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# Can we nudge farmers into saving water? Evidence from a randomized experiment

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CEE-M Working Paper 2018-10

# Can We Nudge Farmers Into Saving Water? Evidence from a randomized experiment.

Sylvain Chabé-Ferret\*    Philippe Le Coënt†    Arnaud Reynaud‡  
Julie Subervie§    Daniel Lepercq¶

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## Abstract

Improving water efficiency is a growing challenge for the Common Agricultural Policy. In this article, we test whether social comparison nudges can promote water-saving behavior among farmers. We report on a pilot Randomized Controlled Trial, in which information on individual and group water consumption were sent every week to farmers equipped with smart meters. We do not detect an effect of nudges on average water consumption. We however find that the nudge decreases water consumption at the top of the distribution while it increases consumption at the bottom. This study highlights the potential of nudges as an agricultural policy tool.

Keywords: Nudges, Behavioral Economics, Irrigation Water Use, Government Policy.  
JEL Classifications: D90, Q25, Q58.

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\*French National Institute for Agricultural Research (INRA), TSE and IAST

†CEE-M, Univ Montpellier, CNRS, INRA, Montpellier SupAgro, Montpellier, France, TSE

‡French National Institute for Agricultural Research (INRA) and TSE

§French National Institute for Agricultural Research (INRA) and CEE-M

¶Compagnie d'Aménagement des Coteaux de Gascogne (CACG)

# 1 Introduction

Agricultural production is among the most water-intensive human activities in the European Union (EU).<sup>1</sup> Water scarcity is already a key challenge in Southern Europe and it is expected to become even more severe and widespread in the coming years because of climate change. From 1960 to 2010, renewable water resources per capita have decreased by 24 percent in Europe, particularly in southern Europe, and the key objectives of the Seventh Environment Action Programme related to quantitative management of water for the years 2002–2014 have not been achieved (EEA, 2017). Improving water use efficiency, including the efficiency of irrigation in agriculture, has thus become one of the priorities of the new Common Agricultural Policy (CAP) 2014-2020.<sup>2</sup> The CAP, currently relies on the complementary effects of three policy instruments: cross-compliance requirements (i.e. the compulsory environmental obligations to be met by farmers to be eligible for EU payments), green direct payment, and investment subsidies for water-efficient technologies. The last two instruments however represent a considerable expense and political tensions between farmers and regulatory agencies make it difficult to apply regulatory or tax-based approaches in some countries like France. In such context, agricultural researchers and practitioners have considered a new approach that is increasingly being adopted in other public policy contexts: embed insights from the behavioral sciences into program designs to trigger pro-environmental behaviors among farmers (Ferraro, Messer, and Wu, 2017). In this study, we test whether what the behavioral sciences call social comparison nudges – reports comparing individual consumption to the consumption of similar neighbors – can contribute to the promotion of water-saving behavior among French farmers.

There has been considerable interest recently in the ability of social comparison nudges to trigger changes in pro-environmental behaviors (Schubert, 2017; Croson and Treich, 2014). Social comparison nudges can be a cost-effective way to change behavior even if their effects are small because they can be applied to a large population at a small cost. Most of the empirical evidence described in the scientific literature on green nudges has focused on consumers' behavior and has been able to demonstrate significant, albeit small, effects on electricity and water consumption for example (Allcott, 2011; Ferraro, Miranda, and Price, 2011; Byerly et al., 2018). It is still unclear though whether social comparison nudges can influence the behavior of economic agents in a professional or income-generating activity such as farming (Messer, Ferraro, and William, 2015; Ferraro, Messer, and Wu, 2017). On the one hand, there are good reasons to believe that the responses to nudges of economic agents in a professional context might differ from responses of consumers. If the activity to

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<sup>1</sup>The Agriculture, Forestry and Fishing sector represents 51.4 percent of total water use in the European Union. These figures are provided by the website of the European Environment Agency 2017.

<sup>2</sup>Regulation (EU) No 1305/2013 of the European Parliament and of the Council of 17 December 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) No 1698/2005.

be nudged is important for the economic agent's income, they may react intensely to new information about others' practices. This assumption is supported by recent studies which highlights the influence of social norms in farmers' pro-environmental decisions (Le Coent, Préget, and Thoyer, 2018; Kuhfuss et al., 2016; Burton, 2004). On the other hand, it is also likely that farmers have already reached a private optimum and are not likely to change their behavior following a non-monetary incentive. It thus remains an empirical question whether social comparison nudges can be efficient in changing strategic agricultural practices, such as the amount of water use for irrigation.

During the summer of 2017, we implemented a Randomized Control Trial (RCT) in partnership with a water distribution company in South-West France, the Compagnie d'Aménagement des Coteaux de Gascogne (CACG), to test the effectiveness of a social comparison nudge to reduce farmers' use of irrigation water. The use of smart meters and an automated texting platform made it possible to send weekly text messages to farmers containing their own water use and that of their neighbors at a very low cost. We ran two experiments: the first one (Experiment 1) involved farmers equipped with smart meters, who received water use reports on their individual consumption and that of their neighbors, while the other one (Experiment 2) involved farmers with traditional meters, who thus received weekly reports on their neighbours' water consumption only. In both experiments, as a protection against possible Hawthorne effects that have been found in similar studies (Schwartz et al., 2013), farmers in the control group receive a weekly placebo text message containing an invitation to optimize water usage, but devoid of any information on their own consumption and on that of their neighbors.

