Are Conservation Programs Additional? Evidence from the French Grassland Conservation Program*

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September 4, 2018

Preliminary, Please do not quote

Abstract

In this paper, we estimate the additionality of a major Payment for Ecosystem Services (PES) program, the French Grassland Conservation Program. We exploit the change in eligibility requirements for the extensive grazing schemes that occurred between 2000 and 2003, when the criteria of a ratio of permanent grassland to agricultural usable area higher than 75% was suppressed. We use this natural experiment in a Difference-in-Differences design. We compare changes in farm outcomes between the group of communes where the number of contracts increased after the policy reform and the group of communes where the number of contracts remained the same. We find that the policy change lead to a small increase in grassland area in treated communes, increase that comes mainly at the expense of croplands.

Keywords: Payment for Ecosystem Services, Grassland, Natural Experiment, Treatment Effect.
JEL: Q15, Q18, Q24, Q28, Q57.

*We thank the Observatoire du Développement Rural, especially Gilles Allaire, Cedric Gendre, Pierre Cantelaube and Eric Cahuzac for their generous sharing of time, expertise and data. We also thank Giséle Giroux for facilitating the access to data. We are particularly grateful to Lionel Védrine for explaining the program details and to Valentin Bellasen for sharing his knowledge on the environmental impacts of grassland. We especially thank Stefania Pozzi for outstanding research assistance. We also thank Jennifer Alix-Garcia, Céline Nauges and participants to the PENSEE and TSE internal workshops for fruitful discussions and comments. We gratefully acknowledge financial support from the French National Research Agency (ANR) as part of the PENSEE (Payments for ENvironmental Services: an Evidence-based Evaluation) project and "Investissements d'avenir" program (Centre d'accés sécurisé aux données(CASD)). All remaining errors are our own.

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1 Introduction

In order to strike the right balance between agriculture and the environment, policy-makers in both developed and developing countries are increasingly resorting to Payments for Ecosystem Services (PES). PES are voluntary agreements between a buyer (a landowner) and a seller (the Government or private users) in which a payment is given conditional on an environmental service being adequately provided (Alston et al., 2013). The payment is computed so as to compensate the landowner for the average compliance costs and for the forgone farming revenue associated with the adoption of greener practices. In general, a PES program targets at least one of the four environmental services among carbon sequestration, watershed services, biodiversity and scenic beauty. In the developing world, PES are widely used in the implementation of programs aimed at Reducing Emissions from Deforestation and forest Degradation (REDD). The purpose of these programs is to offer financial rewards to developing countries in exchange for emission reductions achieved through decreased deforestation. As of September 2016, there were 454 REDD+ projects located in 56 countries (International Database on REDD+ projects). In the context of the developed world, the United States Conservation Reserve Program (CRP) is one of the largest PES, with a funding of 2 billion dollars yearly, which represents one third of all federal funding for land conservation and recreation (Ferris and Siikamaki, 2009). In this program, farmers receive an annual payment if they convert highly erodible cropland to grassland. In the European Union, PES were introduced as ”Accompanying Measures” of the 1992 Common Agricultural Policy (CAP) reform and since 2000 they become a core instrument of rural development policies, being categorised as second pillar policies. The EU budget allocated to PES schemes evolved from 76 million Euro in 1993 to 3.03 billion Euro in 2010 (Arata and Sckokai, 2016). This makes the European PES program one of the biggest in the world.

In France, the Grassland Conservation Program was implemented in 1993 to reduce the decreasing pattern of grassland cover over the last 40 years: from 43% of the agricultural area in 1970 to only 27% in 2010. This decline is worrisome as extensive grassland management is believed to generate positive environmental externalities. It has been shown that grasslands store carbon in the soil (Soussana et al., 2004), are associated with low levels of water pollution (Agouridis et al., 2005) and with a high biodiversity level (Bretagnolle et al., 2012). Thus, the extent of grassland conversions is a central issue in the sense that the environmental impact of grassland loss greatly depends on the type of land use into which it is converted. Literature reviews on land use change and soil carbon demonstrate that while grassland to cropland conversions entail net soil carbon emissions, a conversion to forest land is carbon neutral with regards to soil carbon (Guo and Gifford, 2002; Poeplau et al., 2011), and therefore detrimental to climate mitigation when biomass is added to the budget. Similarly, grasslands are associated with higher water quality than croplands, but forest lands may again top both land uses (Abildtrup et al., 2013; Fiquepron et al., 2013). Therefore, knowing to which land use grassland is converted into is crucial when assessing the environmental impact of grassland conversions and hence the environmental impact of policies aimed at grassland conservation.

One critical parameter for evaluating the cost-effectiveness of a PES program is additionality (Chabé-Ferret and Subervie, 2013). It measures how much greener farmers practices have become thanks to the program. However, estimating this parameter is not an easy task since participation in this type of programs is voluntary and the potential for adverse selection is high. Indeed, farmers with the lowest costs of meeting the PES requirements are the most likely to enter the program. As a result, the program might end up paying some farmers for doing nothing differently from what they would have done without any payment. For this reason, additionality can be lower than expected and the overall efficiency of the program compromised. On the contrary, the higher its additionality, the most cost-effective a program is.

Most of the literature so far has used observational methods to estimate the additionality of PES programs. Observational methods compare contracting farmers to non-contracting farmers that have the same observed characteristics. However, these methods run the risk of being severely biased because of unobserved confounders. In the case of the French Grassland Conservation Program, Chabé-Ferret and Subervie (2009) show that observational methods are infeasible because the common support condition is not fulfilled. In other words, almost all eligible farmers have contracted a PES scheme aimed at grassland conservation, so there are not enough similar non-participants to perform the matching technique on.

Some papers have estimated the additionality of PES programs using Randomized Controlled Trials (Jack, 2013; Jayachandran et al., 2016). However, RCTs are not always doable, especially in the context of massive programs and also due to constraints on experimenting with EU funds. Other, few papers, relied on natural experiments to estimate the additionality of small scale PES programs. For example, Kuhfuss and Subervie (2018) look at the additionality of the French PES aimed at pesticide reduction. They use the exogenous variation in the timing of the implementation of the program as a natural experiment. Simonet et al. (2018) use the introduction of a Brazilian Forest conservation program to estimate its additional effects.

Even though PES programs are becoming increasingly important within the CAP framework, there is very little research evaluating them. To our knowledge, Pufahl and Weiss (2009), Chabé-Ferret and Subervie (2009) and Arata and Sckokai (2016) provide the only econometric analyses using a treatment effect approach that explicitly investigate the effects of EU PESs on grassland conservation. Pufahl and Weiss (2009) apply a DID-matching approach to a non-representative subsample of German farms to show that PESs are likely to increase both the area under cultivation and grassland. Chabé-Ferret and Subervie (2009), also using DID-matching, failed to provide statistically significant estimates of the impact of grassland extensive schemes in France. Finally, Arata and Sckokai (2016) use similar econometric tools to identify a statistically significant increase in the share of grassland for participant farmers which they attribute to the overall PES scheme, in five E.U. member states.

In this paper, we depart from the approach used in previous studies and we estimate the additionality of the French Grassland Conservation Program by exploiting the exogenous variation in the eligibility requirements that happened between 2000 and 2003. To our knowledge, this paper is among the first to evaluate a major nationwide conservation program using a natural experiment. Only Alix-Garcia et al. (2015) have previously evaluated a Mexican PES program that pays landowners for protecting forest. However, our paper differs in context and methodology, since we leverage as much as possible on the natural experiment to correct for the selection bias.

