (Euros/ha)	Average rental price grassland (Euros/ha)
2013	All	238	541	149	66
2020	Reform	214	602	168	83
	Δ Ref0Mod_2013	-8	+23	-2	-4
	Δ Decrease_2013	-144	+438	-28	-11
	Δ Mod_2013	-146	+450	-26	-1

Source: Own calculations. "Δ[name scenario]" provides values compared to those calculated in Reform.

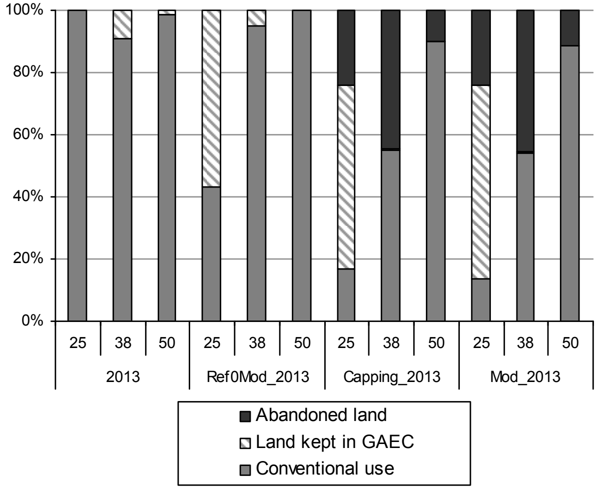
The suppression of modulation and its "transfer" (i.e. the decrease in Pillar I payments between 2013 and 2014, see Table 48 above) to each hectare of UAA already causes some more closing of farms and a consequently higher average farm size than in Reform. But the yearly decrease in Pillar I payments from 2014 to reach 100 Euros per hectare in 2020 as modelled in Decrease_2013 provokes the closing of two thirds of farms compared to Reform, all other things being equal. Average farm size equals almost the double than the one observed in Reform. Two more farms have even closed down in Mod_2013 compared to Decrease_2013 and the average farm size is twelve hectares higher.

Regarding rental prices, the decrease in Pillar I payments per hectare between 2013 and 2014 to consider the removal of modulation as modelled in Ref0Mod_2013 leads to slightly lower rental prices compared to Reform in 2020. On the other hand decreases in rental prices for both arable land and grassland are much higher in Decrease_2013 compared to Reform (17 % lower for arable land; 13 % for grassland). However, rental prices for grassland have not decreased in Mod_2013 compared to Reform in 2020; this has to do with the AEP increasing progressively from 2013 and inciting farms to participate in the AEM "extensive grassland", therefore stimulating grassland use in the region and consequently its attractiveness.

5.4.1.2 A lower attractiveness for agricultural land

Progressively decreasing Pillar I payments per hectare has obvious consequences on land use in the model. As shown in Figure 56, even arable land is not fully used anymore in the two scenarios Decrease_2013 and Mod_2013 in 2020 to the contrary of Ref0Mod_2013. In those two scenarios, low quality arable land ("25" in the figure) is mostly kept in GAEC like in Ref0Mod_2013 but abandoned as well at the level of 22 % which is not the case in Ref0Mod. While arable land on better soils of the region ("38" and "50") is either used conventionally or kept in GAEC in Ref0Mod_2013 in 2020, it is abandoned at the levels of more than 40 % for medium-low quality arable land (38) and 10 % for medium-high quality land (50) in both scenarios Mod_2013 and Decrease_2013.

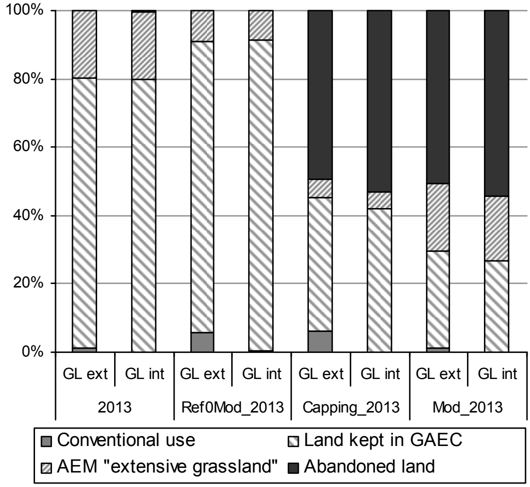
Figure 56: Arable land options used by farms in OPR in 2020 in each scenario



Source: Own figure. 25, 38 and 50 stand for arable land qualities in OPR, 25 being the worst and 50 the best found in the region and introduced in the model.

Regarding grassland, its conventional use is rather marginal as shown in Figure 57. While it is massively kept in GAEC in Ref0Mod_2013 in 2020 and used in the AEM at the level of only 8 %, more than 50 % is abandoned in both scenarios Decrease_2013 and Mod_2013. In other words, it is even not worth keeping this land at least in GAEC. However, in Mod_2013, almost 50 % of grassland still in use in used as extensive grassland in the framework of the AEM while the rest is kept in GAEC. This is due to the increase in the AEP linked to each hectare of grassland used in the AEM between 2013 and 2020. In 2020 the AEP reaches 320 Euros per hectare; by adding the 100 Euros per hectare of Pillar I payments, farmers therefore get 420 Euros per hectare in total for the conversion of grassland into extensive grassland. Results show that in Mod_2013, the yearly increase in the AEP after 2013 helps keeping the level of grassland used as extensive in the framework of the AEM at its 2013 level between 2013 and 2020. In other words, the increase in the AEP encourages the productive use of grassland in the region even after a sharp decrease in Pillar I payments.

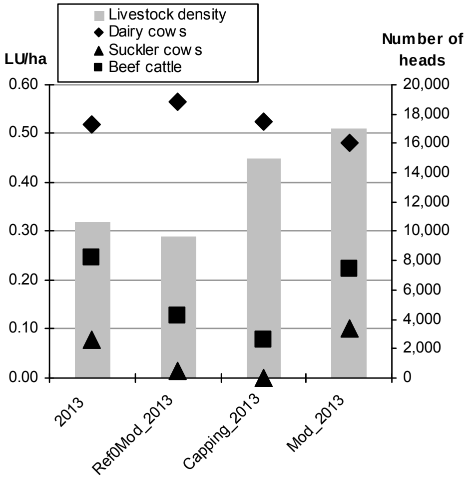
Figure 57: Grassland options used by farms in OPR in 2020 in each scenario



Source: Own figure. "GL ext" stands for low quality grassland; "GL int" stands for high quality grassland.

Figure 58 shows that while livestock density per hectare has decreased in 2020 in Ref0Mod_2013 since 2013, it is the contrary for the two other scenarios; this is due more to the abandonment of land instead of keeping it in GAEC like in Ref0Mod_2013 than to a real increase in animal production. However, when comparing Mod_2013 to Decrease_2013 and Ref0Mod, the increase in the AEP has made beef cattle and suckler cow productions more attractive for farmers.