Our analysis does not show any significant impact of the treatment on average total consumption in both experiments. Our precision enables us to rule out large to medium effects of the social comparison nudges on water consumption. These results nevertheless mask a strong heterogeneity of effects in Experiment 1. The treatment seems to have decreased the proportion of farmers who consume more than 80 percent of their quota, which suggests that social comparison nudges can be effective at correcting the behavior of those who irrigate the most and who are also presumably more likely to waste water. The treatment also seems to have decreased the proportion of those who do not consume water at all. This suggests that the treatment also had a perverse effect since it triggered unexpected consumption decisions among those who would have not consumed any water in the absence of intervention – something often referred to as boomerang effect in the literature. We discuss this result in the paper. Although the results of this pilot are not scalable, we see at least two important takeaways from them. First, they suggest that insights from behavioral sciences can be used to trigger water-saving behavior — and maybe other pro-environmental practices – among farmers, provided boomerang effects can be avoided. Second, they also suggest that nudges could be mobilized on a larger scale to improve the design of the second pillar of the CAP.

The paper is structured as follows. Section 2 provides key results of the rapidly growing literature on green nudges. Section 3 presents the context of the study. Section 4 describes the experimental design and the data. Section 5 presents the results. We discuss these results in Section 6 and conclude with policy implications in Section 7.

## **2 Literature on social comparison nudges**

A large amount of research in economics and psychology has been devoted to testing the effect of social comparison nudges on pro-environmental behavior using experimental approaches. Social comparison nudges, based on a comparison between individual consumption and the consumption of neighbors, have been shown to have an effect on the reduction of households' electricity and water consumption (Allcott, 2011; Ferraro and Price, 2013; Nolan et al., 2008; Ayres, Raseman, and Shih, 2013; Costa and Kahn, 2013; Ferraro, Miranda, and Price, 2011). Similar results have been obtained on curbside recycling (Schultz, 1999) and guests' towel reuse in hotels (Goldstein, Cialdini, and Griskevicius, 2008). There are however contradictory results on whether social comparison nudges have long term effects with some authors finding that they do (Ferraro, Miranda, and Price, 2011; Allcott and Rogers, 2014) and others that they do not (Dolan and Metcalfe, 2015). The effect of social comparison nudges on the adoption of pro-environmental behavior relies on two different psychological mechanisms. First, people may have misperception of what other people do (what Cialdini, Reno, and Kallgren (1990) call descriptive norms). The nudge may correct this misperception and provoke a change in behavior by fear of social sanction (Sunstein, 1996) or because it contains an information on what is likely to be an effective action to undertake (Thøgersen, 2014). Second, the nudge might make the behavior of others more salient at the moment of the decision and may influence the behavior through automatic heuristics (Cialdini, Reno, and Kallgren, 1990).

Several studies have found evidence of a boomerang effect of social comparison nudges, where informing households of the behavior of their peers inadvertently drives some of them to increase the unwanted behavior (Cialdini, Kallgren, and Reno, 1991). Schultz et al. (2007) find that providing information on average energy usage produced either desirable energy savings or on the contrary an increase of energy consumption, depending on whether households were already consuming at a low or high rate. This boomerang effect was however cancelled when the social information nudge was coupled with an injunctive norm message in the form of an emoticon (smiling when consumption was below average), indicating that consuming below average is socially desirable. In a similar way, Ayres, Raseman, and Shih (2013), based on two RCTs run in partnership with utility companies providing electricity and natural gas, find that treated households in the lowest deciles of pretreatment energy users actually increase their energy usage. Schubert (2017) provides two explanations for the boomerang effect. First, it may be that providing information about the

descriptive norm provides agents in turn with a so-called "moral license" to keep engaging in gray behavior (Cialdini et al., 2006). Second, this phenomenon may result from what social psychologists refer to as "normalization", the idea that individuals tend to move closer to the norm they perceive as currently prevailing among their peers (Sherif, 1953). Some studies suggest that heterogeneity in response to social comparison nudges may also come from individual preferences.<sup>3</sup>

There is, to our knowledge, almost no experimental evidence on the impact of nudges on actual farmers' decisions outside of farmers' intention to (re-)enroll in agri-environmental programs (Kuhfuss et al., 2016; Chen et al., 2009; Wallander, Ferraro, and Higgins, 2017; Messer, Ferraro, and William, 2015), with the exception of Chabé-Ferret et al. (2018) that report on the effect of a social comparison nudge on the adoption of alternatives to pesticide use.

### **3 Context of the experiment**

Our social comparison nudge has been implemented in the Neste system located in the South-West of France (Figure 1). The Neste system is a system of rivers artificially recharged by upstream reservoirs located in the Pyrenées mountains through a 29 km long canal, the Neste canal, constructed between 1848 and 1862 to overcome the recurring lack of water in the rivers of Gascony. The Neste system covers an area of 800,000 ha and gathers the catchment areas of 17 main rivers. The land is mainly dedicated to agriculture, with about 500,000 ha that are cultivated, of which 50,000 ha are irrigated.

