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# Impacts of socio-economic factors on farm household dynamics - Empirical survey data in an agent-based model application

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***Abstract***

This paper addresses three issues of socio-economic factors of Hungarian farm households and their impacts on structural change. This concerns the role of age as a factor influencing the opportunity costs of labour, the impact of empirical age patterns on structural change, and the role of a varied probability of young farm successors entering into the farming business. Results of a farm household survey are integrated in simulation experiments with the agent-based model AgriPoliS which has been adapted to a Hungarian case study region. It could be shown that impediments of a flexible labour adjustment slow down structural change while the timing of persisting or exiting of farms highly depends on the age distribution of farmers.

**Key words: socio-economic characteristics, farm households, empirical age patterns, farm succession, structural change**

**JEL classification: Q 14, Q 18**

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## Introduction

Socio-economic characteristics, economic framework conditions and activities of farm households highly influence structural change in agriculture whether as an accelerating or inhibiting factor (BUCHENRIEDER et AL. 2007). Structural change can be interpreted as a result of the dynamic interplay between different driving factors. Particularly specific socio-economic characteristics such as age or education of farmers are major farm internal driving factors. Other driving factors are external to the farm and even to the agricultural sector. Examples are wages in other sectors of the economy or the agricultural policy environment (HAPPE et AL. 2009). Several studies (BLAAS et AL. 2007, JELINEK et AL. 2007) focus on the impacts of the EU-accession on the agricultural sector of Central and Eastern European Countries (CEEC). However, only a few studies analyse this political process against the background of socio-economic conditions such as the challenges coming from demographic change.

## Outline

This paper is divided into two main parts: The first part presents a farm household survey of farm households which has been carried out in three study regions in Hungary. Hungary has been chosen as a typical CEE-Country that is particularly affected by the tremendous impacts of demographic change. The survey focuses on the age patterns of farm-family members and demography-related issues such as uncertainty within farm succession processes.
In a second part, selected demographic issues are operationalised within a scenario setting and simulation experiments are carried out with an agent-based model which has been adapted to a Hungarian model region. In a first step, the major model characteristics and the adjustments necessary to represent the dualistic farm structure of the model region are shown. The model region is represented by differentiated legal types of individual and corporate farms which differ with respect to their objectives and some specific assumptions. The final analyses of the simulations are driven by the question how heterogeneous farms evolve in response to specific characteristics such as age patterns and uncertainty of farm successions. The analyses focus on indicators which show the direction, speed, and intensity of structural change for both legal types.

## Demography of farm households in CEE-Countries

As in Western Europe, many rural areas in the CEE-Countries are affected by an outflow of the young and flexible parts of the population as a result of labour migration. In conjunction with an increasing life expectancy this leads to an ageing of the remaining population. As the increase of life expectancy can generally not compensate the migration outflow this leads additionally to an overall shrinking of the rural population. CEE-Countries are particularly affected by this demographic change as their rural population is comparatively poor. Additionally, labour market participation rates are notably low in older age groups and retirement usually takes place earlier compared to the OECD-average. Table 1 presents some structural characteristics of individual farms in Hungary, Poland, the Czech Republic and Slovakia. While the Czech Republic and Slovakia are similar with regard to the high extent of dualism in their farm structures, Hungary and Poland are different. Polish individual farms hold an important position in view to all indicators. In contrast, Hungary shows a kind of “moderate dualism” as individual farms occupy half of the total agricultural area (46.3%) and contribute almost half of the total output (45.3%). Except for Poland, less than 10% of the farmers are younger than 35 years. The share of farmers facing retirement in a short- to medium-term perspective (>= 55 years) ranges between 39% and 46%. These farms will soon face a generational transfer or closure of their business if the operator retires. The subgroup of farmers who have already reached the retirement age (>= 65 years) is extremely high in Hungary and Slovakia with 27.8% and 32.9%, respectively.

Table 1: Importance of individual farms in HU, PL, CZ, and SK, 2007

| | Unit | Hungary | Poland | Czech Republic | Slovakia |
|---|---|---|---|---|---|
| **All individual farms** | | | | | |
| **Total** | % of all farms | 95.8 | 99.7 | 89.0 | 88.1 |
| **Land** | % of total agricultural area | 46.3 | 89.6 | 28.8 | 18.2 |
| **Labor** | % of total annual work units | 61.6 | 96.8 | 22.7 | 21.6 |
| **Production** | % of total standard gross margin | 45.3 | 90.8 | 23.8 | 18.7 |
| **Age distribution of individual farmers** | | | | | |
| **Age < 35 years** | % of individual farms | 7.6 | 12.3 | 9.8 | 3.6 |
| **Age >= 55 years** [a)] | % of individual farms | 45.3 | 38.7 | 41.0 | 45.8 |
| **Age >= 65 years** | % of individual farms | 27.8 | 16.2 | 18.5 | 32.9 |

Note: [a)] Data from 2003.
Source: EUROSTAT 2007: FSS - Farm Structure Survey.

## A survey of farm households in Hungary

In order to obtain deeper insights in the prospective structural change in rural areas, one part of the "SCARLED" research project was the accomplishment of a farm household survey in five Central and Eastern European Countries (Bulgaria, Hungary, Poland, Romania, and Slovenia). The survey covered important data on farm households, e.g. the activities of household members, their personal characteristics (age, education), their time allocation (on-farm, off-farm), their agricultural production etc. The survey took place in different regions in order to capture some of the variation and heterogeneity existing between regions.

### *Survey farms in the study region "Northern Great Plain"*

The Hungarian survey data contain about 250 farm households, 80 in each of three study regions. In each of these regions interviews have been conducted in three villages. One of the chosen study regions (Nuts II level) is the region "Northern Great Plain" in the Northeast of the country. Firstly, the queried farm households have been distinguished to farm households smaller and larger than or equal to 4ha as the typical farms in the subsequent agent-based modelling approach should have a minimum size of 4ha.[1] The model application is based on a set of typical farms representing the region "Borsodi Mezoseg"[2] which is a smaller sub-region adjacent to and partly inside the Northern Great Plain region. This is important as a strict transferability of the survey results to the aforementioned sample of typical farms is only feasible for farm households larger than or equal to 4ha in the region "Northern Great Plain".

