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Economics of Governance


# Social pressure, uncertainty, and cooperation*

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**Abstract.** We analyse the role of uncertainty in a sequential game where players have to decide whether to contribute to a public project or not. A player's payoff may depend on his belief about the other player's action which allows us to model social pressure. Using the theory of psychological games, we show that the players' propensity to choose an individually costly action such as cooperation in a public project may increase if there is some uncertainty about who has cooperated before. A central agency, e.g. the government, can induce incomplete information by using a randomization policy, thus crowding in private contributions.

**Key words:** social pressure, psychological games, cooperation

**JEL classification:** C72, H41

## 1. Introduction

In his 1962 book Milton Friedman writes: "*We might all of us be willing to contribute to the relief of poverty,* provided *everyone else did. We might not be willing to contribute the same amount without such assurance.*"[1] For him this very fact serves as a justification for governmental action to alleviate poverty. In the present paper we will make the same prediction as Friedman, but invert the motivation: *Provided everyone else contributes to a charitable project, we may feel forced to contribute also. Without such pressure we may be happy to keep the money for our own.*

* We are indebted to Martin Dufwenberg as well as two anonymous referees for valuable comments.

[1] Friedman (1962), p.191.

Such reasoning underlies the *social pressure motive* for private contributions to a public good (see e.g. Ireland 1973, Johnson 1973, or Amos 1982). However, applying game theoretic tools we show that in the absence of any other motives, such as altruism, and in the absence of public programs, the social pressure motive is not sufficient to guarantee private contributions.[2] This negative result still holds when a central agency (such as a government or the organizer of a project) cooperates and individuals are perfectly informed about the agency's action. But it does not necessarily hold when there is incomplete information about the agency's action. In fact, we show that with uncertainty private cooperation may increase in the probability that the agency cooperates.[3] Insofar, the inversion of Friedman's argument provides a basis for governmental action, too, and it demonstrates that usual crowding–out hypotheses need not generally be true.

In order to model the social pressure motive we rely on utility functions which do not exclusively depend on private wealth and consumption. In economic theory, the utility of an agent generally depends on such physical or psychological commodities, and the value of these goods (or bads) is typically assumed to be independent of the way they have been gained. However, feelings of justice or injustice, for example, seem to matter when people evaluate their belongings. If a person finds a $100 bill and makes no attempt to find the unfortunate person who lost it, she might enjoy less utility from the $100 than from another $100 that she received as a present. This need not be true with everybody and everywhere. If she lives in a society where honesty is expected from finders, pangs of conscience may arise. But if it is considered as a sign of foolishness not to keep found money, she will fully enjoy it and her utility might be even greater than from a gift of $100.

Expectations of others concerning one's own action and one's own expectations about others seem to play an important role in all situations involving social cooperation. Examples are contributions to NGOs like amnesty international, Greenpeace or the Red Cross (which may be organized on a local level), to public broadcasting (in the US), to charity for the poor or cooperation in local community projects. Regarding charity in Europe, many activities that were part of a paternalistic system of charity in the 19th century, are now performed by the collective. Either the federal government or—according to the principle of subsidiarity—local administrative units organize the system of social security. Public responsibility characterizing the welfare state has been criticized for crowding out private responsibility. When help is provided and even guaranteed by a public agency, this discharges citizens from their obligation to step in themselves. However, if social pressure is an important driving force of behavior, crowding out does not necessarily take place. Rather, if there is at least one individual deliberately conforming to the cooperation norm, this can gen-

[2] It may, however, work in the presence of a small fraction of altruistic people. See footnote 9.

[3] The decisive difference between private cooperation and contributions of a central agency is that the latter does not trigger social pressure. Typically, if a social project is entirely funded by the government, for example, and this is known by everybody, nobody feels responsible to contribute anything.

erate pressure on others to cooperate as well. In many instances of fundraising activities, current earnings are made public several times in order to induce even more contributions. For example, German TV shows raising money for charitable organizations or projects often indicate the current amount of contributions several times during the show.[4] Although this can be explained as demonstrating a sufficient level of earnings in the sense of Friedman's argument cited above, we argue that it may also generate social pressure.

