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Deciding for others: Local public good contributions with intermediaries

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ABSTRACT

Given that pure public goods' broader use is often limited by distance, congestion, or borders, local public goods are prevalent. The decision for the provision of these local public goods is often made by individuals who do not get to consume them. It is, therefore, not clear whether the classic free-riding problem result holds in this framework. We study the provision of a local public good where the public good contribution decisions are made by non-local intermediaries who neither contribute from their own endowment nor directly benefit from the local public good. Each intermediary decides for only one public good beneficiary. Intermediaries make decisions under two compensation mechanisms where their incentives are either non-aligned (fixed), or aligned (variable), with those of the beneficiaries they represent. We find that the use of intermediaries, regardless of the compensation mechanism, significantly increases contributions to the provision of the public good.

1. Introduction

Local public goods are provided locally and their consumption is affected by factors such as geography, distance, organizational structures, or congestion. Many public goods such as public schools, general practitioner clinics, waste collection, park and road maintenance, local libraries and sporting facilities fall under this category. However, while most public goods in the field are local, and hence at least somewhat rivalrous or excludable (Buchanan, 1968), most economic experiments still use the standard setup of pure public goods.[1] Importantly, the local public good framework allows for the public good contribution decision to be made by an intermediary who is not a beneficiary of the good. Indeed, the decisions for the provision of many local public goods, like the ones already mentioned, are made by elected or non-elected councils or representatives such as lawyers or accountants who may or may not be direct beneficiaries of the goods themselves.

Even though cooperation is the socially optimal outcome in both pure and impure public good games, rational choice theory of social dilemma problems predicts under-provision; individuals are expected to not cooperate, and keep their contributions to the public good low, due to free-riding incentives (Ledyard, 1995; Ostrom, 2000). An exhaustive number of experimental studies have shown that participants do fail to achieve contribution levels anywhere near the socially optimal outcome upon repeated interaction (Chaudhuri, 2011). Subsequent research has looked into mechanisms that increase cooperation, such as contests, sanctions (see Chaudhuri, 2011, for a non-exhaustive review), leadership, and threshold mechanisms. In leadership settings the leaders move first and provide a positive example for followers increasing cooperation, but at the cost of adding sequentiality into the problem (see for example, Güth, Levati, Sutter, & Van Der Heijden, 2007; Rivas & Sutter, 2011). In contest settings the winner is granted a prize which acts as an incentive to contribute more to the public good. Examples of contests include Tullock lotteries (see, for example, Morgan & Sefton, 2000; Tullock, 1980), rank-order tournaments (see, for example, Angelovski, Neugebauer, & Servátka, 2019; Bos, 2011; Faravelli & Stanca, 2012), or all-pay auctions (see, for example, Goeree, Maasland, Onderstal, &

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[1] Pure public goods are defined as those that are perfectly non-excludable and non-rivalrous in consumption for the entire population, i.e. no individual can exclude another individual from using them, and one individual's consumption does not affect another's consumption. Local public goods often fail to be non-excludable: for example public schools can exclude students that do not reside very close to them (within their "catchment area"), and a public park in one city de facto excludes residents of another city located far away. Furthermore, virtually all local public goods do not have infinite capacity and are prone to congestion, therefore fail to be non-rivalrous: for example, the consumption of users of a local swimming pool running at capacity affects the consumption of other individuals who would like to enjoy the swimming pool but cannot. As such, local public goods cannot be considered pure public goods (see further discussion on local and impure public goods in Angelovski et al., 2019, and on local public goods in Gallier et al., 2019).

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Turner, 2005).

With this paper we aim to utilize the local public good setup to test an alternative mechanism, the use of intermediaries, for solving the free-rider problem inherent to social dilemmas. We study experimentally how contribution decisions are impacted when made by intermediaries who are themselves non-beneficiaries of the goods. For this purpose, we devise an experiment where the contribution decision for each local public good beneficiary is made by a separate intermediary who does not contribute their own funds to the local public good, nor directly benefits from it. As mentioned earlier, in practice many local public good decisions are made on behalf of local beneficiaries by intermediaries who often do not get to consume this (local) public good themselves.[2] As such, we aim to test the effectiveness of their decision-making as a mechanism for facilitating the provision of public goods.

