STRUCTURAL ADJUSTMENT OF SWISS DAIRY FARMS – FARM EXIT AND FARM TYPE CHANGE

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Abstract

This paper analyses which factors drive the structural change in Switzerland. We focus on dairy farms to examine why farmers abandon farming or change to another production type. Using administrative data from the agricultural policy information system, the results from logistic regression show that retirement is one of the main reasons for farm exits. Besides, dairy farms that are more specialized exhibit higher probabilities of farm exit whereas farm size and the adherence to organic or animal welfare standards reduce the exit probabilities. Farm type changes occur rather at younger age and by farms that are acquainted with organic and free-range animal husbandry. These findings highlight the viability of small and less specialized farms in the Swiss dairy sector and the relevance of product differentiation.

Keywords

Structural change, farm type, farm exit, dairy farm, Switzerland

1 Introduction

Structural change in agriculture is ubiquitous and persistent. Farms cease operations whereas others grow in size. Some farms specialize in certain farm enterprises whereas others diversify into new farm units or farm related business units. Representing these different structural developments and understanding what exactly happens in the farming sector is of high political importance.

Structural change is particularly pronounced in Swiss dairy farming contributing to a relatively high decline of the number of farms compared to other farm types (AGRISTAT et al., 2019). Over the last 20 years, both the number of dairy farms and of dairy cows have decreased, while the quantity of milk produced has remained relatively constant (AGRISTAT et al., 2019; OBRIST, 2019). Around 30 percent of Swiss farms belong to the dairy farm type (ZORN, 2020). Dairy farming is the most important branch of Swiss agriculture with a share of over 20 percent to the output value of the agricultural sector (OESCHGER, 2013; BFS, 2019).

The Swiss dairy market, however, is characterized by decreasing added value (BOKUSHEVA et al., 2019). While the number of dairy cows is shrinking, the number of suckler cows is steadily increasing (RÜSSLI, 2019). The growing share of specialised suckler cow farms (their share has grown from three percent in 2000 to eight percent in 2018, ZORN, 2020) is explained by consumer demand for meat from natural livestock farming and extensive use of meadows and pastures (BRINER et al., 2012). This development is supported by animal welfare and biodiversity payments (OECD, 2015) and diverse labelling schemes (PUSCH, 2015; BOESSINGER et al., 2018). Anecdotal evidence suggests that many small and medium sized dairy farms resign from milk production and change to suckler cows. This is explained by barriers to growth and the relieve of labour from the burden of milking. Furthermore, if young dairy farmers' situation does not allow specialisation, they alternatively often diversify farm business (KRAMMER et al., 2012). The structural developments of the dairy farm sector are of high importance for Swiss agricultural, environmental as well as regional policies. Furthermore, the Swiss agricultural sector can provide a relevant blueprint for neighbouring European regions.

Previous analyses of structural change in agriculture focus on factors explaining general farm exit (BREUSTEDT et al., 2007; KAZUKAUSKAS et al., 2013; ROESCH et al., 2013; KATCHOVA et

al., 2017; SAINT-CYR et al., 2019) some of which considering specifically dairy farms (THIERMANN et al., 2019). The issue of farm diversification is analysed (WEISS et al., 2000; HANSSON et al., 2010; DELAME et al., 2015) either as regards income diversification by taking up off-farm employment (RØNNING et al., 2006; BARNES et al., 2015; WELTIN et al., 2017) or on-farm diversification (VIK et al., 2011; MERANER et al., 2015). Only recent studies shed light on the structural development of farm types (STORM et al., 2016; NEUENFELDT et al., 2019; SAINT-CYR et al., 2019). STORM et al. (2016) reveal different exit probabilities and growth rates between farm types. NEUENFELDT et al. (2019) point to the relevance of farms' "historic specialisation" for structural change at regional level. Accounting for spatial interactions in the analysis of farm exit, SAINT-CYR et al. (2019) also find considerable variation between farm types.

We contribute to the literature by providing empirical evidence for the driving factors of farm type changes, i.e., switches from milking to another related branch of farming such as suckler cow husbandry. The structural development of dairy farms is linked to questions of the intensity of agricultural production (e.g. in case of specializing, dairy farming may be accompanied with farm growth) or the question of income diversification (e.g. in case of less intensive farming, suckler cows) and therefore relevant for the agricultural market, income and environmental issues.

This paper is structured as follows: The next section gives an overview on prior studies and proposes hypotheses. The third section describes the data and shows descriptive findings before the methodological approach is explained. The following section presents the regression results. The last section concludes.

2 Literature review and hypotheses

The literature review focuses on studies on dairy farms' development. Our specific interest lies on the one hand on farm exits and, on the other hand, on changing the farm type, i.e. leaving specialised dairy farming in favour of other farm types. Based on the review of empirical literature, we develop hypotheses on factors influencing dairy farm exits and farm type changes.

ZIMMERMANN et al. (2006) identify in a literature review technological progress, price relations (between production factors), market structure, human capital, demographic development, employment of household members (on- vs. off-farm work) and agricultural policies as general drivers of structural change. Regarding the farm household, a higher **age** of the farm operator is supposed to increase the exit probability (GALE, 2003) while the existence of a farm successor is expected to decrease this probability (DONG et al., 2016). Moreover, with larger family size, the probability to have a farm **successor** increases since incentives and labour resources for farm growth are available (WEISS, 1999). Hence, we expect a lower exit probability with an increasing **number of family workers** resulting in a decrease of the exit probability.