Our empirical strategy is to compare changes in outcomes between farmers living in communes[1] where the number of grassland conservation contracts increased between 2000 and 2003 and farmers living in communes where the number of contracts remained stable. We exploit this natural experiment in a difference-in-differences design and we recover an intention to treatment effect on farmers located in treated communes. We find some evidence that the eligibility criteria change lead to a small increase in grassland area, increase that comes at the expense of croplands and to a smaller extent from fodder areas. We also find evidence of more land transactions between farmers living in treated communes.

The remainder of the paper is structured as follows: Section 2 describes the French grassland conservation program; Section 3 exposes our empirical strategy; Section 4 introduces the data sources and summarizes the dataset used in this paper; Section 5 presents the results and Section 6 concludes and describes our future work.

[1]The commune is the smallest French territorial division for administrative purposes.

2 The French Grassland Conservation Program

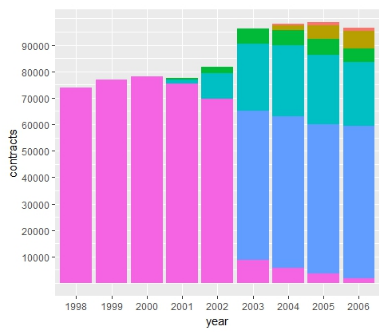
In France, support to extensive grazing was created in 1993 to stop the decline of grassland area. The program was first called ”Prime au Maintien des Systemes d'Elevage Extensifs” (PMSEE). PMSEE was a five year contract in which farmers committed to keep the grassland on the same parcels for the duration of the contract. In exchange, they were paid 35 to 46 Euro per hectare of grassland if they met two criteria: *(i)* a specialization rate (share of grassland in the total usable agricultural area) higher than 75% and *(ii)* a loading ratio (density of livestock units per hectare of forage area) inferior to 1.4. In 1998, PMSEE was renewed for another five years and an eligibility requirement related to the use of fertilisers was introduced: farmers were not allowed to exceed 70 units of nitrogen per hectare of grassland. The PMSEE was replaced in 2003 by a new extensive grazing scheme called ”Prime Herbagère Agro-Environnementale” (PHAE). The eligibility criteria for the PHAE were similar to those for PMSEE with three main exceptions. First, the thresholds for eligibility in terms of share of grassland and density of livestock units varied at department level.[2] Some departments kept the same thresholds as the PMSEE, while others chose a threshold for the specialization rate smaller than 75%, but never smaller than 50%. Also, some departments set the loading ratio higher than 1.4 LU/ha, but never larger than 1.8. Second, additional requirements were introduced, especially in order to limit the use of phytosanitary products and fertilizers on the plots. Finally, the payments were increased to 76 Euro per hectare of grassland.

PMSEE and PHAE were two national programs that specifically target grassland conservation. However, starting in 2000, France launched an ambitious new PES program as part of the National Plan for Rural Development (NPRD). It was first called ”Contrat Territorial d'Exploitation” (CTE) and was replaced in 2003 by ”Contrat d'Agriculture Durable” (CAD). Among all the new PES that this program instituted, two broad categories were actually subsidies to grassland conservation: the measures 19 and 20. The PES 19 subsidized the maintenance of grassland opening, where it was colonized by scrubs and trees, while the PES 20 subsidized extensive grassland management through mowing and/or pasture. The eligibility requirements for PES 19 and 20 were mainly that fertilization was limited on the field (in general, below 60 units of nitrogen per hectare of grassland). The main difference is that the PES 19 and 20 did not have any requirements on the specialization rate. As a consequence, these measures were taken also by farmers who were in general not eligible for PMSEE or PHAE due to a small share of grassland. Thus, PES

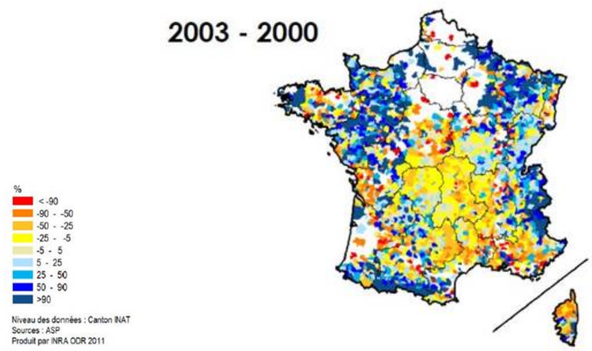
[2] There are 95 departments in France.

19 and 20 generated a new influx of farmers into the French Grassland Conservation Program (see Appendix A for a timeline and the eligibility requirements of the French Grassland Conservation Program).

As Figure 1a shows, the total number of contracts for grassland conservation surged in 2003, mainly thanks to the new PES 20. It is this increase that we use as a natural experiment. Figure 1b shows that the area engaged in a grassland conservation scheme increased mainly in the peripheral regions of France, whereas it remained rather stable in the center.



(a) Number of contracts



(b) Change over time in percent of acreage covered by PES 19 and 20 and PHAE

Figure 1: Grassland Conservation Program in France

3 Empirical Strategy

Our empirical strategy is to analyse the change in eligibility requirements that happened between 2000 and 2003, with the introduction of PES 19 and 20 and PHAE in a difference-in-differences (DID) design. We compare outcomes before and after the policy reform for the group of farmers living in communes where the number of grassland contracts increased (treated) to the group of farmers living in communes where the number of contracts decreased or remained stable (control). The two comparison groups can be easily identified in Figure 1b. The treatment group is located in non-mountain areas, where agriculture is dominated by large-scale intensive livestock, milk and arable production. Farmers in these areas were in general not eligible to PMSEE, but could contract a grassland conservation scheme through PES 19 and 20. The control communes are located in the central basin of France, where most of the extensive cattle growing is done due to less favourable natural conditions for agricultural production. The farmers in these communes were covered by PMSEE until 2002 and by PHAE since 2003. Therefore, they did not subscribe to PES 19 and 20.

Given that we have panel data on more than two periods, we use as estimation technique the two-way fixed effects, which is just an extension of the simple DID design. We prefer an aggregated level analysis over an individual level analysis that requires the implementation of a difference-in-differences combined with instrumental variable strategy. We do so because one of the main identification assumptions, the stable unit treatment value assumption (SUTVA), does not hold in our case for the individual level analysis. Indeed, SUTVA states that there should be no effect of the program on the control group, while Chabé-Ferret and Subervie (2009) show that PHAE triggered land transfers between the group of beneficiaries and non-beneficiaries. At commune level, this assumption is likely to hold since by aggregating farm outcomes we account for the land transfers taking place within a commune.

