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Comparing Compliance Behaviour of Students and Farmers – Implications for Agricultural Policy Impact Analysis

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Comparing Compliance Behaviour of Students and Farmers – Implications for Agricultural Policy Impact Analysis[1]

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Abstract

Increasing popularity of economic experiments for policy impact analysis has led to an ongoing debate about the suitability of students to substitute professionals as experimental subjects. To date, subject pool effects in agricultural and resource economics experiments have not been sufficiently studied. In order to identify differences and similarities between students and non-students, we carry out an experiment in the form of a multi-period business management game that is adapted to an agri-environmental context. We compare the compliance behaviour of German agricultural students and German farmers with regard to water protection rules and analyse their responses to two different green nudge interventions. The experimental results reveal that the direction of the response to the policy treatments is similar. Even unexpected behaviour could be reproduced by the student sample. Nevertheless, the magnitude of the treatment effects differed between the two samples. This implies that experimenters in the field of agricultural and resource economics could use the subject pool of students to analyse the direction of nudge policies. If predictions should be made about the magnitude effects, we suggest using a professional subject pool.

Keywords: subject pool effect; green nudges; policy impact analysis; compliance behaviour

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1. Introduction

Experimenters predominantly use the standard pool of students as experimental subjects. (Danielson and Holm, 2007; Herberich and List, 2012). One major advantage of using student samples is their lower cost. Opportunity costs are higher for professionals than for students in taking part in an experiment (Fréchette, 2016). Therefore, it is necessary to pay professionals appropriate incentives to participate in experimental studies. Consequently, monetary constraints may limit the goal to reach a sufficient sample size to produce reliable and meaningful results. Another factor limiting the usage of professionals is availability. Usually, students are easier to recruit than a group of professionals (Harrison and List, 2004). Moreover, specific groups are difficult to address. However, the use of student samples can represent a threat to external validity. Research has shown that students represent a more homogenous group in terms of their socio-demographic characteristics (Anderson et al., 2013; Bocquého et al., 2013). Further differences to the general population are their educational background and their lower task experience compared to entrepreneurs (Harrison and List, 2008; Khera and Benson, 1970).

A number of studies have analysed the behavioural differences between the two subject pools for a variety of economic experiments (Fréchette, 2015). Some of these studies reveal that students and non-students tend to perform similarly, while other studies show that they behave slightly differently. For example, in classic economic experiments, especially related to other-regarding preferences, students usually behave more selfishly and rationally (Frigau et al., forthcoming; Belot et al., 2015). Furthermore, in social preference games, it has been shown that pro-social behaviour is likely to be higher in non-student samples (Anderson et al., 2013; Fehr and List, 2004).

In contrast to standard economic experiments which aim to test specific economic theories, policy experiments address the impact of policies designed to tackle specific problems of policy implementation. The evaluation of subject pool effects in experiments addressing policy impact analysis is rather rare. For choice experiments measuring willingness-to-pay (WTP), Mjelde et al. (2016) conclude that it is not recommendable to use students for policy analysis. Compared to the non-student sample, the WTP varied considerably and the student sample also showed some inconsistencies. In a meta-study concerning the application of the technology acceptance model, King and He (2006) showed that in this case students may only serve as surrogates for professionals but not for the general population.

Experiments designed as business management games can also inform policy makers. In agricultural economics research such business management games have been conducted with students (Mußhoff and Hirschauer, 2014) as well as with farmers (Holst et al., 2014; Dörschner and Mußhoff, 2015; Buchholz et al., 2016; Hermann et al., 2017), but no study has compared behavioural differences between students and farmers in the exact same experiment. Also Cason and Wu (2018) claim that subject pool effects in the field of agricultural economics are insufficiently studied.

Another field that is lacking experimental evidence due to high access barriers in real life is the field of compliance behaviour of farmers. Non-compliance to agri-environmental regulations can lead to negative externalities for the environment and human well-being (Pretty et al., 2001). In agricultural production, this can be the case for example with nitrogen runoff representing a severe threat to surface water quality. Until now, there is no experimental study related to regulatory compliance in an agricultural setting that compares students' and farmers' behaviour. In other areas of compliance, differences between students and non-students have been addressed by only a few studies to date and their results are contradictory. In the case of tax compliance, Alm et al. (2015) found similar behaviour of students compared to non-students in identically carried out experiments. Whereas Choo et al. (2016) found differences in their study about tax compliance behaviour. Students' behaviour was less compliant than real tax payers participating in a laboratory experiment with identical treatment conditions.

For reducing non-compliance, traditional policy approaches exist such as command-and-control measures or economic incentives. Recently, behavioural interventions in the form of nudges are increasingly considered as an alternative or supplement to existing policies. Especially for reducing negative externalities, so called green nudges are popular among policy makers and researchers (Schubert, 2017). In the context of agricultural economics, experiments have been conducted to investigate how nudges can affect farmers' participation in agri-environmental schemes (Kuhfuss et al., 2015), adoption of water quality management techniques (Barnes et al., 2013) or environmentally friendly behaviour (Czap et al., 2015). These three studies used farmers as participants. How the effects of nudging differ between students and non-student study-subjects has not yet been considered.

Even though subject pool effects in classic economic experiments have been studied comprehensively, there is little known about subject pool effects in policy experiments, especially in an agri-environmental context. This subject bias can be decisive for policy

recommendations if study results from student samples are not generalizable for the group of interest. Against this background, this paper focuses on subject pool effects in a policy experiment designed to analyse the effects of green nudges. We carry out a multi-period business management game that is adapted to the farm context and in which the two subject pools are confronted with different nudge treatments. We compare compliance behaviour of the two groups in order to assess the potential to use agricultural students instead of professionals in experiments, the latter being costly and more difficult to address. Focusing on the use of green nudges as an additional policy instrument to reduce non-compliant behaviour in the context of environmental protection rules, the present paper aims to validate if students and farmers are responsive to behavioural interventions in the same way.

The remainder of this paper is structured as follows: In Section 2, we review the existing literature on the differences and similarities between (agricultural) students' and farmers' characteristics and behaviour. Section 3 outlines the design of the experiment. The results are presented in Section 4. In Section 5, we discuss our results, draw our conclusions and provide future research prospects.