Additionally, the farm structure is usually considered as driver for farm exits. In case of dairy farms, **farm size** is measured by the number of cows (THIERMANN et al., 2019). With an increasing number of cows, the exit probability is supposed to decrease (BRAGG et al., 2004). Given the relatively small herd sizes of Swiss dairy farms compared to neighbouring countries, larger farms may reap considerable scale economies. A **high stocking rate** can increase dairy profitability (MA et al., 2020) and on the one hand can be considered as an indicator of farm growth and correspondingly lower exit or change probabilities (ZIMMERMANN et al., 2012); on the other hand, it could also indicate growth barriers due to scarce farm land. Farm **specialisation** (proxied by the Herfindahl-Hirschman index (PIET, 2016)) could either result in higher dairy profitability and stability or increase income volatility (BRAGG et al., 2004) and thus the probability of farm exit or farm type change.

Another important factor for dairy farms' development is their orientation in terms of differentiation, i.e. **quality labels**. A prominent share of organic milk characterizes the Swiss milk market. Organic farming allows especially dairy farms to increase the selling price and to reduce farm vulnerability (HOFER, 2002; BOUTTES et al., 2019). **Organic** dairy farms in Switzerland attain higher incomes despite smaller herd sizes (HOOP et al., 2019). In Swiss agriculture, **animal welfare** standards, offer further potential to differentiate: "Animal welfare through housing system" (BTS [*Besonders Tierfreundliche Stallhaltungssysteme*]) and "regularly keeping animals outdoors" (RAUS [*Regelmässiger AUSlauf ins Freie*]) are supported by direct payments. These programmes not only allow differentiating between specific animal welfare qualities, but they also provide public subsidies. Hereby we expect a lower exit probability. However, the adherence to the requirements of RAUS can also form a growth barrier since its fulfilment could be more challenging for larger farms. The milk market conditions are considered by the **indexed milk price**.

Swiss agriculture is highly subsidized (OECD, 2019). To reflect the dependency of farms from **direct payments**, we expect a stabilising effect from the sum of direct payments a farm receives (HOFER, 2002; BREUSTEDT et al., 2007). Furthermore, the relation of direct payments to a farm's standard output[1] allows further insights into the **strategic orientation** on direct payments (e.g. by focusing on extensive production and biodiversity payments) versus a more pronounced market orientation. With decreasing dependence from public subsidies, we expect a lower exit and change rate.

Structural adjustment can considerably differ between **regions** (HUETTEL et al., 2009; ZIMMERMANN et al., 2012). The regional differentiation in valley, hill and mountain region, allows considering such effects. Across farm types, Swiss farm exit rates increase with more difficult production conditions from the valley to the mountain region (ZORN, 2020). We expect a similar effect for dairy farms (HOFER, 2002).

Off-farm comparative income reflects the attractiveness of off-farm job opportunities. This is relevant for both farm exits as well as for part-time work. With increasing opportunity costs of staying in the agricultural sector due to higher **off-farm incomes**, we expect a higher exit rate as well as a higher rate of change to less labour intensive farm types such as suckler cows. For Swiss dairy farmers, LIPS et al. (2016) determined a high preference to stay in this business. By the means of a discrete choice experiment, they quantified the necessary yearly income compensation for changing from dairy to suckler cows at around 50 000 CHF. Generally, the empirical effect of off-farm labour on farm exit is not clear (RAMSEY et al., 2019). Finally, the **unemployment rate** at cantonal level is considered to represent the labour market conditions.

3 Data

We use annual panel data on the farm level for the years 2000 to 2018 from the Federal Office for Agriculture (FOAG) to empirically test the proposed hypotheses. The FOAG collects the data in the context of the management of direct payment programs, called agricultural policy information system (AGIS). The dataset represents a general farm register, so it corresponds to a census of all Swiss farms. The use of administrative data typically involves a larger sample size (in contrast to surveys) and less potential for measurement errors.

In order to avoid distortions caused by extremes at the lower tail of the distribution, we refer to the definition of an agricultural holding used by the Federal Statistical Office (FSO). This definition is based on minimum farm sizes (such as 1 ha of farm land area, 30 ares of special crops or minimum animal numbers (FSO, 2016)). Farms that do not meet these minimum

[1] The standard output is the average monetary value of agricultural production at producer prices (EUROSTAT, 2018). The standard output includes the costs of production and excludes direct payments.

standards are excluded from the analysis. In accordance with the selection criteria used by the Swiss farm accountancy data network (FADN), year-round farms (in contrast to summering farms) and farming cooperatives were considered for the present analysis (RENNER et al., 2019). Regarding the legal form, only natural persons or ordinary partnerships are included (hereby excluding companies with shared capital or public companies).

Since our focus lies on dairy farms, we consider only farms, which are at least once classified as dairy farm[2] during the period of observation (2000-2017) and which received direct payments in at least one year. All other farms are not considered in this analysis.

