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Structural change in agriculture and farmers' social contacts: Insights from a Swiss mountain region

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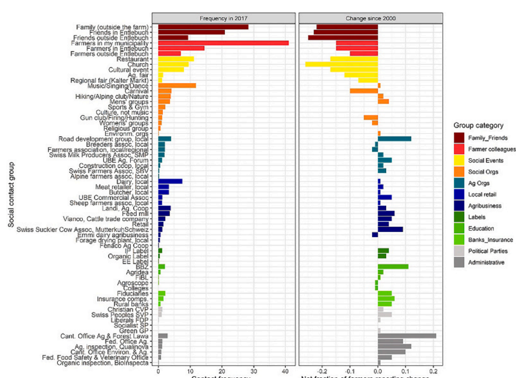
HIGHLIGHTS

- A farm' survey combined with agricultural census data reveals relationships between (changing) farm structures and social connections.
- Farmers have a high, but decreasing frequency of informal contacts and lower, but increasing frequency of commercial and administrative contacts.
- High workloads correlate with less frequent contacts with family, friends, and colleagues.
- Managers of larger and more intensive farms have more frequent—but also more rapidly declining—social contacts.
- Beyond direct interventions that foster social capital, policy actions should consider the interconnections between social and structural change.

GRAPHICAL ABSTRACT



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ABSTRACT

CONTEXT: Farm numbers are steadily declining in Europe and globally while farms become larger and more intensive. Driven in part by worsening macroeconomic conditions, these structural changes and the associated rationalization of agricultural supply chains have affected social relations in rural areas. In turn, farmers' social contacts influence farming decisions. Social and structural changes are thus interconnected, and they affect the resilience of rural areas through their influence on environmental, social, and economic capital.
OBJECTIVE: We examine the connection between farm structures and farmers' social contacts in the UNESCO Biosphere Reserve Entlebuch (UBE), a mountain region in central Switzerland with a strong presence of family farms, and explore the implications of social and structural change for rural resilience.
METHODS: We conduct a survey of $N = 102$ farming households and combine it with farm-level agricultural census data and interviews with key stakeholders ($N = 13$) to analyze farmers' current social contacts and their

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changes since the year 2000. We use regression and cluster analyses to examine the relationship between (changes in) social contacts and farm-level characteristics.
RESULTS AND CONCLUSIONS: Farmers in the UBE have a high, but decreasing frequency of contacts with family, friends, and colleagues and lower, but increasing frequency of commercial and administrative contacts. Workloads have increased by 6% in five years, driven by farm-level expansion of agricultural area (+5%)—including expanding ecological compensation areas—and intensification in managed areas (+3%), leading to parallel processes of intensification and extensification. Since most of these family farms do not hire workers, growing workloads directly impinge on farmers' free time, affecting informal contacts most. Farm managers in larger and more intensive farms have more frequent and more diverse, but also more rapidly declining, social contacts. Our results point to a net loss in social capital as social contacts become less frequent and shift from local and informal to regional and national professional contacts.
SIGNIFICANCE: A 17% decline in farm numbers in 15 years reflects the vulnerability of farms in this region. Growing financial strain, workloads, time pressure and the associated erosion of informal contacts contribute to this vulnerability. Policymakers from local to national should recognize the contribution of farmers' diverse social networks towards rural resilience and seek options to maintain and enhance such networks. Beyond direct interventions that foster social capital, policymakers should more rigorously consider the short- and long-term interconnections and tradeoffs between different forms of capital.

1. Introduction

European agriculture has undergone important structural changes in the last decades in the form of declining farm numbers, growing farm size, and increased management intensity, mechanization, and specialization (Berti and Mulligan, 2016; Besser et al., 2017; Lowder et al., 2016; Neuenfeldt et al., 2019; Van Vliet et al., 2015). These changes are driven in part by the progressive liberalization of agricultural markets, the associated stagnation or decline in farm-gate prices for agricultural commodities, and the removal of price supports (Neuenfeldt et al., 2019; Stock et al., 2014). In Switzerland, the number of farms has halved over the last 50 years (Zemp, 2011), with similar trends across Europe (O'Donnell, 2019), the United States (Semuels, 2019) and other developed countries (Van Vliet et al., 2015). Mounting macroeconomic pressures have especially affected mountain farms, which have a lower comparative advantage (Huber et al., 2015; MacDonald et al., 2000), and small-medium and family farms, which are less capitalized and technologically intensive (Jackson-Smith and Gillespie, 2005; Zimmermann and Heckelei, 2012). Nevertheless, family farms remain the predominant form of farming in Europe (Besser et al., 2017) and comprise 90% of all farms globally (Lowder et al., 2016). Government subsidies for agriculture seek to address the related issues of structural change and rural biodiversity declines (Bundesrat, 2009). However, the shift from price stabilization measures to direct payments, which are tied to mandatory and voluntary environmental and animal welfare practices (OECD, 2017), has also increased the administrative and management complexity of farming (Ritzel et al., 2020).

Structural transformations have an impact on the social fabric of rural communities. At the farm level, increasing farm size, higher workloads, longer working hours, and a growing administrative burden translate into less time for social exchange, which can increase stress and feelings of social isolation (Gregoire, 2002). Challenging macroeconomic conditions have also forced agricultural supply chains—not just farmers—to become more efficient by implementing "lean" principles (Taylor, 2005). This streamlining can reduce opportunities for social exchange among farmers. As an example, the abandonment of central milk collection points in favor of farm-level milk collection in Switzerland has eliminated a traditional place for farmers' daily social exchange. The growing importance of national and international supply chains and decline of local "proximity" agriculture—as evidenced by falling numbers of local butcheries and dairies (Forney and Häberli, 2017)—may also affect farmers' place attachment by reducing their local social networks (Raymond et al., 2010; Tsolakis et al., 2014).

The influence of structural factors on social connections also works in the opposite direction. Farmers' social networks influence farm management decisions through the diffusion of knowledge, practices, attitudes, and values (Brown et al., 2018; Gray and Gibson, 2013). The structure of social networks—for example, the combination of close, local "bonding" and geographically and socially distant "bridging" connections—can influence the adoption of farm-level innovations (Albizua et al., 2020; Cofré-Bravo et al., 2019), including new technologies and practices, certifications and labels, or agro-environmental measures (Karali et al., 2014; Padel, 2001; Skaalsveen et al., 2020; van Duinen et al., 2016).

Understanding the relationship between, and evolution of, farm structures and farmers' social connections is relevant for steering rural development towards sustainability. Social capital has a positive effect on economic development and public goods provision (Burton et al., 2005), and it contributes—together with economic and environmental capital—to the resilience of rural areas (Wilson, 2010). Understanding the link between social connectivity and broader structural factors can also help optimize information dissemination strategies in rural communities (Albizua et al., 2020), identify leverage points for sustainable transformations (Oreszczyn et al., 2010), and help avert vicious cycles where structural and social simplification reinforce each other and reduce both innovation and biodiversity (Allen et al., 2014). Moreover, mental health issues associated with social isolation and stress in rural communities (Bjornestad et al., 2019; Judd et al., 2006; Malmberg et al., 1999) are emerging as important public health concerns (BauernZeitung, 2012).

Previous studies on the relationship between farm-level characteristics and farmers' social networks and social embeddedness have yielded contradictory results. In a study of Swiss and German farms, Besser et al. (2017) find that smaller farm size correlates with a higher number of personal contacts and a higher share of local contacts. However, in a study of farmers' social networks in northern Spain, Albizua et al. (2020) find that larger and more intensive farms are more socially connected, both locally and regionally.

Here, we examine the relationship between social connections and farm structures in the UNESCO Biosphere Reserve Entlebuch (UBE), a mountain region in central Switzerland with a traditionally strong presence of dairy and cattle farms. We hypothesize that: 1) Growing workloads and more streamlined agricultural supply chains have reduced farmers' opportunities for—and frequency of—personal and farmer-to-farmer social contacts; at the same time, contacts with government and agribusinesses have increased with growing farming intensity, output, and administrative burden. 2) Farmers' social contacts and their changes depend on certain farm and farmer characteristics. For example, large and intensive farms may have more frequent interactions with agribusinesses due to their higher focus on productivity; social contacts of dairy and mountain farmers may have been disproportionately affected by changing macroeconomic conditions; more diversified farms may have a more diverse set of social contacts; and organic farms, constituting a minority, may be more socially isolated than non-organic farms.

To address these hypotheses, we conduct a survey among 102 farming households in the UBE and ask farm managers about their current (2017) frequency of social contacts across 64 social contact groups, changes in social contacts since the year 2000, and reasons for the changes. We also obtain agricultural census data on farm-level structures. Additionally, we interview four farmers and nine other agricultural stakeholders to understand the dynamics of structural and social change in the region.

We investigate the link between farm and farm manager characteristics on the one hand and, on the other hand, social contact diversity, frequency, composition, and degree of "localness". We also examine the social contact pattern of large and intensive farms. Our broad-spectrum approach assumes that the analysis of farming structures and practices requires an understanding of farmer social networking, and *vice-versa*.

