



**AgEcon** SEARCH  
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

*The World's Largest Open Access Agricultural & Applied Economics Digital Library*

**This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.**

**Help ensure our sustainability.**

Give to AgEcon Search

AgEcon Search  
<http://ageconsearch.umn.edu>  
[aesearch@umn.edu](mailto:aesearch@umn.edu)

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

# Transfer of single farm payment entitlements to farm successors: impact on structural change and rental prices in Switzerland

GABRIELE MACK<sup>1</sup>, ANKE MÖHRING, ALI FERJANI, ALBERT ZIMMERMANN, STEFAN MANN

Agroscope Reckenholz-Tänikon (ART), Socioeconomics Research Group, 8356 Ettenhausen, Switzerland

**Abstract.** This paper analyses the impact of tradable and non-tradable single farm payment (SFP) entitlements for farm successors on structural change and the lease market. Using the example of Swiss agriculture, the effects on rental-price trends and farm-exit rates are investigated. An ex-ante normative impact analysis is performed with the agent-based agricultural-sector model SWISSland, which simulates structural change processes and income trends in Swiss agriculture over a period of up to 15 years. A land market implemented at municipality level simulates the plot-by-plot leasing of land to surrounding neighbouring agents that is common in Switzerland. Allocation of plots to tenants as well as lease pricing is modelled taking into account the farm-specific land rents. The results show that personalised SFP entitlements which could not be transferred to a farm successor not only cause an intensification of structural change, but would also thus lead to a substantial reduction in rental prices. SFP entitlements which were successfully transferred to farm successors have only a slight impact on structural change and the rental prices of arable land. Only for grass-land in the mountain region does a stronger shift result in a significant reduction in rental prices.

**Keywords.** rental market, agent-based modelling, agricultural sector model, structural change, single farm payments, farm succession.

**JEL Codes.** Q150; Q120

---

## 1. Introduction

The introduction of single farm payments (SFP) is an integral part of the agricultural policy reform planned by the Swiss government from 2014 onwards. Before the reform, direct payments in Switzerland were primarily based on agricultural area and livestock units. Now, after the introduction of the reform, payments based on livestock units have been substantially reduced, and are disbursed exclusively for animal-friendly housing systems. Single area payments (SAP) and SFP will be the most important payment schemes from 2014 onwards. To ensure that agricultural policy and the direct-payment system are

---

<sup>1</sup> Corresponding author: [Gabriele.mack@agroscope.admin.ch](mailto:Gabriele.mack@agroscope.admin.ch).

as effective and efficient as possible, concrete aims that bear close scrutiny are set out in the Federal Council's Message on Agricultural Policy for 2014-17 (AP 14-17). SAP are spent to ensure the provision of adequate supplies of high-quality food and to preserve the natural heritage, the environment and biodiversity.

The introduction of SFP in 2014 was completely new in the almost-20-year history of the Swiss direct-payment system. Entitlements for SFP are farm-specific, and the payments amount to the total support received by the farm in the period prior to the reform in order to ensure a socially acceptable level of income after the reform. During the consultation period which marks the beginning of every policy-reform process in Switzerland, policy-makers intended to couple SFP entitlements to the cultivation of the farm and to the person managing the farm in the first year after the reform, while the transfer of SFP entitlements from this person to his farm successor was not planned. The aim of fully decoupling SFP from production factors was to increase land mobility and to lower rental prices in Switzerland (BLW, 2011). The consultation period resulted in the policy decision to enable the transfer of SFP entitlements to farm successors (Bundesrat, 2012). It was also decided to shift SFP to SAP within a period of eight years.

A large number of studies have examined the distributional effects of a shift from SAP to SFP in the EU from both a static and a dynamic perspective (Happe and Balmann, 2002; Kilian and Salhofer, 2008; Kilian *et al.*, 2012; Ciaian and Kancs, 2012). The dynamic perspective takes into account the fact that subsidy payments may induce structural changes in the economy, such as productivity growth and exit/entry of farms. These structural changes may in turn affect the distributional effects of subsidies.

Happe and Balmann (2002) have shown for the Hohenlohe region in Baden-Württemberg that more frequent farm exits and falling rental prices are especially to be expected when farm payments are completely decoupled – i.e. when they impose no obligations on the recipients and allow for the possibility of continuing to receive the direct payments even in the case of farm exit. Ciaian *et al.* (2008) have demonstrated theoretically that in the case of inelastic land supply, area payments may be capitalised into land values, benefiting landowners instead of farmers. Based on a partial equilibrium model, Ciaian and Kancs (2012) have shown that the capitalisation of SAP into land rents is increasing. By applying a general equilibrium model, Ciaian *et al.* (2008) discovered that from a static perspective, i.e. without considering structural change, the SFP only benefits farmers. In a dynamic world, effects depend upon the nature of structural change, as well as on the tradability of entitlements.

The aim of this paper is to analyse the impact of transferring SFP entitlements to farm successors on the latter's farm-take over decisions, on structural change, and on rental prices in Switzerland. The paper then goes on to present the impact on structural change and rental prices of a shift from SFP to SAP.

In this study, a normative impact analysis is performed with the agent-based agricultural sector model SWISSland, which simulates the structural-change processes and income trends in Swiss agriculture over a maximum period of 15 years. The study describes in detail the municipal scale of SWISSland, and the modelling of both the rental-market decisions taking place at the municipal level, and of rental pricing. It focuses primarily on the methods for specifying the FADN-based agents in terms of geo-referenced attributes in the initial year, as well as illustrating the modelling of farm-succession decisions.

Chapter 2 gives an overview of the agent-based sector model SWISSland, introduces the database, and describes the spatial structures and modelling of the rental market. Chapter 3 outlines the model scenarios and describes the results. Chapter 4 contains a discussion of the results.

## 2. Methods

### 2.1 Overview of the agent-based sector model SWISSland

The agent-based sector model SWISSland simulates structural-change processes and income trends for Swiss agriculture. It also explicitly models farm-takeover decisions by young successors, and the transfer of SFP entitlements to these successors. The agent population of the sector model is based on the 3,400 FADN farms which provide their book-keeping data to Agroscope Reckenholz-Tänikon ART's Farm Accountancy Data Network. These FADN farms represent a sample of the approximately 55,000 Swiss farms operating in 2006-2008. Geographically, the 3,400 FADN farms are spread throughout Switzerland. Because, however, a spatially realistic local structure is necessary for simulating land trade among agents, a spatial reference on the municipal scale was implemented in the sector model. Figure 1 gives an overview of the data sources, as well as specifying the agents' attributes in the initial year and the agent's behaviour.

