DIRECT PAYMENTS AND ON-FARM EMPLOYMENT: EVIDENCE FROM A SPATIAL REGRESSION DISCONTINUITY DESIGN

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Abstract

Direct payments are regarded as a suitable instrument to safeguard jobs in the agricultural sector. However, empirical findings to date do not unambiguously support this expectation. We further empirically investigate this research question on dairy farms under weak identifying assumptions using a spatial regression discontinuity design. The Swiss direct payments system creates a discontinuous jump near the border of agricultural production zones for the amount of public subsidies a farm receives. We find that an additional CHF 50,000 can generate a job for a female family worker in the dairy sector. Male employment is not affected. These results show that direct payments can safeguard traditional family farming.

Keywords

direct payments, on-farm employment, dairy farming, spatial regression discontinuity design, Switzerland

1 Introduction

Direct payments are found to slow down the structural change in the agricultural sector (BREUSTEDT and GLAUBEN, 2007; KEY and ROBERTS, 2006), an effect for which they are often criticized. However, direct payments may also safeguard on-farm employment as these payments reward the provision of public goods and serve as income support for lower paid jobs in the agricultural sector (e.g. MANN and LANZ, 2013; PETRICK and ZIER, 2012, for Switzerland or the European Union). E.g., in Switzerland the median labour income of a farm family worker amounts to about 60,000 Swiss francs (valley region) while in the second and third sector the median salary is about 15,000 Swiss francs higher (FOAG, 2020). Since the argument of a decent agricultural entrepreneurial income is furthermore relevant for the security of supply of food and the development of rural areas (FINGER and EL BENNI, 2021; WUEPPER et al., 2021), policymakers frequently use it to defend public expenditure for farming (EUROPEAN COMMISSION, 2017).

Strengthening employment outside of urban regions is especially important in predominantly rural countries like Switzerland in which commuting to larger towns with better job opportunities is often time-consuming. From an international perspective, Switzerland is also one of those countries that highly subsidizes the agricultural sector (OECD, 2015). Thus, the question arises if government expenditure can truly enhance employment prospects.

Following neoclassical theory, an increase of direct payments that are completely decoupled from production like a lump-sum payment lead to a parallel upward-shift of a household's budget constraint. Thus, overall employment (off- and on-farm) is expected to decrease through an income effect (AHEARN et al., 2006; EL-OSTA et al., 2004). KEY and ROBERTS (2009) explain that this decline will reflect in off-farm employment as farm households optimize on-farm labor supply such that the value marginal product of labor equates the off-farm wage rate irrespective of the household's income. When including non-pecuniary benefits from farming in the optimization problem, their model shows that on-farm employment increases while labor supply off-farm decreases. Beyond that, GARRONE et al. (2019) emphasize the role of other channels than income like investment in capital, land or education to describe the effect of direct payments on employment. Deviating from the assumption of perfect markets, there might be also other reasons why workers do not reduce labor supply, e.g. mobility constraints or transaction costs.

These suggestions may be also a good explanation why empirical findings differ. Several articles analyze the decoupling effect of the Common Agricultural Policy (CAP) in the

European Union. A grassland support in Sweden is found not only to have a positive effect on jobs in the agricultural sector (NORDIN, 2014), but also on jobs off the farm (BLOMQUIST and NORDIN, 2017). Similarly, RIZOV et al. (2018) estimate positive off-farm employment effects of decoupled subsidies for small and medium-sized enterprises. PETRICK and ZIER (2011) explain that decoupled payments have the potential to release labor and find a negative impact on on-farm employment in Germany (PETRICK and ZIER, 2011, 2012). The same can be found for France (DUPRAZ and LATRUFFE, 2015).