2. Methods

2.1. Study area

The region Entlebuch in the canton of Luzern, Switzerland (Fig. 1) received the status of UNESCO Biosphere Reserve Entlebuch (UBE) in 2001 as a natural and cultural landscape (UNESCO, 2018). The UBE comprises eight municipalities, covers 39′700 ha, and its population of approximately 17′000 residents has remained relatively constant over the last three decades (lustat, 2022). Roughly half of the UBE's surface consists of protected core and buffer zones, with the rest devoted to agriculture, which generates 23% of the region's economic output (LUSTAT Statistik Luzern, 2019). Land use consists of forests (43%), grasslands (47%), and steep or rocky terrain (10%) unsuitable for agriculture (Knaus, 2013), with cropland virtually absent. Most farms (98%) are family owned and operated and employ little to no hired labor. The UBE is classified as a mountain region, with elevation ranging from roughly 800 m (mountain zone 1) to 2400 m (mountain zone 4). Dairy cow, suckler cow, and veal mast farms are most common, with a small number rearing sheep, goats, or horses. Many farms raise pigs in addition to cattle in varying proportions. Between 2003 and 2018, farm numbers decreased by 17% to 848, while average farm size increased by 23% to 17.2 ha (BLW, 2020a).

Ecological Compensation Areas (ECAs) comprise on average 16% (±11%) of farm agricultural area (lawa, 2017), above the minimum 7% threshold that qualifies farms for agricultural subsidies (BLW, 2020a). In Switzerland, ECAs are broadly divided into Q1 ECAs, which are predominantly practice-based (e.g., subject to low-frequency forage cutting), and Q2 ECAs, which are predominantly output-based (number of biodiversity indicator species). Q2 areas are considered to be of higher ecological value, are subject to stricter requirements and constraints, and receive higher compensation (BLW, 2022a).

In 2017, 8% of UBE farms were certified organic (UBE, 2020), lower than the Swiss average of 13% (BFS, 2020a, 2020b). The region also possesses a local origin label ("Echt Entlebuch") for locally produced milk and dairy products, meat, and other regional specialty products, such as honey or herbs.

Because Q2 areas are defined based on indicator species rather than farming practices, they depend considerably on preexisting terrain conditions, such as the presence of wetlands (Rudin et al., 2015).

2.2. Data collection

A total of 400 surveys (S7) were mailed in November 2017 to randomly-sampled commercial farms in the UBE operating year-round and excluding summer-only operations (alps), non-commercial operations, cooperatives, slaughterhouses, cattle traders, and transhumance (seasonal livestock migration) activities. From the farms that met the selection criteria ($N = 884$), we excluded 241 farms that had been selected to receive a survey, unrelated to this study, around the same dates. The resulting sampling frame was thus $N = 643$, from which a random sample of $N = 400$ was drawn. We did not target all 643 farms in order to avoid overtaxing farmers with surveys in this region, which has been the focus of studies in the recent past. The survey response rate was 27%, corresponding to 102 usable responses from a total of 110 returned surveys. Average farm size and distribution across elevation zones are not significantly different from non-respondents and from the UBE average (S3).

The survey was addressed to the farm manager or managers in the case of joint management (e.g., couples). It asked about the characteristics of the farm and farm manager, including age, formal and continued education, people living and working in the farm, certifications and labels, and off-farm income. We did not ask gender; according to agricultural census data, 90% of farms in the 400-farm sample are managed by a man, 5.0% by a woman, 2.3% by a two-gender couple, and the rest by several family members (1.3%) or non-family arrangements (1.0%). In practice, many farms are co-managed by a—mostly—two-gender couple who makes farming decisions jointly; however, because of the fluidity of informal farm management configurations (Contzen and Forney, 2017), the distinction of farm-level

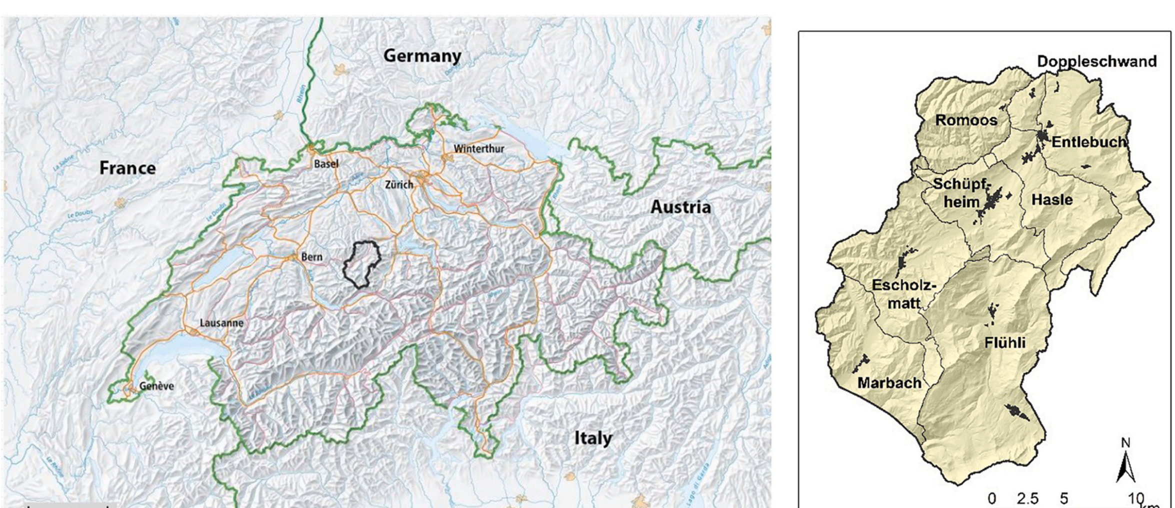

Fig. 1. (Left) Location of the Entlebuch region, since 2001 designated UNESCO Biosphere Reserve Entlebuch (UBE) (black boundary) in Switzerland. (Right) Detailed map of the municipalities comprising the UBE. Source: Federal Office of Topography swisstopo.

decision-making by gender is difficult. The survey also asked about farm managers' current (2017) social contacts across 64 social contact groups (Table 1), changes in contacts since 2000 (increase, decrease, or no change), and reasons for changes. The date in the past used to evaluate social contact changes was referred to as "approximately fifteen years ago (i.e., around the year 2000)" in order to provide two timeframes for recollection.

To inform the survey design and gain qualitative insights into the dynamics of structural and social change in the UBE over the last decades, we conducted open-ended interviews with four farming households and nine representatives from agricultural organizations and institutions. These included the local agricultural college (BBZN), the cantonal Office of Agriculture (lawa), the cantonal Office of Agricultural Inspection (Qualinova), the UBE Agricultural Forum, a large agricultural inputs cooperative (Landi), the cooperative of Central Swiss Milk Producers (SMP), two local dairies, and a local breeding cooperative. We also pre-tested the survey with four other farming households.

We obtained additional farm-level information from agricultural census data in 2017 (the year the survey was administered) and 2012 (the earliest available records in comparable format) from the cantonal administration (lawa, 2017). Census data included elevation zone, total agricultural area (*landwirtschaftliche Nutzfläche* or LN), workload (*Standardarbeitskräfte* or SAK), livestock units (*Grossvieheinheiten* or GVE) for each livestock type, and size of Q1 and Q2 ECAs. SAK is a weighted measure of workload based on farm structure (e.g., agricultural area, livestock units, crop types, slope, etc.) and farming practices; for instance, 0.022 units of SAK correspond to one hectare of agricultural area (LBV, 2019, Art. 3). SAK is a very relevant metric for farmers in Switzerland, since farm-level subsidies are largely calculated based on this value. GVE is a weighted measure of livestock units based on resource use intensity; as an example, GVE units assigned to dairy cows, suckler cows older than two years, and fattening pigs are, respectively, 1.0, 0.6, and 0.17 per head (LBV, 2019, Art. 27 Abs. 1).

2.3. Analysis

We wish to assess whether there is a relationship between, on one hand, social contact patterns (social contacts and their changes) and, on the other hand, farm and farmer characteristics, including changing farm structures. We first present a summary of farm structural variables (size, intensity, and ECA fraction) and their changes in the UBE between 2012 and 2017 (Section 3.1). We use three measures of farm size, namely standardized workload (SAK), standardized livestock units (GVE), and agricultural area (LN), and two measures of intensity, namely output intensity (GVE/LN) and workload intensity (SAK/LN). The calculation methodology of SAK changed in 2016, effectively reducing average SAK values. To calculate SAK changes between 2012 and 2017, we calculate adjusted 2017 SAK values using the 2012 methodology (S6). We then use descriptive statistics to show farmers' social contacts in 2017 and their changes since 2000 and use qualitative data to contextualize the findings (Section 3.2).