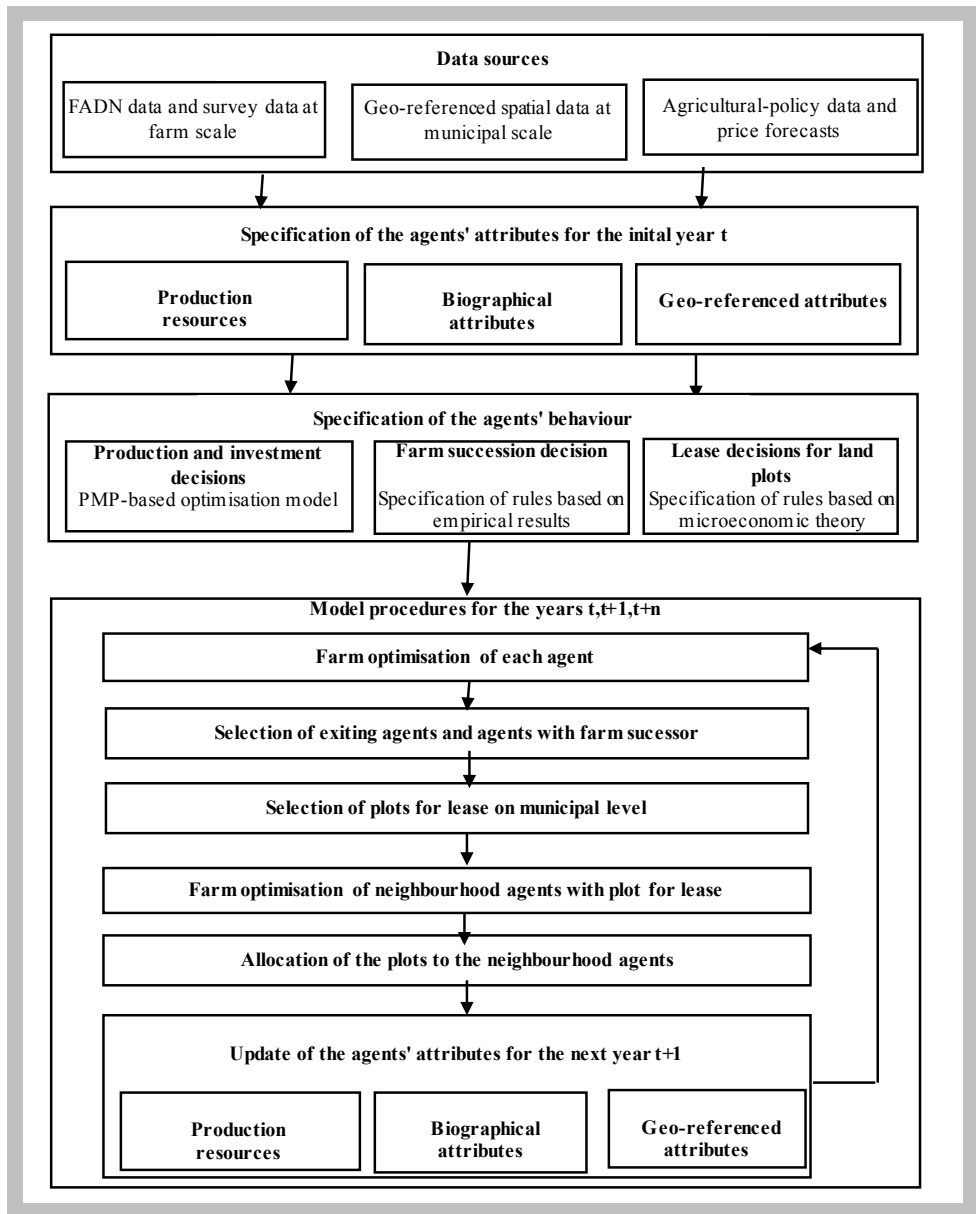
The selection of all 3,400 FADN farms as agents ensures detailed individual farm records for modelling the agents' production resources. A study by Moehring *et al.* (2010) describes the agents' attributes in great detail in terms of production resources and biographical attributes. In Moehring *et al.* (2011), detailed explanations are given for the modelling of production and investment decisions based on individual-farm optimisation models, as well as for the modelling of farm exit and handover decisions. In Zimmermann *et al.*, 2011 model results are shown.

Because only about 0.2% of the entire utilised agricultural area in Switzerland changes owner each year (Giuliani, 2002), whilst the majority of the land provided by exiting farms is rented, land-purchase decisions are not modelled in SWISSland.

### 2.2 Defining neighbourly relationships for FADN-based agents

The 3,400 FADN-based agents are located throughout Switzerland, and do not usually have a neighbourly relationship with each other. To model land trade among these FADN-based agents, a spatially realistic municipality structure including neighbourhood patterns among farm locations was implemented in the sector model. The municipality structure is based on seven existing Swiss municipalities. The seven reference municipalities were chosen from among Switzerland's 2,765 municipalities in a two-step procedure. Firstly, a municipal typology was created on the basis of size (utilised agricultural area or UAA), difference in altitude (between the lowest and highest point above sea level of the UAA), and distribution of the farmland over different altitude levels within a municipality. These attributes were selected because they determine the accessibility and the driving time between the farm locations and the plots of a municipality. The horizontal and vertical distances between the farm locations and the plots were estimated for Switzerland's

Figure 1. Schematic model overview of the agent-based sector model SWISSland.



Source: Own illustration.

2,765 municipalities. On this basis, five municipality groups were selected to which all of Switzerland's 2,765 municipalities were assigned (Table 1). Secondly, taking the representativeness of farm type and size into account, at least one genuinely existing municipal-

ity per group was chosen, and specific geo-referenced data (topology of the plots cultivated on each farm, location of the farm buildings) were determined for each farm in the municipality. Data were processed in a GIS in order to generate information on distances from farm buildings to plots, as well as on neighbourhoods, plot size, and form of cultivation. The main selection criterion for the reference municipalities was the availability of geo-referenced data for all farm locations and fields within the municipality (Table 2). The farms located in the reference municipalities served as a source of information for the description of the FADN-based agents in terms of spatial and topographic characteristics.

**Table 1.** Description of the municipality groups.

Municipality Group	No. of Municipalities per Group	Average UAA (ha)	Standard Deviation UAA (ha)	Average Difference in Altitude (m)	Standard Deviation of Difference in Altitude (m)
1	1,016	316	301	90	54
2	571	411	273	231	132
3	480	614	627	372	131
4	350	1,125	928	1,421	389
5	334	1,223	1,565	1,381	377

UAA: Utilised Agricultural Area.

Source: Own calculations.

