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Does corruption affect cooperation? A laboratory experiment

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Abstract In this paper, we analyze the nature of cooperation in different corruption regimes. In a laboratory experiment with university students in Mexico, individuals play first a corruption game and then a public goods game. The corruption game is divided into three groups: high- and low-monitoring scenarios as well as a control group not exposed to the game. The public goods game is divided into three groups: the standard game, a game with centralized punishment executed by an exogenously assigned leader, and a game similar to the second one, but adding the possibility of counter-punishment. There are four key results. First, there is more corruption in the low-monitoring group. Second, in the public goods game there is less cooperation in the low-monitoring group than in the group with more intensive monitoring. Third, the option of punishment increases cooperation, but the sensitivity to punishment is greater in the high-monitoring (low-corruption) group. Fourth, the option of counter-punishment of the leader decreases cooperation. Our results highlight the importance of corruption in decreasing trust and social capital and show the difficulty of promoting cooperation when corruption is prevalent.

Keywords Corruption · Cooperation · Leader · Public goods · Laboratory experiment

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1 Introduction

The less developed countries of the world have a greater prevalence of corruption (Bai et al. 2013). Numerous studies have explored how extractive institutions are related to corruption and hinder economic development (Acemoglu et al. 2005; Mauro 1995). The World Bank has affirmed that corruption is "among the greatest obstacles to economic and social development. It undermines development by distorting the rule of law and weakening the institutional foundation on which economic growth depends" (World Bank 2015). Lack of trust in a society represents a form of diminished social capital and retards economic development (Algan and Cahuc 2013). In this paper, we examine the relationship between corruption and social capital, testing in particular the effectiveness of different institutions in promoting trust and cooperation under alternative corruption regimes.

Recent work has attempted to understand the determinants of corruption at the microeconomic level using laboratory experiments (Abbink et al. 2002). In the corruption game, an individual offers a bribe to a public official and the official decides whether to accept the bribe in exchange for preferential treatment. This literature has focused mainly on interventions to decrease corruption (Abbink 2006). Other experimental studies in economics have focused on how to foster cooperation among groups. Studies of the public goods game, for example, have shown that the contribution of individuals to a common project decreases as the game progresses (Ledyard 1995). However, when individuals are allowed to punish other members of the group, most individuals use punishment targeted at free-riders as a device to increase contributions (Fehr and Gächter 2000). This literature has emphasized the powerful effect of punishment as a means of increasing contribution rates in a public goods game.

In this paper, we bring together the concerns of these corruption and cooperation studies, analyzing whether frames of corruption affect how individuals cooperate in a public goods game. In order to examine the interaction of different punishment institutions with corruption regimes, we set up a two-stage between-subjects laboratory experiment with university students in Mexico. First, individuals are exogenously assigned to one of three groups: a corruption game with the probability of getting caught of 25 % (which we denote as the high-monitoring group), a corruption game with the probability of getting caught of 5 % (the low-monitoring group), and a control group not exposed to the corruption game. The corruption game consists of a firm offering a bribe to an official to get a special permit. After the corruption game, individuals play a public goods game in one of three different groups: the standard game, a game with centralized punishment executed by an exogenously assigned leader, or a game similar to the second one but with the added possibility of counter-punishment. Our key contribution is to demonstrate how mechanisms to improve cooperation are affected under different corruption scenarios.

We find four main results. First, in the corruption experiment, individuals in the high-monitoring group commit fewer corrupt acts than those in the low-monitoring groups. This is true both for individuals acting as firms and for those acting as public officials. Second, individuals more exposed to corruption (low-monitoring) cooperate less in the public goods game than those who are less exposed (high-monitoring) and those who do not participate in the game. Third, introducing the option of punishment increases cooperation. However, this increase is greater in the high-monitoring group (low corruption) than in the low-monitoring group (high corruption). Fourth, counter-punishment of the leader decreases cooperation relative to the scenario in which punishment is exercised solely by the leader. Cooperation in the group with counter-punishment is higher for the low-corruption group than for the high-corruption group. These results demonstrate that the same public policy applied in different contexts (low and high corruption) has differentiated results.

This paper is organized as follows. Section 2 discusses the existing literature on corruption and cooperation; at the end of the section we discuss the contribution of this paper in light of those studies. Sections 3 and 4 discuss the experiment and its implementation. In Sect. 5, we discuss the four main results of the paper, and in Sect. 6 we offer some conclusions.

2 Literature review

2.1 Background on corruption

There is an extensive literature that analyzes the measurement and impact of corruption.[1] In this brief review, we focus on the experimental evidence about corruption, which is summarized in Abbink (2006). The typical corruption game consists of a bribery game between two individuals, the proponent and the respondent. Proponents have to decide whether to offer a bribe to respondents and if so, the amount to be offered. Respondents then decide whether to accept the bribe, and at the same time the value of the favor to be paid. Proponents judge the size of their bribes in proportion to the size of the favors they hope to receive. Respondents, however, have no real incentive to do large favors: once they receive a bribe, nothing in the arrangement compels them to follow through with a favor, especially where the cost is great. In this sense, the proponent is better off not offering the bribe: there is no guarantee of receiving a favor in exchange for payment. The respondent is better off taking the bribe and doing nothing.