To analyze social contact patterns, we aggregate the 64 social contact groups into 12 social contact categories, which in turn are further aggregated into four aggregate categories (personal; colleagues; commercial; and professional non-commercial) (Table 1). Each social contact group is classified as municipal, regional (within the canton of Lucerne), or national; an alternative classification differentiates contacts within and outside the UBE. Social contact frequency is calculated using weighting factors (1 = annual, 2 = monthly, 3 = weekly, and 4 = daily) (Stewart, 1999) and aggregated by social contact category and respondent. An alternative weighting scheme (1/12/52/365) is used to illustrate social contact frequency graphically and to assess results' sensitivity to weighting. We calculate the diversity of contacts using the Shannon diversity index, $H = -\sum_{i=1}^{n} p_i ln(p_i)$ (Spellerberg and Fedor, 2003), where p_i is the contact frequency in each social contact group i

Table 1
Description of social contact groups and categories.

Social contact category (N = 12)	Social contact group (N = 64)	Municipal (M) Regional (R) National (N)	Inside UBE Outside UBE (o)
Administrative	Federal Office of Agriculture	N	o
	Federal Food Safety and Veterinary Office	N	o
	Cantonal Office of Agriculture and Forest lawa	R	o
	Cantonal Office of the Environment and Agriculture	R	o
	Agricultural inspection office Qualinova	R	o
	Organic inspection office BioInspecta	R	o
Education (Professional, non-commercial*)	Professional Training Center for Nature and Food (*Berufsbildungszentrum Natur und Ernährung*, BBZN)	R	UBE
	Agridea (Swiss Agricultural Extension)	N	o
	Agroscope (Swiss Center for Ag. Research)	N	o
	Colleges	N	o
	FiBL (Swiss Center for Organic Farming Research)	N	o
Labels (Professional, non-commercial*)	Organic certification label Bio Suisse	N	o
	Local origin label Echt Entlebuch	N	o
Political Parties	Christian CVP	R	o
	Liberals FDP	R	o
	Green GP	R	o
	Socialist SP	R	o
	Swiss Peoples' SVP	R	o
Agricultural Organizations (Professional, non-commercial*)	Central Swiss Milk Producers Cooperative SMP	N	o
	Swiss Farmers Association SBV	N	o
	UBE Agricultural Forum	R	UBE
	Alpine Farmers' Association, local	R	UBE
	Farmers' Association local/regional	R	UBE
	Forage drying plant, local	R	UBE
	Sheep Farmers Association, local	M	UBE
	Breeders' Association, local	M	UBE
	Road development group, local	M	UBE
	Construction cooperative, local	M	UBE
Agribusiness (Commercial*)	Swiss Suckler Cow Association MutterkuhSchweiz	N	o
	Fenaco agricultural cooperative	N	o
	Retail	R	o
	Landi agricultural cooperative	R	UBE
	Vianco cattle trade company	R	o
	Feed mill	R	UBE
	Emmi dairy agribusiness	N	o
Local Retail (Commercial*)	UBE Commercial Association	R	UBE
	Dairy, local	M	UBE
	Butcher, local	M	UBE
	Meat retailer, local	M	UBE
Banks and Insurance (Commercial*)	Fiduciaries	R	UBE
	Rural banks	R	UBE
	Insurance companies	R	UBE
Colleagues*	Farmers in my municipality	M	UBE
	Farmers in the UBE	R	UBE
	Farmers outside the UBE	N	o
Family and Friends (Personal*)	Family (not living the farm)	M	UBE
	Friends in the UBE	R	UBE
	Friends outside the UBE	N	o
	Church	M	UBE

(*continued on next page*)

Table 1 (*continued*)

Social contact category ($N = 12$)	Social contact group ($N = 64$)	Municipal (M) Regional (R) National (N)	Inside UBE Outside UBE (o)
Social Events (Personal*)	Cultural event	M	UBE
	Restaurant	M	UBE
	Agricultural fair	M	UBE
	Regional fair (*Kalter Markt*)	R	UBE
Social Organizations (Personal*)	Environmental organizations	R	o
	Women's groups	M	UBE
	Men's groups	M	UBE
	Sports & Gym	M	UBE
	Music/Singing/Dance	M	UBE
	Carnival	M	UBE
	Culture, not music	M	UBE
	Hiking/Alpine club/Nature	M	UBE
	Gun club/Firing/Hunting	M	UBE
	Religious group	M	UBE

* Four aggregate categories used in Fig. S7.

and $n = 64$ is the number of social contact groups. For changes in social contacts, a reported increase, decrease, and no change in contacts are assigned, respectively, a value of +1, −1, and 0, and values are added up by group and respondent.

We use a cluster analysis to examine whether there are differences in social contact patterns between farmers in large and intensive *vs.* smaller and less intensive farms (Section 3.3). We use the k-means method to group respondents into two clusters based on farm size (SAK) and output intensity (GVE/LN) (Section 3.3). We then use a Welch two-sample *t*-test to compare both groups based on social contact frequency, changes in social contacts, and farm characteristics. We use a Pearson Chi square test to assess whether both groups are distributed similarly across farm types and elevation (S5). The number of observations in the cluster analysis after removing missing data is $N = 101$.

The cluster analysis does not allow us to control for multiple regressors at a time. Thus, we conduct a regression analysis to examine the relationship between social contact patterns and a larger set of variables representing farm and farmer characteristics (Section 3.4). We use Ordinary Least Squares (OLS) linear regression to assess social contact frequency across nine social contact categories, changes in social contacts across the same categories, social contact diversity, and share of local contacts as a function of farm and farm manager characteristics. We use the 1–4 weighting scheme for social contact frequency in order not to assign an excessive weight to weekly and daily contacts, but we also estimate regression models using the 1–365 weighting scheme to assess results' sensitivity to weighting.

The choice of independent variables used in the cluster and regression analyses (Table 2) is based on the literature (Besser et al., 2017) and authors' experience in the region. We include farm managers' age, years living in the farm, years managing the farm (experience), years of formal education, number of courses taken in the last five years, and number of times seeking advice by extension services in the last five years. We further define a binary variable indicating a high level (more than three years) of formal agricultural education. We do not include gender (see Data Collection above). Variables capturing farm-level characteristics include farm size and intensity, elevation, number of household members living in the farm, number of household members working on the farm, presence of employees or apprentices, non-agricultural income, agritourism activities, organic certification, local origin ("Echt Entlebuch") label, and the fraction of Q1 and Q2 ECAs over total agricultural area.

Because the three measures of farm size (workload, livestock units, and agricultural area) are highly correlated and we wish to understand the separate effect of farm size and intensity, we use Principal Component Analysis (PCA) to obtain uncorrelated measures of overall farm size (FarmSize_PCA), output intensity (FarmIntensity_PCA), and workload

Table 2
Independent variables used in the analysis. Values refer to 2017.

Variable	Description	Values or Range	Mean (SD)
SAK	Standardized workload (*Standardarbeitskräfte*)	0–3.7	1.3 (0.7)
GVE	Standardized livestock units (*Grossvieheinheiten*)	0–55	22 (13)
LN	Agricultural area (*Landwirtschaftliche Nutzfläche*), ha	44–179	17 (8.5)
FarmSizePCA	Farm size measure based on PCA scores	−1.5–2.1	0 (0.66)
WorkloadPCA	Workload intensity measure based on PCA scores	−0.41–0.51	0 (0.13)
FarmIntensityPCA	Output intensity measure based on PCA scores	−0.6–0.9	0 (0.25)
Q1	Q1 ecological compensation areas, ha	0–5.5	1.1 (1.0)
Q2	Q2 ecological compensation areas, ha	0–10	1.8 (2.1)
Q1_fraction	Q1/LN*100, %	0–39	6.6(6.0)
Q2_fraction	Q2/LN*100, %	0–51	9.9 (10)
Label_Organic	Organic certification label Bio Suisse	1 = Yes ($N = 11$), 0 = No ($N = 91$)	–
Label_EE	Local origin label Echt Entlebuch	1 = Yes (N = 11), 0 = No (N = 91)	–
Agritourism	Presence of agritourism activities (binary)	1 = Yes ($N = 7$), 0 = No ($N = 95$)	–
Age	Age of farm manager	20 = 20–35; 36 = 36–50; 51 = 51–65; 66 = Over 66	39 (11)
Experience	Number of years managing the farm	1 = 1–4; 5 = 5–15; 16 = 16+	11 (6)
YearsLivingFarm	Number of years living in the farm	1 = 1–4; 5 = 5–15; 16 = 16+	14 (4)
Edu	Formal agricultural education	1 = Minimum; 2 = 2 Years; 3 = 3 Years; 4 = HFP/FA; 5 = HF; 6 = College or University	2.9 (1.2)
Edu01	More than three years of formal agricultural education (binary)	0 = Edu categories 1–3, $n = 74$ 1 = Edu categories 4–6, $n = 28$	0.27 (0.45)
Courses	Number of courses (continued education) taken in last 5 years	0–6	1.0 (1.6)
Advice	Number of advice (extension) services received in last 5 years	0–6	0.9 (1.5)
LivingInFarm	Family members living in the farm	1 = Alone; 2 = Couple; 3 = With parents; 4 = With children; 5 = With parents and children	3.8 (1.0)
WorkingInFarm	Family members working in the farm	1 = Alone; 2 = Couple; 3 = With parents; 4 = With children; 5 = With parents and children.	3.5 (1.1)
Employees	Apprentices and/or employees (hired labor) on the farm (binary)	0 = Neither ($N = 87$); 1 = At least one apprentice and/or employee ($N = 15$*). (*at least one apprentice: n = 6; at least one employee: n = 7; at least one apprentice or employee: n = 2)	–
IncomeNonAg			24 (28)