Of course, group size may be an important determinant of the force of social pressure. If social pressure works externally by sanctioning or stigmatizing people who deviate from the standard of behavior, this necessitates observability of actions and thus small, closely knit groups of people. However, social pressure may also be internalized, which is what we shall focus on. In this case, for actions and expectations of others to drive a person's behavior, it is only necessary that this person observes what others do *in aggregate*. This information is provided e.g. by publicizing current contributions to a project. Nevertheless, behavioral norms are probably more effective in small groups where they are enforced by internal *and* external sanctions, e.g. norms of social cooperation in local community projects, clubs, or local administrations.

A large part of the literature on private contributions to public goods can be grouped into the following four classes. The *traditional pure public good model* assumes that the agent behaves as if he receives utility from personal consumption and the total amount of the public good. The agent's contribution, government funding, and contributions of others are perfect substitutes. Therefore, dollar–for–dollar crowding–out must occur (see e.g. Roberts 1984). However, considering the impact of tax deductibility of charitable contributions in this type of model, Glazer and Konrad (1993) show that maximum deduction allowances together with low initial tax rates may lead to crowding–in of private contributions by an increase in governmental provision of the public good.

A second class of models contains the so–called *impure altruist model* and models where contributions have a private and a public good characteristic. Agents receive utility from private consumption, their own donation, and the overall level of giving where contributions of others and government funding are perfect substitutes. This framework suggests less than dollar–for–dollar crowding–out. Theoretical models include those by Cornes and Sandler (1984, 1994), Steinberg (1987), and Andreoni (1990) while empirical support can be found in Abrams and Schmitz (1978, 1984) and Kingma (1989). Adding one restriction to this model, namely that agents do not care about the total level of contributions, which implies that other sources are no substitutes for the agent's personal contributions, leads to zero crowding–out. Empirical support for this version is provided by Reece (1979).

[4] A recent example is a TV show running for the entire day of April 17, 1999 on the public Austrian TV channel ORF as well as 3sat. This fundraising show for the refugees from Kosovo asked viewers to make a call for a money donation. About every twenty minutes, a music video was shown while the names of the donors, their city of residence and the amount donated were displayed on the TV screen.

The third and most general approach is the so–called *source–of–contributions model*. Agents contribute to relieve their feelings of guilt or to increase social standing. An agent's utility function positively depends on total contributions, but the source of the contributions plays a role. Thus, government funds and contributions of others are imperfect substitutes and lead to different levels of crowding–out. Schiff (1985) suggested this general model of (charitable) contributions. This approach comes closest to our model as it differentiates between public spending and private contributions, which is central to our analysis.

Finally, there is an alternative approach to explaining private contributions (to charity), which draws on *moral or group–interested behaviour*. Among others, Sen (1977) and Sugden (1984) argue that a principle of reciprocity or moral constraints drive individual behavior. Our model relies on feelings like guilt or shame which are rooted in the moral domain, but we focus on the effects of a public agency's intervention on the dynamics of those feelings.

In contrast to the crowding–out hypothesis we show that when knowledge or expectations about other people's contributions enter the utility function of agents, a clever social design can *crowd in* private contributions although agents are completely non–altruistic. More specifically, we model the case in which an agent does not benefit from her contribution directly, i.e. she does not derive any utility from the fruits of cooperation. This can be justified in two ways: It may often be the case that when deciding whether to contribute or not, people do not foresee the future benefits of a project. The other reason for our assumption is that we want to analyze the worst case where people do not display any altruism, where not all of them benefit individually from cooperation, but where, from the point of view of a social planner, the project increases overall welfare.[5]

In order to analyze behavior when expectations about other players' behavior enter a player's utility function, we use psychological games.[6] The main characteristic of a psychological game is that the players' payoffs do not only depend on what others do, but also on what they think what others do, i.e. on their beliefs. A player's belief system may consist of a hierarchy of beliefs over what she thinks the other players will do, what she thinks the other players think she does and so forth. For our purpose of modeling social pressure, first order beliefs are sufficient, i.e. beliefs about what other players *do*. In equilibrium, the beliefs must be consistent with actual choices. In general, adding beliefs as variables of the utility function increases the number of equilibria of a game. A psychological equilibrium can be more, less or equally efficient than the Nash equilibrium/equilibria of the game. In our model, the concept of psychological equilibrium allows for equilibria in which people perform a costly action that does not yield any direct benefit for them, solely because they believe that others perform this action as well.