Another explanation for different empirical findings is the variety of econometric methods used in these articles implying different identifying assumptions and parameters of interest that are estimated. E.g., PETRICK and ZIER (2011) use an estimator that allows for time-constant unobserved heterogeneity. Endogeneity issues may for example arise whenever the amount of direct payments a farmer receives is a strategic decision that depends from management skills. If these skills cannot be observed and also affect the on-farm labor demand, then the estimate will be biased under selection on observables assumptions. In this article, we exploit the implementation of the Swiss direct payments system and apply a spatial regression discontinuity (RD) design that needs weak identifying assumptions (e.g., IMBENS and LEMIEUX, 2008; LEE and LEMIEUX, 2010). Our analysis focuses on dairy farms as a labor-intensive farm type of which each year about two percent abandon farming and about one percent changes to the more labor-extensive suckler cow husbandry (ZORN and ZIMMERT, 2020). In contrast to prior studies, we use detailed farm-level data instead of data sources from some more aggregated administrative unit. The data set allows to distinguish between male and female employment. This aspect has been neglected in existing literature and provides new insights.

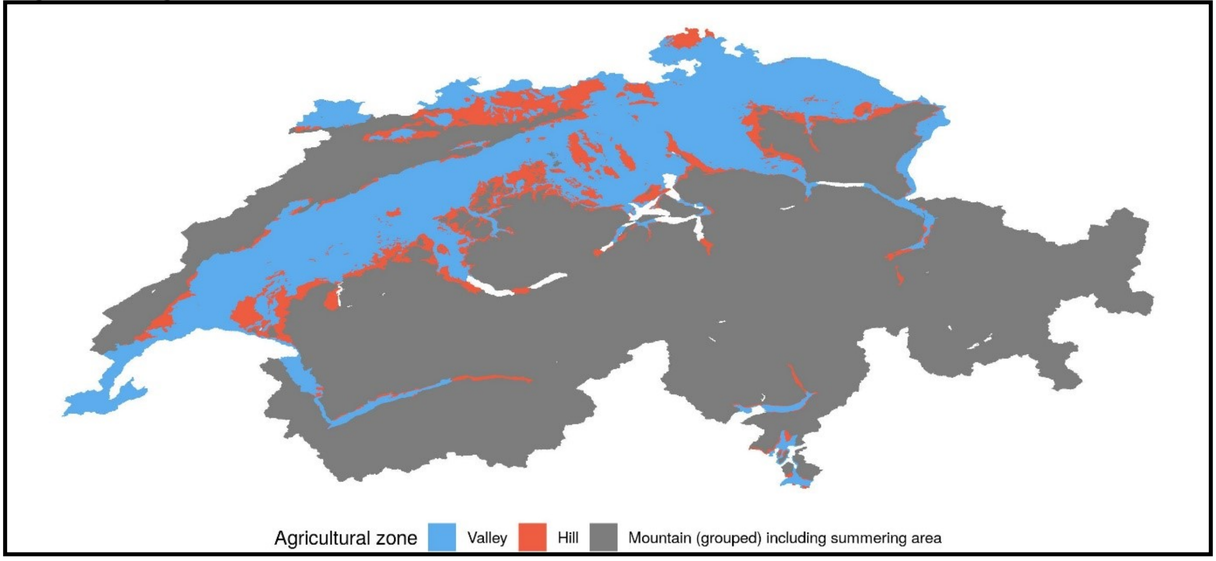
2 Empirical strategy

2.1. Effect identification

To investigate the effect of direct payments on the agricultural employment we exploit the implementation of the Swiss direct payments system and apply a spatial regression discontinuity (RD) design. The direct payments system consists of six different programs (see Table 1). In general, the amount of direct payments a farm receives not only depends on the size of the utilized agricultural area (UAA) and the number of animals, but also on the topographical zone of the UAA. The Federal Office for Agriculture (FOAG) maintains an agricultural production cadastre in which agricultural land is classified according to production conditions (climate, traffic situation/accessibility, surface design, altitude, exposure) (FOAG, 2008). Areas characterized by harder production conditions get higher subsidies especially reflected in the program for the preservation of the cultural landscape (so-called farmland payments; FOAG, 2021). In the analysis, we will use two different treatment variables; one is the amount of farmland payments only and the other the total amount of direct payments a farm receives. The discontinuity of the latter is based on the jump of the farmland payments.