### *Age patterns of the survey farm households*

Table 2 presents data on the number of farm households and statistical data on the age of farm operators in the region "Northern Great Plain". About 60% of the surveyed farm households are larger than or equal to 4ha, slightly more than a third are larger than or equal to 10ha, and some 8% are larger than or equal to 75ha. Assuming the age of starting a farming career as a farm successor is 30 years and ends with 65 years the theoretical mean age of a farmer would be 47.5 years. Compared to this figure, Table 2 shows an overageing for all size classes except for the size class of large farm households (>= 75ha).

[1] This constraint has to be made as the model represents typical production activities of farms focussed on the market production and disregards subsistence and semi-subsistence farms.
[2] There is a collection of data for this region based on regional statistics and FADN data. A brief description of this model region is given in the section "Regional application – Model region".

Table 2: Age structure of farm household operators in the region “Northern Great Plain”

| | All | >= 4ha | >= 10ha | < 4ha | < 10ha | >= 75ha |
|---|---|---|---|---|---|---|
| **Number** | 83 | 49 | 29 | 34[a)] | 54[a)] | 7 |
| **% of all farms** | 100% | 59% | 35% | 41% | 65% | 8% |
| **Mean age** | 50.6 | 51.6 | 51.0 | 49.1 | 50.4 | 45.0 |
| **Median age** | 51 | 52 | 52 | 50 | 50 | 50 |
| **Standard deviation** | 10.9 | 10.2 | 10.8 | 11.7 | 7.1 | 12.4 |
| **Variance** | 117.8 | 104.7 | 116.1 | 136.7 | 50.4 | 154.0 |
| **Min.** | 28 | 28 | 28 | 30 | 29 | 28 |
| **Max.** | 77 | 74 | 74 | 77 | 77 | 61 |

Note: [a)] Includes also farm households with no agricultural area (ten farm households).
Source: Questionnaire SCARLED.

Figure 1 shows that the age distribution does not significantly differ in all groups except for the group of the smallest farms (< 4ha, not considered) and the group of the largest farms (>= 75ha). In the latter group operators tend to be younger. However, this group consists only of 7 farms and one can assume that farm successions did already take place on some of these farm households.

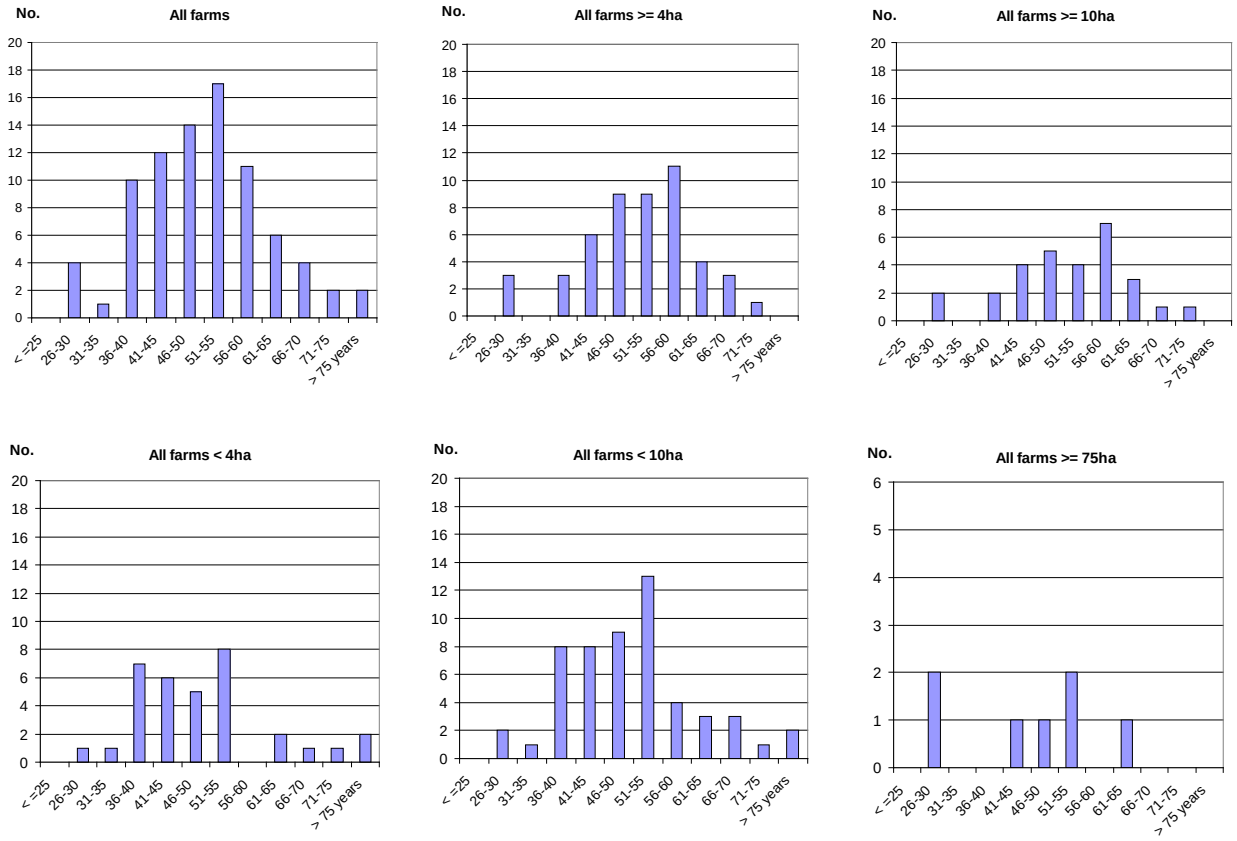



Figure 1: Age distribution by age groups in the region “Northern Great Plain”
Source: Questionnaire SCARLED.

