Culture and Agricultural Biodiversity Conservation

Yanbing Wang * Sergei Schaub David Wuepper Robert Finger

Agricultural Economics and Policy Group, ETH Zürich, Zürich, Switzerland

* Corresponding author.
Address: Sonneggstrasse 33, 8092 Zürich, Switzerland;
E-mail addresses: yanbwang@ethz.ch (Y. Wang), seschaub@ethz.ch (S. Schaub), dwuepper@ethz.ch (D. Wuepper), rofinger@ethz.ch (R. Finger).

Culture and Agricultural Biodiversity Conservation

Abstract

Agriculture is a main source of environmental degradation and biodiversity decline. We investigate the causal effects of culture on pro-environmental behaviors of the agricultural population (farmers), and how policy instruments interact with culture to influence individual behavior. We exploit a unique natural experiment in Switzerland, which consists of two parts. First, there is an inner-Swiss cultural border between German- and French-speaking farmers who share the same natural environment, economy, and institutions, but differ in their norms and values. Second, in 2014, there was an unexpected and vast agri-environmental policy reform that increased the monetary incentive to enroll land into biodiversity conservation. Using a spatial difference-in-discontinuities design and panel data of all Swiss farms between 2010 and 2017, we show the following findings: Before the reform, farmers on the French-speaking side of the cultural border systematically enrolled less land into biodiversity conservation, compared to the German-speaking side. With increased monetary incentives following the 2014 policy reform, the French-speaking farmers enrolled more additional land than the German-speaking farmers, shrinking the discontinuity. These findings indicate that cultural effects on pro-environmental behaviors are more important when external incentives are relatively low, and with increased economic incentives, cultural differences become less important. We discuss the implications for research and especially for policy.

Keywords: biodiversity, conservation, culture, environmental behavior, agri-environmental schemes, result-based schemes

JEL codes: Q57, Q18, Q28

1. Introduction

Agricultural and food systems are main sources of environmental degradation and biodiversity decline globally, and also in Europe (e.g., Foley et al., 2011; Leclère et al., 2020; Pe'er et al., 2014). Agri-environment schemes (AES) are a key policy instrument to encourage farmers to switch to more environmentally friendly practices and contribute to more sustainable agriculture. Despite a history of over three decades of AES in Europe, the effects of such schemes in improving environmental quality remain mixed (e.g., Cullen et al., 2018; Mann, 2018; Uthes & Matzdorf, 2013; Wuepper & Huber, 2021). Most AES in Europe provide payments to farmers to reward their provision of ecosystem services and compensate for the income foregone and additional cost incurred in order to comply with higher environmental and ecological standards. The success of an AES depends on incentive schemes that effectively trigger farmers' participation. Crucial to the effectiveness of incentive schemes is how well the incentives match with farmers' preferences, which, shaped by farmers' social and cultural background, determine farmers' decision-making (Dessart et al., 2019). Indeed, previous literature has indicated that farmers' response to pro-environmental policies depends on their social and cultural background (Rode et al., 2015; Wuepper, 2020; Zemo & Termansen, 2021), highlighting the importance of placing agri-environmental policymaking in the cultural context.

In this study, we investigate the role of culture in farmers' response to incentives under biodiversity-conserving AES. We leverage a unique setting at the inner-Swiss French-German language border, where different native languages represent different cultural backgrounds within common political and economic frameworks. The within-country cultural difference, combined with a country-wide policy reform in Switzerland in 2014 that substantially increased AES payments, creates a unique natural experiment to evaluate the effects of culture on farmers' response to increased incentives for biodiversity conservation that is free of confounding institutional effects. We analyze more than 3,500 farms near the inner-Swiss French-German language border from census panel data of over 51,600 farms over an eight-year period in a spatial difference-in-discontinuities framework.

Previous literature shows that farmers' participation in AES depends on their preferences and perceptions of the schemes (e.g., Dessart et al., 2019; Rode et al., 2015). However, a recent review of AES programs in Europe also reveals large mismatches between program design and farmers' preferences, which limit the effectiveness of AES (Tyllianakis & Martin-Ortega, 2021). Such mismatches highlight the importance of tailoring policy design to capture farmers' preferences. The complexity in farmers' preference in terms of AES participation arises because participation decision goes beyond the economic or financial dimension faced by an individual farmer. Rather, it is embedded in the broader social and cultural context (Kuhfuss et al., 2016; van Dijk et al., 2016; Villamayor-Tomas et al., 2019). Social and cultural backgrounds shape farmers' demand for compensation for pro-environmental practices, and how farmers interpret payments offered under AES (Rode et al., 2015; Zemo & Termansen, 2021). To better understand farmers' preference in this regard, recent research on farmers' provision of environmental goods and services has placed more attention on behavioral factors and highlighted the importance of accounting for the cultural and social context that shape farmers' behavioral characteristics in agri-environmental policy design and evaluation (see Dessart et al., (2019) for a review).

The relationship between individuals and the natural environment is influenced by their social and cultural environment, which shapes the values, mindset, and norms in a community of common cultural and social background. For farmers, such influences manifest in how they use natural resources such as land and water, and their intrinsic motivations to conserve resources and adopt pro-environmental practices (Kolinjivadi et al., 2019; Van Hecken et al., 2019). With monetary compensations, AES provide farmers with extrinsic motivations to provide environmental public goods.[1] Farmers' response towards AES depends on how they perceive the monetary incentives, which is shaped by their social and cultural backgrounds (Rode et al., 2015). In other words, social and cultural background influence how extrinsic motivations from the AES interact with farmers' intrinsic motivations to provide environmental public goods. Several studies have shown that cultural and social background shapes a population's environmental attitudes and pro-environmental behaviors (e.g., Litina et al., 2016; Schumacher, 2015; Steg, 2016; Videras et al., 2012). However, in the context of agricultural practices, empirical evidence on how cultural and social backgrounds could influence one's response to extrinsic incentives for pro-environmental behavior remains largely qualitative (e.g., Burton et al., 2008; Taylor & Grieken, 2015; Warren et al., 2016), while quantitative evidence is still limited (e.g., Wuepper, 2020).

While culture is a multi-dimensional concept, language serves as a meaningful proxy of culture. As the basis of communication, common language forms the premise for individuals to develop social relationships and social norms. Social interactions shape and spread the preferences, values, and beliefs of individuals that share the same native language, from which a common social identity is developed. Language also carries the preferences, values, and beliefs down from one generation to the next, maintaining consistency in the social identity over time. As such, differences in the behaviors across language groups reflect cultural differences (e.g., Eugster et al., 2011; Filippini & Wekhof, 2021). Previous literature has documented differences in economic behavior and preference across language groups, for example, risk attitudes, savings

[1] In addition to monetary compensations, which is the focus of our study, extrinsic motivation can also include non-monetary strategies such as information nudges (e.g., Kuhfuss et al., 2016).

rates, and health behaviors (e.g., Chen, 2013), among which several studies examined the language groups within Switzerland (e.g., Brown et al., 2018; Eugster et al., 2011; Herz et al., 2021). In particular, culture, proxied by a common language, shapes the environmental attitude and provision of environmental goods of individuals in the language group (Filippini & Wekhof, 2021). Existing studies exploiting the cultural effects on pro-environmental behaviors, however, primarily focus on the general population, and rigorous quantitative analysis on the behaviors of individual groups with particularly significant environmental impact, such as farmers, is still absent from the literature. Furthermore, existing literature has not considered how culture-driven behavioral differences change over time, for instance, in response to changes in economic incentives.

Our study contributes to the literature on the relationships between culture, policy incentives, and environmental behavior. We show that cultural effects on environmental behavior apply not only among the general population, but also to sub-populations with a strong common identity, such as the farming community. Moreover, we show that policy incentives can alter cultural effects on environmental behavior. Furthermore, our study contributes to the literature on biodiversity conservation and sustainable agriculture under AES. We examine how farmers from geographically adjacent cultural groups responded differently towards a policy reform that substantially increased AES payments, as well as the potential mechanisms behind the different responses. We provide quantitative evidence of the role of culture in farmers' decisions to conserve biodiversity, which buttress placing agri-environmental policymaking as well as policy evaluation in the cultural context. Conducting a cross-cultural case study within the same country allows us to avoid confounding treatment effects that arise from differences in the institutional frameworks in multi-country studies.

Our analyses reveal systematically different biodiversity conservation behaviors under AES between German- and French-speaking farmers in Switzerland, with the difference partially attributable to farm structural differences developed over time, which represent specific elements of culture. Difference in the response of farmers from the two language groups to the policy reform further indicate that increased AES payment incentives can potentially mitigate the culture-driven behavioral difference in biodiversity conservation.

The rest of this paper is organized as follows: Section 2 provides backgrounds on biodiversity conservation AES, the language regions in Switzerland, and a conceptual background of our analyses; Section 3 presents the empirical framework; Section 4 presents the data, Sections 5 and 6 reports and discusses the results, respectively, and Section 7 concludes.

2. Background

AES for biodiversity conservation

In Europe, AES were introduced in the 1990s (Kleijn & Sutherland, 2003). In Switzerland, AES were first introduced in 1992 (Curry & Stucki, 2010), and in 1993, AES specific for biodiversity conservation became available to counteract the loss of biodiversity habitats in agriculture. In the current Swiss farming systems, various direct payments, including agri-environmental direct payments, exist and those payments represent a key income component for farmers (El Benni et al., 2016). The initial biodiversity conservation AES consisted of voluntary action-based direct payments that reward farmers for land management practices that conserve biodiversity on ecological focus areas (later renamed to biodiversity promotion areas) (Mack et al., 2020). In 1999, the Swiss government introduced a minimum fraction requirement of the utilized agricultural areas to be eligible for direct payments under biodiversity conservation AES (7% for farmland and 3.5% for special crops (Mann & Lanz, 2013)). In 2001, result-based payments and agglomeration bonuses (also referred to as “network bonuses”) were introduced on top of action-based payments. In the Swiss system, result-based biodiversity conservation AES reward farmers for achieving specific biodiversity outcomes, namely occurrence of targeted indicator species, and agglomeration bonuses reward farmers for collective efforts in providing spatially connected biodiversity conservation areas (Huber et al., 2021; Krämer & Wätzold, 2018; Mack et al., 2020; Villamayor-Tomas et al., 2019). Action- and result-based payments comprise the two quality levels under the category “quality” contributions of the biodiversity conservation AES, which are fully funded by the federal government. Agglomeration bonuses comprise the “networking” category of the AES (Huber et al., 2021). Our study focuses on the quality contributions since they concern individual enrollment decisions at the farm level.