Figure 58: Number of ruminants and livestock densities in OPR in 2020 in each scenario compared to 2013



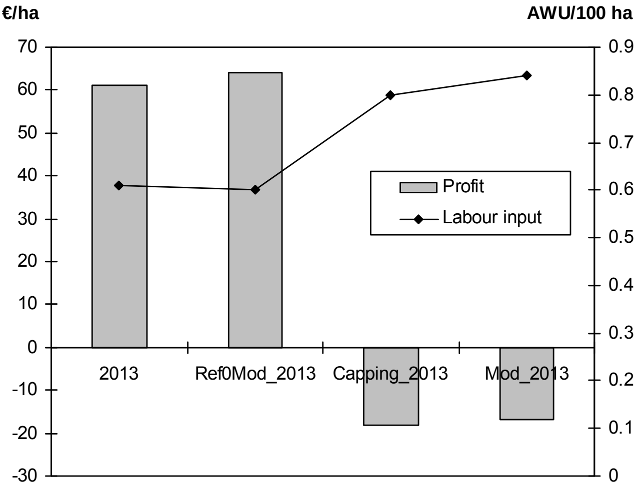
Source: Own figure.

The AEP incites farmers still operating in the region to keep sucker cow and beef cattle production at almost their 2013 levels and prevents their progressive abandonment as observed in Ref0Mod_2013.

5.4.1.3 A sharp decrease in profits… before it240 gets better

The decrease in Pillar I payments has obvious consequences on farm profits throughout the region as shown in Figure 59. In 2020 profits are negative in both scenarios Decrease_2013 and Mod_2013.

Figure 59: Development of profit and labour in OPR between 2013 and 2020 in each scenario



Source: Own figure.

Labour input in agriculture has decreased in both scenarios Decrease_2013 and Mod_2013 as well and amount about 75 % of the 2013 level. However, it is to note that both profits and labour are a bit higher in Mod_2013 than in Decrease_2013, not enough though to state that the increase in AEP do really make a significant difference when Pillar I payments are progressively sharply cut. The question is then the following one: which are the farms which went through the storm of decreasing Pillar I payments and still operate in 2020?

5.4.2 Who did survive the decrease in Pillar I payments at all?

5.4.2.1 Drastic changes in acreage distribution among farms

The yearly decrease in Pillar I payments did not evenly affect farms when considering their legal form as shown in Table 50 below. Particularly, individual farms are those having registered most closings between 2013 and 2020[70]. Merely 9 % still operate in 2020 compared to 2013 in Decrease_2013 and Mod_2013, while this percentage reaches 81 % in Ref0Mod_2013. Although surviving individual farms show a doubled average farm size in 2020 in the two scenarios Decrease_2013 and Mod_2013, this farm group has lost lots of agricultural land on the way and rents or owns only one fifth of its 2013 UAA. In the contrary,

[70] There are three reasons for closing in the model: because of higher opportunity costs outside agriculture, because a generation change occurred and consequently actualised opportunity costs are too high to continue farming for the successor or because the farm is illiquid, i.e. it can not borrow any money anymore.

when no decrease in Pillar I payments occur as it is the case in Ref0Mod_2013, individual farms gain 7 % acreage compared to 2013 and compared to the other legal forms; in Ref0Mod_2013, while partnerships keep their 2013 acreage in 2020, legal entities lose 3.4 %. However, these two legal forms do not lose as much acreage as individual farms do in 2020 in the two scenarios Decrease_2013 and Mod_2013. Legal entities still occupy 66 % of their 2013 UAA and partnerships 82 %. Their average farm sizes increases as well. In the Decrease_2013 scenario, legal entities are in average 8 % larger than in 2013 whereas partnerships gained 23 % of UAA per farm. Differences between Decrease_2013 and Mod_2013 are quite tiny. There is a small decrease in total UAA occupied by each legal form in Mod_2013 compared to Decrease_2013 in 2020 while average farm size is in total a bit higher due to legal entities' expansion. It means that the increase in the AEP neither encourages a higher use of grassland nor slows down farms' closing rate nor prevents massive land abandonment due to the decrease in Pillar I payments.

Table 50: Number of farms and average farm size considering legal forms in 2020 in all scenarios and compared to 2013

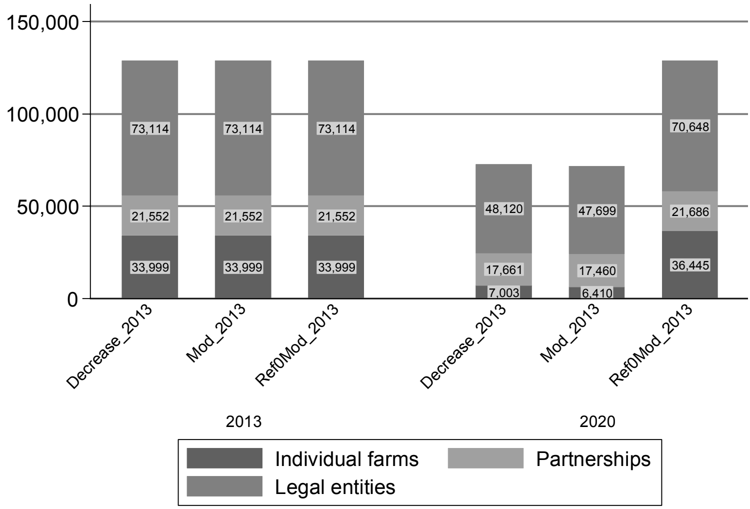
	Number of farms	Average farm size (ha/farm)	Standard deviation	Minimum	Maximum	Total UAA occupied (ha)
Individual farms						
2013	150	227	124	27	742	33,999
Ref0Mod_2013	121	301	165	68	863	36,445
Decrease_2013	14	500	167	190	778	7,003
Mod_2013	13	493	176	291	828	6,410
Partnerships						
2013	42	513	224	217	939	21,552
Ref0Mod_2013	40	542	222	209	933	21,686
Decrease_2013	28	631	269	226	1,275	17,661
Mod_2013	28	624	230	223	1,276	17,460
Legal entities						
2013	46	1,589	604	653	2,490	73,114
Ref0Mod_2013	45	1,570	569	676	2,472	70,648
Decrease_2013	28	1,719	600	819	2,505	48,120
Mod_2013	27	1,767	600	866	2,593	47,699
Total						
2013	238	541	603	27	2,490	128,665
Ref0Mod_2013	206	625	595	68	2,472	128,779
Decrease_2013	70	1,040	699	190	2,505	72,784
Mod_2013	68	1,052	714	223	2,593	71,569

Source: Own calculations.

