Rice farming and the origins of cooperative behaviour

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Abstract: This paper provides novel evidence for links between historic farming practices and current norms of cooperative behaviour. We hypothesise that the cooperation required in wetland rice farming gives rise to strong cultural norms of cooperativeness. We compare participants from prefecture cities that predominately practice wetland rice cultivation, to those from non-rice regions. A public goods game with and without punishment is the main measure for cooperative behaviour. Results indicate a strong and robust positive effect of wetland rice farming on cooperative behaviour and pro-social punishment. Complementary, consistent evidence from a natural field experiment and a survey further enriches our data.

Keywords: cooperative behaviour, public goods game, rice farming

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1 Introduction

In the broad context of exploring historical and cultural influences on economic development, a recent active body of research has established considerable variation in economic preferences within and across countries (Falk *et al.*, 2018). These preferences, particularly trust and patience, are causally related to economic development (Knack and Keefer, 1997; Algan and Cahuc, 2010; Dohmen *et al.*, 2018; Tabellini, 2010; Khadjavi *et al.*, 2021). The origins of these preferences have been the topic of empirical and theoretical research (Galor and Özak, 2016; Nunn and Wantchekon, 2011), thus connecting cultural and historical differences to current economic development levels.

The preference for cooperation is another key element that influences economic development, the rule of law, and the quality of institutions (Knack and Keefer, 1997; Herrmann *et al.*, 2008; Tabellini, 2008). Furthermore, there is mounting evidence that, like trust and patience, preferences for cooperation vary across cultures and societies (Alesina and Giuliano, 2015; Falk *et al.*, 2018; Gächter *et al.*, 2010; Herrmann *et al.*, 2008; Butler and Fehr, 2018). However, the cultural and historical origins of cooperative behaviour remain mostly unexplored.

This paper addresses this gap by examining the connection between regional differences in historical agricultural activity and contemporary differences in cooperative behaviour. In particular, we explore whether and how historical agricultural practices that require high levels of cooperation and coordination shape current cultural norms of cooperativeness. We attend to this question by examining the specific case of traditional wetland rice farming.

Researchers have long recognised the influence of agricultural activities on people's beliefs and preferences.[1] Talhelm *et al.* (2014) have described how traditional wetland rice farming differs from wheat farming in some detail. They highlight the high infrastructure costs and intense labour requirement in rice farming, derived from the need to level paddy fields, transplant rice seedling, and create and maintain an irrigation system. Indeed, researchers have estimated that wetland rice farming requires at least twice the amount of labour compared to other crops such as wheat and corn (Fei, 1945; Buck, 1935). Traditional wetland rice farming is only possible by coordinating and cooperating extensively with other rice farmers within a village or across villages (Talhelm, 2015; Fei, 1945; Wong, 1971).

Talhelm *et al.* (2014) provide evidence that a history of wetland rice farming has a persistent influence on culture and norms. Their proposed 'Rice Theory' shows that students in traditional wetland rice farming regions have a more holistic thinking style, while students from other regions possess a more analytic thinking style. Their work is a seminal contribution in explaining eastern and western cultural differences. With their focus being on thought style and collectivism, they did not explore cooperation or group dynamics.

To test whether wetland rice farming gives rise to cooperative behaviour, and the role of punishment, we compare individuals from regions that predominately practice wetland rice cultivation to those from other regions. We follow Talhelm *et al.* (2014) by defining a province or prefecture city as predominantly wetland rice farming if more than 50% of its cultivated land is paddy fields. The provincial-level data comes from the National Bureau of statistics (China Statistical Yearbook, 1996) . The prefecture city data, which is one administrative level below provinces in China, comes from each province's Statistical Yearbook. To avoid

[1] See the 'subsistence style theory' (Berry, 1967; Nisbett *et al.*, 2001); and on the influence of agricultural practices on gender roles (Boserup, 1970).

changes caused by recent advances in technology, we use the earliest data available (1996) and soil suitability as an instrumental variable to reflect the historical farming situation as closely as possible.

The experimental sessions were conducted in four provinces in China. Two of which are wetland rice provinces (Zhejiang and Hunan province) and two non-rice provinces (Hebei and Shandong province). We recruited local, Han Chinese, and first-year university students in each province based on their hukou. Hukou is a household registration system employed in China. The policy requires that individuals register the hukou at their city of residence, and they can only register their hukou at one prefecture city. By "local students" we mean that their hukou was registered at the province of the experiment.

We implement the public goods game (PGG), with and without punishment as the main measure of cooperativeness. Since we also focus on differences in punishment, we use the repeated version of PGG, which allows us to study the dynamics of cooperative behaviour and punishment and permits differences to emerge. To this end, our design is similar to that of Herrmann *et al.* (2008), who study punishment in PGGs across sixteen countries.

To control for potential confounding factors and aiming to gain a deeper understanding of the mechanisms through which rice influences cooperative behaviour, we collect a wide range of variables both within the lab and from other sources. The former include the Triad task (the main dependent variable in Talhelm *et al.* (2014) which is commonly used in social psychology to measure cultural thought), individualism and collectivism questionnaire (Triandis and Gelfand, 1998), social preferences (Dictator Game and Ultimatum Game), risk attitude (Holt and Laury, 2002), and a coordination game (the Stag Hunt game (Skyrms, 2004)). The latter variables include GDP and patent per capita, land characteristics, soil suitability index for wetland rice farming, and migration flow across Chinese prefectures. Please see sections 3 and 5 for more information.

The results reveal a robust and consistent effect of wetland rice farming on cooperative behaviour. In both the PGG with and without punishment, participants from wetland rice prefecture cities contribute significantly more than their non-rice counterparts. Moreover, we find that wetland rice participants are more predisposed to punish free-riders, defined as group members who contribute less than the punisher. At the same time, there is no difference in punishing cooperators, defined as group members who contribute more than or equal to the punisher.

These conclusions hold after we control for thinking styles, which is the primary dependent variable in Talhelm *et al.* (2014), and for the social styles measured by the individualism and collectivism questionnaire (Triandis and Gelfand, 1998). This suggests that the influence of wetland rice cultivation on cooperative behaviour is likely to be direct rather than mediated via social or thinking styles.

Several potential threats to inference, and possible alternative interpretations, are examined and ruled out. First, by recruiting only Han Chinese first-year University students, several potential confounds - such as educational background, language, ethnic related culture, and political institution – are controlled by design. Second, we control for a set of covariates which might be related to rice farming or cooperation. These include variables on economic development, geo-climate conditions, and a set of cultural covariates collected in the lab. Third, to further address the issue of endogeneity, we use wetland rice suitability as an instrument for the paddy field statistic. Fourth, we compare participants' current hukou to their fathers' birthplace to check whether self-selection into or out of rice regions can explain the results. Lastly, the migration of the general population might shape the local norm, since people carry their local norm with them to new locations (Putterman and Weil, 2010). Following Zhu *et al.* (2019), we collect data from the Fifth National Population Census of the People's Republic of China (2000 Chinese Census) and construct a migration matrix. Using the matrix, we calculate the migration adjusted rice suitability index and population net-flows into the rice and non-rice regions. Our results are robust to all of the above exercises.

We also provide additional data that supports the validity of our results beyond the laboratory-experimental context. We report findings from contributions to Wikipedia and a survey regarding the provision of public goods. The survey refers to the China Family Panel Studies (CFPS), an extensive, representative survey of the Chinese population. The questionnaire contains a variable that can be considered as a local public good—the tidiness of the street where the interviewees live. Despite the limitations of our complementary measures, they do point to actual differences between regions with different agricultural backgrounds in the willingness to provide public goods. In all cases, the differences are in line with our experimental results.

To the best of our knowledge, this is the first paper that shows traditional agricultural activities have a profound and lasting effect on contemporary individuals' cooperative behaviour and punishment. Our paper contributes to several distinct bodies of literature. Firstly, there are several papers exploring the various possible effects of rice cultivation. Talhelm *et al.* (2014) show that rice provinces nurture collective social styles and holistic thinking styles, while wheat provinces give rise to individualist social styles and analytic thinking styles. The finding is replicated in a field setting where customers in Starbucks need to pass through chairs that obstruct the pathway (Talhelm *et al.*, 2018). They find that individuals in wheat provinces are more likely to move the chairs out of their way, which is consistent with the theory that individualistic individuals are more inclined to adjust the environment to fit themselves rather than the other way around. Talhelm and English (2020) show that rice regions in China have tighter social norms (Gelfand *et al.* (2006)) compared to wheat regions. The authors also theorise the connection between rice farming and punishment, since tight norms refer to the number of explicit rules guiding people's behaviour and the willingness to sanction violators in a society. The present paper provides the first piece of empirical evidence supporting the hypothesis to the best of our best knowledge.[2]

Chew *et al.* (2015) compare cooperative behaviour between participants from rice and non-rice *provinces* using a two-person one-shot PGG. Using data from the China Household Income Project, Ge *et al.* (2021) show that people from rice regions are more likely to help their relatives and neighbours. Zhu *et al.* (2019) use county level-data, which is one level finer than prefectures, to investigate how rice legacy influences innovativeness. We contribute to this line of literature by showing that the legacy of wetland rice farming extends to cooperative behaviour and punishment.

Moreover, this paper contributes to the body of research working with experimental and behavioural methods to explore how economic preferences and beliefs vary systematically across societies and countries. Differences in preferences, including bargaining, coordination, risk, efficiency, fairness, and cooperation have been found among countries including Israel, Japan, the US, Yugoslavia, India, China, Norway, and less developed and small-scale societies (Roth *et al.*, 1991; Henrich *et al.*, 2001; Jackson and Xing, 2014; Hsee and Weber, 1999;

[2]There exists anecdotal evidence indicating that Chinese and Japanese farmers (China and Japan are tight societies) do punish norm breakers (Fei, 1983; Suehara, 2006), yet empirical evidence is scarce.

Gächter *et al.*, 2010; Herrmann *et al.*, 2008). See Falk *et al.* (2018) for a first comprehensive comparison on a wide range of economic preferences among individuals from 76 countries. It might be plausible to find differences in preferences between populations that vary significantly regarding their culture, economic development, and political-historical background, and this has now been well documented. Our paper adds to this body of research by documenting differences in cooperation between regions within one country, where individuals are ruled by one political party, possess similar ideologies, speak the same language, and share a common history.

This paper also contributes to the literature documenting how individuals' social preferences and beliefs vary within countries. Aiming at solving the puzzle of the persistent North-South development gap in Italy, Bigoni *et al.* (2016) find that Northern Italians contribute more in the PGG and trust more in a three-person trust game. Bigoni *et al.* (2019) find that it is beliefs and aversion to social risk, instead of preferences for conditional cooperation, that underlies the results in Bigoni *et al.* (2016). Researchers have documented differences in other countries. Rustagi and Veronesi (2016) find that cooperation differs among participants from Switzerland's three main language regions. Gächter and Herrmann (2011) conduct public goods with and without punishment in rural and urban Russia. They find that rural residents and mature (older than 30) participants contribute more in the PGG but find no systematic differences in punishment. Brosig-Koch *et al.* (2011) find that participants living in Western Germany give more to those who get an unfortunate outcome in a dice rolling game than those living in the East part of Germany. This paper contributes to this line of research by documenting that punishment can vary systematically within a country, depending on the local norms. Moreover, this paper offers a somewhat stringent within-country comparison, since the institutional quality, language, participants' education backgrounds, and political system are the same.