In an agricultural policy reform launched in 2014, the Swiss biodiversity conservation AES were redesigned with the objective of increasing effectiveness in biodiversity conservation. With this redesign, both action- and result-based payments increased. Given the new focus of the agricultural policy on result-oriented schemes, expansion in result-based payments was particularly substantial and applicable to large land area (Mack et al., 2020, also see Table A1 for an overview). In addition, since result-based payments primarily apply to ecological focus areas based on grassland, the redesigned payment schemes essentially place more weight on biodiversity conservation in grasslands.[2]

Since action- and result-based biodiversity conservation AES differ in the required adjustment of agricultural practices (and therefore efforts of famers), we expect that farmers perceive the two types of schemes differently and that this difference also depends on culture. Furthermore, with differences in the payment increase between the two types of AES after the policy reform, the change in the extrinsic motivation provided by the two schemes also differs. As a result, culture may play different roles in farmers’ responses to the payment increases in the two types of AES. Therefore, we separately examine farmers’ response to the policy reform in action- and result-based payment schemes.

Language regions in Switzerland

Switzerland is a linguistically diverse country with four official languages. According to official statistics in 2019, German is the native language for 62.6% of Swiss citizens, followed by French (22.9%), Italian (8.2%), and Romansch (0.5%). Each of the 26 Swiss cantons (federated states that comprise the Swiss Confederation) can determine its official language(s), and in some cantons, each municipality (a municipal unit below the cantonal level) can determine its own official language(s). As such, the Swiss language regions do not fully overlap with administrative regions. For instance, the German-French language border runs through the cantons Bern, Fribourg, and Valais (BFS, 2017).

We focus our analysis on the German-French language border because the Alps, running west-east, largely coincides with the language borders between German, Italian, Romansch language regions (see, e.g., Filippini & Wekhof, 2021). This natural barrier also leads to different climate conditions, and thus different agricultural activities. By contrast, the German-French language border runs largely north-south and does not coincide with natural barriers. Furthermore, as discussed above, a large part of this language border runs within rather than along canton borders.[3]

[2] Other landscape types to which the payment schemes are applicable include cropland and woody elements. Cropland-based ecological focus areas are only eligible for action-based payments, and woody elements are eligible for both levels of payments. Furthermore, grapes (vineyards) are eligible for result-based payments.
[3] Since apart from federal-level policies, agricultural policies only exist at the cantonal level, the effects of cantonal agricultural policies on farmers’ decision-making are unlikely to confound with cultural effects.

The Swiss language borders create natural experiments to test how culture influences behaviors independent of the political and institutional background, which eliminates confounding effects in these dimensions. Since native language is passed down in the family rather chosen by an individual, it is also unlikely for sorting to occur near the language border. Previous literature has documented empirical evidence of behavioral differences across the Swiss language regions in an array of dimensions. Examples include the preference for imported goods (Egger & Lassmann, 2015), family values and informal care for elderly family members (Gentili et al., 2017), demand for social insurance (Eugster et al., 2011), and ownership of electric cars (Filippini & Wekhof, 2021). These studies provide empirical evidence of cultural differences among the general Swiss population. However, to our knowledge, no prior study has investigated cultural differences within a profession-specific subgroup in the population such as farmers. It is possible that shared values and norms within a group of individuals with a common identity (farmers in our context) overshadows the cultural differences in the general population. Previous literature has indicated a strong self-identity shared among farmers, which could contribute to farmers' resistance to participating AES (e.g., Burton et al., 2008). In such a case, policymaking to promote biodiversity conservation would not concern cultural differences within the farming population but rather preferences from the group as a whole. In the case that cultural differences remain distinct within the farming population, preferences arise from cultural background need to be taken into consideration in policymaking.

Conceptual background

In the context of biodiversity conservation, culture may shape not only farmers' intrinsic motivations for biodiversity conservation, but also how farmers react to (changing) incentives that promote biodiversity conservation - as we discussed above. In particular, depending on the cultural context, the monetary rewards system of an AES may reinforce farmers' motivation to conserve biodiversity, or replace farmers' intrinsic motivation with extrinsic motivation (Akers & Yasué, 2019; Cinner et al., 2020; Rode et al., 2015). As is summarized in Rode et al. (2015), a lack of cultural context, and a lack of baseline information on farmers' intrinsic motivation, that is, farmers' motivation to conserve biodiversity prior to the introduction of AES payments, are major challenges in assessing the effectiveness of AES. While our study allows us to compare the behaviors of farmers with different cultural backgrounds, we still face the challenge of lacking baseline information on farmers' intrinsic motivation for biodiversity conservation, as our study period does not contain the inception period of the AES. Nonetheless, the policy reform in 2014 allows us to compare the behavioral changes between farmers of different cultural backgrounds in response to this reform. Thus, our analysis provides meaningful insights in the role of culture in farmers' conservation decisions under changing payment schemes. This is especially relevant given that AES have been established for decades in many countries, and under increasing social and environmental pressure, agri-environmental policies might expand in the future (e.g., Schaub et al., 2020). We conceptually describe the comparisons in our study below.

Consider two groups of farmers with different cultural backgrounds. Culture influences farmers' initial intrinsic motivation to conserve biodiversity and how farmers respond to monetary incentives provided under AES. Let M_{kt} denote "motivation for biodiversity conservation", and let a_{kt} be a "response parameter" to monetary incentives for cultural group k at time t. Both parameters depend on culture K, which determines the general perceptions of conservation practices and monetary incentives, but also on the constraints for conservation at a given time period. The constraints can arise from current farming practices, for instance, farms with more intensive input use face greater direct cost (e.g., from displacing labor or machinery) and greater opportunity cost since these farms are likely to be more profitable (e.g., Huber et al., 2021). These constraints could limit farmers' motivation to conserve biodiversity, especially if the monetary compensation is insufficient to offset the cost. Let B_{kt} denote the barrier to conservation in monetary terms, $M_{kt} = M_{kt}(K,\ P_t - B_{kt})$ and $a_{kt} = a_{kt}(K, P_t - B_{kt})$ for each period t from 1 up to τ. For the initial period 0 before monetary incentives are introduced, M_{k0} reflects farmers' intrinsic motivation. At $t = 1$, monetary incentives are introduced under an AES, and for each subsequent period, a change in the monetary incentives is introduced. Let P_t denote the monetary incentives at time period t. At a given time period τ, the motivation for biodiversity conservation for culture k is given by $M_{k\tau} = M_{k0} + \sum_{t=1} a_{kt}P_t$. a_{kt} reflects how farmers from a certain cultural group k respond to monetary incentives to conserve biodiversity at time t. We expect that, in general, $a_{kt} > 0$ and $\partial a_{kt}/\partial P_t > 0$, that is, monetary incentives enhance farmers' motivation, yet the magnitude of a_{kt} depends on the cultural context and the level of monetary incentives relative to the (financial) barrier to conserve.[4] Conservation effort C, and therefore the amount of direct payment received, increases with farmers' motivation up till a limiting value $\bar{C}_{kt}$: $\frac{\partial C_{kt}}{\partial M_{kt}} > 0$ and $C_{kt} \leq \bar{C}_{kt}$. $\bar{C}_{kt}$ reflects a farm's short-term adjustment potential for biodiversity conservation due to the above-mentioned constraints. In the long run, restrictions in adjustments for biodiversity conservation imposed by these constraints could be relaxed.

Since we do not observe the baseline (intrinsic) motivation, M_{k0}, a comparison in farmers' participation at any given time period reflects a combination of intrinsic motivation difference, and difference in response to the monetary incentives, both of which are culture-dependent. For two groups with different cultural backgrounds $k = k_1, k_2$, $\Delta M_\tau = M_{k_2 0} - M_{k_1 0} + \sum_{t=1}\left(a_{k_2 t} - a_{k_1 t}\right) P_t$. This comparison provides meaningful insights into the role of culture in farmers' biodiversity conservation behavior under AES. Any future adaptation of the payments would be built on the existing AES, which reflect the interactions between farmers' intrinsic motivation and previous monetary incentives. A study that compares farmers' motivation for nature conservation with and without monetary rewards found that monetary rewards mitigates the difference in farmers' motivation based on values and belief (but in absence of monetary rewards) (Lokhorst et al., 2011). Hence, we expect that $\left(M_{k_2 0} - M_{k_1 0}\right)\left(\sum_{t=1}\left(a_{k_2 t} - a_{k_1 t}\right) P_t\right) < 0$, that is, monetary incentives offered by AES may reduce the baseline cultural difference in biodiversity conservation. Furthermore, a comparison of farmers' participation decisions across time periods with different levels of monetary incentives provides insights into the role of culture in farmers' response to a specific policy change. Suppose an AES payment scheme is introduced in period $\tau = 1$, and updated in period $\tau = 2$, then a comparison of the differences in participation across the two cultural groups is: $\Delta M_2 - \Delta M_1 = \left(a_{k_2 2} - a_{k_1 2}\right)P_2$. That is, in the second comparison, behavioral differences between the two cultural groups prior to period 2 are differenced out, and only farmers' response in period 2 are concerned. This comparison sheds light on the effectiveness of the updated monetary incentives in mitigating the culture-driven difference in biodiversity conservation. In our empirical analyses, we estimate ΔM_τ for each year in our sample period, and compare the change in ΔM_τ before and after the policy reform in 2014 to understand how cultural influences farmers' response to the policy reform.