The first paper that analyzed corruption in a laboratory experiment was Abbink et al. (2002). It analyzes the typical corruption game but adds treatments like the impact of bribes as a negative externality on society, and also the severity of punishment for those who are caught in corrupt acts. In the corruption game, approximately 20 % of players do not offer a bribe. When there is a probability of getting caught, the proportion that does not offer a bribe increases to 50 %. The externality on society has no effect on players' decisions. Subsequent research by Abbink and Hennig-Schmidt (2006) shows that the framing of the study, in which a "bribe" is explicitly mentioned in the instructions or not, has no impact on the results.

1 See Banerjee et al. (2012), Mauro (1995), Shleifer and Vishny (1993), Bardhan (1997), Jain (2001).

In this study, we are interested in how corruption varies with culture and how contagious it is. The first question is usually approached by looking at individuals from different countries facing the same decision. Using international university students in a bribery game, Barr and Serra (2010) find that corruption in the laboratory experiment is related to corruption in their country of origin. Similarly, Cameron et al. (2009) report that a higher exposure to daily corruption increases the tolerance of the participants towards illicit actions, and a lower disposition to punish these actions. Finally, Fisman and Miguel (2007) find that parking violations by foreign diplomats in New York City are related to the corruption index in their country of origin.

The second question concerns the contagiousness of corruption. Gingerich et al. (2015) implement an experiment in Costa Rica with two random treatments. A flyer is delivered to some households with information about an increase in the number of corrupt acts witnessed by citizens. Another version, given to different households, contains information about the inability of the Costa Rican government to tackle corruption. Participants then respond to two different questions about their disposition to offer a bribe. The persons exposed to the first flyer are more likely to offer a bribe than those in the control group. This result favors the hypothesis that corruption is contagious (see also the result in Innes and Mitra 2013).

These laboratory experiments have served not only to understand the extent of corruption, but also to estimate the impact of different public policies on reducing it.[2] In this paper, however, our immediate interest is not in analyzing how to reduce corruption, but in examining how corruption affects the dynamics of cooperation and the response of systems that foster cooperation. Given the powerful effects of corruption on culture, along with peer effects, we frame the subjects in different scenarios of corruption and analyze how cooperation is affected.

2.2 Background on cooperation

To study cooperation experimentally, researchers typically use the public goods game that is played with groups of participants, each of whom owns an initial endowment. Participants can assign part of their endowment to their private accounts or invest in a common group project. The sum of all investments in a group is multiplied by a factor and divided equally among its members. At the end of a round, individual players' profits are the sum of the money saved in their private accounts and the benefits from investing in the project. Assuming that all participants are selfish and rational utility maximizers, the Nash equilibrium of this game predicts that no player will invest in the common project, because, by

[2] Public policies like staff rotation in public offices (Abbink 2004), levels of monitoring (Beekman et al. 2013; Banerjee et al. 2012; Olken and Pande 2012; Alatas et al. 2009; Schikora 2011a), rewards to whistleblowers (Wu and Abbink 2013; Schikora 2011b), asymmetric punishments (Abbink et al. 2014), and better salaries for public officials (Armantier and Boly 2011; Barr and Serra 2009) have been proven effective in reducing corruption (although it is not eliminated). However, these results must be taken carefully because they rely on the idea of a well-designed and efficient punishment institution (Abbink et al. 2014). Other experiments related to corruption and cooperation include tax compliance experiments for an example see Kogler et al. (2013).

backward induction, players know that they can benefit from others' contributions even if they do not contribute. Following this model, all of the players will decide that the best strategy is not to contribute, and they will all be left only with their initial endowment. However, the results of multiple public goods games show that not all players behave as the Nash equilibrium predicts, and that some invest part of their endowment (Chaudhuri 2009; Ledyard 1995). With repetition of the game, however, the degree of cooperation tends to decrease, mainly because of the heterogeneity of the players (Fischbacher et al. 2001); some are more willing to cooperate, depending on the reciprocity of others. Fehr and Gächter (2000) show that a punishment option, after contributions are revealed, increases cooperation. This result has prompted several researchers to analyze institutional frameworks that include or exclude punishment in order to promote cooperation.[3]

Punishment can take one of two general forms. It might be used in a centralized way, where only one player can punish the others, or in a decentralized way, where any participant can punish another. Both types of punishment are effective in increasing the degree of cooperation within groups, but centralized punishment is more efficient (Andreoni and Gee 2012; O'Gorman et al. 2009).

Leaders might serve to dispense centralized punishment; they are an example of an institution that might allow societies to achieve higher standards of welfare. Leaders can be chosen either exogenously (by a random lottery) or endogenously (through democratic election). Researchers are interested in the effect of leaders moving first in a game on the basis of public information and in their use of punishment on members of the group. A leader moving first can promote cooperation in a group (Gächter et al. 2012; Gächter and Renner 2014). Baldassarri and Grossman (2011) and Grossman and Baldassarri (2012) compare the degree of contribution in different groups and find that cooperation is higher where leaders are selected endogenously than in those where they are chosen exogenously. The intuition behind this observation is that players who select a leader might feel more trust inside the group and choose to cooperate more (Grossman 2014).[4]

Recent research has also analyzed the possibility of counter-punishment. In real life, punishment without a valid reason will surely prompt retaliation. An effective mechanism to counteract the behavior of bad leaders is the opportunity to punish them in a second stage of the game, where we would expect no counter-punishments of good leaders. Research on the impact of decentralized counter-punishment has found that it decreases cooperation, punishment, and welfare because subjects retaliate at an increasing rate (Denant-Boemont et al. 2007; Nikiforakis 2008).