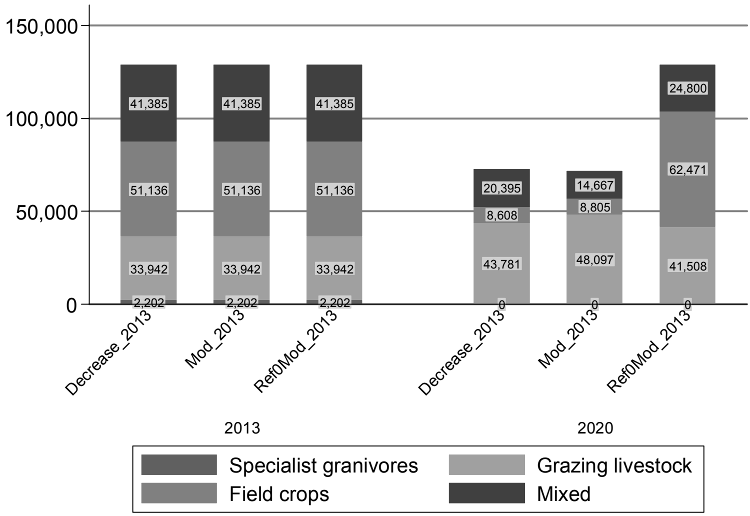
As shown in Table 50 above, individual farms and legal entities are the legal forms having lost most acreage between 2013 and 2020. Figure 60 (a) below illustrates the figures already obtained above in Table 50 while Figure 60 (b) displays acreage distribution in each scenario in 2020 considering farm type. When comparing Ref0Mod_2013 with the two other scenarios, we can conclude that individual farms and legal entities oriented towards field crop farming have closed for the most, letting room to the other farm types, especially grazing livestock farming.

Figure 60: Acreage shares considering legal form (figure a, in hectares) and technical orientation (figure b, in percent) in 2013 and in 2020

(a)



(b)



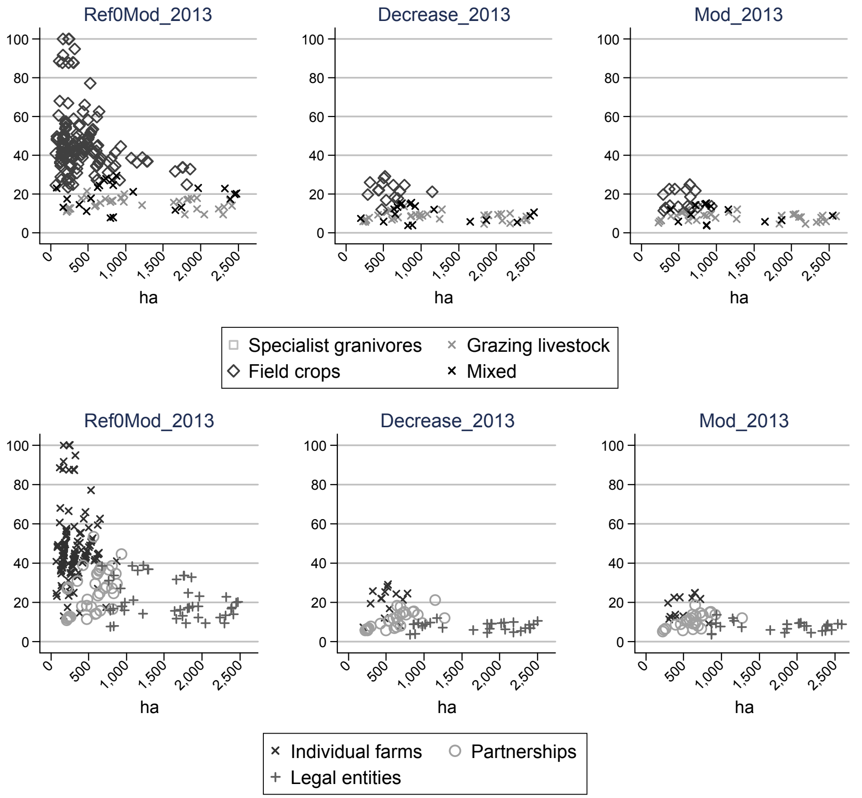
Source: Own figure.

When comparing Decrease_2013 and Mod_2013, it is to state that grazing livestock farming has gained some more agricultural area with the increase in the AEP as implemented in Mod_2013, at the expense of mixed farms mostly while surviving field crop farms occupy the same acreage in both scenarios Decrease_2013 and Mod_2013. Actually, farms classified as grazing livestock farms occupy more than the two thirds of agricultural area in the Mod_2013. It is a bit more than the 60.2 % of UAA observed in Decrease_2013.

5.4.2.2 Dependency to Pillar I payments and comparison of profits

The decrease in Pillar I payments may actually affect farms having heavily relied upon their distribution to continue farming. Figure 61 confirms and illustrates this straightforward assumption and allows considering which farms have closed depending on their dependency to Pillar I payments.

Figure 61: Ratio of Pillar I payments over agricultural factor income in 2020 by farm type (top) and by legal form (bottom) for each scenario (in %)

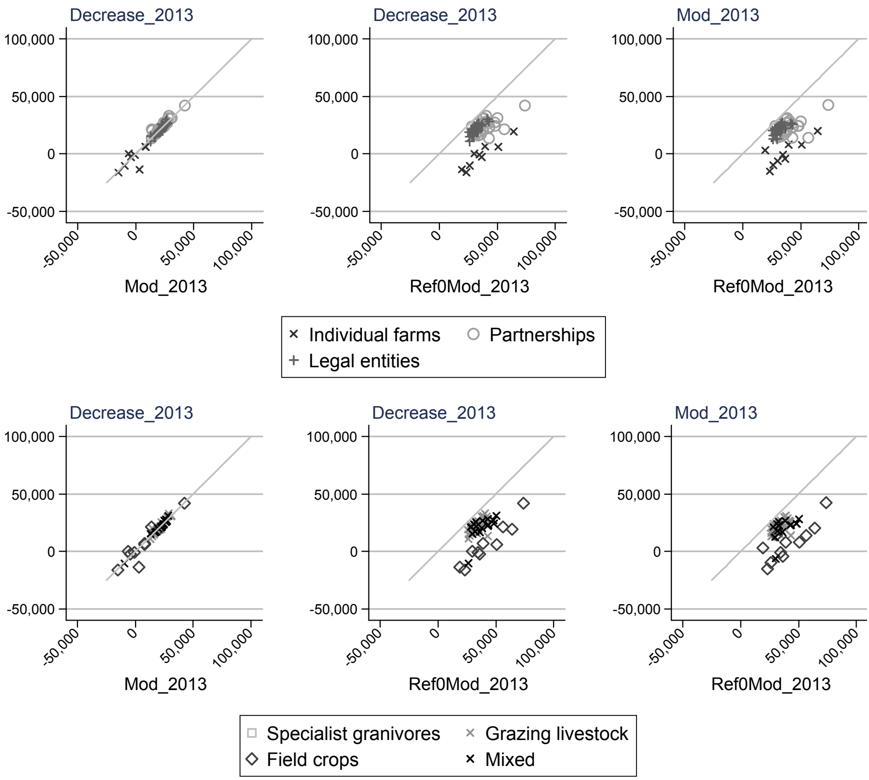


Source: Own figure.

Without any decrease in Pillar I payments as implemented in Ref0Mod_2013, the majority of farms in OPR would still see most of their agricultural factor income constituted of those payments in 2020. Mostly individual farms oriented towards field crop farming would be found among these highly-dependent farms, but some partnerships and legal entities oriented in field crop farming and mixed farming as well. Figures related to both scenarios Decrease_2013 and Mod_2013 are quite similar and reveal the complete absence of farms seeing their agricultural factor income constituted of more than 30 % and 25 % of Pillar I payments respectively.

Regarding the situation of profits per AWU in 2020 Figure 62 below compares their values in the three scenarios against each other depending on farms' legal type and technical orientation.