2. Related literature

Subject pool effects may pose a threat to external validity. This is of paramount importance if experiments are designed to inform policy. In this section, we summarise findings of experiments for policy impact analysis comparing student and non-student samples. First, we highlight experiments that utilised students of various disciplines, mainly economics, and compared them with farmers. We then look, (as this is the case in our study), at a specific group of agricultural students compared to farmers. An overview of the studies reviewed can be found in Table 1 where we summarise the studies' research focuses and the sources of data as well as the authors' conclusions whether students should be used as surrogates for farmers.

In an experiment designed to investigate a decentralised bargaining market, Waichman and Ness (2012) found very similar performance of students and farmers. The only difference was that farmers' payoffs to buyers were slightly higher than the payoffs of students. To analyse factors influencing the participation in carbon offset markets, Herberich and List (2012) elicited risk preferences of students and farmers in a multiple price list experiment. Their results reveal that the farmer sample was slightly more risk averse than the sample of students. In an experiment aimed at evaluating the performance of ambient tax mechanisms to regulate nonpoint source water pollution, Suter and Vossler (2013) compare the behaviour of

students with dairy farmers. They found that farmers who manage small farms contribute lower emissions compared to students with the same size of operating business, while farmers managing large farms contributed higher emissions than the student sample with the same size of operation. Fooks et al. (2016) found similar behaviour of students and agricultural landowners in an experiment testing network bonuses and spatial targeting in a reverse auction for ecosystem services. The only deviation of behaviour was that farmers tended to learn faster and therefore performed better than students resulting in higher environmental benefits. In addition, students were more budget sensitive than landowners but the response to the treatments was still the same in both samples. Hermann and Mußhoff (2016) elicited time preferences of students and farmers using two different methods. Time preference is important in this context since it can influence the response to a policy. In their study, decision making behaviour differed in one of the two methods between students and farmers. All of these studies reveal that behaviour of students and farmers is very similar but not identical. There are minor differences of responses to policy interventions. Nevertheless, the direction of the response is the same while the magnitudes may vary between farmers and students.

After reviewing studies that compare the behaviour of farmers and students of various disciplines in policy experiments, we now move on to the comparison of a more specific group, agricultural students who share more characteristics and experiences with agricultural decision makers (e.g. through family farming background, completed agricultural training, professional experience). Only a few studies to date have addressed the differences in behaviour between farmers and such students. Taylor et al. (2004) conducted an experiment with agricultural students and farmers in order to test the use of auctions for reducing agricultural nonpoint source pollution. The two groups of participants showed similar behaviour but this finding should be viewed with caution as the sample size (18 farmers and 15 agricultural students) is rather small. Austin et al. (2005) developed animal welfare attitude scales based on a sample of Scottish pig and sheep farmers and a sample of agricultural students. The attitude structures of farmers and students were similar but with nuanced differences on some levels. Maart-Noelck and Mußhoff (2014) showed that differences between farmers and agricultural science students arose in the decision making behaviour regarding their risk attitude. To measure the risk attitude, they used two different risk elicitation methods. In the experiment, German agricultural students were more risk-averse than German farmers independent of which elicitation method was used. Due to the low number of studies, the question of whether subject pool effects exist in the context of

experiments in agricultural policy cannot be answered clearly. In some cases, the sample size of the studies is low, which prevents drawing conclusions on the generalisability of the results.

Table 1. Studies comparing students and farmers as experimental subjects

		Subject pool		
Study	**Research topic**	**Students**	**Non-students**	**Conclusions**
Taylor et al. (2004)	Group contracts for voluntary nonpoint source pollution reduction using experimental auctions	15 undergraduate agricultural students at Ohio State University	18 Ohio farmers attending the Ohio Farm Bureau Annual Meetings in Columbus, Ohio	"The small sample size of this study prevents across group comparison of farmer and student group behavior." (p.1197)
Austin et al. (2005)	Attitudes towards farm animal welfare	236 agricultural students at the Scottish Agricultural College	123 Scottish sheep farmers and 70 Scottish pig farmers	"Five narrower facets were extracted for farmers and six for students, with the two factor structures being similar." (p.107) "It was also possible in the present study to identify a lower level in the hierarchy of farmers' welfare attitudes, revealing a richer attitude structure underlying the broad dimensions. At this level the attitude facets for farmers and students were slightly different, although the structures showed similarities." (p.117) "Farmers who have a superficial approach to welfare tend to score high on empathy while students with this approach tend to score low." (p.118)
Herberich & List (2012)	Influence of risk preferences on the decision to participate in a carbon offset market.	49 economics students at the University of Chicago	25 farmers located at the Soil and Water Conservation District Office in Dekalb, Illinois, and 16 farmers at an agricultural conference in Springfield, Illinois.	"There is suggestive evidence that farmers are slightly more risk averse than students. This is interesting considering the inherent risk in the agricultural industry. The lower risk tolerance exhibited by farmers could be due to the abstract nature of the experimental instruments, which students may be more familiar with." (p.463)
Suter & Vossler (2012)	Performance of ambient tax mechanisms targeting emissions of dairy farms	48 undergraduate students	48 dairy farmers	"Relative to the students, farmers operating small firms tend to choose significantly lower emissions decisions, while operators of large farms choose emissions decisions that are significantly higher." (p.105)
Waichman et al. (2012)	Farmers' performance and subject pool effect in decentralised bargaining markets	45 students from various departments of the University of Kiel	45 farmers from the federal state of Schleswig-Holstein in Germany	"Overall, we do not find differences in performance between farmers and students regarding quantities, prices, and allocative efficiencies. We do find, however, that farmers yield more of the payoff to the buyers than the students." (pp.366-367)
Maart-Noelck & Mußhoff (2014)	Measuring the risk attitude of decision makers of different groups with different methods	105 students of a German university (95 % agricultural students)	106 German farmers	"Students are not a suitable convenience group for making conclusions about the risk attitude of German farmers. This applies independently from the selected measuring method." (p.350)