[3] Another possibility is to provide information to group members. When a group is informed that all its members share a common attitude towards cooperation, the levels of cooperation reach close to the highest level (Gächter and Thöni 2005). This might be explained by the fact that knowing about others' preferences decreases players' uncertainty and information costs and they decide to cooperate more (Bowles and Gintis 2004).

[4] An elected leader can also help avoid antisocial behavior by non-cooperators (Kamei et al. 2014; Ertan et al. 2009). Both inside and outside the laboratory, elections are important in order to maintain leaders that represent the best choice, in cases where information plays a fundamental role (Hamman et al. 2011; Pande 2007).

2.3 Contribution to the studies of corruption and cooperation

The laboratory experiments on corruption and cooperation discussed above have found robust results characterizing the relevant variables, but the relation between corruption and cooperation has not yet been clarified. Using a natural experiment with rural households in Liberia, Beekman et al. (2014) relate the impact of corruption on the degree to which people cooperate. Their study considers as a measure of corruption the amount of in-kind transfers lost in 2 days under the watch of local leaders, and uses it to create an index of leaders showing the most and least corrupt. With this information, individuals in each community participate in a public goods game, followed by an investment game where they have to choose how much to save from their endowment and how much to invest in a lottery. These two games allow a measurement of how corruption affects people's incentives to invest in public and private goods. As expected, the results show that individuals living in communities with corrupt leaders invest less in local public goods. In a related article, Beekman et al. (2013) use the same communities and measures of corruption and find that individuals living in communities with corrupt leaders also show less productive investment and propensity to trade. In a cross-country study analyzing cooperation using a public goods game, Herrmann et al. (2008) find that individuals in less developed regions cooperate less than in those that are more developed.

These studies all support the hypothesis that corruption negatively affects people's cooperation and investment decisions.[5] However, their main disadvantage is that corruption is not exogenously assigned. The relationship between corruption and investment or trust could thus be driven by unobserved factors at the community level or by reverse causality. Our contribution in this paper is twofold: first, we randomly vary the exposure to corruption to test the impact on cooperation, and second, we randomly vary mechanisms to improve cooperation in order to understand how they interact with exposure to corruption. A novel variation in this later stage is the use of punishment by a leader as well as the possibility of counter-punishment of the leader (both in a context of a centralized institution).

3 The experiment

The experiment is implemented in two stages and has a between-subjects design. In the first stage, subjects are faced with a corruption game, where subjects' exposure to corruption is randomly varied by increasing the probability of detection. There is also a control group that is not influenced by the corruption framing. The main purpose of the first stage is to create different perceptions of trust and reciprocity among the participants related to the exploitable benefits of corrupt behavior. In the second stage, participants play a public goods game. Players are randomly assigned to one of three groups: (1) a traditional public goods game without the option of

[5] Another recent experiment is Banerjee (2014). Playing a corruption game decreases trust in subsequent experimental games.

punishment; (2) centralized punishment by a leader without counter-punishment; and (3) centralized punishment by a leader with the option of counter-punishment. Using this design, we analyze the impact of monitoring on corruption, the relationship in a public goods game of corruption and cooperation, and the ways in which cooperation can be fostered under different corruption regimes.

3.1 Stage 1: the corruption game

The structure of the corruption game follows that proposed by Abbink et al. (2002), where we have a firm (or citizen) that wishes to install a factory next to a river. Among other requirements, the firm needs an environmental certificate from the local government establishing that it does not exceed the limits of pollution to the river. The firm initiates the process of obtaining the certificate with the public official who will be in charge of evaluating the case and determining whether to grant the certificate. The firm has the possibility of offering the official a bribe, to serve as an incentive to grant the certificate. The instructions for all players specify that the granting of a certificate implies a decrease in the cleanliness of the river, in order to make clear the negative social impact of the bribe (Lambsdorff and Frank 2010).[6] The instructions, delivered individually, indicate the role each player will play in five rounds. The identity of the players in the game is anonymous, and partners play together only once in the course of the game.

Figure 1 shows the sequential steps of the game. The firm (or citizen) moves first. The firm must decide whether to offer a bribe to the public official as an incentive to grant the certificate. If it decides to offer the bribe, the amount t of the bribe must be chosen from its initial endowment, from $\{0, 1, \ldots, 9\}$. Besides the amount selected for the bribe, the firm must incur a fixed expense of 2 experimental currency units (ECU) that represents the initial approach to the public official (this is a sunk cost, because the firm must pay it, whether the public official accepts the bribe or not).

After seeing the decision by the firm, the public officials make a decision. If a bribe is offered, they must choose whether to accept it or not. If they decide to accept it, the amount will be deducted from the firm's account, and three times that amount will be added to their account (Abbink et al. 2002). The public officials must then decide whether to grant the certificate. Granting the certificate implies an effort, because they must justify it to their superiors and complete the necessary paperwork. In this experiment, if the public officials decide to grant the certificate, their payoff is reduced by 6 ECU; if they do not grant it, they keep the entire payoff.