Switzerland's natural space is characterized by the threefold division into the Jura, the Central Plateau and the Alps (WACHTER, 1995). The Central Plateau stretches from Lake Geneva to Lake Constance at an altitude of about 400 to 600 m above sea level. Switzerland's arable farming is concentrated on the Central Plateau (FOAG, 2020). The cadastre distinguishes between three areas, the valley, the mountain and the summering area (seasonal alpine farming). The valley area, which represents 61 % of Switzerland's UAA, is further differentiated in two zones, the valley (78 % of the area) and the hill zone (22 %, compare blue and red areas in Figure 1). The valley zone is characterized by arable farming, intensive forms of production and a relatively small proportion of biodiversity areas (FOAG, 2020). The hill zone represents a transitional area between the valley zone and the mountain region. In this climatically and in terms of accessibility favoured area compared to the mountain region, the surface design of the land, i.e. its slope limits arable farming. Livestock farming predominates in the hill zone (FOAG, 2008). The valley and hill zones are mainly located in the Swiss Plateau and its fringes with the Jura and the Alps. Our analysis focuses on these two zones since the majority of Swiss farms is located there, leading to a sufficient large sample size.

Figure 1: Agricultural zones in Switzerland



Notes: White polygons represent lakes that are not labelled as an agricultural zone. Source: Authors' illustrations using data from https://data.geo.adrin.ch/ch.blw.landwirtschaftliche-zonengrenzen/.

Let the potential outcome in dependence from treatment be denoted by $Y\,(T)$ for which we assume a linear model

$$Y(T) \equiv f(T) = \sigma_0 + T\gamma + V_0$$

where Y is the outcome variable (number of persons working on-farm) and T is the continuous treatment variable (the amount of direct payments a farm receives). σ_0 is a constant and V_0 represents an error term. Then, our parameter of interest is depicted by γ.

Under selection on observables assumptions, any estimator of γ would be biased if we cannot fully observe all relevant variables that influence T and Y. Hence, we relax assumptions and rely on an instrumental variable (IV) strategy.

In the following we restrict to two zones, the valley zone with less difficult production conditions and the hill zone with more difficult production conditions. We argue that farms with production site in different zones close to the zone boundary face similar production conditions while their direct payments discontinuously differ as a function of a running variable Z due to the design of the direct payments system. The binary indicator of farm location D serves as an instrument for the amount of direct payments T a farm receives. D takes up one if the distance to the zone boundary (the running variable Z) exceeds some threshold c and it is zero otherwise. We define the zone boundary as $c = 0$ which translates into all farms in the hill zone having a positive distance to the boundary ($D = 1$) while those in the valley zone are characterized by negative distance measures ($D = 0$).

Zone assignment is only a relevant instrument for the amount of direct payments if both are highly correlated. The direct payments system determines that plots in the valley zone are not eligible for farmland payments designated for the maintenance of cultivated landscape. Plots in the hill zone, on the contrary, are eligible for 100 Swiss francs per hectare of UAA as a contribution to maintain an open landscape. Additionally, they are also eligible for payments for farming on steep slopes: 410 Swiss francs per hectare of UAA with a slope of 18 to 35 %, 700 Swiss francs for more than 35 to 50% slope and 1000 Swiss francs for more than 50% slope. As farms may have plots of UAA in several zones, our RD design is not of sharp nature, but can be called fuzzy.

The key assumption in an IV design is that D must not be directly correlated with Y conditional on observables X, but only affects Y via T. I.e., the IV estimator uses that part of the variation in T which is induced by the instrument. In general, the farm site may be a relevant predictor for on-farm employment if one thinks of more difficult production conditions that demand for higher labor input. However, with the RD approach we limit the farms to a small region around the zone boundary such that the production conditions are likely to be very similar and only T discontinuously differs.

2.2. Estimation

To obtain the parameter of interest we use two-stage least squares (TSLS) and estimate the following two equations for the subset $c - h < Z \leq c + h$ with h being the chosen bandwidth around the zone boundary and $\hat{T}$ representing the vector of the predictions of Equation (3):

$$\text{1st stage: } \mathrm{T} = \tau_1 + D\varphi + \mathrm{Z}\lambda_1 + X\delta_1 + V_1 \qquad (3)$$

$$\text{2nd stage: } \mathrm{Y} = \tau_2 + \hat{T}\gamma + \mathrm{Z}\lambda_2 + X\delta_2 + V_2 \qquad (4)$$

τ_1 and τ_2 are constants, V_1 and V_2 error terms. HAHN et al. (2001) show that the TSLS estimator without controls can be numerically identical to an estimator of the RD estimand or local Wald ratio. We also estimate this proposition with local linear regression and find very similar results. In this short version, however, we do not show the findings.