Figure 62: Comparison of profits per AWU (all labour costs included) in 2020 (in Euros) by legal form (top) and technical orientation (bottom)



Source: Own figure.

One has to notice that the increase in the AEP has not exerted any decisive influence on profits when comparing Decrease_2013 and Mod_2013. In the opposite, cuts in Pillar I payments in those scenarios have logically disadvantaged all farms still operating in the region compared to the situation in Ref0Mod_2013. Most affected are individual farms in field crop farming for which Pillar I payments allow to keep positive profits if at all.

5.4.3 Conclusion

The cuts in Pillar I payments after 2013 are undoubtedly the main drivers of farm structural developments of OPR. Table 51 below summarises the main policy outcomes of the preceding experiments.

Table 51: Summary of impact of cuts in Pillar I payments and/or modulation in the case study region OPR in 2020

		Decrease_2013	Mod_2013	Ref0Mod_2013
Regional level				
	Farm structures	– General decrease in the number of farms in the region compared to the continuation of the actual policy – Increase in average farm size		
		– Only 40% of farms operating in 2013 are still in the sector in 2020 – Average farm size almost doubled since 2013 – No structure conserving effect of higher AEP		– Compared to the continuation of the actual reform, 8 more farms closed down – Average farm size 3.8% larger
	Land markets	– Decrease in rental prices for arable land and grassland compared to the continuation of the actual policy		
		– Arable land loses 19% of its value as calculated without Pillar I cuts		– Slight decrease in rental prices for arable land and grassland compared to the continuation of the actual reform
			– Rental price for grassland at the same level as if the actual policy was continued	
	Land use	– Low quality arable land massively kept in GAEC –		
		– Abandonment of some parts of arable land (22% of low quality; 46% of medium-low quality and 10% of medium-high quality arable land) – Abandonment of more than 50% of all grasslands, otherwise mostly kept in GAEC		– Arable land fully used whatever its quality – Medium-low and medium-high quality arable land mostly used conventionally – Grassland fully used, mostly kept in GAEC, 10% in the AEM
			– 40% of used grassland in the AEM – Suckler cow and beef cattle productions more attractive for farmers	
	Profits	– In average negative profits per hectare – Increase from 2021 and positive again from 2024		– Slight increase in profit per hectare compared to 2013
Individual level				
Acre age shares		– Only 9% of individual farms operating in 2013 still in the agricultural sector in 2020 – Average farm size doubled; loss of 4/5[th] of 2013 acreage in total – Legal entities still occupy 66% of their 2013 UAA; partnerships, 82% – Gain in average farm sizes; 8% by legal entities, 23% by partnerships		– 81% individual farms still in the agricultural sector – Gain of 7% in acreage – Partnerships keep their 2013 acreage; legal entities lose 3.4%
		Decrease_2013	**Mod_2013**	**Ref0Mod_2013**
Farms closing		– Individual farms and legal entities oriented towards field crop farming closed down		
		– Grazing livestock farming occupies 60.2% of total UAA	Grazing livestock farming occupies 67.2% of total UAA at the expense of mixed farms compared to Decrease_2013	– Field crop farming occupies almost 50% of total UAA

		Decrease_2013	Mod_2013	Ref0Mod_2013
Dependency to Pillar I payments		– No farm with more than 30% of Pillar I payments in agricultural factor income	– No farm with more than 25% of Pillar I payments in agricultural factor income	– Most of agricultural factor income constituted of Pillar I payments by: – individual farms oriented towards field crop farming – partnerships and legal entities oriented in field crop farming and mixed farming
Profits		– Decrease in Pillar I payments unfavourable to all farms, particularly to individual farms in field crop farming		
			– Higher AEP do not mean higher profits	

Source: Own figure.

6 DISCUSSION AND CONCLUSION

The overall objective of the study was to depict structural and distributive implications of recent CAP reforms and other relevant policy designs in the agricultural sector. Three decoupling modalities following Fischler's reform proposals for the CAP have been compared as well as recent discussions and decisions in the framework of CAP's Health Check. In addition, future paths for the CAP after 2013 have been considered and investigated in the form of yearly varying direct payments. The agent-based model AgriPoliS adapted to the German district Ostprignitz-Ruppin (OPR) in the Federal State of Brandenburg has been used to investigate structural and distributive issues implied by recent reforms and changes in the CAP. Two innovations have been introduced in the model in order to better tackle regional issues. First, three different soil qualities for arable land and two for grassland have been created. Farms received a mixture of those soils in the initialisation phase therefore more heterogeneity among farms has been introduced. Second, the possibility to use grassland extensively in the framework of the agri-environmental measure "extensive grassland", as actually in place in the OPR region, has been introduced in the farm optimisation programme.

In a first series of simulation experiments, three decoupling modalities, namely a historic payment, a regional payment and the actual German dynamic hybrid decoupling have been implemented from 2005 in the model. In a second series of experiments, two modulation modalities between 2009 and 2013 have been compared. First, a modulation increasing with farm size, or progressive modulation, was introduced in the model. The same modulation rates than those introduced in 2009 consecutively to the Health Check of the CAP have been used. Second, a homogenous modulation with rates increasing between 2009 and 2013 was implemented for all farms receiving more than 5,000 Euros of Pillar I payments. In the third and last series of experiments yearly cuts in Pillar I payments are introduced from 2013 onwards parallel to increases in the AEP for the use of extensive grassland. General impacts as well as distributive aspects are investigated and analysed in a short, medium and long term perspective (2009, 2013 and 2020 respectively). Impacts on farm structures, agricultural production, land uses and rental prices constitute a first set of analyses perfomed in the study. The comparison of distributive aspects regarding direct payments as well as profits and agricultural incomes resulting from CAP reforms constitutes the second milestone of this work.

6.1 Outcomes of decoupling

6.1.1 Impacts on farm structures, land uses and rental prices

Simulations of the three decoupling scenarios show that the introduction of the regional payment is inhibiting structural change in the sense that less farms close down compared to the two other decoupling scenarios from 2009. Despite the persistence of lower profits compared to the other decoupling scenarios, the regional payment offers the best opportunities for farm growth, especially for small farms. On the contrary least farms survive after 2005 with the introduction of a historic payment. This has surely to do with the ownership structure in OPR which undergoes tremendous changes through decoupling. Land transfers occur from small or medium-small farms owning most of their land to larger farm units renting most of it. The highest increases in farm size are observed by individual farms oriented in field crop farming especially in the case of a regional payment. The attractivity of land is strongly influenced by distributive patterns of Pillar I payments. For instance, grassland becomes attractive in case of a regional payment right from 2005 and from 2013 in the case of the actual dynamic hybrid payment. Most of grassland used from 2005 or 2013 is then kept in GAEC. The increase in rental prices for grassland observed between 2004 and 2005 in the case of a regional payment confirms the analyses performed by VELAZQUEZ (2008). Indeed, in case of a regional payment, all UAA is eligible for payment. This keeps rental prices high and therefore transfer efficiency to farms is lower than in the historic model. However, simulations show that in case of the historic payment, rental prices increase later on in the same proportions than those observed in the two other decoupling models. This has to be related to high entitlement values compared to the two other models as also expected by VELAZQUEZ (2008). After 2005 there are no more entitlements than land declared as used in 2004. Farm growth can therefore only be supplied by released land from other farms. Land is then kept in GAEC, i.e. not necessarily used for production purposes.