In order to have different corruption scenarios, we randomly assigned the probability of monitoring to one of two values. In the low-monitoring scenario, players have a 5 % probability of getting caught, and in the high-monitoring scenario the probability is 25 %. If players are caught in an act of corruption, they lose their earnings from the round. It is expected that the levels of corrupt behavior

[6] The externality is not costly in monetary (ECU) terms. We follow the procedure in Abbink et al. (2002), and based on the results in Abbink and Hennig-Schmidt (2006), we do not include the word "corruption" in the experimental instructions. Of course, if these latter results do not hold for our sample, including the word might have had different effects. Additional research is needed on the external validity of previous findings as applied to developing countries.

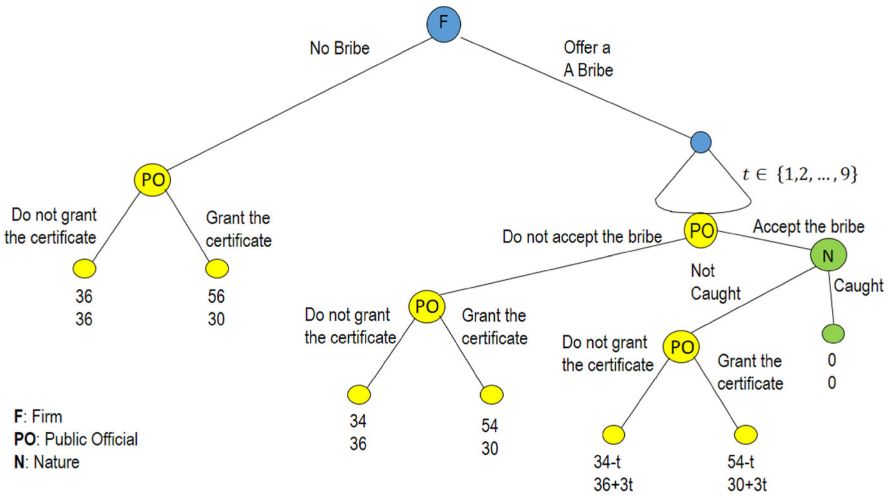

Fig. 1 Graphic representation of the corruption game. Created by authors based on Abbink et al. (2002). *Numbers* refer to payments in experimental currency units (ECU). *F* refers to a firm and PO to a public official. The firm moves first and then the public official. *N* refers to the situation where a public official accepts a bribe and there is a probability of getting caught; if caught, both players receive zero payment (probability 5 % in low-monitoring scenario and 25 % in high-monitoring scenario)

are higher with low monitoring because of the greater benefits and lower risks involved. In this first stage, we also include as a baseline a control group that does not play the corruption game.

In this game, the equilibrium for the firm is not to offer a bribe, with the public official not granting the certificate. By backward induction, the firm knows that not granting the certificate is a dominant strategy for the public official. Even if a bribe is offered, it best suits the interests of the public official not to grant the certificate. Firms thus decide not to offer a bribe in the first stage of the game.

3.2 Stage 2: the public goods game

In the second part of the experiment, the public goods game, groups of four participants are randomly formed, taking into account each participant's treatment in the corruption game (whether they participated in a high- or low-monitoring group, or in the control group). This means that all the participants in a group in this stage faced the same treatment in the first stage, and participants are informed of this fact in order to make it clear what kind of partners they might expect. The identity of all players is kept anonymous throughout the game. The players are divided into three groups: (1) the standard public goods game without the option of punishment; (2) centralized punishment by a leader but no counter-punishment; and (3) centralized punishment by a leader with the option of counter-punishment. The new groups play together for five rounds in a partner mode.

3.2.1 The standard public goods game

The standard public goods game consists of a simultaneous assignment decision for each player regarding the initial endowment. The initial endowment is 20 ECU for each participant, and they have two ways to use it: save all or part of it in a personal private account, or invest all or part of it in a shared group project (x). The profitability of the common project is calculated by multiplying the sum of the investments in it by two and dividing it into equal shares among the four participants in each group ($0.5\sum_{j=1}^{4} x_j$). The payoff for the participants is calculated as follows:

$$\pi_i = 20 - x_i + 0.5\sum_{j=1}^{4} x_j \tag{1}$$

After the contributions are made by all the members in all groups, players are informed of their earnings for the round and the contribution of their group's partners. If the participants are rational and selfish, their dominant strategy is not to invest in the common project, but to save their endowment in their private accounts. This happens because players can profit from their partners' investments in the common project without having to invest in it. If all the players follow this prediction, then none invest in the common project. The best choice in social terms, however, is that all participants invest their endowments in the common project. The profit is then 40 ECU each, a profit of 160 ECU for the group.