Lastly, we contribute to the emerging body of literature investigating the origins of observed differences in people's preferences. Studies have shown that an occupation that requires intensive cooperation leads to individuals being more cooperative than those whose occupation does not require high levels of cooperation (Gneezy *et al.*, 2016; Leibbrandt *et al.*, 2013). The effect does not go beyond the individuals involved in the studied occupations. In contrast, participants in our paper are university students, not rice farmers. As such, our paper is more in line with research on how historical practices and events shape present-day cultural norms that manifest in individuals' social preferences. For example, Alesina *et al.* (2013) trace the origins of less equal workplace gender norms to a historical practice of plough agriculture. Galor and Özak (2016) show a connection between traditional agriculture and future orientation. Nunn and Wantchekon (2011) find that the various levels of mistrust within Africa originate from different histories regarding the transatlantic and Indian Ocean slave trades. Enke (2019) shows that the heterogeneity of moral systems – bundles of psychological and biological functionalities that regulate human behaviour in social dilemmas – can be attributed to the dynamic interaction between economic development and family network structures. Buggle (2020) finds that historical practice of irrigation agriculture shapes present-day collectivist norms. The historical natural experiment of the Kuba kingdom (17th century) enables Lowes *et al.* (2017) to connect rule-obeying norms to historical forms of institution. Our paper contributes to this sparse research on historical institutional origins for contemporary norms. It makes a case for the argument that socio-economic history has profound influence on regional differences in economic preferences.

The remainder of the paper is structured as follows: Section 2 explains the conceptual framework. Section 3 illustrates the experimental design and data collection. Non-parametric and regression results are presented in section 4. A series of robustness checks are performed in section 5. In section 6, we present two pieces of evidence from the field to show that our main results are not a product of artificial situations that participants encounter in the lab. Section 7 concludes.

2 Conceptual Framework

2.1 Particular features of wetland rice farming

In this section we discuss the particular features of wetland rice farming and outline how its cultivation may have allowed differences in cooperative behaviour to emerge in China. Cultural psychologists and, more recently, economists (Galor and Özak, 2016; Nunn and Wantchekon, 2011; Enke, 2019), have discussed the role of different ways to produce food in shaping behaviour and beliefs, both in the short- and in the long-term.

Wetland rice, as Fuller and Qin (2009, p. 88) note, is "a highly productive crop, but this productivity is paid for with labour and water." Indeed, wetland rice yields about 4 times more tons per hectare than dry-land rice (Khush, 1997; Bray, 1986), and 82% more than wheat.[3] However, it is also very demanding in water, which creates conditions that foster cooperative behaviour.

The increased labour requirements for wetland rice farming are owed to two practices that increase production. The first practice is transplanting. Farmers grow rice seedlings in

[3] For the productivity compared to wheat we used the yield per hectare in China for paddy field rice and wheat in 1991, the earliest available year.

small plots, where they can better control the amount of water, and transplant the seedlings to the main fields when they have grown enough. A side-benefit of transplanting is that it also frees up the main fields for the cultivation of other crops until it is time to plant the seedlings. The second practice is field preparation. Paddy fields have to be flattened to ensure even water distribution for optimal production (IRRI, 2007). If the field is uneven, some parts will have too much water and others will have too little. Both situations impede the growth of the plant and decrease its yield. Fei (1945) and Buck (1935) have calculated the extra labour cost of rice cultivation to about twice the amount of labour compared to other crops such as wheat or corn. Because of the high labour requirement, small families cannot self-sustain by farming rice (Fei, 1945; Buck, 1935; Talhelm, 2015).

The increased labour requirements of wetland rice have been known for a long time. For example, a Chinese farming guide in the 1600s suggested: "If one is short of labour power, it is best to grow wheat...the reason for not planting rice is to economise on labour power"(quoted in Elvin, 1982, p. 30). In order to satisfy the labour requirements of wetland rice, farmers would engage in labour exchange with their neighbours or extended family members. One family would help the other with the understanding that those receiving help would return the favour in the same manner, not in money or other gifts. It is important to note that labour exchange was driven by economic necessity, as it was taking place during peak labour times, and if one could not return the labour, they were expected to hire others to do it instead (Fei, 1945).[4]

In addition to increased labour, wetland rice is very demanding in water. Irrigation networks are often associated with wetland rice cultivation. Farmers connected to the same

[4]Suehara (2006) makes similar observations regarding traditional wetland rice farming in Japan and contrasts it with labour exchanges in DR Congo.

irrigation network had to coordinate on when to fill and empty their fields (Fei, 1946; Bray, 1986). Building the irrigation network itself requires the pooling of resources, both financial and labour. Furthermore, irrigation networks require maintenance which poses externalities on other users. For example, it is not sufficient that a family maintains the irrigation walls in their plot. If the neighbours do not maintain their walls, all the fields risk becoming flooded, thus reducing the yield for everyone. Finally, wetland rice farmers had to devise ways to share the water. This was of particular importance during years of low rainfall.

2.2 The link between rice farming and cooperative behaviour

Because of the particular features of wetland rice cultivation, its farming should be conducive to increased cooperation among farmers.

Take for example the irrigation networks described above. Their creation, maintenance, and operation present aspects of commons problems. Increased cooperation could solve those problems efficiently. Building a new irrigation network is easier if many families work together and share the cost. Similarly, repairing the irrigation walls is necessary, but each family individually has an incentive to free-ride and avoid the cost of the repairs. Moreover, labour exchange is a way to solve the problem posed by the increased labour requirements of wetland rice. Reciprocity, an essential component of cooperation, could underpin this solution and prevent farmers from not returning the favour.

It is important to contrast these features with the cultivation of wheat or other dry-land crops. Those crops have lower labour requirements (Fei, 1945), largely negating the need for labour exchanges. In addition, rainfall is sufficient for their cultivation and they do not require elaborate irrigation networks. This means that farmers in areas that could not grow wetland rice did not have to come up with ways to solve the commons problems associated with the cultivation of paddy field rice.

Since cooperation is welfare maximising for wetland rice cultivation, cooperative social norms are more likely to emerge in rice farming communities. This logic is consistent with standard cultural evolution models, which posit that the intergeneration transmission of norms is subject to a natural-selection-like process (Boyd and Richerson, 1985). In such a model, Tabellini (2008) emphasises the role of parental choices for the emergence of a cooperative norm. If growers of wetland rice realised that their children would fare better if they were more cooperative, they would instil in them attitudes that favoured cooperation.

Punishment could play a crucial role in the emergence of this norm. In the model of Tabellini (2008), it increases the payoff from cooperating. In the same vein Gavrilets and Richerson (2017) show that punishment is more successful in endogenising the cooperative norm than other means. As a result, they predict that punishing free-riders matters more for the evolution of a cooperative norm, than the direct benefits from cooperating. Similarly, Aoki (2001) highlights the importance of punishment in a model describing the production of wetland rice in Korea. In that model production is sustained by a shared belief that shirking will be punished, which can be interpreted as a descriptive norm (Cialdini *et al.*, 1990).

A natural question then is why would rice farming be well suited to punishment. Ray (1998, p.510) gives three conditions under which punishment is likely to emerge as a strategy to sustain cooperation: 1) a positive individual gain from successful cooperation, 2) observable actions of each individual member of the community by others, and 3) enforceable sanctions.[5]

[5]We interpret enforceable to mean "incentive compatible", not in the strict sense of "enforceable in court".

Wetland rice farming satisfies all these conditions. Paddy field rice has a much higher yield per hectare than traditional alternatives, such as dry-land rice (Bray, 1986; Khush, 1997) or wheat Talhelm and Oishi (2018).

Moreover, free-riders can be easily identified; their names can spread quickly within the small and closed communities that are those villages; there are multiple ways to punish free-riders. It is worth expanding on this last point: the kind of cooperation required to grow wetland rice is multifaceted and takes place among families in close spatial proximity. Free-riders could be punished by withholding labour exchange, by exclusion from the irrigation network (if technologically feasible), or by social ostracism Aoki (2001). Moreover, if a family did not maintain their irrigation walls or did not reciprocate a labour exchange, they could be punished not just by those directly harmed, but also by their relatives, friends, and the community as a whole. There is indeed anecdotal evidence that punishment of shirkers and free-riders was taking place in wetland rice growing villages in China, Japan, and Korea (Suehara, 2006; Fei, 1983; Aoki, 2001). Greif (1994) also emphasises the role of punishment in sustaining cooperation in collectivistic communities and punishment is likely linked to the tighter social norms in wetland rice regions in China (Talhelm and English, 2020).

To be sure, the fact that wetland rice cultivation is conducive to greater cooperation does not mean that we will necessarily observe increased cooperative behaviour. Why, then, do wetland rice farmers in China exhibit greater cooperative behaviour? It is clear that ecological determinism is not a satisfactory explanation for the emergence of cooperative behaviour (Talhelm and Oishi, 2018). Likewise, the mere existence of a psychological predisposition to cooperate may not be sufficient to sustain cooperative behaviour on its own, particularly in the long-term (Gavrilets and Richerson, 2017). Paddy field rice farming should then be viewed as a catalyst that facilitates the interplay between pre-existing elements in ways that allow the emergence and persistence of cooperative behaviour. To put it another way, wetland rice farming does not guarantee sustained cooperative behaviour, but it makes it more likely that it will emerge.

To conclude, cultivating wetland rice is attractive to farmers because of greater yield compared to the alternatives. At the same time, it requires small- and large-scale cooperation on numerous issues throughout the year. Repeated interactions on multiple domains are situations well-suited for the punishment of free-riders. In addition, models of cultural evolution identify punishment as a crucial factor in the emergence of cooperative norms. Those norms can be transmitted from generation to generation, presumably to the present day, and help sustain the cooperative equilibrium. In the following sections we will present evidence of both increased cooperative behaviour in wetland rice farming areas in China and of a greater propensity to punish free-riders. These findings are in line with the conceptual framework outlined in this section.

3 Experimental Design and Data Collection

3.1 Empirical strategy

We compare cooperative behaviour between participants from rice and non-rice regions to test our hypothesis. However, the simple comparison cannot establish a causal effect of wetland rice farming on cooperation. Several factors might bias the result. Firstly, rice and non-rice participants might have different backgrounds unrelated to the local norm shaped by rice farming, such as education. Second, the simple comparison might suffer from omitted variable bias – variables associated with rice farming and cooperation underlie the findings. Lastly, migration could drive the results – cooperative participants self-select into rice farming regions.

We minimise differences in the backgrounds of our participants, other than those related to rice and non-rice farming, through the recruitment protocol for our experiments. We elaborate on this point later in this section. To deal with the omitted variable bias we use the soil suitability index for the cultivation of rice as an instrumental variable. In addition, we collect covariates that might be related to both rice farming and cooperation not only from the laboratory but also from other sources. Finally, to address the selection bias, we construct an immigration adjusted rice suitability index which we also use in instrumental variable regressions, and we control for migration flows of the general population and the migration history of our participants.

We first describe how the rice and non-rice regions are defined and how we recruited participants to the laboratory experiment. The following subsection describes the experimental design. Finally, we enumerate the variables collected from sources outside of the laboratory.

3.2 Province and Prefecture Classification

We conducted laboratory experiments at four public universities located in four provinces in China – Hebei, Shandong, Hunan, and Zhejiang province.[6] All the universities rank between 100 to 300 nationally, out of 2300 private and public universities. All the universities are located in urban areas.

[6]The universities are Hebei University, Shandong Normal University, Hunan Agricultural University, and Zhejiang University of Economics & Finance.

For most of the analyses, we use prefecture level rice statistics, which is one administrative level lower than a province.[7] For both administrative levels, we follow Talhelm *et al.* (2014) by classifying a region as rice if more than or equal to 50% of its cultivated land is devoted to wetland rice farming, a region is classified as non-rice otherwise. The reason that we use the proportion of paddy field instead of rice output is that some rice is produced on dry lands, which is not cooperation intensive. Another reason is that rice output is sensitive to various environmental conditions such as drought, flood, or pest damage. Consequently, a low rice output in a given year does not imply that a region is non-rice.