3. Empirical Strategy

Our analysis utilizes a large and fully representative panel dataset covering all Swiss farms over eight consecutive years, a period within which a natural experiment occurred, i.e., a sudden increase of agri-environmental payments under a policy reform. The data covering this natural experiment allows us to identify the effect of culture on farmers' response to increased economic incentives for biodiversity conservation. To identify this effect, we use a (fuzzy) spatial difference-in-discontinuities design. The cultural background of the farmers is proxied by their native language, and we define farmers with a French-speaking background as the treatment group and farmers with a German speaking background as the control

[4] The case that $a_{kt} < 0$ correspond to a crowding-out effect of monetary incentives.

group. In the simplest case of only two periods, we would then have a 2×2 design with a pre- and a post-treatment period (before and after the policy reform), and we estimate whether the discontinuity in biodiversity conservation at the inner-Swiss language border changed from before to after the treatment.[5] With multiple periods, the logic remains the same, only that we estimate for each year the discontinuity in biodiversity conservation at the language border, and how these dynamics changed from all the pre-treatment periods to all the post-treatment periods (see also e.g., Garg & Shenoy, 2021; Grembi et al., 2016 for examples of the application). Agricultural lands close to the language border share similar topological and biophysical features. Moreover, since the language border largely lies within canton boundaries, the same institutional environment (e.g., legal frameworks, direct payments, extension services) applies to farms on both sides of the language border within each canton. In other words, within canton boundaries, discontinuities observed at the language border are free from confounding treatment effects due to cantonal policies. As such, the difference in biodiversity conservation payment can be attributed to cultural differences that drive farmers' preferences. Since the native language of the population does not perfectly correspond to the language region, that is, a small fraction of German-speaking nationals reside in the French-speaking region and vice versa (BFS, 2017, also see Figure A1), we apply a fuzzy regression discontinuity design.[6] We use language region (defined by distance to the language border) as an instrument for the treatment, i.e., having French as the native language, which proxies for the cultural effect. Our outcomes of interest are AES payments (total payment, action-based payment, and result-based payment) for biodiversity conservation in CHF per hectare[7]. The running variable is distance to the language border.

For each year in our sample period t, we estimate the reduced-form model for the fuzzy spatial regression discontinuity design where we use the language region of a municipality to instrument for having French (compared to German) as the native language:

$$y_{im}^{(t)} = \beta_0^{(t)} + \beta_1^{(t)} F_m + \beta_2^{(t)} Dist_m + \beta_3^{(t)} F_m Dist_m + \beta_4^{(t)} X_{im} + u_{im}^{(t)}$$

where y_{im} is the per-hectare biodiversity conservation AES payment received on farm i in municipality m in year t, F_m is a dummy variable that equals 1 if municipality m is in the French-speaking region, $Dist_m$ is the distance from municipality m to the language border, X_{im} is a set of covariates, and u_{im} is an error term. In the baseline regression discontinuity design, we include in X_{im} canton effects, farm type, spatial coordinates of the municipality, slope, elevation, and precipitation. These covariates ensure that we identify β_1, the cultural effect on biodiversity conservation, by comparing farms in the French- and German-speaking regions that are comparable in these respects. We cluster standard errors at the municipality level.

A tradeoff between precision and bias lies in the choice of bandwidth around the border. A larger bandwidth allows for more farms to be included, at the potential risk of comparing over a more heterogeneous landscape. As our study spans over multiple years, we apply the same bandwidth for all years to ensure comparability of the estimated effects over time. We start with the optimal robust bias-corrected bandwidth (Calonico et al., 2020) of the year 2010, which is approximately 10km. Since the choice of agricultural practice largely depends on climate and topographical features, we also consider the bandwidth within which these features are comparable. We test whether there exist discontinuities in terms of climate and topographical features across the language border within the bandwidth in our study area (discussed in detail in the Data section). Table A2 shows that within a 10km bandwidth, there is no statistically significant

[5] Note that the policy reform applied to all farms in Switzerland. Thus, the treatment in our setting is the *interaction* between the policy reform and having a French-speaking background.
[6] Hahn et al. (2001) provides detailed discussions on the difference between sharp and fuzzy regression discontinuity designs.
[7] Note that we focus on payment rather than area enrolled, because each payment category is also a proxy for the ecological value and farmers' effort in the associated practice assigned by the payment provider. See also Data section for details.

difference in slope, elevation, and precipitation on the two sides of the language border within the study area.

To further investigate the potential mechanisms behind any discontinuity in terms of biodiversity conservation at the language border, we examine the roles of two additional sets of covariates. The first set of covariates concerns farm structure and management practices, including farm size, land-use intensity (measured by livestock unit per hectare), and labor intensity (measured by standard labor unit per hectare). These characteristics provide proxies for farm profitability and mechanization, which affects the opportunity cost of conservation practices. The second set of covariates include population density and tree cover potential (without human influence) (Bastin et al., 2019). These covariates provide proxies for human impact measured at the municipality level, and thus general room for biodiversity conservation practices for farms in the respective municipality. In the case that additional covariates eliminate or reduce the baseline discontinuities, we could consider such covariates as potential mechanisms behind the discontinuities (Noack et al., 2021). In our context, if the additional covariates eliminate or reduce the estimated discontinuities in biodiversity conservation across language regions from the baseline analyses, we could consider farm structural conditions characterized by these covariates as channels through which culture influences conservation practices. Note that difference in farm structural conditions, such as farm growth and intensity, are also driven by the social and cultural background (Inwood, 2013), and thus can be considered as elements of culture. Table 1 provides descriptions of our outcome and treatment variables, covariates, and the running variable.

Table 1. Variable description

Variable	Unit	Description
Farm-level		
Action-based payment	CHF/hectare	Action-based payment received per hectare of farm area
Result-based payment	CHF/hectare	Result-based payment received per hectare of farm area
Total payment	CHF/hectare	Sum of action- and result-based payments per hectare
Farm size	Hectare	Area of farm
Labor intensity	SAK/hectare	Standard labor unit (SAK) per hectare
Land use intensity	LSU/hectare	Livestock unit (LSU) per hectare
Municipality-level		
Share French-speaking	Percent	Share of french speakers in overall population, based on 2000 census
Distance	Meter	Shortest distance between municipality and language border; negative for municipalities in French-speaking Switzerland, positive for municipalities in German-speaking Switzerland
Precipitation	Millimeter/year	Annual precipitation in 2017, measured at centroid of municipality
Elevation	Meter	Average elevation of a municipality
Slope	Degree	Average slope of a municipality
Tree cover potential	Percent	Tree cover potential as calculated in Bastin et al. (2019)
Population density	Heads/hectare	Population per hectare of each municipality, based on 2000 census and Arealstatistik 2004/2009

Robustness checks

Discontinuity in farmers' response Our main analyses allow us to observe the changes in the discontinuities in biodiversity conservation AES participation across cultures. As a robustness check, we estimate whether there are discontinuities in farmers' response to the 2014 policy reform with a regression discontinuity design on differenced per-hectare AES payment across the pre- and post-reform time periods. We follow Butts (2021) and take the first difference over time at the farm level, and then use the differenced outcomes in a regression discontinuity design. To do so, we first need to restrict our sample to farms that appeared in the census at least one time both before and after the policy reform in 2014. We then calculate the difference in the average AES payments per hectare between the periods before and after 2014 (that is, 2010-2013, and 2015-2017), and estimate if there are discontinuities in this average time difference at the language border. A drawback of this approach is that farms that appeared in only one period need to be dropped. Furthermore, some farms dropped out of the census due to farm-restructuring, for example, purchased by another farm.[8] This implies that structural information such as farm size and labor unit under farms of the same identifier changed over time for some farms. Therefore, for farms that experienced reconstructing, the first-differenced per-hectare AES payments also reflect structural changes over time. Also because of the change in farm structure in some farms, we only estimate the baseline specification without including farm structural information as covariates. Nonetheless, this approach provides direct estimates on farmers' response to the policy reform in 2014, and we expect the estimates to be qualitatively consistent with results from the main analyses.

Placebo test To examine whether discontinuities in AES participation at the language border, in fact, reflect spurious effect, we conduct placebo tests by artificially shifting the language border ones to the west and ones to the east. We do so by changing the cutoff of the running variable, i.e., distance to the language border, to -15km and 15km, such that the artificial border lies mostly within the French and German language region, respectively. We continue to use a 10km bandwidth in the placebo tests.[9]

4. Data

Our primary data source is annual census data on all Swiss farms from 2010 to 2017, which contains farm structural information and biodiversity conservation AES payment received by farmers. In the year 2010, over 51,600 farms appeared in the census, of which over 3,500 lied within the 10km bandwidth in valley or mountain zones with at least one hectare of grassland. In the main analyses, we focus on payment levels (per hectare of overall farm size) rather than areas enrolled, because each payment category is also a proxy for the ecological value and farmers' efforts in the associated practice assigned by the payment provider. Thus, the payment a farm receives shall also reflect the overall ecological value it provides. For instance, a farm can receive payments for managing grassland less intensively, and for planting flower strips between plots of land. The former payment category often applies to relatively large areas with low per-hectare payment, while the latter only applies to small areas, but the per-hectare payment is much higher (Table A1). Using area enrolled as the outcome would add up the two types of enrollment without distinguishing the ecological values. Since the participation in AES is often associated with farm size (e.g., Mann, 2005), and farms in the French-speaking parts of Switzerland are on average larger than farms in the German-

[8] The structural change in Swiss agriculture is overall modest, especially if compared with other European countries. In the period 2000-2018, on average 1.76% of farms disappear (Zorn, 2020).

[9] Since the share of French speakers is very unevenly distributed within the bandwidth surrounding the artificial language borders, a fuzzy regression discontinuity design would inflate the coefficient estimates to unrealistically large values. We therefore conduct a sharp regression discontinuity design for the placebo tests.

speaking parts, we use per-hectare payment as the outcome variable. That is, the outcome measures the average ecological value per hectare of land a farm provides.