(continued on next page)

Table 2 (*continued*)

Variable	Description	Values or Range	Mean (SD)
	Non-agricultural income, Swiss Francs	0 = 0; 1 = 1–20 k; 21 = 21 k – 40 k; 41 = 41 k – 60 k; 61 = 61 k – 80 k;	
81 = 81 k – 99 k; 100 = 100 k+			
Farm type	Dairy cow (*Milchkuh*)	DairyCow ($N = 44$)	–
	Suckler cow (*Mutterkuh*)	SucklerCow (N = 15)	
	Mixed cattle (*Rind gemischt*)	MixedCattle (N = 10)	
	Pigs (*Veredelung*)	Pig ($N = 5$)	
	Goats, sheep, or horses	Sheep_Goat (N = 6)	
	Combined, cattle and pigs/poultry	Combined (N = 13)	
	Other (mixed cattle and/or other animals)	Other (N = 9)	
Agricultural (elevation) Zone	Mountain zone 1	Zone_1 (N = 28)	–
	Mountain zone 2	Zone_2 ($N = 48$)	
	Mountain zones 3 & 4	Zone_34 ($N = 26$)	

PCA = Principal Component Analysis; SD = Standard deviation; HFP/FA = Höhere Fachprüfung/Berufsprüfung mit Fachausweis (professional examination), HF=Hochfachschule (college).

intensity (Workload_PCA) (S4).

We assume that social contacts might be influenced by the type of farming system. To control for this factor, we categorize farms based on livestock composition following the Swiss farm typology (Hoop and Schmid, 2016), yielding seven farm types, including 44 dairy cow farms (*Milchkuh*), 15 suckler cow farms (*Mutterkuh*), and 10 mixed cattle farms (*Rind gemischt*) mostly dedicated to veal mast, in all of which cattle exceeds 75% of GVE; 5 pig farms, i.e., where pigs exceed 50% of GVE (*Veredelung*); 6 farms where goats, sheep, or horses exceed 50% of GVE; 13 combined farms with cattle and over 25% pigs or poultry, and 9 "other" farms that do not meet the classification criteria. Of these, four are mostly dedicated to suckler cow husbandry, two are predominantly dairy cow farms, one raises mostly mixed cattle, and two farms have other animals. We use farm type as an independent variable in the regression analysis and examine the distribution of groups across farm types in the cluster analysis.

In the regression analysis, we do not include the independent variable years living in the farm because of its correlation with experience, and similarly we remove the number of household members living in the farm because of its correlation with household members working on the farm. We do not arcsine-transform the share of local contacts, as recommended by Wilson et al. (2010), as it does not improve normality or symmetry of the distribution. All variables in the regression and cluster analysis are centered (by subtracting the sample mean) and scaled (by dividing by the sample standard deviation), except for binary variables, which are centered but not scaled (Schielzeth 2010). We use adjusted-R2 and the Akaike Information Criterion (AIC) to evaluate model fit. The number of observations in the regression analysis after removing missing data is $N = 96$.

All data analyses and sample generation are conducted using the R statistical language and environment (R Core Team, 2019); we use the *kmeans* function in the *cluster* package for the cluster analysis (Maechler et al., 2019), and the *lm* and *princomp* functions in the *stats* package in base R for the OLS regression and the PCA analysis, respectively.

3. Results

In this section, we first present an outline of changing farm structures in the period between 2012 and 2017, followed by an overview of farmers' social connections in 2017 and their changes over the last two decades, assessing patterns in large and intensive farms, and across farm types and farmer characteristics.

3.1. Farm structures and changes

Agricultural census data for 2012 and 2017 shed light on farm-level structural changes in the five-year period preceding the survey. Among surveyed farms, standardized workload (SAK) effectively increased by 6% on average, driven by average increases of 5% in agricultural area (LN) and 3% in livestock units (GVE). Output intensity, calculated as the ratio of livestock units over agricultural area (GVE/LN), increased by 1%, or 3% excluding ecological compensation areas (ECAs). Workload intensity (SAK/LN) increased by 2% with respect to 2012 levels. Almost three quarters (72%) of the expansion in agricultural area was due to increases in ECAs. However, whereas the average fraction of Q1 areas decreased slightly from 7.0% (±5%) in 2012 to 6.6% (±6.0%) in 2017, the Q2 fraction increased from 7.0% (±5%) to 10% (±10%).

3.2. Social contact frequency, changes, and reasons for changes

Farmers in the UBE have frequent and predominantly local contacts with family (outside the farm proper), friends, and colleagues, which take place mostly on a daily or weekly basis (Fig. S-1) and on average 65 times a year with colleagues and 60 times a year with family and friends (Fig. 2). Contact frequency with farmers outside the UBE is roughly six times lower than with local colleagues. Professional contacts take place 53 times a year, a majority of which are commercial contacts (36 times), for example with local retailers like dairies or butchers (17 times) or with agribusinesses (14 times). Farmers participate in traditional social organizations—in particular, singing, dancing, and music groups—and social events, such as frequenting restaurants or attending religious services, on average 64 times a year, divided evenly between social organizations and events. Participation in agricultural organizations occurs on average 13 times annually. Administrative contacts with cantonal or federal government offices have the lowest frequency, occurring on average 8 times a year. The most frequent social contacts—private contacts with family and friends and participation in social events—have suffered the largest drop since 2000 (Fig. 2). Participation in social organizations has remained relatively constant, with shifts between organizations. Administrative contacts, especially with agricultural reporting and controlling agencies, have increased, as have contacts to agribusinesses. Engagement in farmers' organizations has also increased slightly.

The most frequently mentioned reasons for changes in social contacts is having a higher workload (75% of respondents) and, closely connected, having less time (57%) (Fig. 3). Changes in social contacts are also attributed to changes in farm household composition (such as children leaving) (66%), or to decreasing farm numbers in the region (39%). While around 40% of respondents indicate that they find social contacts to be more important than previously, a similar number (34%) report that people are now less interested in cultivating social contacts.

Qualitative interviews provide additional insights into the dynamics of social and structural change in the region. Worsening macroeconomic conditions—most importantly, the declining prices for meat and milk—induce farmers to produce more. Growing farms, livestock numbers, economic activities, and administrative burden increase farmers' workloads. In a context of limited and expensive farm labor, growing mechanization through the acquisition of tractors or milking and other machinery raises farmers' labor productivity, but also their level of debt. Beyond mechanization, some farmers are turning towards activities with a lower labor intensity than traditional dairy cow farming, such as veal mast or extensive dairy farming, as well as off-farm employment. Worsening economic conditions and more erratic weather patterns are sources of growing stress. Growing workloads and longer working hours contribute to the feeling that "everything moves faster" and that "there is no free time". As a result, social contacts have become "more targeted"—for example, text messages or brief phone calls have replaced longer and "untargeted" daily phone calls.