However, as previously noted, the literature on public goods games shows some cooperation among players. The average individual contribution starts at around 50 % of the endowment and declines with each round. This behavior is not consistent with the Nash equilibrium, and various researchers have explored why there is cooperation. Among the possible explanations are confusion, altruism (Andreoni 1995), inequity aversion (Fehr and Schmidt 1999), conditional cooperation (Fischbacher et al. 2001), and strategic behavior related to the multi-round setting of the experiment (which includes reciprocity concerns and beliefs about other people's contributions as in Fischbacher and Gächter 2010). There is no evidence for confusion as a factor in the main result of these games (Andreoni 1995). A recent study shows that multi-round motives are more important than altruism, inequity aversion, and conditional cooperation, but that all of these factors explain cooperative behavior (Yamakawa et al. 2016).

3.2.2 Centralized punishment by a leader but no counter-punishment

The dynamic of this game is similar to the standard public goods game, but a few features are added. Before the first round starts, it is explained to the participants that one player has been exogenously selected. This player (who is not explicitly named as a leader in the experiment) will have the ability to reduce the profits of the partners. It is explained that after all investment decisions have been made in a group, and after all the players know their own profits and the contribution of others, the selected player will decide how much to reduce the others' profits. There is a cost to doing so, however. Each punishment unit the leader buys delivers three units of punishment to the punished player: if the leader decides to pay 1 ECU to punish another player, the latter's profit will be reduced by 3 ECU (the leader can use up to 10 ECU to punish each player).[7] After the leader makes this decision, players learn how many ECU they receive as punishment (but they are not told about the punishment received by others). Then a new round starts. The profit function for players other than the leader is:

$$\pi_i = 20 - x_i + 0.5 \sum_{t=1}^{4} x_t - 3y_j, \tag{2}$$

where y represents the units of punishment received from the leader. The leader's equation is:

$$\pi_i = 20 - x_i + 0.5 \sum_{t=1}^{4} x_t - \sum_{j=1, i \neq j}^{4} y_j, \tag{3}$$

where the last sum corresponds to the punishment to others.

By backward induction, considering the cost of punishment, leaders decide not to punish others. Taking this into account, the other players have no incentive to invest in the common project at the decision stage. Thus, as in the standard public goods game, the dominant strategy of the players is not to invest in the public good, but to save everything in their private accounts. It is important to note that, given the conditions of the game, it is impossible for the players to coordinate a common strategy.

3.2.3 Centralized punishment by a leader with counter-punishment

This treatment is similar to the previous one, with the added possibility of counter-punishment after the leader has decided on punishment. We add the possibility that punished participants are able to punish the leader in return. However, the cost and value of this counter-punishment is different than the leader's cost. As before, the leader pays one ECU to punish others three times as much. The cost of the counter-punishment, however, is three times its impact. The idea behind this difference is to reflect the power differential between the leader, representing an institution, and an ordinary player.

As in the previous version of the public goods game, after the leader has decided on the punishment of the rest of the group, the players know their own profit, the contributions to the project by each of the others, and their own punishment. Those players who are punished by the leader must decide whether to apply counter-punishments, taking into account their profits from the round and the cost of counter-punishment. At the end of the round the players will know their final profit

[7] This cost is standard in the literature; we follow the procedure in Gächter and Thöni (2005) and O'Gorman et al. (2009).

after counter-punishment, and then a new round starts. The profit function for players other than the leader is:

$$\pi_i = 20 - x_i + 0.5 \sum_{t=1}^{4} x_t - 3y_j - 3z_j \cdot 1(y_j > 0) \tag{4}$$

with z as the units of counter-punishment of the leader, taking into account its cost (only players who receive punishment can choose a counter-punishment, $1(y_j > 0)$). The leader's profit function is:

$$\pi_i = 20 - x_i + 0.5 \sum_{j=1}^{4} x_j - \sum_{j=1, i \neq j}^{4} y_j - \sum_{j=1, i \neq j}^{4} z_j \tag{5}$$

with the last sum representing the counter-punishment received by the leader.

By backward induction, similar to the other two treatments, it is expected that the costly counter-punishment for the non-leader participants will not be used. Taking this as a given, the leader decides to not punish the rest of the group because of the cost of that punishment. Finally, by having no incentive to cooperate with each other, all the participants decide to save their endowment in their personal accounts.

4 Experimental procedure

The experiment was carried out in April and May 2015 with students from several schools of the Autonomous University of San Luis Potosí (Mexico). The students were invited to participate through posters distributed at the schools, and directly in visits to some classrooms. Because students came from different areas of study, in order to have comparability among groups the sample was restricted to first-year students (these students also had more time to participate in the experiment than higher-level students).

At the beginning of the session each participant received a large yellow envelope that contained all the necessary material, including answer sheets and individual instructions for each stage of the experiment. In each round, the players' decisions were delivered to the experimenters in a white envelope. The decisions were captured online on a pre-programmed spreadsheet, which helped experimenters to speedup the process of each round. Instructions were read aloud in each session, and the distance between players was sufficient to prevent communication among them. At the end of the session they responded to sociodemographic survey questions, with questions related to their knowledge about corruption and their attitudes about trust and fairness to others.