Within specific payment categories, the payment amount for the same conservation practice also differentiates across different topographical zones to reflect the difference in difficulty to deliver the ecological value. For example, payments are lower in mountain zones where the provision of extensive grassland is associated with lower (opportunity) costs (Huber et al., 2021). The main topographical zones include valley, hill, and four mountain zones. Agricultural lands are classified into these zones to reflect production conditions, including climate, slope, altitude, and transport accessibility (FOAG, 2021). Since suitable agricultural activities and conservation practices vary across agricultural zones, participation in biodiversity conservation AES also differs: the fraction of ecological focus areas in the mountain zones are much higher than that in the valley (FOAG, 2020). Therefore, we examine biodiversity conservation in different zones separately.

Historically, land characteristics that define agricultural zones may also influence the formation of the borders of cultural regions. An example would be that a mountain ridge overlaps with the border that divides two language regions, such that cultural differences across language regions would confound with topographical and biophysical differences. To avoid such confounding effects, we restrict our study area to sections of the language border that run through rather than along the borders of agricultural zones (Figure 1). This step ensures the production conditions across the language border to be comparable. We omit farms in hill zones since hill zones are unevenly distributed across the language border. As such, our sample comprises farms in valley and mountain zones in the study area.[10]

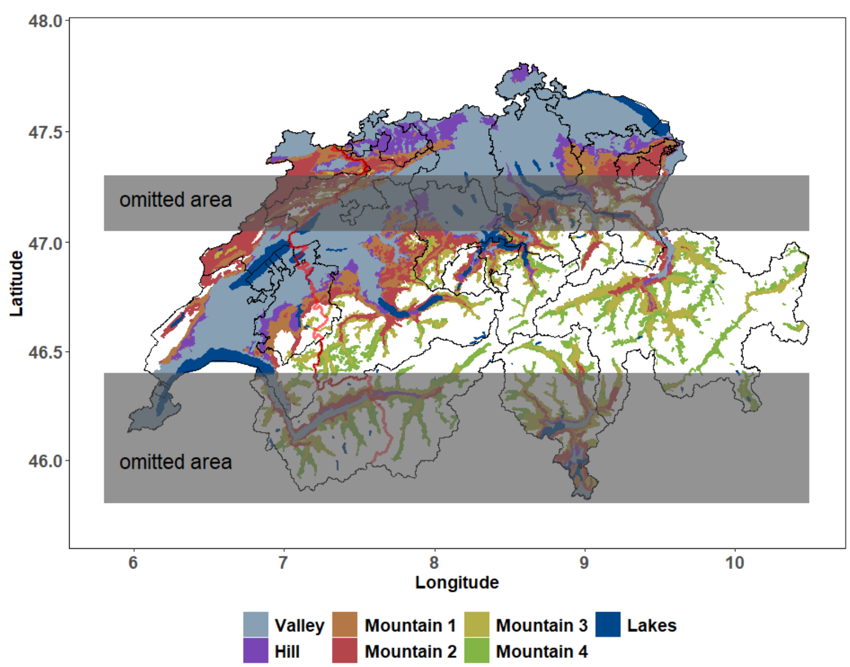

Figure 1. Study area

Since some payment categories apply only to grassland while others both to grassland and cropland, the payments farms receive depend on the farming activities. The distribution of farm types is similar across the border (Figure A2), such that any difference in biodiversity conservation is unlikely to be due to large

[10] Since topographical and payment differences are both smaller within the four mountain zones compared to mountain-valley differences, we combine the mountain zones I through IV into one mountain zone.

differences in the distribution of farming activities in the two language regions. Furthermore, we restrict the sample of farms to those that contain at least one hectare of grassland, such that the payment increases in 2014 which focused on grassland are relevant to all observations.

The running variable for our regression discontinuity design is the shortest distance between each municipality to the language border (in the year 2021). Since a number of Swiss municipalities went through mergers since the year 2000, we follow Engist (2021) and account for the municipality merges over the sample period.

We obtain municipality-level share of French-speaking population and population density from the 2000 census. Annual precipitation is measured in 2017 by MeteoSuisse, and slope and elevation information are measured by Shuttle Radar Topography Mission. Table 2 provides descriptive statistics of the covariates.

Table 2. Descriptive statistics of covariates by language region

Farm-level

	Mountain			Valley		
Variable	French	German	Difference	French	German	Difference
Farm size	32.28	21.53	10.75***	35.25	25.83	9.42***
	(22.68)	(13.42)		(25.68)	(32.07)	
Labor intensity	0.84	0.82	0.02*	0.82	0.91	−0.09***
	(0.26)	(0.19)		(0.72)	(0.59)	
Land use intensity	1.35	1.13	0.22***	0.99	1.12	−0.13***
	(0.82)	(0.49)		(0.9)	(1.16)	

Municipality-level

	Within 10km bandwidth			Entire study area		
Variable	French	German	Difference	French	German	Difference
Share French-speaking	0.85	0.03	0.82***	0.89	0.01	0.88***
	(0.1)	(0.04)		(0.07)	(0.02)	
Precipitation	966.09	989.18	−23.09	957.48	1116.67	−159.19***
	(174.41)	(183.22)		(182.34)	(274.87)	
Elevation	716.61	698.65	17.96	683.33	684.93	−1.60
	(233.48)	(367.78)		(215.92)	(394.7)	
Slope	9.88	10.09	−0.21	7.21	10.04	−2.83***
	(5.99)	(6.72)		(4.57)	(6.82)	
Tree cover potential	80.88	76.35	4.53***	82.87	77.60	5.27***
	(7.55)	(12.3)		(8.71)	(13.26)	
Population density	2.71	1.54	1.17**	2.62	3.77	−1.15***
	(5.58)	(1.29)		(6.02)	(5.18)	

Farm-level statistics based on 2014 census. See Table 1 for the years at which municipality-level covaraites were measured.

5. Results

Baseline analyses

Figure 2 shows the baseline coefficient estimates of the per-hectare AES payment differences between the two language regions by year. A negative coefficient indicates a lower amount of payment is received on a per-hectare basis on the French-speaking side. Since the payment increase in 2014 primarily applies to result-based payments, and it takes a different amount of time for farmers to reach the requirement of targeted indicator species on the farmland, the payments received in 2014 may only partially measure farmers' response. We therefore focus our discussion on the payments received in the periods 2010-2013 (Period 1) and 2015-2017 (Period 2). As we discuss in the conceptual framework, differences in payments across language regions within each period reflect a combination of differences in farmers' intrinsic motivation to conserve biodiversity and their response to the monetary incentives available in that period. Differences across the two periods (i.e., the difference-in-discontinuities), on the other hand, reflect the difference in farmers' responses to the policy reform across the language groups.

In both mountain and valley agricultural zones, farms in the French-speaking regions on average received less AES payment for biodiversity conservation per hectare than those on the German-speaking side over both Period 1 and Period 2. In Period 1, the magnitude of differences across language regions was larger in action-based payments than in result-based payments. This pattern applied to both mountain and valley zones. However, these differences in the two types of AES gradually converged over Period 2, indicating farmers' different responses in action- and result-based biodiversity conservation practices to the policy reform. Since the payment increases due to the 2014 policy reform apply to all farms, in the case that farms on both sides of the language border responded exactly the same (or if there were no response at all), we would observe an increase in the payment gap from Period 1 to Period 2 simply because of rescaling. Therefore, an increase in the payment gap could arise from either equivalent response to the policy reform from both language regions, or relatively less response from the French-speaking farmers. This is the case for result-based payment, especially in the valley zone. On the contrary, a decrease in the payment gap from Period 1 to Period 2 indicates relatively stronger response from the French-speaking farmers, which is the case for action-based payments.

Taking a closer look into the effect of culture in biodiversity conservation in the mountain zones (Panel A of Figure 2), the estimated total per-hectare payment received by French-speaking farmers fell short by 53-72 CHF compared to their German-speaking counterparts over Period 1 (with standard errors, *se* henceforth, of 3 CHF or less). Differences in action-based payments largely account for the total payment gap. To place the estimates in context, the unconditional average (i.e., simple group average) per-hectare payment received by mountain farms in the French-speaking regions (within the 10km bandwidth) over the same period was 73 CHF. A comparison indicates a large cultural effect in biodiversity conservation, with the French-speaking farms fell short by up to 99 percent compared to the German-speaking counterparts. In terms of response to the policy reform, over Period 2, the per-hectare payment gap slightly widened for result-based payments yet slightly narrowed for action-based payments. The total payment difference over Period 2 ranged from 60-76 CHF per hectare ($se = 5$ CHF in each year over this period), and the unconditional average payment received by French-speaking farmers over this period was 165 CHF. Comparing the payment gaps relative to the unconditional average payments between the two periods, the relative economic significance of the payment shortfall by French-speaking farmers decreases after the policy reform, indicating the increased monetary incentives tend to reduce the effect of culture on biodiversity conservation.

In the valley zone, the estimated total per-hectare payment received by French-speaking farmers was 106-128 CHF ($se \leq 8$ CHF) less than their German-speaking counterparts over Period 1 (Panel B of Figure 2).

The unconditional average per-hectare payment in the valley was 175 CHF in the French-speaking regions. Differences in action-based payments again largely account for the total payment gap. Over Period 2, the payment gap ranged from 71-115 CHF per hectare ($se \leq 8$ CHF), while the unconditional average per-hectare payment was 258 CHF in the French-speaking region. Similar to the mountain zones, the relative economic significance of the cultural effect decreases after the policy reform. The slight decrease in the total payment gap in the valley zone results from distinctively opposite trends in the two types of payments. While French-speaking farmers fell further short in receiving result-based payments, the gap in action-based payments appeared to narrow.