Although different from what we propose in this paper, there is existing work focusing on intermediaries in public good contribution decisions. The literature is split between using endogenously elected decision-makers (Hamman, Weber, & Woon, 2011 use the plurality rule to select the allocator while İriş, Lee, & Tavoni, 2019 use majority voting) or exogenously appointed ones (see for example, Bernard, Dreber, Strimling, & Eriksson, 2013; Hauge & Rogeberg, 2015; Kocher, Tan, & Yu, 2018; Oxoby, 2013). A lot of this work builds on existing knowledge from principle-agent theory (see, for example, Aghion and Tirole, 1997), with the idea that coordination problems are somewhat lessened by delegation. Importantly, the experimental literature on delegation in public good games differs from what we propose here in two significant ways: 1) the majority of the literature uses the global and pure public good setup implying that the decision-maker are themselves a beneficiary of the public good, and 2) the majority of this literature delegates the public good contribution decision to only one decision-maker. For example, Kim, Iris, Lee, and Tavoni (2022), split participants into local groups and randomly appoint one local member of each group to act as a representative for that round and make an identical global public good contribution decision for local each group member.

In the most common implementation of delegation to intermediaries group members donate to an intermediary who then decides the public good game contributions for both themselves and the group (individually or collectively). Corazzini, Cotton, and Reggiani (2020) point out that this type of implementation inherently brings forth issues of trust in the intermediary. For example, the intermediary may choose to not contribute at all to the public good, while still benefiting from its consumption. Such behavior can lead to erosion of trust in the intermediary, ultimately resulting in the rest of the participants not delegating to them.

One way of tackling trust issues that arise due to intermediaries' conflicts of interest, is by decoupling the incentives of the direct contributor and beneficiary from those of the intermediary who makes the contribution decisions. While the framework of pure and global public goods does not allow this decoupling to be possible (due to everyone having the possibility to contribute to the public good and everyone having equal access to it), our framework of local public goods does. By separating the public good decision from its direct beneficiaries, the free-riding phenomenon should be ameliorated: in our ***Fixed*** treatment the public good contribution decisions are made by two intermediaries who decide for one direct beneficiary each and are paid for this service a fixed fee by the beneficiaries.

On the other hand, it may be that it is not only incentives that affect contribution decisions; having the decision be made by an intermediary, even if incentives are aligned, may be enough for free-riding levels to fall. To examine this, in our ***Variable*** treatment, the contribution decisions are also made by two intermediaries who decide for and are paid by one direct beneficiary each, but now the incentives of a direct beneficiary align with those of their intermediary: the payment of the intermediary is an increasing function of the beneficiary's public good game earnings. Therefore, in expectation, contributions in *Variable* should not differ from a standard public good game where the direct beneficiaries make the decisions about how much to contribute themselves. Nevertheless, we know from the work on delegation in ultimatum games that the mere presence of intermediaries may affect how the game is perceived, ultimately affecting participants' decision-making (see, for example, Fershtman & Gneezy, 2001). We therefore question whether the different framing of *Variable* may still alter the manner in which individuals, who are not direct beneficiaries, respond to the public good problem even in the case in which incentives are aligned and free-riding incentives still exist. Finally, our ***Baseline*** treatment is almost identical to the standard public good game where the decision to contribute is made by the direct beneficiaries. The only change from the standard public good game is that the beneficiaries know of the existence of two more players who do not participate in the public good game and are only paid a show up fee.

Our main finding is that the use of intermediaries, in both treatments, significantly increases public good contributions compared to the *Baseline* treatment: intermediaries make better decisions from the social point of view and their contributions are significantly greater relative to the *Baseline*. The main message we present is that intermediaries are more efficiency-oriented than the direct beneficiaries of the public good game, even when their incentives are aligned with those of the direct beneficiaries. Importantly, our results suggest that the standard approach to studying public good games may be overstating under-provision if its results were to be generalized to all classes of public goods and provide an avenue for further research.