**Table 2.** Features of the reference municipalities.

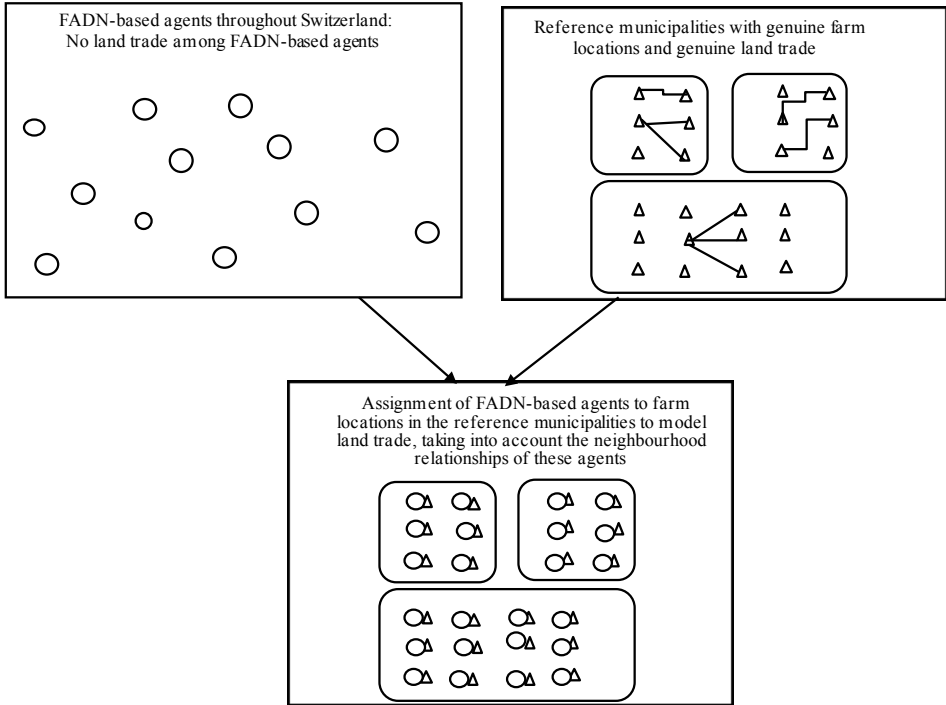
Name of Reference Municipality	Municipality Group	UAA (ha) per Reference Municipality	No. of Plots per Reference Municipality	Difference in Altitude (m)	No. of Farms per Reference Municipality	Total No. of Reference Municipalities in the Model
Oberembrach	1	591	394	202	31	9
Illnau-Effretikon	2	1,158	735	197	54	7
Vechigen	3	1,467	799	396	102	7
Trimmis	4	479	995	1,961	49	14
Alpnach	5	922	729	1,551	78	7
Engelberg	5	722	483	1,823	58	8
Giswil	5	1,181	1,076	1,727	109	7

Source: Own calculations.

To model land trade among the FADN-based agents, each agent was assigned to a matching farm location in a reference municipality (Figure 2).

The principal criteria for the assignment of FADN-based agents to farm locations of the reference municipalities were matching attributes which were present in both datasets,

**Figure 2.** Assignment of FADN-based agents to farms in reference municipalities to model land trade.



particularly farm area (ha UAA, ha grassland, ha arable land), altitude (m.a.s.l.) and the zones to which they belonged (lowland zone to mountain zone 4). Because the number of FADN-based agents was significantly higher than the number of farm locations in the reference municipalities, our first step was to duplicate the reference municipalities which were underrepresented in terms of these allocation features. This was done by minimising the sum of the squared deviations between the attributes of the FADN-based agents and the farms locations of the reference municipalities. Because over half of all FADN-based agents had farm locations in a reference municipality of group 5, taking one reference municipality for group 5 into account would require approx. 20 duplications per municipality. In order to limit the number of duplications per municipality, it was decided to take three genuinely existing municipalities into account for group 5. The duplication procedure led to the total number of 59 SWISSland municipalities (last column of Table 2).

An advantage of this method is that it allows the topology and the distances between plots to be modelled highly realistically, even though it is difficult to ensure the representativeness of all features (topography, UAA per municipality, farm type, zone). The 3,400 FADN-based agents were assigned to the actual farms of the SWISSland municipalities by minimising the sum of the squared deviations of these attributes between the FADN-based agents and the actual farm in each case. The allocation of agents to the 59 municipalities could in turn be formulated as an optimisation problem. The binary solution vari-

able of such a system would, however, be a matrix in the 'No. of agents \* No. of farms in the reference municipalities' dimension, which would overtax the available solution capacities. Assignment is therefore via a gradual loop formulation in which each agent is successively assigned to the most suitable farm in the reference municipalities in each case that is not yet taken. The most suitable farm in each case is the one with the smallest deviations in its attributes. In the event of unequal size representations of the attributes, this process could result in no suitable actual farm in the reference municipalities still being available for the last agents to be allocated. Because of this, the attributes of both the agents and the farms of the reference municipalities are transformed beforehand into rank values. In this way, and because it leaves several farms of the reference municipalities still available to the last agent to be allocated, an adequate distribution result is achieved.

Because the most important criterion for the assignment of the FADN-based agents to the farms of the SWISSland municipalities was the matching of the attribute 'farm area', differences in farm size between the agents and the farms of the reference municipalities were very small. Where minor differences existed, reference-municipality farm plots were uniformly scaled up or down so that farm area corresponded exactly to that of the relevant FADN-based agents. In addition, several other FADN-based agent attributes (e.g. percentage of arable land; percentage of slopes and steep land) were transferred to the allocated plot structures.

Consequently, all FADN-based agents are determined by spatial characteristics (farm-yard coordinates; number of plots with meadows and arable land; coordinates of the plots and their field-farmyard distance), and ultimately possess 'virtual' neighbouring agents whose plots border on other agents.

### 2.3 Modelling farm-takeover decisions

In Switzerland, farming exit is shaped primarily by the farm manager's life cycle. Normally, once the farm manager turns 65 and starts receiving his state pension – coinciding with the lapse of entitlement to direct payments – the farm either closes down and the land is put up for lease, or the farm's production resources (i.e. land and capital resources) are transferred in their entirety to a family successor (Meier *et al.*, 2009). Under the present framework conditions, farms are only very seldom given up before pensionable age is reached (Rossier and Wyss, 2006). Furthermore, fewer than 10% of Swiss farm managers are older than the statutory retirement age of 65. In an empirical study, Rossier and Wyss (2006) discovered that in Switzerland, farm-succession decisions are significantly influenced by number of sons in the family, location of the farm (lowland, hill or mountain region), size and type of the farm, receipt of direct payments, and farm income.