Study	Research topic	Subject pool		Conclusions
		Students	Non-students	
Fooks et al. (2016)	Testing network bonuses and spatial targeting for benefits in ecosystem service markets	96 undergraduate economics students at a university in the north-eastern United States	24 agricultural landowners in Wye Mills, Maryland	"Agricultural landowners in the field experiment generally performed better than students, which is consistent with faster learning. There was no evidence of structural differences between the groups in terms of response to the treatments; performance of the program with landowner participants appeared to be less budget-sensitive than with students." (p.485)
Hermann & Mußhoff (2016)	Measuring time preferences with different methods	178 students from various departments of the University of Göttingen	111 German farmers	"The estimated discount rates for German farmers varied between the two methods in both magnitude treatments, while the discount rates of students were only different in the treatment with greater magnitudes." (p.25)

3. Experimental procedure

Recruiting of participants

The experiment was conducted online in November and December 2016 with a sample of German farmers and a sample of German agricultural students. Farmers were recruited via a mailing list from the Farm Management Group of the Faculty of Agricultural Sciences at the University of Goettingen, while students were recruited among the undergraduate agricultural students at two universities located in Goettingen and Halle (Saale).

Structure of the experiment

The overall study consists of four parts. Compliance behaviour was assessed via an extra-laboratory experiment (cf. Charness et al., 2013) in the form of a single-player multi-period business management game. Moreover, the participants' risk attitudes were determined by a Holt-and-Laury lottery (Holt and Laury, 2002) and the participants had to state their law-abiding attitude in a general sense on a Likert scale ranging from zero to ten. Additionally, socio-demographic characteristics of farmers and students, as well as socio-economic characteristics of the farmers were collected via a questionnaire. A translated English version of the instructions that were submitted to the participants in German is presented in the supplementary data, (cf. Appendix Parts 1-3).

Assessment of non-compliant behaviour

In the business management game, the task for participants was to manage a virtual farm over eight production periods. In each period, the participants had to make three kinds of production decisions. They had to determine the production program by choosing between the cultivation of grain maize, wheat or canola for each field. Next, they had to determine the amount of fertiliser for application. If a field was adjacent to a body of water, participants had to state the distance to the water which should be maintained while applying fertiliser. The last decision resembled the compliance decision. At the time the experiment was conducted (November and December 2016), a minimum distance to the water of three meters was legally specified (from 02 June, 2017, onwards four meters). If participants stated a lower distance than three meters, this was recorded as non-compliance. The minimum-distance-to-water rule of three meters was present over the entire duration of the experiment and was stated in the instructions for the participants.

Experimental treatments

Participants were randomly assigned to one of three groups at the beginning of the business management game. In the first four periods, the framework remained the same. In the last four periods, conditions stayed the same only for the first group, the control group. Whereas the two other groups A and B received empathy nudge messages according to their assigned treatment. Participants of group A were provided with information about the consequences of non-compliant behaviour regarding the minimum-distance rule, i.e. the environmental and health effects that may occur as a consequence of fertiliser inputs into bodies of water. This information was supported by pictures of a dead fish, a crying baby, and fertiliser which has been placed illegally on a buffer strip. The nudge treatment for participants of groups B added a social comparison to the information and pictures provided, and informed participants that most other farmers in the area comply with the minimum-distance-to-water rule. A detailed description of the treatments can be found in the appendix (cf. Appendix Part 1).

According to the literature, one would expect that both nudge treatments would reduce non-compliant behaviour, with nudge B (additional social comparison) being more effective than nudge A (only information and pictures) (Boer et al., 2006; Schultz et al., 2007; Goldstein et al., 2008). Participants of all three groups were confronted with the minimum-distance-to-water rule at all times during the experiment. A financial penalty for breaking the rule was not incorporated in the experiment due to low expected sanctions in reality resulting from low inspection intensities (Commission Implementing Regulation (EU) No 809/2014) and difficulties to identify polluters (Dowd et al., 2008).

Elicitation of risk attitude

The participant's risk attitude was quantified by the utilisation of a Holt-and-Laury lottery (Holt and Laury, 2002), a well-established multiple price list method in the field of risk attitude measurement (Anderson and Mellor, 2009), which has been applied widely in the field of agricultural economics (Hellerstein et al., 2013; Maart-Noelck and Mußhoff, 2014; Nielsen et al., 2013). In ten decision situations, the participants had to choose between two lotteries (lottery A or B). In the safer lottery A, prize money of either 20 € or 16 € was distributed, whereas in the riskier lottery B one could gain either 38.50 € or 1 €. The probability of winning one of the two available prizes in a particular lottery was altered in each decision situation by 10 %, starting with a 10 % probability of winning the higher amount and a 90 % probability of receiving the lower amount. With increased probability, the expected values increased as well. In situations one to four, expected values in lottery A were

higher. From situation five on, lottery B became the option with a higher expected value compared to lottery A (cf. Appendix Part 2).

Incentives

One convention of experimental economics is to provide financial incentives for participants for carefully considered decisions (Guala, 2005). At the very beginning of the experiment, participants were informed about participation allowance and that further prize money could be won in the following experimental tasks. Information about the chances of winning and determination of prizes were specified for the business management game and the lottery at the beginning of each particular task.

As an incentive to take part in the full study, every student received an Amazon gift voucher for 10 €, and every farmer received one for 30 € upon completion. The higher amount for farmers reflects the higher opportunity costs of participation. Other monetary rewards were the same for both farmers and students. Financial incentives were also set here in such a way that a trade-off was created between profit and compliant behaviour, which ensured that the participants reveal their true preferences. Experiments involving socially undesirable behaviour and non-compliance can experience distortions if participants can behave free of charge in a socially desirable way (Milfont, 2009; Norwood and Lusk, 2011). In the business management game, prize money was awarded according to the participants earned profits. Participants were informed that 10 % of the participants would be randomly drawn, and those selected would receive 100 € for every 100,000 € of total profit generated in the business management game. Thus, management game performance was measured in terms of total profit gained at the end of the business management game.

In the lottery task, which consisted of ten decision situations, every fifteenth participant was randomly chosen. Subsequently, a decision situation was selected by the first roll of a ten-sided die for each winner. The second roll of this die determined the amount paid out according to the decision of the participant for the respective lottery. Prize money between 1 € and 38.50 € could be won due to the lottery design.