One major advantage of the data set is its panel structure. The panel structure allows analysing individual farm behaviour over a long period. Hence, we can use the panel data to define outcome variables of interest, i.e., farm exits and changes of the main production type.

A farm exit is a binary variable indicating the last period a farm received direct payments. Direct payments in Switzerland are provided for farmers younger than 66 years. Farmers that pass this age threshold without handing over the farm to a younger farmer are considered as farm exit, too. This classification is justified by the low attractiveness to take over the farm and supported by the data.

A change of the farm type is a binary variable taking up one if a dairy farm changes its main production type into the suckler cow farm type or related combined farm type. For this, we classified farm types into five categories according to the importance of cattle with specific consideration of dairy and suckler cows. Class 1 consists of specialised dairy farms and class 5 of arable crop and granivore farms.[3]

Table 1 shows descriptive statistics of the outcome variables. We observe about 440,000 data points (about 30,000 farms) of which about two percent experiences an exit between 2000 and 2017. About one percent of all observations change their main production type from dairy farm to farm class 3, suckler cow production.

Table 1: Summary statistics of outcome variables

Variable	Mean	Standard deviation	Number of farms	Number of observations
Farm exit	0.018	0.132	29,871	441,838
Farm type change: from dairy to suckler cow	0.011	0.102	29,853	441,567

Source: Own calculations based on AGIS 2000-2017.

The explanatory variables are shown in Table 2. As expected for European family farms, mainly family members carry out the work on Swiss dairy farms. Only about 13 percent have non-family employees. The average herd size in the pooled sample is 16.3 dairy cows, which is relatively small for dairy farms in the European context. A considerable share of the farms are organic (12 percent) and three out of four farms keep their cows regularly outdoor.

The Herfindahl-Hirschman index (PIET, 2016) based on 29 farm enterprises (sum of squared enterprises' shares in farm's total standard output) describes the degree of specialisation of a farm. The average value of 0.412 indicates that Swiss dairy farms are relatively diverse. Direct payments' total is 47,729 CHF per farm. This corresponds to 42 percent of farm's standard

[2] Farm types in Switzerland are classified according to physical criteria such as stocking rate, the share of arable land in a farm's utilisable agricultural area (UAA) and the shares of animal species in farm total or cattle livestock units (LU) (MEIER, 2000; HOOP et al., 2019).

[3] Class 1 of the farm typology consists of the farm type specialised dairy (share of dairy in farm's cattle LU 25 %<), class 2 comprises specialised cattle farms (75 %< share of cattle in farm's total LU), class 3 covers specialised and combined suckler cow farms (25 % share of suckler cow in cattle LU) and combined cattle farms, class 4 represents non-cattle ruminants such as horses, sheep and goats whereas class 5 consists of arable crop, specialised crop and granivore farms.

output. The regionally differentiated mean of the annual salary in the second and third sector is included to depict the off-farm job opportunities of the farmer. It amounts on average to 63,763 CHF. The milk price decreased during the period of analyses almost constantly by more than 20 %; we used three-year averages of this price index to reflect the medium-term impact.

Table 2: Summary statistics of explanatory variables

Variable	Mean	Standard deviation
Number of workers (family)		
1	0.084	0.278
2	0.362	0.481
3	0.297	0.457
4	0.177	0.382
5	0.045	0.206
5<	0.035	0.183
Apprentices (binary)	0.029	0.168
Employees (binary)	0.126	0.332
Age of the farmer (years)	45.064	13.484
Direct payments in 1000 CHF	47.729	27.681
Ratio of direct payments / SO	0.421	0.226
Number of dairy cows	16.322	12.175
Stocking rate (LU/UAA)	1.414	0.934
Organic farm (binary)	0.123	0.328
Animal welfare housing system (BTS, binary)	0.354	0.478
Regularly keeping animals outdoors (RAUS, binary)	0.755	0.430
Herfindahl-Hirschman index (0: diversified, 1: specialised)	0.412	0.115
Comparison salary in 2nd and 3rd sector in 1000 CHF	63.763	5.554
Milk price index (2015: 100)	115.881	10.175
Unemployment rate (Canton level)	0.024	0.009
Valley region	0.217	0.412
Hill region	0.353	0.478
Mountain region	0.430	0.495
Number of observations	441,838	

Source: Own calculations based on AGIS 2000-2017, milk price data from the FSO and unemployment data from the State Secretariat for Economic Affairs SECO.

Additionally, we also control for regional characteristics (administrative and agricultural zones) that may consider regional policies, but also topographical or climatic particularities. A small share of 22 percent of the dairy farms is located in the valley region, 35 percent are in the hill region and most of them are located in the mountain region. Furthermore, we add information on the main production type according to a farm typology of five categories reflecting their proximity to dairy production, which is depicted in Table 3.