Therefore, we estimate the treatment effect at commune level through the following equation:

$$Y_{ct} = \widetilde{\alpha} D_{ct} + \widetilde{\beta} X_{ct} + \widetilde{\eta_c} + \widetilde{\xi_t} + \widetilde{\epsilon_{ct}} \tag{1}$$

where Y_{ct} is the aggregated outcome variable (for example grassland area in commune c at time t), D_{ct} takes a value of one starting in 2003 for communes where the number of contracts increased between 2000 and 2003, X_{ct} is the vector of aggregated control variables (for example mean farm size in commune c at time t), η_c and ξ_t represent commune and year fixed effects. The fixed effects control for time-invariant unobserved commune characteristics (e.g. altitude, slope) and for effects that are common to all communes at one point in time (e.g. changes in CAP policies that affect every farmer in the same way). It is reasonable to think that, in treated communes, among the analysed farmers there are not only PES beneficiaries, but also farmers that did not contracted any measure. Since we cannot disentangle between the two groups, we assume that a farmer located in a commune where the number of PES contracts increased has a higher probability of being eligible and possibly benefit from a grassland program. Therefore, what we recover here is the effect of the change in eligibility criteria for farmers potentially affected by this change (i.e. an intention-to-treat effect). For this approach to be consistent, there should be no systematic differences in trends between treated and control communes before 2003.

4 Data

We construct the database at commune level using two types of data. First, we use administrative data from France's Service and Payment Agency (ASP) provided to us by the Sustainable Development Observatory (ODR). This dataset contains the number of farmers receiving either PMSEE, PHAE, PES 19 or 20 every year from 1998 to 2007, in each commune. We build the comparison groups by computing the growth rate in the number of contracts in 2003 with respect to 2000. If the growth rate is positive, the commune belongs to the treated group, while if the growth rate is less or equal to zero, the commune is used as control.

Second, in order to estimate the outcome variables, we resort to data from two sources. Our main outcomes are the area of grassland, crops and fodder, the total utilised agricultural area, the share of grassland in the utilised agricultural area (specialization rate), the number of livestock and their density (loading ratio). A detailed definition of these variables is given in Appendix B. We use farm level data provided by the Ministry of Agriculture. More specifically, we use the 2000 agricultural census and the farm structure surveys from 1993 to 2007. These surveys are conducted every two years between censuses on 10 % of farmers. Thus, to construct our outcome variables, we first weight the farm level data using the sampling weights provided in the survey and then we sum the weighted data at commune level. We estimate the control variables in the same way and from the same datasets as the outcomes. Our controls include the type of crop orientations, the mean economic size of the farms and the number of farms in each commune.

We also use commune level satellite data on grassland, agricultural and crop area from Corine Land Cover. This project is part of the CORINE (Coordination of information on the environment) program of the European Commission and provides localized geographical information on the land cover of 39 European States. It is the result of visual interpretation of satellite images with the use of additional data such as topographic maps, thematic land cover maps, statistical information and aerial photographs. The scale of production is 1/100 000 and the minimum mapping unit is 25 ha. The continuity of the program and the dissemination of Corine Land Cover data are guided by the European Environment Agency. In France the producer is the Observation and Statistics Service of the Ministry of the Environment. Data is available for years 1990, 2000, 2006 and 2012, but we only use the first three years in our analysis. Yet, due to the 25 ha threshold on the minimum mapping unit and the 1/100 000 mapping scale, the commune level data is not very precise (Corine Land Cover User Guide).

In the commune level analysis we look at farmers[3] and we restrict the sample to those communes where at least one farmer has received a subsidy for grassland conservation over the period 1998 to 2007. This sample constraint enable us to compare potentially more similar communes than if we would have considered all communes in France. We work with two balanced panels: one from 1993 to 1997 and one from 2000 to 2007. The reason why we decided to split the data into two periods is that survey identifiers are erased at each census. In our case this happens in 2000, so having a coherent balanced panel over the whole period is impossible. We thus use a balanced panel of 13,880 communes from 1993 to 1997 to perform the placebo test and a balanced panel of 14,391 communes from 2000 to 2007 to recover the treatment effect. Among these, 10,812 communes are common between the two periods.[4] We choose the time window 1993-2007 to avoid possible complications due to the fact that there was no grassland conservation program before 1993 and that the new scheme starting in 2007 had many changes compared to the previous one.

Table 1 reports the mean and standard deviation of our outcome variables, by treatment group and sample. Treated and control communes do not differ much in terms of mean specialization rate and loading ratio. However, farmers in treated communes are characterized by owning more land in crops, fodder and grassland and having more animals. This selection in levels does not create any problems for our identification strategy since the DID methodology removes permanent differences between the treated and control group.

5 Results

In this section we present both graphical evidence and regression results of the treatment effect on outcomes for the commune level analysis. As a general description, the first column of plots in each figure (denoted by (a)) represents the placebo test on the 1993-1997 sample of communes. The second one (denoted by (b)) shows the treatment effect of the program on the sample of communes from 2000 to 2007. The first plots of each column present the trends in average outcome variables by treatment status, while the second line of plots show the yearly coefficient on the difference between treated and

[3]We consider as farmers those having at least one hectare of utilised agricultural area on their farm.

[4]We also build a balanced panel of 10,812 communes over the whole period, but we observe a huge drop in all our outcome variables between 1997 and 2000 that we cannot explain otherwise than by a weighting problem. We choose thus to split the sample into two periods in order to avoid capturing this decrease in the treatment effect.

controls. These coefficients can be interpreted as an estimate of the impact of being treated on the outcome variable in a given year. The effect is statistically significant if zero is not included in the 95% confidence interval, represented by dashed lines.

Figure 2 plots the total number of grassland conservation contracts over time, by treatment status for our sample of communes. As expected (and by construction), the treated communes see a sharp increase in the number of participants starting in 2001 and especially marked from 2002 to 2003. The number of beneficiaries in treated communes jumps from slightly above 40,000 in 2000 to slightly above 65,000 in 2003. In the control communes, the number of beneficiaries decreases slightly over time.

How does the change in the number of contracts translate in terms of outcomes? Figure 3 shows that the yearly coefficients fluctuate around zero before 2000, which means that there is no difference in grassland area between treated and control communes from 1993 to 1997. Between 2000 and 2007 the wedge opens up, suggesting a small positive impact of the Grassland Conservation Program. Not the same pattern arises for the utilised agricultural area in Figure 4. We can observe a small increase in the agricultural area in the pre-treatment period and this represents a failure of the parallel trend assumption for this outcome variable. Therefore, the increase we observe after 2000 for the treated communes with respect to controls cannot be attributed to the program. The same remark can be made for the specialization rate in Figure 5. In Figure 6 we see that from 1995 to 1997 there is a significant increase in the crop area between treated and control communes, while after 2000 the difference becomes negative. The fodder area does not seem to be affected by the change in eligibility requirements, as the yearly coefficients swing around zero after 2000 (Figure 7). Figure 8 shows that the number of livestock increases slightly in the pre-treatment period in treated communes, and it continues to increase even after 2000. Finally, from Figure 9 it seems that there is no difference in treated and control communes in terms of loading ratio between 1993 and 1997. However, after 2000 there is slight decrease in the loading ratio that could be attributed to the treatment. To sum up, the visual examination of trends in outcome variables suggests that there is a small positive effect of the program on the grassland area and a small negative effect on the loading ration in treated communes. For the other outcomes considered the parallel trends assumption does not hold, so we cannot form conclusions about the policy effect.

Table 2 presents the results of the fixed effects regression both with and without the additional control variables mentioned previously in the data section. The results on the pre-2000 sample confirm that trends between treated and controls are parallel for the grassland area and the loading ratio. For the other outcome variables, the estimated coefficients suggest that there was an increasing trend in treated communes even before the policy reform. Therefore, for these variables we cannot interpret the coefficients estimated between 2000 and 2007 as representing the effect of the grassland program. Nevertheless, we find that the change in eligibility criteria lead to an increase of 11.53±7.9 ha in grassland area and a decrease in the loading ratio of 0.04±0.16. These results still hold after conditioning on covariates.