4. Results

Sample characteristics and attitudes

The sample comprises 144 agricultural science students and 163 farmers whose characteristics are summarised in Table 2. Students are on average 21 years and farmers on average 39 years old. The most noticeable difference between the two subject groups is the share of female

participants. In the student sample 47 % are female whereas in the farmer sample, there are only 7 % female farmers. This is due to a low share of female farm managers in Germany, e.g. in 2013, 9 % of German farms were managed by women (DBV, 2016). The average household size is 3 members for students and 4 members for farmers. The average level of education is 14 years of schooling for both students and farmers. 23 % of the students have completed an agricultural training program. 61 % of the farmers have completed an agricultural training program and 59 % have a university degree, 26 % have both.

Comparing the means of sociodemographic characteristics, we find clear differences between the sample of agricultural students and the sample of farmers in age, gender, share of participants being member in an association and completing an agricultural training program. These differences can be described as statistically significant with p-values < 0.0001. For the comparison of the two samples, we used the non-parametric Mann-Whitney U test for continuous data (e.g. age) and the Chi-square test for categorical data (e.g. gender). Furthermore, these tests reveal no statistically significant differences in the case of the average number of household members and the average years of education.

Result 1: There are differences in sociodemographic characteristics between agricultural students and farmers.

Table 2. Summary statistics of participants[1]

	Students (n=144)	Farmers (n=163)	Statistical Significance of Differences
Demographic characteristics			
Average age in years	21.4 (3.2)	38.6 (12.0)	p-value < 0.0001[2]
Share of female participants (%)	47.2	7.4	p-value < 0.0001[3]
Average number of household members	3.3 (1.9)	3.8 (1.5)	p-value = 0.0873[2]
Average years of education	13.5 (1.7)	14.4 (3.4)	p-value = 0.5139[2]
Share of participants with			
association membership (%)	18.8	69.3	p-value < 0.0001[3]
agricultural training (%)	23.6	61.3	p-value < 0.0001[3]
university degree (%)	n.a.	58.9	
Attitudes			
Risk (HLL-value)[4]	4.9 (1.5)	5.0 (1.6)	p-value = 0.4750[2]
Risk averse (%)	50.0	52.1	
Risk neutral (%)	40.3	36.8	p-value = 0.8041[3]
Risk seeking (%)	9.7	11.0	
Law-abidance (self-assessment)[5]	6.9 (2.1)	7.4 (1.9)	p-value = 0.0752[2]
Rather law abiding (%)	72.2	76.7	
Neither nor law abiding (%)	18.1	16.6	p-value = 0.5675[3]
Rather not law-abiding (%)	9.7	6.7	

[1]Standard deviation is indicated in brackets; [2]Chi-square test; [3]Mann-Whitney U test; [4]0-3 = risk seeking, 4 = risk neutral, 5-10 = risk averse; [5]0-4 = rather not law-abiding, 5 = neither nor, 6-10 = rather law-abiding

In the Holt-and-Laury lottery task, 50 % of the students show risk-averse behaviour compared to 52 % of the farmers. 40 % of the students and 37 % of the farmers are risk-averse. The remaining 10 % of the students and 11 % of the farmers are risk-seekers respectively. Furthermore, 72 % of the students and 77 % of the farmers generally consider themselves rather law-abiding. 18 % of the students and 17 % of the farmers state that they are neither particularly law-abiding nor non-law-abiding. 10 % of the students and 7 % of the farmers do not see themselves as particularly law-abiding. Even if we observe slight differences in the percentage shares for both risk attitude and law-abidance, these differences cannot be described as statistically significant according to the Chi-square test (p-values > 0.05).

Result 2: There are hardly any differences between agricultural students' and farmers' attitudes regarding risk attitude and law-abidance.

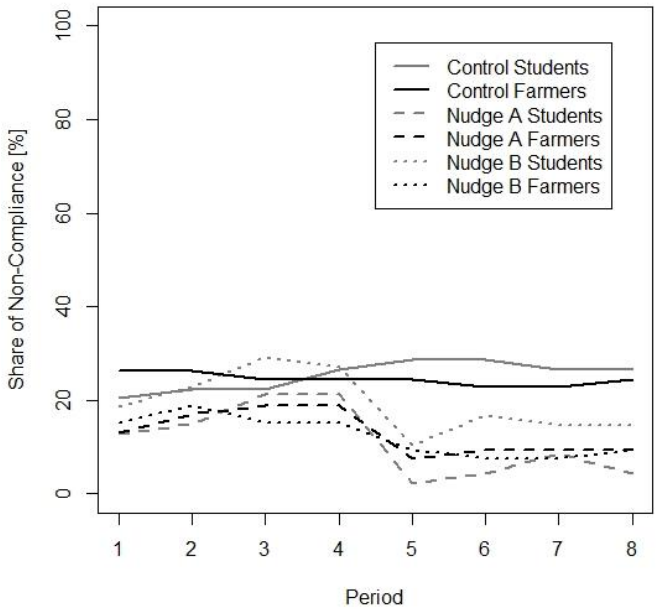

Figure 1. Average share of non-compliance

Compliance behaviour

The behaviour of the experimental subjects regarding the minimum-distance-to-water rule was assessed both categorically (compliance vs. non-compliance) and metrically (illicitly fertilised area in m^2). Figure 1 shows the average share of non-compliance for each group and subject sample in each period. In periods 1 to 4 (before the policy treatment), the average share of non-compliance is 22 % in the student sample and 20 % in the farmer sample as indicated in Table 3. This small difference cannot be described as statistically significant according to the Chi-square test (p-value = 0.3709). Non-compliance starts in a range of 12 %

to 26 % in period 1 and reaches a range of 15 % to 27 % in period 4 before the treatment occurs. The average share of non-compliance in the student sample rises from period 1 to 4. The farmers' average share is rather stable compared to the student sample throughout the first four periods.

Result 3: On average, non-compliance is similar in both samples, but in the student sample it is less stable over time compared to the farmer sample.