In all the treatments, after the instructions were read aloud, examples were given to help the participants understand the dynamic of each game, the possible earnings with each decision, and how to use properly the material. Remaining questions were answered in private. The average length of each session was 70 min, including the reading of the instructions and the final payment for the experiment. The payoff for the corruption game was made at an exchange rate of 40 *centavos* (Mexican pesos) per ECU for one of the five rounds, selected at random. For the public goods game, the payoff was for all rounds at an exchange rate of 50 *centavos* (Mexican pesos) per ECU. A payment of 20 pesos was added for attendance. The maximum total payment was 133 pesos ($16.60 USD in PPP), and the minimum was 81 pesos ($10.10 USD in PPP), with an average of 112 pesos ($14 USD in PPP). There were a total of five sessions with 164 participants.

5 Results

5.1 Corruption

Figure 2 shows the results of the degree of corruption in the low-monitoring scenario (5 % probability of getting caught) and the high-monitoring scenario (25 % probability of getting caught). It includes results for 64 individuals in the role of the firm for five rounds. In Panel A we see that in the low-monitoring scenario, 52 % offer a bribe, as compared with 35 % in the high-monitoring scenario (Mann–Whitney test, p value $= 0.0023$). These figures imply an elasticity of bribery with respect to the probability of getting caught equal to -0.9. Consistent with the literature on corruption and dishonesty, extrinsic motivations (the probability of getting caught) appear not to fully eliminate corrupt behavior. Panel B shows the extensive margin of the bribe. To facilitate interpretation of the graph, we show the bribe offered as a percent of the maximum bribe (9 ECU). The high-monitoring group offers a larger bribe than the low-monitoring group (Mann–Whitney test, p value $= 0.0005$), possibly with the intent of increasing the probability of receiving the certificate given the higher risk of getting caught.[8]

Figure 3 shows the behavior of public officials. In Panel A we see the extensive variation in reaction to a bribe. As the behavior of public officials is contingent on whether a bribe is offered, we show both the decisions of all public officials and also only those receiving a bribe offer. Public officials are 14 % points less likely to accept the bribe in the high-monitoring scenario than in the one with low monitoring (statistical significance 1 %). Because of the small sample size, once we restrict the analysis to public officials receiving a bribe offer, the difference is no longer statistically significant. However, these results suggest that officials also react to the monitoring environment. In the low-monitoring scenario, combining data from Figs. 2 and 3, we see that roughly half the firms offer a bribe and that of those offers half are accepted. Thus, in roughly 25 % of transactions a bribe is offered and accepted. However, offering a bribe has no effect on whether the public official grants the certificate (Panel B)[9]: there is no evidence of reciprocation by public officials.

[8] The online appendix includes regression results for each figure shown, controlling for different covariates. These results are similar to those presented in each figure.

[9] We also estimate whether there is any statistically significant difference in issuing the certificate when the public official accepts the bribe, and we find results similar to those in Fig. 3.

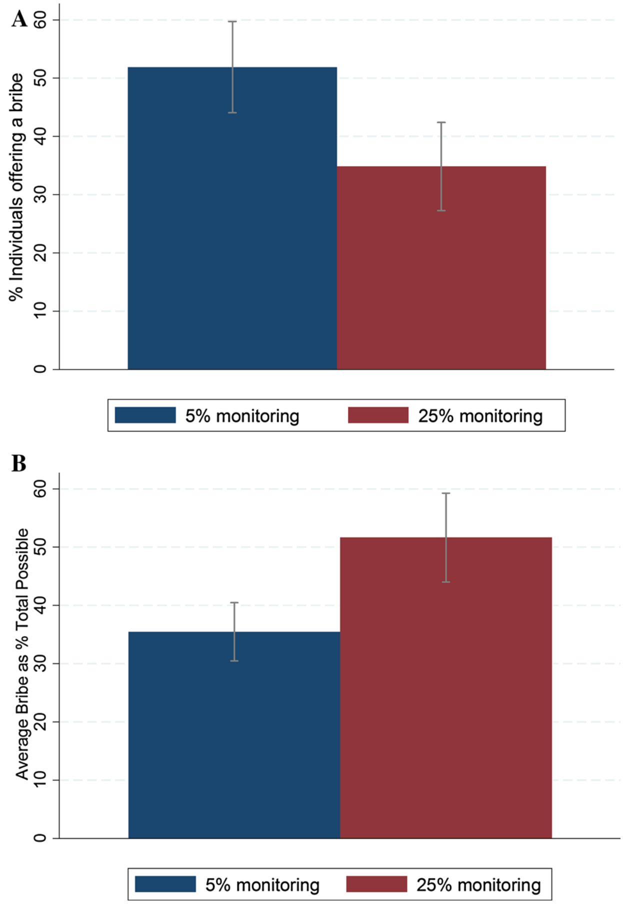

Fig. 2 Corruption behavior of firms. Panel **a** shows the percentage of individuals acting as firms who offer a bribe to the public official. Panel **b** includes only individuals who offer a bribe; it shows the bribe offered as a percentage of the maximum possible bribe. The figures of 5 and 25 % monitoring refer to the probability of getting caught. The *error bars* refer to 95 % confidence intervals. There are five rounds for each individual and 64 individuals

Main result 1: The low-monitoring group shows higher corruption than the high-monitoring group. The number of transactions in which both the firm and the public official commit acts of corruption is roughly 25 % in the low-monitoring group and 12 % in the high-monitoring group. The results are qualitatively similar to Abbink et al. (2002).