4 Method

Due to the binary nature of the outcome variables, we use multivariate logistic regression to analyse how different factors contribute to farm exits and changes. In general, the conditional probability of the outcome variable y taking up 1 is denoted by

$$P(y_i = 1 \,|x_i, \beta) = \Lambda(x_i{'}\beta) = \frac{\exp(x_i{'}\beta)}{1 + \exp(x_i{'}\beta)}$$

where i is the farm index, x a set of explanatory variables, β a vector of coefficients and Λ the logistic function. Hence, β corresponds to the coefficients of a linear regression on the logarithm of the odds

$$\log\left(\frac{P(y_i = 1 \,|x_i, \beta)}{1 - P(y_i = 1 \,|x_i, \beta)}\right) = x_i{'}\beta + \varepsilon_i$$

with an error term ε. The standard errors of these coefficients are clustered on farm level.

As we are interested in the estimated marginal effect

$$\frac{\delta\, P(y_i = 1\,|x_i, \hat{\beta})}{\delta\, x_{ij}} = \frac{\delta\, E(y_i\,|x_i)}{\delta\, x_{ij}} = \lambda(x_i'\hat{\beta})\hat{\beta}_j$$

of variable $1, \ldots J$, the sign of β can only inform about the direction of the effect. To interpret the size, we indicate average marginal effects

$$\widehat{AME_j} = \frac{1}{N}\sum_{i=1}^{N}\frac{\delta\, P(y_i = 1\,|x_i, \hat{\beta})}{\delta\, x_{ij}}$$

for selected variables.

5 Results

Before turning to the multivariate analysis, we show summary statistics for the explanatory variables by differing values of the outcome variables. Similar to Table 2, the following Tables 3 and 4 illustrate how the (unconditional) means differ between the group of farms without and with exit or change respectively. Exit *(change)* observations represent the last observation of an abandoning *(changing)* farm, whereas all other farms as well as previous years' observations of an abandoning *(changing)* farm are summarized in the column "Farm exit *(Farm type change)* = 0".

Not surprisingly, Table 3 shows that older farmers are more likely to exit farming. Exiting farms employ fewer family workers and a lower share of these farms employ non-family workers. This could be linked to the smaller average herd size (12 dairy cows) of exiting farms, requiring less work input. The Herfindahl-Hirschman index as a measure of specialisation indicates a higher degree for exiting farms, which contradicts our expectation. Larger farms (measured either in employees or dairy cows) seem to be less concerned by an exit.

The share of farmers fulfilling additional standards, such as organic, animal welfare through housing system and regularly keeping animals outdoor (free range) is significantly lower for exiting farms. Likewise, total direct payments are considerably lower for farms that leave the sector. This can be partly explained by smaller herd size and lower production system payments (such as organic or animal welfare payments) of exiting farms.

The comparison salary in the second and third sector is slightly higher for the exiting group. Concerning the agricultural regions, we cannot find any systematic, large difference between those farms without and with exit. The only significant difference can be found for the valley region. Majority of farms exit directly from dairy farming and do not change their farming type before.

Within the farms that do not exit, changes of farm types may occur. Here, our specific interest lies on changes to the suckler cow farm types (group 3). The descriptive statistics of the farms that change their farm type to suckler cow and those who do not are illustrated in Table 4. There is no significant difference concerning the farmer's age between the group with and without change. Production type changing farms are on average smaller (number of dairy cows) and exhibit higher shares of organic and free range but lower animal welfare housing production systems. Finally, farm type change occurs more often by less specialised dairy farms. Regional differences are slightly more pronounced compared to the exit analysis. More farms in the hill and mountain region change to suckler cow production.

Table 3: Summary statistics of staying and leaving farms

Variable	Farm exit = 0 Mean	Std. dev.	Farm exit = 1 Mean	Std. dev.	Mean difference between groups	
Age of the farmer (years)	44.930	13.399	52.471	15.904	7.541	***
Number of workers (family)						
1	0.082	0.274	0.199	0.399	0.116	***
2	0.360	0.480	0.461	0.498	0.100	***
3	0.298	0.458	0.207	0.405	-0.091	***
4	0.179	0.383	0.097	0.296	-0.082	***
5	0.045	0.208	0.018	0.134	-0.027	***
5<	0.035	0.184	0.018	0.133	-0.017	***
Apprentices (binary)	0.029	0.169	0.011	0.105	-0.018	***
Employees (binary)	0.126	0.332	0.103	0.304	-0.023	***
Direct payments in 1000 CHF	48.007	27.639	32.424	25.591	-15.583	***
Ratio of direct payments / SO	0.421	0.226	0.422	0.230	0.001	
Number of dairy cows	16.407	12.165	11.634	11.767	-4.773	***
Stocking rate (LU/UAA)	1.414	0.934	1.385	0.959	-0.029	***
Organic farm (binary)	0.124	0.329	0.071	0.256	-0.053	***
Animal welfare housing system (BTS, binary)	0.357	0.479	0.187	0.390	-0.170	***
Regularly keeping animals outdoors (RAUS, binary)	0.759	0.428	0.574	0.495	-0.185	***
Herfindahl-Hirschman index	0.411	0.115	0.444	0.133	0.033	***
Comparison salary in 2nd and 3rd sector in 1000 CHF	63.752	5.552	64.393	5.599	0.641	***
Milk price index (2015=100)	115.907	10.172	114.430	10.185	-1.477	***
Unemployment rate	0.024	0.009	0.024	0.009	0.001	***
Valley region	0.217	0.412	0.229	0.420	0.012	**
Hill region	0.353	0.478	0.349	0.477	-0.004	
Mountain region	0.430	0.495	0.422	0.494	-0.008	
Farm class						
1: Specialised dairy farms	0.665	0.472	0.722	0.448	0.057	***
2: Specialised cattle farms	0.169	0.375	0.144	0.351	-0.025	***
3: Suckler cow farms and combined cattle farms	0.077	0.267	0.073	0.261	-0.004	***
4: Horse/sheep/goat farms	0.012	0.107	0.017	0.131	0.006	***
5: Arable crop, granivore farms	0.077	0.266	0.043	0.202	-0.034	***
Number of observations	433,768		8,070			