[5] The model can thus be interpreted as a model of social pressure that extends to welfare neutral or even socially harmful actions.

[6] See Geanakoplos, Pearce, and Stacchetti (1989); for some applications to the economics of trust and corruption see Huang and Wu (1994) and Dufwenberg (1995), and to the topic of fairness and game theory Rabin (1993).

In order to keep things as simple as possible while preserving the strategic structure of the problem, we restrict our analysis to 2–person games throughout the paper. We start with two simple games without a central agency where people suffer from pangs of conscience if others cooperate and they do not. It is shown that cooperation is very unlikely if there are only parties involved that maximize their individual utility. The first warm–up game introduces two players deciding simultaneously whether to contribute to a project or not. As the game has the structure of a coordination problem, there are several Pareto–ranked equilibria. The second game differs from the first only in that players move sequentially. Thus, player 2 knows whether player 1 contributed to the project or not. In that case, neither of the players contributes.

Finally, we introduce a central agency or project planner. Arguing that the sequential move structure is more natural than the simultaneous one for the applications we have in mind, the two players decide one after the other. However, the agency decides on its contribution simultaneously with the first player. The agency's *policy* is commonly known. But since we allow for a random policy, both players may not know whether it contributed anything to the project or not. The second player observes the sum of both contributions and then decides whether to contribute or not. After all decisions have been taken, the players are informed about total contributions and receive their payoffs. As they are not informed about individual contributions, the uncertainty may never fully be resolved and beliefs about the other player's behavior enter equilibrium payoffs. For example, if the second player believes that the first player cooperated with a high probability and he did not cooperate, his payoff is lower than if he believes the first player cooperated only with a very low probability.

It is shown that in the case of a deterministic policy, private cooperation is zero in the unique subgame perfect equilibrium. But when the agency randomizes between cooperating and not cooperating, other perfect equilibria exist and some of them imply a positive level of private contributions. Thus, we offer an explanation for governments or local agencies partially financing private organizations (for example NGO's like the Red Cross, privately organized soup kitchens, voluntary organizations for social work, private aid programs). Uncertainty about who finances these projects leads to more private activity than a situation where the agency's action is common knowledge.

In Section 2 the situation without a central agency is analyzed. Such an agency, with the ability to commit to a randomization policy, is included in the analysis of Section 3. Section 4 concludes the paper.

## 2. Contribution games without a central agency

### *2.1. Simultaneous moves*

Consider a situation in which two persons must choose between contributing or not contributing to a public project. It is assumed that people do not derive utility from their own virtue and generosity, but incur a cost of $-1$ if they make a payment. But worse than paying one unit is a situation in which it turns out that the other player contributed and oneself did not.[7] Denote the disutility after discovering to be the only one who behaved selfishly by $-\alpha$ and assume that $\alpha > 1$. If nobody decides to contribute, both players' payoffs are zero.

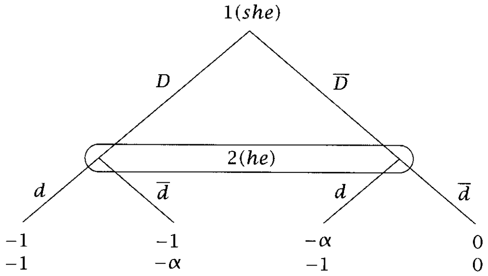


**Fig. 1.** Simultaneous moves game

The game depicted in Figure 1 has two equilibria in pure and one in mixed strategies. As $\alpha > 1$, it is an equilibrium when both players contribute, i.e. choose strategies $(D, d)$. Independent of the impact of a player's conscience (the size of $\alpha$), it is always an equilibrium if both do not contribute $(\overline{D}, \overline{d})$. This second equilibrium leaves both players better off because they are not 'forced' by the other's generosity to contribute themselves. Instead of ending up with payoffs $(-1, -1)$, they get away with $(0, 0)$. Notice that the equilibrium $(\overline{D}, \overline{d})$ is payoff dominant and risk dominant for $1 < \alpha < 2$ whereas $(D, d)$ is risk dominant for $\alpha > 2$. The third equilibrium is one in which the players randomize between contributing or not. The probability of cooperation by player 1 (player 2) is denoted by $q$ $(r)$. Both players are indifferent between cooperating and not cooperating if the other player cooperates with probability $\frac{1}{\alpha}$. The mixed equilibrium is $(q = \frac{1}{\alpha}, r = \frac{1}{\alpha})$.

