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The effect of wolves on the exit and voicing exit of Swiss mountain farmers

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ABSTRACT

Wolves are perceived as a threat by small ruminant farmers in Switzerland. In this study, we examined whether there is an association between exit from small ruminant farming and wolf prevalence. We drew on Hirshman's "exit, voice, and loyalty" theory to shed light on (1) farmers' exit strategies in the past and (2) famers' voice on future intentions of exiting ("voicing exit"), when dealing with wolves. Using farm panel data from Swiss small ruminant farmers (13,954 regular farms and 3758 Alpine summer farms), we first applied a mixed-effect logistic regression model to estimate famers' exit rate from small ruminant farming. We then conducted a survey among farmers (n = 928) to show correlations between the farmers' burden caused by wolves and intention of how long to continue farming and keeping small ruminants. We differentiated between regular "all-year" farms and Alpine summer farms. We were able to show that wolves, among other important factors, played a small but significant role in the exit from small ruminant farming, mainly on farms with small herds. The survey results also revealed that farmers exposed to greater wolf pressure were more likely to voice potential exit from small ruminant farming. In general, there is a real threat that farmers will exit small ruminant farming because of wolves. We highlight that farmers' exit from small ruminant farming should be seriously taken into account for further wolf management decisions.

1. Introduction

In recent years, several European countries (Kuijper et al., 2019; Recio et al., 2020) and the United States (Maletzke et al., 2016) have seen a rising number of wolves, which are considered an ecological enrichment by conservationists (Ojalammi and Blomney, 2015; Trouwborst et al., 2016 Sazatornil et al., 2019). Most farmers, however, have a much more negative attitude toward these predators (Wallner and Hunziker, 2001). Rural sociologists have indicated that sheep farmers in regions where wolves are active suffer from increased distress (Zahl-Thanem et al., 2020). Both popular media (Dassler, 2021) and scientific studies (Hinojosa et al., 2018) show that farmers consider the wolf a serious threat to grassland management in rural areas. This fact makes wolves in the landscape a suitable case for an application of the Hirshman "exit, voice, and loyality" model from a farmer perspective.

In one of the most influential interdisciplinary models in social sciences, Hirshman suggested that consumers would face three different options when confronted with declining levels of services: they could loyally stick to their choice, they could exit from the relationship to the supplier, or they could voice their concern through joint action (Hirshman, 1970). This model that links political action and economic behavior has become a fruitful way to understand processes of emigration (Hirshman, 1978), public sector management (Paul, 1992), and divorce (Katz, 1997). In the realm of agriculture, Hirshman's model has been applied to the export market (Goldsmith, 1986), ethical consumption (Newholm, 2000), and responses to poor rural policies (Collantes, 2010). The framework is continuously applied in various institutional environments (Michaelsen, 2016; Broccardo et al., 2020; McEwan and Murphy, 2022).

We use the case of the reappearance of the wolf in the Swiss Alps to apply the Hirshman (1970) framework to sheep and goat farmers, who are (at least subjectively) challenged by the possibility of livestock losses. Exit, voice, and loyalty can be considered and discussed individually. A growing wolf population that threatens the safety of sheep and goats can lead to the abandonment of a farm, the exit option. Alternatively, farmers may decide to mobilize, use media and increase the pressure on policy-makers, the voice option. Finally, farmers may also ignore threats and eventual damage, continuing farming as usual, which would be the loyalty option. However, in this article we focus on (1) exit and (2) voicing exit (we consider the latter to be a partial aspect of

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Hirshman's voice). We use voicing exit to describe farmers' threats and plans to leave the farm as it has been mainly covered by quantitative work so far (Gallagher et al., 2009; Shorten, 2013). Voicing exit may be a promising strategy for sheep farmers in the mountain region to press for more active wolf management. If farmers could make the idea credible that they will abandon their farms if the threat from wolves persists, the protection status of wolves could be relaxed and eventually reduce the pressure on farmers.

We applied a farm panel data using a logistic regression model to investigate the effect of wolves and other variables on farmer exit. To identify voicing exit, we implemented a multinomial regression analysis based on questionnaire survey data among farmers. The separate results of exit and voicing exit will later be compared in the discussion and synthesized for the conclusion.

2. Wolves and farms in the Swiss Alps

The first year in the 20th century when wolves were frequently observed in the Swiss Alps was 1995. The wolf population grew exponentially, and in 2021, between 130 and 150 wolves were detected within Swiss borders (Schürpf and Marti, 2021). This increase is also reflected in the number of sheep and goats (and occasionally cattle) killed by wolves. Before 2015, the wolves never killed more than 400 domestic animals (livestock) per year; in 2020, this number reached 820 (KORA, 2021). Even though various political initiatives were submitted to relax the protected status of the wolf, the wolf remained on the list of strictly protected species. This is especially a thorn in the side of farmers who are directly and negatively affected by wolves.

Swiss agricultural policy (with almost the highest agricultural subsidies in the world) finances protection measures against wolves (e.g., fences). However, Werder and Moser (2021) estimated that public payments only reimburse two-thirds of costs. Additionally, efficient herd protection is only possible above a certain herd size (Mettler et al., 2014), where a shepherd, a livestock guardian dog, or a better fencing system can be applied due to higher revenues. Although the government reimburses farmers for animals that have been killed, which is a method applied worldwide to encourage human–carnivore coexistence (Dickman et al., 2011), farmers are hard hit by these attacks. Since farmers with very small herds have a higher emotional connection to individual animals and lesser options for herd protection measures, this type of farmers seems to be particularly vulnerable to wolf depredation. Many newspapers report highly frustrated farmers discovering their animals being torn apart (Arnold, 2021; Bäuerle, 2021; Vogt, 2021). These voices are sufficiently credible to hypothesize a negative association between farmers' willingness to carry on with sheep farming and the occurrence of wolf attacks.

There are two different types of farms in the Swiss Alps: (1) the regular or year-round farms where farmers live, keep their livestock throughout the year, and graze them on their pasture land, and (2) Alpine summer farms, which are only used during the summer months. Alpine summer farms can be found on large high-altitude pastures and are stocked with livestock from regular farms (vertical-transhumance), to relieve the farmer on the regular farm in production of fodder for the winter regular farms. Alpine summer farms have great structural differences, which is why they were examined differently in this study.

As in most European countries, more farmers exit the agricultural sector than enter it (Zorn, 2020). While Switzerland's rate of farm abandonment is lower than that in Germany and Austria (Mann, 2014), the numbers of both regular Swiss farms and Swiss Alpine summer farms decline at a pace of around two per cent per year.

Quantitative and qualitative studies have already investigated in depth the attitudes of the affected persons (Williams et al., 2002; Bjerke et al., 1998; Bongi et al., 2022; Stauder et al., 2020), specifically farmers (Sjölander-Lindqvist, 2009; Stronen et al., 2007), toward wolves. Furthermore, media articles (e.g., Schuller, 2021) have shown that daily kills on Alpine summer farms at the beginning of the summering season may be the reason for abandoning Alpine summer farms. Although the possible effect of wolf expansion landscape management and farming has been previously discussed (Kouřilová et al., 2019; Strand et al., 2019; Strand, 2021), no quantitative evidence on the effect of wolves on Swiss farm management has been collected, especially on any correlations between wolf pressure and eventually exiting farms.

To fill this knowledge gap, we address in this paper farmers' exit rates in the past and farmers' intentions (voicing exit) to exit farming because of wolves. Based on prior knowledge, we propose the following two hypotheses:

H1. Local damage caused by wolves can partially explain sheep and goat farm exits, especially those with small herds.

H2. Farmers' voicing exit can be partially defined by wolf pressure.