3 Data

We use farm level data from the Federal Office for Agriculture (FOAG) on the years 2014 to 2016 (FOAG, 2018). The data originates from the administration and management of the direct payments and contains information on the farm, its labor force, the farmed area and animal data. The panel dataset corresponds to a census of all Swiss farms that receive direct payments. Our analysis focuses on the most important Swiss farm enterprise, dairy, and includes specialized dairy farms and combined farms with a focus on dairy production.[1] We further restrict to farms that cultivate at least one hectare farmland. Finally, we have 26,437 observations from 9,760 farms.

As outcome variables we use the number of family workers (including the farm operator), differentiating between male and female persons. The data collection distinguishes three different categories of employment: less than 50 %, 50 to 74 % and more than 74 % of a full-time equivalent. According to the existing literature on on-farm employment, we do not distinguish between part- and full-time employment such that one part-time worker is counted as one worker (e.g., GARONNE et al., 2019; PETRICK and ZIER, 2011). Table 1 gives summary statistics of the data set. On average, 1.6 male workers and about one female worker are employed per farm. Men work on almost all farms (almost every farm has a male farm operator), while the proportion of farms with female workers is just under 80 %.

About 30 % of the observed farms are located in the hill zone. Corresponding to the specification and as already mentioned above, we use two distinct treatment variables: the total amount of direct payments a farm receives (on average 57,454 Swiss francs) and the amount of farmland payments (on average 3,214 Swiss francs). The latter is a subset of the total amount for which we can observe the largest jump at the zone boundary.

[1] We also examine only the subsample of specialized dairy farms. As the results are very similar, we use the larger sample including combined farms with a focus on dairy production.

Table 1: Summary statistics

Variable	Mean	Standard deviation
Outcome variables		
Number of male family workers	1.613	0.680
Farms with at least one male family worker (binary)	0.994	0.076
Number of female family workers	0.986	0.638
Farms with at least one female family worker (binary)	0.805	0.396
Treatment		
Farms located in the hill zone (binary)	0.296	0.457
Total amount of DP (DP _tot)	57.454	33.276
Farmland payments (maintenance of cultural landscape DP _CL)	3.214	5.044
Control variables $X1$: DP for		
biodiversity (BD	8.033	8.481
landscape quality (LQ)	1.822	2.852
production system (PS)	10.848	9.168
resource efficiency (RE)	0.467	1.115
ensuring food supplies (FS)	26.784	5.304
a socially acceptable transition (TS)	6.287	3.684
Control variables $X2$		
Utilized agricultural area (UAA) in hectare	25.990	14.583
Number of livestock units (LU) of cattle	32.265	21.731
Number of livestock units (LU) of pigs/poultry	0.627	2.618

Notes: N = 26,437. DP = direct payments measured in 1000 Swiss francs. Source: Authors' calculations with AGIS data 2014-2016.

The remaining types of direct payments are used as control variables, as these represent a good summary of the main farm characteristics. These are payments for biodiversity (BD), landscape quality (LQ), for environment / animal-friendly production systems (PS), resource efficiency (RE) payments and payments for ensuring food supplies (FS; see OECD, 2015, for a more detailed explanation). The latter payments make up the biggest part of the total amount. For a transitional period after implementing the new direct payments system in 2014, additional payments (TS) are provided. These are decreasing over time. The second set of covariates consists of structural farm characteristics such as the UAA (on average 26 hectare), the number of livestock units (LU) of cattle (on average 32 cattle) as well as those of pigs/poultry (on average less than one).