To check whether our results remain the same with different specification and sample of communes, we perform some robustness checks. To solve for a potential endogeneity concern due to the fact that eligibility criteria is set at department level, we include department-specific yearly fixed effects in our main specification (Table 3). Then, we restrict the sample to the same communes for the whole 1993-2007 period (Table 4) and we look at the unbalanced sample of communes (Table 5). Even though the precision and magnitude of the estimated coefficients varies slightly with the sample size (i.e the bigger the sample size, the more precise estimation), in all cases the main results are unchanged compared to the ones estimated on the balanced sample of different communes between the two periods.

We cannot support conclusions about many of our outcome variables, but it looks like the farmers located in treated communes shifted some of their land from crops, and to a lower extent from fodder area, to grassland. However, the small increase in the utilised agricultural area suggests that there is also something else happening. It could be that some of the increase in grassland area comes at the expense of other land uses, such as forest or scrubs or because farmers expand their farm by buying or renting land from shrinking or intensifying farms. We can test the first hypothesis by looking at outcomes such as buildings area, poplars area, forest area and non-productive land, again aggregated at commune level. The results in Table 6 show that there were no significant changes in these variables from 1993 to 2007. Therefore the increase in the utilised agricultural area at commune level does not come from this type of land uses. To test the second hypothesis we look at the aggregated utilised agricultural area that is owned, rented or in sharecropping. From Table 7 we find that, after 2000, there was a strong preference for renting land (39.83±12.94 ha) rather than owning it (-23.56±10.04 ha) in treated communes with respect to control communes. Therefore, it seems that the increase in agricultural area, and implicitly a part of the increase in grassland area, comes from rented land.

As a final robustness check of our results, we perform again the baseline analysis using Corine Land Cover data. Table 8 reports fixed effects results using satellite data on land use, both on the same sample of communes as in the previous treatment effect analysis

(2000-2007) and on the full sample of communes with at least one grassland PES beneficiary. The point estimates lack statistical significance at conventional levels, therefore we find no changes in our outcome variables between the two groups of communes. This is mainly due to the fact that the minimum mapping unit for Corine Land Cover data is as big as 25 ha and thus it cannot recover small and scattered changes in land use. Nevertheless, we can identify the same switch from croplands to grassland in treated communes.

Putting everything together, our tentative interpretation is that the policy reform has induced some farmers living in the treated communes to keep more grassland on their farms mainly at the expense of croplands and it also seems to have induced land transactions between farmers. Our interpretation is in line with Pufahl and Weiss (2009) findings that, in order to comply with the program requirements, farmers choose to expand grassland while keeping total livestock units stable on their farm. They further argue that farm growth is mainly achieved by renting additional land.

6 Conclusion

Payments for Ecosystem Services are being increasingly used in the context of development and environmental policies around the world. Yet, the empirical analysis of their effectiveness remains somewhat sparse. In this paper we provide one of the first evaluation of a major nationwide PES program, the French Grassland Conservation Program. Unlike most of the literature so far, our approach does not rely on matching beneficiaries with similar non-beneficiaries. Instead, we use the exogenous change in eligibility criteria for participating in a grassland program as a natural experiment. We perform the analysis at aggregated, commune level, comparing changes in outcomes both over time and between communes where the number of grassland contracts increased after the policy change and communes where the number of contracts remained the same or decreased. Even though we cannot identify the farmers benefiting from the grassland PES within a commune, we recover the effect of the change in eligibility criteria on all farmers located in treated communes, accounting for land transfers as well.

Our results suggest that some farmers in treated communes increased the grassland area on their farm at the expense of croplands, while others possibly by renting land from other farmers. This is in line with results from previous research evaluating the effect of overall PES programs in a given country on grassland and other farm outcomes. However, our results are in general not estimated with enough precision to support rigorous conclusions. We believe that this is mostly due to the sampling noise, since we estimate commune level totals from weighted survey data. To overcome this issue, we plan to perform the empirical analysis using the log of outcomes and also look at the individual level analysis.

On a longer run, we would like to assess the true cost for a farmer to participate in the program and to evaluate the impact of the program on climate change mitigation by quantifying the avoided CO_2 emissions. True costs refer to the decrease in profits that the farmer has experienced as a consequence of adopting green practices. Since PES are voluntary programs, it is most likely that farmers costs of adopting the greener practices are lower than the compensation they receive, otherwise they would not have chosen to participate in the scheme. The problem is that the greater the difference between true costs and compensation, the less cost-effective the program is. To evaluate these costs, we are going to look at the gross margin per hectare of grassland of every farmer reporting to the Farm Accountancy Data Network. If the profit per hectare of grassland is greater than zero and equal to the amount of subsidy received, then the subsidy is just an extra revenue for the farmer, and the cost-effectiveness of the program is at risk. To evaluate the impact of the program on climate change mitigation, we plan to couple a carbon calculator, similar to the one used in Baudrier et al. (2015), with land use and management changes attributed to the program. By applying our empirical strategy to land use data from TERUTI surveys, we can identify more precisely the types of conversion avoided thanks to the grassland conservation program and therefore a reliable proxy for the avoided CO_2 emissions. As a final goal of this paper, we would like to gather everything in a cost-benefit analysis of the French Grassland Conservation Program.

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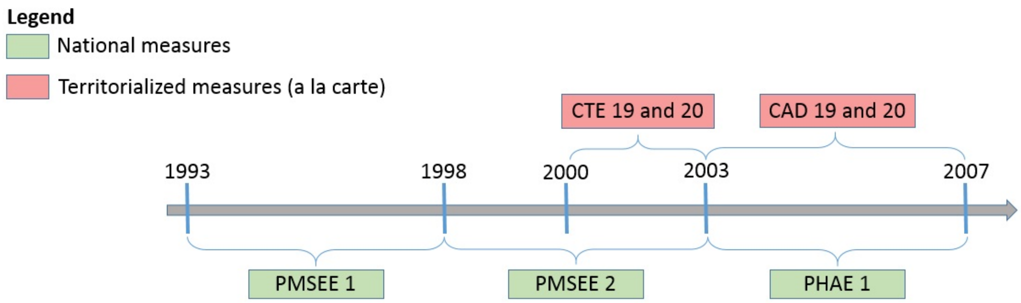
A The Grassland Conservation Program in France



Eligibility Criteria / Measure	PMSEE 2	PHAE 1	CTE/CAD 19 AND 20
Farmer's age	≤ 60 years	≤ 60 years	—
Farm size	≥ 3 ha UAA and ≥ 3 LU	—	—
Specialization Rate (Grassland/Utilised Agricultural Area)	≥ 75%	≥ 50% - ≥ 75% department dependent	—
Loading Ratio (Livestock Units/Fodder Area)	≤ 1.4	≤ 1.4 - ≤ 1.8 department dependent	≤ 1.4 - ≤ 1.8 department dependent
Fertiliser use (Units of Azote/ha of Grassland)	≤ 70	≤ 60	≤ 60
Max amount of subsidy / ha of grassland	**46€**	**76€**	**91€**

B Data

Outcome variables (Census and Survey data):

- grassland area (ha) = natural grassland or pastures having more than 6 years on the same plot and low productivity grassland area;
- utilised agricultural area (ha) = annual crops, permanent crops and temporary and permanent grassland;
- crop area (ha) = cereals, industrial crops, pulses and protein crops;
- fodder area (ha) = corn forage and silage, forage root crops and other annual forages;
- livestock units = cattle, equines, goats and sheep (expressed in cattle units);
- specialization rate (%) = the share of temporary and permanent grassland in the utilised agricultural area;
- loading ratio = density of livestock units in the forage area (permanent grassland and fodder area without corn forage).