3. Materials and methods

3.1. Data collection

To identify the effect of wolves on exit and voicing exit, we used two different types of data and applied for each a different analysis. Following, we describe first the data collection for exit followed by the description of data collection for voicing exit.

3.1.1. Exit

We aimed to investigate correlations between wolf pressure and "exiting" small ruminant farming. For this purpose, we used panel data for regular and Alpine summer farms provided by the Federal Office of Agriculture and stored in the Agricultural Information System (AGIS). Farmers are required to report annual farm data to AGIS, as this can create control and transparency for direct payments. The timeline of the data ranges from 2000 to 2021 for regular farms and from 2004 to 2021 for Alpine summer farms. We restricted the data to farms that keep sheep and goats. As most wolf attacks on livestock during the study time occurred in the mountain region of the Swiss Alps (Vogt et al., 2022), we restricted the study area to the Swiss Alps, which is spatially defined by the Alpine Convention Impact (Fig. 1). Thus, Swiss farms outside the Alpine Convention parameter were not taken into account. In total, our analysis was based on 142.262 observations for 13.954 regular farms between 2000 and 2021 and 33.707 observations for 3758 Alpine summer farms between 2004 and 2021.

Farmers were not present in the data when they did not keep any sheep or goats. Hence, the last year that farmers were recorded in the data was the year they exited. This last year was coded as 1 in the dependent binary variable "exit," while 0 described all the other years in which the farmer had continued keeping sheep and goats. Since several farmers kept animals with temporal breaks, several exits per farmer were possible. Because the farm identification number in AGIS is linked to the farm manager and not to the farm, a farm transfer between generations was also counted as a farm exit.

As the main explanatory variable, we used data on killed small ruminants provided by the Swiss in-state foundation for carnivore monitoring and research (KORA). These data contained the locations and dates of kills by wolves. Unfortunately, it was not possible to assign killed livestock to individual farms. However, it was possible to analyze the kills on the municipality level on an annual basis. We calculated an indicator for wolf pressure by dividing the number of kills by the available number of farms per municipality, which we will call the "kill factor". We measured this kill factor for several further years after a kill happened to test if kills might have a delayed effect on a farmer's decision to exit small ruminant keeping.

Table 1 summarizes the data used to explain farm exits for regular farms. Besides the exit and the kill factor, several control variables were considered. In this, we strongly followed Zorn and Zimmert (2022), who investigated the structural changes in dairy cow husbandry using the same database.

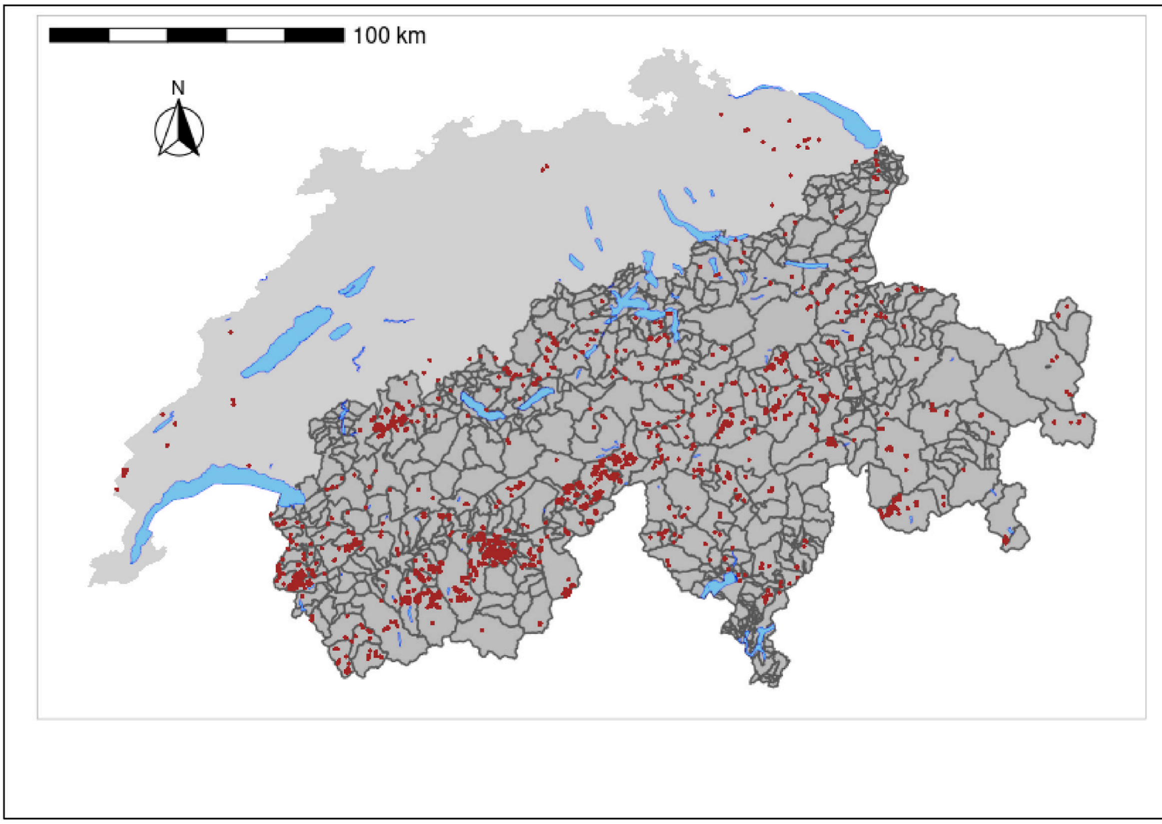

Fig. 1. Map of Switzerland, with the municipalities in the Swiss Alpine region colored dark gray. The brown dots represent individual sheep and goats killed by wolves between 1999 and 2021. The blue areas are water bodies. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

In addition to age as an obvious factor, the number of foreign and family workers on the farm, the character of a full- or part-time farm, the farm portfolio, and the total number of sheep and goats per farm were expected to have an influence. Flock size was categorized into 1–15, 16–40, 41–100, and more than 100 animals to distinguish between different farm types. Further control variables comprised Switzerland's three different agricultural regions, the farm area in hectares, and direct payments per livestock unit (LSU). One LSU is an agricultural–ecological measure used to compare the density and numbers of grazing livestock that corresponds to an average of six sheep or goats. Direct payment levels for slopes and steep slopes that were paid to subsidize the aggravated work in steep terrain (to indicate the steepness of a farm's area) and the choice for or against organic and animal welfare labels were also considered.

At the municipal level, another variable was used to describe the municipality's remoteness. For this purpose, the Federal Office for Spatial Development uses data on the time it takes to travel by car from one municipality to the next agglomeration. The longer the time, which is given in minutes, the more remote the municipality.

On an annual level, producer prices for lamb meat and goat dairy products were used to describe changes in market prices. Finally, we considered agricultural policy changes to be very important drivers for structural changes and thus exiting.

Due to structural differences, not all variables depicted in Table 1 made their way into Table 2, where the explanatory variables for structural changes in Alpine summer farms are indicated.