5.2 Cooperation

Figure 4 shows the main results of the pooled outcomes of the five rounds in the public goods game. It includes the percent contribution to the public good in terms of the initial endowment (20 ECU) for each of the corruption groups. High-

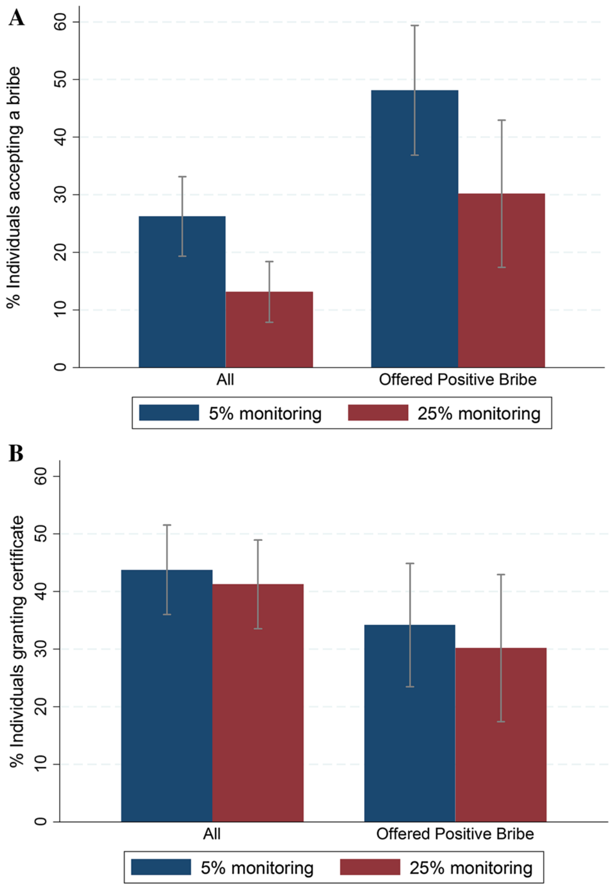

Fig. 3 Corruption behavior of public officials. Panel **a** shows the percentage of individuals acting as public officials who accept a bribe from a firm. Panel **b** shows the percentage of public officials who decide to grant a permit. The figures of 5 and 25 % monitoring refer to the probability of getting caught. *Error bars* refer to 95 % confidence intervals. There are five rounds for each individual and 64 individuals

corruption groups (low monitoring) show 20 % less cooperation than the low-corruption group (high monitoring) and the control group. This result is consistent with the findings of Beekman et al. (2013, 2014). There are no statistically significant differences between the control group and the low-corruption group.

> Main result 2: Groups with higher corruption (low monitoring) cooperate less than groups with lower corruption (high monitoring) and a control group with no corruption framing.

The figure also includes cooperation by treatment in the second stage of the experiment. Each individual is assigned to one of three groups: (1) a standard public goods game without the option of punishment; (2) centralized punishment by a

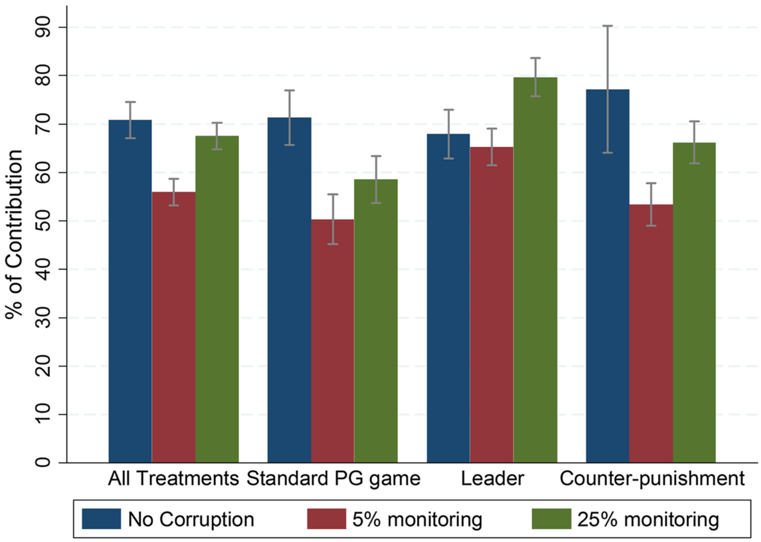

Fig. 4 Relationship between corruption and cooperation. The corruption game includes three groups: a control group with no exposure to the game, and groups with 5 and 25 % monitoring, respectively, where the percentages refer to the probability of getting caught. "All treatments" refers to pooling observations from the three treatments in the public good games (standard public good game, a game with centralized punishment by a leader without counter-punishment, and a game with centralized punishment by a leader with counter-punishment). Results as shown are the contribution as percentage of the 20 ECU endowment. *Error bars* refer to 95 % confidence intervals. There are five rounds for each individual

leader with no counter-punishment; and (3) centralized punishment by a leader with the option of counter-punishment. Previous research has found that punishment (both centralized and decentralized) increases contribution rates (Andreoni and Gee 2012; Fehr and Gächter 2000; O'Gorman et al. 2009). Our experimental results confirm this previous evidence. Pooling groups from the first stage, we find an average contribution in the punishment group (without counter-punishment) of 71 %; in the standard public good game without punishment the figure is 59 % (difference statistically significant at the 1 % level).