It is in the players' interest to coordinate themselves in order to reach the no–contribution solution. Thus, the chance for a positive amount of private contributions seems relatively small in the considered setting. But the case becomes even more desolate if the second player can observe the first player's move before making her choice.

### *2.2. Sequential moves*

Figure 2 depicts the game in which player 2 knows whether player 1 did or did not contribute. This simple sequential structure stylizes the typical time structure of carrying out a social project where people can make contributions in a number of rounds. Often, the current state of the project, e.g. the sum of contributions is made public after a certain time and more contributions are asked for by pointing to the successful, but not yet sufficient activities of the project. Thus, player 2's

[7] This reflects the nature of *social pressure*.

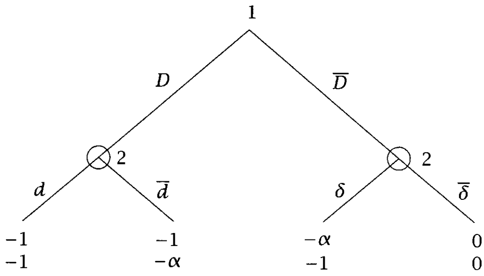


**Fig. 2.** Sequential move game

strategy consists of two actions, one for each possible move of player 1, i.e. for each possible amount of contributions.

Begin with player 2's decision. His optimal move when player 1 cooperated is to cooperate as well (choose $d$). Similarly, if player 1 does not cooperate, it is optimal not to cooperate either (choose $\overline{\delta}$). Taking this into account, player 1 will always choose not to cooperate ($\overline{D}$) where she receives a payoff of zero instead of $-1$. The unique subgame perfect equilibrium is the strategy combination $(\overline{D}, d, \overline{\delta})$ where the sum of private contributions is zero.[8] Both games demonstrate that feelings of guilt in the context of social pressure may not provide a sufficiently strong individual motive for social cooperation in its widest sense.

## 3. Contribution game with a central agency

After investigating two situations where individuals choose whether to privately contribute to a project or not, we now add a central agency (for example a government) as a third party, though we do not model this party as a player. Rather we argue that the central agency designs or affects the rules of the game.

When a project gets started and people are asked to cooperate, e.g. to donate money, it is generally not obvious from the beginning who else will be contributing to it. In game theoretic terms, people move simultaneously because they are not aware of the other players' actions. After a certain period of time, however, figures about the success of the project, e.g. the amount of money that has been donated, are made public. People then know how large the sum of all contributions is, but they do not learn who cooperated. What is important in our model, they cannot distinguish between public and private contributions. Adding the central agency thus introduces imperfect information about who cooperated *at the end* of the game when all players have moved. This is an important feature of the game, pointing to the fact that social pressure does not require the identities of contributors to be revealed after the game. Rather, uncertainty about the source of contributions is a necessary condition for the crowding mechanism that we analyze.

[8] The two other equilibria in pure strategies $(D, d, \delta)$ and $(\overline{D}, \overline{d}, \overline{\delta})$ are not subgame perfect.

The two groups of people, the uninformed and the (relatively) informed, are summarized in player 1 and player 2 for reasons of tractability. Note that free–riding is not a problem if there are groups of players because a player's utility loss from not contributing although she believes others have contributed does not rely on this becoming public information. Rather, the social pressure is internalized in our model, resulting in feelings of guilt which operate regardless of the information of others about one's own actions. In the first stage, player 1 and the central agency move simultaneously. In the second stage, player 2 observes the sum of contributions and chooses whether to contribute or not.

Figure 3 illustrates the extensive form of the game without specifying the payoffs.