On Swiss Alpine summer farms, animals are counted in Normalstössen (NST), which corresponds to one LSU over 100 days. As for regular farms, we expected a nonlinear correlation between the exit rate of farmers and herd size in interaction with the kill factor. We therefore applied the same categories as Moser et al. (2019), who divided the sheep summer farms into large (<75 NST), medium (35–75 NST), and small herds (<35 NST). Since we also considered goat summer farms, which very often keep only a very small flock, we decided to implement a category with less than 5 NST. On Alpine summer farms, three different grazing systems are known for sheep grazing, which are subsidized differently by the government, due to their effect on grassland biodiversity. "Permanent shepherding" requires a shepherd to lead and guard the flock. This system receives the highest contribution per NST. Due to the high costs for the shepherd, however, permanent shepherding is profitable only from a minimum size of 450 animals upwards (Mettler et al., 2014). "Rotational grazing," the second system, requires that clear grazing management be aimed at with the help of fences. The third system, "permanent grazing" is the least well compensated system with direct payments, and livestock graze free-ranging without fences or shepherds. This grazing system has the worst effect on pasture biodiversity (Boggia and Schneider 2012), as the stationary grazing of animals provides for under- and overuse of individual pasture areas. The government aims graduated direct payments at farms with optimizing pasture management with financial incentives and thus promoting biodiversity. Since additional herd protection measures are easier to implement with permanent shepherding and rotational grazing (BAFU, 2019), we expected a faster exit rate of Alpine summer farmers using permanent grazing.

Compared to regular farmers, where almost all farm in the form of a "natural person," two more legal systems are commonly known on Alpine summer farms, namely the "corporation" and "public administration and associations."

Over- and understocking appear when the predefined stocking rate (herd size) cannot be reached. Deviation from the normal stock reduces direct payments and can therefore lead to a higher exit rate (Schulz et al., 2018). Therefore, we distinguished between "normal stocking,"

Table 1
Summary statistics of burden and associated explanatory variables for regular farmers. Statistical quantities for continuous variables are defined as mean and standard deviation for dummy and factorial variables in the share of the respective level in the total quantity.

Regular farms (panel data)						
Variable	***Meaning***	***Level***	***Mean (sd)***	***Min***	***Max***	***Frequency***
Dependent						
Exit	Farmer exits or continues small ruminant farming in current or previous year	1 = exit				0.11
		0 = continue				0.89
Explanatories						
Kill factor	Number of killed goats and sheep per farm in a municipality in a given year.	Total number of kills/farms	0.04 (0.05)	0	51	
Herd size	Herd size categories of small ruminants in a farm (definition based on interviews)	In individuals:				
		1–15				0.54
		16–40				0.28
		41–100				0.14
		>100				0.03
Type	Species of small ruminants kept on the farm	Sheep				0.52
		Goats				0.33
		Sheep and goats				0.15
Cattle	Binary variable explaining if cattle kept on the farm	1 = yes				0.65
		0 = no				
Dairy production	Binary variable explaining if small ruminants used for dairy production	1 = yes				0.33
		0 = no				0.67
Summering	Binary variable explaining if small ruminants summered in the given year or the year before	1 = yes				0.61
		0 = no				0.39
BTS	Farmers participated in the “animal welfare housing system” program	1 = yes				0.93
		0 = no				0.07
RAUS	Farmers participated in the “regularly keeping animals outdoors” program	1 = yes				0.63
		0 = no				0.37
Organic	Farmers produced with an organic label	1 = yes				0.18
		0 = no				0.82
Direct payment per LSU	Amount of direct payment a farmer received per livestock unit (LSU)	in 1000 CHF*/LSU	2.72 (2.49)	0	272	
Area	Size of farm land area	ha	14.5 (11.1)	1	191	
Steepness	Steepness of a farmer’s agricultural land expressed by the amount of direct payment for slopes and steep slopes in the farm’s land area	in 1000 CHF/ha	0.26 (0.21)	0	2.18	
Employment	Categorized gainful activity of the farmer	Full-time-farm				0.7
		Part-time-farm				0.27
		Retirees **				0.03
Foreign workers	Number of non-familial workers on the farm	Number of workers	0.04 (0.27)	0	30	
Family workers	Number of familial workers on the farm (farm manager not included)	Number of workers	0.95 (0.39)	0	8	
Age class	Farmers’ ages based on clusters in the distribution of farmers’ ages on exit rate.	<30 years				0.05
		30–54 years				0.7
		55–64 years				0.21
		65 years				0.01
		>65 years				0.03
Region	Agricultural regions in which the farmer works.	Valley				0.08
		Hill				0.18
		Mountain				0.74
AP14	Years before and after 2014, where a total new agricultural policy plan was implemented.	after				0.4
		before				0.6
Lamb price	Average yearly lamb slaughter price	CHF/kg	11.5 (1.12)	9.51	13.3	
Goat milk price	Average yearly goat milk price	CHF/kg	1.52 (0.11)	1.3	1.89	
Remoteness	Remoteness of a farms’ municipality in driving time to an agglomeration	min	44.5 (22.7)	4	109	
Unemployment rate	Numerical variable explaining the share of unemployed person per canton (regional administrative unite) and year	Unemployed people/workable people in percent	2.25 (1.23)	0.27	6.19	

* 1 CHF = 1 USD
** Retirees are the same as Age class >65 years.

“understocking,” and “overstocking.” At the municipal and annual levels, we used the same explanatory variables as for the regular farms.

3.1.2. Voicing exit

Based on the factors that had been shown to be central in previously performed interviews, we conducted a survey targeting 1000 regular farms and 1000 Alpine summer farmers in early 2021 in German, French, and Italian, which are all national languages of Switzerland. The addresses of the farmers consulted were randomly taken from the AGIS provided by the Federal Office of Agriculture (FOAG) of Switzerland, with the precondition that they had kept at least one sheep or goat on their regular or Alpine summer farm in 2019. Since wolves’ range has so far been limited to the mountainous regions of Switzerland, the available addresses were restricted to the Alpine region. In a first step, the requested persons were asked to participate in the survey online. In a second step, in addition to a reminder letter, we enclosed a paper questionnaire that the respondents could return.

To obtain dependent variables for “voicing exit,” we first asked the farmers for how many more years they would manage the farm, and second, how they were planning to continue keeping small ruminant

Table 2
Summary statistics of burden and associated explanatories for Alpine summer farmers. Statistical quantities for continuous variables are defined as mean and standard deviation for dummy and factorial variables in the share of the respective level in the total quantity.

	Alpine summer farms (panel data)					
Variable	*Meaning*	Levels	*Mean (sd)*	*Min*	*Max*	*Frequency*
Dependent						
Exit	Dummy variable explaining if a farmer exits or continues small ruminant farming	1 = exit				0.1
		0 = continue				0.9
Explanatory						
Kill factor	Number of killed goats and sheep per farm in the municipality in a given year	Total number of kills/farms	0.14 (1.25)	0	68	
Herd size	Categorical variable to describe herd size categories of small ruminants in a farm (partially defined by Moser et al., 2019)	in NST:				
		<5 NST				0.56
		5–35 NST				0.32
		35–75 SNT				0.08
		>75 NST				0.04
Type	Categorical variable explaining the species of small ruminants kept on the farm and the grazing system used for the sheep	Goats				0.54
		Permanent shepherding				0.05
		Rotational grazing				0.08
		Permanent grazing				0.20
		Permanent shepherding and goats				0.01
		Rotational grazing and goats				0.02
		Permanent grazing and goats				0.02
		Sheep and goats				0.08
Cattle	Binary variable explaining if cattle kept on the farm	1 = yes				0.65
		0 = no				0.35
Dairy production	Categorical variable explaining if small ruminants used for dairy production	1 = yes				0.5
		0 = no				0.5
Legal system	Categorical variable explaining the legal system in which form an Alpine summer farm was managed	Corporation				0.28
		Natural person				0.64
		Public administration and association				0.09
Stocking	Categorical variable explaining if a predefined stocking rate could be reached	Normal stocking				0.81
		Understocking				0.11
		Overstocking				0.08
Direct payment per NST	Numerical variable explaining the amount of direct payment a farmer receives per Normalstoss (NST)	in 100 CHF/NST	3.82 (3.18)	0.02	59.5	
AP14	Years before and after 2014, where a total new agricultural policy plan was implemented.	After				0.62
		Before				0.38
Lamb price	Average yearly price of lamb slaughter price	CHF/kg	11.5 (1.16)	9.51	13.3	
Goat milk price	Average yearly price of goat milk price	CHF/kg	1.53 (0.13)	1.3	1.89	
Remoteness	Remoteness of a farm's municipality in driving time (by car) to an agglomeration	Minutes	40.9 (22.5)	4	109	
Unemployment rate	Share of unemployed persons per canton (regional administrative unit) and year	Unemployed people/people able to work (per cent)	2.25 (1.23)	0.69	5.37	

farming (see Table 3). The focus explanatory variable was "burden" based on a 7-point Likert-scale statement that described if the burden caused by wolves was bearable or not for the farmer. The answer possibilities ranged from "totally disagree" to "totally agree." We assumed that if a farmer's burden from wolves was high, an exit from farming was reasonable.