In the agent-based model SWISSland, these findings on the determinants of farm transfer are implemented in a two-stage decision-making process. In a first step, agents with sons determine their potential successors. If an agent has no son, the farmland is put up for lease. In a second step, an income criterion for the takeover decision by the 'successive agent', to the effect that the attainable household income of the farm must be higher than an exogenously determined minimum household income, is implemented in the model. This minimum income is based on an average reference income for the second and third sector in Switzerland. Takeover of the farm's production resources (land and



capital resources) by the ‘successive agent’ occurs only when this income criterion is met. Farm succession and farm exit are therefore determined both by the rate at which agents reach pensionable age, and by the percentage of successful takeovers, which is in turn dependent on income trends. In the subsequent years of the farm succession, land-leasing options and investment options in animal- housing systems are modelled.

#### 2.4 Underlying data for modelling the land market

The individual farm records (2006-2008 three-year average) of 3,400 currently operating FADN family farms provided a detailed factual basis for modelling the agents’ production resources (land use, livestock, family and non-family labour, financial values), production costs, prices and direct payments. Land-ownership data was used to define the total area of both owned and rented land (Table 3).

**Table 3.** Area of owned and rented farmland in the plain, hill and mountain regions.

		Plain region		Hill region		Mountain region	
FADN Farms	No.	1,420		980		994	
Area		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Total land	ha	20.06	10.96	17.24	10.24	17.92	11.36
Owned land	ha	11.30	7.02	10.57	6.90	10.80	8.57
Rented land	ha	8.76	9.59	6.66	8.80	6.90	9.74

Source: Calculated on the basis of Agroscope Reckenholz-Tänikon ART’s Farm Accountancy Data Network (FADN) data pool (ART, 2006-2008).

In the absence of a nationwide Swiss statistical survey on grassland and arable-land rental prices, the FADN sample of specialised arable and grassland farms was used to provide a rough estimate of the lease prices for grassland and arable land in the plain, hill and mountain regions of Switzerland (Table 4). The compulsory upper limits of the lease prices depend on the productive value of the land, determined on a regular basis by the Swiss cantonal authorities.

#### 2.5 Modelling Land Exchange and Lease Pricing

A precondition for land trade among agents is a neighbourly relationship. Because such a relationship derives from farm locations within a municipality, land-trade modelling is limited to agents whose farm locations are in the same municipality. SWISS-land models a plot-by-plot land lease from ‘exiting agents’ to the remaining agents in the immediate vicinity. The ‘exiting agents’ are those having no farm successor to whom

**Table 4.** 2006-2008 three-year-average lease prices (CHF/ha) for arable land and grassland in the Swiss plain, hill and mountain regions.

Region	Plain	Hill	Mountain
Arable land			
Average for 2006-2008 <sup>1)</sup>	745	690	527
Standard deviation <sup>1)</sup>	301	327	135
Grassland			
Average for 2006-2008 <sup>1)</sup>	629	516	420
Standard deviation <sup>1)</sup>	190	215	230

Calculated on the basis of the sample of specialised arable and grassland farms from Agroscope Reckenholz-Tänikon ART's Farm Accountancy Data Network (FADN) data pool (ART, 2006-2008).

they can hand over, or those whose potential successor decides against taking over the farm on economic grounds (see Section 2.3). The agents in the near vicinity of an exiting agent form the group of agents interested in the latter's plots. Decisions to allocate land to the neighbouring agents as well as lease pricing are modelled as a plot-by-plot bidding process. The initial lease price asked by an exiting agent is based on the average regional values of the FADN farms for arable land and grassland in the base year (see Table 4). Because these regional averages are close to the compulsory upper limits for rental prices that are measured against the productive value of the land, these values are also taken as upper limits for regional lease prices.

An agent's lease decision for a plot depends on its income growth. As the supply of plots rises, other production resources such as labour generally exert a limiting effect, causing the plot-based economic benefit to decline. To calculate the increase in income of all neighbouring agents involved in the bidding process, each of these agents is optimised with the new plot. The neighbouring agent receives the plot which generates the highest profit at the upper limit of the lease price. If, however, the upper limit of the lease price is higher than the increase in income of all agents in the near vicinity, the bidding process is repeated, taking other agents in the wider vicinity into account. Where the upper limit of the lease price is also too high for agents in the wider vicinity, it is assumed that the exiting agent will reduce the lease price in steps and that the bidding process will recommence. Should the situation arise where the lease price is greater than zero and no neighbouring agent is able to generate a profit for a plot, the plot becomes fallow land. Provided that a neighbouring agent benefits from leasing only when the lease price is zero, it is assumed that the exiting agent leaves the neighbouring agent the plot before it becomes fallow land.

Empirical studies conducted in two regions of Germany (Strom, 1998) show that the number of farms involved in the lease market is limited, ranging between one and five farms. Based on the findings of Strohm (1998), it was assumed that the five nearest neighbours were involved in the bidding process. Only in the event that no agent could be found were three further neighbours considered. These restrictions on the number of bidding agents in the same municipality limit the number of optimisation runs to an acceptable range. A stepwise 20% reduction in lease prices was also stipulated in order to limit the number of optimisation runs.

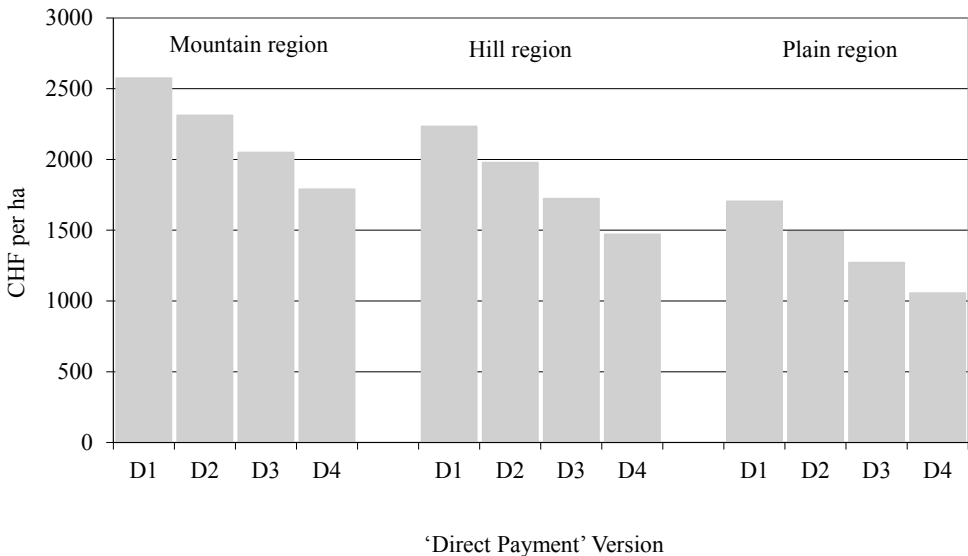
**3. Scenario definitions and results**

The first scenario assumes that SFP are transferable from the exiting agent to the successor agent in the subsequent years of the reform. This scenario is hereinafter referred to as ‘Transferable SFP’. The second scenario implies that SFP could not be transferred to a successor agent after the reform. This is thought to negatively influence the successor agent’s decision regarding takeover, as well as to enhance structural change. Scenario 2 is hereinafter referred to as ‘Non-Transferable SFP’. In both scenarios, all output and input prices except those for land are constant over time.