The Neste system is managed by a single operator, the CACG. The public service mission of the CACG consists in contributing to the economic development of the Neste area, through land use planning and management of water resources. One important task of the CACG is to allocate water across consumptive uses (domestic consumption, considered as an absolute requirement, and irrigation, which can be restricted in case of shortage) and quality requirements (ecological flows). The relationship between the CACG and farmers connected to the CACG water network is defined by a formal contract. This contract specifies a discharge rate and a quota associated to each unit of discharge rate subscribed by a farmer. Irrigation metering is mandatory, and a volumetric pricing is implemented with a penalty in case of non-compliance with the individual water quota. The recent evolution of rainfall patterns and expected impacts of climate change increase the pressure on water resources and increase the risk of defaults in the provision of water to farmers throughout the cropping season. The CACG is therefore trying to identify ways to reduce water use among

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<sup>3</sup>Costa and Kahn (2013) show that social comparison nudges are two to four times more effective with political liberals than with conservatives. Goldstein, Cialdini, and Griskevicius (2008) highlight that the influence of social comparison nudges depend on the extent to which individuals identify themselves with the reference group. Delmas and Lessem (2014) show that social information has an effect when it is made public only.

farmers.

Since 2004, the CACG has started to replace its traditional water meters by smart meters called CALYPSO. The CALYPSO device is an ultrasonic meter that sends data in real time to a web-interface. The CACG has developed a SMS-based system allowing to send messages to each farmer having subscribed a water quota. In our experiment, we combine the information on water consumption provided by the smart meter CALYPSO with the SMS-based communication system of the CACG.

## 4 Experimental Design and Data

We carried out two experiments in collaboration with the CACG from July to September 2017 in three watersheds of the Neste System: Arros, Les Baises and Boues. In both experiments, we test whether a social comparison nudge delivered by weekly mobile text messages (11 in total) may have an effect on farmers' water consumption. The protocol of these experiments has been registered in the the American Economic Association's registry for randomized controlled trials (Le Coent, Chabé-Ferret, and Reynaud, 2017).

In both experiments, farmers in the treatment group received an invitation to optimize their water usage supplemented by an estimate of the average water consumption of their neighbors. The estimate of average water consumption was computed using smart meter readings of the previous week. The smart meter readings are sent to a centralized database, which enabled us to observe directly farmers' decisions and to compute the weekly average of water consumption at the watershed level. The water consumption database is integrated with an automated SMS platform, which enabled us to craft our messages automatically and to directly send them to the cell phones of customers.

Experiment 1 was run with a sample of 200 farmers equipped with CALYPSO smart meters. 101 farmers were randomly assigned to the control group and 99 to the the treatment group. The control group received the following normative message: "Hello Mr X. Water conservation is important for your watershed. Please keep on optimizing your irrigation." In addition to this normative message, treated farmers received information about their own water consumption and the average of water consumption at the watershed level: "On DD/MM, you have consumed XX percent of your water quota. (CONGRATULATIONS!) The irrigating farmers of your watershed have used on average XX percent of their quota". Experiment 2 was run with a sample of 261 farmers equipped with traditional water meters. The treatment (131 farmers) and the control group received the same message as received bu farmers in Experiment 1, except that they were not provided any feedback on their own consumption (since such information is not provided by traditional meters).

Our design has six important features. First, sending messages to the control group enables to prevent Hawthorne effects, i.e. behavioral changes only due to the awareness of being observed. In most experiments on electricity consumption the control group did not



receive any message leading to criticisms that the social information detected may only be due to Hawthorne effects (Schwartz et al., 2013). Second, we measure water consumption as a share of the water quota rather than using the volumetric consumption. Water consumption expressed as a share of the quota can be used to compare water consumption for farms of different sizes and producing different crops. Third, the social information on water use is provided at the watershed level (and for the Arros river also at the province level). We indeed consider that the reference value should be associated with a group that shares a similar social identity (Goldstein, Cialdini, and Griskevicius, 2008) or a similar production context. Fourth, we exclude the farmers with zero consumption when computing the average consumption (in percentage of the quota) for each geographical group of farmers equipped with CALYPSO smart meters. With this decision, we wanted to avoid confusing farmers by mixing up intensive and extensive margin decisions. Fifth, farmers whose consumption was below the average consumption received a "Congratulations" message which aimed at neutralizing possible "boomerang" effect (Schultz et al., 2007). Sixth, we did not send the "congratulations" message to farmers that had zero water consumption, considering that this may not be the result of a particular effort but rather characterized farmers that had not used water rights due to their production system.