Notes: *** p<0.01, ** p<0.05, * p<0.1. Source: Own calculations based on AGIS 2000-2017, milk price data from the FSO and unemployment data from the SECO.

In the following section, we will analyse if these unconditional findings will turn out to be robust in a multivariate regression approach. Table 5 presents the results of two logistic regression models: (1) exit from farming and (2) the change of farm type from dairy to suckler cow types. Notice that average marginal effects are illustrated. For variables, whose squared terms or other interactions are included in the logistic models, the overall marginal effect is given. For selected continuous variables (age, dairy herd size, Herfindahl-Hirschman index, direct payments), graphical illustrations of marginal effects are provided.

First, the results of the model "(1) Exit" from farming are presented. The probability of farm exit increases with age, employees, the dependence on direct payments, the degree of specialisation, off-farm opportunity costs of labour and difficulty of production (in hill and mountain regions). Against farm exit work a large number of family workers, large herd size, quality and animal welfare programs (organic, BTS, RAUS), elevated cantonal unemployment as well as increasing direct payments. E.g., additional 1000 CHF of direct payments lower the exit probability by 0.05 percentage points.

Table 4: Summary statistics of farms that keep dairy farm type and those who change to suckler cow farm types

Variable	Farm type change = 0		Farm type change = 1		Mean difference between groups	
	Mean	Std. dev.	Mean	Std. dev.		
Age of the farmer (years)	45.065	13.487	44.895	13.355	-0.170	
Number of workers (family)						
1	0.084	0.277	0.095	0.293	0.011	**
2	0.362	0.481	0.378	0.485	0.016	**
3	0.297	0.457	0.282	0.450	-0.015	**
4	0.177	0.382	0.165	0.371	-0.013	**
5	0.045	0.206	0.046	0.210	0.002	
5<	0.035	0.183	0.034	0.181	-0.001	
Apprentices (binary)	0.029	0.168	0.023	0.151	-0.006	
Employees (binary)	0.126	0.332	0.128	0.334	0.002	***
Direct payments in 1000 CHF	47.752	27.669	44.040	27.598	-3.711	***
Ratio of direct payments / SO	0.422	0.226	0.424	0.182	0.002	
Number of dairy cows	16.342	12.200	13.974	8.801	-2.368	***
Stocking rate	1.415	0.938	1.342	0.560	-0.073	***
Organic farm (binary)	0.122	0.327	0.161	0.368	0.039	***
Animal welfare housing system (BTS, binary)	0.354	0.478	0.325	0.469	-0.029	***
Regularly keeping animals outdoors (RAUS, binary)	0.777	0.430	0.770	0.421	0.014	**
Herfindahl-Hirschman index	0.412	0.115	0.405	0.112	-0.007	***
Comparison salary in 2nd and 3rd sector in 1000 CHF	63.764	5.557	63.421	5.183	-0.344	***
Milk price index (2015=100)	115.873	10.176	116.636	10.043	0.763	***
Unemployment rate	0.024	0.009	0.023	0.009	0.000	**
Valley region	0.217	0.412	0.189	0.391	-0.028	***
Hill region	0.353	0.478	0.368	0.482	0.015	**
Mountain region	0.430	0.495	0.444	0.497	0.013	*
Number of observations	436,905		4,662			

Notes: *** p<0.01, ** p<0.05, * p<0.1. Source: Own calculations based on AGIS 2000-2017, milk price data from the FSO and unemployment data from the SECO.

Second, the model "(2) Farm type change to suckler cow" presents partly similar effects of the explanatory factors. The probability of a farm type change increases with employees, for organic farms, with the adherence to free range livestock (RAUS), higher comparison wages and milk prices as well as with increasing difficulty of production conditions (hill or mountain area). Decreasing effects go along with age, direct payments, a higher ratio of direct payments to a farm's total standard output, the stocking rate, farm specialisation and a higher unemployment rate.

Oppositional coefficient signs between the exit and change model can be observed for age, the ratio of direct payments to the standard output, for organic farms, for the adherence to free range livestock (RAUS) and the degree specialisation. Few variables are in either the exit model or the change model of economic and statistical relevance, such as the number of dairy cows, the stocking rate and the milk price index.