Since we are interested in the influence of traditional agricultural practices, rather than modern farming techniques, we use cultivation data from 1996, which are the earliest available for most provinces and prefectures.[8]

Based on the above, Zhejiang and Hunan – the two prominent wetland rice farming provinces – have the majority of their cultivated land devoted to paddy fields, the percentages are 78.2% and 84.3% respectively. On the other hand, Hebei and Shandong are non-rice provinces as the percentages are only 1.9% and 2.3% respectively. Importantly, the two rice provinces have been prominent wetland farming rice provinces since the Song Dynasty (Fan, 2007).

3.3 Participant Recruitment

The goal is to recruit participants who have been exposed to local norms or customs for a long time but are similar otherwise. To this end, we use administrative data from the

[7] We treat Beijing, Shanghai, Tianjin and Chongqing as prefectures even though they are province-level cities.
[8] One participant comes from the Yulin prefecture in Guangxi province. However, Guangxi does not have prefectural level cultivated land data. We use province level data instead. For Hebei, we use prefectural level cultivated land statistics from 2007, which are the earliest available.

universities to recruit participants with a local household registration. Other criteria are being Han Chinese and being first year university students.

Locally registered students are more likely to have lived in the region for a longer period of time. This is because families need to have a local hukou to enjoy a wide range of benefits provided by the local authority, which includes education, welfare, eligibility to purchase a house and others. To further check whether participants have been living in rice or non-rice region for the majority of their life, we use the birth province of their fathers to identify participants whose families might have moved from a non-rice region into a rice region or vice versa. There are only a handful of participants recruited in a non-rice province who stated that themselves or their fathers had a hukou in a rice province. This is similar for participants recruited in rice provinces. Excluding them from our analysis does not alter our findings. The above also suggests that our results are unlikely to be driven by cooperative families self-selecting into rice regions.

We restrict the sample to Han Chinese because they share the same cultural origins (Wen *et al.*, 2004) . In addition, ethnic minority groups may have unique customs that might confound our results. From the post-experimental questionnaire, we identify three participants from ethnic minorities. Excluding them from the analysis yields similar results, hence we decide to keep them for the data analyses. We do not recruit Han Chinese from Tibet, Xinjiang, and Inner Mongolia, as these areas are traditionally herding regions and may have different cultural norms compared to areas where agriculture is the main subsistence (Nisbett *et al.*, 2001).

Finally, we recruit freshmen to minimise the indoctrination effect (Frank *et al.*, 1993). It is also worth noting that school curricula in China follow a very busy national curriculum.

This is particularly the case for senior high-school, where students prepare for the National College Entrance Examination. These factors help homogenise, as much as possible, the experience of our participants prior to beginning their university studies. There were nine participants who are not first year students. Including or excluding them does not affect our results and hence we include them in the analyses.

The recruitment process is as follows: each university provided a list of qualified students from which we randomly drew a preliminary sample. Administrative employees from each university then tried to contact the selected students. We provided a script template to help with recruitment. We emphasised that it was an economic study, they would receive monetary payments as compensation for their time, their decisions in the study would be anonymous and would not affect their records related to university in any way, and, most importantly, participation was voluntary. The show-up rate was 57.32%.

It is worth emphasising that our participants were not professional farmers and they were less likely to self-select into rice or non-rice regions. These are vital conditions to identify the causal impact of culture on behaviour as Guiso *et al.* (2006, p. 26) put it: "To claim a causal link, ..., focus on those dimensions of culture that are inherited by an individual from previous generations, rather than voluntarily accumulated."

3.4 Measures from the Laboratory

3.4.1 Experimental Measures of Cooperative Behaviour

We use the PGG to measure participants' level of cooperation. Participants play eight periods of PGG under the no-punishment condition followed by eight periods of punishment condition. They know there will be another game after the no-punishment condition, but they are not informed about its content until the completion of the no-punishment condition.

In the no-punishment condition, participants are randomly divided into groups of four and the group composition is fixed throughout the eight periods. In each period, each participant has an endowment of 20 points and need to decide how many points to contribute to a group account (the remaining points are allocated to their individual account). The total points in the group account are multiplied by 1.6 and then evenly distributed among all group members. In particular, each participant faces the following payoff function:

$$u_i = (20 - c_i) + (1.6 * \sum_{j=1}^{4} c_j) \ / \ 4$$

in which u_i is i's payoff, c_i is i's contribution to the group account, and $\sum_{j=1}^{4} c_j$ is the sum of contribution made by all group members.

The contributor gains 0.4 points for each point contributed to the group account. Therefore, contributing nothing always give participants the highest material payoff regardless of other group members' contributions. On the other hand, each point contributed to the group account increases the payoff of everyone by 1.6 points, and hence the group level payoff is highest if all group members contribute 20 points. In the latter case, each participant earns 32 points, which is higher than the self-interest outcome (20 points).

After all participants have made their decisions, the amount of contribution of each participant, their earning from the group account, and their total earning in the current period are shown on their computer screen. The contribution of each group member is displayed in a random order on the computer screen in each period so that participants cannot associate any contributions with a particular group member. This information is publicly shown because we intend to ensure comparability between the no-punishment and punishment condition – in the latter, group members' contributions must be revealed. The random shuffle of each members' contribution in the punishment condition is necessary because we would like participants' punishment decisions only based on individual's contribution level in the current period, not because of reputation built in previous periods. Participants need to press the 'CONTINUE' button to proceed to the next round.

After the no-punishment condition, participants are randomly regrouped and play eight periods of the punishment condition. The first part of the punishment condition is the same as the no-punishment condition: participants choose their contribution level and then receive information regarding other group members contribution. Afterwards, participants proceed to the punishment stage. At this stage, each participant chooses how many punishment tokens to assign to other group members. They can assign at most ten punishment tokens to one group member. Each token costs one point to the punisher and reduces the earnings of the punished participant by three points. Punishment tokens received could not reduce a participant's earnings below zero. However, negative profits are possible for some combinations of tokens received and assigned. This information is made clear to the participants. After punishment, participants receive their final earnings in each period. They are informed about their earnings in the first stage, the total punishment tokens received and assigned to others in the punishment stage, and their final earnings. The participants are only told the total punishment tokens received but not the identity of the punishers.

3.4.2 Other Measures from the Lab

Using both behavioural tasks and survey questions, we elicit a battery of measures that might be associated with cooperative behaviour or wetland rice farming.

First, we use the Triad task to measure participants' thinking styles. The task is first developed by Chiu (1972). It presents respondents lists of three items, such as monkey, banana, and elephant. Participants are asked to choose which two items among the three belong to the same category. Social psychologists have found that people from collectivistic cultures choose more relational pairings (monkey, banana), whereas people from individualistic cultures choose more abstract pairings (monkey, elephant). For example, Ji *et al.* (2004) find stark differences between Chinese and US participants. More related to this study, Talhelm *et al.* (2014) find that participants from rice and non-rice provinces in China respond differently, with those from rice provinces choosing more relational pairings.

Besides the Triad task, we administrate the individualism and collectivism questionnaire developed by Triandis and Gelfand (1998). This concept is first proposed by Hofstede in his influential work on cultural dimensions theory (Hofstede, 1980). It has inspired a large literature in the field of social psychology and is considered one of the most important cultural traits. Moreover, recent studies suggest that individualism and collectivism are related to important economic behaviour such as competitiveness (Leibbrandt *et al.*, 2013) and trade (Hajikhameneh and Kimbrough, 2019).

We also use games from the experimental economics literature to account for participants' social preferences and beliefs. It is established in the literature that social preference, beliefs, and risk attitudes are important factors that influence behaviour in social dilemma situations (Mengel, 2018; Fischbacher *et al.*, 2001; Fischbacher and Gächter, 2010; Butler and Fehr, 2018). To test whether the influence of wetland rice cultivation on cooperation operates directly or indirectly via the aforementioned preferences and beliefs, we conduct the dictator game (DG), the ultimatum game (UG), the stag hunt game (SH), and a non-incentivised multiple price list lottery task (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Holt and Laury, 2002; Skyrms, 2004).

In the DG, participants are randomly divided into first movers and second movers. The first mover's task is to allocate money between herself and an anonymous second mover. The second mover has no influence over the first mover's decision. While the first movers are making their choices, we ask second movers the amount they expect to receive, which reflects their beliefs on others' social preferences. We use this as a measure of preferences and beliefs regarding prosocial behaviour in the absence of strategic incentives (e.g. punishment). As discussed above prosociality is associated with the willingness to cooperate.

The UG is similar to the DG except that the second mover can reject the allocation made by the first mover, in which case both parties earn nothing. We employ the minimal acceptable offer method where second movers need to pre-specify the minimum amount they would accept. The allocation is automatically rejected if the first mover offers less than that amount. We use this as a measure of prosocial behaviour in the presence of strategic considerations. The minimum acceptable amount is also indicative of one's willingness to forego a profit in order to punish an undesirable behaviour. Participants' roles are fixed in both DG and UG to minimise reciprocity concerns.

The SH is an one-shot, two-player coordination game with the payoff matrix shown in figure 1. Because "Hare" provides a fixed return irrespective of the other participant's decision, it can be seen as a safe choice. Hence, choosing "Stag" is a measure of our participants' willingness to opt for the payoff-maximising action in the face of uncertainty regarding the action chosen by the other player. Participants in the PGG face a similar problem, since their final payoff depends on the choices of others.

Table 1. *Payoff matrix of the Stag Hunt Game*

	Stag (@)	Hare (#)
Stag (@)	(30, 30)	(12, 22)
Hare (#)	(22, 12)	(22, 22)

3.4.3 Discussion

As we have highlighted the importance of punishment in sustaining cooperation, we are particularly interested in studying how rice farming influences punishment decisions and whether the introduction of punishment opportunities affects cooperation. To this end, we implement the repeated version of the PGGs. There are two main advantages. It allows us to investigate how punishment differentially influences the dynamics of contribution over time between rice and non-rice societies. It also permits participants to learn the game (Nikiforakis, 2008), without which differences in cooperation levels between rice and non-rice participants might not emerge. This is because the PGG is neutrally framed and our participants are students who might not have experienced intensive wetland farming activities. We settled on eight periods for each condition due to time constraints – the experimental sessions already last for two hours.

Because of the punishment condition and the repeated game setting, it is impractical to implement the strategy method in which participants are asked to specify the amount of contribution conditional on *all* possible values of other group members' average contribution, as in Bigoni *et al.* (2019). In our case, this would mean that in each period participants would need to make 21 decisions in the no-punishment condition. This gets decisively more complicated in the punishment condition as participants also need to take into account the amount of punishment received and also need to make a contingent plan regarding punishing other group members. To circumvent this, we use DG and UG to capture participants' social preferences such as inequality aversion and reciprocity, which are important drivers of cooperative behaviour (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Mengel, 2018; Fischbacher *et al.*, 2001; Fischbacher and Gächter, 2010; Butler and Fehr, 2018).

Additionally, the behaviour in DG and UG might shed some light on participants' strategic behaviour and understanding of the games. An altruistic first mover might allocate similar amounts to the second mover in the two games, while a selfish yet strategic first mover might significantly increase her allocation from the DG to UG for fear of being rejected. We find no difference in this regard between rice and non-rice participants.

The main reason we include the SH is that irrigation, an important element of wetland rice farming, requires intensive coordination among farmers (Buggle, 2020; Talhelm and Oishi, 2018). Thus, we are interested in whether the ability to coordinate can manifest in a coordination game. Secondly, in the SH ('hare', 'hare') is the risk dominant equilibrium whereas ('stag', 'stag') is the Pareto efficient equilibrium. A player should choose 'stag' only if she is sufficiently sure the other player will also choose 'stag'. Hence, the choice in SH might serve as another proxy (the first is the belief in the DG) of their beliefs regarding the other players' actions.

3.4.4 Procedure at the Lab

After all participants arrived in the lab and prior to getting any instructions of the study, they were asked to sign a consent form.