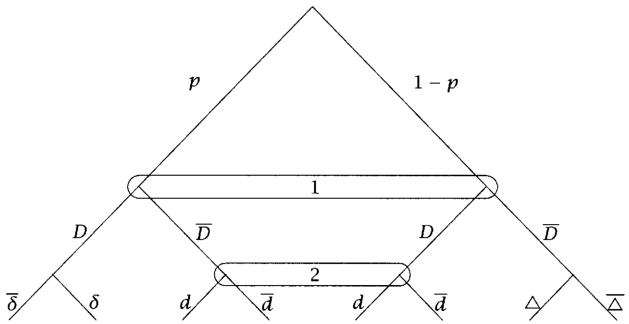


**Fig. 3.** Structure of the game with a government

The structure of the game in Section 2.2 is preserved, only the central agency's choice in the first stage is added. The agency is modeled as nature from the players' point of view, i.e. it has already decided upon a *funding policy* which is commonly known. The policy is characterized by the probability $p$ with which the agency contributes one unit.[9]

In case of $p = 0$ or $p = 1$, i.e. in case of a *pure* funding policy, the game can be split into two subgames perfectly equal to the game analysed in the previous subsection. We summarize this by

**Proposition 1** *In case of perfect information about the central agency's action ($p = 0$ or $p = 1$), there will be no private contributions in the unique subgame perfect equilibrium.*

*Proof.* Straightforward. □

In case of $0 < p < 1$ the game changes in a significant way. Now, observing overall contributions after the second stage does not always allow players to infer

[9] This allows for an alternative interpretation of the model. Instead of a central agency, there might be a third person involved who is known to be altruistic (or intrinsically motivated for some reasons) and who is known to contribute to public projects with a certain frequency or probability. If this person is not a neighbour or an acquaintance, his behavior does not generate social pressure directly, but possibly indirectly due to the uncertainty about who contributed. However, in the following we will always refer to a central agency.

the other player's contribution. In general, both players can only form (posterior) *beliefs* about the other player's behavior when having observed the sum of contributions, which makes it interesting to use the concept of *psychological games*. While a player's belief for the event that the other player contributed is either 0 or 1 in the first two games, here it is possible that this belief is in the closed interval $[0, 1]$. We argue—in the spirit of the social pressure motive—that players receive a negative payoff of $\alpha$ times their belief for the event that the other player has contributed in case they did not contribute themselves. This means that beliefs enter payoffs, which is the reason why we cannot model the situation at hand as a standard game.

Let $c_i \in \{0, 1\}$ be player $i$'s contribution, $x$ be the sum of contributions (including the central agency), $\xi_j$ player $i$'s *prior* belief that $j$ will contribute, and let $E_i(x, c_i, \xi_j)$ be player $i$'s *posterior* belief for the event that the other player has contributed given $x$, $c_i$, $\xi_j$.[10] In a psychological game players' payoffs may depend on prior beliefs about other players' behavior, i.e. in our case player $i$'s payoff may depend on $\xi_j$. Those players who contribute, receive $-1$ as before. Player $i$'s payoff after not having contributed and after having observed a total of $x$ units is a function of $x$ and $\xi_j$. Given any vector $(x, 0, \xi_j)$ player $i$ can calculate his posterior belief $E_i(x, 0, \xi_j)$. If this belief is 1, he is sure that the other player contributed. Therefore he will receive $-\alpha$. If $E(x, 0, \xi_j) = 0$, he will receive his best payoff which equals 0. In case of $0 < E(x, 0, \xi_j) < 1$, we assume that his payoff is linear in his belief, i.e. he will receive $-\alpha E_i(x, 0, \xi_j)$.[11]

Before turning to the properties of $E(\cdot)$ let us introduce the notion of equilibrium in a psychological game. In general, a psychological equilibrium is given by a strategy vector $s$ and a vector of beliefs $b$ which satisfy the following two conditions: $(i)$ Given beliefs $b$, all players play best replies. $(ii)$ Beliefs $b$ are rational. In the case of our model we can formalize these conditions as follows.

Let $q$ and $r$ denote the probabilities that player 1 and player 2 contribute one unit and let payoffs be denoted by $\Pi_i(q, r, \xi_1, \xi_2)$.

**Definition 1** *A vector $(q^*, r^*, \xi_1^*, \xi_2^*)$ is a psychological equilibrium of the contribution game with a central agency if*

$(i)$ $q^* = \arg\max_q \Pi_1(q, r^*, \xi_1^*, \xi_2^*)$ *and* $r^* = \arg\max_r \Pi_2(q^*, r, \xi_1^*, \xi_2^*)$
$(ii)$ $q^* = \xi_1^*$ *and* $r^* = \xi_2^*$.