Outcome variables (Corine Land Cover data):

- grassland area (ha) = grass cover of floral composition, not under a rotation system, mainly used for grazing;
- agricultural area (ha) = arable land, permanent crops, grassland and heterogeneous agricultural areas;
- crop area (ha) = arable land.

Table 1: Mean and Standard deviation of outcome variables, by treatment group and by sample

	1993-1997		**2000-2007**	
	Treated group	**Control group**	**Treated group**	**Control group**
Grassland area	580.72	489.66	543.43	419.28
	(781.76)	(680.09)	(764.12)	(565.9)
Utilised agricultural area	1389.29	1144.32	1327.12	1069.74
	(1422.42)	(1180.28)	(1324)	(1021.94)
Crop area	422.32	341.7	413.59	346.48
	(684.77)	(585.27)	(625.98)	(517.25)
Fodder area	92.55	71.66	78.51	62.82
	(196.92)	(176.03)	(153.85)	(135.41)
Livestock units	1169.75	911.16	1107.4	829.29
	(1503.49)	(1254.75)	(1394.58)	(1115.56)
Specialization Rate	56.35	56.23	54.74	52.73
	(32.71)	(34.22)	(32.74)	(34.09)
Loading Ratio	1.54	1.48	1.57	1.55
	(2.8)	(4.93)	(5.48)	(7.38)
Observations	**7,701**	**6,179**	**8,106**	**6,285**

C Results

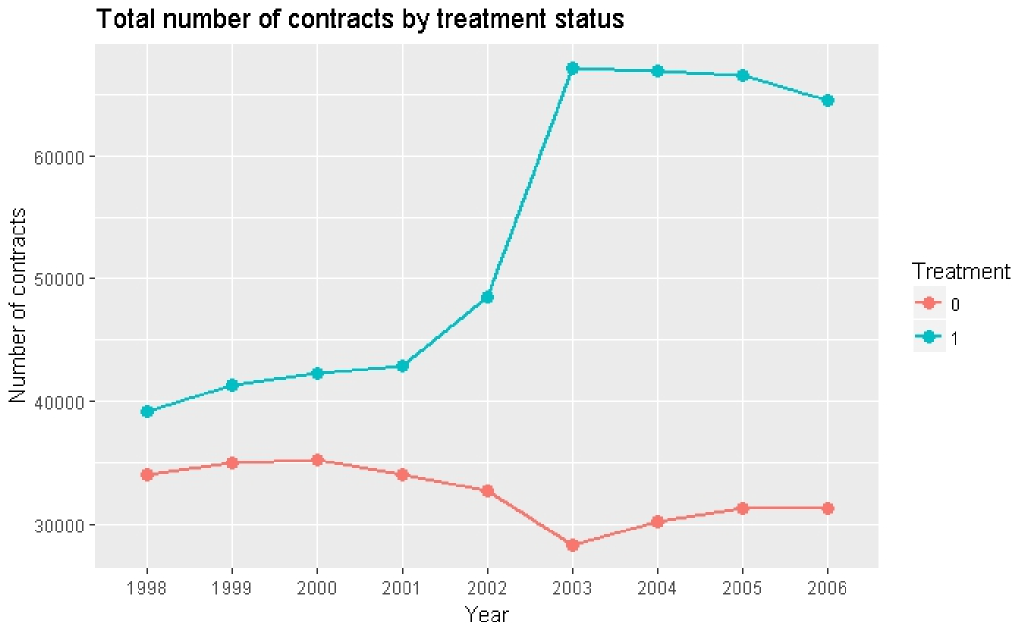
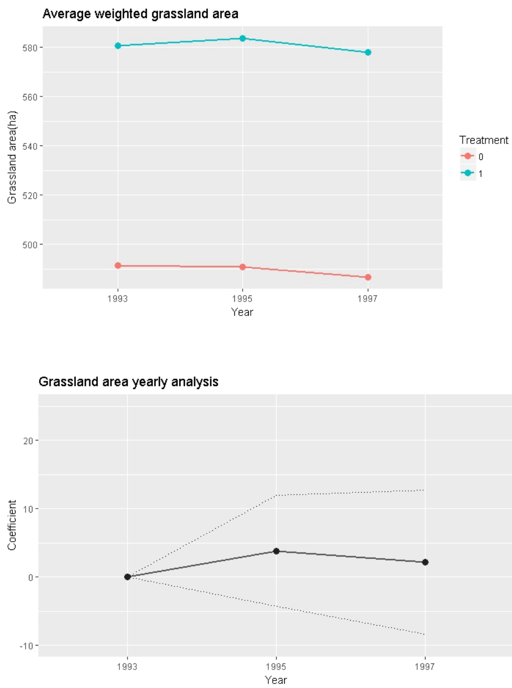
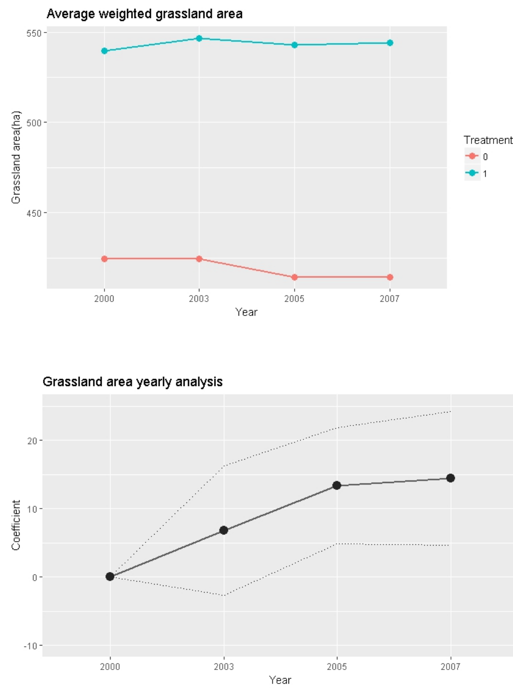


Figure 2: Total number of grassland conservation contracts from 1998 to 2006 by treatment status