*Demographic change and farm succession*

Overageing as a main phenomenon of demographic change becomes crucial for farm households when the farm succession is uncertain. With regard to structural change, it is rather the lack of a successor than the ageing (overageing) itself which is problematic. Hence, in the present survey farms were questioned about their farm succession plans.

Table 3 shows that only 13 of 49 farm households (27%) have already designated a farm successor while 61% have not. Within the latter group, 19 farm households (39%) state that a potential successor exists but his/her future plans are still unclear.

The average farm sizes of those farm households stating that a farm successor has already been designated and those which suffer by unclear succession plans do not differ significantly (42.7ha versus 44.8ha). But median farm sizes differ - 20.0ha in the first group compared to 9.9ha in the last group. This reveals that there are some outliers in the latter group, i.e. one can conclude that larger farms tend to have more definite plans regarding their future.

Among the 13 farm households where a farm successor has already been designated (Answer "Yes") are four where the successor - generally the child of the both farm household heads - is already working on the farm. These farms are all larger than 20ha.

Comparing the average (and median) ages of the farm operators of the group of those stating "Yes" and those stating "No", it is plausible that the average (and median) values in the group with clear succession plans are higher (55.7 years and 56.0 years, respectively). Those stating "No" are younger (49.3 years and 50.0 years, respectively). The older the farm operators the more they are faced to the question of the future farm development in excess of their own working life horizon.

Table 3: Farm succession plans (farms >= 4ha in the region "Northern Great Plain")

| | | Characteristics of farm households | | | |
|---|---|---|---|---|---|
| | No. of farm households | Av. farm size | Median farm size | Av. age operator | Median age operator |
| Has a successor already been designated? | | | | | |
| "Yes" | 13 (27%) | 42.7 | 20.0 | 55.7 | 56.0 |
| Among "Yes": children working on household | 4 | 47.3 | 49.5 | 54.0 | 55.5 |
| Among "Yes": no children/too young | 5 | 25.5 | 7.0 | 53.0 | 56.0 |
| Among "Yes": children with off-farm job | 4 | 59.5 | 18.5 | 60.8 | 61.5 |
| "No" | 30 (61%) | 44.8 | 9.9 | 49.3 | 50.0 |
| Among "No": a potential successor exists but succession still unclear | 19 | 29.9 | 10.0 | 49.7 | 50.0 |
| Among "No": definitely no successor (yet) | 9 | 65.3 | 8.0 | 48.1 | 52.0 |
| "No answer" | 6 (12%) | 18.5 | 15 | 54.2 | 54.0 |
| Total | 49 | | | | |

Source: Data from Questionnaire SCARLED, own calculations.

## The modelling approach

The simulation model applied within this study is AgriPoliS (HAPPE et AL. 2006, KELLERMANN et AL. 2008). This model treats agricultural farm structures as complex adaptive systems with farms as agents which perceive their environment and act and interact in response to changes of their environment and their status. The key characteristics of regional farm structures such as heterogeneous farms, space, product markets and production factors are considered for regional adaptations of AgriPoliS. On the individual level, farm-internal factors which relate to specific human and physical conditions of the farm, e.g. the age of the farm operator or the quality of the farm land are considered. On the other hand there are farm-external factors representing outside forces (e.g. wage levels, product prices, the agricultural policy framework) which also induce adjustment reactions.
A sample of suitable weighted typical farms represents the characteristics of specific regional farm structures (SAHRBACHER and HAPPE 2008).
Starting the model, the initial endowments of farms with production factors of labour, land, machinery, buildings, liquidity, and borrowed capital are specified based on standard farm management norms and technical data. The production and investment decisions of each farm are calculated by using a mixed integer programming model. Each line of production is valued with a specific gross margin.
In view to investment options (stables, machinery), there are economies of size as the fixed costs per unit and the labour demand are lower for larger operations. Farms have a farmstead and their farmland is either owned or rented-in by farms.
The farms interact and compete indirectly on the land market which is endogenous to the model such that actions of farms directly influence the land prices. The land market is implemented via an iterative sequential auction. Farms calculate a bid for a free plot of land. This bid is equal to the shadow price minus a specific share of the shadow price for costs such as taxes and fees minus transport costs. In the end, the plot is allocated to the farm with the highest shadow price. Key events within the modelling procedure are possible farm closures. If this happens the timing and the reasons for a farm exit are of particular interest. In the standard version of AgriPoliS farms exit if they are illiquid or if their opportunity costs of farm-owned production factors of labour[3], land, and capital are higher than the expected farm household income.

### *Dualistic farm structures in Hungary - two different types of farm agents*

The Hungarian study region has a moderate dualistic structure, i.e. there is a small group of large farms which are mainly organised as corporate farms (CF). These farms utilise almost half of the agricultural land. On the other hand there is a large number of small individual farms (IF) which utilise slightly more than half of the agricultural land. Individual and corporate farms differ with respect to several aspects: This concerns their objective, their labour endowment, and the assumptions in the course of the intergenerational transfer of the farming operations. Individual farms are equipped with family labour (and additional hired labour if necessary) while corporate farms operate solely based on external hired labour. The farm-family labour of IF can be partly or fully allocated to off-farm activities if this is expected to be more profitable. Furthermore, IF are assumed to maximise their household income while CF maximise profits.

[3] As CF operate without exception on the basis of hired labour they only weigh up for the opportunity costs of land and capital. Concerning the opportunity costs of farm-family labour on IF different assumptions are made compared to the standard version of AgriPoliS. These assumptions are defined in the section of the scenario description.