In order to solve the game, we first focus on the properties of the posterior beliefs $E(\cdot)$ which are an important determinant of the payoffs. Clearly, $E_1(3, c_1, \xi_2) = E_2(3, c_2, \xi_1) = 1$ (when three units are observed, both players must have contributed). Also, $E_1(0, c_1, \xi_2) = E_2(0, c_2, \xi_1) = 0$. Furthermore, it is clear that $E_i(2, 0, \xi_j) = 1$ and that $E_i(1, 1, \xi_j) = 0$.

In the next step we argue that at the end of the game player 1 *always* knows whether 2 contributed or not. Why? Total funding can be either zero, one, two,

[10] Formally, $E(x, c, \xi) : \{0, 1, 2, 3\} \times \{0, 1\} \times [0, 1] \to [0, 1]$.

[11] Geanakoplos *et al.* do not allow for posterior beliefs entering the payoffs directly. Note that we do not violate their concept since players do not directly entertain posterior beliefs in our model. Instead, the function $E(\cdot)$ describes in which way the prior beliefs affect payoffs.

or three units. With zero and three units both players are fully informed. With a total of one unit, each player is fully informed as long as she/he contributed it her/himself. Now consider the following three cases from the point of view of player 1:

- If the total amount is two and player 1 did not contribute, she knows that one unit comes from the central agency and one unit comes from player 2. Thus, $E_1(2, 0, \xi_2) = 1$ (as stated above).
- If the total amount is two and player 1 did contribute, player 2 must have contributed as well. It is clear that the second unit either comes from the agency or from player 2. But if it came from the agency, player 2 would have observed two units and would have contributed a third. Hence, the second unit cannot come from the agency but must have been contributed by player 2 such that $E_1(2, 1, \xi_2) = 1$.
- If the total amount is one and player 1 did not contribute, player 2 did not contribute as well because she would never contribute after observing zero at the end of the first stage. Hence, $E_1(1, 0, \xi_2) = 0$.

Of course, player 1 benefits from the fact that player 2 makes an informed decision in the second stage.

Now we have specified all beliefs a player may have about the other player's behavior after the end of the game except for $E_2(2, 1, \xi_1)$ and $E_2(1, 0, \xi_1)$. While the first one is not relevant (when player 2 contributes he receives a fixed payoff of $-1$), $E_2(1, 0, \xi_1)$, i.e. player 2's expectation of player 1's contribution when one unit has been contributed, has to be specified. Again, $p$ denotes the probability that the government contributes one unit to charity. Recall that $q$ and $r$ denote the probabilities that player 1 and player 2 contribute one unit. Furthermore, recall that $\xi_1$ denotes player 2's prior of $q$. Then, player 2's posterior belief for the event that player 1 contributed (after not having contributed himself and after having observed a total of one unit at the end of the game) is

$$E_2(1, 0, \xi_1) = \frac{(1-p)\xi_1}{(1-p)\xi_1 + (1-\xi_1)p}.$$

In order to solve the game which is now completely specified, notice first that there are dominated strategies for player 2. It is always optimal for him to contribute one unit if he observes that two units have been donated already (choose move $\delta$). On the other hand, if nothing has been donated until the end of stage 1, player 2 will never contribute anything himself (choose move $\overline{\Delta}$). The resulting truncated game is depicted in Figure 4.

Now, we can state

**Proposition 2** *Strictly positive private contributions can occur in (perfect) psychological equilibria in the case of* $\frac{1}{\alpha} < p < 1$.