Changing macroeconomic conditions and farm structures have

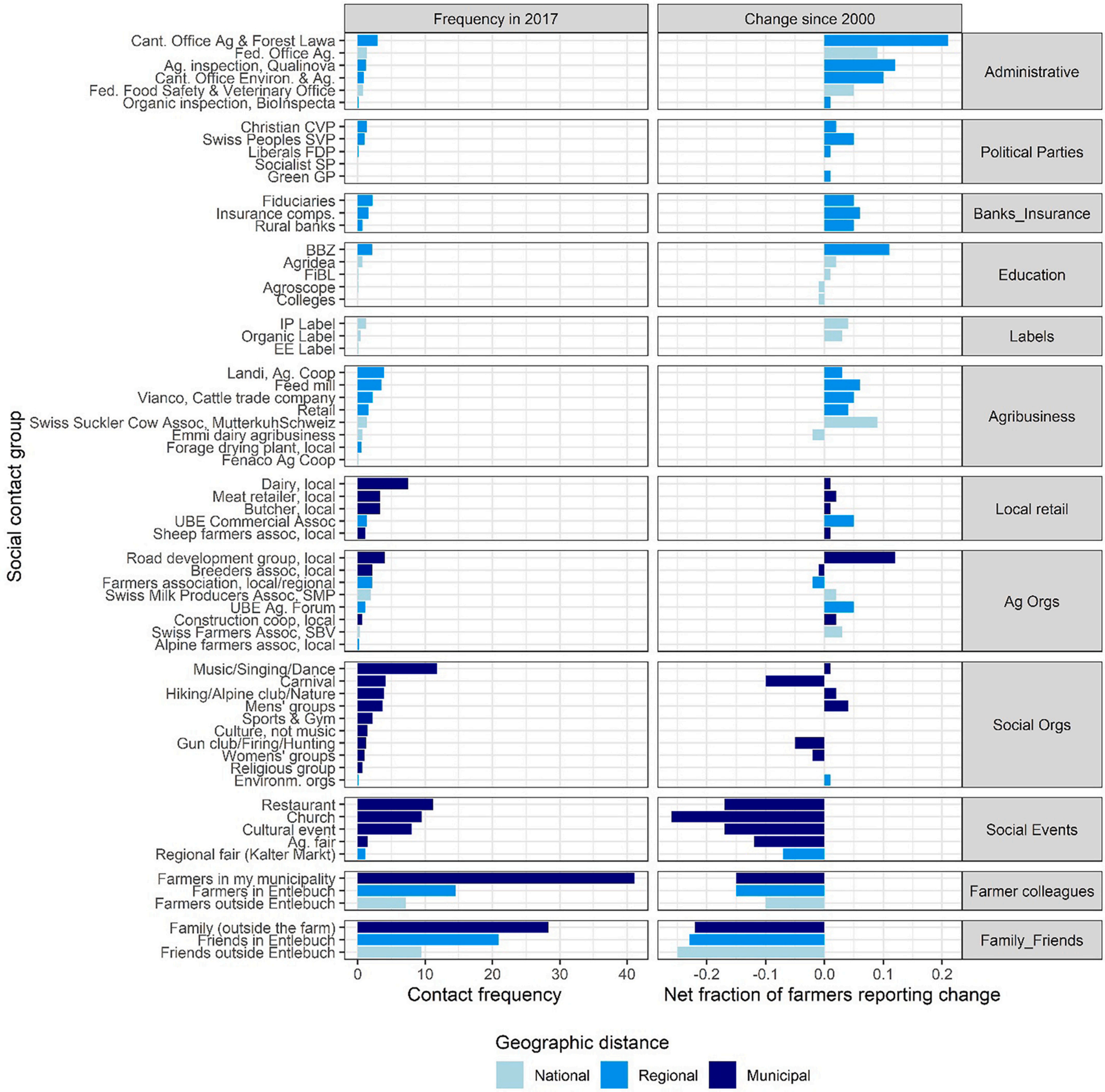

Fig. 2. FREQUENCY: Current (2017) annual frequency of social contacts (weighted from 1 = annual to 365 = daily) by social contact group, averaged across respondents. CHANGE: Change in social contact frequency (+1 = increase, 0 = no change, −1 = decrease) since the year 2000, averaged across respondents (values represent the net fraction of farmers). Colors indicate geographic distance.

affected many areas of social life in important and subtle ways. Social exchanges, such as restaurant outings with friends and neighbors, and participation in all kinds of social and agricultural events have declined in frequency and time allocated to each activity. Farmers now shop for groceries weekly or biweekly at the supermarket rather than buying bread daily at the bakery, which constituted a place for social interaction. And whereas dairy farmers used to gather daily or twice-daily at the central milk collection point in the village, this practice has now been replaced by farm-level milk collection by truck. Online processes have made administrative tasks more efficient but have also eliminated opportunities for social exchange by replacing in-person transactions in local meeting places, during which "you would drink a beer and talk to your colleagues while you waited". "Fence line conversations" between neighboring farmers are increasingly rare, as are cooperation and reciprocal help. For example, whereas families frequently exchanged childcare services, the fact that more parents now have off-farm jobs makes this increasingly difficult, which in turn requires families to send their children to costly daycare centers. Farmers also hardly exchange labor or machinery anymore and feel that they are more and more "each to their own".

3.3. *Cluster analysis: social contacts in large and intensive farms*

To analyze social contact patterns of large and intensive farms we use

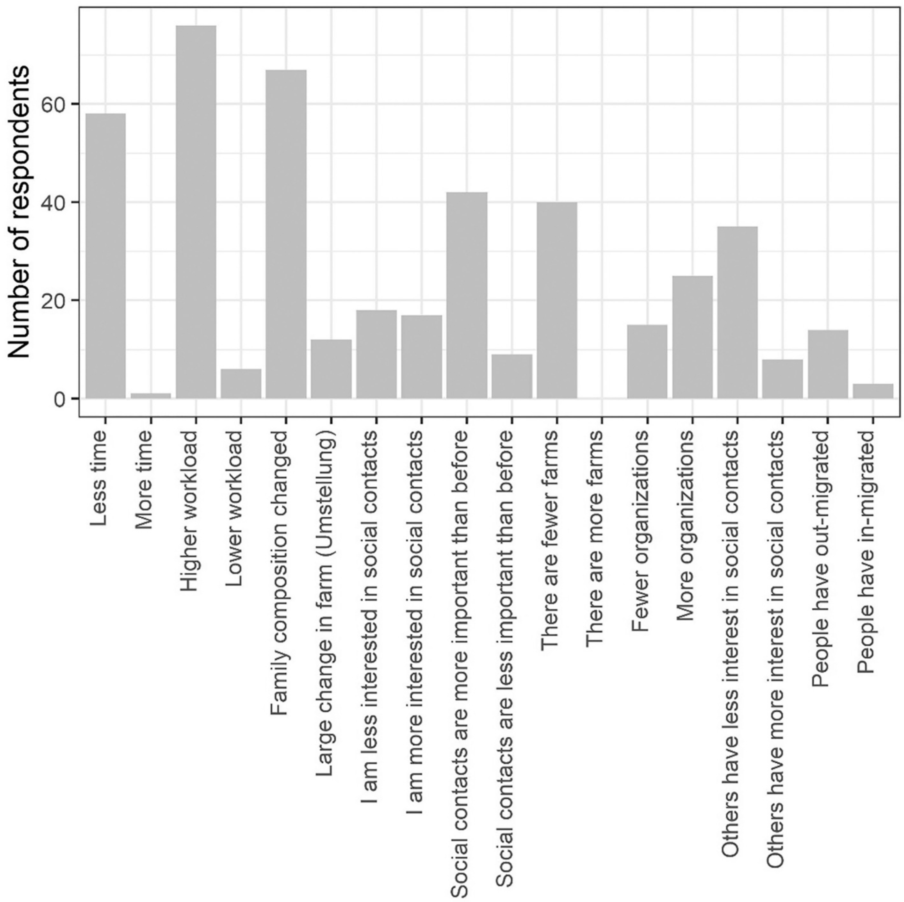

Fig. 3. Reasons for changes in the frequency of social contacts since the year 2000 (fixed responses; multiple answers were allowed). Y-axis indicates number of affirmative responses out of a total of $N = 102$ respondents.

a cluster analysis to group farms based on a measure of farm size (SAK) and output intensity (GVE/LN), yielding N1 = 47 Group 1 farms (larger and more intensive) and N2 = 54 Group 2 farms (smaller and less intensive). Group 1 farms have more family members who live and work in the farm, more employees or apprentices, and lower non-agricultural incomes than Group 2 farms. Group 1 farm managers also have more years of farm management experience, more years of formal agricultural education, and have participated in more continued education courses over the last five years (2012–2017) (Fig. 4C; Table S5-C).

Farmers in Group 1 have a higher diversity of social contacts and a higher overall frequency of social contacts (Fig. 4A; Table S5-A). Group 1 social contact frequencies are higher across all social contact categories except family and friends. The differences between the two groups are larger among professional than personal contacts and only significant ($p < 0.1$) for agribusiness, local retail, administrative, and educational contacts. Bivariate plots of social contact frequencies against output intensity and farm size measures (Fig. S7) similarly show that farmers in larger farms and farmers in more intensive farms have a higher frequency of professional—particularly commercial—contacts. Contacts with colleagues exhibit a correlation with output intensity but not with farm size, and personal contacts do not appear to be correlated with farm size or intensity.

Changes in social contacts are also different in both groups. Group 1 farmers evidence higher losses in overall social contacts, including higher losses in personal contacts (significant for social event participation) and significantly higher losses in contacts with colleagues than Group 2 (Fig. 4B; Table S5-B). In fact, Group 2 farmers report no net changes in contacts with colleagues, whereas Group 1 farmers report a large decrease (Table 3).

Pearson Chi squared tests reveal that farms in both groups are not distributed similarly across farm type and elevation (S5). Around two thirds of dairy, mixed cattle, suckler cow, and other farms are in Group 2; all combined (cattle and pig) and most sheep, goat, and horse farms are in Group 1; and pig farms are approximately evenly distributed. Farms in elevation zones 1 and 2 are evenly distributed among both groups, whereas 77% of farms located in the highest elevation zones (3 and 4) are in Group 2. This uneven distribution could have a confounding effect on the interpretation of group-level differences. However, regression results show heterogeneous contact patterns among farms that are predominantly represented in one or the other group, suggesting that differences in social contacts between Groups 1 and 2 are not due to differences in farm type or elevation zone.