We further asked for farm-specific characteristics, herd size, farm structure, farm orientation, and farmer's age, which were used as additional explanatory variables in the models.

3.2. Data analysis

3.2.1. Exit

As described in section 3.1, we used panel data to identify drivers for farm exit. The dependent variable y denoted a farm that exited small ruminant farming. Given the binary nature of the dependent variable, we applied a mixed-effect logistic regression model to identify correlations between wolf pressure and a change in the exit range of farmers under various control variables.

We implemented an interaction term between the kill factor and the four different herd size categories to identify a structural dependent effect of the kill factor on 1) regular farm and 2) Alpine summer farm exit. The interaction term between kill factor and herd sizes was applied to identify differences between herd size categories and wolf pressure.

Formally, for farm f, and year t, we used the following regression:

$$y_{f,t} = \beta_0 + \beta_1 \text{herdsize}_{f,t} + \beta_2 \text{killfaktor}_{f,t} * \text{herdsize}_{f,t} + \beta x'_{f,t} + \gamma_f + \gamma_t + \varepsilon_{f,t} \tag{1}$$

where y is the probability of "exit," β_0 is a constant, β_1 is a contribution of explanatory herdsize, β_2 is a contribution to the interaction of killfaktor and herdsize, $x'_{f,t}$ is a matrix of additional variables and its coefficients, γ_f the random effect for farms, γ_t the random effect for year, and $\varepsilon_{f,t}$ is an error of the model. β values were estimated using a maximum likelihood procedure as predefined in the lme4 package for R v4.0.5 (Bates et al., 2015). Estimates are presented and additionally in average marginal effects, using the marginaleffects package for R v4.0.5 (Arel-Bundock, 2022).

It is unknown how many years after a wolf kill an effect is detected from these kills. For this reason, we calculated different models, first applying the kill factor to the first year only, then to two years and finally extending it further to the end of the data record. Using a Bayesian information criterion (BIC) among these models, we selected the best fitting model.

Table 3
Summary statistics of dependent (bold) and explanatory variables based on questionnaire survey for Alpine summer and regular farmers. Statistical quantities for continuous variables are defined as mean and standard deviation for binary and factorial variables in the share of the respective level in the total quantity.

Variables	Meaning	Measurement	Mean Alpine summer farmers (sd)	Frequency Alpine summer farmers	Mean regular farmers (sd)	Frequency regular farmers
Dependent						
How long continue farming	Ordered categorical variable explaining how long a farmer will run the farm	Single choice answer:				
		1–2 years		0.07		0.04
		3–5 years		0.1		0.05
		6–10 years		0.15		0.1
		>10 years		0.37		0.38
		uncertain		0.3		0.43
Future small ruminants	Categorical variable explaining if farmers will keep small ruminants in the future	continue = keeping small ruminants in the future		0.85		0.83
		exit = exit small ruminant farming		0.10		0.06
		uncertain = farmer is uncertain about small ruminants in the future		0.05		0.11
Explanatories						
Burden	Numerical variable explaining the farmer's statement: "The burden of wolves is no longer bearable for my farm."	Based on a 7-point Likert scale answer, where 1 = totally disagree … 7 = totally agree	3.96 (2.04)		3.42 (2.14)	
Age	Numerical variable explaining the farmer's age	years	49.8 (12.4)		48.9 (10.9)	
Cattle	Variable explaining if cattle kept on the farm	Yes		0.47		0.63
		no		0.53		0.37
Herd size	Numerical variable explaining small ruminants' herd size	NST for summer farms, individual animals for regular farms	25.4 (40.5)		24.6 (31)	
Successor	Variable explaining if farmers already have a successor for their farm	Yes		0.5		0.46
		no		0.5		0.54

3.2.2. *Voicing exit*

We estimated two different models explaining how long farmers would continue farming and if they would continue keeping small ruminants using data from the questionnaire survey. The models were applied for each regular and Alpine summer farm separately. Using multilevel variables as dependent variables in both model types, we applied multinomial logistic regressions to predict the probability of observation i and outcome k:

$$p(k,i) = \beta_{0,k} + \beta_{1,k}\text{burden}_i + \sum X_i' + \varepsilon_i \quad (2)$$

where p is the probability of outcome k or i, β_0, k is a constant, $\beta_{1,k}$ is a contribution of burden_i, X_i' is a matrix of additional variables, and $\varepsilon_{f,t}$ is an error of the model. These estimates were calculated using the nnet package for R v4.0.5 (Venables and Ripley, 2002) and presented as average marginal effects (Croissant, 2020).

The models were applied to regular farmers and Alpine summer farmers separately. In the first model, we used the burden from wolves to identify correlations with how long farmers would continue farming ("How long continue farming"). To increase the model prediction, further variables were included, which are represented in Table 3. In the second model, the same explanatory variables were used to predict farmers' intention to continue keeping small ruminants, exiting, or being uncertain in the near future ("Small ruminant keeping").

4. Results

4.1. *Exit*

4.1.1. *Regular farms*

Using the BIC information criterion, we identified the best model where kills were applied to farms in the year they occurred and to the following year.

The best explanatory power we obtained for our model was 24% (Fig. 2, Table A1). The kill factor focus variable showed a weak positive correlation with exiting small ruminant farming with herds of fewer than 15 animals ($p = 0.05$).

If the kill factor increased by one, and holding all other variables constant, the probability of abandoning small herds may have increased by 0.7% (95% CI 0–1.3%). Farmers with 16–40 animals also showed a higher exit rate, although the p-values lay at 0.19 and thus defined the correlation as not significant. Furthermore, for farmers with larger herds, no correlation could be estimated between the exit rate and the kill factor.

Further farm structure characteristics explain differences in the exit rate of small ruminant farming, as shown in Fig. 2. Interestingly, when direct payments for steep slopes increased by 1000 CHF per hectare agricultural area, farmers' probability for exit decreased by −4.5%.

The farmer's demographic variable of age correlated strongly with exit from small ruminant farming. In particular, farmers who turned 65 and were thus retired and no longer received direct payments, had a very high probability of exiting.

Neither agricultural product prices nor changes in agricultural policy correlated significantly with changes in exit rates.

4.1.2. *Alpine summer farms*

Similar to the model for regular farms, the best model for summer farms was selected via BIC and included a kill factor that was applied to the year the kills occurred and the year after. The best explanatory power we obtained for our model was 37% (Fig. 3, Table A2).