Arable land is always fully used in all three tested scenarios. However, the decoupling of Pillar I payments makes low quality arable land be kept in GAEC but taken out of production. Actually, in the case of the continuation of the Agenda 2000 policy beyond 2005, these low quality lands would have been set aside. Therefore decoupling leads to a concentration of productive activities on better soils whereas poor soils are minimally used, which is in line with ISERMEYER (2003) and FRASER (2009).

The possibility to observe the development of rental prices for each soil quality separately allows the observation of capitalisation of Pillar I payments on low quality arable land. Believing SWINNEN et al. (2008), capitalisation is most visible in marginal, less fertile lands where other drivers of rental prices are less important. This is supported by this study as low quality lands are only used to be kept in GAEC, not for productive purposes. Moreover, the introduction of cross-compliance linked to decoupling plays an important role in the decrease of employment in agriculture. This decrease is partially linked to the abandonment of ruminant productions. Freed time is used by family workers to occupy a job outside the farm and the number of agricultural employees is reduced. This meets conclusions by SWINNEN et al. (2008) finding empirical evidence that with the introduction of decoupling and cross-compliance, farmers may have more freedom in their production decisions. Farmers can therefore reduce non-profitable activities or become part-time farmers (PETRICK and ZIER, 2011).

Renting most of their land makes farms much more sensitive to policy changes. Therefore distributive effects of direct payments are important to consider as they may strongly influence the development of those rental prices, therefore production decisions and finally profits and incomes.

6.1.2 Distributive effects of direct payments

Believing ISERMEYER (2003) the sudden introduction of a regional payment may immediately lead to either over- or under-compensation which ISERMEYER estimated could have reached 100 €/ha on 20 % of the UAA. Similarly, by comparing the outcomes of a hypothetical historic model to those of the actual German hybrid dynamic model, KLEINHANß (2007) finds that in the historic model, entitlement levels would be below 200 €/ha and above 500 €/ha for about 10 % of the UAA each. Simulation results do not reach these extremes in the case study region. Due to the lower value taken by the regional payment from 2005, an over-compensation only occurs on 12 % of the UAA. At the other end of the distribution, a loss in direct payments of more than 50 €/ha concerns 15 % of the UAA. In case of the historic payment, in 2013, entitlements are beyond or under a 10 % variation around the average payment (277 €/ha) on 11.5 % of the UAA.

The variation in land-linked entitlements values before and after decoupling is important for farms. In average, an important share of farms' agricultural factor income is constituted of direct payments in 2013. Individual farms in field crop farming see most of their agricultural factor income based on Pillar I payments, especially with a regional payment. However this ratio does not exceed 40 % for other legal forms in any of the three scenarios. Obviously the modalities of allocation of Pillar I payments have an influence on the overall inequality observed in their distribution. The increase in overall inequality in agricultural factor incomes between 2004 and 2013 as well as the increase in the contribution of Pillar I payments to this overall inequality show that none of the decoupling scheme does really change distributive inequalities observed between farms. The highest polarization and Gini indices are found in the case of the actual hybrid payment. The highest contribution of Pillar I payments in increasing overall inequality in agricultural factor incomes is observed in this scenario as well. Beside this, it is the scenario where Pillar II payments help decreasing overall inequality the most.

Decoupling benefits the whole sector due to the possibility to focus on the most productive activities on-farm and to keep marginal land in GAEC. Therefore labour input in agriculture decreases and Pillar I payments *per annual working unit* increase for most farm groups between 2004 and 2013. Considering Pillar I payments *in volume*, results confirm the findings of KLEINHANß (2007) according to whom in the historic model in 2013, intensive beef fattening and intensive milk production would have kept more payments compared with the other decoupling models. However, *per annual working unit*, this is not the case anymore for most livestock farms for which Pillar I payments stagnate compared to 2004. Among them, legal entities lose Pillar I payments independent of their technical orientation. Field crop farming, mostly operated by individual farms, has gained a lot with decoupling, especially with the actual hybrid payment. Actually in this scenario these farms could almost triple the amount of Pillar I payments per annual working unit compared to 2004. This tremendous increase in Pillar I payments would have not been that visible if Pillar I payments would have been considered per farm. This increase is due to large expansions by renting free grassland from 2005 in case of a regional payment, progressively until 2013 with the actual hybrid payment. Parallel to this labour intensity is reduced due to the possibility to keep land in GAEC but not to produce on it. These results are in line with KLEINHANß (2007) who mentions that fully implemented regional flat rates after 2013 would induce significant redistributions in favour of extensive farms and less-favoured areas, while intensive cattle farms would be negatively affected. Other beneficiaries of decoupling are granivore farms including individual farms which can increase acreage and grow to further invest in pig production while they would otherwise be constrained by limitations on stocking densities in the model. Even though the hybrid payment actually helps avoiding profit losses in a short term perspective as mentioned by ISERMEYER (2003), it does not help farms to be less dependent on direct payments than they already were before 2005. This reduces potential room for manoeuvre and therefore will complicate future CAP reform negotiations.

6.2 Impacts of modulation

Simulation results show that both modulation schemes tested in the study provoke the closing of more farms compared to the situation without cuts in Pillar I payments. Farms closing are all mainly small individual farms. This may contradict expectations made during CAP's Health Check negotiations on the consequences of modulation in Eastern Germany. It was feared that especially very large farms would be threatened in their existence due to the drastic cuts which could cause further job losses in already economically underdeveloped areas. These expectations are not confirmed by the simulation experiments for the region OPR. Similar results were obtained by BALMANN et al. (2008) and KELLERMANN et al. (2009) for the Central Saxonian Loess Region. Results even show that smaller farms (mostly individual farms plus some partnerships with less than 300 ha, receiving less than 100,000 Euros of Pillar I payments and farms receiving between 100,000 and 200,000 Euros of Pillar I payments, mostly partnerships, some individual farms and a few legal entities with some 300 to 600 ha) would lose ground on the land market. They would lose acreage in both modulation schemes to the benefit of medium-large farms (receiving between 200,000 and 300,000 Euros of Pillar I payments, mostly legal entities and a few partnerships). Obviously, the "smaller" farms suffer more from the introduction of modulation rates of up to 10 % than the medium-large farms. Also large farms (receiving more than 300,000 Euros Pillar I payments, all legal entities) lose acreage and downsize with the actual hybrid payment between 2008 and 2013. However, none of them closes down with modulation. Results even show that those large farms as well as medium-small farms would gain some acreage in case of a progressive modulation compared to the introduction of a homogenous one. Modulation of Pillar I payments logically exerts a pressure on farm profits. To this extent the highest losses are found for small and medium-small farms, especially by small individual farms oriented towards field crop farming. It is to note that, when looking at profits large farms are again not more penalized by progressive modulation compared to a homogenous modulation for all farms. Finally, considering the reasons invoked for capping and progressive modulation, the assumption was made that "public funds should aim at correcting inequalities by supporting those who derive fewer advantages from the market organizations" (BUREAU et al., 2007). Following the transparency initiative for the publication of beneficiaries of EU funds, the EU Commission considered cuts in Pillar I payments as a necessary instrument to consider the redistributive issue among farms (EU COMMISSION, 2007a). However simulation results show that a weak progressive modulation would neither prevent inequality in the distribution of Pillar I payments from increasing between 2008 and 2013, nor makes inequality decrease much more than with no modulation at all. A homogenous modulation would even have reached better scores. Finally, no significant increase in the participation of farms to the AEM "extensive grassland" with modulation could be observed. Therefore, modulation rather succeeded more in limiting visible excesses pointed out by public opinion than being a sensible redistributive tool between Pillar I and Pillar II.