The extent of non-compliance is measured as the illicitly fertilised area. In periods 1 to 4, this value is lower in the student sample compared to the farmer sample. Nevertheless, this difference cannot be described as statistically significant according to the Mann-Whitney U test (p-value = 0.7846). Comparing the share and the extent of non-compliance, we see that although fewer farmers show non-compliant behaviour than students, the extent of non-compliance is higher for farmers. This means that if a farmer decides to break the rule, it is much more common that the farmer violates the rule more severely by choosing a bigger area that is illicitly fertilised. Students on the contrary choose smaller areas but violate the rule more often. This becomes even clearer if we only analyse the average area that was illicitly fertilised by participants that decided to break the rule, our deviant population. Here, the differences are described as statistically significant by the Mann-Whitney U test (p-value < 0.0001).

Result 4: The average extent and the severity of non-compliance are higher in the farmer sample compared to the student sample.

Table 3. Non-compliant behaviour of participants before treatment (periods 1–4)

Non-Compliance	Students	Farmers	Difference
Share of non-compliance	21.7 %	19.6 %	-2.1 (p-value = 0.3709)[1]
Extent of non-compliance	320.4 m^2	396.4 m^2	76.0 m^2 (p-value = 0.7846)[2]
Severity of non-compliance in deviant population	1,476.3 m^2	2,019.1 m^2	542.8 m^2 (p-value < 0.0001)[2]

[1]Chi-square test; [2]Mann-Whitney U test

If we look at periods 5 to 8 after the treatment (Table 4), we can see that overall the nudge treatments had a positive effect on reducing non-compliance in both samples. For nudge A, the effect seems to be stronger for the student sample where the share of non-compliance is reduced from 18 % to 5 % compared to 17 % to 9 % in the farmer sample. Nevertheless, this difference cannot be described as statistically significant by the Chi-square test (p-value = 0.1024). For nudge B, the effects in the student and farmer sample are similar where non-

compliance is nearly halved (25 % to 14 % for students, 16 % to 9 % for farmers). The Chi-square test also indicates no statistically significant difference (p-value = 0.0768).

Result 5: The two nudge types reduced the average share of non-compliance in both samples. In the student sample, nudge A was more effective than nudge B. In the farmer sample there was hardly any difference between the two nudge types.

Now, we compare the effects of the nudges on the extent of non-compliance. Overall, the results show that the nudge treatments had a positive effect on reducing the extent of non-compliance in both samples. The effect of nudge A is stronger in both samples. If we compare the two samples, nudge A reduced the extent of non-compliance even more in the student sample than in the farmer sample. For nudge B, the reduction was higher in the farmer sample. But these differences cannot be described as statistically significant (p-value = 0.0970 and 0.0768).

Result 6: The two nudge types reduced the average extent of non-compliance with nudge A being more effective than nudge B in both samples.

Focusing on the non-compliant subjects, we analyse the effects of the two nudge interventions on the severity of non-compliance measured as illicitly fertilised area. The effects of nudge A are rather low compared to the effects of nudge B in both samples. Furthermore, nudge A produces opposite effects in the two samples. In the student sample, the illicitly fertilised area decreases by 3 % (52 m^2) and in the farmer sample it increases by 3 % (71 m^2). More considerable differences can be observed in the case of nudge B. In the student sample, the severity of non-compliance increases strongly by 56 % (+ 764 m^2) and in the farmer sample by 27 % (453 m^2). However, the differences between nudge A and B in the samples cannot be described as statistically significant (p-value = 0.4455 and 0.9904).

Result 7: In the rule-breaking group of students and farmers, nudge B leads to a great increase of the extent of non-compliance. Effects of nudge A are very low in both groups.

Table 4. Comparison of Non-Compliance before and after treatment

Non-Compliance	Students		Farmers		Difference (p-values)	
	before	after	before	after	before	after
Share of non-compliance						
Control	23.0 %	27.6 %	25.4 %	23.7 %	0.5528	0.3622
Nudge A	17.6 %	4.8 %	17.0 %	9.0 %	0.8799	0.1024
Nudge B	24.5 %	14.1 %	16.0 %	8.5 %	0.0343	0.0755
Extent of non-compliance						
Control	319.3 m^2	480.8 m^2	559.5 m^2	514.6 m^2	0.2042	0.6024
Nudge A	305.5 m^2	80.9 m^2	348.3 m^2	190.2 m^2	0.9737	0.0970
Nudge B	336.0 m^2	300.4 m^2	269.1 m^2	180.9 m^2	0.0503	0.0768
Severity of non-compliance in deviant population						
Control	1,390.8 m^2	1,745.0 m^2	2,199.5 m^2	2,172.8 m^2	<0.0001	0.0241
Nudge A	1,740.5 m^2	1,688.9 m^2	2,050.8 m^2	2,122.1 m^2	0.0846	0.4455
Nudge B	1,372.6 m^2	2,136.1 m^2	1,677.9 m^2	2,130.6 m^2	0.2754	0.9904

5. Discussion and Conclusion

The main goal of this study was to investigate a potential subject pool effect between the samples of agricultural students and farmers in a policy experiment. The comparison of risk attitudes indicates hardly any differences between the two samples. We find a slightly higher average risk aversion (5.0 vs 4.9) and a slightly higher share of risk-averse subjects (52 % vs. 50 %) in the farmer sample which is in line with findings from Herberich & List (2012), even though they examined economics students instead of agricultural students. We also find a slightly higher share of risk-seeking farmers compared to students (11 % vs. 10 %) and consequently a lower share of risk-neutral farmers (37 % vs. 40 %). The very similar results are contrary to the study of Maart-Noelck and Mußhoff (2014) who highlight that independent of the method used *"students are not a suitable convenience group for making conclusions about the risk attitude of German farmers."* (p. 350). Their student sample comprises German agricultural students compared to German farmers as is the case in our study. The risk attitude was also elicited by means of a Holt-and-Laury lottery, but the design slightly differs in comparison with our study. The winning amounts in the lottery of Maart-Noelck and Mußhoff (2014) were ten times higher than in the lottery used in our study. Rabin (2000) argues that low stakes foster risk-neutral behaviour which could explain the differences (higher share of risk neutral students and farmers) between our samples and the samples of Maart-Noelck and Mußhoff (2014). Another difference in the design of our lottery was the included display of expected values which should support a better understanding by the participants.