*Modelling entry and exit dynamics - successions on individual farm households*

In AgriPoliS, a main difference between IF and CF with regard to the intergenerational transfer of the farm consists in the assumption for IF that the farm operator runs the farming operations for a period of 35 years and then the operation has to be continued by a successor. As the existence and willingness of a potential successor is often connected with uncertainty, this aspect is included within the scenario settings. In contrast, for CF it is assumed in a rather simplistic way that they do not face any issues on farm succession as all necessary labour-input can be hired on the labour market, including potential successors. The assumption of a working life of 35 years is based on two considerations: on the one hand WEISS (1999) approximates the mean age of entering the farming business as a successor by an age of 30 years. On the other hand the date of the farm transfer to the next successive generation is assumed to take place at an age of 65 years.[4] These considerations lead to a generational change after 35 years.[5]
In AgriPoliS, a potential successor only enters if the expected farm income is higher than the expected off-farm income. The decision to continue is assumed to create sunk cost, as specific investments in human capital of the farm successor are necessary. Therefore, it is considered for the opportunity costs to take over a farm that there is a mark-up of 25% to the level of the alternative off-farm wage level for a potential successor. Once a successor has decided to enter, opportunity costs revert to the original level without the mark-up. In the case that the opportunity costs of the successor and for the own capital and land are higher than the expected farm household income, the farm is closed down and all farm land is released to the land market.

## Regional application, policy, and scenarios

*Model region*

AgriPoliS was calibrated to represent the dualistic farm structure of the region "Borsodi Mezoseg". This region is located in the North-East of Hungary adjacent to and partly inside of the Northern Great Plain region. The initialised region has a size of about 33,400ha.[6] About 55% of the area is managed by IF which constitute 97% of farms, the remaining share is occupied by CF. The average farm size of IF amounts to 21ha while CF use on average 625ha per farm. The group of IF is quite heterogeneous as the majority of 60% of IF is smaller or equal than 10ha. The two largest IF operate on 130ha and 300ha, respectively. The average livestock density is comparatively low in the model region (0.16 LU/ha). In the range of IF the livestock density is slightly higher (0.20 LU/ha) compared to CF as the IF are engaged in all livestock activities (Table 4). But the livestock activities are unequally distributed among IF as only 53% of them keep livestock. The specific lines of livestock production - different kinds of cattle and sheep - reveal that livestock is predominately kept to make use of grassland (28% of the UAA) and less fertile parts of the arable land. The region is not characterised by intensive livestock activities in the range of e.g. fattening pigs, sows, chicken, or egg production.

[4] In Hungary, the official retirement age is committed to 62 years. This applies to dependent employees. For private farmers there is no fixed retiring age. The survey data show that only a few farm operators continue the farming business exceeding the age of 65 years. This concerns only 33 of all 256 farm households surveyed (= 12.9%).

[5] The survey data show that the farm operator and the partner are usually of the same age. Hence, the working life is assumed to be synchronously for the operator and the partner as well.

[6] Farms smaller 4ha are not considered, i.e. this area refers to all farms larger than 4ha.

Table 4: Importance of individual farms in the model region

| Characteristics | All farms | Share of Individual farms |
|---|---|---|
| Farms (no.) | 901 | 97% |
| Utilised agricultural area (ha) | 33,362 | 55% |
| thereof Grassland (ha) | 9,357 | |
| Dairy cows (no.) | 2,185 | 59% |
| Beef cattle (no.) | 1,645 | 76% |
| Suckler cows (no.) | 9,140 | 78% |
| Sheep (no.) | 27,250 | 58% |

Source: Based on Hungarian Census of Agriculture 2000.

### *The agricultural policy framework*

The simulations start in 2004 when Hungary became a part of the EU. Hungary opted for the implementation of a simplified single area payment scheme (SAPS) which consists of incrementally increasing payments year by year with a starting level of 25% of the old member states' direct payment level. These payments are augmented by coupled Complementary National Direct Payments (CNDP), so called "top-ups" for specific crops and livestock. This policy framework applies to all scenarios.

### *Scenarios*

The four scenarios are defined so that the starting scenario is rather simplistic and, through a relaxation of assumptions, the scenario setting becomes more realistic. The scenarios focus on three issues concerning the ageing and succession of farmers:

(i) The level of opportunity costs for farm-family members over their period of the professional life. Opportunity costs are assumed to be constant or declining with increasing age.
(ii) The initial age distribution within the sample of individual farmers. This is an equal distribution in the standard version of AgriPoliS. In this application it is calibrated to an empirical age distribution.
(iii) The assumptions regarding the existence of a successor and his potential willingness to succeed.

*Scenario "Reference"*
It is assumed that the opportunity to find a job outside agriculture is constant over the working life of a farmer, i.e. old farmers face the same opportunity costs as their young colleagues.
Specific model parameters and key assumptions applying to all scenarios are shown in the Annex.

*Scenario "Age-dep"*
This scenario assumes an age-dependent decline of opportunity costs over time. A typical farmer is assumed to have a specific agricultural education which can hardly be remunerated fully outside the farming sector. Moreover, the mobility to switch to another (off-farm) profession declines with advancing age following CHAMPION (1998) who states that the potential payoff of a new job is lower for older employees. Furthermore several studies on the agrarian labour market in CEE- Countries state that middle-aged and old farmers have little or no off-farm job opportunities (e.g., RIZOV and SWINNEN 2004, and BOJNEC et AL. 2003). The decline of opportunity costs is implemented step-wise: It is assumed that a successor becomes the farm operator with an age of 30 years. For the first 15 years being the farm operator it is assumed that the farmer still has full opportunities, i.e., he would receive the full off-farm wage level. In the next 10 years he would receive only the half off-farm wage and nothing in the last 10 years in the age from 55 to 65. These assumptions hold for all farm-family labour, i.e. the operator and the partner.