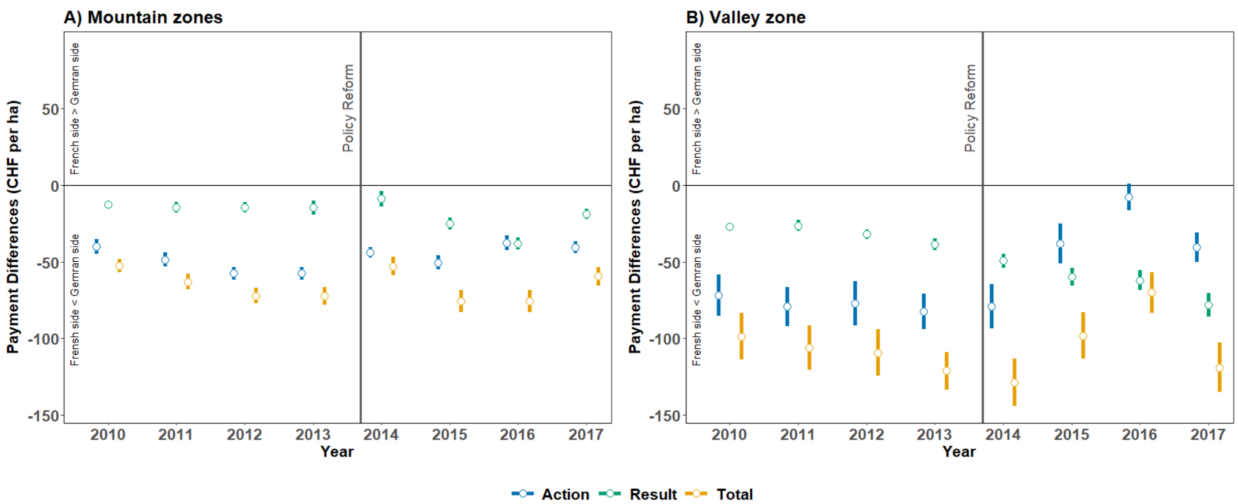

Figure 2. Coefficient estimates of payment difference (baseline)

Potential mechanisms

We next look into potential mechanisms through which culture influences farmers' biodiversity conservation by including additional covariates in the regression discontinuity design. For the mountain zones, adding covariates on farm structure and farm management styles (farm size, labor intensity, and land-use intensity) results in a payment gap in the range of 40-61 CHF per hectare ($se \leq 3$ CHF) over Period 1, and 43-48 CHF per hectare ($se \leq 4$ CHF) over Period 2 (Panel A of Figure 3). While the payment gaps are still statistically significant as we include covariates on farm structure and farm management styles, the magnitude of total payment gap decreases by 15-37 percent compared to estimates in the baseline analyses. As we further include covariates on human impact (population density and tree cover potential), the payment gap further reduced to 30-53 CHF per hectare ($se = 3$ CHF) over Period 1, and 25-30 CHF per hectare ($se = 2$ CHF) over Period 2 (Panel A of Figure 4). These reductions translate to additional reductions by 11-24 percent of the payment gap in the baseline analyses. As such, the additional covariates reduces the total payment gap in the baseline analyses by up to 61 percent, though the remaining payment gap is still statistically significant. For result-based payments, with both sets of additional covariates added, the economic significance of the payment gap became minor (2-16 CHF per hectare), especially over Period 2, indicating a stronger response to the policy reform by French-speaking farmers when structural differences are held fixed.

These results indicate that for mountain zones, the discontinuities in participation in biodiversity-promoting AES at the language border largely manifest in structural differences in farming conditions. Since differences in farm structural conditions can arise from cultural differences (Inwood, 2013), the influence of culture on biodiversity conservation in this case can be considered indirect, that is, via structural difference between farms developed over time. Descriptive statistics of the additional covariates show that, on average, the French-speaking mountain regions are relatively less densely populated, with larger average farm size, labor intensity, and land-use intensity (and a possibly higher level of mechanization). These characteristics indicate greater opportunity costs for farmers to adopt conservation practices by forgoing production. This is particularly the case for result-based AES, which involves greater adjustment costs compared to action-based AES. As we account for the structural differences between farms in the two language regions, the magnitude and economic significance in the gap in result-based payments became diminished, especially over the post-reform period. A possible explanation is that the payment increases for large and profitable farms were still not sufficient to compensate for the profit loss and additional cost if farmers were to participate in AES. On the contrary, smaller farms often largely rely on direct payments, especially those with relatively lower farm household income and less income from off-farm labor (El Benni & Finger, 2013; El Benni & Schmid, 2021). Therefore they were more responsive to the policy reform to implement extensive measures.

Turning to the valley zone, additional covariates do not incur substantial changes in the estimated payment gaps both before and after the policy reform (Panel B of Figures 3 and 4). Descriptive statistics show that compared to the mountain zones, there exist less systematic differences in these covariates in the valley zone. While farm size is consistently larger in the French-speaking region, other covariates show mixed patterns. Land-use intensity is higher in the French-speaking region prior to the policy reform yet slightly lower afterwards. While this pattern aligns with the change in the action-based payment gap, the difference in land-use intensity does not further explain the gap. The French-speaking region has a slightly higher population density, and there is no significant difference in labor intensity and tree cover potential between the two regions. These results indicate that the cultural differences in farmers' biodiversity conservation do not manifest via the observed structural differences that affect agricultural production in the valley zone. Rather, the payment gaps reflect farmers' preferences regarding biodiversity conservation beyond structural conditions such as farm size and management styles.

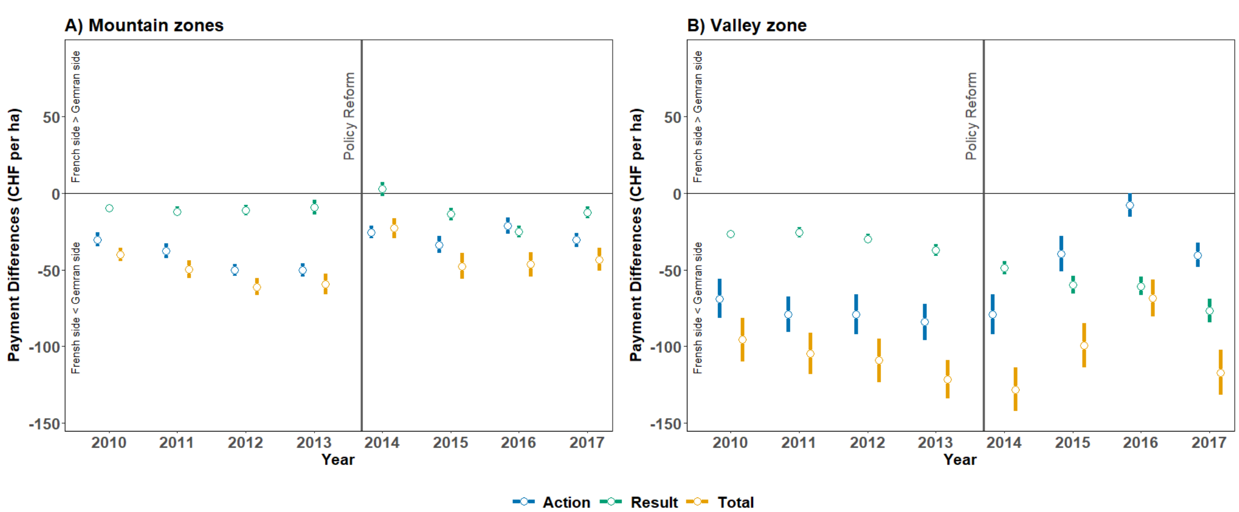

Figure 3. Coefficient estimates of payment difference (additional covariates: farm size, labor intensity, land-use intensity)

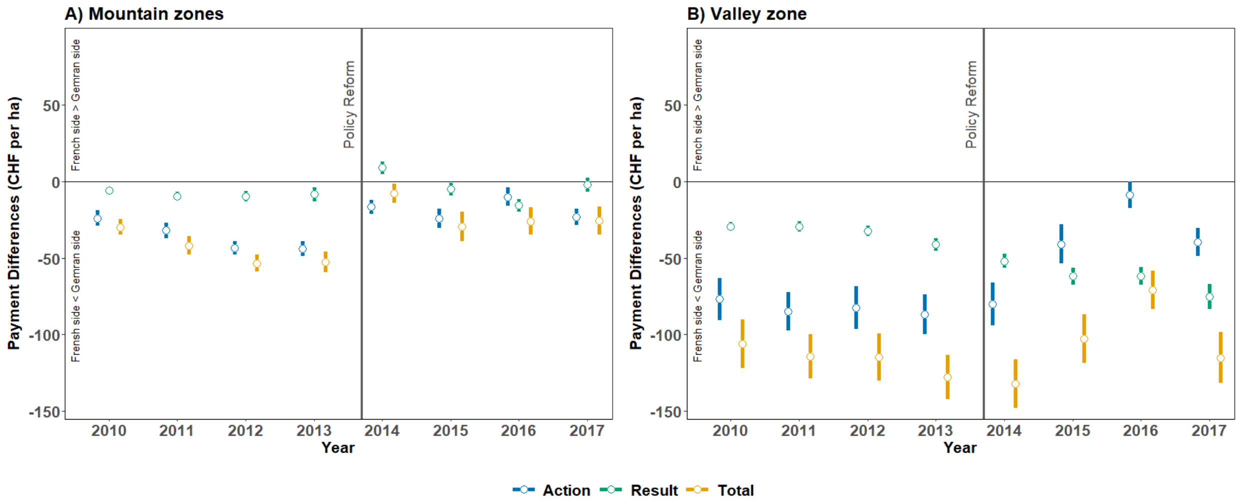

Figure 4. Coefficient estimates of payment difference (additional covariates: tree cover potential, population density)

Robustness checks

Table A3 reports estimates of the regression discontinuity design on differenced per-hectare AES payments before and after the 2014 policy reform. While the magnitude of discontinuities in farmers' response to the policy reform are similar in terms of total payment per hectare in the mountain and valley zones, the responses differ in action- and result-based payments. Consistent with trends shown in Figure 2, for the subset of farms that appeared in the census dataset in both Period 1 and Period 2, those in the French-speaking region responded more strongly towards action-based payments after the policy reform in both mountain and valley zones, and less strongly towards result-based payments in the valley zone. While Figure 2 does not show a clear pattern in the change in action-based payment gap in the mountain zones, estimate in Table A3 indicate a stronger response by French-speaking farmers, implying a decrease in the payment gap. These results again indicate that the policy reform mitigated farmers' behavioral difference in terms of participating in biodiversity conservation AES between the language regions.