Nevertheless, Hermann and Mußhoff (2017) showed that this does not have an impact on risk elicitation for students.

The results on non-compliance show that the average share of non-compliance is similar in both samples. Whereas the extent and the severity of the deviant participants is higher in the farmer sample compared to the student sample. This is in contrast to previous findings, e.g. Choo et al. (2016) found that students behaved more often non-compliantly than non-student subjects in the context of tax compliance. Higher shares of non-compliant behaviour might be explained with more experience in the business context (Khera and Benson, 1970). That means that farmers are more accustomed to command-and-control measures in the specific context of water protection rules. With regard to the low control intensities and the difficulties to identify polluters, farmers might be better able to assess the consequences of their behaviour.

Moreover, our results share several similarities with the findings of Alm et al. (2015). In their study on tax compliance, students and non-students behaved similarly, particularly regarding the response to the policy treatment, albeit not always in their levels. The similar response to the nudge treatments and the higher effectiveness of nudge A in both samples in our study is also in agreement with Ferré et al. (2017). Analysing the responses of student and non-student samples, she concludes that the ranking of policy options does not differ. Hence, our findings support the idea that this holds also for different types of nudge interventions.

Finally, the results indicate the presence of a boomerang effect for nudge B in both samples. This means that the nudge intervention backfired and increased non-compliant behaviour in the student and the farmer sample. Furthermore, the initial expectation that nudge B would be more effective than nudge A cannot be confirmed for both subject pools. These findings are particularly important in the sense that even unexpected effects appear parallel in both samples. However, the magnitude of the treatment effect differed which is in line with Bolton et al. (2012) who found for the newsvendor problem that the direction of effects was similar but different for the magnitude.

In conclusion, the results of this policy experiment show that agricultural students and farmers behaved similarly regarding the direction of the response but differed in their levels. Consequently, we suggest that agricultural students can be a good low-cost option in policy experiments where the aim is to analyse the direction of policy effects. The use of students may also be appropriate to gain first insights into yet uninvestigated policy tools since even

unexpected effects can be revealed before implementing a policy. Care must be taken if predictions should be made concerning the magnitude or level of certain behaviour and response to policy tools. Here, we suggest using farmers. In this case, online experiments as an alternative to laboratory experiments can facilitate acquisition of experimental subjects.

Our conclusions, however, are limited to the investigated policy type and context. We only assessed the impact of green nudges on compliance behaviour with water protection rules. Future work should concentrate on whether subject pool effects exist for other types of policy instruments such as command-and-control measures or economic instruments. To analyse context dependency of subject pool effects, future studies should target other areas of agriculture where non-compliance is likely to occur. Furthermore, it would be interesting to compare other potential subject groups in the agricultural sector such as apprentices with agricultural students and farmers.

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Appendix

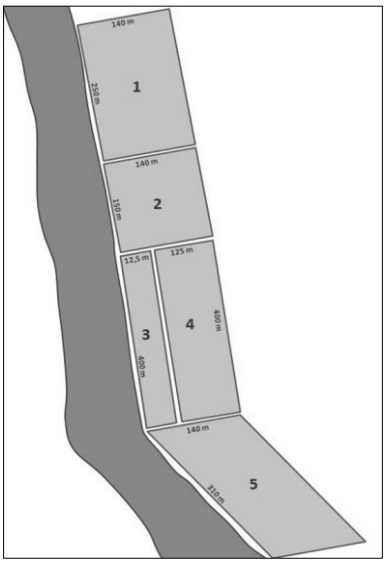
Part 1: Business Management Game

Instructions

Over 8 periods, you will manage an agricultural farm in a region characterised by small-scale agriculture. Your arable land is 15 hectares. The fields you cultivate are mainly located near a water body. Some of the fields are threatened by drought.

Within the business management game, you have to determine the production programme of your farm eight times. In addition to the selection of crops, you must also consider how much fertiliser you want to use. The yields achieved depend on the fertiliser intensity.

At the end of each production period, all products are sold at their current market price. The profit will be credited to your account. The goal is to achieve the highest possible overall profit at the end of the business management game.



In the figure on the right side, you can see your farmland.

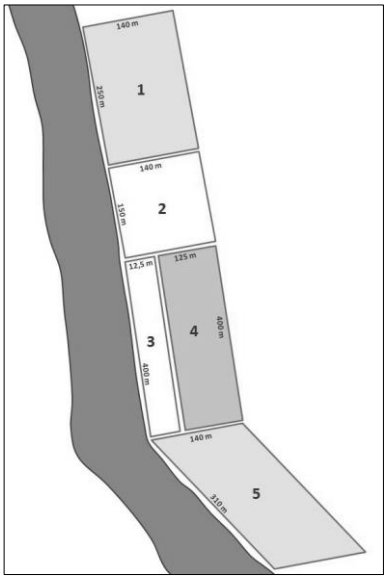
The following crops can be cultivated on the fields:

- Grain maize
- Canola
- Wheat

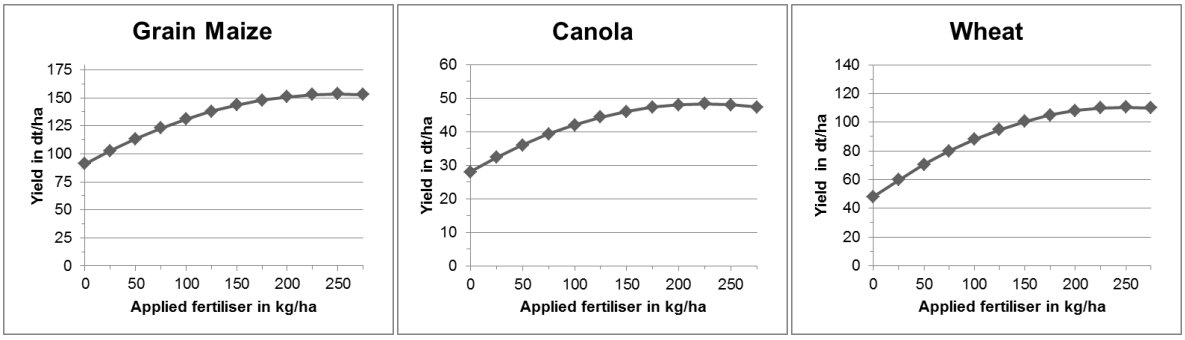
Please note that each crop must be cultivated on at least one field.
For simplification reasons, no specific crop rotations have to be followed.