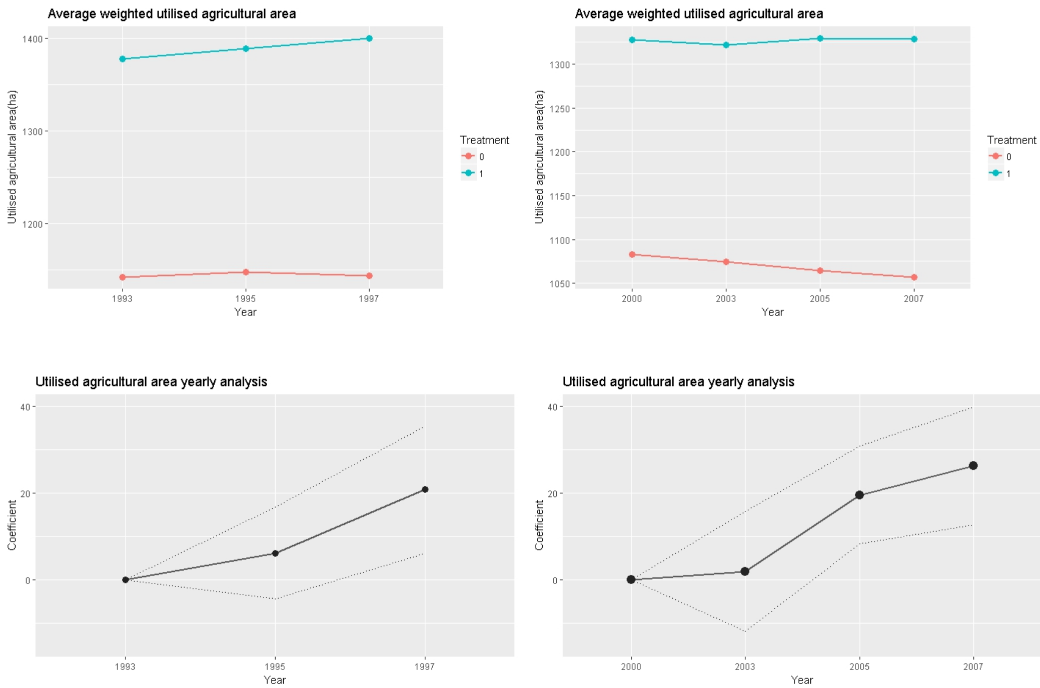


(a) Placebo Test (1993-1997)



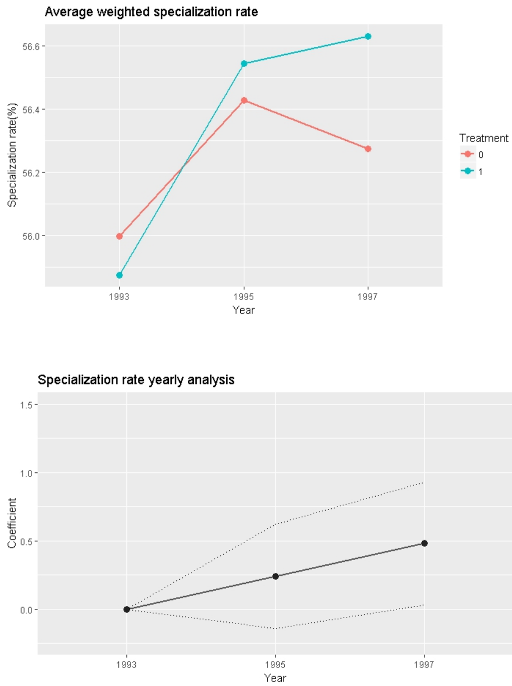
(b) Treatment Effect (2000-2007)

Figure 3: Trends in grassland area by treatment status and sample

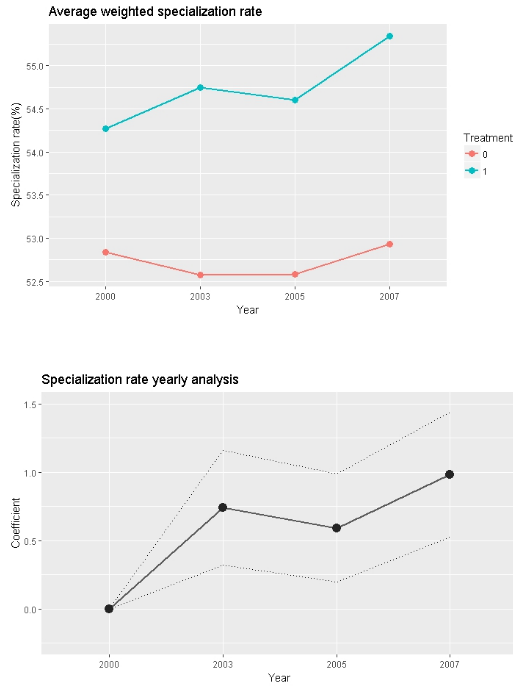


(a) Placebo Test (1993-1997)
(b) Treatment Effect (2000-2007)

Figure 4: Trends in utilised agricultural area by treatment status and sample

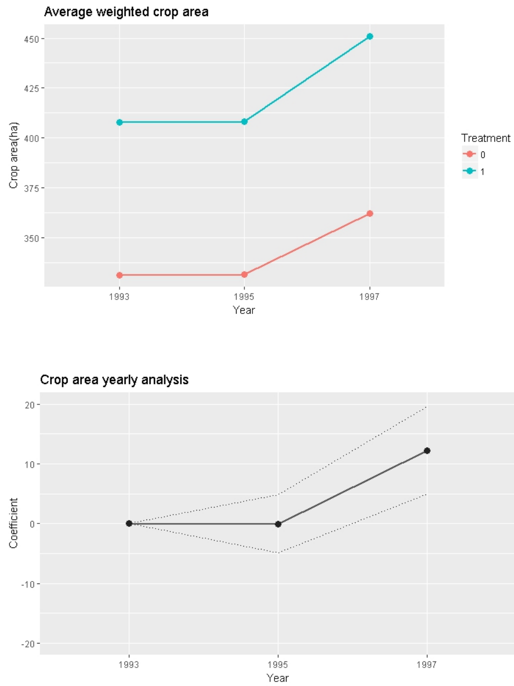


(a) Placebo Test (1993-1997)

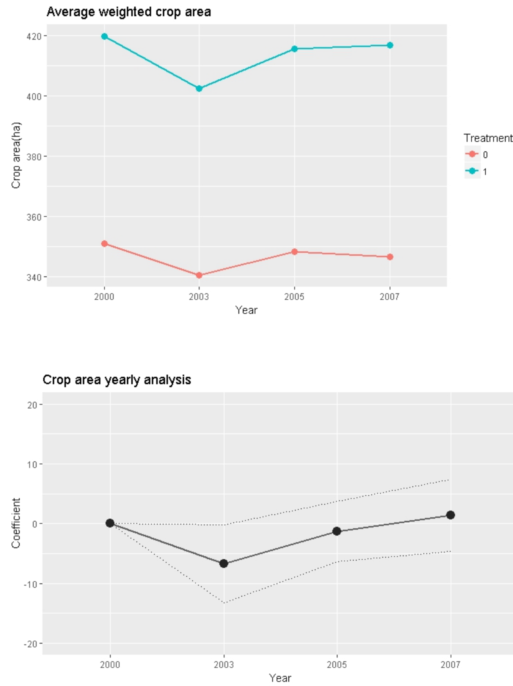


(b) Treatment Effect (2000-2007)