For the calculation of the running variable, we use the coordinates of the farm site and determine the Euclidean distance to the agricultural zone boundary.[2] As the farms are located in multiple polygons in the two zones (61 polygons in the valley zone, 238 polygons in the hill zone), we have more than one potential threshold. Hence, for farms located in a polygon of the valley zone ($D = 0$), the running variable is calculated as the shortest distance from the farm coordinates to the next polygon boundary of the hill zone. For farms in the hill zone ($D = 1$), the distance is calculated to the nearest boundary of the valley zone. Figure 2 shows an illustrative example for several farms each represented by a circle located in the same polygon. The white polygon belongs to the hill zone and the grey polygon to the valley zone. The shortest distance is calculated to the large grey polygon where the white polygon is located in.

[2]To calculate the Euclidean distance we use the **R**-function gDistance of the package rgeos.

Figure 2: Running variable is shortest distance from farm to next polygon

Notes: Circles represent farm coordinates in one polygon of the hill zone (white) with Euclidean distance (lines) to the nearest polygon of the other zone (grey). Source: Authors' illustrations using AGIS data 2014-2016 and data from https://data.geo.adrin.ch/ch.blw.landwirtschaftliche-zonengrenzen/.

4 Results

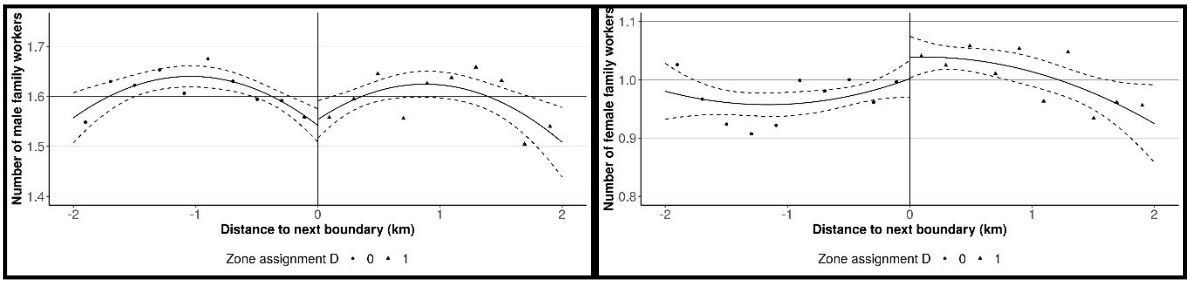
4.1. Graphical analysis

Before turning to the point estimates of the RD approach, a graphical analysis will illustrate our findings. Figure 3 shows mean values of the outcome variables by treatment status calculated for different bins of the running variable. Additionally a regression line with its confidence bands is plotted representing predictions of a regression with polynomials of order two of the outcome variable on the distance measure. The calculated means and the regression line are almost symmetric for the number of male employees. However, for the number of female employees we can detect a jump at the threshold. Treated farms have on average more female family workers.

The extent of the jump of the treatment can be seen in Figure 4. We distinguish two related treatment variables described in Section 3. For both measures the mean values discontinuously change at the threshold by about 3,000 Swiss francs.

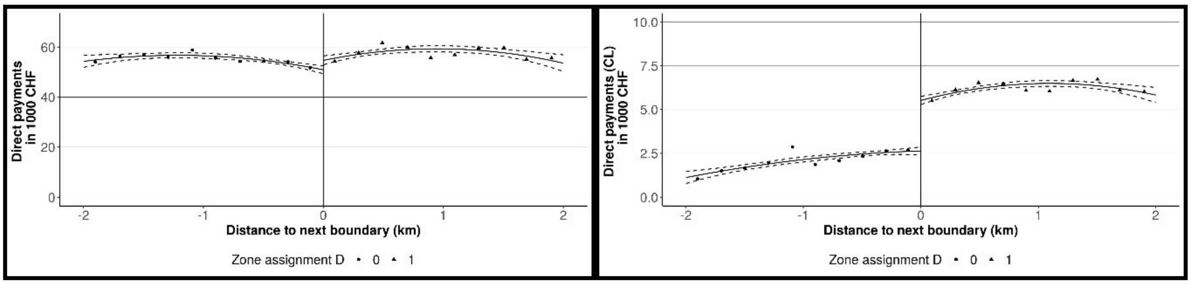
Figure 5 represents the comparative analysis between treated and control farms for the remaining types of direct payments that we use as control variables. Large discontinuities may not generally question the identification strategy, but they may hint at the necessity to condition on these control variables (IMBENS and LEMIEUX, 2008). We cannot detect any statistically significant difference suggesting that these variables are well balanced at the threshold. The same holds for the other set of control variables (Figure 5). Although farms in the valley zone ($D = 0$) get larger in terms of utilized agricultural area and the number of animals the more distant from the threshold, the means are approaching the closer to it. Thus, we can also conclude from the graphical analysis of the covariates that the manipulation at the threshold does not seem to be of concern.