*Scenario "Empirical"*

A further step towards a realistic implementation of model assumptions concerns the initial age distribution within the group of IF. In previous applications the initial age assignment consisted of an equal distribution. Each individual farm operator was assigned by a random age which leads to a random distribution of age among all individual farm operators, irrespective of any farm characteristics. This implementation has been extended in AgriPoliS by an option to implement age structures according to empirical data sources, e.g. based on survey data. The initial assignment of age to the farm operator (and the partner) is based on the findings on the relationship between farm size and age as shown in Table 5: .[7] The mean age of 52.5 years in the smallest farm size group (>= 4ha and < 10ha) is approximated by a triangular function which has its peak at an age of 52.5 years, i.e. the centre is skewed to the right according to the distribution in the respective farm size class.[8] This initialisation is applied for each size class separately. Only the size class of the largest farms (>= 60ha) is not affected by an "overageing" as the mean value amounts to only 47.0 years.

Table 5: Age distribution by size classes (farms >= 4ha in the region "Northern Great Plain")

| **Farms between …** | **>= 4ha and < 10ha** | **>= 10ha and < 25ha** | **>= 25ha and < 60ha** | **>= 60ha** |
|---|---|---|---|---|
| **Number (total 49)** | 20 | 10 | 9 | 10 |
| **Mean age of operator** | 52.5 | 54.1 | 52.1 | 47.0 |

Source: Questionnaire SCARLED.

*Scenario "Succ_random"*

Closely linked to the problem of ageing appears the problem of farm successions. This is a subsequent problem which becomes even more pressing the older the farm operator is. The survey results suggest that succession processes on individual farm households are often uncertain. The number of farm households which state definite plans regarding farm succession is small (only 13 farms of 49) and the number of those farm households stating uncertainty on farm succession is comparatively high (19 farms). To cover this phenomenon of uncertainty there is a scenario implemented for which it is assumed that the probability of a potential successor is 50%.[9] This assumption is independent of any other characteristics of IF, i.e. if a potential successor exists, a decision to continue is based on opportunity cost considerations.

[7] The setting of the farm size borders is somehow arbitrary but chosen in view to a suitable fitting for the sample of typical farm households within the modelling.

[8] A symmetric triangular age distribution within the borders of 30 and 65 years has its peak at a value of 47.5 years. A peak at 52.5 years reflects the overageing within this farm size class as this procedure generates an age distribution where most farm operators are aged 52.5 years while only a few are old and even less are young farmers.

[9] All other scenarios assume that there is always a willing successor who decedes on the basis of opportunity cost considerations to continue the farm.

## Simulation results

The following sections focus on selected aspects of agricultural structures and changes in them. Each simulation runs for 35 periods, such that intergenerational transfers take place at least once per farm.[10] Results are based on five independent replications of each scenario (cf. Table 6) where the age of assets, the farm location, and the variable production costs are varied randomly.[11]

Table 6: Scenario matrix

| Scenario name | Opportunity costs | Initial age distribution | Succession |
|---|---|---|---|
| *"Reference"* | Constant over work life | Equal | Always successor |
| *"Age-dep"* | Age-dependent | Equal | Always successor |
| *"Empirical"* | Age-dependent | Empirical | Always successor |
| *"Succ_random"* | Age-dependent | Empirical | Randomly (50%) no successor |

Source: own.

In a first step, the impacts coming from different assumptions on the opportunity costs of labour of the farm household members are analysed (scenarios *"Reference"* and *"Age-dep"*). In the next scenario (*"Empirical"*), the impacts of an empirically based initial age distribution are addressed to show the influence of demography on the speed and intensity of structural change. Closely linked to this issue, the impacts of a 50%-probabilty of farm successions are focussed in the scenario *"Succ_random"*. Furthermore, the analyses shed light on the competition and the different developments within both legal types as the farm structure is dualistic (e.g. farm incomes reflect the remuneration of the whole producing entity and the factors used in it, the labour input gives some indications on the efficiency and costs of production while the livestock density reveals insights on the production intensity).

### *Speed of structural change*

As Figure 2 (a) shows, the number of IF declines over the simulation period of 35 years, the starting year of the simulations is 2004. The decline is the fastest in the reference scenario, i.e., if the opportunity costs are assumed to be constant over the working life period of farm-family members. Later, structural change slows down.[12] The decline of IF is notably slower in the beginning of the alternative simulation runs which assume that age plays a role with regard to the existence and value of opportunities.[13] While the group of IF is quite numerous and heterogeneous in the beginning, the group of CF is rather homogenous. Their number (24) is constant over all simulation runs and in all scenarios. However, CF are declining in size: the average size of CF amounts initially to 625ha and shrinks to 510ha in period 35 (iteration 35) which is caused by some initially middle-sized and large IF which continue in growing.

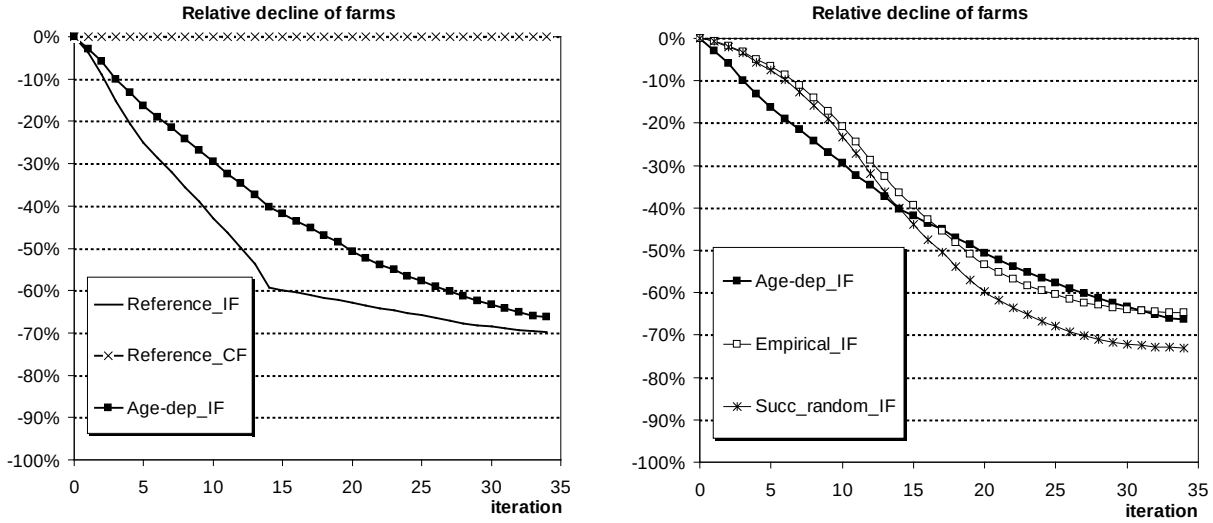
[10] The quite long 35-years period was chosen because of this fact. For the analyses of incomes the time frame was reduced to a narrower time frame of 10 years as many model developments show up in the early simulation runs.