To investigate the effects of a partial shift from SFP to SAP, the SFP were reduced and shifted to SAP on a percentage basis, whilst SAP-based ecological payments and LU-based payments for animal-friendly housing systems remained steady in order to safeguard the Swiss Government’s environmental objectives.

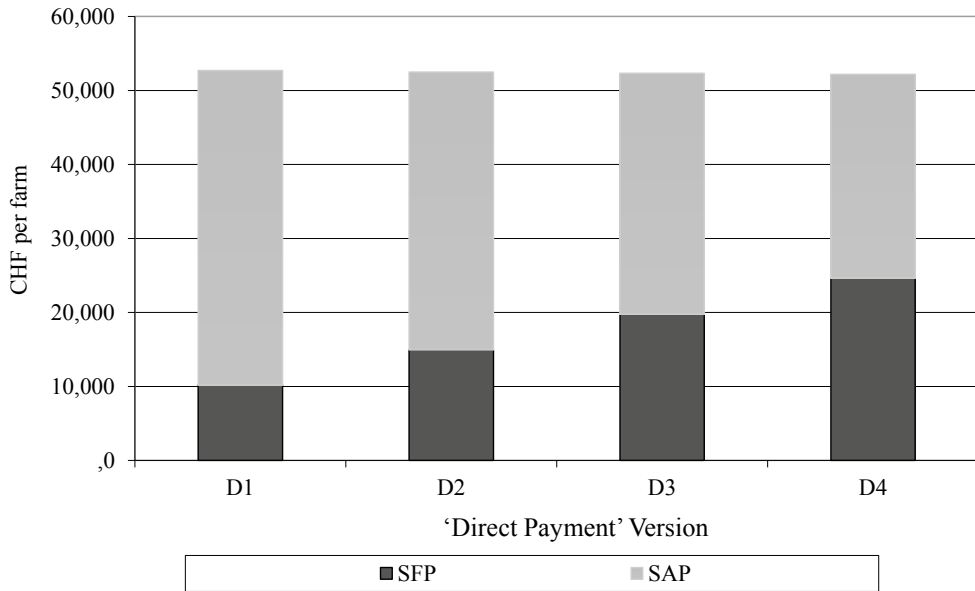
In both scenarios, four versions of allocation of direct payments to SAP and SFP are considered. Version 1 is characterised by high SAP in combination with low SFP, Version 4 by low SAP in combination with high SFP. Versions 2 and 3 lie in between. Figure 3 shows the average level of the single area payments per hectare for the four versions. Since the higher the altitudinal belt, the greater the hardship allowances paid, area payments increase from the plain to the mountain region. Relatively speaking, SAP decrease from Version 1 to 4 by up to 40% (Figure 4). Viewed in absolute terms, the reduction is around CHF 700 per hectare.

**Figure 3.** SAP per hectare (including ecological direct payments and cultural-landscape payments)



Sources: Own calculations.

**Figure 4.** Ratio of SAP to SFP averaged over all agents.



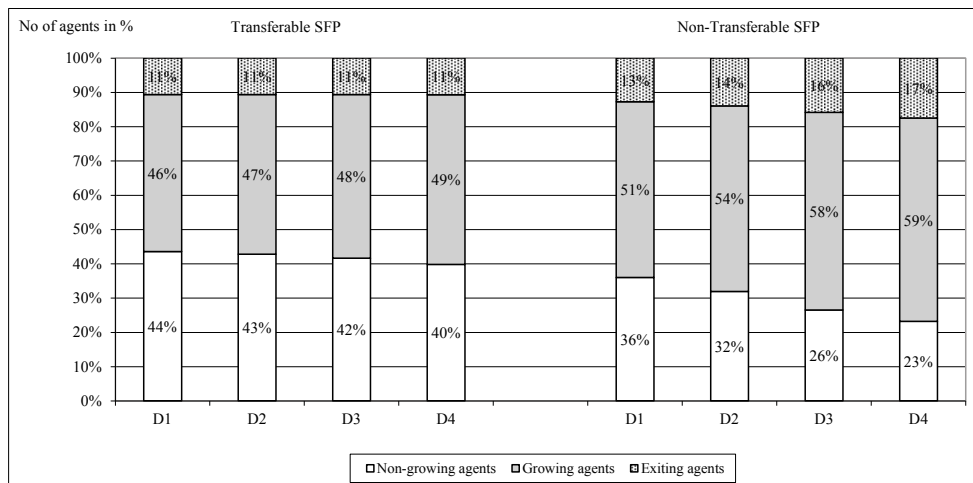
Sources: Own calculations.

The transferability of SFP entitlements to successive agents substantially affects the number of exiting agents and growing agents (Figure 5). The number of exiting agents increases from 11% ('Transferable SFP' scenario) to 17% when SFP entitlements are non-transferable. Since the number of exiting agents also determines the supply of land put up for lease, the number of growing agents also increases, from around 46% to between 51 and 59%. The number of non-growing agents decreases from between 44 and 40% ('Transferable SFP') to between 36 and 23% ('Non-transferable SFP') (Figure 5). The modelling of a plot-by-plot leasing procedure from exiting agents to growing agents ensures that one exiting agent's plots are rented on average by four agents (Figure 5). This closely matches leasing patterns in Swiss agriculture (Lauber, 2006).

Figure 6 shows that the number of exiting agents is disproportionately high in the 'smallest farm size' category (< 10 ha) for both scenarios, whilst the number of non-growing agents is over-represented in this category. By contrast, the number of growing agents is disproportionately high in the 'middle farm size' categories, and is decreasing in the 'largest farm size' category. This means that the 'middle farm size' categories experience the highest economic gain from leasing land, whilst in the 'smallest' and 'largest' categories the economic benefit is lower, due to limited production capacities.