Table 5: Average marginal effects of logistic regression

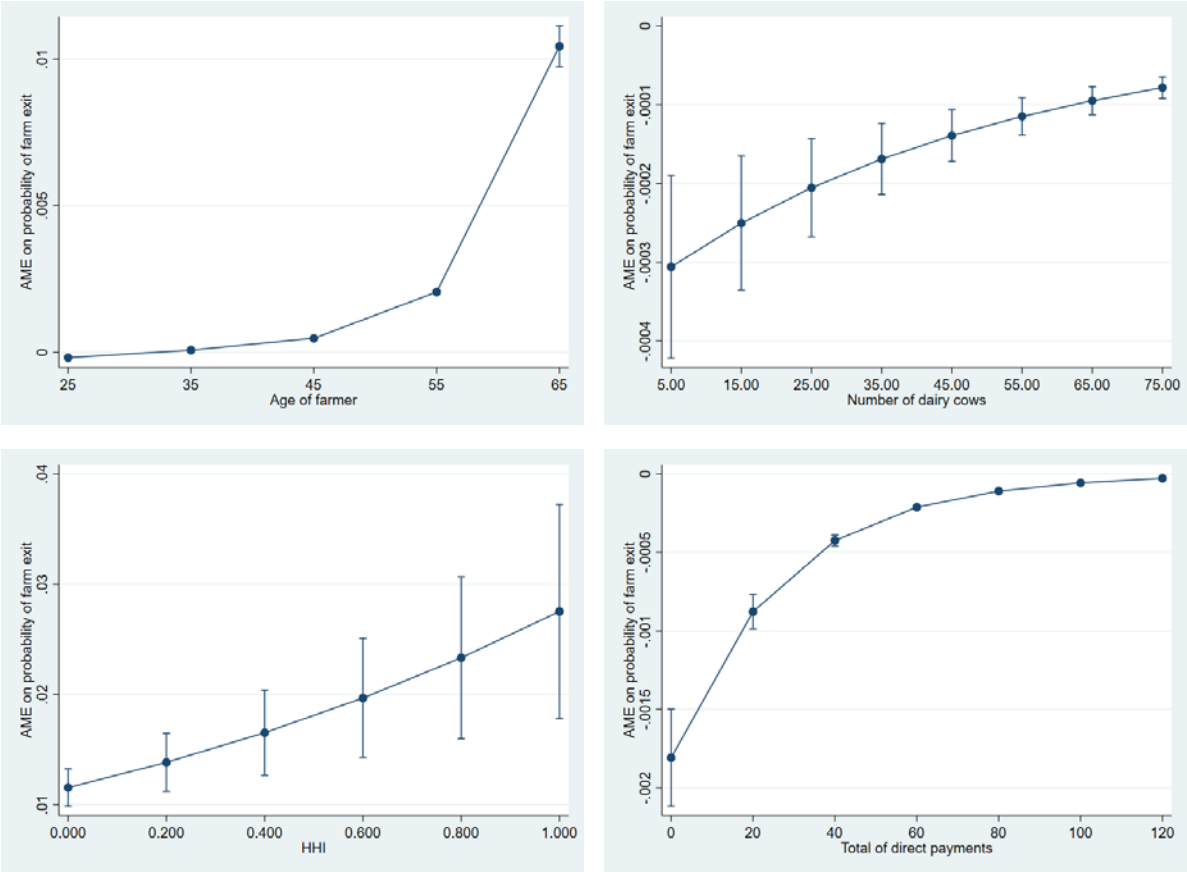
VARIABLES	Exit		Farm type change to suckler cow	
Age of the farmer (years)°	0.0018	***	-0.0001	***
	(<0.0001)		(<0.0001)	
Number of family workers (1 is base category)				
2	-0.0057	***	-0.0003	
	(0.0007)		(0.0006)	
3	-0.0109	***	-0.0010	
	(0.0008)		(0.0007)	
4	-0.0123	***	-0.0013	*
	(0.0009)		(0.0007)	
5	-0.0142	***	0.0001	
	(0.0012)		(0.0010)	
5<	-0.0136	***	-0.0002	
	(0.0013)		(0.0011)	
Employees (binary)	0.0054	***	0.0020	***
	(0.0008)		(0.0006)	
Apprentices (binary)	-0.0001		-0.0002	
	(0.0018)		(0.0011)	
Direct payments in 1000 CHF°	-0.0005	***	-0.0002	***
	(<0.0001)		(<0.0001)	
Ratio of direct payments /	0.0068	***	-0.0109	***
standard output (SO)	(0.0016)		(0.0016)	
Number of dairy cows°	-0.0003	***	-0.000002	
	(<0.0001)		(<0.0001)	
Stocking rate°	-0.0002		-0.0034	***
	(0.0004)		(0.0004)	
Organic farm	-0.0025	***	0.0034	***
(binary) °°	(0.0008)		(0.0007)	
Animal welfare housing	-0.0030	**	-0.000002	
system (BTS, binary) °°	(0.0007)		(0.0005)	
Regularly keeping animals	-0.0013	***	0.0039	***
outdoor (RAUS, binary) °°	(0.0005)		(0.0005)	
Herfindahl-Hirschman	0.0170	***	-0.0096	***
index	(0.0021)		(0.0019)	
Comparison salary in 2nd and	0.0009	***	0.0025	***
3rd sector in 1000 CHF	(0.0003)		(0.0003)	
Milk price index (2015=100)	<0.0001		0.0008	***
	(0.0001)		(0.0001)	
Unemployment rate	-0.3075	***	-0.2248	***
	(0.0572)		(0.0446)	
Region (Valley region is base category)				
Hill region	0.0040	***	0.0126	***
	(0.0016)		(0.0015)	
Mountain region	0.0097	***	0.0438	***
	(0.0036)		(0.0085)	
Number of observations	441,838		441,567	
Number of farms	29,577		29,599	
YEAR DUMMIES	YES		YES	
CANTON DUMMIES	YES		YES	
PRODUCTION TYPE DUMMIES	YES		NO	
NOT INCLUDED CANTONS°°°	-		SH	