*Proof.* It is simple to find the two pure equilibria, $((\overline{D}, \overline{d}), \xi_1 = 0, \xi_2 = 0)$ and $((D, d), \xi_1 = 1, \xi_2 = 1)$. Since we are especially interested in the equilibrium in

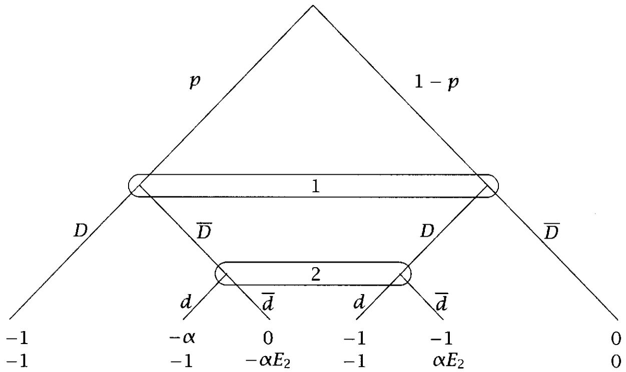


**Fig. 4.** Reduced game

which both players contribute, we show that $((D,d),\xi_1 = 1,\xi_2 = 1)$ is also a trembling–hand perfect psychological equilibrium. According to Geanakoplos et al. (1989) a psychological equilibrium is trembling–hand perfect if the equilibrium of the according standard game (which is obtained by plugging the equilibrium beliefs into the payoffs) is trembling–hand perfect.[12] Let $\varepsilon$ be player 2's tremble and $\mu$ player 1's. Since an equilibrium of a psychological game demands rational expectations, $q = \xi_1 = 1$. Next, note that for checking whether an equilibrium is trembling–hand perfect it is sufficient to prove for all players that the pure strategy of a certain player remains optimal when all other players tremble and these trembles go to zero. If player 1 deviates by playing $\overline{D}$, she receives the payoff $-\alpha(1-\varepsilon)p$ in the $(\varepsilon,\mu)$–perturbed game. Requiring action $D$ to be strictly better than $\overline{D}$ means that $-\alpha(1-\varepsilon)p < -1$ has to hold. It follows that $\varepsilon < \frac{\alpha p-1}{\alpha p}$. If player 2 deviates in the $(\varepsilon,\mu)$–perturbed game he receives $-\alpha$, indepent of $\varepsilon$ and $\mu$. Since $\alpha > 1$ and $\frac{\alpha p-1}{\alpha p} > 0$, the equilibrium is perfect. Next we show that there is also a mixed equilibrium $((q^* = \frac{p}{(2-\alpha)p+\alpha-1}, r^* = \frac{1}{p\alpha}), \xi_1 = q^*, \xi_2 = r^*)$. For player 1 to be indifferent between her two pure strategies $pr\alpha = 1$ has to hold which delivers $r^* = \frac{1}{p\alpha}$. For player 2 to be indifferent $\alpha\frac{(1-p)\xi_1}{(1-p)\xi_1+(1-\xi_1)p} = 1$ has to hold which yields $\xi_1 = \frac{p}{(2-\alpha)p+\alpha-1}$. Since beliefs have to be consistent this implies $q^* = \frac{p}{(2-\alpha)p+\alpha-1}$. Thus, we have shown that a strictly positive level of private contributions is reached in one perfect psychological equilibrium in pure strategies as well as in a mixed psychological equilibrium. □

We shall point out several implications of the result. In the games without a central agency we found that positive contributions can occur in equilibrium. However, these equilibria do not survive standard refinement concepts, e.g. in the case of sequential moves, equilibria with positive contributions are not subgame perfect. This does not hold in the presence of a central agency where the con-

[12] This is the concept adopted here. Alternatively, Kolpin (1992) shows that perfection defined by allowing strategies and beliefs to be sensitive to the trembles of rivals, is a refinement of the equilibrium concept defined by Geanakoplos et al. (1989) and allows him to establish existence of an equilibrium surviving his refinement.

tribution equilibria survive the application of perfectness.[13] In fact, it can even happen that the contribution equilibrium is the only pure equilibrium surviving trembling–hand perfectness. It is easy to see that the no–contribution equilibrium is perfect if and only if $p > (1-\alpha)/(2-\alpha)$. Thus, if $\alpha > 2$, the no–contribution equilibrium does not survive the refinement and (provided that $p > 1/\alpha$) the contribution equilibrium is the only pure equilibrium which is perfect.

Furthermore, the proposition shows that if the agency changes its policy from not contributing or contributing with a low probability ($p \leq \frac{1}{\alpha}$) to a policy with a high contribution probability ($p > \frac{1}{\alpha}$), crowding–in is possible. Whereas in the former case only the no–contribution equilibrium can be expected, in the latter case two further equilibria survive equilibrium refinements—one in pure and one in mixed strategies and both implying positive contributions. Analogously, a policy change from $p$ with $\frac{1}{\alpha} < p < 1$ to either $p < \frac{1}{\alpha}$ or $p = 1$ can imply crowding-out.