3.4. Regression analysis: Relationship between farm(er) characteristics and social contacts

Regression models provide additional insights by controlling for farm-level variables. Adjusted R2 values range from 0.11 to 0.24 for models of current social contact frequency (Fig. 5A), from −0.1 to 0.14 for models of changes in contact frequency over the last two decades (Fig. 5B), and from 0.06 to 0.2 for models of social contact diversity and share of local contacts (Fig. 5C). The scaling scheme (1/2/3/4 or 1/12/52/365) for social contact frequency does not substantially affect the size, direction, and significance of results (see regression tables in S2).

Controlling for agricultural area and livestock number, higher workloads (WorkloadPCA) are strongly correlated with less frequent contacts with family, friends, and colleagues. Yet workload-intensive farms have more frequent contacts with local retail (Fig. 5A) and a

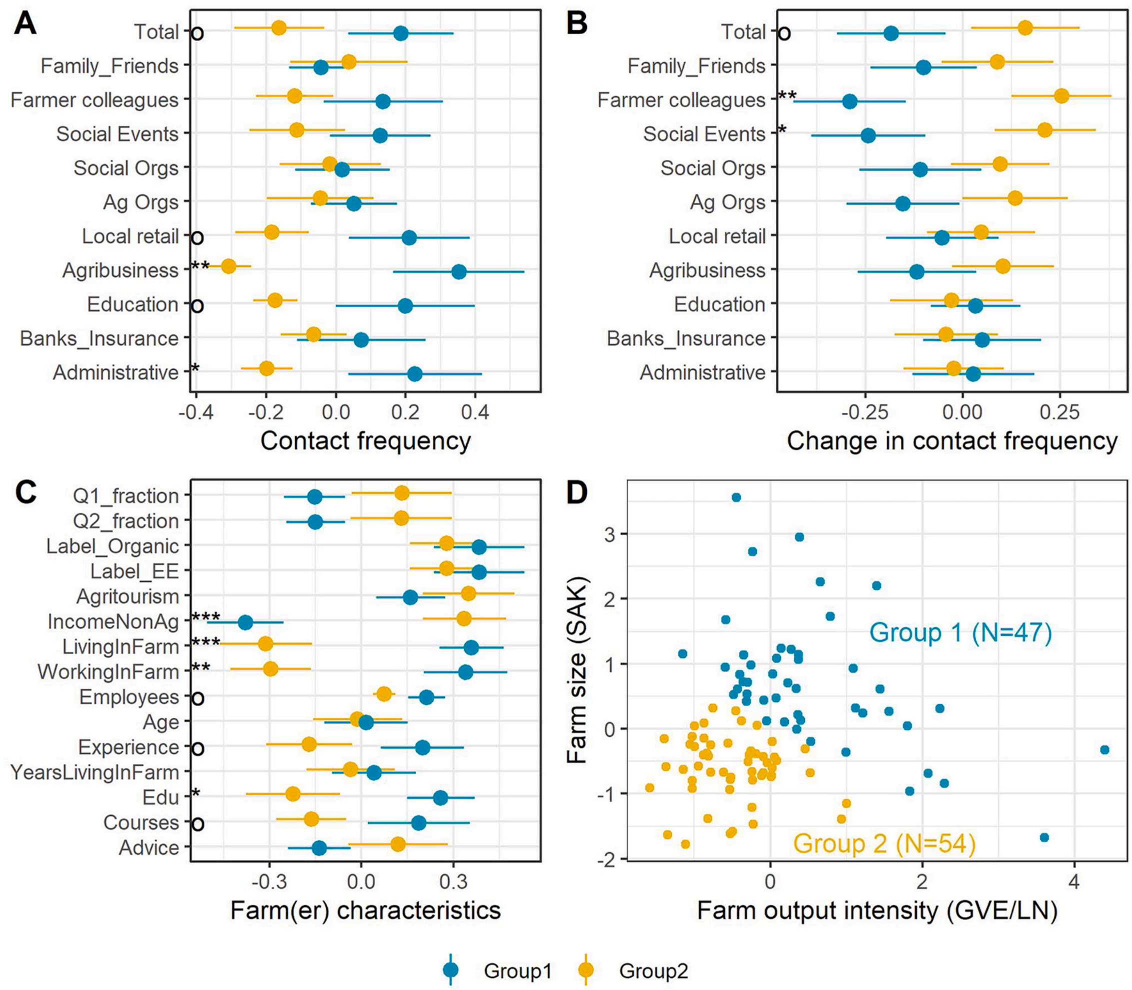

Fig. 4. (A) Current (2017) social contact frequency and (B) change in social contact frequency since the year 2000 across social contact categories for farmers in Group 1 (larger and more intensive farms) and Group 2 (smaller and less intensive farms), resulting from the cluster analysis (D). (C) Differences between the groups across farm-level variables. All variables are standardized (centered and scaled). Bars represent the standard error (SE) of the mean, calculated as $SE = SD/\sqrt{N}$, where N is the group size and SD is the standard deviation. *p*-values: *** < 0.005, ** < 0.01, * < 0.05, o < 0.1.

larger share of "hyper local" contacts within the municipality (Fig. 5C). This could point at a connection between workload intensity and the production and local commercialization of value-added goods and services, such as direct marketing of farm products, which count towards farms' standardized workload values (BLW, 2022b). Output intensity (FarmIntensityPCA) is not correlated with current social contact frequency, but more output intensive farms have gained more contacts with agricultural organizations and local retail over the last two decades (Fig. 5B). In farms with one or more employees, managers report larger gains—or smaller losses—in contacts with colleagues.

A high level of formal education is correlated with more frequent contacts with educational institutions (Fig. 5A). Surprisingly, high levels of formal education also correlate with larger losses in contacts with family, friends, and colleagues over the last two decades (Fig. 5B). Course participation, however, is correlated with gains in contacts with family and friends, and more frequent current exchanges with family, friends, and colleagues. Seeking advisory services (Advice) is inversely correlated with social contact diversity (Fig. 5C). Participation in social events and organizations has decreased most among older managers (Fig. 5B). Farmers who have taken over the farm more recently (lower experience) have a higher diversity of social contacts, and social contact diversity is also inversely correlated with non-agricultural income (Fig. 5C).

The effects associated with the organic and local origin (EE) labels have opposite signs—negative for organic farms and positive for EE farms—for contact frequencies with family, friends, local retail, and participation in social events (Fig. 5A). Because these interactions occur predominantly at a local level, organic farmers also have a lower share of local contacts, although this effect is not significant at $p = 0.1$ (Fig. 5C). Farms offering agritourism services have above-average contacts with local retail, exhibit above-average participation in events and organizations (significant only for social organizations) (Fig. 5A), and have a higher social contact diversity (Fig. 5C).

Farmers at higher elevations (zones 2–4) do not appear to be socially or professionally isolated compared to zone 1 farms. Higher elevation farms report above-average participation in social events (significant for zone 2) and contacts with educational institutions (Fig. 5A), and larger increases in contacts with agribusiness, educational institutions, and social and agricultural organizations (significant for zone 3) (Fig. 5B). Farms in zones 2–4 also have more frequent contacts with banks and insurance companies than farms in zone 1.

There are no obvious patterns in social contacts among different farm types (Fig. 5A). Among these, suckler cow farms have closer ties to agribusiness and combined farms have closer ties to local retail. Goat, sheep, and horse farms report fewer contacts with family, friends, colleagues, and lower social event participation (significant for family and friends only) compared to dairy cow farms. Pig farmers report large increases in contacts with banks and insurance companies over the last