We administered the tasks in the following order: a multiple price list risk elicitation task, the Triad Task, the DG, the UG, the SH and PGG with and without punishment. The games prior to the PGGs were played without providing any feedback so as to minimise their impact on subsequent games. The participants knew that each session consisted of several parts, but they did not know the content of the forthcoming parts until the corresponding instructions were provided. One of the five games was randomly selected for payment (DG, UG, SH, and the PGGs). If the PGGs were chosen, the experimenter would further draw one period. participants' earnings were exchanged to Chinese Yuan at the rate: 1 points = 0.5 Yuan (about 8 US Cents).

Since the social psychology literature suggests that collectivist societies value group membership (Liu *et al.*, 2019; Tajfel, 1970; Triandis, 1995; Triandis and Gelfand, 1998), we conducted a priming treatment in half of the sessions. The procedure was simple. In Hebei for example, after all participants arrived in the lab and were waiting for instructions, the experimenter stated: please note that all of you are from Hebei province. We find that priming has no effect on participants' behaviour, we therefore pool the data from priming and no-priming sessions for the analyses (see section B in the appendix for the results related to the effect of priming).

The experiment was conducted between Oct 2015 and Jan 2016 in China. All the tasks were programmed using z-Tree (Fischbacher, 2007). There were a total of 524 participants. 116 participants in Hebei, 156 participants in Shandong, 128 participants in Hunan and 124 participants in Zhejiang. We ran 6 sessions per province. All the sessions were conducted on Saturdays and Sundays. Each session lasted for about 2 hours. The average earnings were 30 Yuan (about 5 US dollars), including a 15 Yuan show-up fee. The earnings were comparable to the hourly minimum wage.

3.5 Data Collected from other Sources

Besides individual level preferences and beliefs, a region's economic development and environmental conditions might also shape people's cooperative behaviour. To control for the former, we collect prefectural level GDP per-capita of 2015 from each province's bureau of statistics.[9] For the latter, we obtain several prefecture level geo-climate variables from the International Institute for Applied Systems Analysis (IIASA) and Food and Agriculture Organisation of the United Nation (FAO) database (Fischer *et al.*, 2002). These include terrain slope, soil depth, and land cover patter. We also compile the wetland-rice suitability index for the Instrument Variable estimation (IV) from the same database.

Moreover, Talhelm *et al.* (2014) and Zhu *et al.* (2019) show that rice regions have lower patent rates than non-rice regions in China. We therefore collect prefecture level patent per-capital data from the Chinese Research Data Service Platform (CNRDS, n.d.).[10]

Lastly, to test whether the results are driven by internal migration, we follow the methodology of Putterman and Weil (2010) and Zhu *et al.* (2019) to construct a 337×337 migration matrix based on the 2000 Chinese Census (China Population Census, 2000). We also use the matrix to calculate prefecture level migration adjusted rice suitability index and net migration flows.

[9]This data is also available at China Zhiwang (CNKI, n.d.).
[10]*https://www.cnrds.com*

4 Main Results: Rice Cultivation and Cooperative Behaviour

We find that groups consisting of participants from rice prefecture cities contribute more than their non-rice counterparts in both the no-punishment condition (periods 1 - 8) and the punishment condition (period 9 - 16). In particular, in the no-punishment condition, the difference is 11% and is marginally significant (Mann-Whitney U Test at the group level: $p = 0.071$ — 63 non-rice and 61 rice groups. The p-value slightly drops if we remove the last period to account for the end-game effect: $p = 0.052$). In the punishment condition, the difference increases to 15% and is highly significant (Mann-Whitney U Test at the group level: $p = 0.012$ — 62 non-rice and 61 rice groups). These findings are depicted in figure 4.[11]

We now turn to more formal tests of the relationship between rice cultivation and contribution in the PGGs. In particular, we investigate the following equation:

$$y_{it} = \alpha + \beta * \%\ \text{Paddy Field}_{prefecture\ city} + \mathbf{X}_i{}'\mathbf{T} + \epsilon_{it} \quad (1)$$

where i indexes individuals and t indexes periods in the PGG. The dependent variable is participants' contribution in each period. $\%\text{Paddy Field}_{prefecture\ city}$ is the percentage of cultivated land devoted to paddy field at the prefecture city level. The results are similar if we use an indicator variable which equals one if the participant comes from rice prefecture cities and zero otherwise. $\mathbf{X}_i$ is the set of baseline covariates, which includes dummies for

[11]We exclude mixed groups from figure 4 and the corresponding non-parametric tests since the analysis is based on the group level and we are interested in the rice/non-rice comparison. We include them in later regression analyses that are based on individual decisions.

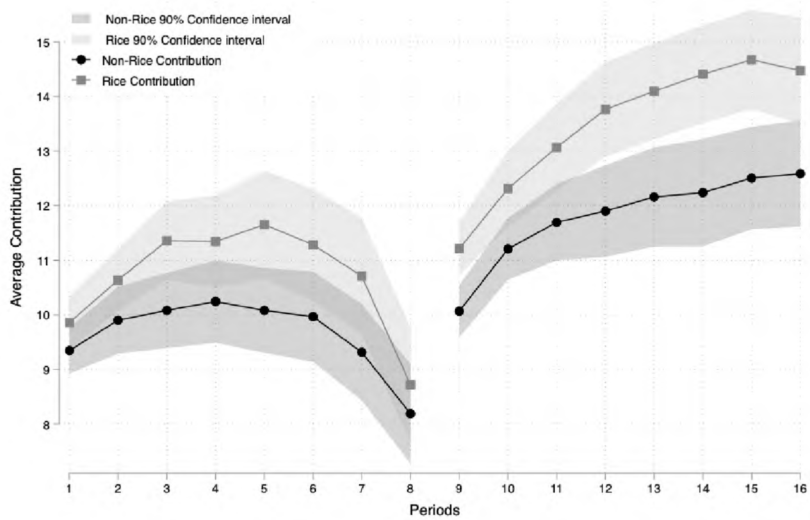

Figure 1. *Group Level Average Contribution in the Public Goods Game*

Notes: Periods in the horizontal axis, group level average contribution in the PGG in the vertical axis. Periods 1-8 are always the no-punishment condition and periods 9-16 are always the punishment condition. The difference in the no-punishment condition is weakly significant: Mann-Whitney U Test at the public goods group level: $p = 0.071$, while the difference is stronger in the punishment condition: $p = 0.012$.

gender, science or liberal arts track for senior high school,[12] single child, age, their family income level relative to their town of residence, and the priming treatment.

The results from non-parametric tests carry over to the regression analyses. Estimates of equation (1) on contribution in the PGG without and with punishment are reported in column (1) of table 2 panels A and B respectively. The coefficient in panel A column (1) suggests that a 10% increase in the percentage of paddy field leads to about 0.12 points increment in contribution. At first glance, this effect seems quantitatively small. However,

[12]In China, senior high school students must choose whether to pursue a science or liberal arts track. The curriculum differs between the two tracks. The compulsory courses for both tracks are Chinese, English and Mathematics. For the Science track, students study Physics, Chemistry and Biology, while for the liberal arts track, students focus on History, Politics, and Geography. Some universities do not permit students with the arts track to apply for certain majors, such as maths, physics, and computer science.

to gain a more accurate picture of the effect of rice cultivation on cooperative behaviour, one needs to acknowledge the fact that the percentage of paddy field in rice prefecture cities is much higher than non-rice prefecture cities. The difference is nearly 80 percentage points (2.6% compared to 81%) in our data. Given this, the coefficient in panel A column (1) implies participants from rice prefecture cities contribute about 0.96 (0.12×0.8) points more than their non-rice counterparts in the no-punishment condition. The coefficient from the punishment condition (panel A column (1)) suggests the difference is about 1.21 points (1.51×0.8).

We find suggestive evidence that the difference in contribution between rice and non-rice participants is larger in the punishment treatment compared to the no-punishment treatment. Recall that participants randomly regroup after the no-punishment condition. It is therefore impossible to compare group level contributions between the no-punishment and punishment conditions. Instead, we investigate how the punishment condition influences cooperation at the individual level. On average, non-rice participants contribute 2.11 points more in the punishment condition compared to the no-punishment condition. This difference is 36.5% higher for rice participants and is statistically significant (Mann-Whitney U Test at the individual level: $p = 0.012$ — 237 non-rice and 238 rice participants). However, this result is not very robust to clustering the standard errors to control for within-group dependency. In particular, we estimate a modified version of equation 1 in which a) we pool the data from the two conditions and b) the regressors are Paddy $\text{Field}_{prefecture\ city}$, dummy for the punishment condition, their interaction term, and the set of baseline covariates. The interaction term is positive and statistically significant, suggesting rice participants respond stronger to the punishment condition. However, it loses significance if we include the groups that have participants from both rice and non-rice regions, though the sign remains positive.

Besides higher contribution, participants from rice prefecture cities also assign more punishment points to free-riders. Following Herrmann *et al.* (2008) and Gächter *et al.* (2010) we define free-riders as participants who contribute less than the assigner's contribution and define cooperators as participants who contribute more than or equal to the assigner's contribution (hereafter we use assigner to refer to the punisher and use receiver to refer to the punished participants). Another method that is also commonly used in the literature to classify free-riders and cooperators is to compare group member's contribution with other group member's average contribution (to name a few papers that use this method to classify free-riders: Fehr and Gächter (2000); Denant-Boemont *et al.* (2007); Nikiforakis (2008)). Using this method, the variable of interest is usually the total punishment points *received* by free-riders. We reach similar conclusions if we use this method: free-riders from rice prefecture cities receive more punishment points than free-riders from non-rice prefecture cities. The reason we did not use this method to present the results related to punishment is that we believe defining free-riders and cooperators from the assigner's perspective is more appropriate since we are interested in how participants punish other group members, instead of the amount of punishment points they receive.

Figure 4 shows the average punishment points assigned to others, conditional on the difference in contribution level between themselves and other group members. It indicates that whenever the receiver's contribution is less than that of the assigner's, participants from rice prefecture cities assign more punishment points than participants from non-rice prefecture cities. The [0] category implies the receiver's and assigner's contributions are the same. Therefore, the three categories to the left of [0] are cases in which the assigner's contribution is higher. If we pool the three categories to the left of [0] into one punishing free-riders category, the results indicate that participants from rice prefecture cities assign 50% more punishment points to free-riders compared to their non-rice counterparts and the difference is highly statistically significant (Mann-Whitney U Test at the individual level: $p = 0.003$ – 252 non-rice and 234 rice participants). Figure 4 also illustrates that there is no difference in how participants punish cooperators. Indeed, if we merge the four categories to the right of category [0], inclusive, the difference is not statistically significant (Mann-Whitney U Test at the individual level: $p = 0.587$ — 267 non-rice and 256 rice participants). The results are similar if we remove the [0] category from the punishing cooperators category.

To study the effect of rice farming on punishment more formally, we estimate equation 1 using punishment points assigned to other group members as the dependent variable. We estimate the equation separately for punishing free-riders and for punishing cooperators.