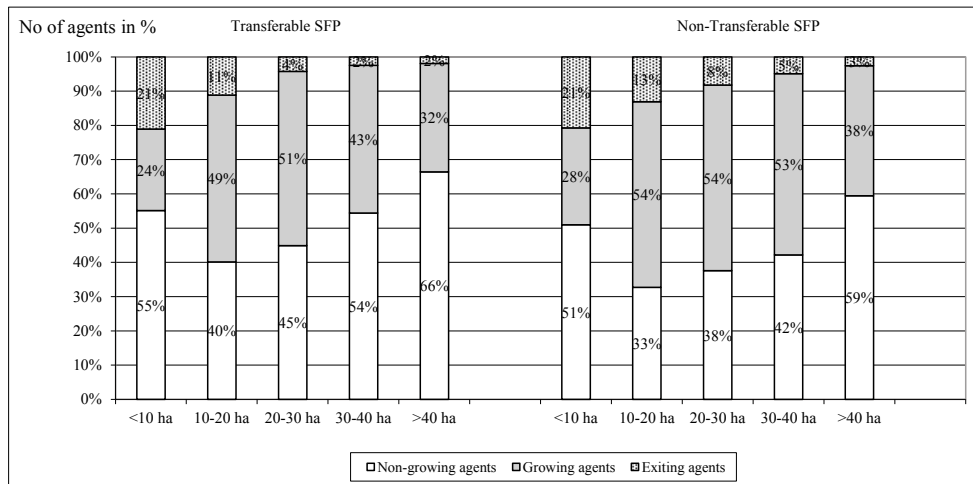
The percentage of agents taking over their predecessor's farm is also higher in 'larger farm size' categories (Fig. 7).

**Figure 5.** Share of growing, non-growing and exiting agents in the transferable and non-transferable SFP scenarios.



Sources: Own calculations.

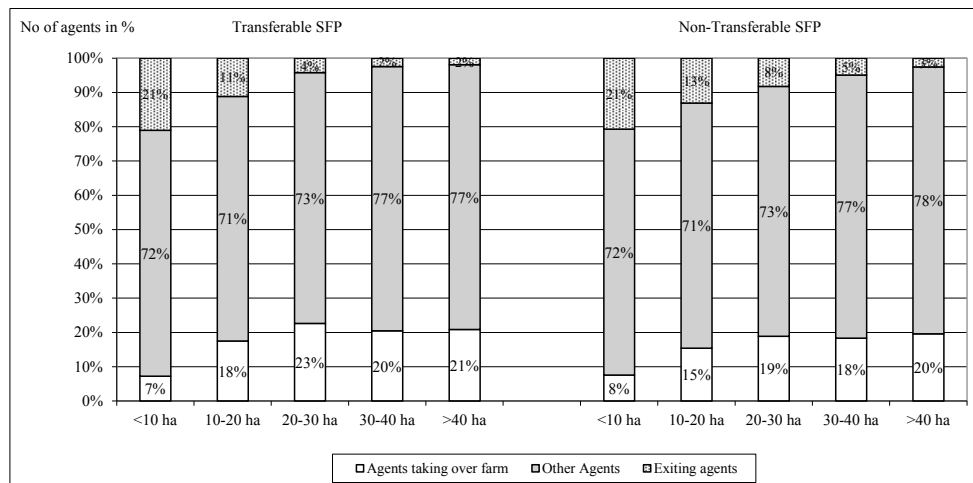
**Figure 6.** Share of growing, non-growing and exiting agents in different farm-size categories (D1).



Sources: Own calculations.

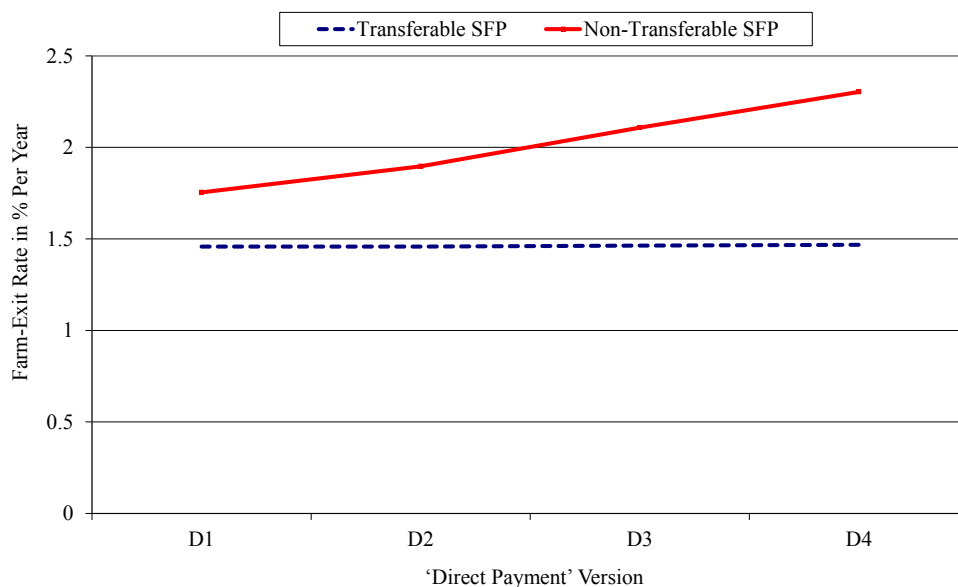
Transferability of SFP from the exiting agents to their successor agents yields an average farm-exit rate of around 1.5% in the period under consideration (Figure 8). This more or less corresponds to the farm-exit rate observed in Switzerland from 2000 to 2010. A gradual reduction in SAP (Direct-payment versions D1-D4) does not affect the

**Figure 7.** Percentage of exiting agents and agents taking over farm from predecessors in different farm-size categories (D1).



Sources: Own calculations.

**Figure 8.** Average farm-exit rates for the whole of Switzerland in the transferable and non-transferable SFP scenarios.