In the case of summering farms, we saw significant correlations between increased exit and increased kill factor for farms with herds of 5–35 NST ($p < 0.001$). For each increasing kill on a farm within a municipality, the probability of exit increased by 0.45% (95% CI 0.2%–0.67%). Summer farms with fewer than 5 NST small ruminants also showed a positive correlation between kill factor and exit rate, which was, however, not significant ($p = 0.056$). Each additional kill per farm in a municipality increased the probability of exiting farms with less than 5 NST small ruminants by 0.65% (95% CI 0.02%–1.3%). Summer farms with herds larger than 35 NST small ruminants showed no

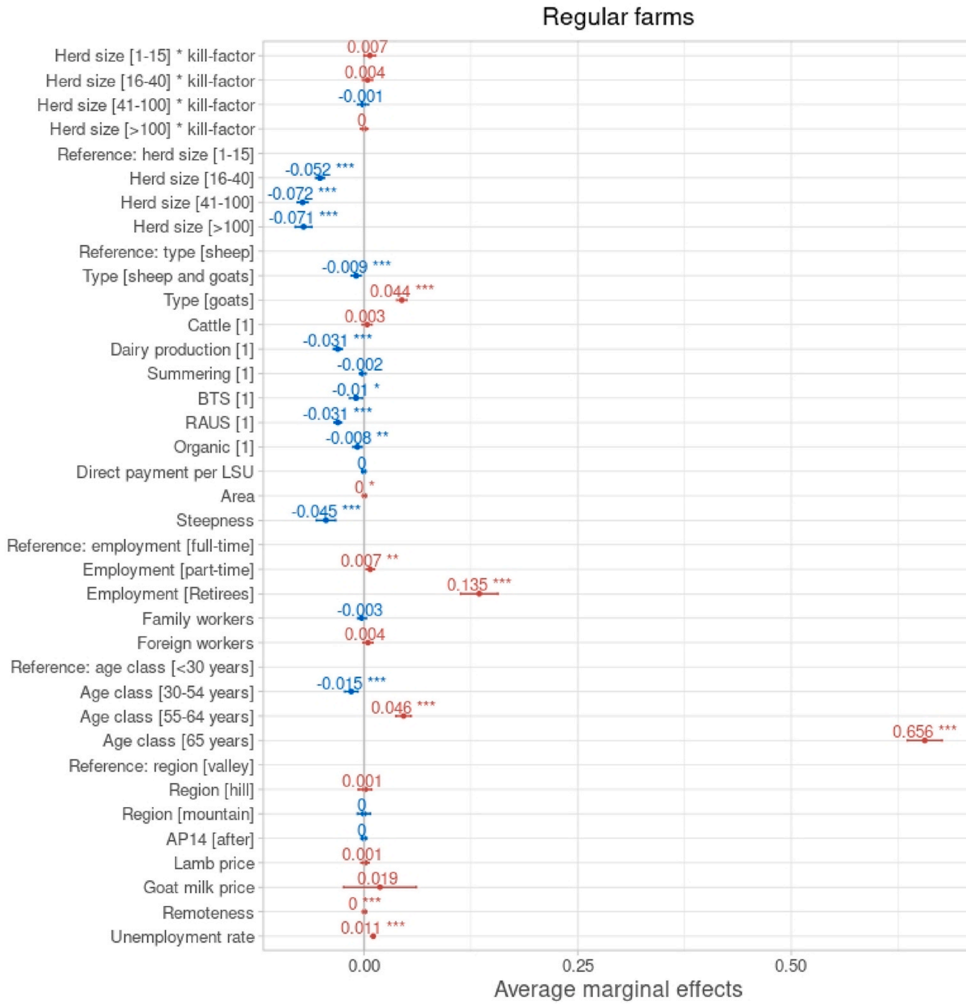

Fig. 2. Average marginal effects of exiting small ruminant farming on regular farms. Marginal effects greater than zero increases the exit rate whereas marginal effects lower than zero decreases the exit rate. Significance: ***p < 0.001, **p < 0.01, *p < 0.05.

correlation between the kill factor and the exit rate.

Similar to regular farmers, we found that farmers with smaller herds exited small ruminant summering significantly more often than farmers with larger herds. No significant difference was found between the sheep grazing systems. A separate model revealed that the correlation of the grazing system and exit rate was masked due to strong correlations between herd size and grazing systems. The effects of different farm structural characteristics can be seen in Fig. 3.

The understocking of summering farms led to an increased exit rate. Additionally, higher direct payments decreased farmer's exit rates. Non-farm-specific variables also partially explained the exit rate from small ruminant summering. The effect of agricultural policy had already been masked by the increased direct payments per NST and random effect year and was therefore no longer significant.

4.2. Voicing exit

The total response rate was 46.4%, with 928 responses, including 492 regular farmers and 436 Alpine summer farmers. Observations with missing data were deleted, resulting in 461 observations for both models of regular farms, and in 374 and 401 observations for the Alpine summer farm model "How long continue farming" and "Small ruminant keeping", respectively.

4.2.1. Exit farming

In the first model, the intention of how long farmers would continue farming was examined. As indicated in Fig. 4 (top), the probability for regular farmers to continue farming for only 1–2 years increases by 0.8% (95% CI 0%–1.6%) for one unit increase in burden, holding all other predictor variables constant. In addition, farmers' intention to continue farming for 6–10 years decreased by −1.6% (95% CI -2.9%–0.2%) for one unit increase in burden, holding all other predictor variables constant. Not significantly different were the probabilities for farmers willing to continue for 3–5 years, more than 10 years or being uncertain. In addition, age and the herd size correlated with how long farmers intended to continue farming (Table A3).

For Alpine summer farms (Fig. 4, center), an increasing burden by one unit decreased the probability of continuing farming for more than 10 years by −3.8% (95% CI -6%–1.6%), and increased the probability for being uncertain by 2.6% (95% CI 0.4%–4.8%) but not for the other levels. However, contradicting the findings in the panel data analysis of Alpine summer farms, increasing age decreased the probabilities of continuing farming for 6–10 years, more than 10 years, and being uncertain. Again, as expected, Alpine summer farmers already having a successor for their farm tended to continue farming for longer.

4.2.2. Exit small ruminant farming

In a second model, we identified drivers for farmers' intention to continue keeping small ruminants in the near future on regular farms

Fig. 3. Average marginal effects of exiting small ruminant farming on Alpine summer farms. Marginal effects greater than one increases the exit rate whereas marginal effects lower than one decreases the exit rate. Significance: ***p < 0.001, **p < 0.01, *p < 0.05.

(Table A4), which are presented in Fig. 4 (bottom left). For regular farmers, an increasing burden by one unit decreased the probability to continue farming by 2.7% (95% CI -4.2%–1.2%) and the probability of being uncertain to continue with small ruminants increased by 1.9% (95% CI 0.6%–3.2%). In addition, only an increasing herd size correlated negatively with exit and positively with continue farming.

For Alpine summer farms, burden also affects the relation of continue farming and being uncertain. (Fig. 4, bottom right). The probability of being uncertain increased significantly by 2% (95% CI 0.7%–3.5%) and decreased the probability of continue farming by −2.9% (95% CI -4.7% to −1%) being with a one-unit increase in burden. This means that farmers with a high burden caused by wolves were more uncertain if small ruminants should be kept in the future. Furthermore, age was the only additional variable that significantly correlated with a higher probability of being uncertain.

5. Discussion

Using panel data on small ruminant farmers in the Swiss Alps, we searched for correlations between wolf pressure and a higher rate of exiting small ruminant farming. Our results revealed that wolves had an effect on exiting sheep and goat farming on regular farms, but the correlation was low and only noticeable in farms with small-sized herds. Similar results came up by investigating the Alpine summer farms' panel data, where we found a significant correlation between livestock kills and exiting smaller herds of sheep and goats. We additionally used a questionnaire survey to investigate farmers' "voicing exit." The questionnaire survey mainly supported the findings above because we found significant correlations between an increasing voiced exit of goat and sheep husbandry and farmers' higher burden caused by wolves, exceeding the effect that was measured in the analysis of the past.