Figure 5: Trends in specialization rate by treatment status and sample

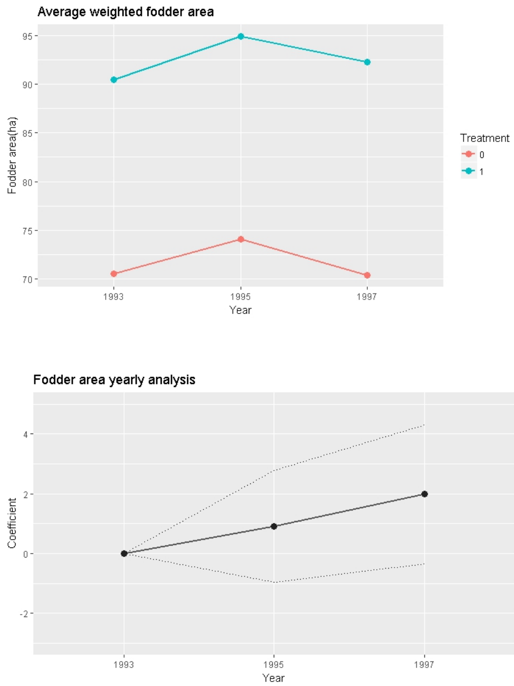


(a) Placebo Test (1993-1997)

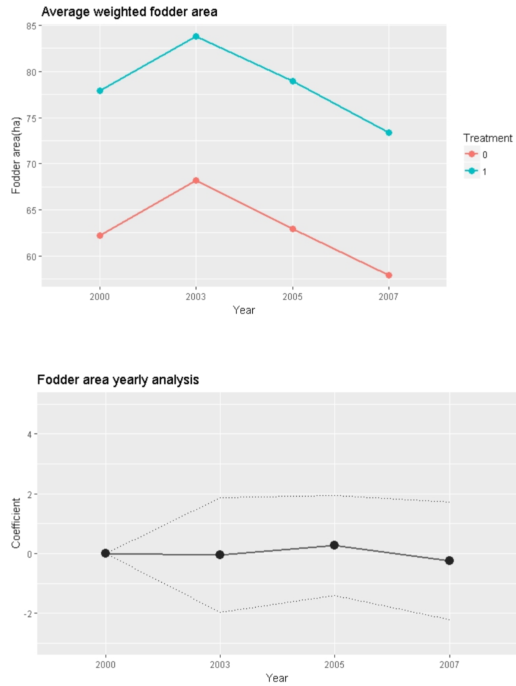


(b) Treatment Effect (2000-2007)

Figure 6: Trends in crop area by treatment status and sample

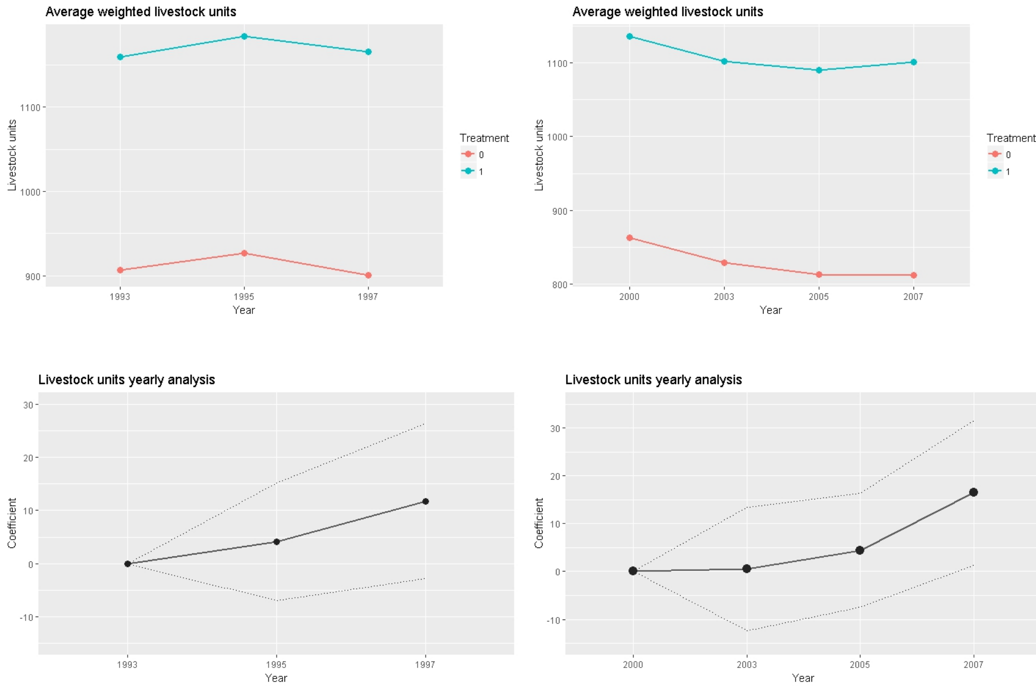


(a) Placebo Test (1993-1997)



(b) Treatment Effect (2000-2007)

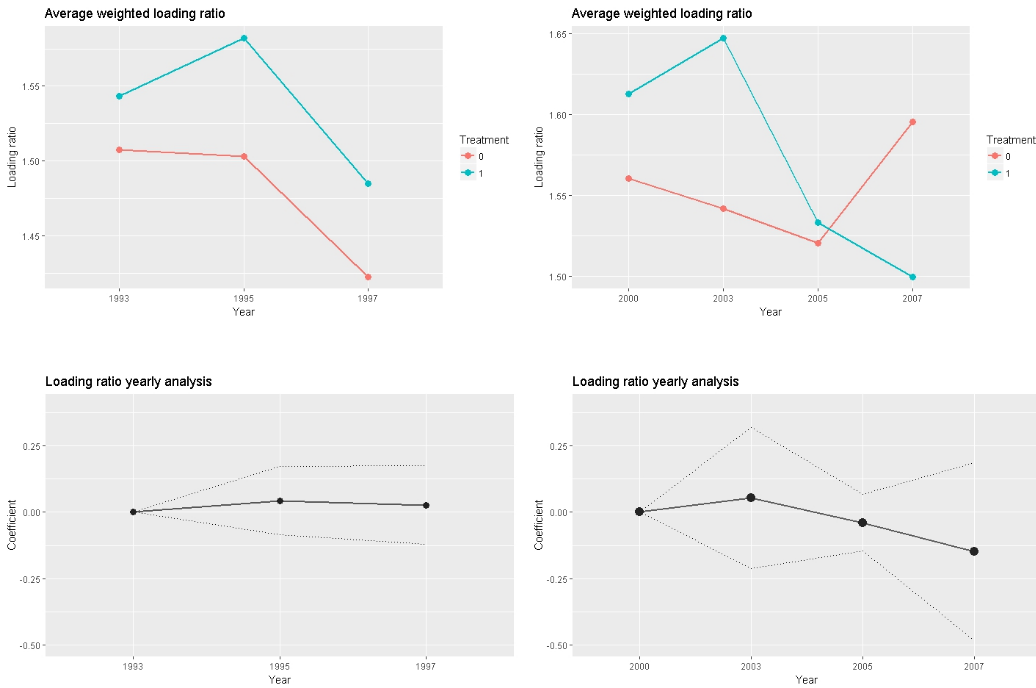
Figure 7: Trends in fodder area by treatment status and sample



(a) Placebo Test (1993-1997)

(b) Treatment Effect (2000-2007)

Figure 8: Trends in livestock units by treatment status and sample



(a) Placebo Test (1993-1997) (b) Treatment Effect (2000-2007)

Figure 9: Trends in loading ratio by treatment status and sample

Table 2: DID-FE Results

	Placebo Test (1993-1997)		**Treatment Effect (2000-2007)**	
	No controls	With controls	No controls	With controls
Outcome Variables				
Grassland area	3.01	5.30	11.53**	12.66***
	(4.28)	(4.06)	(3.95)	(3.77)
Utilised agricultural area	13.51*	17.50***	15.95**	16.85**
	(5.89)	(5.22)	(5.40)	(5.08)
Crop area	6.11*	7.28**	−2.20	−1.53
	(2.82)	(2.64)	(2.40)	(2.30)
Fodder area	1.45	1.76	−0.01	−0.13
	(0.94)	(0.92)	(0.76)	(0.74)
Livestock units	7.95	11.05*	7.13	7.85
	(5.84)	(5.19)	(5.70)	(5.26)
Specialization Rate	0.36	0.40*	0.77***	0.83***
	(0.19)	(0.18)	(0.18)	(0.17)
Loading Ratio	0.03	0.03	−0.04	−0.05
	(0.06)	(0.07)	(0.08)	(0.08)
Observations	**13,880**	**13,880**	**14,391**	**14,391**

Note: Year and commune fixed effects estimation. Robust standard errors clustered at commune level in parenthesis. *p $<$ 0.1; **p $<$0.05; ***p $<$ 0.01.