Figure 3: Outcome variables



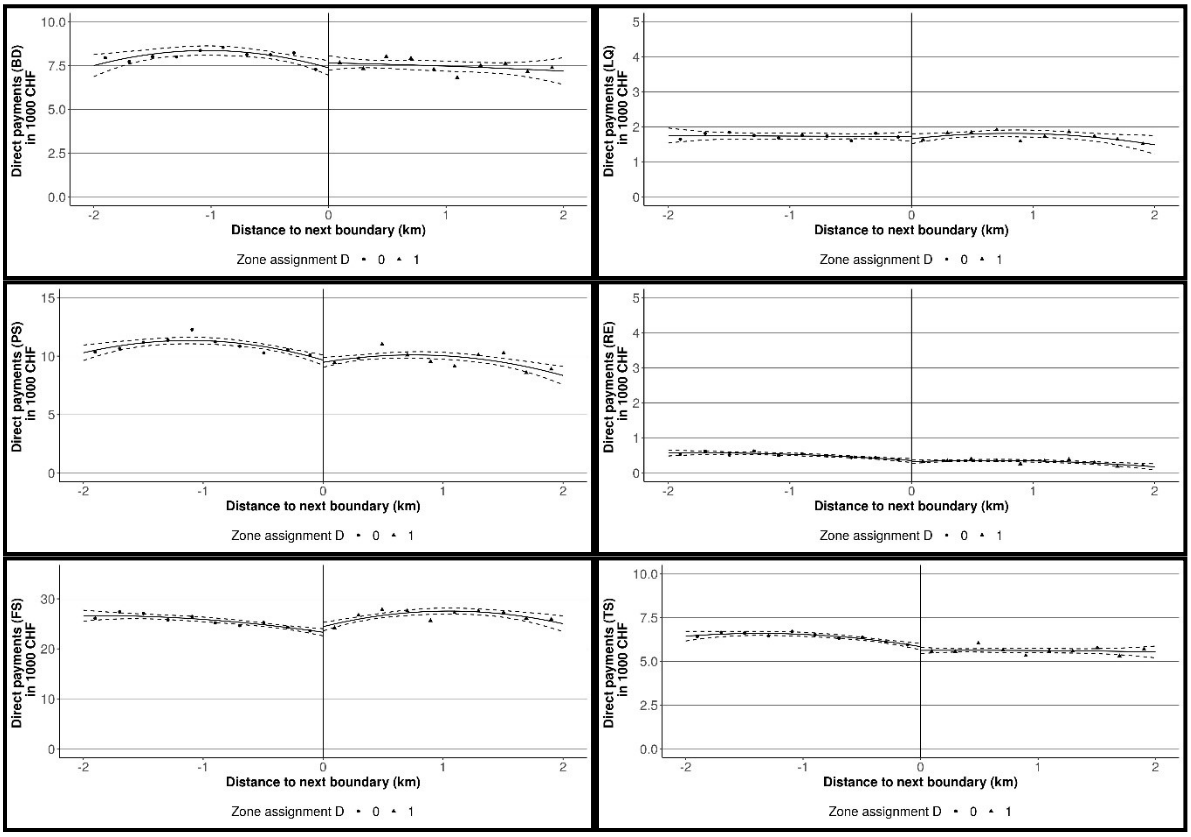
Notes: The solid line corresponds to fitted values of a linear regression on the distance measure with a polynomial of degree two. The dashed lines limit the 95%-confidence band of the fitted values. The dots represent mean values in 0.2 km bins. N = 16,249. Source: Authors' illustrations using AGIS data 2014-2016.