We then contrast the results of the standard public goods game and the version with centralized punishment by a leader without counter-punishment. In the case of the control group, not exposed to corruption, there are no differences in the contribution rate. However, for both the low- and high-monitoring groups there are substantially higher contribution rates when punishment is allowed. Moreover, the difference in cooperation is larger in the high-monitoring group (36 %) than in the low-monitoring group (30 %). Of all the combinations in the experiment, the highest contribution rate is in the group with high monitoring (low corruption) and centralized punishment without the counter-punishment option. We interpret these results to mean that cooperation can be fostered more easily with punishment in low-corruption groups than in high-corruption groups.[10]

[10] On average, earnings in the high-monitoring group are 2 % larger than in the low-monitoring group. However, average earnings are lower in the treatment of counter-punishment with high monitoring than with low monitoring.

The results also show the importance of the leader in setting beliefs for the rest of the players. Gächter et al. (2012), Gächter and Renner (2014), and Jack and Recalde (2015) show how leaders promote cooperation in public goods games through building positive beliefs about the proper contribution rate. In our experiment, individuals in a group cannot identify the leader, but they know there is a person who has the power to punish other members. Apart from the impact of leaders on group behavior, it could be argued that a higher degree of contribution in the high-monitoring scenario is due to a higher degree of punishment by leaders than where there is low monitoring. However, the high-monitoring case does not show a greater level of punishment (statistical results shown in the Online Appendix). Therefore, it is more likely that other factors, like trust, foster intrinsic motivations to cooperate more.

> Main result 3: Punishment increases cooperation over the scenario without punishment. Cooperation is also more sensitive to punishment in low-corruption scenarios.

Finally, we want to test the impact of vengeance in the form of counter-punishment. Figure 4 shows that for the group not exposed to corruption there are no differences in the contribution rates related to the absence or presence of counter-punishment. However, both the low- and high-monitoring groups decrease their contributions in the presence of counter-punishment. In this scenario, cooperation in the presence of counter-punishment is still larger in groups with less corruption. Our result is in line with Nikiforakis (2008), who also finds a decrease in cooperation with counter-punishment combined with decentralized punishment. However, in our case the result may be counterintuitive. More checks and balances in the form of counter-punishment should encourage the leader to promote cooperation, but the results show otherwise (although our treatment only allows counter-punishment if the person received a punishment in the first place). The decrease in cooperation might be due to a combination of a lower contribution from the leader, a lack of punishment, and players' expectations. In all treatments in our experiment, punishment by the leader decreases when there is the possibility of receiving counter-punishment (statistical results in the Online Appendix). This is likely due to fear of retaliation. For the rest of the channels we are not able to test the relative importance of expectations. Future work may use the strategy method to disentangle the relevance of expectations and trust in members of the group, and examine how these affect cooperation rates.

> Main result 4: Vengeance in the form of counter-punishment of the leader who carries out centralized punishment decreases cooperation. Nevertheless, cooperation is higher in low-corruption groups than in high-corruption groups.

6 Conclusion

Corruption is more prevalent in poorer countries. An important question is thus how to fight corruption in order to promote economic development. Using laboratory experiments, previous research has made progress in understanding how corruption might be decreased. In this paper we use a public goods game to extend those studies, focusing on the consequences of different corruption regimes on cooperation.

In a laboratory experiment with university students in Mexico, individuals first play a corruption game and then a public goods game. The corruption game is divided into two groups: high- and low-monitoring scenarios, which promote fewer and more acts of corruption, respectively. The public goods game is divided into three groups: the standard game, a game with centralized punishment executed by an exogenously assigned leader, and a game similar to the second one but with the added possibility of counter-punishment. The goal of the experiment is to analyze how different corruption regimes interact with different institutions that promote cooperation.

We find four key results. First, a higher probability of getting caught in a corrupt act decreases corruption. Second, individuals with greater temptation to corruption (a lower probability of getting caught) cooperate less than individuals with lesser temptation (a higher probability of getting caught) or individuals who do not participate in the corruption game. Third, adding the option of punishment increases cooperation. However, cooperation increases relatively more with punishment in the low-corruption group than in the high-corruption group. Fourth, including the option to counter-punish the leader decreases cooperation. Cooperation in the group with counter-punishment is higher for the low-corruption group than for the high-corruption group. These results highlight the importance of corruption in decreasing trust and social capital and also the difficulty in promoting cooperation when corruption is prevalent. In macroeconomic terms, corruption affects economic development both directly and indirectly through trust and social capital.

There is an important implication of the result that counter-punishment decreases cooperation, one which calls for further analysis. The global agenda to reduce corruption has included the implementation of checks and balances to deter abuses of power. The idea is that extrinsic motivations play a key role in how public officials behave. Although this strategy may be successful in fighting corruption, our results suggest that it may decrease intrinsic motivation to do good. As in our experiment, checks and balances may decrease cooperation. For example, a public official may not want to apply the law to a citizen doing wrong out of fear of retaliation. This behavior discourages other citizens from cooperating. Indeed, an interesting avenue for future research would be to analyze the robustness of these results and deepen our understanding of cooperation and institutional design in corrupt societies.

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