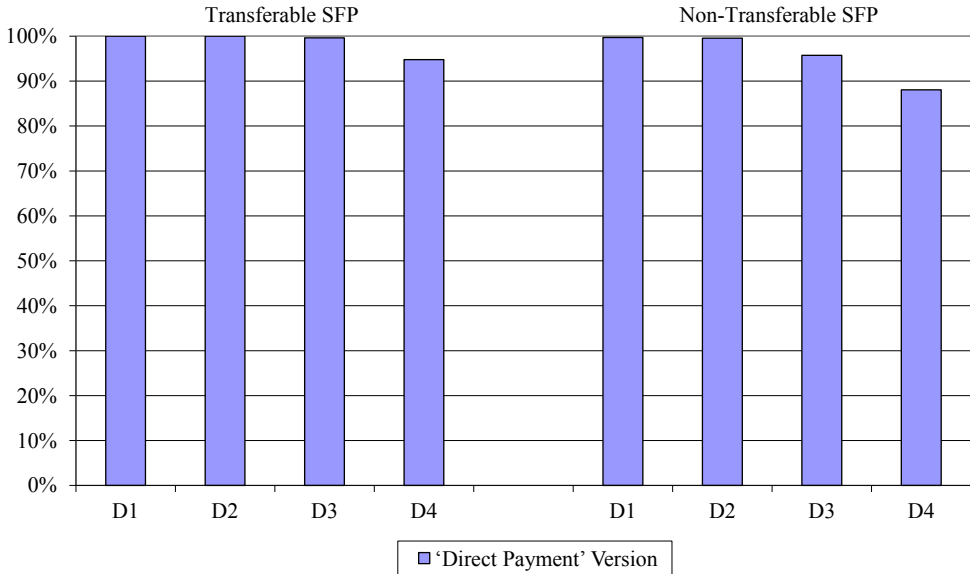


Source: Own calculations.

agents' exit rate if the SFP are completely transferable (cf. Figure 8). By contrast, in the 'non-transferable SFP' scenario, successors receive no SFP. This causes a corresponding drop in their income, which in turn brings about a rise in the exit rate from version 1 to 4 (Figure 8).

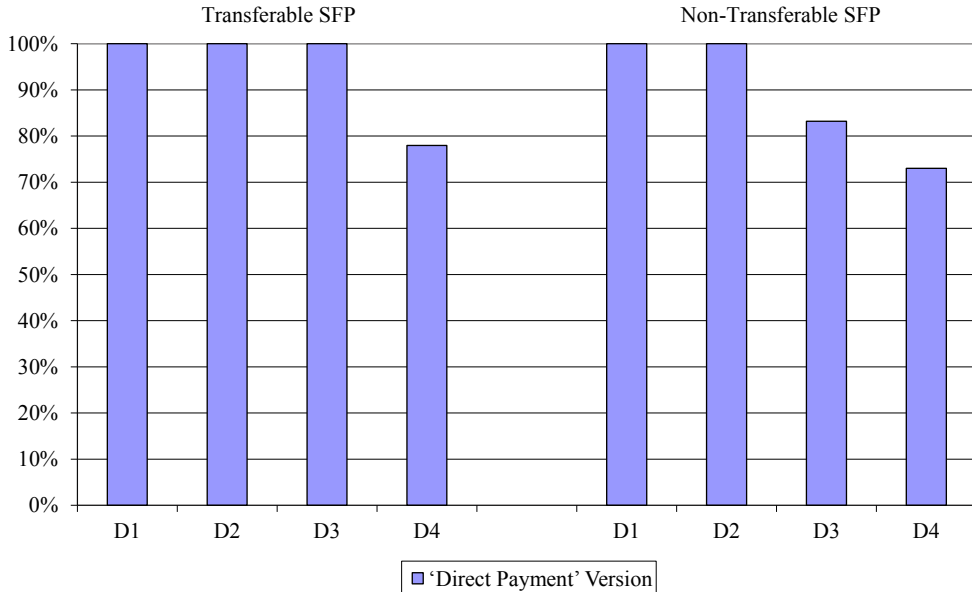
Figures 9 and 10 show the effects of transferable SFP entitlements on the lease prices of recently leased arable and grassland plots. Both figures give the average values of the last three forecast years as a percentage of the lease prices of the base years 2006-2008. Figure 9 shows that the lease prices for arable land in the 'transferable SFP' scenario change only slightly. Only if the SAP are reduced by up to CHF 700 per ha (version 4) do the lease prices fall by around 7%. This clearly demonstrates that with a relatively moderate farm-exit rate of 1.5%, a shift from SAP to SFP has only a limited influence on lease prices. If, on the other hand, the supply of leased land increases – as in the 'non-transferable SFP' scenario – a somewhat sharper fall in lease prices for all recently leased arable plots of up to 12% on average is to be expected. Lease prices for grassland, especially in the mountain region, are falling by up to 30% (Figure 10). Accelerated structural change and an increase in the supply of land are the main causes of significantly lower lease prices.

**Figure 9.** Lease prices for arable land (plain region): Average value of all newly leased plots in the last 3 forecast years (100% corresponds to the lease-price level in the initial years 2006-2008).



Source: Own calculations.

**Figure 10.** Lease prices for grassland (mountain region): Average value of all newly leased plots in the last 3 forecast years (100% corresponds to the lease-price level in 2006-2008).



Source: Own calculations.

#### 4. Discussion and conclusion

The agent population of the sector model is based on the 3,400 FADN farms. Geographically, the 3,400 FADN farms are spread throughout Switzerland. Because, however, a spatially realistic local structure is necessary for simulating land trade among agents, a spatial reference on the municipal scale was implemented in the sector model. The geo-referenced local data describe the location of all farmyards and their cultivated plots of land, with the actual plot sizes as well as the distance and altitude differences between the farmyard and plots constituting the underlying data for the simulation of the land market in SWISSland. In this respect, the sector model differs fundamentally from other agent-based models that divide the space into raster cells of equal size (Balmann, 2000; Happe, 2004; Lobianco and Esposti, 2010; Van der Straeten *et al.*, 2010). In total 59 municipalities were introduced in SWISSland in order to model neighbourly relationships among the FADN-based agents. These municipalities were derived from seven duplicated genuine reference municipalities. Neighbouring-agent type, number of plots per agent, and plot sizes – all of which influence the leasing decisions of the agents and their changes in farm size – are determined by the models’ spatial references, as defined by the selected reference municipalities. Model validations with further reference municipalities are therefore necessary in order to estimate the impact of the selected reference municipalities on the model results.



For the modelling of structural change in agent-based models farm-takeover criteria specified by numerical constraints are necessary (Lauber, 2006). Although driving forces of structural change are known for Switzerland from Rossier *et al.* (2006) specified constraints are not available. For that reason an exogenously determined minimum household income for farm exits was introduced in the model. This assumption influences the number of exiting farms and their farms size distribution substantially. For that reason further studies on driving forces of farm-takeover decisions are necessary.

The modelling of the land market with the agent-based sector model SWISSland simulates the plot-by-plot leasing of land to the surrounding neighbour agents that is customary in Switzerland. The bidding process is restricted to eight neighbour agents within the same reference municipality. Based on the findings of Strohm (1998), it was assumed that only five nearest neighbours were involved in the bidding process. Only in the event that no agent could be found were three further neighbours considered. According to Berger (2001) it was also assumed that plots which could not find a tenant are reoffered in subsequent years on the land market. The lease price is modelled iteratively, with the current lease price being assumed as an upper limit. If there is no tenant for this value, the lease price is lowered incrementally. All these model assumptions ensure that plots finding no tenant farmer and becoming fallow land are not overestimated by the model (Lauber, 2006).