The results demonstrate a significant association between rice cultivation and the punishment of free-riders (table 3 panel C column 1). The paddy field coefficient implies participants from rice prefecture cities on average assign about 0.23 (0.29×0.8) more punishment points than participants from non-rice prefecture cities. Readers might notice that we controlled for the assigner's and receiver's contribution (we refer to them as "contribution effects"). The inclusion of contribution effects is essential to obtain a clean inference on how rice cultivation influence punishment. Otherwise, it is not clear whether the difference in punishment originates from attitudes towards free-riders or from the difference in cooperation between assigners and receivers. In addition to total punishment points assigned to others, we also investigate the effect of rice cultivation on the probability of punishing and the intensity of

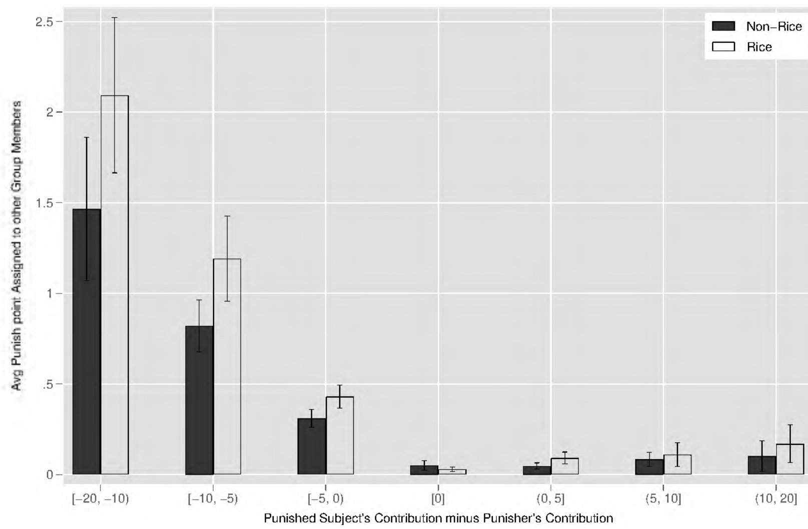

Figure 2. *Punishment Points Assigned to Others*

Notes: The x-axis is the difference between the receiver's and the assigner's contribution. It is constructed by firstly calculating the contribution difference and then classifying the difference into seven categories. For example, [-20, -15) means the receiver's contribution is between 20 (inclusive) and 15 (exclusive) points lower than that of the assigner's. The y-axis is the average punishment points assigned to others conditional on these seven categories. If we merge all the categories in which the receiver contributes less than the assigner (the three categories to the left of [0]), the difference is highly statistically significant (Mann-Whitney U Test at the individual level: $p = 0.003$ - 252 non-rice and 234 rice participants). If we merge all the remaining categories in which the receiver's contribution is at least the same as the assigner's, the difference is not statistically significant ($p = 0.587$ - 267 non-rice and 256 rice participants).

punishment. The conclusions are similar: the percentage of paddy field is positively associated with the probability and intensity of punishing free-riders. The coefficients related to the punishment of cooperators (anti-social punishment) are not reported here because they are either not significant or quantitatively small.

5 Addressing Causality

Results from the previous section suggest the percentage of rice paddy field is positively associated with cooperation and punishment in the PGGs. However, these results do not necessarily imply that the association is causal. The OLS estimates might suffer from omitted variable bias or self-selection issues.

We conduct a series of exercises to demonstrate that these concerns are unlikely to bias our results. Firstly, we control for a large set of covariates, collected from both within the lab and from other sources, that might be related to wetland rice cultivation or cooperation. Second, we use prefecture city level rice suitability index as an instrumental variable. Third, by comparing participant's current hukou location to their father's birthplace we show that self-selection of the experiment participants does not affect our results. Lastly, to control for the internal migration of the general population, we use the 2000 Chinese Census to create a migration adjusted rice suitability index and variables related to migration flow. Our results are robust to all those exercises.

5.1 Controlling for Observables: Economic Development, Land Characteristics and Cultural Traits

5.1.1 Economic Development

Studies have shown that economic development has a profound influence on individual's level of trust and cooperation (Inglehart and Baker, 2000; Henrich *et al.*, 2001, 2010; Khadjavi *et al.*, 2021). Therefore, the difference in cooperative behaviour could be attributed to the higher level of economic development among rice prefecture cities rather than traditional rice cultivation itself. To check, we control for GDP per capita at the prefecture city level for 2015, the latest available data when we conducted the experiment. We also control for the participant's hukou type (rural or urban) as the Urban-Rural inequality gap in China is substantial (Sicular *et al.*, 2007; Yusuf, 2008).

Innovation is one key driver of economic growth and prosperity. Moreover, Zhu *et al.* (2019) find that wetland rice farming has a negative influence on patent generation. We therefore collect prefecture level patent per capita from the Chinese Research Data Service Platform (CNRDS, n.d.).

5.1.2 Land Characteristics and Cultural Traits

Different geo-climate conditions between rice and non-rice prefecture cities might foster different social norms that in turn influence cooperative behaviour. To rule out this alternative explanation, we control for geo-climate characteristics and a large set of cultural covariates.

The geo-climate variables are from the IIASA and FAO data base (Fischer *et al.*, 2002). We use terrain slope, soil depth, and land cover pattern. We also collect irrigation data from Stefan *et al.* (2015), the results are similar after controlling for it. In section 2, we described why the labour intensity of field preparation and commons problems introduced by irrigation are both indispensable elements of rice cultivation. Therefore, we do not study the two components' differential influence on cooperative behaviour and punishment. We leave this for future research.

Furthermore, we control for a set of variables related to cultural traits. We consider these cultural traits as proxies for geo-climate conditions, which allow us to control for a wide range of unobservable geo-climate variables. The validity of this strategy relies on the assumption that if geo-climate factors do have profound influences on human's beliefs and behaviour, its effect should encompass a large set of traits, not cooperative behaviour only.

From the social psychology literature, we borrowed questionnaire based measures for thinking styles (Chiu, 1972) and individualism and collectivism (Triandis and Gelfand, 1998). We also use games from the experimental economics literature to account for participants' social preferences and beliefs. These include the DG, the UG, the SH, and a non-incentivised multiple price list lottery task.

Column (2) of tables 2 and 3 presents the estimates controlling for economic development, land characteristics, and questionnaire based cultural covariates. The percentage of paddy field is positive in contribution of the no-punishment condition (Panel A) but loses significance. The coefficient remains significant in contribution of the punishment condition (Panel B), and punishing free-riders (Panel C).

The results controlling for variables measured from the experimental economics literature are shown in columns 3-5 of tables 2 and 3. Column 3 controls for participants' risk attitudes and their beliefs in the SH game. Columns 4 and 5 control for first mover's and second mover's behaviour in the DG and UG, respectively. It is not possible to run one regression to include both first movers and second movers, as they are different participants. The main results remain significant. We control for all the covariates at once in columns 7 and 8. The results remain robust for most of the specifications.

5.2 IV Estimation

Our second method of addressing the concern of omitted variable bias is to use the wetland rice suitability index to instrument for the percentage of paddy fields. The suitability index is taken from the IIASA and FAO's Global Agro-ecological Zones (GAEZ v3.0)(Fischer *et al.*, 2002). It includes the rice suitability index for five arc-minute by five arc-minute grid-cells globally. We use two indices to instrument wetland rice paddy field: irrigation-low-labour input and irrigation-mediate-labour input since these conditions resemble traditional wetland farming. The irrigation-high-labour input, on the other hand, refers to the usage of fully mechanical machinery and hence requires low labour intensity. The first and second stage 2SLS estimates are reported in table 4. The percentage of paddy field remains positive and significant when we control for the baseline covariates (see columns 1, 4 and 7). The magnitude of the coefficient is also similar to that measured by OLS.

One concern of using the rice suitability index as an instrument is that the exclusion restriction cannot be taken for granted. The reason is that the index is essentially a function of a set of geo-climate conditions. These geo-climate conditions themselves might be related to both social norms and cooperative behaviour. Therefore, the suitability index could influence cooperation through channels other than rice cultivation. We follow Alesina *et al.* (2013) to address this issue. In particular, we check the robustness of the IV estimates by controlling for the full set of covariates that are potentially correlated with the suitability index. The results remain robust (see columns 2-3, 5-6, and 8-9).

5.3 Controlling for Migration

Another potential source of bias is due to self-selection, that is, cooperative households or individuals prefer to migrate to wetland rice farming regions and less cooperative ones migrate to non-rice regions.

We first check whether participants of the present study's experiment suffer from this selection bias. By comparing participant's current hukou prefecture to their father's birthplace, we can identity participants who had migrated into or out of wetland rice farming regions. There are only a handful of participants whose hukou is registered at a rice prefecture but report that their father was born in a non-rice province, or the other way around. Excluding them from the analyses does not affect the results in anyway. This indicates that self-selection of the participants does not bias the results.

At a broader level, a region's local norm or culture might be shaped by migrations from other regions, since migrants might bring the norm or culture of their origin regions with them to their new destinations (Putterman and Weil, 2010). We perform two exercises to address this concern.

Firstly, following Putterman and Weil (2010) and Zhu *et al.* (2019), we construct a 337×337 migration matrix from the 2000 Chinese Census (China Population Census, 2000). Each row and column represents a prefecture city. The entries show the proportion of local residents (row prefecture) migrated from the column prefecture. Each row sums to one. We pre-multiply this matrix to the rice suitability index which results in a migration-adjusted rice suitability index. The 2-SLS estimates using this new IV is shown in table C in the appendix. The results are similar to the unadjusted IV estimation.

Second, we control for each prefecture's net migration inflow from rice and non-rice prefectures, following Zhu *et al.* (2019). The net inflow from rice is calculated by subtracting out-flow migration to rice prefectures from in-flow migration from rice prefectures, normalised by population. Net inflow from non-rice is calculated analogously. The regression results controlling for the migration pattern are shown in columns (6) - (8) of table 2 and table 3. We also control for the migration pattern in the IV estimation (table 4). Our results remain robust to this exercise.

One concern of the strategies used in this section to address migration is that the data only reflects modern population flows. Historical data are not available. Therefore, we cannot identify the ancestral origins of the residences in each prefecture. However, this might not be a major issue because the participants are university students instead of professional farmers and their families are less likely to have self-selected into rice or non-rice regions. These are vital conditions to identify the causal impact of culture on behaviour as Guiso *et al.* (2006, p. 26) put it: "To claim a causal link, ..., focus on those dimensions of culture that are inherited by an individual from previous generations, rather than voluntarily accumulated."

6 Additional Evidence From the Field

In the previous section, we have demonstrated that rice cultivation has a profound and consistent influence on participant's cooperative behaviour. However, it is not clear whether the finding is a product of artificial situations that participants encounter in the lab or can manifest in real life situations. To address this concern, we present two pieces of evidence that rice cultivation is associated with behaviour observed in the field.

The first evidence comes from Wikipedia, which is a non-profit website service that relies on voluntary contribution to offer free and open access information to the general public. We show that people from rice regions are more likely to contribute to the entries related to local topics. Second, data from the CFPS suggests that percentage of paddy field is a strong predictor of local communities' street tidiness scores.

6.1 Evidence form Wikipedia

Wikipedia is a global encyclopedia that relies on voluntary contributors to write its entries and provide content that anyone can enjoy. As such it is a prime example of a public good (Georganas and Li, 2010; Chen *et al.*, 2020). Research suggests that although Wikipedia is blocked in China, there exists a community of Wikipedia users who reside in mainland China (Zhang and Zhu, 2011). Moreover, the Chinese entries are also more likely to be edited by human editors instead of automated content editors (for more details see: *https://stats.wikimedia.org/EN/Sitemap*). Naturally, the hypothesis is that users from rice dominant areas contribute more to the Wikipedia articles. We use the number of edits and the total size in bytes of the Chinese version Wikipedia entries on each prefecture city. Every contribution to Wikipedia is recorded as an edit. Therefore, it is a direct measure of contribution to a public good. However, edits would give the same weight to adding a paragraph and to correcting a small error. Thus, we also use the total size in bytes to control for the magnitude of the contributions to the public good.

We focus our attention to contributions made to the entries of prefecture cities, since the encyclopedia does not provide any data to identify the location of its contributors and IP addresses may not be reliable given the widespread use of VPN in mainland China. The assumption is that contributors need to have both knowledge of the topic and an interest in improving its presentation on Wikipedia. Further, we assume that people who possess both qualities in sufficient levels live or have lived in the past in those areas, therefore offering us an indirect way to control for location. We use the Wikipedia's own list of Chinese prefecture cities in February 2017 for the data analyses. There were 206 prefecture cities in mainland China, of those 195 are eligible for our purpose – we exclude prefecture cities with large minority populations.