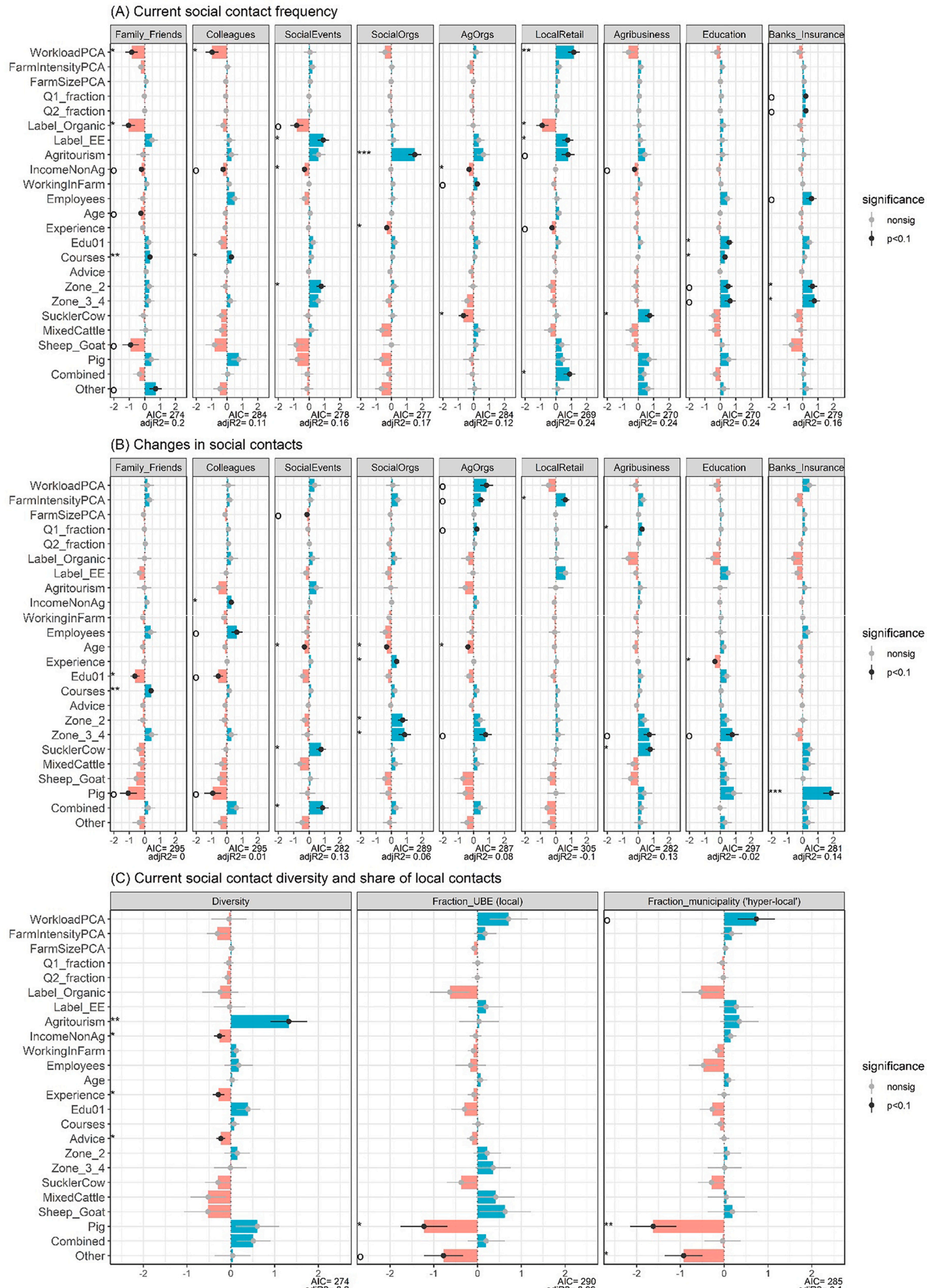

Fig. 5. Regression results: (A) current (2017) social contacts and (B) changes in social contacts (since 2000) across nine social contact categories. (C) Current (2017) social contact diversity calculated using the Shannon diversity index, share of local contacts (within the UBE), and share of "hyper-local" contacts within the municipality. Explanatory variables (rows) are farm(er) characteristics. Bar length and color represent, respectively, regression coefficient value and sign (red: negative; blue: positive). Pointrange bars indicate standard error of regression coefficients; color indicates significance level (black: $p < 0.1$). p-values: *** < 0.005, ** < 0.01, * < 0.05, o < 0.1. Regression results tables are shown in the supplementary data (S2). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

two decades and large losses in contacts with friends, family, and colleagues over that period (Fig. 5B). Pig farmers also have a lower share of local contacts (Fig. 5C).

4. Discussion

We report on a survey of 102 farming households in a Swiss rural mountain region with a large predominance of family farms. Our findings have several implications for our understanding of farm-level social and structural dynamics and their connection with the broader macroeconomic and policy context.

4.1. Social contact trends and patterns

Farmers in the UBE have diverse social networks, with a high, but decreasing frequency of personal contacts and lower, but increasing frequency of commercial and administrative contacts. Compared to the year 2000, farmers have less frequent contacts with colleagues, family, friends, and they participate less frequently in social events. At the same time, administrative, commercial, and professional non-commercial contacts have increased, likely because of higher administrative burdens and growing demand for—and dependence on—high-intensity inputs and breeds, and related information needs.

Our hypothesis that social contact losses have been more severe across dairy cow and cattle farms is not confirmed; rather, a majority of these farms falls into the category of smaller and less intensive farms ("Group 2") in the cluster analysis, which report fewer losses in social contacts. Furthermore, our hypothesis that farms at higher elevations are more socially and professionally isolated compared to lower-elevation farms is also not confirmed; the regression analysis shows that higher-elevation farms report larger gains—or smaller losses—in social event participation and commercial contacts, and cluster analysis results suggest that this might be connected to the fact that these farms are smaller and less intensive. Finally, our results suggest a certain social isolation among goat, sheep, and horse farms, possibly because traditional farms retain a closed-knit network forged over time that is not prevalent among the new "exotic" farms not dedicated to cattle farming.

Organic farms appear to have more regionally dispersed professional networks, whereas those with the local origin (EE) label exhibit stronger local connections. Organic farms constitute a minority in Entlebuch's rural society and are still considered—like goat or sheep farms—"outsiders" by most. Consequently, they may be drawn to regional and national networks with like-minded farmers, similar to what has been reported for no-till farmers (Skaalsveen et al., 2020). Yet farmers offering agritourism activities—a relatively new and still rare business model—evidence frequent local engagement in social organizations, strong connections to local retail, and a high diversity of social contacts, which presumably include their suppliers and guests. This combination of local "bonding" ties and "bridging" ties across social and professional fields has been linked to farm-level innovation (Cofré-Bravo et al., 2019), including rural tourism (Saxena, 2006), and suggests a relationship between economic and social contact diversification.

4.2. Are large and intensive farms coping better?

Farms in the UBE have undergone important structural changes in the five-year period between 2012 and 2017. Strong increases in farm size (+5%) and farm output intensity (+1% overall and + 3% outside ecological compensation areas) reflect growing macroeconomic pressures and the need to produce more tied to the dismantling of production quotas and price supports (Stock et al., 2014) and the decline or stagnation of milk and meat prices (Haller, 2014, p.10-11). Trends are similar in other developing countries, where farm size has increased by roughly 50% between 1960 and 2000 (Lowder et al., 2016).

Hence, a central question is whether large and intensive farms exhibit different social contact patterns and trends compared to smaller and less intensive farms. Our results suggest that this is the case. Larger and more intensive ("Group 1") farms have more frequent social contacts across the board—except contacts with family and friends, which have similar frequencies in both groups—and more diverse social contacts. Similar to Albizua et al. (2020), we also find that larger and more intensive farms have closer ties to commercial actors, in this case agribusiness companies and local retail, presumably because these farms have a higher dependence on inputs, specialized breeds, and technology. Our findings further suggest a higher level of administrative complexity in these farms. Group 1 farmers also have more frequent contact with educational institutions, which may evidence a higher need for information to keep up with changing technology and regulations, and could help explain Albizua et al. (2020)'s conclusion that intensive farmers act as central sources of farming knowledge in the community. In Group 1 farms, higher levels of household and hired labor, lower shares of off-farm employment, and perhaps higher levels of mechanization and automatization (Finger et al., 2019) may afford farm managers more free time to engage socially and professionally. From a local farmer's perspective, higher yields, efficiency, and mechanization might symbolize "good" or "successful" farming and afford farm managers reputational gains that ultimately translate into higher levels of social capital across personal and professional networks (Burton et al., 2005; Burton, 2004).

Despite their higher overall social contact frequency and diversity, managers in large and intensive farms also report higher overall *losses* in social contacts over the last two decades. In particular, these managers have lost more personal contacts and especially more farmer-to-farmer contacts. In fact, managers in smaller and less intensive farms ("Group 2") report no net losses in contacts with colleagues, which indicates that such losses are concentrated among Group 1 farms. These results suggest a growing individualization especially among farmers in large and intensive farms, which could be tied to the streamlining of farming tasks and growing reliance on expensive machinery, thereby reducing the need for—and benefits of—cooperation and "neighboring" (Burton et al., 2005; Sutherland and Burton, 2011). This is also underscored by survey respondents' perception that "people are now less interested in cultivating social contacts" and interviewees' perceptions that farmers are increasingly "each to their own". Taken together, our findings suggest that managers of larger and more intensive farms have more—but also more rapidly declining—levels of social capital within personal, farmer, and professional networks.

Finally, our findings do not align with those of Besser et al. (2017), who find that smaller farm size correlates with a larger number of close personal contacts and a larger share of local contacts. We find no differences in personal contact frequency and share of local contacts between Group 1 and 2 farmers. Moreover, our aggregate measure of farm size is not correlated with social contact frequency, diversity, or share of local contacts.