The allocation of plots to agents is performed according to purely economic criteria – not always the case in real-life scenarios in Switzerland, where leasing decisions are often made based on personal relationships (Lauber, 2006; Strohm, 1998). This leads to an overestimation of economic driving forces of land allocation processes and results in the economic advantage of leasing and farm growth being overestimated rather than underestimated. On the other hand the modelling of the plot-by-plot leasing of land to neighbouring agents is common practice in Switzerland. In addition the modelling of real plot sizes, and the differences in distance and altitude between the farmyard and the plots enables the simulation of farm-size distributions changing fairly smoothly in the context of structural change as the results show.

The results show that SFP which are tradable to farm successors increase the pace of structural change by very little, and have only a slight effect on lease prices. As long as a delayed structural change of the current order of magnitude of about 1.5% per annum prevails in Switzerland, only minimal effects on lease prices are to be expected, especially for arable land. It is only for grassland in the mountain region that a fairly intensive shift to single farm payments causes a significant reduction in the lease prices. Moreover, calculations confirm that intensification of structural change through non-tradable SFP would lead to a significant reduction in lease prices, meaning that non-tradable SFP entitlements would be an effective policy instrument for enhancing land mobility and structural change. The results of this normative study confirm the findings of previous studies.

## References

ART (Agroscope Reckenholz-Tänikon Research Station ART), 2006 to 2008. Grundlagenbericht 2006 to 2008. Agroscope Reckenholz-Tänikon Research Station ART, Ettenhausen.

- Balmann, A. (2000). Modeling Land Use with Multi-Agent Systems. Perspectives for the Analysis of Agricultural Policies. Proceedings of the IIFET 2000: Microbehavior and Macroresults.
- Berger, T. (2001). Agent-based Spatial Models Applied to Agriculture: A Simulation Tool for Technology Diffusion, Resource Use Changes and Policy Analysis. *Agricultural Economics* 25(2): 1-16.
- BLW (2011). Vernehmlassung zur Agrarpolitik 2014-2017 (AP 14-17). Weiterentwicklung der Agrarpolitik in den Jahren 2014 bis 2017. Erläuternder Bericht. 23. März 2011. BLW, Mattenhofstrasse 5, 3003 Bern.
- Bundesrat (2012). Botschaft vom 1. Februar 2012 zur Weiterentwicklung der Agrarpolitik in den Jahren 2014-2017 (Agrarpolitik 2014-2017) (BBl 2012 2075).
- Ciaian, P., Kanacs, d'A. and Swinnen, J. F. M. (2008). Static and Dynamic Distributional Effects of Decoupled Payments: Single Farm Payments in the European Union. Available at SSRN: <http://ssrn.com/abstract=1142728> or <http://dx.doi.org/10.2139/ssrn.1142728>
- Ciaian, P. and Kanacs, d'A. (2012). The Capitalization of Area Payments into Farmland Rents: Micro Evidence from the New EU Member States. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie* 60(4): 517-540.
- Giuliani, G. (2002). Landwirtschaftlicher Bodenmarkt und landwirtschaftliche Bodenpolitik in der Schweiz. Eine theoretische und empirische agrarökonomische Analyse anhand von Daten über Handelsfälle von Landwirtschaftsland in den Kantonen Aargau, Graubünden und Zürich. ETH Dissertation No. 14781.
- Happe, K., and Balmann, A. (2002). Struktur-, Effizienz- und Einkommenswirkungen von Direktzahlungen. *Agrarwirtschaft* 51: 376-389.
- Happe, K. (2004). Agricultural policies and farm structures. Agent-based modelling and application to EU-policy reform. *Studies on the Agricultural Food Sector in Central and Eastern Europe. Halle, Institute of Agricultural Development in Central and Eastern Europe (IAMO)* 30: 298.
- Kilian, S. and Salhofer, K. (2008). Single payments of the CAP: where do the rents go? *Agricultural Economics Review* 9(2): 96-106.
- Kilian S., Antón, J., Salhofer, K. and Röder, N. (2012). Impacts of 2003 CAP reform on land rental prices and capitalization. *Land Use Policy* 29: 789-797.
- Lauber, S., (2006). Agrarstrukturwandel im Berggebiet. Ein agentenbasiertes, räumlich explizites Agrarstruktur- und Landnutzungsmodell für zwei Regionen Mittelbündens. Tänikon, Eidgenössische Forschungsanstalt Agroscope Reckenholz-Tänikon ART.
- Lobianco, A. and Esposti, R. (2010). The Regional Multi-Agent Simulator (RegMAS): An open-source spatially explicit model to assess the impact of agricultural policies. *Computers and Electronics in Agriculture* 72: 14-26.
- Meier, B., G. Giuliani and Flury C. (2009). Flächentransfers und Agrarstrukturentwicklung bis 2007. *Agrarforschung* 16(5): 152-157.
- Möhring, A., Zimmermann, A., Mack, G., Mann, S., Ferjani, A. and Gennaio, M.-P. (2010). Multidisziplinäre Agentendefinitionen für Optimierungsmodelle. *Schriften der Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaus e.V.* 45: 329-340.

- Möhring, A., Mack, G., Zimmermann, A., Gennaio, M.-P., Mann, S. and Ferjani, A. (2011). Modellierung von Hofübernahme und –Aufgabeentscheidungen in agentenbasierten Modellen. *YSA* 2011, 163-188.
- Rossier, R. and B. Wyss, (2006). Determinanten der Hofnachfolge. *Agrarforschung* 13(4): 144-149.
- Strom., R. (1998). Verlaufsformen der Faktormobilität im Agrarstrukturwandel ländlicher Regionen. Eine empirische Studie am Beispiel von Betriebsaufgaben in den Kreisen Emsland und Werra-Meißner. Dissertation, University of Göttingen. Wissenschaftsverlag Vauk. Kiel.
- Van der Straeten, B., Buysse, J., Nolte, S., Lauwers, L., Claeys, D. and Van Huylenbroeck, G. (2010). A multi-agent simulation model for spatial optimisation of manure allocation. *Journal of Environmental Planning and Management* 53(8): 1011-1030.
- Zimmermann, A., Möhring, A., Mack, G., Mann, S., Ferjani, A. and Gennaio, M.-P. (2011). Die Auswirkungen eines weiterentwickelten Direktzahlungssystems. Modellberechnungen mit SILAS und SWISSland. ART-Bericht 744. Agroscope Reckenholz-Tänikon Research Station ART, Tänikon, CH-8356 Ettenhausen.