The results are presented in table 5. The main variable of interest is percentage of paddy field of the province in which the prefecture cities are located. We control for population of the urban area of the prefecture cities, GDP per capita of the province in 2005, the growth rate of GDP per capita between 2005 and 2015, the number of 5A tourist attractions in the prefecture cities (prefecture cities that have more 5A attractions might have more edits/bytes simply because there are more pictures showcasing the 5A sites), internet usage rate in 2016, the percentage of college graduates in 2015, distance from Beijing, distance from the coast, and the percentage of GDP owed to the service industry in 2015.[13]

The odd number columns in table 5 present the OLS estimates. Percentage of paddy field is strongly associated with both the number of edits (column 1) and the size of the page (column 3). The coefficient suggests that a 1% increase of the cultivated area devoted to paddy field is associated with a 0.7% increase in both measures. In the even columns, we

[13]The GDP owed to the service industry is a proxy for economic development. We thank Thomas Talhelm for the suggestion and generously sharing the data.

use the rice suitability index at the province level as instrument variables. The results are the same. Results were similar when we ran the same regressions but restricted the data to the provinces where we conducted the experiment.

6.2 Evidence from the CFPS

Our second piece of evidence comes from the CFPS (Institute of Social Science Survey, Peking University, 2015). What makes this survey suitable for our research is that interviewers are required to rate the tidiness of streets in the communities where interviewees live. The tidiness of streets is, arguably, a public good. The residents who take care not to litter streets and help maintain its tidiness volunteer their time and effort but will benefit only if others contribute as well. Another mechanism through which the public good might be provided is via the government – local authorities in rice regions could invest more in cleaning and maintenance, which could reflect the stronger demand by local residents for tidier streets.

The independent variable is the percentage of rice paddy fields at the province level. The control variables are GDP per capita at the province level in 2010 and 2014, the number of households in the interviewee's neighbourhood, a dummy on whether the community is urban or not, and a 2014 year dummy indicating the second wave of the panel. Due to the privacy policy, the survey only provides data regarding the location of the communities at the province level. We exclude communities that are minority residential areas.

We report random effects OLS without any controls in column 1 of table 6. The percentage of rice paddy field is positively associated with the rating. The results are robust to the inclusion of additional controls (column 2) or use rice suitability as IV (column 3). The above conclusions hold if we restrict the sample to the provinces where we conducted the experiment. This finding offers further support that rice-farming provinces in China have tighter social norms (Talhelm and English, 2020). Unfortunately, the data related to personal characteristics of the interviewers are not available. Hence, we cannot conduct robustness exercises regarding the influence of the interviewers' characteristics on the ratings.

7 Conclusion

This paper explores the roots of individuals' cooperative behaviour. The hypothesis is that hundreds of years of traditional wetland farming, which requires intensive cooperation among fellow farmers, give rise to a cooperative social norm that persists over generations. Using the PGG with and without punishment as our main measurement of cooperativeness, we find participants from traditionally wetland rice prefecture cities contribute and punish free-riders more compared to their non-rice counterparts. It is important to note that we do not claim wetland rice farming is the only origin of preference for cooperation, rather, we show it is likely one of the potentially many other factors that contribute to the formation of such preferences.

Our considerations on the endogeneity issue start from the participant recruitment stage. We recruited Han Chinese first year university students, which already held a number of potential confounds constant, such as ethnic related culture, educational background, language, and political systems. Furthermore, we controlled for a series of variables that might be related to cooperation or rice farming from both the experimental sessions and other sources. We ran IV regressions using the wetland rice suitability index as instrument variable. Lastly, we used the 2000 Chinese Census data to show that migration does not drive the results.

Given that our participants are not farmers themselves and they do not have extensive (if at all), direct exposure to rice farming, we attribute those differences to a cultural norm that emerged in historically rice cultivating areas and has been transmitted through generations over the years. We also provide evidence of increased cooperation in the field, suggesting that our results are likely to extend beyond the laboratory environment.

One caveat of our results is that we only offer indirect evidence regarding the existence of the norm. Future research could provide more direct evidence. An interesting avenue for this is the use of text analysis of folk stories and songs, following Michalopoulos and Xue (2021) to pin down the values and norms that one generation attempted to pass on to another. Another caveat is that although we have invested a large amount of effort in trying to establish a causal link between historical wetland rice farming and contemporary cooperation, it is possible we have not controlled for every confounding factor. Further research could utilise natural experiments to narrow down the list of confounding factors and offer stronger identification. Another interesting direction of future research is to dig deeper into the mechanisms underlying differences in cooperative behaviour discovered in this paper. To this end, one could follow the design of Bigoni *et al.* (2019), where the authors show that it is differences in beliefs and aversion to social risks, not preferences that explains the North – South Italy divide in cooperative behaviour.

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Table 2. *Controlling for Observables*

Panel A: Contribution in the No Punishment Condition								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Perc. Paddy Field	1.161**	0.996*	1.188**	1.258**	1.216*	1.107**	1.696**	0.664
	(0.479)	(0.604)	(0.472)	(0.626)	(0.636)	(0.490)	(0.738)	(0.733)
Constant	7.672***	8.705**	5.357***	3.899	8.763***	7.912***	2.167	5.905
	(0.946)	(3.434)	(1.215)	(3.635)	(1.894)	(0.979)	(4.608)	(4.872)
Development Covariates		Yes					Yes	Yes
Land Characteristic Covariates		Yes					Yes	Yes
Cultural Covariates		Yes					Yes	Yes
Culture Covariates (Behavioural)								
Risk Attitude			Yes				Yes	Yes
Coordination			Yes				Yes	Yes
UG Offer				Yes	NA		Yes	NA
DG Offer				Yes	NA		Yes	NA
UG MAO				NA	Yes		NA	Yes
DG Belief				NA	Yes		NA	Yes
Migration Controls						Yes	Yes	Yes
Baseline Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Period and Period Sq	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared (Overall)	0.0747	0.0793	0.0846	0.141	0.0780	0.0780	0.168	0.108
Observations	4176	4056	4176	2088	2088	4176	2024	2032
Panel B: Contribution in the Punishment Condition.								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Perc. Paddy Field	1.505***	1.714***	1.507***	1.629***	1.582***	1.444***	2.527***	1.457**
	(0.381)	(0.549)	(0.379)	(0.560)	(0.585)	(0.382)	(0.757)	(0.694)
Constant	-5.835***	-8.561**	-7.678***	-16.35***	-4.147	-5.967***	-26.51***	-7.073
	(1.884)	(3.579)	(2.005)	(5.727)	(2.807)	(1.902)	(5.996)	(4.484)
Development Covariates		Yes					Yes	Yes
Land Characteristic Covariates		Yes					Yes	Yes
Cultural Covariates		Yes					Yes	Yes
Culture Covariates (Behavioural)								
Risk Attitude			Yes				Yes	Yes
Coordination			Yes				Yes	Yes
UG Offer				Yes	NA		Yes	NA
DG Offer				Yes	NA		Yes	NA
UG MAO				NA	Yes		NA	Yes
DG Belief				NA	Yes		NA	Yes
Migration Controls						Yes	Yes	Yes
Baseline Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Period and Period Sq	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared (Overall)	0.142	0.142	0.150	0.174	0.150	0.144	0.199	0.165
Observations	4176	4056	4176	2088	2088	4176	2024	2032

Notes: Clustered standard errors at the prefecture city level are reported in parentheses (* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$).

Table 3. *Controlling for Observables Continued*

Panel C: Punishment Points Assigned to Free-Riders	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Perc. Paddy Field	0.288***	0.303***	0.288***	0.335***	0.273**	0.290***	0.365***	0.305***
	(0.0783)	(0.0832)	(0.0768)	(0.100)	(0.106)	(0.0776)	(0.129)	(0.109)
Constant	-1.556**	-2.426***	-1.616**	-2.484	-1.234	-1.448*	-2.454	-1.924
	(0.769)	(0.917)	(0.771)	(1.559)	(0.960)	(0.761)	(1.729)	(1.204)
Development Covariates		Yes					Yes	Yes
Land Characteristic Covariates		Yes					Yes	Yes
Cultural Covariates (Questionnaire)		Yes					Yes	Yes
Culture Covariates (Behavioural)								
Risk Attitude			Yes				Yes	Yes
Coordination			Yes				Yes	Yes
UG Offer				Yes	NA		Yes	NA
DG Offer				Yes	NA		Yes	NA
UG MAO				NA	Yes			Yes
DG Belief				NA	Yes			Yes
Migration Controls						Yes	Yes	Yes
Baseline Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Contribution Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Period and Period Sq	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared (Overall)	0.198	0.205	0.202	0.228	0.189	0.207	0.245	0.232
Observations	3823	3741	3823	1986	1837	3823	1947	1794

Notes: Clustered standard errors at the prefecture city level are reported in parentheses (* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$).

Table 4. *Wetland Rice Suitability as IV*

Panel A: First Stage 2SLS Estimates.	Contribution No Punish Condition			Contribution Punish Condition			Punish Points to Free-Riders		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Low-labour input	0.0174***	0.0209***	0.0184***	0.0174***	0.0209***	0.0184***	0.0163**	0.0200***	0.0192***
	(2.78)	(5.81)	(6.01)	(2.78)	(5.81)	(6.01)	(2.54)	(6.75)	(6.87)
Intermediate-labour input	0.0383**	0.0184	0.0256**	0.0383**	0.0184	0.0256**	0.0423**	0.0241**	0.0214**
	(2.38)	(1.62)	(2.26)	(2.38)	(1.62)	(2.26)	(2.57)	(2.51)	(2.14)
F-Stat	125.7	226.0	240.7	125.7	226.0	240.7	145.8	307.7	277.8
Panel B: Second Stage 2SLS Estimates.									
Perc. Paddy Field	1.556***	2.604***	0.865	1.768***	2.956***	1.700**	0.235***	0.327***	0.253**
	(0.494)	(0.792)	(0.738)	(0.454)	(0.844)	(0.784)	(0.0754)	(0.106)	(0.119)
Constant	7.524***	-0.0772	5.585	-5.893***	-27.57***	-7.460	-1.548**	-2.358	-1.852
	(0.947)	(4.691)	(4.880)	(1.881)	(6.117)	(4.567)	(0.767)	(1.743)	(1.177)
Baseline Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Development Covariates		Yes	Yes		Yes	Yes		Yes	Yes
Land Characteristic Covariates		Yes	Yes		Yes	Yes		Yes	Yes
Cultural Covariates (Questionnaire)		Yes	Yes		Yes	Yes		Yes	Yes
Culture Covariates (Behavioural)									
Risk Attitude		Yes	Yes		Yes	Yes		Yes	Yes
Coordination		Yes	Yes		Yes	Yes		Yes	Yes
UG Offer		Yes	NA		Yes	NA		Yes	NA
DG Offer		Yes	NA		Yes	NA		Yes	NA
UG MAO		NA	Yes		NA	Yes		NA	Yes
DG Belief		NA	Yes		NA	Yes		NA	Yes
Migration Controls		Yes	Yes		Yes	Yes		Yes	Yes
Contribution Controls	NA	NA	NA	NA	NA	NA	Yes	Yes	Yes
Period and Period Sq	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared (Overall)	0.0718	0.166	0.108	0.140	0.198	0.165	0.196	0.244	0.229
Observations	4168	2024	2032	4168	2024	2032	3823	1947	1794

Notes: Clustered standard errors at the prefecture city level are reported in parentheses (* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$).