We were able to identify a positive correlation between the exit rate of regular farmers with very small herds and high wolf pressure. These findings correlate with different non-scientific descriptions that small farms in particular suffer from wolves (Venetz, 2008).

Those farmers do not keep their animals for economic reasons, whereas farmers with larger herds define sheep and goats as their incomes (Gazzarin, 2019), so that exiting small ruminant farming would entail major structural changes.

As for regular farms, the kill factor had a significant effect on smaller ruminant herds on Alpine summer farms. Although the herd sizes of both farm types are not directly comparable, we see a clear pattern that smaller flocks are more affected by wolves.

On Alpine summer farms, farms with fewer than 5 NST small ruminants keep mostly goats and have an economic focus on cattle grazing. Those farmers do not consider herd protection measures for small ruminants due to poor cost-benefit ratios. Moreover, herd protection, such as livestock guardian dogs (LGD) and fences, would hinder the management of cattle, according to many farmers, even if for example in the USA, cattle can be protected efficiently with herd protection measures

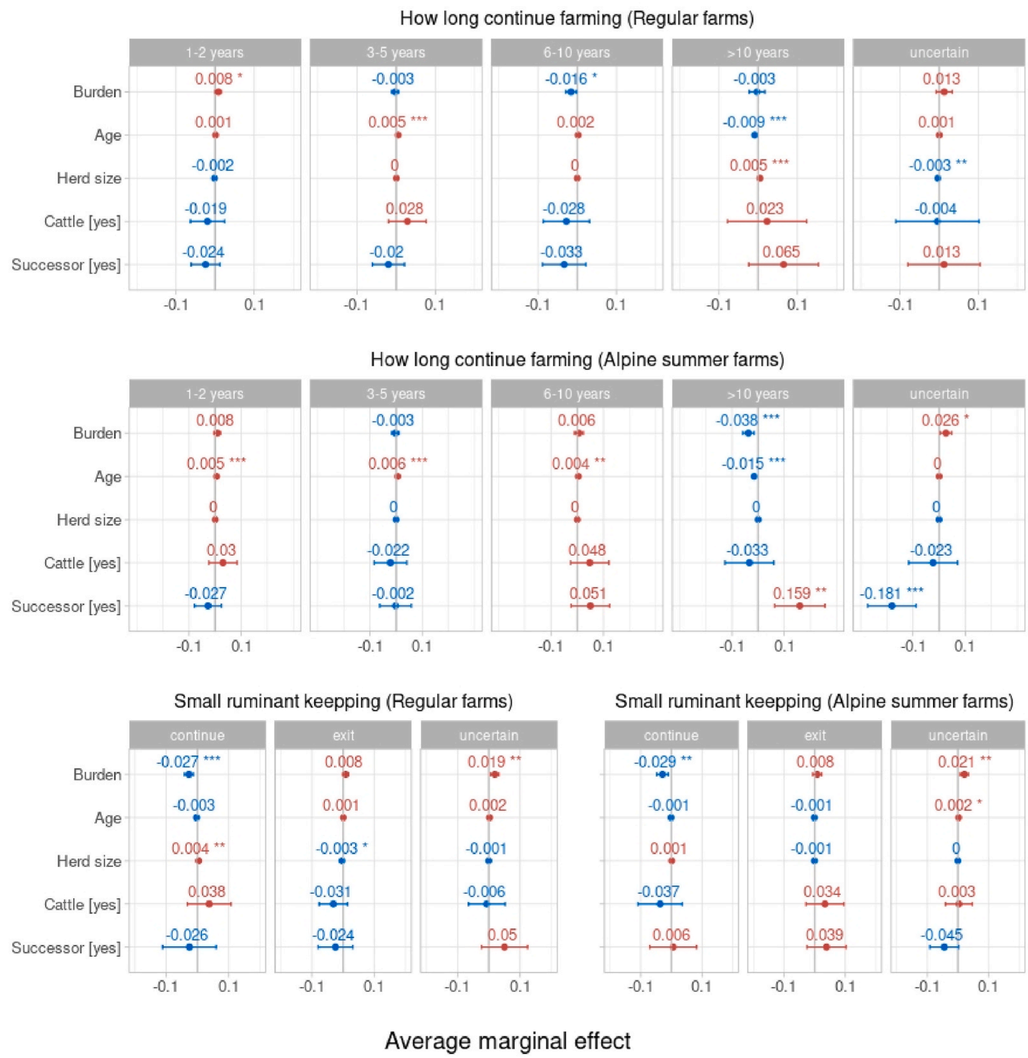

Fig. 4. Average marginal effects of the results from the multinomial logistic regression on questionnaire survey answers. Average marginal effects for how long farmers intend to continue farming on regular farms (top) and Alpine Summer farms (center). Bottom: Average marginal effects for farmers intend to continue keeping small ruminants in the near future on regular farms (left) and Alpine Summer farms (right). Significances: ***p < 0.001, **p < 0.01, *p < 0.05.

(Gehring et al., 2010). In combined cattle-goat farms, wolf pressure can lead to the decision to exit small ruminant keeping, but it will not have a major economic impact, since cattle farming will continue and the farm will remain cultivated.

The situation is different for farms with herds of 5–35 NST. The proportion of small, pure ruminant herds is meaningfully higher than on farms with <5 NST. Often, a small ruminant exit is equated with the abandonment of an entire farm. Herd protection measures are more difficult to implement on small herds. Since small herds often graze on remote and marginal land (Bollmann et al., 2014), the use of fences is difficult and often permeable due to the terrain (Mettler et al., 2014). LGD are also unsuitable for such small herds (Landry et al., 1999). Herd protection measures are very often time-, money-, and workload-consuming (Moser et al., 2019), which is not practical for farmers with limited resources.

We were also able to identify drivers for voicing exit using the questionnaire survey. Increasing age explained a reduced probability of continuing farming for many years. This is comprehensible, since old farmers have a higher exit rate than younger farmers and will not continue farming for many years (Corsi et al., 2021; Zorn and Zimmert, 2022). More interesting, however, was the fact that an increasing burden increased the probability of continuing farming for 1–2 years and reduced it for 6–10 years. Although most effects were not significant, we see a trend that increasing burden reduces the intention to exit farming earlier.

We found similar results for Alpine summer farmers. However, age had a greater effect on how long they would farm compared to regular farmers. This contradicts the results of the panel data analysis, where we identified age as a main explanation for exiting regular farms, whereas age did not explain Alpine summer farms exits at all.

The questionnaire survey further revealed a significant effect of an increasing wolf burden on regular and Alpine summer farmers' decision to being uncertain if they should continue and a non-significant trend to exit farming. Being uncertain indicated that farmers thought about the future and probably considered giving up sheep and goats for certain reasons. Simultaneously, probabilities of continuing farming decreased on both farm types with increasing burden. This led us to the conclusion that wolf pressure is a potential driver for deciding to amplify thoughts about exiting small ruminant farming, although they might still continue keeping them.

That the wolf indeed leads to higher burden and stress could be confirmed by Zahl-Thanem et al. (2020) or also Sjölander-Lindqvist (2009) and Flykt et al. (2022) through qualitative analysis. With our study, however, we could additionally show that farmers have a higher probability to exit early because of stress, as it was previously shown by Peel et al. (2016). Voicing exit is therefore a threat by farmers to explain the grievances around the wolf that should be taken seriously by politicians and decision-makers.