In both experiments, the treatment was allocated with random stratified sampling. In Experiment 1, the strata were defined by: 1) collective or individual irrigation facility; 2) river basin; 3) province; 4) size of the quota and 5) initial consumption at the beginning of the experiment null or positive. In Experiment 2, the strata were defined by: 1) collective or individual irrigation facility; 2) river basin; 3) size of the quota and 4) consumption as a share of quota in 2016. In Experiment 1, we were informed just before the start of the experiment, that some smart meters did not communicate properly results. In order to control this problem, farmers with defective smart meters were included in specific strata.<sup>4</sup> In what follows, we report the results only for the 152 farmers who had functioning smart meters during the whole period. For this subset of farmers, we have 11 water consumption observations (including the one collected before the experiment started). In Experiment 2, data collection was more lengthy as CACG staff needed to physically go in the field to read the water consumption on the meters. For this experiment we have only one observation: cumulative water consumption as of February 12. We have the data collected from 239 out of the 261 farmers initially part of the experiment. This is due to the closure of 22 contracts during the season.

After randomization, the extent of balance between treatment and control groups was tested regarding water quota, water consumption in 2016 (in volume), water consumption in 2016 (as a share of quota), water consumption in 2017 before the start of the experiment

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<sup>4</sup>These farmers received the same information as farmers of Experiment 2 for the beginning of the experiment. Starting from 22 August 2017, 30 farmers had their smart meters fixed and started receiving the full information.

(as a share of quota). We moreover crossed the data set with the 2010 Agricultural Census and were able to check the balance of additional variables, as shown in Table 1.

## 5 Results

We first look at the effect of our nudges on total water consumption in each experiment. This analysis was pre-registered. We then look at the heterogeneity of effects in Experiment 1. This part of the analysis was not pre-registered. We present these results nevertheless since they are extremely suggestive on the possible effects of a social comparison nudge.

### Impact on total and weekly water consumption

Figure 2, that shows the cumulative water consumption over time in Experiment 1, suggests that the gap between the two groups widens over time, with a trend for consumption to be higher in the control group than in the treated group after August 22nd. This difference is however not large and we cannot reject the null hypothesis of no difference between groups at the end of the period. The average consumption in the treated group reaches 26 percent of the quota on September 12 (Col. 1) compared to 27 percent in the control group (Col. 2) (Cf. Table 2). For Experiment 2, we find 25 percent of the quota in the treated group (Col. 4) and 24 percent in the control group (Col. 5). Again, the null hypothesis of no impact cannot be rejected.

We then look at the weekly water consumption to check whether the intervention had an effect on particular dates of the experiment. Figure 3 reveals that the gap between the two groups peaked on 22 and 29 August. Given our level of precision, we are however not able to detect significant differences at these dates (statistics not provided).

### Heterogeneous effects of the intervention

We then examine whether the absence of average impact conceals opposite heterogeneous effects. Figure 4 shows the distribution of water consumption in both groups in Experiment 1. Three main results emerge graphically. First, the number of farmers consuming no water is higher in the control group. Second, the number of farmers whose consumption exceeds 80 percent of the quota is smaller in the treatment group. Third (and consequently), the number of farmers consuming some water but less than 80 percent of their quota is larger in the treatment group. This suggests that the social comparison nudge has prompted some farmers who would not have consumed water to start consuming and also changed the behavior of large consumers, discouraging them from consuming more than 80 percent their quota.

Statistical analysis broadly supports the impression generated by Figure 4. Table 2 shows the results of OLS regressions of the treatment variable on a dummy variable that equals one when a farmer does not consume any water during the season and zero otherwise. The results show that the intervention significantly decreased the proportion of farmers who did not consume water by 10 percentage points, from 39 to 29 percent on average.<sup>5</sup> Figure 5 moreover shows that this effect appeared gradually during the experimental period. Note that this estimate is statistically significant at the 10 percent level only - the 95 percent confidence interval is  $10.2 \pm 10.6$  percentage points - and thus is only suggestive of possible effects.<sup>6</sup> Table 2 also provides the results of OLS regressions of the treatment variable on a dummy variable that equals one when a farmer consumed more than 80 percent of the quota during the season and zero otherwise. The results indicate that the intervention significantly decreased the proportion of farmers who consumed the most by 7 percentage points, from 10 to 3 percent. Again, this estimate is statistically significant at the 10 percent level only and the 95 percent confidence interval is  $7.5 \pm 7.8$  percentage points. Accordingly, the proportion of those farmers who consumed more moderately, i.e. between zero and 80 percent, significantly increased by 17 percentage points – from 51 to 68 percentage points. This result is more precise than the previous ones:  $17.7 \pm 12.0$  percentage points, suggesting that the nudge yields to a bunching of water consumption around the mean in Experiment 1.

We then ran the same regressions using data from Experiment 2. The results do not reveal any of the effects detected in Experiment 1.

## 6 Discussion

Although the results of this pilot cannot yet be generalized, we see three takeaways from them. First, our results suggest that professional farmers do not seem to react much more to social comparison nudges than consumers do. Previous results indeed show that the effect of social comparison nudges on electricity or water consumption by households are very small, in the sense of Cohen's *d*.<sup>7</sup> We reject large and medium effects of the social comparison nudge in both our experiments. For water consumption, the Cohen's *d* corresponding to the extreme of the 95 percent confidence interval of the impact of the nudge is -0.29 in Experiment 1 and -0.13 in Experiment 2. Our results are nevertheless still compatible with small effects, keeping open the possibility that farmers respond slightly more than house-

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<sup>5</sup>We moreover ran robustness checks in order to take into account meter replacement during Experiment 1. Same results hold. They are displayed in Table A.1.