[11] Like in reality there are differences with regard to the managerial performance of farms which is implemented in the way that some farm operators have lower variable production costs compared to others. It is assumed that production costs vary by 10% between farms. However, these different managerial abilities are assigned to farms by random, i.e. independently of any other characteristic such as age (experience) or farm size and they remain constant throughout the entire simulation.

[12] The "kink" of the curve at iteration 13-14 marks a point where all potential "exit-farms" of the smallest farm size classes have quitted. Afterwards, the exiting concerns other farms and slows down.

[13] The slightly different final levels of the curve of the scenario *"Reference_IF"* and *"Age-dep_IF"* are caused by complexity as in the scenario *"Age-dep_IF"* do some farms not exit which exit within the other scenario (or at another moment during the simulations which makes a difference). Hence, the interdependencies can provoke that exiting farms in one scenario do not exit in the other, simply because their competitive environment - constituted by the other farms - has changed.

Figure 2 (b) shows the developments on the number of IF in the scenarios *"Empirical_IF"* and *"Succ_random_IF"* (scenario *"Age-dep_IF"* is also depicted therein). The shapes of the curves differ. The consideration of the empirical age structure together with the age-dependent opportunity costs cause an even slower structural change in the first periods than in the scenario *"Age-dep_IF"*, but an accelerated structural change thereafter, before slowing down again in the final periods. The combination of the two assumptions that a.) the initial farm sample is overaged (according to the empirical findings) and b.) opportunity costs decrease over time, cause that there are many farmers initially in the stage to be old and have less opportunities (scenario *"Empirical"*). Hence these farms persist for quite a while, but then, the number of annual generational changes increases as well as the speed of exits increases because many potential young successors considering higher opportunity costs are not willing to continue farming (iterations 8-23).
Towards the end of the simulations there are increasingly less farms confronted with a generational change (compared to the scenario *"Age-dep_IF"*) and at the end of the simulations (iteration 35) there are as many farms as in the scenario *"Age-dep_IF"* with its implementation of an equal initial age distribution. The comparison of these two scenarios shows that the timing of farm exits and persistence depends on the initialisation of age patters.
These phenomena occur even stronger in the scenario *"Succ_random_IF"* assuming only a 50%-chance that a potential successor exists. This scenario is characterised by a significantly stronger decline in the number of IF (what would be expected a priori, too).
This can be explained by the fact that there are many typical "exit-farms" which quit anyway. The assumption on having no willing successor at the generational change substitutes somehow the farm-internal calculation of opportunity costs, i.e. if a farm would not be affected by a missing successor it would decide by the opportunity cost consideration to exit from farming.




(a) (b)

Figure 2: Number of farms in different scenarios (relative decline)
Source: own calculation.

*Incomes*

With regard to the total farm income there are strong differences between both legal types. Initially the average total farm income of CF amounts to 90,000 €/farm while it is on a level of 11,000 €/farm in the group of IF.[14] The remuneration with regard to an AWU is shown in Table 7: . The strong increase of the total farm income per AWU on IF is caused by a "sample effect" as many of the small IF leave the sample in the first simulation periods. The increasing volume of payments - as major impact of the CAP-Implementation - does only slightly cause this income increase as there is a capitalisation of payments to the landowners via increasing rental prices. This affects CF as well because they operate to more than 90% on rented land. This is reflected in a very slight income increase per AWU on CF. Initially, CF show a higher remuneration of farm labour. In the middle term perspective the remuneration levels converge driven by an increase on IF.[15] This phenomenon of convergence can partially be generalised as there are a few IF which strongly grow and show characteristics which could only be observed on CF in before.