Table 3: DID-FE Results (including Department x Year FE)

	Placebo Test (1993-1997)		Treatment Effect (2000-2007)	
	No controls	With controls	No controls	With controls
Outcome Variables				
Grassland area	2.93	4.60	10.38**	11.98***
	(4.03)	(3.88)	(3.78)	(3.58)
Utilised agricultural area	11.25*	14.67**	14.10**	15.57**
	(5.35)	(4.77)	(5.39)	(4.80)
Crop area	3.48	4.38	−2.35	−1.86
	(2.64)	(2.47)	(2.53)	(2.33)
Fodder area	1.57	1.79*	0.16	0.02
	(0.91)	(0.89)	(0.79)	(0.76)
Livestock units	7.07	10.19*	7.72	8.49
	(5.60)	(5.02)	(5.49)	(4.96)
Specialization Rate	0.38*	0.41*	0.55**	0.62***
	(0.18)	(0.17)	(0.17)	(0.17)
Loading Ratio	0.03	0.02	−0.04	−0.04
	(0.06)	(0.06)	(0.13)	(0.13)
Observations	**13,880**	**13,880**	**14,391**	**14,391**

Note: Year and commune fixed effects estimation. Standard errors in parenthesis. *p < 0.1; **p <0.05; ***p < 0.01.

Table 4: DID-FE Results (the same sample of communes)

	Placebo Test (1993-1997)		**Treatment Effect (2000-2007)**	
	No controls	With controls	No controls	With controls
Outcome Variables				
Grassland area	2.65	4.46	12.53**	13.72**
	(5.07)	(4.80)	(4.80)	(4.58)
Utilised agricultural area	15.39*	17.85**	15.80*	16.38**
	(7.03)	(6.21)	(6.58)	(6.19)
Crop area	5.98	6.65*	−2.37	−2.28
	(3.40)	(3.18)	(2.90)	(2.79)
Fodder area	1.48	1.71	−0.23	−0.16
	(1.14)	(1.11)	(0.92)	(0.90)
Livestock units	9.33	11.13	7.50	9.53
	(7.01)	(6.22)	(6.94)	(6.41)
Specialization Rate	0.44*	0.48*	0.55**	0.60**
	(0.21)	(0.20)	(0.20)	(0.20)
Loading Ratio	0.01	0.00	−0.03	−0.03
	(0.08)	(0.09)	(0.10)	(0.10)
Observations	**10,812**	**10,812**	**10,812**	**10,812**

Note: Year and commune fixed effects estimation. Robust standard errors clustered at commune level in parenthesis. *p < 0.1; **p <0.05; ***p < 0.01.

Table 5: DID-FE Results (unbalanced sample of communes)

	Placebo Test (1993-1997)		**Treatment Effect (2000-2007)**	
	No controls	With controls	No controls	With controls
Outcome Variables				
Grassland area	3.17	5.44	10.98**	11.75**
	(4.19)	(3.98)	(3.80)	(3.63)
Utilised agricultural area	13.46*	17.44***	15.89**	15.36**
	(5.77)	(5.11)	(5.16)	(4.86)
Crop area	5.81*	7.02**	−1.30	−1.35
	(2.76)	(2.58)	(2.28)	(2.18)
Fodder area	1.47	1.77*	−0.18	−0.42
	(0.92)	(0.90)	(0.71)	(0.70)
Livestock units	8.80	11.73*	5.93	5.47
	(5.75)	(5.11)	(5.39)	(4.98)
Specialization Rate	0.43*	0.47*	0.56**	0.64**
	(0.19)	(0.19)	(0.19)	(0.19)
Loading Ratio	0.03	0.03	−0.04	−0.04
	(0.06)	(0.07)	(0.07)	(0.07)
Observations	**14,745**	**14,745**	**20,292**	**20,292**

Note: Year and commune fixed effects estimation. Robust standard errors clustered at commune level in parenthesis. *p $<$ 0.1; **p $<$0.05; ***p $<$ 0.01.

Table 6: DID-FE Results for the first hypothesis on SAU increase

	Placebo Test (1993-1997)		**Treatment Effect (2000-2007)**	
	No controls	With controls	No controls	With controls
Outcome Variables				
Buildings area	0.13	0.22	0.26	0.26
	(0.17)	(0.17)	(0.14)	(0.14)
Poplars area	0.27	0.23	−0.16	−0.16
	(0.29)	(0.27)	(0.14)	(0.14)
Forest area	1.36	1.65	1.61	1.52
	(3.13)	(3.12)	(4.02)	(3.97)
Non-productive land	−0.50	−0.42	−0.86	−0.86
	(1.45)	(1.45)	(1.53)	(1.54)
Observations	**13,880**	**13,880**	**14,391**	**14,391**

Note: Year and commune fixed effects estimation. Robust standard errors clustered at commune level in parenthesis. $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Table 7: DID-FE Results for the second hypothesis on SAU increase

	Placebo Test (1993-1997)		**Treatment Effect (2000-2007)**	
	No controls	With controls	No controls	With controls
Outcome Variables				
Utilised agricultural area owned	−0.24	2.58	-23.56^{***}	-21.97^{***}
	(4.89)	(4.70)	(5.02)	(4.85)
Utilised agricultural area rented	16.07^{*}	16.92^{*}	39.83^{***}	39.06^{***}
	(6.67)	(6.51)	(6.47)	(6.31)
Utilised agricultural area in sharecropping	−2.33	−1.99	−0.64	−0.56
	(2.23)	(2.22)	(1.38)	(1.37)
Observations	**13,880**	**13,880**	**14,391**	**14,391**

Note: Year and commune fixed effects estimation. Robust standard errors clustered at commune level in parenthesis. $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Table 8: DID-FE Results using satellite data

	Placebo Test (1990-2000)	Treatment Effect (1990-2006)	
	(2000-2007 sample)	(2000-2007 sample)	(All beneficiaries)
Outcomes			
Grassland area	−0.01	0.64	0.43
	(0.33)	(1.31)	(0.98)
Agricultural area	0.52	0.93	0.67
	(0.32)	(0.61)	(0.46)
Crop area	−0.04	−0.63	−0.30
	(0.34)	(1.47)	(1.08)
Observations	**14,388**	**14,388**	**20,317**

Note: Year and commune fixed effects estimation. Robust standard errors clustered at commune level in parenthesis.