<sup>6</sup>We express the precision of our results by reporting the size of the half 95 percent confidence interval around them.

<sup>7</sup>A large effect is defined as a Cohen's *d* of the order of 0.8. A medium effect is defined as a Cohen's *d* of the order of 0.5. A small effect is defined as a Cohen's *d* above 0.2 and a very small effect as Cohen's *d* of the order of 0.01. Cohen's *d* is computed by dividing the treatment effect by the standard deviation of outcomes in the control group.

holds to social comparison nudges. It remains to be checked whether farmers react in the same way as consumers, with very small responses, or more, with small responses. Larger, more precise experiments will be needed in order to answer this question.

Second, the results of Experiment 1 provide evidence of a boomerang effect of a social comparison nudge in the context of professional economic agents. Two features of our experiment might have combined to generate a boomerang effect at the extensive margin. First, we did not add the "congratulations" message for farmers with zero consumption since we were unsure how they would interpret the message. Second, we computed the average water consumption only for farmers that have consumed a strictly positive amount of water, in order not to confuse farmers about intensive versus extensive margins of water consumption. We tried to make this clear in the message by saying that the average consumption is computed for farmers that irrigate. But if interpreted incorrectly as an unconditional average, and in combination with the absence of a "Congratulations" moderator, this might have given the impression to farmers not consuming water that everybody else was consuming water and that we were encouraging them to do so too.

The results from Experiment 2 might help to shed some light on the reasons for the Boomerang effect. The results from Experiment 2 do not provide evidence in favor of a boomerang effect. Because Experiment 2 only differs from Experiment 1 by not sending information on their own consumption to farmers, and since farmers in both experiments are very similar, we can see two possible explanations for this result. First, receiving an information on their own consumption might have triggered a decision to start consuming water for farmers that were previously not consuming any water, when comparing their own consumption with that of their neighbors that consume a positive amount of water. This interpretation is a bit contrived since farmers that do not consume any water are supposed to know it already. Second, it might be that receiving information on their own consumption does not make any difference between Experiment 1 and Experiment 2 for farmers consuming no water, but that we are only seeing the effect of sampling noise. This is a possibility, since the confidence intervals in both experiments are overlapping. More research is needed to estimate this potential boomerang effect with more precision and whether sending a "Congratulations" message to the farmers with zero consumption would make the potential boomerang effect disappear.

Our third takeaway is that the nudge seems to have modified the behavior of farmers who consume the most in Experiment 1, and not in Experiment 2. A tentative interpretation of these results is that the farmers who consume the most are also those who tend to waste the water resource and receiving information on their own consumption allowed them to become aware of their excessive behavior. More precise research is needed to confirm whether such effect exists.

## 7 Conclusion

Although improving efficiency of water in agriculture has been a clear objective of the European CAP for a long time, agricultural water use still remains a major contributor to water scarcity in Europe, especially in the Mediterranean regions. This situation opens the door to designing and implementing new tools for inducing changes in farmers' behavior regarding the conservation of water resources. Among them, nudges are more and more viewed as a promising policy tool, able to complement those already used by European public authorities (EESC, 2017). This is particularly true for nudges aiming at achieving environmental objectives (i.e. energy/ecological transition, reduction of resource waste, sustainable water use, etc.) for which traditional public policy tools have proven to be ineffective and/or too costly.

In this paper we have tested whether a social comparison nudge can contribute to promote water-saving behavior in agriculture. Disappointingly, our results do not reveal a significant reduction of average water use. We detect hints of reduction in water consumption among the largest water users, but at the same time our nudge significantly stimulated water consumption from farmers that do not use water. These results suggest that nudges may indeed influence farmers' behavior and that particular attention should be paid to the design of nudges in order to obtain the expected policy results and to use it on a wider scale.

An obvious prerequisite for using this type of nudge is the metering of agricultural water use. Water metering is already a policy tool included in the CAP. For instance, EU (2011) explicitly mentions smart metering in the portfolio of water efficiency measures to be included in the road map to a resource efficient Europe. The social comparison nudge we have proposed and assessed in our experimental setting should then be viewed as a complement to water metering. Nudges could also be used in conjunction with other policy instruments such as water pricing (incentive pricing, peak-pricing, time-of-use pricing, etc.), water permits and environmental taxes. Some recent works indeed suggest that there are conditions under which nudges and taxes should coexist (Farhi and Gabaix, 2017).