Figures A3 and A4 show results from the placebo test for which we artificially shift the language border to the east and the west by 15 kilometers, respectively. The estimated payment differences largely decrease in magnitude for both the mountain and valley zones, and are mostly statistically insignificant. These results provide evidence that the estimated difference in farmers' participation in biodiversity conservation are not driven by spurious effects, but rather reflect cultural differences.

6. Discussion

Our study shows systematically different behaviors in terms of the level of participation in biodiversity-promoting AES between German- and French-speaking farmers. For both agricultural zones (mountain and valley), French-speaking farmers lagged their German-speaking counterparts in participating biodiversity conservation AES. Such behavioral differences across the language regions, even with identical AES design, as well as comparable institutional framework, topographical, biophysical features, and farming activities, evidence that culture plays a role in farmers' preference in conserving biodiversity.

Furthermore, culture influences farmers' response to monetary incentives for biodiversity conservation. For mountain zones, a large portion of the cultural difference in AES participation and the response to the policy reform can be attributed to structural differences in farms and farming environments across the language border. French-speaking farmers responded relatively more strongly to the policy reform than German-speaking farmers, such that the two groups of farmers behaved similarly post-reform when their farm structural conditions are comparable. In other words, for farmers in the French-speaking mountain region, response to increased monetary incentives under AES may be partially limited by farm structural conditions. Tailored policies targeting large and intensively managed farms may contribute to increasing biodiversity provision, especially since these farms have relatively more room to implement extensive measures to conserve biodiversity. For the valley zone, the differences in AES participation and response to the policy reform between the language groups rather reflect farmers' preference beyond the structural conditions of farms. For future research, a comprehensive understanding of the relevant cultural dimensions that lead to different farmers' preferences could facilitate tailored policymaking to incentivize biodiversity conservation by farmers of different cultural backgrounds.

Despite of a persisting difference in total AES payments across the language regions, the relative economic significance of the difference (compared to unconditional average payments) decreased after the policy reform. This indicates that increased monetary incentives could mitigate culture-driven behavioral difference in biodiversity conservation. These findings are consistent with previous literature that indicates that values and beliefs play a less important role in conservation practices when monetary rewards are involved (Lokhorst et al., 2011). In particular, farmers in the French-speaking region responded more strongly towards payment increase under action-based AES, but not result-based. Since action-based AES are prerequisites for farmers to further participate in result-based AES, these findings suggest the increased monetary incentives introduced by the policy reform were effective in motivating farmers to participate more extensively in biodiversity conservation, which potentially paves the way for more substantial land use adjustment to conserve biodiversity in the future (i.e., via participating in result-based AES). On the contrary, it is also possible that the policy reform was only effective in inducing biodiversity conservation at the action level, without achieving measurable outcomes in enhancing biodiversity. As we discuss in the conceptual background, adjustment for biodiversity conservation are subject to restrictions due to current farming practices more so in the short run than in the long run. Since result-based AES require more adjustment of farming practices than action-based AES, these restrictions could be particularly relevant to result-based AES in the short run. Therefore, it is possible for stronger response towards increased incentives under result-based AES to take place in the long run, as the restrictions are gradually relaxed. Future research on the long-run implications of incentive changes under AES is thus warranted.

7. Conclusion

In this study we investigate a natural experiment within Switzerland where a national level agricultural policy reform increased the monetary incentives for biodiversity conservation for farmers from different cultural backgrounds. Using farm census panel data, we analyze cultural differences along the inner-Swiss French and German language border in both farmers' level of participation in biodiversity conservation AES, and their response to the policy reform.

Our findings indicate that while farmers from different cultural backgrounds may have different motivations to conserve biodiversity, monetary incentives offered by AES could potentially mitigate the behavioral difference. We show that the 2014 agricultural policy reform in Switzerland was effective in terms of motivating French-speaking farmers who previously lagged in biodiversity conservation to take initial steps (i.e., via a stronger response towards action-based AES).

Our study advances the understanding of the role of culture in environmental behaviors and economic decision-making by quantifying the relative importance of monetary versus cultural motivations, as well as their interaction. Culture-driven behavioral differences can arise not only within the general population, but also in sub-populations characterized with a common profession and considered to share a strong common identity. This bears important implications for policymaking, especially when targeting at a particular sub-population, in our context agri-environmental policymaking. For policymakers, our results indicate that first, culture plays a role in shaping farmers' pro-environmental behavior in terms of biodiversity conservation. Our analyses quantify this cultural effect and show that it is far from trivial. Second, monetary incentives offered by AES help mitigate the cultural gap in biodiversity conservation, as evidenced by the stronger response to the increased incentives from the cultural group that was previously behind. Furthermore, our study generate broad implications for a wide range of policy scenarios where identical policy instruments with monetary incentives for pro-environmental behaviors are applied to individuals with diverse cultural backgrounds. Policymakers need to bear in mind the cultural differences among individuals when expecting and evaluating their response to a policy instrument.

References

Akers, J. F., & Yasué, M. (2019). Motivational Crowding in Payments for Ecosystem Service Schemes: A Global Systematic Review. *Conservation & Society*, *17*(4), 377–389. https://doi.org/10.4103/cs.cs

Bastin, J., Finegold, Y., Garcia, C., Mollicone, D., Rezende, M., Routh, D., Zohner, C. M., & Crowther, T. W. (2019). The global tree restoration potential. *Science*, *79*, 76–79.

BFS. (2017). *Sprachgebiete der Schweiz*. https://www.bfs.admin.ch/bfs/de/home/statistiken/bevoelkerung/sprachen-religionen/sprachen.assetdetail.2546353.html

Brown, M., Henchoz, C., & Spycher, T. (2018). Culture and financial literacy: Evidence from a within-country language border. *Journal of Economic Behavior and Organization*, *150*, 62–85. https://doi.org/10.1016/j.jebo.2018.03.011

Burton, R. J. F., Kuczera, C., & Schwarz, G. (2008). Exploring Farmers' Cultural Resistance to Voluntary Agri-environmental Schemes. *Sociologia Ruralis*, *48*(1).

Butts, K. (2021). Geographic difference-in-discontinuities. *Applied Economics Letters*, 1–5. https://doi.org/10.1080/13504851.2021.2005236

Calonico, S., Cattaneo, M. D., & Farrell, M. H. (2020). Optimal bandwidth choice for robust bias-corrected inference in regression discontinuity designs. *Econometrics Journal*, *23*, 192–210. https://doi.org/10.1093/ectj/utz022

Chen, M. K. (2013). The Effect of Language on Economic Behavior: Evidence from Savings Rates, Health Behaviors, and Retirement Assets. *American Economic Review*, *103*(2), 690–731.

Cinner, J. E., Barnes, M. L., Gurney, G. G., Lockie, S., & Rojas, C. (2020). Markets and the crowding out of conservation-relevant behavior. *Conservation Biology*, *35*(3), 816–823. https://doi.org/10.1111/cobi.13606

Cullen, P., Dupraz, P., Moran, J., Murphy, P., Flaherty, R. O., Donoghue, C. O., Shea, R. O., & Ryan, M. (2018). Agri--Environment Scheme Design: Past Lessons and Future Suggestions. *EuroChoices*, *17*(3), 26–30. https://doi.org/10.1111/1746-692X.12187

Curry, N., & Stucki, E. (2010). Swiss Agricultural Policy and the Environment: An Example for the Rest of Europe to Follow? *Journal of Environmental Planning and Management ISSN:*, *40*(4), 465–482. https://doi.org/10.1080/09640569712047

Dessart, F. J., Barreiro-Hurlé, J., & van Bavel, R. (2019). Behavioural factors affecting the adoption of sustainable farming practices: a policy- oriented review. *European Review of Agricultural EconomicsAgricultural Economics*, *46*(3), 417–471. https://doi.org/10.1093/erae/jbz019

Egger, P. H., & Lassmann, A. (2015). The causal impact of common native language on international trade: Evidence from a spatial regression discontinuity design. *The Economic Journal*, *125*(1980), 699–745. https://doi.org/10.1111/ecoj.12253

El Benni, N., & Finger, R. (2013). The effect of agricultural policy reforms on income inequality in Swiss agriculture - An analysis for valley, hill and mountain regions. *Journal of Policy Modeling*, *35*(4), 638–651. https://doi.org/10.1016/j.jpolmod.2012.03.005

El Benni, N., Finger, R., & Meuwissen, M. P. M. (2016). Potential effects of the income stabilisation tool (IST) in Swiss agriculture. *European Review of Agricultural Economics*, *43*(3), 475–502. https://doi.org/10.1093/erae/jbv023

El Benni, N., & Schmid, D. (2021). Off-farm income and direct payments-an indispensable diversification strategy of Swiss farmers. *Q Open*.

Engist, D. (2021). *Swiss municipality mergers since 2000*. https://doi.org/10.3929/ethz-b-000492382

Eugster, B., Lalive, R., Steinhauer, A., & Zweimu, J. (2011). The demand for social insurance: does culture matter? *The Economic Journal*, *121*(556), 413–448. https://doi.org/10.1111/j.1468-0297.2011.02479.x.

Filippini, M., & Wekhof, T. (2021). The effect of culture on energy efficient vehicle ownership. *Journal of Environmental Economics and Management, 105,* 102400. https://doi.org/10.1016/j.jeem.2020.102400

FOAG. (2020). *Landwirtschaftliche Zonen*. https://www.blw.admin.ch/blw/de/home/instrumente/grundlagen-und-querschnittsthemen/landwirtschaftliche-zonen.html

FOAG. (2021). *Agrarbericht 2021 des Bundesamtes für Landwirtschaft*. https://www.blw.admin.ch/blw/de/home/services/agrarbericht.html

Foley, J. A., Ramankutty, N., Brauman, K. A., Cassidy, E. S., Gerber, J. S., Johnston, M., Mueller, N. D., Connell, C. O., Ray, D. K., West, P. C., Balzer, C., Bennett, E. M., Sheehan, J., Siebert, S., Carpenter, S. R., Hill, J., Monfreda, C., Polasky, S., Rockstro, J., … Zaks, D. P. M. (2011). Solutions for a cultivated planet. *Nature*, *478*(7369), 337–342. https://doi.org/10.1038/nature10452

Garg, T., & Shenoy, A. (2021). The Ecological Impact of Place-Based Economic Policies. *American Journal of Agricultural Economics*, *103*(4), 1239–1250. https://doi.org/10.1111/ajae.12193

Gentili, E., Masiero, G., & Mazzonna, F. (2017). Journal of Economic Behavior & Organization The role of culture in long-term care arrangement decisions. *Journal of Economic Behavior and Organization*, *143*, 186–200. https://doi.org/10.1016/j.jebo.2017.09.007

Grembi, B. V., Nannicini, T., & Troiano, U. (2016). Do Fiscal Rules Matter? *American Economic Journal : Applied Economics*, *8*(3), 1–30.