Some fields have an increased risk of drought stress. This can lead to a yield reduction. A drought stress index of 1 means a 10 % yield reduction for all crops. A 2 means a 20 % yield reduction compared to an area with a drought stress index of 0.

Field	Size	Drought stress index
1	3.5 ha	1
2	3.0 ha	0
3	0.5 ha	0
4	5.0 ha	2
5	4.0 ha	1

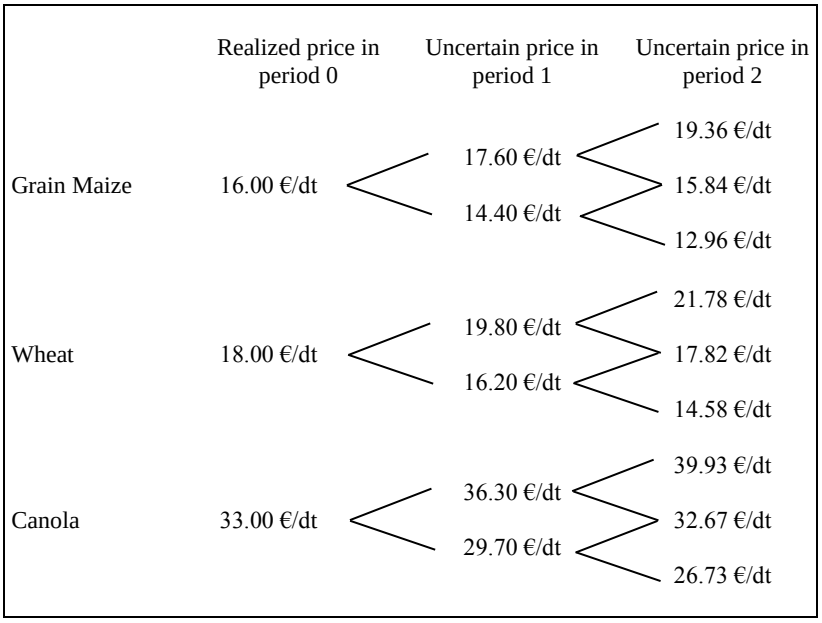


Once you have selected the crops for the individual fields, you have to decide how much fertiliser you would like to use. The following figures show the yield depending on the amount of fertiliser applied.



(These figures will also be displayed later when you make your decision.)

At the end of the production period, the harvested products are sold at the current market price. These market prices are uncertain and fluctuate by 10 % from the previous price. This means that with a probability of 50 % each, the price increases by 10 % or falls by 10 %. The possible price developments over two periods are shown below:



Since the fields are in private ownership, there is no need to pay rent. The following variable costs are accrued for the cultivation of the individual crops (the fertiliser costs are not yet included):

	Costs per ha
Grain maize	€ 950
Canola	€ 820
Wheat	€ 800

The use of nitrogen fertiliser costs 0.59 €/kg. With the assumed fertilisation technology, a distance of at least 3 meters must be carried out to the nearby water body. In each period, you will also receive state transfer payments of 300 € per hectare.

At the beginning, your account balance is 20,000 €. If you overdraw your bank account during the game, you can borrow money from your close relatives without interest. As soon as you have the liquidity at the end of a production period, the borrowed capital is automatically repaid.

Before the business management game begins, please answer a few questions. This enables you to check whether you have understood the basic rules. If you wish to read these instructions again during the experiment, please click on the "Instructions" in the upper right corner of the header.

Control questions

1. Which crops can be cultivated within the business management game? Please choose one of the following:

○ Potato

○ Canola

○ Rye

2. How much does the use of nitrogen fertilisers cost? Please make your choice.

○ 0.59 €/kg

○ 0.79 €/kg

○ 0.99 €/kg

3. By what percentage can market prices rise or fall in the following period? Please enter the corresponding number.

Market prices rise or fall by ____ %.

[The experiment starts, after all control questions have been answered correctly.]

[After period 4, the participants are confronted with the following treatments according to their group assignment]

Nudge Treatment A:

Information for all farmers - nitrate pollution of water bodies

In recent years, nitrate pollution in water bodies in Germany has risen significantly. The legal limit is consistently exceeded.

Environmental associations point out that excessive nutrient inputs endanger water quality and thus the living conditions of plants and animals. These pressures lead to a reduction in biodiversity.

Public health authorities warn against increased nitrate levels that affect drinking water quality and can lead to health problems. Babies may suffer from cyanosis due to increased intake of nitrate. This results in a lack of oxygen, which leads to death by suffocation. Furthermore, it is suspected that the intake of nitrates can trigger cancer.

One reason for these high nitrate values in water bodies is nitrogenous fertiliser inputs. Keeping sufficient distances from the water body can prevent direct runoff or subsequent leaching. The legal distance to the upper edge of the embankment is at least 3 meters, if no devices with precise application technology are used. Environmental associations recommend that a distance of 5-10 meters should be maintained.

Help to improve the water quality!

Nudge Treatment B:

Information for <u>all farmers in your region</u> - nitrate pollution of water bodies

In recent years, nitrate pollution in water bodies in Germany has risen significantly. The legal limit is consistently exceeded.

Environmental associations point out that excessive nutrient inputs endanger water quality and thus the living conditions of plants and animals. These pressures lead to a reduction in biodiversity.

Public health authorities warn against increased nitrate levels that affect drinking water quality and can lead to health problems. Babies may suffer from cyanosis due to increased intake of nitrate. This results in a lack of oxygen, which leads to death by suffocation. Furthermore, it is suspected that the intake of nitrates can trigger cancer.