Table 7: Total farm income (profit + costs for hired labour) per AWU in €

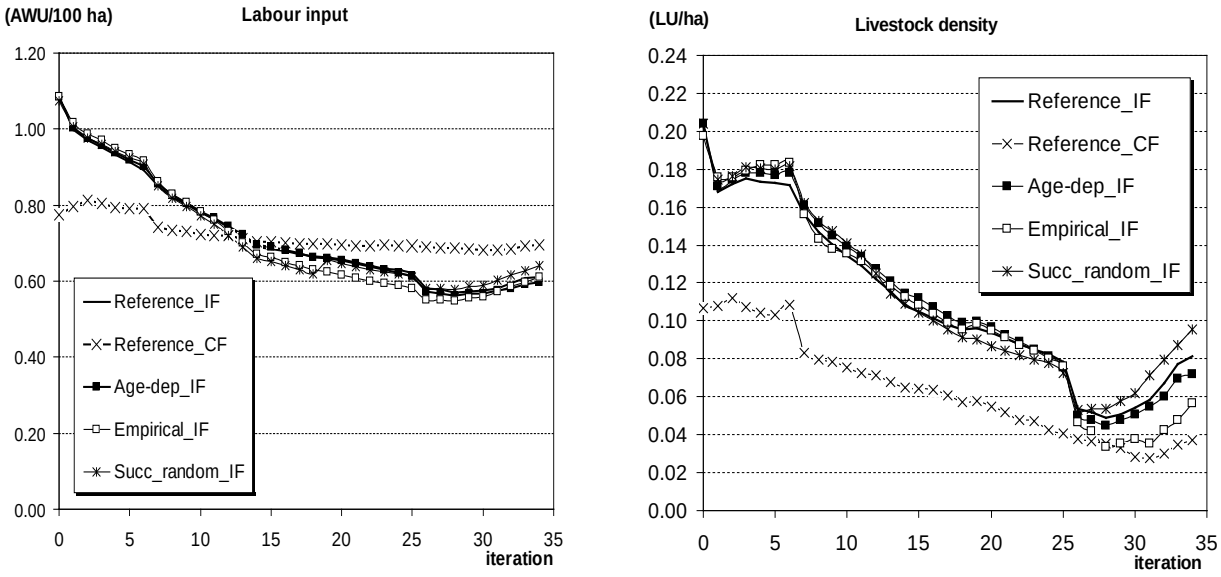
| **Legal type** | **IF** | **CF** |
|---|---|---|
| Scenario | *"Reference_IF"* | *"Reference_CF"* |
| iteration | | |
| t=0 | 7,911 | 24,076 |
| t=5 | 17,347 | 26,422 |
| t=10 | 23,091 | 25,752 |

Note: The developments in the scenarios *„Age-dep_IF"*, *„Empirical_IF"* and *„Succ_random_IF"* are not depicted inhere as they do not differ to the scenario *"Reference_IF"*. This applies to the scenarios of CF as well.
Source: own calculation.

*Labour input and livestock*

The initial labour input of IF and CF differs (Figure 3 (a)). While IF show a value of 1.1 agricultural Annual Working Units (AWU) per 100ha this value amounts to only 0.8 AWU/100ha for CF. Both values are comparatively low which indicates a low livestock density (Figure 3 (b)) and mirrors the large-scale farm structures where most land is managed by large CF or large IF.[16]
The labour input reduction is stronger on IF while the labour input on CF remains almost constant. The reduction on IF is primary caused by the decline in the livestock production (Figure 3 (b)) which, in turn, is the result of the exiting of small IF. The exit of small IF and the simultaneous increase of other IF causes an absolute decrease of the labour input but an increase of labour efficiency because larger farms are more able to exploit economies of scale.
The comparably lower labour decline on CF is caused by some re-investments in the field of sheep and milk production so their labour input decline is more slightly. Within the livestock production there is a strong decline of beef and suckler cow production while the decline of milk and sheep production is moderate. There are hardly any differences with regard to the scenario differentiation. This is the reason for the shifting of the focus towards the differences between the legal types.

[14] Both figures are not comparable but they are given to get an impression of the average absolute income level of both legal types.
[15] The income peak of CF at the iteration t=5 is caused by peculiarities of the premium scheme as there is a peak of premiums for specific livestock lines of production which are predominantly kept on CF.
[16] Within the model phenomena of "economies of scale" are reproduced. The CF compose only 3% of farms in the model region but operate on 45% of the regional area. By including the two largest IF (130 and 300ha) 5% of farms use 57% of the land.




(a) (b)

Figure 3: Labour input (a) and development of livestock density (b)
Note: For reasons of clarity there is for the group of CF only the scenario *"Reference_CF"* depicted because the developments on labour input and livestock density do not significantly differ in the three other scenarios for this legal type.
Source: own calculation.

## Summary and conclusions

The application of AgriPoliS to the Hungarian region "Borsodi Mezoseg" has been extended by using empirical findings of a farm household survey among Hungarian farms. The survey served as an empirical basis to understand demographic dynamics and related issues on the farm household level. The compiled survey data refer to the age structure of farm operators and to the process of farm succession. To gain insights on the latter issue - which is often connected with some uncertainty - the survey farms have been queried with regard to the existence and designation of potential farm successors.

In view to the impacts of demographic patterns on structural change one can somehow predict a steady continuation of structural change by the exiting of small individual farms. The demographic patterns as observed in the farm survey - overageing of operators in the size classes of small farms - provoke a shift of the exiting process as there might appear phases of accelerated (or slowed) structural change. The acceleration of small farms' quitting agriculture happens if there is a peak of frequent generation changes because many potential farm successors decide not to enter the farming business because of better off-farm opportunities. Hence, one can conclude that the timing of persisting and exiting of farms highly depends on the age distribution of farmers. This phenomenon is even more pronounced by assuming that successors are not existent or willing to enter farming by a 50% chance.

Eurostat data, the survey results and the simulation experiments give an indication that the next 15 years will be characterised by frequent farm successions or "non-successions". Both will have impacts on structural change in agriculture. The non-succession will lead to a reduction of farmers and as many exiting farms stem from the group of small farms the land use share within these size classes will shrink while it will increase in the classes of larger farms. Within the model, a successful farm succession can at least be interpreted as a survival of the respective farm. In reality, successful farm successions often imply increasing investment activities (e.g. expansion in farm size, investing into larger stables, opening of additional lines of production).

However, exiting options of individual farmers – including all farm family members – depend on opportunities. With regard to the implementation of an age-dependent declining of these opportunities it could be shown that this initially slows down the number of farm exits significantly, i.e. if there are impediments of a flexible labour adjustment, structural change slows down.

In view to the problem of uncertainty of farm successions – expressed as a problem of missing farm successors – one can conclude that the impacts are not that strong as one would have supposed ex ante. There are typical "exit-farms" which leave anyway and even before a potential succession event. This phenomenon induces also the finding that the impacts of the different scenarios with regard to the indicators of incomes, labour input, and livestock density appear rather negligible. But this finding depends also on the nature of the sample farms which constitute the model region. If, e.g., livestock activities would be mainly located at small farms it can be assumed that the differences between the scenarios with regard to livestock and the livestock density would increase as well.