While in the best fitting exit model, a wolf effect remained for two years after a kill, we assume that wolves mainly have a short run effect, because a longer lasting effect was less significant. We therefore assume that wolf kills function as a shock for farmers, which needs to be distinguished from long-term stress (Meuwissen et al., 2019). However, in consideration for long-term stress, wolves have returned for good and farmers know that they need to adapt to cope with this problem. Whereas farmers with larger herds are able to adapt to the wolf pressure by implementing herd protection measures, small herd farmers rarely are. Due to restricted farmland size and infrastructure, they further cannot increase their herd size to better protect their livestock and thus have a higher potential to exit.

Some farmers with small herds will continue farming, despite the threat of wolves. However, at the point of retirement, successors for taking over the farm will be missing. Farm takeover often results in increasing farm activities or in decreasing them while the focus is placed on non-agricultural income (Mann et al., 2013). Since small farms are more strongly affected by wolves, the latter strategy will occur less frequently. However, what effect the wolf ultimately has on young people taking over farms is not yet known. Therefore, we highly recommend further studies on that.

Going back to Hirshman's theoretical model, farmers seem to use their options coherently. Failing to make their voice heard, the empirical results show that there is a limited effect of wolf prevalence on both the observed exits and the voiced exits by farmers. Our findings support other studies that have hypothesized an effect of wolves on farm exit (e.g. Hinojosa et al., 2018; Kouřilová et al., 2019).

Nevertheless, it is uncertain whether the farm, farmland, or livestock will be taken over by another farmer, or whether the farm will be abandoned. Strand et al. (2021) however, could already show that the total number of farms and livestock are decreasing in Norwegian wolf areas. Although this decline has not yet been scientifically proven in Switzerland, we may assume that with the increased exit rate, farms, land and livestock have been increasingly abandoned. Particularly regular farmers with small herds make an important contribution to the conservation of biodiversity and cultivated land by managing marginal land (Bollmann et al., 2014). Additionally, these farmers are the ones who traditionally practice sustainable agriculture (Mann, 2005; Slámová and Belčáková, 2019).

While the land and livestock of regular farmers with small herds can be taken over by a larger farm and thus still remain cultivated, the land on Alpine summer farms is most likely to be abandoned due to geographical isolation. Loss of these alpine pastures also leads to loss of biodiversity (Bollmann et al., 2014)., and ultimately reduced food production loss of tourist appeal (Mazzocchi et al., 2019).

Although other factors have had a much greater influence on the exit rate than wolf pressure, we recommend that our findings be taken into account in future wolf management and agricultural policy measures. A focus should be placed especially on sustaining small farms, which are currently limited in herd protection measures due to financial and time constraints. Besides a monetary support and optimization of herd protection measures for small farms, a pooling of farms and livestock should always be considered in order to increase the herds and thus reduce the vulnerability for farm exit. In addition, we think that a faster removal of damage-causing wolves should be considered to reduce the number of livestock kills and thus reduce the short-time pressure caused by wolves (Vogt et al., 2022).

Our study is limited from several points of view. Since we were not able to identify kills on individual farms in the panel data, important information was missing, which could have contributed more specific answers to the question of how strong farmers exit to kills on their own farm. Unfortunately, data for herd protection measures were too sparse, so we could not investigate the role of these measures on the exit rate. A direct comparison between the questionnaire and the panel data results was impossible, since the outcomes and explanatory variables differed.

6. Conclusions

Livestock depredation caused by wolves leads to grievances, especially in goat and sheep farming. Media and social uproar complain that because of wolves, farms will be abandoned. However, the effect of wolves on changing farms has been unclear so far.

By taking inspiration from Hirshman's theory of "exit, voice, and loyalty," we focused in this paper on farmers' exit rate and their voiced exit from keeping small livestock in Switzerland. Applying a questionnaire survey and long-term panel data analysis, we were able to show that wolves partially explain exit from small ruminant farming, both in terms of observed exit and in terms of voiced exit by farmers. Our study revealed that mainly farmers with small herds exited more frequently under high wolf pressure. This applies to the regular farms and to the Alpine summer farms and is data-mapped support for complaints that small sheep and goat farms in particular are suffering from the wolf.

Our results indicate that farmers' sorrows around wolf pressure should be taken seriously. We therefore highly recommend to take the farmer's exit and voicing exit into account when dealing with a new wolf management and agricultural policy measures.

Authors statement

Steffen Mink: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing. **Stefan Mann**: Conceptualization, Methodology, Writing – review & editing, Supervision.

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Data availability

The authors do not have permission to share data.

Appendix

Table A1
Average marginal effects of mixed-effect logistic regression model for exiting regular farms

Average marginal effects for exit regular farms			
Predictors	*AME*	*CI*	*p*
Herd size [1–15] * kill-factor	0.0067	0–0.0134	0.05
Herd size [16–40] * kill-factor	0.0039	−0.0019–0.0098	0.188
Herd size [41–100] * kill-factor	−0.0013	−0.0076–0.005	0.696
Herd size [>100] * kill-factor	0.0001	−0.0042–0.0044	0.967
Herd size [41–100]	−0.07199	−0.07811–−0.06588	**<0.001**

(*continued on next page*)

Table A1 (*continued*)

Average marginal effects for exit regular farms			
Herd size [>100]	−0.07092	−0.08068–−0.06117	**<0.001**
Type [sheep and goats]	−0.00939	−0.01498–−0.0038	**0.001**
Type [goats]	0.04405	0.03811–0.05	**<0.001**
Cattle [1]	0.0034	−0.00227–0.00907	0.24
Dairy production [1]	−0.03091	−0.036–−0.02583	**<0.001**
Summering [1]	−0.00174	−0.00558–0.0021	0.374
BTS [1]	−0.00952	−0.01713–−0.0019	**0.014**
RAUS [1]	−0.03083	−0.03516–−0.0265	**<0.001**
Organic [1]	−0.00784	−0.01323–−0.00245	**0.004**
Direct payment per LSU	−0.00044	−0.00123–0.00035	0.275
Area	0.00022	1e-05 - 0.00043	0.041
Steepness	−0.0448	−0.0561–−0.03349	**<0.001**
Employment [part-time]	0.0071	0.00234–0.01185	**0.003**
Employment [Retirees]	0.13474	0.11294–0.15654	**<0.001**
Family workers	−0.00257	−0.00757–0.00243	0.314
Foreign workers	0.00436	−0.00135–0.01008	0.135
Age class [30–54 years]	−0.01514	−0.02286–−0.00741	**<0.001**
Age class [55–64 years]	0.0461	0.03721–0.055	**<0.001**
Age class [65 years]	0.65632	0.63603–0.67662	**<0.001**
Region [hill]	0.00094	−0.00687–0.00874	0.814
Region [mountain]	−0.00036	−0.00781–0.0071	0.925
AP14 [after]	−0.00033	−0.00366–0.00299	0.845
Lamb price	0.00099	−0.00354–0.00552	0.667
Goat milk price	0.01853	−0.02397–0.06104	0.393
Remoteness	0.00026	0.00013–0.00038	**<0.001**
Unemployment rate	0.01062	0.0082–0.01303	**<0.001**

Table A2
Average Marginal effects of mixed-effect logistic regression model for exiting Alpine summer farms.