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## Tables

Table 1: Main characteristics of farmers by group

| Sample used in Experiment 1                    | Nb. obs. | Mean values |         | t-stat |
|--|----------|-------------|---------|--------|
|  |          | Treated     | Control |        |
| Irrigated land (ha)                            | 152      | 23.4        | 29.3    | 0.09   |
| Water consumption in 2016 (m3)                 | 152      | 23,529      | 35,124  | 0.95   |
| Water consumption in 2016 (% of quota)         | 152      | 0.49        | 0.42    | -0.68  |
| Water consumption on July 5, 2017 (% of quota) | 152      | 0.058       | 0.06    | 0.14   |
| Farm size (ha)                                 | 145      | 92.54       | 90.36   | -0.21  |
| Maize-cultivated acreage (ha)                  | 129      | 41.82       | 36.28   | -0.89  |
| Area under property (ha)                       | 106      | 47.51       | 51.44   | -0.55  |
| Farmer's age                                   | 144      | 52.2        | 52.8    | -0.43  |
| Sample used in Experiment 2                    |          |             |         |        |
| Irrigated land (ha)                            | 239      | 34.2        | 27.1    | -1.01  |
| Water consumption in 2016 (m3)                 | 239      | 71,533      | 59,590  | -0.62  |
| Water consumption in 2016 (% of quota)         | 239      | 0.49        | 0.48    | -0.22  |
| Farm size (ha)                                 | 168      | 88.7        | 88.74   | 0.00   |
| Maize-cultivated acreage (ha)                  | 141      | 40.81       | 38.31   | -0.41  |
| Area under property (ha)                       | 103      | 47.64       | 39.84   | -1.25  |
| Farmer's age                                   | 168      | 53          | 53.1    | -0.02  |

Note: Data sources are CACG and the French Agricultural Census (2010)

Table 2: Impacts of the nudge on water consumption

|  | Experiment 1 |         |         | Experiment 2        |          |         |         |                   |
|--|--------------|---------|---------|---------------------|----------|---------|---------|-------------------|
|  | Nb. obs.     | Treated | Control | Difference          | Nb. obs. | Treated | Control | Difference        |
| Cumulative consumption (% of quota)                            | 152          | 0.257   | 0.274   | -0.015<br>(0.043)   | 239      | 0.252   | 0.238   | 0.01<br>(0.028)   |
| Cumulative consumption is null (yes=1)                         | 152          | 0.293   | 0.39    | -0.102*<br>(0.054)  | 239      | 0.342   | 0.286   | 0.067<br>(0.049)  |
| Cumulative consumption is larger than .8 (yes=1)               | 152          | 0.027   | 0.104   | -0.075*<br>(0.040)  | 239      | 0.025   | 0.025   | 0.000<br>(0.021)  |
| Cumulative consumption is positive and smaller than .8 (yes=1) | 152          | 0.68    | 0.506   | 0.177***<br>(0.061) | 239      | 0.633   | 0.689   | -0.067<br>(0.051) |

Note: This table provides the mean value of various outcomes by group as well as the results of OLS regressions of the treatment variable on these outcomes. All regressions include strata fixed effects. Standard errors are in parenthesis. \*\*\*, \*\* and \* indicate a treatment effect significantly different from zero in a two sided t-test at 1%, 5% and 10% respectively.