Notes: Standard errors in parentheses are clustered on the farm level. *** p<0.01, ** p<0.05, * p<0.1.
° These variables are included also in squared terms in the regression analysis. In this table, the overall marginal effect of a variable is presented. °° These variables additionally are considered as interaction variables with the variable direct payments; here the overall marginal effect is presented. °°° The canton Schaffhausen (SH) is not included since not concerned by the considered farm type change within the sample.
Source: Own calculations based on AGIS 2000-2017, milk price data from the FSO and unemployment data from the SECO.

To better understand the specific influence of certain variables, average marginal effects (AMEs) were plotted for the variables age, herd size (number of dairy cows), a farm's specialisation (Herfindahl-Hirschman index) and farms' total direct payments. Figure 1 shows the corresponding AMEs for the farm exit model.

The intersection of the curve illustrating the farm exit probability dependent on the farm operators' age with the x-axis is around 30 years; then, the exit probability is positive. Above 55 years, the exit probability increases sharply. The effect of herd size is statistically significant negative especially for smaller herd sizes; this relatively small effect however further diminishes with herd size. Interestingly, the exit probability of more specialised farms is higher than for diverse farms. The effect of direct payments is negative all over the variable's distribution, but approaches zero for very high values. Hence, one may conclude that higher transfers alone cannot prevent farms from abandoning.

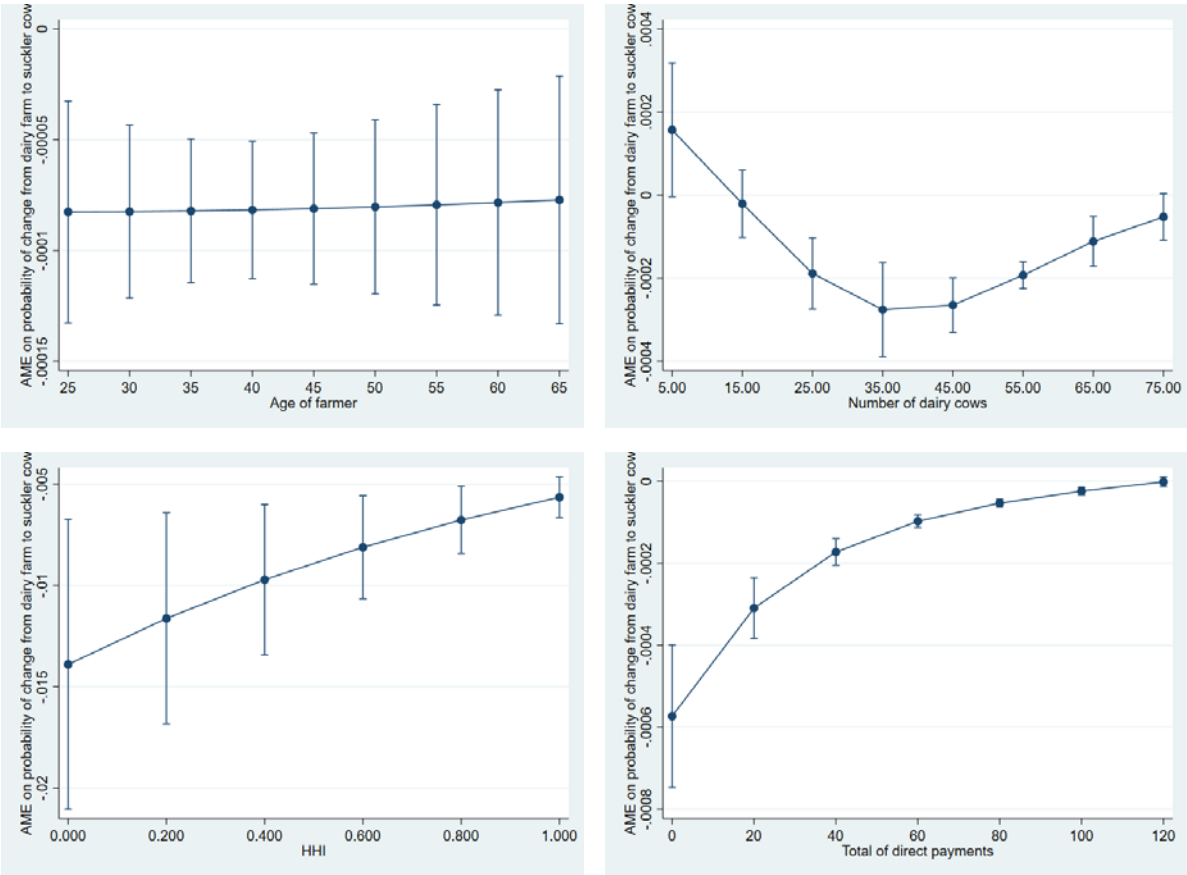
Figure 1: Average marginal effect (AME) of logistic regression for the probability of a farm exit



Notes: Point estimates with 95% confidence interval. Direct payments are measured on an annual basis in 1000 Swiss francs.