Table 5. *Regressions about the total number of edits on the pages of cities in China on the Chinese Wikipedia*

	Number of edits		Size in bytes	
	(1)	(2)	(3)	(4)
	OLS	IV	OLS	IV
Perc. Paddy Field	0.007***	0.007***	0.009***	0.008**
	(0.002)	(0.002)	(0.003)	(0.003)
5A Tourist attractions	-0.012	-0.011	-0.017	-0.015
	(0.010)	(0.009)	(0.012)	(0.011)
GDP Per cap. growth 2005-15	-0.225	-0.222	-0.353**	-0.348**
	(0.156)	(0.150)	(0.171)	(0.164)
GDP Per cap. 2005	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Urban Area (log)	0.963***	0.963***	0.762***	0.762***
	(0.095)	(0.091)	(0.115)	(0.109)
Internet usage rate 2016	0.002	0.002	-0.001	-0.001
	(0.006)	(0.006)	(0.007)	(0.007)
Perc. College Graduate 2015	0.018	0.019	0.025	0.027
	(0.026)	(0.025)	(0.026)	(0.025)
Distance from Beijing	0.055	0.079	0.002	0.047
	(0.118)	(0.128)	(0.152)	(0.175)
Service Industry GDP perc. 2015	-0.035**	-0.035**	-0.045**	-0.045***
	(0.015)	(0.014)	(0.018)	(0.017)
Distance from Coast	0.034*	0.034*	0.043*	0.042**
	(0.019)	(0.018)	(0.021)	(0.020)
Constant	-6.455***	-6.474***	1.841	1.805
	(1.206)	(1.163)	(1.390)	(1.335)
Adjusted R-Squared	0.504	0.504	0.295	0.295
Observations	195	195	195	195

Notes: Standard errors are reported in brackets and are clustered at the province level. Because of the nature of count data, the dependent variable was log transformed for the OLS regressions (* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$). The above results also hold if we restrict the sample to the provinces where we conducted the experiment.

Table 6. *Rice Farming and Tidiness of Streets*

	(1)	(2)	(3)
Perc. Paddy Field	0.794***	0.383***	0.592***
	(0.128)	(0.147)	(0.171)
GDP per Captia		0.0733***	0.0539**
		(0.0253)	(0.0262)
Urban (Dummy)		0.464***	0.460***
		(0.0950)	(0.0955)
No. of Households		0.129***	0.129***
		(0.0252)	(0.0253)
Year 2014 (Dummy)		0.170*	0.203**
		(0.0917)	(0.0924)
Constant	4.484***	3.811***	3.808***
	(0.0674)	(0.103)	(0.103)
R-Squared (Overall)	0.0363	0.128	0.126
Observations	1058	1049	1049

Notes: Random Effects Linear regressions. The dependent variable is the street tidiness index at the community level. The third column reports the second stage IV regression results. Clustered standard errors at the prefecture cities level are reported in parentheses (* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$). The above results also hold if we restrict the sample to the provinces where we conducted the experiment.

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A Regression Results without Indicators

In this section we replicate table 2 and table 3 in the main results section (section 4) without indicators.

Table A1. *Contribution in the no-punishment condition*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Perc. Paddy Field	1.161**	0.996*	1.188**	1.258**	1.216*	1.107**	1.696**	0.664
	(0.479)	(0.604)	(0.472)	(0.626)	(0.636)	(0.490)	(0.738)	(0.733)
Male	2.041***	2.061***	1.898***	2.014***	1.938***	2.039***	1.839***	1.642**
	(0.418)	(0.446)	(0.445)	(0.487)	(0.639)	(0.419)	(0.462)	(0.710)
Science Orient (Dummy)	0.843**	0.808**	0.760**	1.192***	0.377	0.841**	0.871**	0.354
	(0.345)	(0.330)	(0.327)	(0.430)	(0.479)	(0.356)	(0.443)	(0.418)
Single Child (Dummy)	-0.356	-0.353	-0.401	0.326	-1.053	-0.374	0.332	-0.772
	(0.408)	(0.457)	(0.420)	(0.507)	(0.691)	(0.407)	(0.501)	(0.773)
Age	0.0240	0.0260	0.0391**	-0.0926	0.0373*	0.0183	0.0270	0.0801**
	(0.0200)	(0.0320)	(0.0190)	(0.162)	(0.0191)	(0.0214)	(0.162)	(0.0359)
Priming Treatment (Dummy)	-0.442	-0.557	-0.448	-0.259	-0.746	-0.424	-0.336	-0.832
	(0.441)	(0.431)	(0.429)	(0.535)	(0.560)	(0.440)	(0.517)	(0.559)
Relative Income	-0.494	-0.394	-0.476	-0.461	-0.281	-0.560	-0.523	-0.296
	(0.356)	(0.361)	(0.350)	(0.365)	(0.459)	(0.358)	(0.384)	(0.428)
Rural Hukou (Dummy)	-0.204	-0.398	-0.322	0.410	-0.530	-0.243	-0.117	-0.646
	(0.396)	(0.413)	(0.392)	(0.590)	(0.609)	(0.397)	(0.590)	(0.636)
GDP Per Cap. (County)		-0.0615					-0.00993	-0.101
		(0.0840)					(0.0941)	(0.129)
Patent Per Cap		0.00153					-0.0108	0.00917
		(0.0119)					(0.0132)	(0.0191)
Soil Depth		-0.588**					-1.092***	-0.274
		(0.237)					(0.374)	(0.449)
Land Cover Pattern		-0.115					0.0458	-0.468
		(0.250)					(0.326)	(0.337)
Terrain Slope		0.0119					0.0216	0.00995
		(0.0122)					(0.0146)	(0.0178)
Holistic Thinking		1.262					2.458**	0.159
		(0.810)					(1.225)	(1.191)
Collectivistic		0.460					-0.552	1.066
		(0.460)					(0.587)	(0.723)
Individualistic		-0.538					-0.501	-0.293
		(0.428)					(0.537)	(0.618)
Offer (DG)				0.117***			0.118***	
				(0.0273)			(0.0259)	
Offer (UG)				0.0662			0.0856**	
				(0.0488)			(0.0406)	
SH Game			1.228***				1.247**	1.492***
			(0.388)				(0.582)	(0.556)
Risk Attitude			0.0218				0.0999	-0.0397
			(0.101)				(0.125)	(0.133)
Belief (DG)					-0.0469			-0.0400
					(0.0439)			(0.0467)
Min. Accept. Offer (DG)					0.0367			0.0535
					(0.0422)			(0.0405)
Net Inflow from Rice						0.409	-9.563	7.088
						(4.952)	(6.789)	(9.396)
Net Inflow from non-Rice						-12.03	10.48	-14.91
						(15.55)	(23.06)	(23.98)
Period	1.173***	1.183***	1.173***	1.235***	1.111***	1.173***	1.251***	1.116***
	(0.153)	(0.157)	(0.153)	(0.183)	(0.202)	(0.153)	(0.188)	(0.208)
Period × Period	-0.141***	-0.142***	-0.141***	-0.148***	-0.135***	-0.141***	-0.149***	-0.136***
	(0.0161)	(0.0165)	(0.0161)	(0.0198)	(0.0218)	(0.0161)	(0.0203)	(0.0224)
Constant	7.672***	8.705**	5.357***	3.899	8.763***	7.912***	2.167	5.905
	(0.946)	(3.434)	(1.215)	(3.635)	(1.894)	(0.979)	(4.608)	(4.872)
R-Squared (Overall)	0.0747	0.0793	0.0846	0.141	0.0780	0.0780	0.168	0.108
Observations	4176	4056	4176	2088	2088	4176	2024	2032

Notes: Random Effects Linear regressions. Robust standard errors at the prefecture cities level are reported in parentheses (* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$).

Table A2. *Contribution in the no-punishment condition*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Perc. Paddy Field	1.505***	1.714***	1.507***	1.629***	1.582***	1.444***	2.527***	1.457**
	(0.381)	(0.549)	(0.379)	(0.560)	(0.585)	(0.382)	(0.757)	(0.694)
Male	2.241***	2.189***	2.061***	2.122***	2.239***	2.278***	1.924***	2.129***
	(0.311)	(0.308)	(0.305)	(0.511)	(0.492)	(0.312)	(0.500)	(0.547)
Science Orient (Dummy)	1.489***	1.446***	1.447***	1.820***	1.142**	1.567***	1.915***	1.069**
	(0.365)	(0.392)	(0.372)	(0.494)	(0.476)	(0.379)	(0.540)	(0.528)
Single Child (Dummy)	-0.109	-0.162	-0.121	0.522	-0.681	-0.117	0.515	-0.784
	(0.365)	(0.365)	(0.364)	(0.586)	(0.543)	(0.354)	(0.604)	(0.589)
Age	0.0364**	0.0504*	0.0446**	0.336	0.0344**	0.0382**	0.515**	0.0528
	(0.0176)	(0.0271)	(0.0190)	(0.223)	(0.0141)	(0.0190)	(0.207)	(0.0340)
Priming Treatment (Dummy)	-0.0921	-0.125	-0.104	0.171	-0.439	-0.103	0.0460	-0.497
	(0.348)	(0.346)	(0.335)	(0.496)	(0.484)	(0.346)	(0.505)	(0.505)
Relative Income	-0.171	-0.135	-0.171	-0.269	0.0109	-0.156	-0.215	-0.0627
	(0.295)	(0.323)	(0.285)	(0.383)	(0.375)	(0.300)	(0.447)	(0.395)
Rural Hukou (Dummy)	-0.337	-0.487	-0.440	0.599	-1.089**	-0.328	0.0969	-1.266**
	(0.333)	(0.331)	(0.352)	(0.660)	(0.479)	(0.325)	(0.747)	(0.494)
GDP Per Cap. (County)		-0.0102					-0.0838	-0.0232
		(0.0716)					(0.0792)	(0.135)
Patent Per Cap		0.000408					-0.00713	0.0155
		(0.00971)					(0.0117)	(0.0149)
Soil Depth		-0.160					-0.686*	0.438
		(0.284)					(0.411)	(0.381)
Land Cover Pattern		0.0832					0.512	-0.229
		(0.253)					(0.370)	(0.390)
Terrain Slope		0.0127					0.0344*	0.00633
		(0.0131)					(0.0186)	(0.0182)
Holistic Thinking		0.0888					0.686	-0.181
		(0.607)					(0.965)	(1.069)
Collectivistic		0.729					0.475	0.561
		(0.463)					(0.565)	(0.697)
Individualistic		-0.252					-0.396	-0.0400
		(0.403)					(0.539)	(0.512)
Offer (DG)				0.0600**			0.0537**	
				(0.0237)			(0.0239)	
offer UG				0.0392			0.0377	
				(0.0506)			(0.0530)	
SH Game			0.791**				1.421**	0.487
			(0.391)				(0.565)	(0.585)
Risk Attitude			0.154				0.233*	0.0422
			(0.100)				(0.120)	(0.144)
Belief (DG)					0.00456			0.00954
					(0.0350)			(0.0358)
Min. Accept. Offer (DG)					0.00961			0.0153
					(0.0320)			(0.0314)
Net Inflow from Rice						6.092	3.411	6.912
						(4.029)	(8.347)	(5.456)
Net Inflow from non-Rice						-16.07	-8.933	-15.26
						(13.19)	(28.37)	(19.10)
Period	2.243***	2.207***	2.243***	2.477***	2.010***	2.243***	2.431***	1.983***
	(0.267)	(0.273)	(0.268)	(0.340)	(0.399)	(0.268)	(0.346)	(0.405)
Period × Period	-0.0744***	-0.0729***	-0.0744***	-0.0850***	-0.0638***	-0.0744***	-0.0829***	-0.0629***
	(0.0101)	(0.0103)	(0.0101)	(0.0128)	(0.0153)	(0.0101)	(0.0129)	(0.0156)
Constant	-5.835***	-8.561**	-7.678***	-16.35***	-4.147	-5.967***	-26.51***	-7.073
	(1.884)	(3.579)	(2.005)	(5.727)	(2.807)	(1.902)	(5.996)	(4.484)
R-Squared (Overall)	0.142	0.142	0.150	0.174	0.150	0.144	0.199	0.165
Observations	4176	4056	4176	2088	2088	4176	2024	2032

Notes: Random Effects Linear regressions. Robust standard errors at the prefecture cities level are reported in parentheses (* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$).