6.3 CAP after 2013: What would a decrease in Pillar I payments imply?

Simulation results meet some of those made in KELLERMANN et al. (2009)[71], namely that impacts on farm structures are substantial and visible from the first

[71] KELLERMANN et al. (2009) did not implement exactly the same political experiment as the one presented in this study in another studied region, the Central Saxonian Loess Region with much better soils. While here Pillar I payments are progressively yearly reduced to reach 100 Euros per hectare in 2020, KELLERMANN et al. chose (2009) to cut them drastically at the level of 150 Euros per hectare from 2014. Whereas this political design provided interesting results, the one chosen in this study somehow seemed more plausible.

year of payments' cuts. Structural change is substantially speeded up and among those farms closing the huge majority is constituted of individual farms, which are the smallest farms in the region as well. In 2020, only 9 % of individual farms operating in 2013 are still in the agricultural sector. Knowing that in 2013 most individual farms were highly depending on Pillar I payments for the constitution of their agricultural factor income, it is not surprising to see most of them closing down with Pillar I payments decreasing until 2020. Only farms depending on Pillar I payments for less than 30 % of their agricultural factor income in 2013 still remain in the region in 2020. Partnerships and legal entities resist much better to the strong decrease in Pillar I payments (67 % and 61 % remain in the region respectively) and continue farming in 2020 on most of their 2013 UAA. However, total employment in agriculture only reaches 75 % of its 2013 level. In their study KELLERMANN et al. (2009) have rather focused on CAP's Health Check's implications for the agricultural sector and neither considered different soil qualities nor any reallocation of Pillar I payments to Pillar II. Regarding the first point, simulation experiments performed in this study reveal that arable land has lost 19 % of its value and if not abandoned, low quality arable land is massively turned into land kept in GAEC. Regarding the second point, the possibility to participate in the agri-environmental measure (AEM) "extensive grassland" extends model's capabilities in assessing the relative attractiveness of an environmentally friendly measure. Farms receive an agri-environmental payment (AEP) for converting their whole grassland into extensive grassland and this measure proved to be successful in reality. The introduction of this measure in the model is an example of policy relevant experiments to identify possibly successful agri-environmental measures and assess their potential impacts. This would help overcoming difficulties linked to the choice, implementation and monitoring of Pillar II measures as mentioned in BUREAU et al (2007). Results show that the yearly increase in the AEP after 2013 exerts a pressure on rental prices for grassland through the indirect support of land-based animal productions. However, it is neither enough to slow down structural change nor to prevent the abandonment of more than 50 % of available grasslands. But it is enough for farms to keep 40 % of the remaining used grassland as "extensive grassland". In 2020 grazing livestock farming even gained some acreage compared to the situation where Pillar I payments are simply cut without redistribution to Pillar II.

6.4 Conclusion

The three series of simulation experiments helped depicting precise impacts of CAP reform at the very individual level by considering a population of heterogenous farms. The introduction of different soil qualities has added another degree of differentiation between farms and therefore the possibility to better consider natural constraints in farms' decisions. However, no systematic link between soil qualities and farms could be established in the sense that farms randomly received a mixture of each soil quality in the model. In reality, farms make the best out of their capabilities especially considering constraints linked to their location. Even though in AgriPoliS farms can adapt to their environment by investing in best suited activities, the possibility to link specific soil mixtures to specific farm types should be considered to better represent farms'environment in the model. This could be achieved by considering geographical information or by gathering this information with field work and expert knowledge. Of course, this adds some difficulty to the already complex task of adapting the model to a region. However it would allow assessing impacts of continuous policies in heterogenous regions and marginal areas.

Then, the farm's behavioural rule is limited to the maximisation of farm income. Whereas this may be the objective for the majority of professional farms in Europe, some farms may follow other objectives. For instance the resilience to continue agricultural activities which are not profit-maximising may not be consistent with the farm income maximisation rule introduced in AgriPoliS. Life quality on the farm, the preference for performing an agricultural work, the will to hand the farm to children or the lack of perspectives off-farm might constitute some reasons for farmers not to quit the sector as fast as economical logic would suggest. Further work on opportunity costs as well as on optimisation rules could add to model's relevance for policy analysis and help further exploring a multifaceted structural change.

Finally, simulation experiments have been performed in a rather fixed and stable framework. For instance, prices were fixed in the model from the beginning and no variation has been introduced during the simulation. This might be an issue to investigate more closely in future experiments as prices are an important driver in farm planning. Moreover in AgriPoliS farms know which prices they can expect for each product in advance. In other words farms set out their optimisation plan knowing what they have to expect from markets and policy in the next year. This is not the case in reality, except on futures markets; prices are not known in advance on the cash market. Farmers have to consider the risk that their expectations may not be fulfilled while planning rotations and investments. Several factors determine farmers' decision making in this sense. Considering past experiences and successes could be one of them. This would be interesting to integrate in the model in order to better approximate farmer's decisions to quit agriculture or switch to another production system. Confronted to varying prices, farms could show a more realistic resilience to continue what they have been doing if the activity already proved successful in the past. Considering an insurance system could complete and extend the portfolio of available activities and investments at farmers' disposal.

Simulation experiments showed that any public intervention has distributive consequences on farm structures. However, the use of agent-based modelling revealed that any expectations can easily be put into question when considering farms' adaptive capabilities in a dynamic framework. In this sense simulation experiments can provide additional insights on policy impacts compared to more classical approaches. Moreover, analyses performed at the very individual level allow a precise targeting of study groups. This facilitates the identification of main beneficiaries of public support as well as the impact assessment of payments' distributional patterns on farms' investment choice. Agent-based modelling is therefore an appreciable tool which allows depicting impacts of a policy on a highly differentiated population placed on a heterogeneous landscape. Especially when considering a portfolio of voluntary programmes as mostly implemented in the current Pillar II of the CAP, agent-based modelling could help investigating the extent of moral hazard and adverse selection of potential new measures. Consequently a better assessment of required resources would prevent empty or full cashbox phenomena in public expenses. However, as no success can be guaranteed without any clear setting of objectives to be reached at the regional level, it is important at the first place to consider past successes and local knowledge. Therefore agent-based modelling could constitute a helpful tool not only for policy impact assessment, but for policy decision making as well.