# Figures

Figure 1: The Neste system in South-West of France

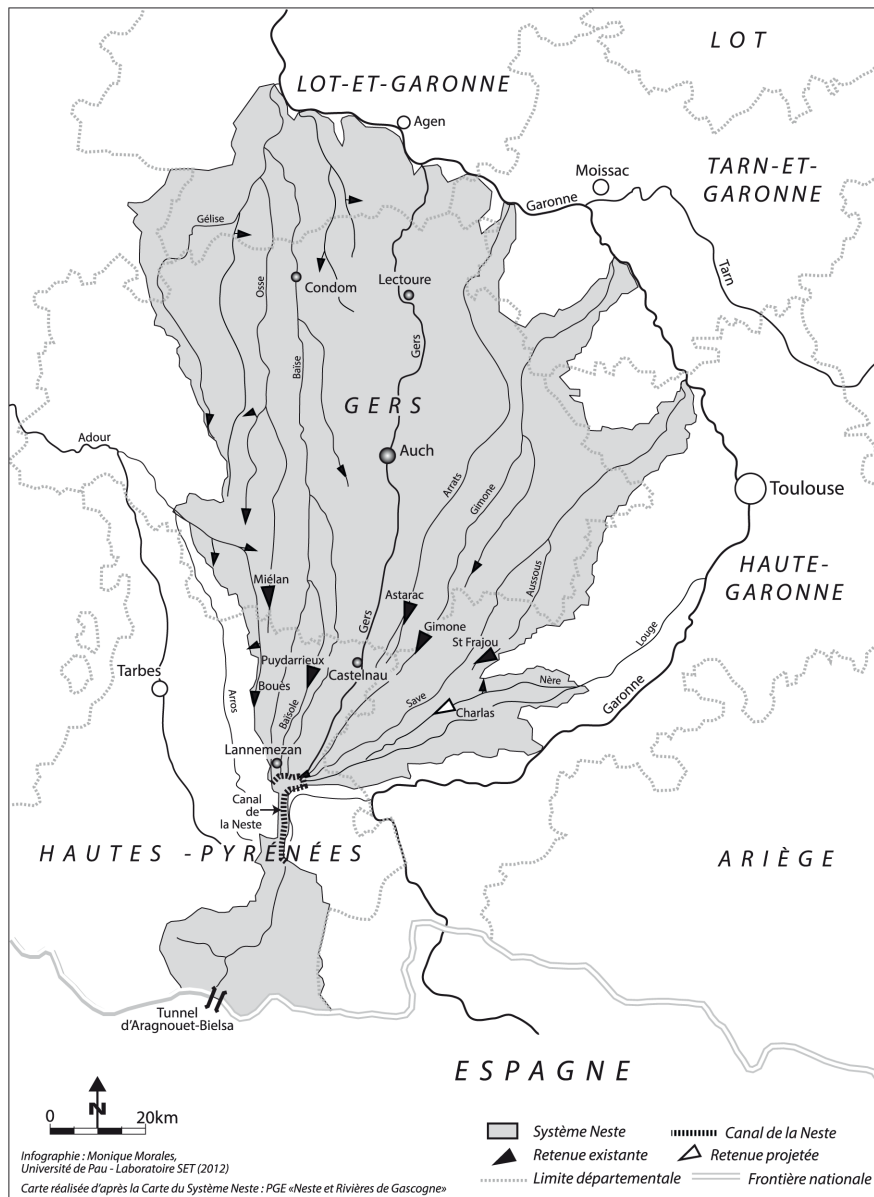


Figure 2: Cumulative water consumption over time by group

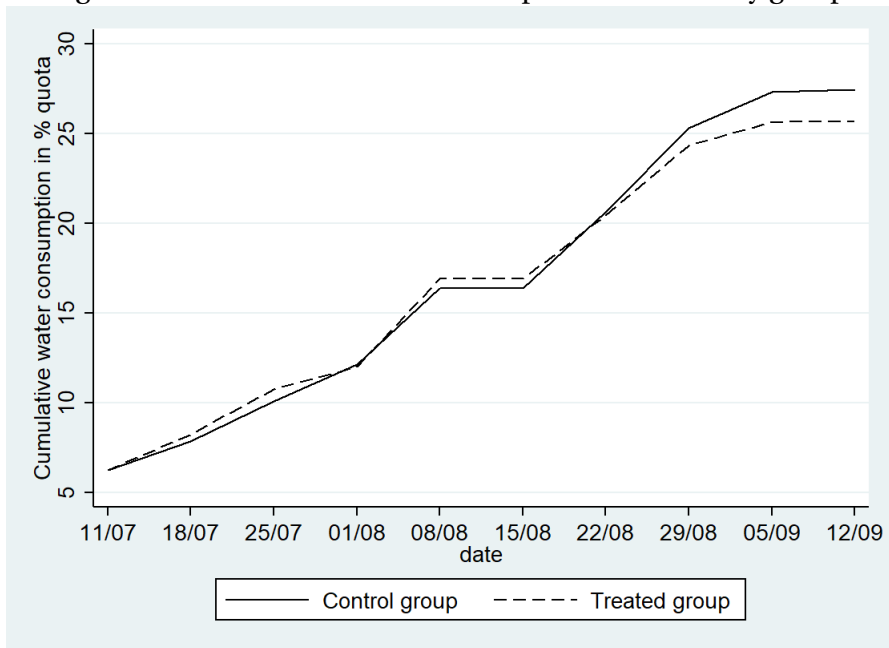


Figure 3: Weekly water consumption over time by group

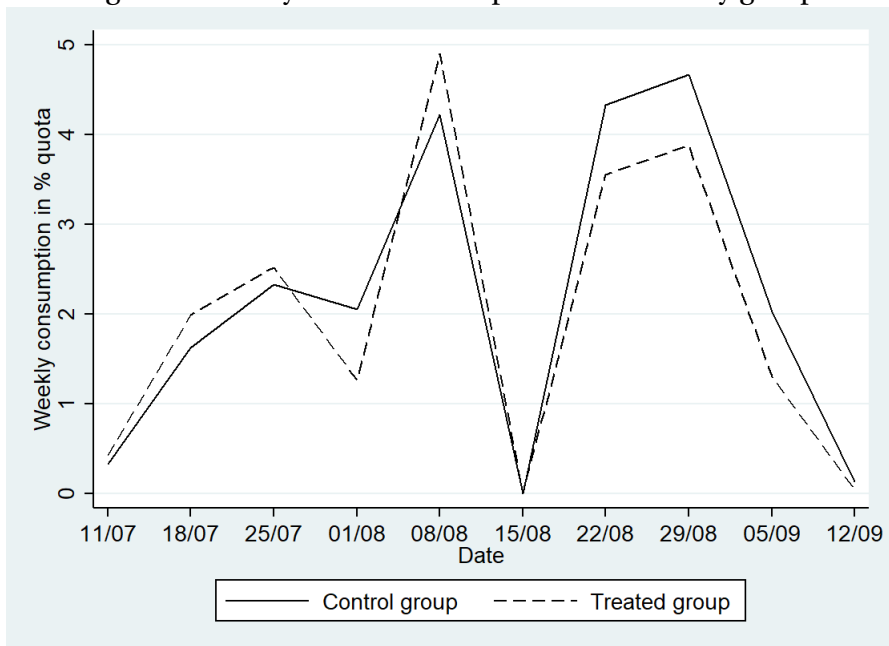


Figure 4: Distribution of water consumption by group (Experiment 1)