Hahn, J., Todd, P., & Van der Klaauw, W. (2001). Identification and Estimation of Treatment Effects with a Regression-Discontinuity Design. *Econometrica*, *69*(1), 201–209.

Herz, H., Huber, M., Maillard-Bjedov, T., & Tyahlo, S. (2021). Time Preferences Across Language Groups: Evidence on Intertemporal Choices from the Swiss Language Border. *The Economic Journal*, *131*(639), 2920–2954. https://doi.org/10.1093/ej/ueab025

Huber, R., Zabel, A., Schleiffer, M., Vroege, W., Brändle, J. M., & Finger, R. (2021). Conservation Costs Drive Enrolment in Agglomeration Bonus Scheme. *Ecological Economics*, *186*, 1–10. https://doi.org/10.1016/j.ecolecon.2021.107064

Inwood, S. (2013). Social Forces and Cultural Factors Influencing Farm Transition. *Choices*, *28*(2).

Kleijn, D., & Sutherland, W. J. (2003). How effective are European agri-environment schemes in conserving and promoting biodiversity? *Journal of Applied Ecology*, *40*, 947–969.

Kolinjivadi, V., Mendez, A. Z., & Dupras, J. (2019). Putting nature ‘to work’ through Payments for Ecosystem Services (PES): Tensions between autonomy, voluntary action and the political economy of agri-environmental practice. *Land Use Policy*, *81*, 324–336. https://doi.org/10.1016/j.landusepol.2018.11.012

Krämer, J. E., & Wätzold, F. (2018). The agglomeration bonus in practice — An exploratory assessment of the Swiss network bonus. *Journal for Nature Conservation*, *43*, 126–135. https://doi.org/10.1016/j.jnc.2018.03.002

Kuhfuss, L., Thoyer, S., Hanley, N., Le Coent, P., & Désolé, M. (2016). Nudges , Social Norms , and Permanence in Agri-environmental Schemes. *Land Economics*, *92*(4), 641–655.

Leclère, D., Obersteiner, M., Barrett, M., Butchart, S. H., Chaudhary, A., De Palma, A., DeClerck, F. A., Di Marco, M., Doelman, J. C., Dürauer, M., & Freeman, R. (2020). Bending the curve of terrestrial biodiversity needs an integrated strategy. *Nature*, *585*(7826), 551–555. https://doi.org/10.1038/s41586-020-2705-y

Litina, A., Moriconi, S., & Zanaj, S. (2016). The Cultural Transmission of Environmental Values: A Comparative Approach. *World Development*, *84*, 131–148. https://doi.org/10.1016/j.worlddev.2016.03.016

Lokhorst, A. M., Staats, H., van Dijk, J., van Dijk, E., & de Snoo, G. (2011). What’s in it for Me? Motivational Differences between Farmers’ Subsidised and Non-Subsidised Conservation Practices. *Applied Psychology: An International Review*, *60*(3), 337–353. https://doi.org/10.1111/j.1464-0597.2011.00438.x

Mack, G., Ritzel, C., & Jan, P. (2020). Determinants for the Implementation of Action- , Result- and Multi-Actor-Oriented Agri-Environment Schemes in Switzerland. *Ecological Economics*, *176*. https://doi.org/10.1016/j.ecolecon.2020.106715

Mann, S. (2005). Farm Size Growth and Participation in Agri-environmental Schemes: A Configural Frequency Analysis of the Swiss Case. *Ournal of Agricultural Economics*, *56*(3), 373–384.

Mann, S. (2018). Conservation by Innovation: What Are the Triggers for Participation Among Swiss Farmers? *Ecological Economics*, *146*, 10–16. https://doi.org/10.1016/j.ecolecon.2017.09.013

Mann, S., & Lanz, S. (2013). Happy Tinbergen: Switzerland ’ s New Direct Payment System. *EuroChoices*, *12*(3), 24–28.

Noack, F., Larsen, A., Kamp, J., & Levers, C. (2021). A bird’ s eye view of farm size and biodiversity: The ecological legacy of the iron curtain. *American Journal of Agricultural Economics*, 1–25. https://doi.org/10.1111/ajae.12274

Pe'er, G., Dicks, L.V., Visconti, P., Arlettaz, R., Báldi, A., Benton, T.G., Collins, S., Dieterich, M., Gregory, R.D., Hartig, F. and Henle, K., 2014. EU agricultural reform fails on biodiversity. *Science*, 344(6188), 1090-1092.

Rode, J., Gómez-baggethun, E., & Krause, T. (2015). Motivation crowding by economic incentives in conservation policy: A review of the empirical evidence. *Ecological Economics*, *117*, 270–282. https://doi.org/10.1016/j.ecolecon.2014.11.019

Schaub, S., Huber, R., & Finger, R. (2020). Tracking societal concerns on pesticides – a Google Trends analysis Tracking. *Environmental Research Letters*, *15*(8), 1–6.

Schumacher, I. (2015). The endogenous formation of an environmental culture. *European Economic Review*, *76*, 200–221. https://doi.org/10.1016/j.euroecorev.2015.03.002

Steg, L. (2016). Values, norms, and intrinsic motivation to act proenvironmentally. *Annual Review of Environment and Resources*, *41*, 277–292. https://doi.org/10.1146/annurev-environ-110615-085947

Taylor, B. M., & Grieken, M. Van. (2015). Local institutions and farmer participation in agri-environmental schemes. *Journal of Rural Studies*, *37*, 10–19. https://doi.org/10.1016/j.jrurstud.2014.11.011

Tyllianakis, E., & Martin-Ortega, J. (2021). Agri-environmental schemes for biodiversity and environmental protection: How we are not yet “hitting the right keys.” *Land Use Policy*, *109*, 105620. https://doi.org/10.1016/j.landusepol.2021.105620

Uthes, S., & Matzdorf, B. (2013). Studies on Agri-environmental Measures: A Survey of the Literature. *Environmental Management*, *51*, 251–266. https://doi.org/10.1007/s00267-012-9959-6 van Dijk, W. F. A., Lokhorst, A. M., Berendse, F., & de Snoo, G. R. (2016). Factors underlying farmers' intentions to perform unsubsidised agri-environmental measures. *Land Use Policy*, *59*, 207–216.

Van Hecken, G., Merlet, P., Lindtner, M., & Bastiaensen, J. (2019). Can Financial Incentives Change Farmers' Motivations? An Agrarian System Approach to Development Pathways at the Nicaraguan Agricultural Frontier. *Ecological Economics*, *156*, 519–529. https://doi.org/10.1016/j.ecolecon.2016.12.030

Videras, J., Owen, A. L., Conover, E., & Wu, S. (2012). The influence of social relationships on pro-environment behaviors. *Journal of Environmental Economics and Management*, *63*(1), 35–50. https://doi.org/10.1016/j.jeem.2011.07.006

Villamayor-Tomas, S., Sagebiel, J., & Olschewski, R. (2019). Bringing the neighbors in : A choice experiment on the influence of coordination and social norms on farmers ' willingness to accept agro- environmental schemes across Europe. *Land Use Policy*, *84*(March), 200–215. https://doi.org/10.1016/j.landusepol.2019.03.006

Warren, C. R., Burton, R., Buchanan, O., & Birnie, R. V. (2016). Limited adoption of short rotation coppice: The role of farmers' socio- cultural identity in in fluencing practice. *Journal of Rural Studies*, *45*, 175–183. https://doi.org/10.1016/j.jrurstud.2016.03.017

Wuepper, D. (2020). Does culture affect soil erosion ? Empirical evidence from Europe. *European Review of Agricultural Economics*, *47*(2), 619–653. https://doi.org/10.1093/erae/jbz029

Wuepper, D., & Huber, R. (2021). Comparing effectiveness and return on investment of action- and results-based agri-environmental payments in Switzerland. *American Journal of Agricultural Economics.*, 1–20. https://doi.org/10.1111/ajae.12284

Zemo, K. H., & Termansen, M. (2021). Environmental identity economics: An application to farmers' pro-environmental investment behaviour. *European Review of Agricultural Economics*, 1–28.

Zorn, A. (2020). Kennzahlen des Strukturwandels der Schweizer Landwirtschaft auf Basis einzelbetrieblicher Daten. *Agroscope Science*, *88*, 1–58.