Table A3. *Punishing free-riders*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Perc. Paddy Field	0.288***	0.303***	0.288***	0.335***	0.273**	0.290***	0.365***	0.305***
	(0.0783)	(0.0832)	(0.0768)	(0.100)	(0.106)	(0.0776)	(0.129)	(0.109)
Male	0.240***	0.237***	0.211***	0.235**	0.217***	0.230***	0.191**	0.194**
	(0.0664)	(0.0639)	(0.0646)	(0.101)	(0.0835)	(0.0663)	(0.0972)	(0.0818)
Science Orient (Dummy)	0.0768	0.0652	0.0844*	0.0698	0.128*	0.0514	0.0638	0.0941
	(0.0502)	(0.0536)	(0.0498)	(0.0762)	(0.0702)	(0.0516)	(0.0852)	(0.0771)
Single Child (Dummy)	-0.0918	-0.101	-0.0869	0.0453	-0.225**	-0.0910	0.0381	-0.190*
	(0.0664)	(0.0669)	(0.0660)	(0.101)	(0.0952)	(0.0639)	(0.0906)	(0.111)
Age	-0.00289	0.000533	-0.00369	0.0232	-0.000762	-0.00433	-0.0108	0.00738
	(0.00275)	(0.00338)	(0.00288)	(0.0505)	(0.00316)	(0.00272)	(0.0570)	(0.00523)
Priming Treatment (Dummy)	0.0462	0.0549	0.0412	0.0213	0.0806	0.0494	0.0556	0.103
	(0.0484)	(0.0497)	(0.0488)	(0.0724)	(0.0889)	(0.0476)	(0.0704)	(0.0942)
Relative Income	0.0671	0.0516	0.0612	0.0111	0.128	0.0506	-0.0357	0.155*
	(0.0467)	(0.0463)	(0.0457)	(0.0651)	(0.0864)	(0.0448)	(0.0659)	(0.0874)
Rural Hukou (Dummy)	0.00504	0.00317	-0.000291	0.151*	-0.130	-0.00500	0.120	-0.141
	(0.0528)	(0.0542)	(0.0532)	(0.0870)	(0.0828)	(0.0524)	(0.0885)	(0.0868)
GDP Per Cap. (County)		-0.000744					0.00845	-0.00104
		(0.0157)					(0.0139)	(0.0215)
Patent Per Cap		0.00136					-0.000485	-0.00281
		(0.00217)					(0.00214)	(0.00234)
Soil Depth		0.0266					0.0375	0.00355
		(0.0672)					(0.0601)	(0.0860)
Land Cover Pattern		0.0226					0.0672	-0.0100
		(0.0364)					(0.0410)	(0.0394)
Terrain Slope		0.000483					-0.000393	-0.000431
		(0.00200)					(0.00226)	(0.00272)
Holistic Thinking		-0.0968					-0.159	-0.0538
		(0.117)					(0.128)	(0.206)
Collectivistic		0.0189					0.123	-0.158
		(0.0754)					(0.101)	(0.104)
Individualistic		0.156***					-0.0234	0.307***
		(0.0581)					(0.0580)	(0.0942)
Offer (DG)				-0.00697			-0.00690	
				(0.00531)			(0.00507)	
offer UG				-0.00313			-0.00561	
				(0.00710)			(0.00774)	
SH Game			-0.0302				-0.0661	0.0413
			(0.0638)				(0.0811)	(0.0854)
Risk Attitude			0.0498***				0.0423	0.0677***
			(0.0176)				(0.0286)	(0.0206)
Belief (DG)					0.00924			0.00793
					(0.00720)			(0.00719)
Min. Accept. Offer (DG)					0.00230			-0.00139
					(0.00556)			(0.00550)
Net Inflow from Rice						-1.609**	-0.961	-1.942
						(0.729)	(1.405)	(1.504)
Net Inflow from non-Rice						2.322	0.290	2.420
						(2.385)	(4.722)	(3.079)
Punisher Contribution	0.0657***	0.0648***	0.0652***	0.0741***	0.0546***	0.0653***	0.0693***	0.0549***
	(0.0101)	(0.0102)	(0.0102)	(0.0159)	(0.0141)	(0.0100)	(0.0152)	(0.0137)
Punished Contribution	-0.145***	-0.144***	-0.144***	-0.152***	-0.137***	-0.144***	-0.146***	-0.140***
	(0.0136)	(0.0136)	(0.0135)	(0.0193)	(0.0223)	(0.0136)	(0.0187)	(0.0224)
Period	0.339***	0.342***	0.338***	0.440***	0.234	0.335***	0.438***	0.232
	(0.121)	(0.124)	(0.120)	(0.152)	(0.143)	(0.121)	(0.155)	(0.148)
Period × Period	-0.0123**	-0.0124**	-0.0122**	-0.0163***	-0.00793	-0.0122**	-0.0163***	-0.00779
	(0.00479)	(0.00494)	(0.00478)	(0.00603)	(0.00562)	(0.00479)	(0.00619)	(0.00579)
Constant	-1.556**	-2.426***	-1.616**	-2.484	-1.234	-1.448*	-2.454	-1.924
	(0.769)	(0.917)	(0.771)	(1.559)	(0.960)	(0.761)	(1.729)	(1.204)
R-Squared (Overall)	0.198	0.205	0.202	0.228	0.189	0.207	0.245	0.232
Observations	3823	3741	3823	1986	1837	3823	1947	1794

Notes: Random Effects Linear regressions. Robust standard errors at the prefecture cities level are reported in parentheses (* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$).

B Results Regarding the effect of Priming – By Rice and non-Rice

To investigate the effect of priming, we regress participants' contribution in the no-punishment and punishment condition and punishment points assigned to free-riders on the treatment dummy and the set of baseline covariates. We also analyse anti-social punishment. Since it is not the main focus of this paper and the results are not significant, we decide not to include them in this table. For the regressions related to punishment, we also control for contributions of the punisher and punished participants.

The results are shown in table B4. The odd columns are about non-rice regions and the even columns are about rice regions. The priming dummy only weakly influence non-rice participants' contribution in the no-punishment condition and is not significant in other seven tests (note that we also test the anti-social punishment). We also perform post regression tests, checking whether the coefficient of priming differs between rice and non-rice regions. The results are not significant. The same conclusion holds if we combine data from both rice and non-rice provinces and include priming, is rice province, and their interaction term as main explanatory variables – the interaction terms are all not significant. In interpreting these results, one need to keep in mind that the prime was very small – just a single sentence in a long experiment– and the direction of the effect is broadly consistent with what one might find if priming group membership has indeed different effects in rice versus non-rice areas. Using stronger primes to investigate this possibility may be an avenue for future research. At this point we hesitate to make such a conclusion and one may only speculate that such an effect exists.

Table B4. *The effect of Priming*

	Contribution - No Punishment		Contribution - Punishment		Punishing Free-riders	
	(None Rice)	(Rice)	(None Rice)	(Rice)	(None Rice)	(Rice)
Priming Treatment	-0.903*	-0.0130	-0.555	0.401	0.0113	-0.00834
	(0.532)	(0.656)	(0.444)	(0.516)	(0.0203)	(0.0225)
Male	2.327***	1.709***	2.143***	2.116***	0.00717	0.0205
	(0.626)	(0.562)	(0.469)	(0.439)	(0.0185)	(0.0216)
Science Orient (Dummy)	0.401	1.237**	1.854***	0.959**	-0.00507	0.00791
	(0.523)	(0.542)	(0.538)	(0.489)	(0.0263)	(0.0253)
Single Child (Dummy)	-0.778	-0.0265	-0.102	0.177	-0.00366	-0.0227
	(0.563)	(0.585)	(0.606)	(0.487)	(0.0176)	(0.0235)
Age	-0.00937	0.0240	0.243	0.0417***	-0.0190	0.000404
	(0.344)	(0.0198)	(0.347)	(0.0147)	(0.0152)	(0.000626)
Relative Income	-0.835*	-0.144	-0.589	0.256	0.0122	0.0165
	(0.480)	(0.511)	(0.424)	(0.381)	(0.0135)	(0.0164)
Rural Hukou (Dummy)	-0.720	0.198	-0.154	-0.598	0.0129	0.0193
	(0.584)	(0.605)	(0.606)	(0.370)	(0.0197)	(0.0252)
Period	0.796***	1.578***	1.892***	2.619***	0.0366	0.0800**
	(0.160)	(0.230)	(0.418)	(0.339)	(0.0229)	(0.0344)
Period Squared	-0.101***	-0.185***	-0.0627***	-0.0870***	-0.00163*	-0.00308**
	(0.0173)	(0.0244)	(0.0160)	(0.0126)	(0.000898)	(0.00129)
Punisher Contribution					-0.00485	-0.0150***
					(0.00304)	(0.00478)
Punished Contribution					-0.000341	0.00513
					(0.00314)	(0.00425)
Constant	10.48	6.508***	-6.526	-7.982***	0.233	-0.378*
	(6.685)	(1.285)	(7.153)	(2.198)	(0.376)	(0.222)
R-Squared (Overall)	0.0874	0.0625	0.156	0.118	0.0289	0.0430
Observations	2160	2016	2160	2016	4442	4263

Notes: Random Effects Linear regressions. Robust standard errors at the prefecture cities level are reported in parentheses (* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$).

C Migration Adjusted Rice Suitability Index

In this section, we use migration adjusted rice suitability index to instrument percentage of paddy fields.

Table C5. *Migration Adjusted Rice Suitability Index*

Panel A: First Stage 2SLS Estimates.	Contribution no Punish Condition			Contribution Punish Condition			Punish Points to Free-Riders		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Low-labour input (adj.)	0.0174***	0.0208***	0.0189***	0.0174***	0.0208***	0.0189***	0.0162**	0.0197***	0.0197***
	(2.67)	(5.74)	(6.19)	(2.67)	(5.74)	(6.19)	(2.44)	(6.32)	(7.51)
Intermediate-labour input (adj.)	0.0403**	0.0201*	0.0249**	0.0403**	0.0201*	0.0249**	0.0441**	0.0260***	0.0207**
	(2.38)	(1.82)	(2.35)	(2.38)	(1.82)	(2.35)	(2.55)	(2.68)	(2.36)
F-Stat	135.2	231.8	262.8	135.2	231.8	262.8	154.6	298.5	282.1
Panel B: Second Stage 2SLS Estimates.									
Perc. Paddy Field	1.589***	2.152**	1.028	1.817***	3.026***	1.854**	0.236***	0.286**	0.205*
	(0.497)	(0.862)	(0.652)	(0.458)	(0.831)	(0.762)	(0.0755)	(0.112)	(0.113)
Constant	7.590***	-0.866	5.448	-5.895***	-27.36***	-7.605*	-1.549**	-2.496	-1.797
	(0.943)	(4.738)	(4.880)	(1.875)	(6.125)	(4.606)	(0.767)	(1.762)	(1.153)
Baseline Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Development Covariates		Yes	Yes		Yes	Yes		Yes	Yes
Land Characteristic Covariates		Yes	Yes		Yes	Yes		Yes	Yes
Cultural Covariates (Questionnaire)		Yes	Yes		Yes	Yes		Yes	Yes
Culture Covariates (Behavioural)									
Risk Attitude		Yes	Yes		Yes	Yes		Yes	Yes
Coordination		Yes	Yes		Yes	Yes		Yes	Yes
UG Offer		Yes	NA		Yes	NA		Yes	NA
DG Offer		Yes	NA		Yes	NA		Yes	NA
UG MAO		NA	Yes		NA	Yes		NA	Yes
DG Belief		NA	Yes		NA	Yes		NA	Yes
Contribution Controls	NA	NA	NA	NA	NA	NA	Yes	Yes	Yes
Period and Period Sq	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared (Overall)	0.0739	0.151	0.107	0.141	0.197	0.163	0.196	0.237	0.227
Observations	4176	2024	2032	4176	2024	2032	3823	1947	1794

Notes: Clustered standard errors at the prefecture city level are reported in parentheses (* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$).