Figure 2 illustrates the AMEs for the change model from dairy to suckler cow farm type. The curve of farm operators' age lies within a constant and low negative range. Regarding herd size, the probability to change to suckler cow farm type is larger but statistically zero for small farms; it turns negative for farms with more than 25 dairy cows. Besides, the more specialised a farm is, the smaller the effect of specialisation gets. The generally negative effect of direct payments diminishes with higher levels of direct payments and approaches zero.

Figure 2: Average marginal effect of logistic regression for the probability of a change from dairy farm to suckler cow



Notes: Point estimates with 95% confidence interval. Direct payments are measured on an annual basis in 1000 Swiss francs.

6 Discussion & Conclusions

This contribution sheds light on details of Swiss dairy farms' structural development. Using administrative data from the agricultural policy information system, logit models are estimated for farm exit and farm type change. According to these models, farm operators' age positively affects farm exit and negatively affects the probability of farm type change. Looking in detail at differentiated age classes, the probability of exits increases sharply for older farmers. This can be interpreted as a generally stable farm situation in the dairy sector, which is coined by farm exits of older farmers (e.g. in case no successor is available).

A higher degree of specialisation goes along with significantly more exits and less farm type changes. Specialised dairy farms in pure grassland areas, where only limited alternative farming activities exist, could contribute to this surprising result regarding farm exit. Economies of scope seem easier to grasp or more attractive than economies of scale. Specialised farms could be more vulnerable due to the focus on a single output.

When differentiating the herd size, we observe that the general decreasing effect of the dairy herd size on the exit is more important for small farms. Furthermore, lower amounts of direct payments have a more stabilising effect than high payments. These results again are quite surprising since we expected a high relevance of scale economies for farm profitability and stability and they point to a remarkable viability of smaller and less specialised farms. LIPS et

al. (2016) explain the relevant steadiness of small Swiss dairy farms by nonpecuniary job preferences such as passion and a preference for self-employment.

The adherence or fulfilment of additional standards such as organic or animal welfare schemes reduces the probability of a farm exit. As expected, such differentiations support Swiss farms' viability. The higher probability of a farm type change for organic and free range farms (RAUS) may be explained by natural growth barriers which go along with the implementation of free range. Since free range is limited to areas close to the barn, such farms could imply a higher probability of diversification since herd size growth relies on additional free range areas. Apart from economic motives, the implementation of organic and RAUS and their effects on a farm type change could be linked to farmers' disposition with regard to moral and environmental concerns (KIELLAND et al., 2010).

Economic conditions such as the comparison salary (increasing exit and change probabilities) and unemployment (decreasing both probabilities) show the expected impact. Milk prices seem not to affect dairy farms' exit decision but increase the propensity to change to suckler cow types.

Regional differences with regard to production conditions and altitude are observed for farm exits and farm type changes. With increasing altitude and difficulty of production, the probabilities of farm exit and farm type change augment as expected.

Finally, we would like to add some thoughts on suitable robustness checks or extensions of the analysis. The quality of the administrative data used in this article is generally high. More details would have been useful with regard to the concrete labour input (which is only documented in three rough categories), farm household's off-farm labour and income, the existence of a potential farm successor and to farm related activities. A high number of family workers roughly models the existence of a potential farm successor. Farm related activities can offer diversification and business development opportunities and could therefore enrich such analyses. However, data on farm related activities such as direct marketing, tourism, services (work as private contractor, care farming) etc. is not yet collected systematically.

The relevance of the economic environment so far is represented by the comparison salary illustrating the off-farm income opportunities and unemployment rates at cantonal level. Further variables describing the economic environment such as regional labour demand (unfilled vacancies) or spatially more detailed unemployment rates could complement the models.

Besides, the outcome variables under consideration all relate to the extensive margin of farm type changes, i.e. change versus no change, and neglect the intensive margin, i.e. the number of dairy or suckler cows. Hence, it may be interesting to examine changes with respect to herd size. This consideration may be also suitable as an additional robustness check since the production type classification may suffer from too strict assignment to a specific farm type. With a continuous outcome measure, the estimation of a linear fixed effects model may be suitable and would allow to use the panel structure of the data. This implies the elimination of time-constant firm-specific effects.

During the analysis of structural change of Swiss dairy farms we observed that both, farm exit and farm type change can occur either directly or as perennial process. Farm type changes could even constitute such an ongoing farm exit. This issue serves further attention.

To conclude the analysis of Swiss dairy farms' structural development reveals a considerable stability of smaller farms. Specialised farms seem more prone to exit. This surprising result must further be examined. If future studies support this finding, it would be of high relevance for Swiss policy makers whose objective is to rise the competitiveness of the Swiss agriculture.

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