Average marginal effects for exit Alpine summer farms			
Predictors	AME	CI	p
Herd size [<5 NST] * kill-factor	0.0064	-2e-04 - 0.013	0.057
Herd size [5–35 NST] * kill-factor	0.0044	0.0022–0.0067	**<0.001**
Herd size [35–75 NST] * kill-factor	0.0009	-9e-04 - 0.0026	0.328
Herd size [> 75 NST] * kill-factor	0.0006	−0.001–0.0026	0.738
Herd size [5–35 NST]	−0.08569	−0.09719–−0.0742	**<0.001**
Herd size [35–75 NST]	−0.11166	−0.12563–−0.09768	**<0.001**
Herd size [>75 NST]	−0.12396	−0.13828–−0.10963	**<0.001**
Type [permanent shepherding]	−0.03445	−0.06157–−0.00732	**0.013**
Type [permanent grazing]	−0.04904	−0.06176–−0.03633	**<0.001**
Type [rotational grazing]	−0.05665	−0.07236–−0.04094	**<0.001**
Type [goats and dairy sheep]	0.02759	−0.00829–0.06348	0.132
Type [goats and permanent shepherding]	−0.0445	−0.08579–−0.00321	**0.035**
Type [goats and permanent grazing]	−0.07576	−0.08925–−0.06228	**<0.001**
Type [goats and rotational grazing]	−0.07862	−0.10077–−0.05648	**<0.001**
Cattle [1]	0.03133	0.01947–0.0432	**<0.001**
Dairy production [1]	−0.07119	−0.08128–−0.06109	**<0.001**
Legal system [natural person]	−0.00328	−0.01299–0.00643	0.508
Legal system [Public administration and associations]	0.00958	−0.00737–0.02654	0.268
Stocking [overstocking]	0.00381	−0.01154–0.01915	0.627
Stocking [understocking]	0.01524	0.00334–0.02715	**0.012**
Direct payment per NST	−0.00479	−0.00779–−0.00179	**0.002**
AP14 [after]	−0.00993	−0.04487–0.02502	0.578
Lamb price	0.00401	−0.01243–0.02045	0.633
Goat milk price	0.06582	−0.00133–0.13298	0.055
Remoteness	−0.00029	−0.00055 - -3e-05	**0.029**
Unemployment rate	0.01325	0.0089–0.01761	**<0.001**

Table A3
Average marginal effects of multinomial logistic regression model for how long regular and Alpine Summer farmers intend to continue farming.

How long continue farming							
	Regular farmers			Alpine Summer farmers			
Predictors	*AME*	*CI*	*p*	*AME*	*CI*	*p*	*Response*
Burden	0.0083	0–0.0164	**0.046**	0.0084	−0.0045–0.0212	0.202	1–2 years
Age	0.001	−0.001–0.0027	0.259	0.0053	0.0028–0.0079	**<0.001**	1–2 years
Cattle [yes]	−0.0194	−0.0631–0.0243	0.384	0.0303	−0.0238–0.0844	0.272	1–2 years
Herd size	−0.0018	−0.0037–0	0.058	0.0002	−0.0001–0.0003	0.516	1–2 years

(*continued on next page*)

Table A3 (*continued*)

How long continue farming							
Successor	−0.0244	−0.0612–0.0125	0.195	−0.0271	−0.0788–0.0246	0.304	1–2 years
Burden	−0.0026	−0.0117–0.0064	0.568	−0.0031	−0.0174–0.0112	0.674	3–5 years
Age	0.0047	0.0019–0.0076	**0.001**	0.0056	0.0029–0.0082	**<0.001**	3–5 years
Cattle [yes]	0.0285	−0.0194–0.0764	0.244	−0.0219	−0.0838–0.0401	0.489	3–5 years
Herd size	0.0004	−0–0.0011	0.244	−0.0003	−0.0011–0.0005	0.461	3–5 years
Successor	−0.0198	−0.0608–0.0212	0.344	−0.0024	−0.0624–0.0576	0.938	3–5 years
Burden	−0.0158	−0.0294–−0.0022	**0.023**	0.006	−0.0112–0.0232	0.496	6–10 years
Age	0.0023	−0–0.0048	0.084	0.0041	0.0011–0.007	**0.007**	6–10 years
Cattle [yes]	−0.0276	−0.0867–0.0316	0.361	0.0482	−0.0251–0.1215	0.197	6–10 years
Herd size	0.0001	−0.0001–0.0011	0.866	0.0003	−0.001–0.0011	0.423	6–10 years
Successor	−0.0332	−0.0886–0.0221	0.239	0.0506	−0.0231–0.1243	0.179	6–10 years
Burden	−0.0029	−0.0229–0.0171	0.778	−0.0376	−0.0593–−0.0159	**0.001**	>10 years
Age	−0.0086	−0.0125–−0.0047	**<0.001**	−0.0152	−0.0187–−0.0117	**<0.001**	>10 years
Cattle [yes]	0.0228	−0.078–0.1236	0.658	−0.0335	−0.127–0.06	0.483	>10 years
Herd size	0.0045	0.0028–0.0062	**<0.001**	0	−0.0013–0.0012	0.946	>10 years
Successor	0.0649	−0.0239–0.1537	0.152	0.1594	0.0632–0.2556	**0.001**	>10 years
Burden	0.013	−0.0075–0.0335	0.214	0.0263	0.0044–0.0482	**0.019**	uncertain
Age	0.0006	−0.0037–0.0049	0.785	0.0002	−0.0034–0.0038	0.896	uncertain
Cattle [yes]	−0.0043	−0.1103–0.1018	0.937	−0.0232	−0.1168–0.0704	0.627	uncertain
Herd size	−0.0032	−0.0055–−0.001	**0.005**	−0.0002	−0.0013–0.0001	0.788	uncertain
Successor	0.0125	−0.0796–0.1047	0.79	−0.1805	−0.2733–−0.0877	**<0.001**	uncertain

Table A4
Average marginal effects of multinomial logistic regression model if regular and Alpine Summer farmers intend to still keep small ruminants in the near future.

Small ruminant keeping							
	Regular farmers			Alpine Summer farmers			
Predictors	*AME*	*CI*	*p*	*AME*	*CI*	*p*	*Response*
Burden	−0.0273	−0.0421–−0.0124	**<0.001**	−0.029	−0.0474–−0.0106	**0.002**	continue
Age	−0.0027	−0.0061–0.001	0.113	−0.0011	−0.0041–0.002	0.499	continue
Cattle [yes]	−0.0257	−0.1116–0.0602	0.557	0.0011	0–0.0024	0.113	continue
Herd size	0.004	0.0014–0.0065	**0.002**	−0.0367	−0.1092–0.0357	0.32	continue
Successor	0.0376	−0.0323–0.1075	0.291	0.0058	−0.0706–0.0821	0.882	continue
Burden	0.0083	−0.0012–0.0178	0.086	0.0082	−0.0063–0.0226	0.268	exit
Age	0.0008	−0.0013–0.0029	0.446	−0.0011	−0.0037–0.0015	0.426	exit
Cattle [yes]	−0.0245	−0.0797–0.0308	0.385	−0.0008	−0.0021–0	0.202	exit
Herd size	−0.0033	−0.0058–−0.001	**0.01**	0.0336	−0.0281–0.0953	0.286	exit
Successor	−0.0311	−0.0765–0.0143	0.179	0.0388	−0.025–0.1026	0.233	exit
Burden	0.019	0.006–0.0319	**0.004**	0.0209	0.0072–0.0346	**0.003**	uncertain
Age	0.0019	−0.001–0.0048	0.202	0.0021	0–0.004	**0.029**	uncertain
Cattle [yes]	0.0502	−0.0236–0.124	0.183	−0.0003	−0.001–0	0.437	uncertain
Herd size	−0.0007	−0.0023–0.001	0.39	0.0032	−0.0407–0.047	0.888	uncertain
Successor	−0.0065	−0.0654–0.0524	0.829	−0.0446	−0.0916–0.0024	0.063	uncertain

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