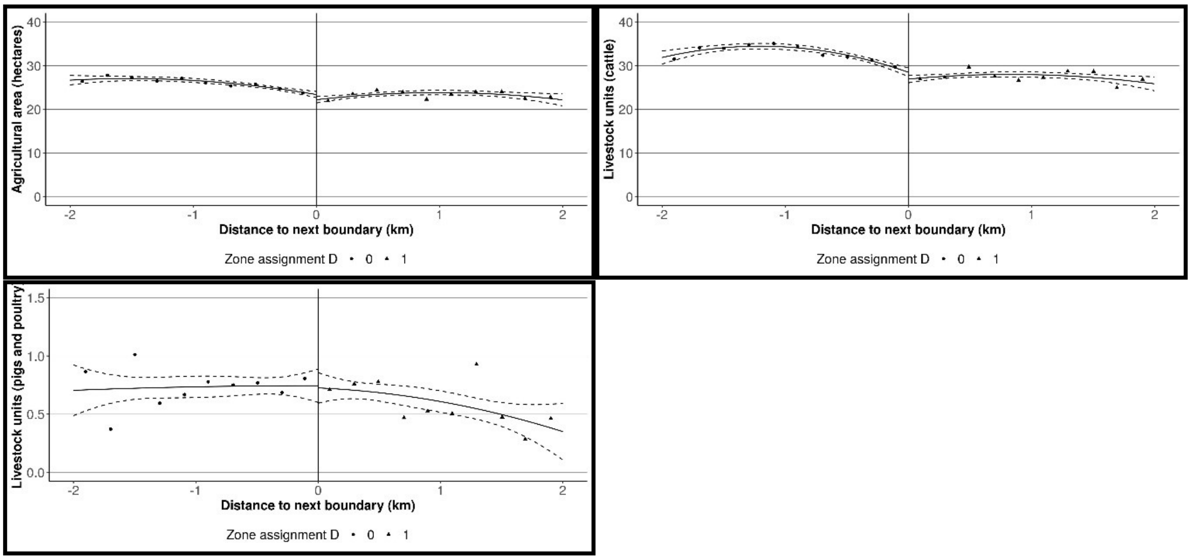
Figure 4: Treatment variables



Notes: The solid line corresponds to fitted values of a linear regression on the distance measure with a polynomial of degree two. The dashed lines limit the 95%-confidence band of the fitted values. The dots represent mean values in 0.2 km bins. N = 16,249. Source: Authors' illustrations using AGIS data 2014-2016.

Figure 5: Covariates





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4.2. Point estimates

The graphical analysis of Section 4.1 suggests a zero effect on the number of male family workers and a positive impact on female family employment. In Table 2 we provide TSLS estimates of γ for different specifications.[3] They all support the graphical findings in showing an estimate close to zero for the number of male workers and a bigger, positive effect on female employment that is also statistically significant. E.g., additional 1,000 Swiss francs of direct payments (aggregated measure DP_tot) increase on-farm employment by 0.009. When considering the amount of farmland payments (DP_CL) as treatment variable, the effect is larger and amounts to 0.014. Including control variables $X1$ (other direct payments programs) or $X2$ (UAA in hectare, LU of cattle, LU of pigs/poultry) slightly changes the effect size. Thus, we conclude that our estimates are quite robust to including controls or not.

As the parameter of interest is a *local* effect (i.e., at the threshold), our estimates may differ for more distant values of the running variable. Though, a direct comparison with the findings of NORDIN (2014) who uses an instrumental variable strategy shows that the results are quite similar. He concludes that a grassland support of additional 250 000 Swedish krona (about 25 000 Euro) generates one job. In our setting additional 50,000 Swiss francs (about 45,000 Euro) of farmland payments generate a job for a female family worker. For specialized dairy farms in the Swiss valley area (i.e. in the valley and hill zone), this amount corresponds to a share of about 85 % of the average annual remuneration per family work unit during the period 2017-2019 (FOAG, 2020).