Appendix to

Culture and Agricultural Biodiversity Conservation

Table A1.Changes in payments under biodiversity conservation AES following the 2014 policy reform (in CHF per hectare)

Payment item	Pre-policy reform (2013)	Post-policy reform (2014)	Difference
Action-based[1]			
Extensively used meadow Valley	1,500	1,500	0
Extensively used meadow Hill	1,200	1,200	0
Extensively used meadow Mountain I and II	700	700	0
Extensively used meadow Mountain III and IV	450	550	100
Litter area[3] Valley	1,500	2,000	500
Litter area Hill	1,200	1,700	500
Litter area Mountain I and II	700	1,200	500
Litter area Mountain III and IV	450	950	500
Low intensity meadows[4]	300	450	150
Extensive pastures and wood pastures		450	450
Applicable only to cropland			
Wildflower fallow	2,800	3,800	1,000
Rotational fallow	2,300	3,300	1,000
Field strips	1,300	2,300	1,000
Field margins on arable land	2,300	3,300	1,000
Result-based[2]			
Extensively used meadow Valley	1,000	1,500	500
Extensively used meadow Hill	1,000	1,500	500
Extensively used meadow Mountain I and II	1,000	1,500	500
Extensively used meadow Mountain III and IV	700	1,000	300
Litter area Valley	1,000	1,500	500
Litter area Hill	1,000	1,500	500
Litter area Mountain I and II	1,000	1,500	500
Litter area Mountain III and IV	700	1,500	800
Low intensity meadow Valley Mountain II	1,000	1,200	200
Low intensity meadow Mountain III and IV	700	1,000	300
Extensive pastures and wood pastures Valley-Mountain II	500	700	200
Extensive pastures and wood pastures Mountain II-IV	300	700	400

1: Action-based payments are given to farmers for certain farming practices, such as extensive management of grasslands. The exact payments are determined by both the farming practice and the agricultural zones (e.g., in the valley, the hills, or one of the mountain zones).
2: Result-based payments are added on top of action-based payments, if certain quality indicators are present, such as a minimum amount of rare indicator species that differ regionally and by habitat. For example, the (action-based) payment for extensively used meadows in the valley remained 1500 CHF per hectare from before to after the policy reform, but the (result-based) bonus payment for the detection of rare indicator plants was increased from 1000 CHF in 2013 to 1500 CHF per hectare in 2014.
3: Litter areas are meadows mowed for animal bedding. No fertilization or pesticides are allowed on these areas
4: "Low intensity" refers to reduced intensity levels that are still higher than "extensive"

Table A2. Tests on covariate balance

Covariate	Coefficient estimate	p-value	Bandwidth
Elevation (m)	-57.3	0.5	10 km
Slope (degree)	2.48	0.21	10 km
Annual precipitation (mm)	-21.7	0.68	10 km

Table A3 Estimates from regression discontinuity design on differenced per-hectare AES payments before and after policy reform

Outcome	Mountain zones	Valley zone
Total payment per hectare	33.5***	32.6***
	(3.1)	(8.3)
Action-based	19.9***	63.3***
	(1.9)	(8.2)
Result-based	13.7***	−30.6***
	(2.2)	(2.3)

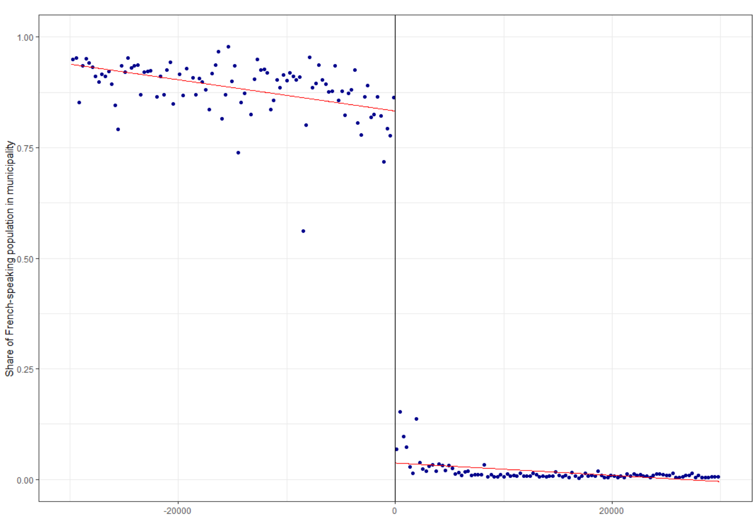

Figure A1. Share of French-speaking population across the inner-Swiss French-German language border

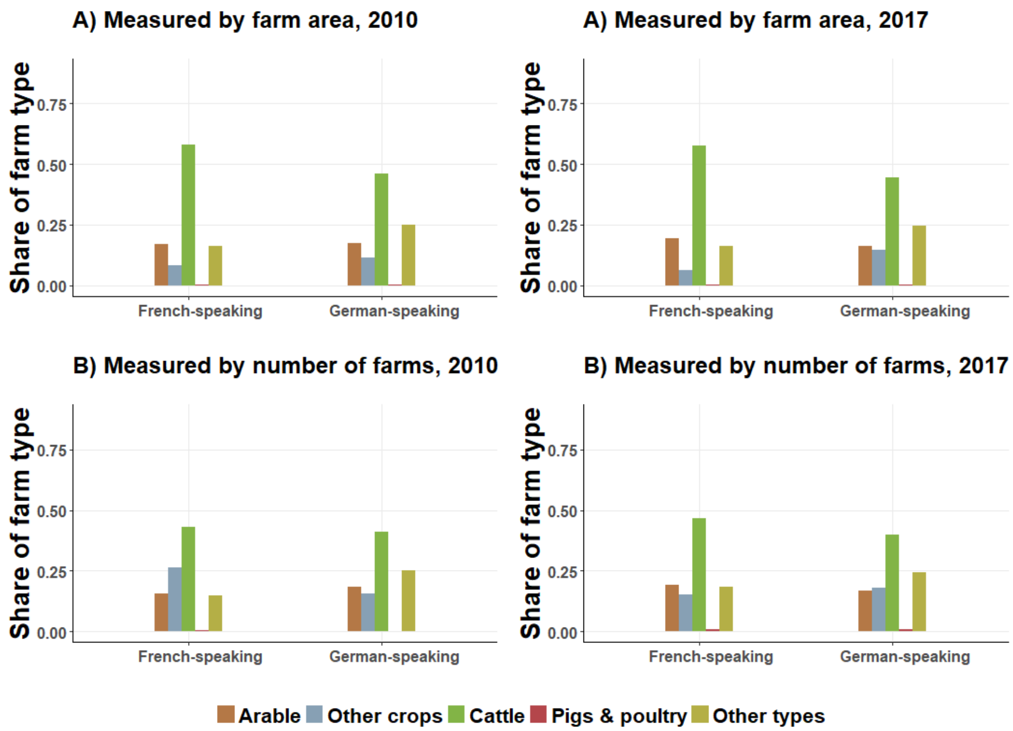

Figure A2. Distribution of farm type

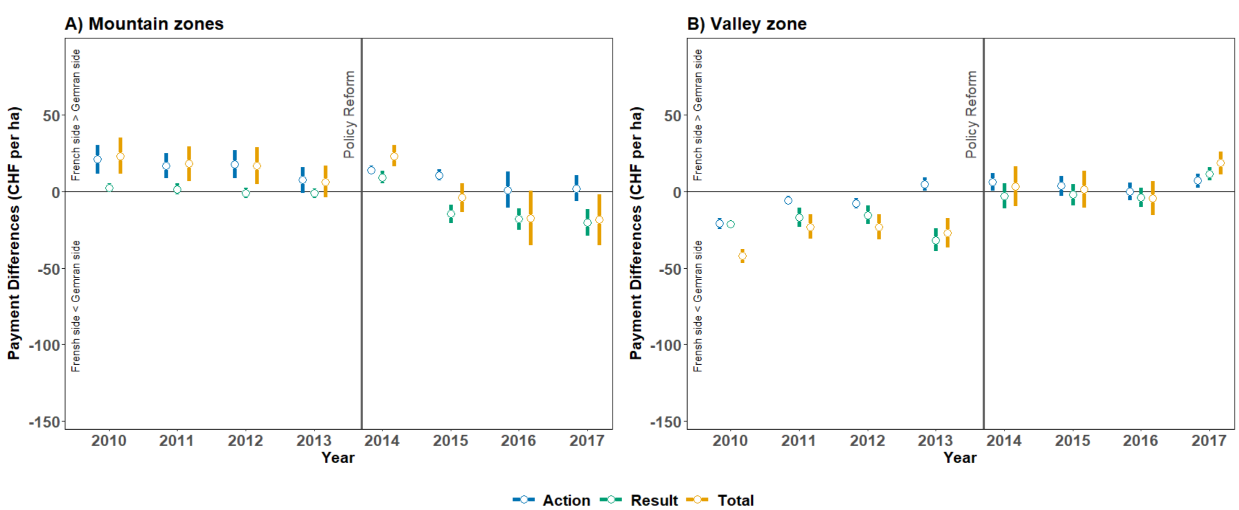

Figure A3. Placebo test with language border shifted to the east by 15km

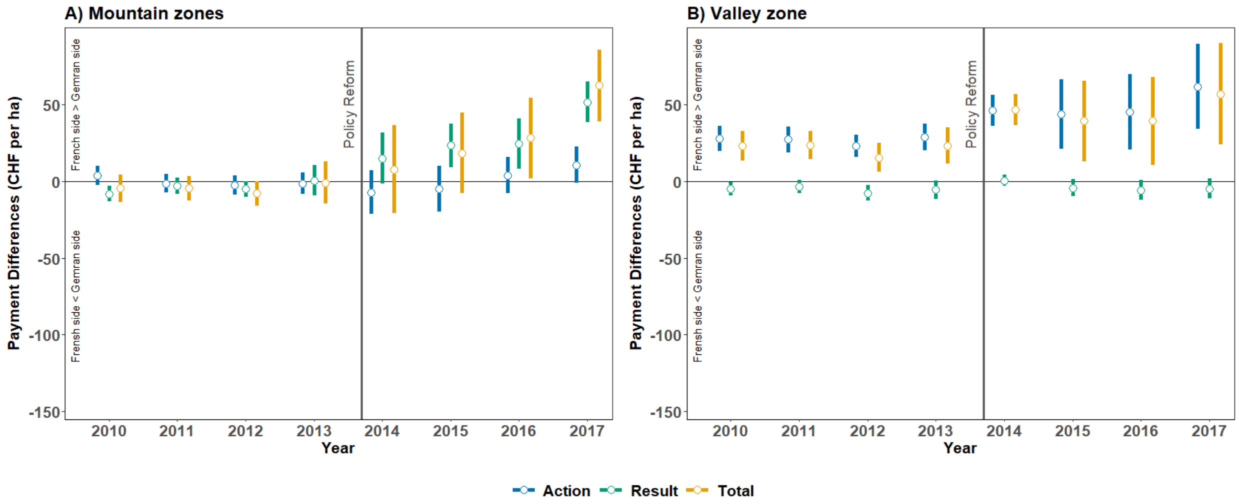

Figure A4. Placebo test with language border shifted to the west by 15km