One reason for these high nitrate values in water bodies is nitrogenous fertiliser inputs. Keeping sufficient distances from the water body can prevent direct runoff or subsequent leaching. The legal distance to the upper edge of the embankment is at least 3 meters, if no devices with precise application technology are used. Environmental associations recommend that a distance of 5-10 meters should be maintained.

An investigation has shown that farmers **in your particular region** comply with the legal distance of at least 3 meters to the embankment's upper edge. **Your colleagues on neighbouring fields** are helping to prevent the input of fertilisers into the water.

Help also to improve the water quality!

Part 2: Holt-and-Laury Lottery

Your decisions in a lottery

In the following, you have to choose 10 times between two lotteries: Lottery A and Lottery B. The lotteries differ in the amounts you can win.

Example: Let's look at line 4 in the table below. A ten-sided die is thrown. If you choose Lottery A, you win 20 € if a 1,2,3 or 4 is thrown or 16 € if a 5,6,7,8,9 or 10 is thrown. If you choose Lottery B, you win 38.50 € if a 1,2,3 or 4 is thrown or 1 € if a 5,6,7,8,9 or 10 is thrown.

Please choose one of the two lotteries in each line.

Decision	**Lottery A**		**Your decision**	**Lottery B**	
	Expected Value	**Prize money** - Dice score	A ❍ ❍ B	**Prize money** - Dice score	Expected Value
1	16.40	**20 €** - 1 **16 €** - 2, 3, 4, 5, 6, 7, 8, 9, 10	A ❍ ❍ B	**38.50 €** - 1 **1 €** - 2, 3, 4, 5, 6, 7, 8, 9, 10	4.75
2	16.80	**20 €** - 1, 2 **16 €** - 3, 4, 5, 6, 7, 8, 9, 10	A ❍ ❍ B	**38.50 €** - 1, 2 **1 €** - 3, 4, 5, 6, 7, 8, 9, 10	8.50
3	17.20	**20 €** - 1, 2, 3 **16 €** - 4, 5, 6, 7, 8, 9, 10	A ❍ ❍ B	**38.50 €** - 1, 2, 3 **1 €** - 4, 5, 6, 7, 8, 9, 10	12.25
4	17.60	**20 €** - 1, 2, 3, 4 **16 €** - 5, 6, 7, 8, 9, 10	A ❍ ❍ B	**38.50 €** - 1, 2, 3, 4 **1 €** - 5, 6, 7, 8, 9, 10	16.00
5	18.00	**20 €** - 1, 2, 3, 4, 5 **16 €** - 6, 7, 8, 9, 10	A ❍ ❍ B	**38.50 €** - 1, 2, 3, 4, 5 **1€** - 6, 7, 8, 9, 10	19.75
6	18.40	**20 €** - 1, 2, 3, 4, 5, 6 **16 €** - 7, 8, 9, 10	A ❍ ❍ B	**38.50 €** - 1, 2, 3, 4, 5, 6 **1 €** - 7, 8, 9, 10	23.50
7	18.80	**20 €** - 1, 2, 3, 4, 5, 6, 7 **16 €** - 8, 9, 10	A ❍ ❍ B	**38.50 €** - 1, 2, 3, 4, 5, 6, 7 **1 €** - 8, 9, 10	27.25
8	19.20	**20 €** - 1, 2, 3, 4, 5, 6, 7, 8 **16 €** - 9, 10	A ❍ ❍ B	**38.50 €** - 1, 2, 3, 4, 5, 6, 7, 8 **1 €** - 9, 10	31.00
9	19.60	**20 €** - 1, 2, 3, 4, 5, 6, 7, 8, 9 **16 €** - 10	A ❍ ❍ B	**38.50 €** - 1, 2, 3, 4, 5, 6, 7, 8, 9 **1 €** - 10	34.75
10	20.00	**20 €** - 1, 2, 3, 4, 5, 6, 7, 8, 9, 10	A ❍ ❍ B	**38.50 €** - 1, 2, 3, 4, 5, 6, 7, 8, 9, 10	38.50

Part 3: Self-assessed law-abidingness

To what extent do you agree with the following statement?

"I always comply with rules and laws."

I totally disagree — neither agree nor disagree — I fully agree

❍ ❍ ❍ ❍ ❍ ❍ ❍ ❍ ❍ ❍ ❍

0 1 2 3 4 5 6 7 8 9 10

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Department für Agrarökonomie und Rurale Entwicklung

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Die Wurzeln der **Fakultät für Agrarwissenschaften** reichen in das 19. Jahrhundert zurück. Mit Ausgang des Wintersemesters 1951/52 wurde sie als siebente Fakultät an der Georgia-Augusta-Universität durch Ausgliederung bereits existierender landwirtschaftlicher Disziplinen aus der Mathematisch-Naturwissenschaftlichen Fakultät etabliert.

1969/70 wurde durch Zusammenschluss mehrerer bis dahin selbständiger Institute das **Institut für Agrarökonomie** gegründet. Im Jahr 2006 wurden das Institut für Agrarökonomie und das Institut für Rurale Entwicklung zum heutigen **Department für Agrarökonomie und Rurale Entwicklung** zusammengeführt.

Das Department für Agrarökonomie und Rurale Entwicklung besteht aus insgesamt neun Lehrstühlen zu den folgenden Themenschwerpunkten:

- Agrarpolitik
- Betriebswirtschaftslehre des Agribusiness
- Internationale Agrarökonomie
- Landwirtschaftliche Betriebslehre
- Landwirtschaftliche Marktlehre
- Marketing für Lebensmittel und Agrarprodukte
- Soziologie Ländlicher Räume
- Umwelt- und Ressourcenökonomik
- Welternährung und rurale Entwicklung

In der Lehre ist das Department für Agrarökonomie und Rurale Entwicklung führend für die Studienrichtung Wirtschafts- und Sozialwissenschaften des Landbaus sowie maßgeblich eingebunden in die Studienrichtungen Agribusiness und Ressourcenmanagement. Das Forschungsspektrum des Departments ist breit gefächert. Schwerpunkte liegen sowohl in der Grundlagenforschung als auch in angewandten Forschungsbereichen. Das Department bildet heute eine schlagkräftige Einheit mit international beachteten Forschungsleistungen.

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