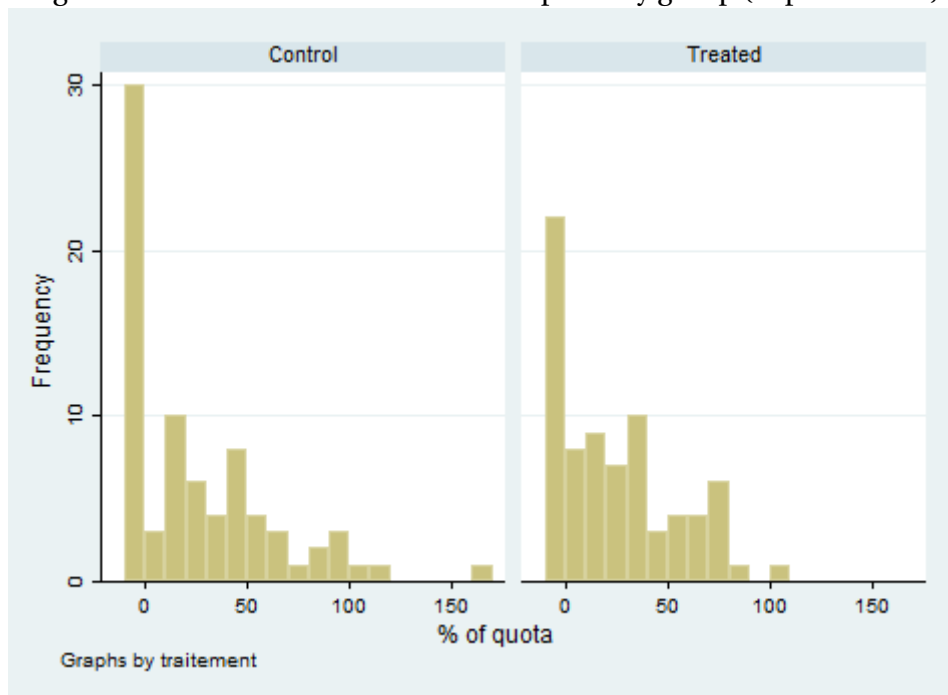
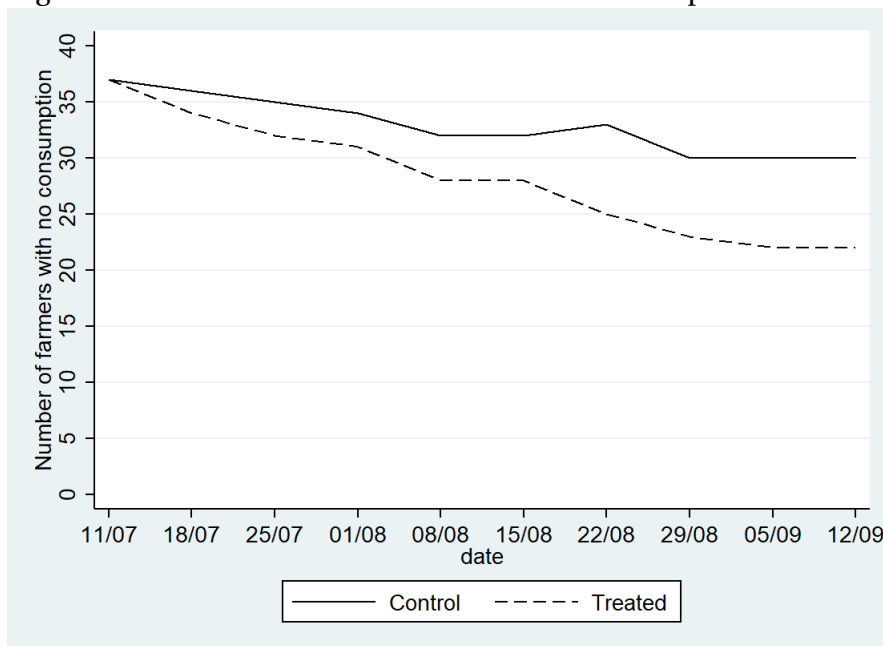


Figure 5: Number of farmers with no water consumption over time



## A Annex

### A.1 Robustness checks

In order to take into account meter replacement during Experiment 1, we use different strategies. In model (1) we exclude from the data-set farmers who had their meters changed less than 2 weeks before the end of the experiment. In model (2), we exclude all farmers who had their meters changed between 01/07/17 and 01/12/17. We indeed consider that meters replaced after the end of experiment may have biased the results during the experiment. We however consider that replacement that occurred after 01/12/17 are due to problems that happened after the experiment and therefore did not affect our results. In model (3), the most restrictive, we exclude all farmers with meters changed between 01/07/17 and 15/03/18.

Table A.1: Impact of nudges on probability to use no water in Experiment 1 with different models taking into account meter replacement

|       | (1)                 | (2)                | (3)                 |
|-------|---------------------|--------------------|---------------------|
| Nudge | -0.115**<br>(0.053) | -0.091*<br>(0.053) | -0.139**<br>(0.058) |
| Cons. | 1***<br>(0.325)     | 1***<br>(0.330)    | 1***<br>(0.314)     |
| F     | 12.10               | 14.33              | 11.95               |
| N     | 148                 | 137                | 123                 |

Note: These OLS regression include strata fixed effects.

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Contact : [laurent.garnier@inra.fr](mailto:laurent.garnier@inra.fr)/ 04 99 61 31 21