2. Experimental protocol

In *Fixed* and *Variable* treatments the public good contribution decisions are made by two intermediaries who decide for one direct beneficiary each. To abstract from strategic considerations and behavioral spillovers (see Angelovski, Di Cagno, Güth, Marazzi, & Panaccione, 2018), the beneficiaries have no choice of whether to delegate their decision or not; delegation happens automatically. All participants were informed of this in the instructions.

The *Baseline* and the other two treatments, *Fixed* and *Variable*, consisted of multiple groups each with four participants: denoted as A, B, X

Table 1
Experimental Structure.

Treatment	Contribution Decision	Passive Participants	Payment - A & B (each)	Payment - X & Y (each)
Baseline	A & B	X & Y	100% of PGG earnings	0 ECU
Fixed	A → X B → Y	A & B	100% of PGG earnings - 20 ECUs	20 ECUs
Variable	A → X B → Y	A & B	80% of PGG earnings	20% of PGG earnings

Notes: 1) A→X indicates that A's public good game decision is made by X; 2) Each participant is paid an extra 40 ECUs for their participation (not shown in the payment structure above).

[2] For example, city council members who vote to allocate funds for the construction of a new public swimming pool or park may reside too far from where it will be constructed to be able to actually enjoy it. Similarly, decision-makers of property management companies make decisions on how much residents or property owners need to pay for maintenance fees and services as well as how to spend these fees. These employees typically do not live in the buildings they manage and therefore do not contribute to the maintenance funds themselves nor directly benefit from the services and improvements funded. Another example is the use of trustees for public pension funds. The trustees, who are often not public employees (so neither contribute to nor benefit from the public pensions) decide on investment strategies and allocations for these funds, which are contributed by public employees.

and Y. A and B are the contributors and direct beneficiaries of the public good, while X and Y are the intermediaries (see Table 1). Each participant is paid a participation fee of 40 experimental currency units (ECUs)[3] and A and B are further endowed with 80 ECUs to be used in the public good game (PGG). In the *Baseline*, we have the classic two-person ($n = 2$) public good (voluntary contribution mechanism) game in which participants A and B individually make a decision of how much of their endowment ($e = 80$ *ECUs*) to contribute to the public good (c_i) thus keeping the rest for themselves ($e - c_i$). The marginal per capita return ($m_i = 0.75$) is the individual multiplier of the sum of the total contributions to the public good. Thus, the final payoff to individual i, $i = A,B$, is determined by their own and the other individual's contributions via:

$$\pi_i(c_i, c_{-i}) = e - c_i + m_i \sum_{j=1}^{n} c_j$$

The intermediaries, participants X and Y, are passive in the *Baseline* treatment; all participants know of their existence but, X and Y make no decisions nor gain directly from the public good game and the only compensation they earn is the participation fee.

The direct beneficiaries, A and B, are passive in the *Fixed* and *Variable* pay treatments and their decision is made by intermediaries X and Y (X decides for A, Y decides for B). The only difference between the two treatments is in the payment structure, *Fixed* or *Variable,* of the intermediary participants. In the *Fixed* treatment, each participant X and Y receives a fixed payment of 20 ECUs from A and B, respectively,[4] which is paid to them independently of the decisions they make. Not accounting for social preferences, X and Y should, game-theoretically, be indifferent between any level of contribution.[5] Finally, in the *Variable* treatment, participants A and B are again passive and keep 80% of the public good game *earnings* each. The remaining 20% of A's (B's) public good game earnings (including earnings from private and public accounts) are paid to X (Y). Notice that, in contrast with the *Fixed* treatment, the incentives of the intermediaries (X and Y) in *Variable* are fully aligned with the incentives of the beneficiaries, and the theoretical predictions are that each of X and Y should contribute nothing to the public good. On the other hand, the socially optimal (efficient) outcome is maximal contributions into the public account in all treatments.