This study considered CAP as it is known today and until 2013. However, discussions are currently on the track to design the future policy to be implemented during the next programming period 2014-2020. The proposal made by the EU Commission on November 18th, 2010 reveals the maintenance of a two pillar structure with complementary roles when possible. Redistribution, redesigning and better targeting of support are issues mentioned to be tackled at the first place by means of an adapted and simplified direct payments system. The current system would be splitted into a basic income support component to all farms (including an upper ceiling for large farms and a minimum for small farms) and a top-up in the form of green payments for simple environmental services, the whole targeted at "active farmers". Less favoured area payments would be transferred to Pillar I. Additional support could be provided to regions with specific natural constraints and to particular farm types by recoupling support to production criteria. These proposals seem to give new names to old instruments as well as to miss the point regarding displayed issues to be tackled, especially the redistributive issue which recently angered European civil societies. Redistribution of support would have to be twofold, namely between Member States and between farms. Between Member States the decline of a single flate rate direct payment as mentioned in the proposal may exclude any further plan to set a unique payment for all European farmers. This would mean no more direct payments should target countries getting the least of it. Then, the continuation of the current distributive modality of direct payments, namely per hectare, will maintain current inequalities between farms and regions and is therefore not likely to properly tackle the farm income issue. If this issue were to be tackled by the CAP, support would not have to be linked to the size of the farm but rather to its financial situation determined by profits and losses. Large farms realise economies of scale and if farm income is to be supported then support should be distributed considering the level of this income and not the size of the farm. It seems unlikely that a better targeting regarding income support shall occur with the new CAP; this issue might not be solved yet.

APPENDIX

Appendix 1: Data used for OPR in AgriPoliS

Market data

- <u>Plant activities – Arable land</u>

As three soil types of different qualities have been introduced in the model, corresponding data for each production activities had to be introduced as well. Table 52, Table 53, Table 54 and Table 55 show data used in the OPR model regarding revenues, variable costs, gross margins and labour requirements respectively for each arable land soil quality.

Table 52: Revenues for each plant production activity by soil type (Euros)

	Low quality (AZ 25)	Medium-low quality (AZ 38)	Medium-high quality (AZ 50)
Winter wheat	532	670	798
Winter barley	387	609	676
Winter rye	457	666	723
Winter rapeseed	322	608	752
Triticale	343	552	628
Oat	353	471	520
Spring wheat	297	515	642
Spring barley	358	543	612
Sunflower	268	429	501
Potato	1,764	2,194	2,328
Sugar beet	1,539	1,759	1,979
Maize silage	0	0	0
Lucerne grass mixture	0	0	0
Linseed	194	251	304
Peas	253	379	442
Lupine	221	307	307
Set aside	0	0	0
Idle land	0	0	0

Source: Own figure.

Table 53: Variable costs for each plant production activity by soil type (Euros)

	Low quality (AZ 25)	Medium-low quality (AZ 38)	Medium-high quality (AZ 50)
Winter wheat	340	412	483
Winter barley	289	398	444
Winter rye	322	453	497
Winter rapeseed	294	459	543
Triticale	251	352	401
Oat	245	292	326
Spring wheat	289	347	385
Spring barley	237	296	325
Sunflower	353	459	516
Potato	1,176	1,384	1,421
Sugar beet	716	743	772
Maize silage	400	486	513
Lucerne grass mixture	592	642	669
Linseed	125	244	283
Peas	324	360	379
Lupine	219	257	262
Set aside	39	39	39
Idle land	0	0	0

Source: Own figure.

Table 54: Gross margins for each plant production activity by soil type (Euros)

	Low quality (AZ 25)	Medium-low quality (AZ 38)	Medium-high quality (AZ 50)
Winter wheat	192	258	315
Winter barley	98	211	232
Winter rye	135	213	226
Winter rapeseed	28	149	209
Triticale	92	200	227
Oat	108	179	194
Spring wheat	8	168	257
Spring barley	121	247	287
Sunflower	-85	-30	-15
Potato	588	810	907
Sugar beet	823	1,016	1,207
Maize silage	-400	-486	-513
Lucerne grass mixture	-592	-642	-669
Linseed	69	7	21
Peas	-71	19	63
Lupine	2	50	45
Set aside	-39	-39	-39
Idle land	0	0	0

Source: Own figure.

Table 55: Labour requirements for each plant production activity by soil type (hours per hectare per year)

	Low quality (AZ 25)	Medium-low quality (AZ 38)	Medium-high quality (AZ 50)
Winter wheat	7.2	8.4	10
Winter barley	6.6	7.7	9
Winter rye	6.4	7.7	9
Winter rapeseed	5.7	8.2	9
Triticale	5.4	7.1	8
Oat	6.1	6.9	8
Spring wheat	4.9	4.9	4.9
Spring barley	6.1	7.2	7.9
Sunflower	4.8	4.8	5
Potato	21.5	24.6	25
Sugar beet	20	20	20
Maize silage	9.7	12.6	13
Lucerne grass mixture	9.8	9.8	10
Linseed	5.9	6.9	8
Peas	5.9	6.9	7
Lupine	5.2	6.2	7
Set aside	2.8	2.8	3
Idle land	1.6	1.6	2

Source: Own figure.

- <u>Plant activities – Grassland</u>

Grassland activities have been introduced in the model as fodder for animals kept in the farm exclusively. Revenues are thus all set to zero and the subsequent gross margins equal variable costs. Two soil qualities have been introduced for grassland, used either as extensive or intensive grassland. Table 56 and Table 57 illustrate respectively variable costs and labour requirements as introduced in the model.

Table 56: Variable costs of production activities on grasslands (Euros)

	Intensive grassland	Extensive grassland
Hay	207	120
Silage	368	177
Pasture	141	81
Idle grassland	0	0

Source: Own figure.

Table 57: Labour requirements for production activities on grassland (hours per hectare)

	Intensive grassland	Extensive grassland
Hay	10.7	8.4
Silage	15.9	10.5
Pasture	11.5	6.7
Idle grassland	1.6	1.6

Source: Own figure.

- Animal activities

As shown in Table 58, animal productions are characterised by gross margin, variable costs and revenues as well as labour requirements in the model.

Table 58: Variable costs, revenues and gross margins for animal activities (Euros) and labour requirements (hours per animal)

	Revenues	Variable costs	Gross margin	Labour requirements	Fodder requirements (in MJ ME[72])
Dairy cows	2346	1046	1300	42.0	26,326[73]
Suckler cows	467	322	145	8.7	36,083[74]
Beef cattle	446	319	127	11.7	23,569
Sows	1023	725	298	14.5	–
Pigs for fattening	335	296	39	1.3	–

Source: Own figure.

72 Mega Joule of Metabolic Energy.
73 Value in Net Energy of Lactation (NEL). For consistency reasons in the model we converted this value into MJ ME and obtained a value of 44,980 MJ ME.
74 Of which 50% had to be delivered by pastures.

However, for ruminants, fodder costs are not entirely included in variable costs, the exception being constituted of concentrates. Actually, ruminants are fed with products grown inside the farm, like grassland products as mentioned above and some products from arable land. Fodder rations are flexible in the model, i.e. each potential plant production for fodder has been attributed a value in terms of maximal energy it can delivers (in metabolic energy). Some minimal requirements for pasture and as regards the total amount of energy per year a ruminant has to become have been introduced in order to get plausible fodder rations at the farm level. The heterogeneity of soils has been introduced through the quantity of energy delivered by productions on different soil qualities, as reported in Table 59.