Table 2: TSLS estimation results of fuzzy RD design

Estimates for	**Number of family workers**			
	1st order polynomial		**2nd order polynomial**	
	Men			
γ_{DP_tot}	0.002	(0.004)	0.001	(0.005)
$\gamma_{DP\_tot,X2}$	0.003	(0.003)	0.003	(0.003)
γ_{DP_CL}	0.004	(0.007)	0.001	(0.007)

[3] In this short version, we do not show the results of the first stage. They show a large positive and statistically significant estimate for φ.

$\gamma_{DP\_CL,X1}$	0.002	(0.008)	0.001	(0.008)
$\gamma_{DP\_CL,X2}$	0.007	(0.006)	0.006	(0.006)
h	1.139		1.139	
N	12,133		12,133	
		Women		
γ_{DP_tot}	0.009	(0.004)	0.012	(0.005)
$\gamma_{DP\_tot,X2}$	0.007	(0.003)	0.008	(0.003)
γ_{DP_CL}	0.014	(0.006	0.017	(0.006)
$\gamma_{DP\_CL,X1}$	0.018	(0.007)	0.021	(0.007)
$\gamma_{DP\_CL,X2}$	0.014	(0.006)	0.017	(0.006)
h	1.512		1.512	
N	14,050		14,050	

Notes: TSLS regression with the R-package AER. γ is the estimate of (4) in different specifications. Control variables $X1$: DP for biodiversity (BD), landscape quality (LQ), production system (PS), resource efficiency (RE), ensuring food supplies (FS) and transitional payments (TS). Control variables $X2$: UAA in hectare, LU cattle, LU of pigs/poultry. Bandwidth (h) choice as in IMBENS and KALYANARAMAN (2012). Standard errors in parentheses. According to the choice of h and the chosen kernel, the number of observations N changes. Source: Authors' calculations with AGIS data 2014-2016.

5 Discussion and conclusion

This article analyzes if direct payments affect on-farm family employment. We find significant positive effects on female family employment. This effect applies to the total of direct payments and is even larger considering farmland payments only. Male family employment, on the contrary, is not affected.

These different findings for male and female family workers may be surprising at first glance. However, since 99 % of the farms considered employ a male family member and the majority of Swiss farm managers are male, additional family employment applies to the partner (spouse). Hence, we conclude that direct payments may safeguard traditional family farming. The effect size amounts to one additional family workforce on the farm generated by 50,000 Swiss francs (about 45,000 Euro) of farmland payments for a job on-farm which is quite in line with findings for Sweden (NORDIN, 2014).

These findings are especially relevant for dairy farming implying constant and intensive workload. Cows must be milked twice a day, which implies long working days. Hence, our findings regarding the positive effect of direct payments on the family workforce can translate into a workload relief for farmers. At the same time, agricultural income per family work unit in Switzerland is particularly low in dairy farming (HOOP et al., 2019). For this reason, amongst others, with the exception of the farm managers, the majority of family members working on-farm are not regularly employed and thus neither receive a classical salary nor are subject to social security contributions. This affects female family members disproportionately (CONTZEN and KLOSSNER, 2015) which is an important issue, as women can play an important role for the development of rural areas, particularly for farm diversification in service activities (EUROPEAN PARLIAMENT, 2016).

Besides, our findings are interesting in the context of further aspects. I.e., the support of family farming may have also implications for other outcomes. Firstly, regarding its effect on rural unemployment, WUEPPER et al. (2021) uncover a negative relationship between family farms and unemployment based on a regression with cross-sectional data. Using a panel data regression, this effect disappears. They attribute this finding to different cultural characteristics of the population and conclude that supporting small farms is not effective for a sustainable development of rural labor markets.

Beyond these considerations, small family farming is often regarded to be more environmentally sustainable. However, WUEPPER et al. (2020) show for Germany that this hypothesis cannot be unambiguously supported and hence, the authors' findings question again the implications of family farming.

After all, the positive employment effects of our analysis show that the farmland contributions can be an effective tool with respect to various direct or indirect objectives of Swiss agricultural policy (FEDERAL ASSEMBLY SWITZERLAND, 2021). By safeguarding adequate farm incomes, they strengthen rural (female) on-farm employment and may also contribute to the objective of a decentralized settlement of the country.

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