The differences between the two legal types are significantly more pronounced. A different development can be observed with regard to the number of farms while the initially wide income gap diminishes through a strong increase of incomes on IF. The group of corporate farms – as competitor within the dualistic farm structure – seem to be well established as none of them is leaving. One can suppose that they benefit from economies of scale which are implemented within the model. To emphasise the result of a decreasing livestock production one should consider the crucial fact that this development goes hand in hand with a further loss on value added and particularly employment in rural areas. On the other side it should be considered that the agricultural policy framework with its increasing area payments leads to a tremendous increase of rental prices and that it stabilises farm incomes as well. This can in turn somehow "overlay" the demographic issues which have been addressed in this analysis. But increasing payments to farmers lead to the problem of a capitalisation of the premium benefits to landowners in the middle- and long-term perspective. But, the policy frame does not inhibit the trend of farm exits which is somehow surprising since other studies (BLAAS et AL. 2007) found that increasing premiums lead to a significant time delay of this adjustment reaction.

## References


BLAAS, G., M. BOZIK, S. BUDAY, H. SIPOVA, E. UHRINCATOVA, L. LATRUFFE, S. DAVIDOVA, H. SCHNICKE, K. HAPPE, C. SAHRBACHER, K. KELLERMANN (2007). Effects of the CAP direct payments on Slovakian agriculture. Deliverable 29 of the EU Specific Targeted Research Project IDEMA SSPE-CT-2003-502171.

BOJNEC, ST., DRIES, L. and J.F.M. SWINNEN (2003). Human capital and labor flows out of the agricultural sector: Evidence from Slovenia. Paper presented at the 25th International Conference of Agricultural Economists (IAAE), Durban, South Africa, 16 - 22 August 2003.

BUCHENRIEDER, G., J. MÖLLERS, K. HAPPE, S. DAVIDOVA, L. FREDRIKSSON, A. BAILEY, M. GORTON, D'A. KANCS, J. SWINNEN, L. VRANKEN, C. HUBBARD, N. WARD, L. JUVANČIČ, D. MILCZAREK, P. MISHEV (2007). Conceptual framework for analysing structural change in agriculture and rural livelihoods. Deliverable 2.1 of SCARLED (SSPE-CT-2006-0044201 (STREP)).

CHAMPION, A. G. (1998). Demography. in: T. Unwin (Ed.) A European Geography, pp. 241 – 259. Harlow: Longman.

EUROSTAT (2007). Farm Structure Survey (FSS) 2005 – Czech Republic, Hungary, Poland, and Slovakia: EUROSTAT.

HAPPE, K., K. KELLERMANN**,** A. BALMANN (2006). Agent-based analysis of agricultural policies: an illustration of the Agricultural Policy Simulator AgriPoliS, its adaptation and behavior. Ecology & Society 11 (1): Art. 49. http://www.ecologyandsociety.org/vol11/iss1/art49/

HAPPE, K., SCHNICKE, H., SAHRBACHER, C., and KELLERMANN, K. (2009). Will they stay or will they go? Simulating the Dynamics of Single-Holder Farms in a Dualistic Farm Structure in Slovakia. *Canadian Journal of Agricultural Economics*. Vol. 57 No. 4, 497 – 511.

HUNGARIAN CENTRAL STATISTICAL OFFICE (2004). Hungarian Census of Agriculture 2000.

JELINEK, L., C. SAHRBACHER, T. MEDONOS, K. KELLERMANN, M. BRADY AND O. BALKHAUSEN (2007). Effects of the CAP direct payments on Czech agriculture. Deliverable 27 of the EU Specific Targeted Research Project IDEMA SSPE-CT-2003-502171.

KELLERMANN, K., K. HAPPE, C. SAHRBACHER, A. BALMANN, M. BRADY, H. SCHNICKE, A. OSUCH (2008). AgriPoliS 2.1 - Model documentation. Technical Report. Halle (Saale): IAMO: http://www.agripolis.de/documentation/agripolis_v2-1.pdf, accessed November 2009.

RIZOV, M., SWINNEN, J.F.M. (2004). Human capital, market imperfections, and labor reallocation in transition. Journal of Comparative Economics 32: 745-774.

SAHRBACHER, C., K. HAPPE (2008). A methodology to adapt AgriPoliS to a region. Technical Report. Halle (Saale): IAMO: http://www.agripolis.de/documentation/adaptation_v1.pdf, accessed November 2009.

WEISS, C. (1999). Farm growth and survival: econometric evidence for individual farms in upper Austria. American Journal of Agricultural Economics 81: 103-116.

**Annex**

| Specific model parameters and key assumptions – model region "Borsodi Mezoseg" | |
|---|---|
| Description | Details |
| Farm is handed over to next generation (Generation change) every ... periods | 35 |
| Labour hours per annual work unit (AWU) | 1,800 h/AWU |
| Off-farm income_1 (operator) | 2.9 €/h |
| Off-farm income _2 (partner) | 2.8 €/h |
| Costs of hired labour | 3.3 €/h |
| Annual increase of labour costs | 2.0% |
| Minimum annual withdrawal of farm household annual work unit (AWU) | 2,300 €/AWU |
| Interest rate level | |
| Long-term borrowed capital | 3.00% |
| Short-term borrowed capital | 3.50% |
| Equity capital interest | 2.00% |
| Equity finance share[a)] | 30% |
| Managerial ability (% of variable costs) | [95, 105] % |
| Plot size | 1.0 ha |
| Length of rental contracts [fixed length] | 9 -18 years |
| Annual transport costs | 30 €/km |
| Overhead costs (Administration, taxes, professional association etc.) | 1% of gross margin from agriculture |

Note: [a)] Access to capital is not restricted by institutional factors, but by the available equity capital on the farms.