4.3. Rising workloads and decreasing informal contacts

Our findings point at strong increases in perceived and standardized workloads among surveyed farms. Standardized workloads (SAK) represent only an approximate measure of real workload, as they do not account for activities that do not qualify for direct payments, such as administrative tasks or off-farm employment. Nevertheless, the 6% increase in SAK—associated in large part with growing farm size and intensity—reflects a real increase in farmers' workloads. Because most farms in this region cannot afford to hire external employees due to the high cost of labor—only nine out of 102 farms employ external labor—growing workloads fall largely on the farm household. Growing off-farm employment rates (BFS, 2021, p.13) accentuate this problem. For farms that are able to hire workers, managing a growing workforce is also associated with additional time burden (Kingwell, 2011). Growing workloads translate into less available free time, both of which are mentioned in the survey as the main reasons for changes in social contacts over the last two decades. We show that a higher workload intensity is negatively correlated with informal contacts with family, friends, and colleagues, suggesting that labor and time shortages impinge most strongly on these “non-essential” contacts. That farms with more employees report fewer losses in contacts with colleagues supports these conclusions

4.4. Parallel intensification and extensification within the farm

Between 2012 and 2017, farm-level expansion of agricultural area in the UBE was largely (72%) driven by increases in ecological compensation areas (ECAs), in particular more stringent and ecologically valuable Q2 areas. At the same time, the intensity of managed plots also grew, leading simultaneously to intensification and extensification within the farm. This suggests an economically “efficient” mode of production whereby expanding farms optimize set-aside compensation areas without sacrificing productivity by intensifying production on actively managed parcels within the remaining farm. Our study suggests the mechanisms that lead to this within-farm “polarization” of production intensity, namely that under a limited workforce, and given the imperative to optimize revenue streams, including subsidies, productive areas are intensifying, while subsidized compensation areas are also expanding, particularly in lower-quality land (Herzog et al., 2005).

The development of expanding ECAs with simultaneous intensification of farming is in line with the Swiss agricultural policy goals of increasing productivity and competitiveness while preserving biodiversity (BLW, 2020b). However, the overall effect of these changes on biodiversity and other ecological indicators is still uncertain. On one hand, intensification is a main cause of biodiversity declines in rural areas (ECA, 2020) and it is associated with mainly negative impacts on ecosystem services (Rasmussen et al., 2018). On the other hand, rural biodiversity studies in Switzerland have found a positive correlation between biodiversity and ECAs, and in particular Q2 ECAs (Birrer et al., 2007; Knaus, 2017; Meichtry-Stier et al., 2014; Meier et al., 2021, p.74). A nation-wide assessment of rural biodiversity has been recently launched in Switzerland, but changes and trends have not yet been published (Meier et al., 2021).

4.5. Implications for farm-level resilience

Our results point to an erosion of social capital in the UBE. Social capital—in the form of trust, common rules, mutual obligations, and connectedness—promotes the exchange of information and other resources (such as labor and machinery), facilitates collaborative action, and as a result has a positive effect on economic and community development, social cohesion, public goods provision, and environmental management (Burton et al., 2005; Sutherland and Burton, 2011). Social capital is embedded in informal relations with family, friends, and neighbors; semi-formal systems such as organizations, clubs, and other special interest groups; and more formal relationships with businesses, education institutions, or government offices (Bubolz, 2001; Burton et al., 2005). Among these, informal and semi-formal systems are the most important for family farmers (Bubolz, 2001). As we show, growing workloads and time constraints impinge most strongly precisely on these “non-essential” social interactions. Challenging macroeconomic conditions may also intensify competitiveness among farmers and further erode networking (Stock et al., 2014). That the changing social contact patterns are most pronounced among larger and more intensive farms suggests that these trends are likely to worsen in the future.

Beyond their effect on social contacts, growing workloads may reach a point where they are no longer viable or “livable” (Milestad et al., 2012). While family farmers' flexible use of family labor and capital is an important element of farm-level resilience (Van Vliet et al., 2015), farmers' ability to cope with increasing workloads is subject to the constraints of household labor availability and the financial feasibility of hiring labor (Huber et al., 2015). Above a certain threshold, growing workloads may ultimately trigger a disruptive change in the succession of a family farm (Huber et al., 2015; Sutherland et al., 2012).

As farmers reduce their social exchanges with neighbors and colleagues, they may use other sources of farming information and guidance, such as agribusinesses, government offices, rural savings and credit banks, insurance companies, and educational and extension institutions—such as, in this case, the local agricultural college. Lacking domain-specific knowledge or being confronted with complex problems sometimes induces farm managers to seek costly farm advisory services. We find that the use of such services is inversely correlated with social contact diversity, suggesting that one of the functions of social contact diversity is to provide informal farm management advice.

The progressive shift from personal to commercial, and from local to more regional and national influences, coupled with increasingly “atomized” farmers who engage less frequently with their colleagues and neighbors, could undermine the creation and exchange of local knowledge and the emergence of locally-adapted innovations in farming in the longer term. Policymakers should recognize the essential role of local information exchange and cooperation, diverse social contacts with different degrees of formality, and social diversity in the resilience of rural areas to global change (Darnhofer et al., 2016; Grêt-Regamey et al., 2019), and should be aware of the mechanisms through which structural changes and growing workloads can undermine these diverse networks.

This work demonstrates the contribution of social network analysis to the understanding of resilience mechanisms. Rural resilience to macroeconomic or climatic stressors can be seen as resulting from the coexistence of—and balance between—social, environmental, and economic capitals (Wilson, 2010). Our results point at the tradeoffs between these capitals and suggest the mechanisms underlying such tradeoffs: we show that farmers' efforts to increase economic efficiency have a “spillover effect” on social and environmental capital by compelling farmers, in turn, to increase the “efficiency” of their social and environmental interactions. The result is a progressive transformation of social relations, which become more targeted, less frequent, and involve fewer informal exchanges with colleagues and close personal relations—all of which, we argue, decrease social capital. Environmental efficiency, on the other hand, leads to larger set-aside areas but more intensive farms overall, with yet unknown overall effects on environmental indicators. With growing efficiency through growing simplification and less redundancy, the resilience of farms is likely to suffer (Folke et al., 2021).

4.6. Limitations

This study has some important limitations. First, data sets are not completely aligned. We measured changes in social contacts over the period 2000–2017 and structural changes between 2012 and 2017 because of limited availability of older agricultural census data. Second, our dataset is small, constrained by the size of the case study area, thus limiting the goodness of fit and significance of the regression analysis and group comparison in the cluster analysis. Third, selection bias is a potential limitation. Farmers who returned our survey may have social network, personal, or farm-level characteristics that are consistently different from those farmers who did not return the survey—for example, they may have more free time. While we are not able to ascertain this kind of selection bias, we find that other farm-level characteristics (elevation zone and farm type) among sampled respondents are not different from sampled non-respondents and from UBE farmers overall. Fourth, recall bias is also a potentially important limitation in a survey that asks participants to recall data from the year 2000. For this reason, we asked about changes in social contacts using only three categories (increase, decrease, and no change), rather than using a more detailed Likert scale. Finally, it is important to contextualize our findings. The Entlebuch area has relatively homogeneous family farm households, rather than a large spread between small farms *versus* large agribusiness corporations. Part of the contrast between our findings and those of other studies (Albizua et al., 2020; Besser et al., 2017) may stem from the different distribution of farm size and intensity.

5. Conclusions

Growing and intensifying farms in the UBE are a reflection of structural changes in agriculture in Switzerland and globally. Our fine grained study of changing social relations and farm structures sheds light on the links between social, environmental, and economic resilience in rural areas dominated by family farms. Farmers in the UBE have diverse social networks, with a high, but decreasing frequency of contacts with family, friends, and colleagues and lower, but increasing frequency of commercial and administrative contacts. Farms are becoming larger and more intensive, in part by increasing ecological compensation areas while intensifying farming on remaining land. Such an approach may optimize returns to labor and may constitute a model of local success. However, growing farms and growing management and administrative complexity, coupled with the unaffordability of hiring workers, raise farmers' workloads and increase time pressure. This impinges on farmers' "non-essential" social contacts most. Yet these informal contacts with family, neighbors, colleagues, and participation in social events may be central for farmers' ability to cope with challenges. The shift from local personal contacts to regional and national professional contacts could also undermine local knowledge exchange and innovation, moving away from locally adapted practices and giving rise to more intensive and standardized models of production.

The alarming drop in farm numbers in the UBE by 17% in fifteen years (2003–2018) reflects the vulnerability of farms in this region. At the same time, stable population numbers reflect the resilience of the region as a whole – for example, through the adoption of value-added labels and services such as agritourism, organic certification, and local origin labels. To steer rural development towards long-term sustainability, policy makers at local to national levels should recognize the essential role of social contact diversity, local information exchange, and cooperation in fostering the resilience of rural areas to global change. Regional and local institutions could foster social contacts and information exchange among farmers, e.g. by organizing on-farm events, creating spaces for spontaneous meetings, or supporting diverse associations in rural areas. Policy makers should also consider the links between structural changes—growth and intensification of farms—and changes in social and environmental capital. Importantly, transformations in social relations may unfold slowly, which warrants analyses that employ a multi-year perspective. Thus, policy actions should more rigorously consider the short- and long-term interconnections and tradeoffs between human, social, economic, and environmental capitals in rural areas. Effective policies to support farm resilience, rural livelihoods and biodiversity will require a local to regional understanding of how farmers (re-)construct personal and professional social networks in changing rural socio-economic systems and under increasingly competitive macroeconomic conditions.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.agsy.2022.103435.

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