Analysing the mixed strategy equilibrium yields a further crowding–in prediction which is stated in the next proposition.[14]

**Proposition 3** *In the mixed equilibrium*

*a) the probability that at least one player contributes approaches 1 as* $p \to 1$.

*b) the probability that both players contribute is increasing in* $p$ *if* $\alpha > 2$.

*c) expected total private contributions are increasing in* $p$ *and approach 2 as* $p \to 1$.

*Proof.* To prove the proposition one has to derive a) the probability that at least one player contributes as $1-(1-q^*)(1-r^*) = \frac{\alpha(p-p^2-1)+1-p}{(\alpha p-\alpha+1-2p)\alpha p}$, b) the probability that both players contribute as $q^*r^* = \frac{1}{((2-\alpha)p+\alpha-1)\alpha}$, and c) the expected total private contributions as $2pq^* + 2(1-p)q^*r^* + p(1-q^*)r^* + (1-p)q^*(1-r^*) = \frac{p^2+1}{(2-\alpha)p+\alpha-1}$. The rest is trivial. □

Proposition 3 can be summarized by saying that in the mixed equilibrium there will be crowding–in beyond the effect of changes in the *policy regime* (as shown above): The more projects a government funds, i.e. the higher $p$, the more frequently individuals will contribute also, and the higher are expected private contributions.

Our analysis, summarized in Propositions 1 to 3, shows that there is a fundamental difference between situations in which agents face uncertainty and situations in which they do not. In the absence of uncertainty (the case of a deterministic policy of the central agency, i.e. $p = 1$ or $p = 0$) agents can easily avoid social pressure by coordinating on the no–contribution equilibrium. With

[13] Note that due to the uncertainty introduced by the agency, the subgame structure of the game is destroyed. We therefore use trembling-hand perfectness as the equilibrium refinement.

[14] In view of the stylized character of our model which considers only two players and binary contributions, the mixed equilibrium might be seen as the most realistic one: In reality there are individuals cooperating in social projects and there are others who do not cooperate. This can be accounted for by the (evolutionary) mass interpretation of mixed equilibria (see e.g. Oechssler (1997)) where it is argued that mixed equilibria reflect the behavior of a *population*.

uncertainty ($0 < p < 1$), coordination becomes much more difficult such that social pressure is more likely to kick in. Observing the contribution of a single unit does no longer inform the second player about the first player's action. If the contribution policy of the central agency is stochastic, the second player always faces the risk that the unit stems from the first player, which may trigger a contribution from the second player. And the anticipation of this may in turn increase the first player's propensity to contribute. Thus, the introduction of uncertainty can "exploit" the agents' fear of social pressure in a very effective way.

## 4. Conclusions

The paper attempts to demonstrate how psychological game theory can help to understand voluntary contributions to public projects. In particular, we have shown that the propensity to cooperate in such a project can be increased by a central agency employing a stochastic funding policy. When public contributions cannot be identified by individuals, but overall contributions are known, people have to reckon with a situation in which their neighbours may have cooperated, e.g. contributed to a charitable organization, while they did not. If certain projects take off quickly due to (non–deterministic and non–detected) public as well as private funding, people may feel they should contribute in order to belong to the crowd, to do what others (probably) did. The theory of psychological games allows us to analyse a situation where uncertainty about what other people did is not fully resolved at the end of the game and beliefs about other people's actions determine a person's utility.

The model offers an alternative rationale for public contributions to social projects. It is not just the real contribution of the agency that matters for the overall level of contributions, but also its effect on individual behavior. We argue that crowding–out arguments are flawed or at least incomplete because they oversimplify the way in which society shapes people's expectations about individual actions. A public welfare system may influence individual behavior in an important way not just by driving out private responsibility, but by activating and making use of implicit norms about what is ethical and what is not. Our model does this in a particular way in that it generates social pressure by public contributions. Similar mechanisms could help to overcome free–rider problems in other contexts where social norms are present and social pressure can be strengthened by the actions of a central agency, e.g. the government.

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