Table 59: Energy deliveries from fodder production activities (in MJ ME)

	Low quality (AZ 25)	Medium-low quality (AZ 38)	Medium-high quality (AZ 50)	Intensive grassland	Extensive grassland
Maize silage	69,615	108,108	117,936	–	–
Lucerne grass mixture	66,976	75,348	79,534	–	–
Hay	–	–	–	45,150	31,500
Silage	–	–	–	71,910	37,060
Pasture	–	–	–	59,360	35,000

Source: Own figure.

Appendix 2: Model assumptions

- Rental contracts: In AgriPoliS, two types of rental contracts can be implemented (cf. KELLERMANN et al., 2008). The first type has a fixed duration, i.e. farmers pay rents until the contract terminates unless the farm leaves the sector prior to the contract termination. Contract lengths are assigned randomly to a plot and are between 9 and 18 years long. The second type of rental contracts gives farms the possibility to terminate the contract after each period and to renegotiate its terms. For the purpose of this study the first option was assumed. Hence, farms in Ostprignitz-Ruppin can re-negotiate the terms of the rental contract after a period randomly defined between 9 and 18 years.
- Transport costs: Farmers incur transport costs from the farmstead to the fields.
- Payment entitlements: Entitlements are assumed to be attached to the plot. They cannot be traded independently.
- Access to capital: Generally, access to borrowed capital is not limited by institutional factors, but by the availability of equity capital on farms. Accordingly, farms have to withhold a certain share of their equity to finance investment and production activities (Table 60).
- Interest rates: Three types of interest rates are considered: interest for long-term borrowed capital, interest on short-term capital, and interest on equity capital which is assumed to correspond to the outside savings rate (Table 60). All interest rates remain constant over time. Moreover, inflation is not considered.

Table 60: Specific model parameters for the capital market[1)]

LT_BC INTEREST	ST_BC INTEREST	EC INTEREST	Equity finance share	Price trend labour
6%	8%	4%	30%	0.5%

Source: Own figure.

Notes: LT_BC_Interest = long-term borrowed capital interest; ST_BC_interest = short-term borrowed capital interest; EC_interest = equity capital interest.

[1)] Factor prices without inflation

- Development of gross margins: For many products, output and input prices show great fluctuations in reality. Due to the planning and expectation horizon of one year in the model, high input prices as well as low output prices would lead to over-reactions of farms in terms of investment and production responses. For that reason, production and investment decisions are based on average gross margin data and published information on investments (KTBL, 2002, LANDESANSTALT FÜR LANDWIRTSCHAFT, 2001). Gross margins are assumed to remain constant throughout the simulations. Moreover, farmers are assumed to be price takers. Throughout the simulation, output prices remain the same. Hence, it is assumed that market adjustments due to a sudden policy change have no production effect in subsequent periods. Hence, farmers' actions exert no impact on market prices.

Farms

- Heterogeneity of farms: Farm agents are characterised by state variables such as age, factor endowments (land, capital, labour), ownership structure, location in space, type, managerial ability, full time or part-time farm. Farm agents utilize different production factors of different types and capacities. Farm agents comprise the population of all agents in the region.
- Farmer's behaviour: Farm agents adapt to changing conditions on markets and to policy changes by changing their production mix. Farm agents can engage in production activities, labour allocation, rental activities for land, production quotas, and manure disposal rights. Labour can be hired on a fixed or hourly basis; family members can work off-farm (Table 61). Farm agents can take on long-term and/or short-term credit. Liquid assets not used on the farm can be invested. A farm agent exits if equity capital is zero, i.e. if the farm is bankrupt, or if farm-owned production factors (land, labour, capital) are expected to earn a higher income outside farming. Likewise, a potential successor takes over the farm only if the expected farm income is at least as high as the comparable industry salary, which is assumed to be 25 % higher than the regular off-farm income (Table 61). Farm agents maximise income.

Table 61: Specific model parameters for family labour

Costs of hired labour (Euro/AWU)[1]	Income off-farm labour (Euro/AWU)	Withdrawals (Euro/AWU)
20,700	17,000	16,000

Source: Own figure.

Note: [1] 1 AWU = 2,2100 hours per year.

To derive farms' actions, a mixed-integer mathematical programming approach is used to combine various farm production activities and investment choices given the farm's resource constraints. Farm agents form expectations about future prices based on adaptive expectations. They anticipate the impact of major policy changes one period in advance. Farm agents know and continuously update their own state and endowments following its decision-making activities. They take into account expected prices for products. Even though farm agents act individually rationally, farm agents' behaviour is myopic because they cannot act strategically. Farm agents sense the state of all plots in the region, and hence can determine the plot they wish to rent.

Appendix 3: Definition of indicators

Economic indicators

Average farm size (ha): average of used land per farm.

Number of farms (number): through the simulation and due to structural change, farms are closing either because of opportunity costs or because they are illiquid. The number of farms displayed throughout the simulations is a good indicator of political impacts on farm potential survival.

Profit (€/ha): average profit per hectare reached by farms in the region with:

profit = total gross margin from plant and animal activities

+ short term interests received from money kept in the bank

– total maintenance of buildings and machinery

– fixed costs

– overheads

– farm rent expenditures

– total distance costs

– long-term interest costs

– short-term interest costs

– cost for variable hired labour

Rental price arable land/grassland (€/ha): rental prices in AgriPoliS are the results of internal calculations made by each agent. During the simulation and between two periods, each agent calculates, for each plot of free land for rent, its shadow price, i.e. the marginal gain of revenue the farm could expect with the rental of an additional piece of land. Each piece of land is one hectare big. Rental prices for grassland and arable land are calculated as the ratio of total rents paid among the region divided by the area rented among the whole region.

Land abandonment (%): percentage of land which is not used by farms in the region.

Environmental indicators

Animal husbandry (LU/ha): this value displays the ratio of total livestock unities over total UAA.

Extensive grassland eligible for AEP (ha): farms face each year a two-way choice with the introduction of the "extensive grassland" agri-environmental measure: will they participate in the AEM or not? If yes, the will convert their grassland into extensive grassland, leading to the distribution of an AEP. This indicator sums the number of hectares converted into "extensive grassland" in the region.

Land kept in GAEC (ha): This indicator is the sum of land kept in Good Agricultural and Environmental Conditions (GAEC) as described in the 2003 CAP Reform. This land is not used for any kind of plant or animal production; it is mowed once a year.

Land set aside (ha): this measure has been implemented in the Old Member States from 1992 and has been introduced in OPR until 2009. Each farm had to keep at least 10 % of its land as set-aside, but not more than 33 %.

Social indicators

Farm exit (number): each year some farms decide to close down. This indicator displays the total number of farms which decided to close down at the end of the year investigated.

Labour inpout (AWU/100 ha): This indicator sums the total labour force directly employed in agriculture per 100 hectares, including family labour employed in agriculture and hired labour.

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