The payment parameters of intermediaries X and Y in *Fixed* and *Variable* treatments were chosen so as to be, in expectation terms, roughly equal. Contribution amounts in one shot public good games, as well in the first round of repeated public good games, have consistently been found to be around 50% of the net endowment (see, for example, Van den Berg, Dewitte, & Aertgeerts, 2020, for a recent confirmation of this finding). Therefore, given the standard (public good) game-theoretic incentive structure of the *Variable* treatment, contributions can also be expected to be, on average, 50% of the endowments. With our parameters, an average public good contribution of 50% in *Variable* would give an average payout of 20 ECU (=0.20 × 40 + 0.2 × 0.75 × 80) for participants X and Y, which is the same as in the *Fixed* treatment.

Ethics approval was obtained from the Middlesex University ethics committee, and the experiment was run using the Qualtrics platform in late 2021. A total of 630 participants were recruited and paid directly through Amazon's MTurk. Each participant was randomly assigned a role and a treatment. After reading the preliminary instructions of a particular treatment (see Appendix B for the complete instructions and procedures for all treatments) and having been informed of their role, some of the participants were asked to make their contribution choices (A and B participants in *Baseline* and X and Y participants in *Fixed* and *Variable*). Passive participants were reminded that they had no choice to make. After this, all participants were asked to answer a short survey including demographic questions, political preferences, as well as a personality questionnaire (see Gosling, Rentfrow, & Swann, 2003) after which the experiment ended. Systematic literature reviews have shown that there is a relationship between personality traits and economic aspirations (see, for example, DeNeve & Cooper, 1998). Economic aspirations have been found to be positively correlated with extraversion and conscientiousness (Roberts and Robins, 2000) and negatively with agreeableness, and openness. Volk, Thöni, & Ruigrok, 2011 has confirmed the positive correlation of agreeableness to prosocial behavior (cooperation) in public good games but did not find significant differences for the other four measures.

Our game is essentially a static game in which a player makes their choices without knowing the choice of the other player. This allows us to use the Qualtrics platform which is asynchronous: at the time when the participants participated in the experiment they were not yet matched with other participants. After all participants had finished answering the survey no further action was required of them and they were paid an initial amount. Next, after collecting the data from Qualtrics, for each treatment we randomly created groups of four participants such that each group had one of each type: A, B, X and Y. The total earnings for each participant were then calculated based on the treatment and the random group they were assigned to. Participants were paid the rest of their total earnings within 48 h of the completion of the experiment.

3. Theoretical and behavioral predictions

Given our research question, whether the existence of intermediaries increases contributions, we can formulate two hypotheses about how the levels of contribution compare across treatments. First, as we have already explained, the incentives of the intermediaries in *Variable* align with the incentives of the direct beneficiaries. As such we should expect that the levels of contribution in *Variable* should not differ from the ones in *Baseline*. Our first hypothesis reflects this idea.

H1. Given the identical incentive structure, contributions in the *Variable* treatment will not be significantly different than those in *Baseline*.

In both treatments which have active intermediaries, *Fixed* and *Variable*, the intermediaries are paid by the direct beneficiaries for making the decision. In the *Fixed* treatment it is easy to see that the intermediaries are excluded from consumption of the local public good. In *Variable*, the payment scheme may seem to be contradicting the idea that intermediaries are excluded from the consumption of the public good, i.e., the idea that the public good is local. By earning a portion of the beneficiary's public good game payoff, the intermediaries are very much affected by the public good outcome without being direct beneficiaries. However, we chose this payment scheme in the *Variable* treatment precisely because the incentives are aligned: in case contributions in *Variable* are higher than in *Baseline,* and H1 is rejected, this would indicate that the act of delegation itself has an effect on contributions.

On the other hand, in *Fixed* the intermediaries should, theoretically, be indifferent between the various levels of contribution. Being fixed, their pay is in no way connected to the final amount of the public account or the earnings of the players. Relative to *Variable*, intermediaries' possible efficiency concerns are thus not offset by the free-riding incentives present in *Variable*. Therefore, it is reasonable to expect that contributions in the *Fixed* treatment will be greater than in *Variable*.

[3] The exchange rate we use is: 1 ECU = 0.025$, i.e. 40 ECU's = 1$.

[4] The fixed payment of 20 ECUs is taken from the show-up fee of participants A and B, so as not to affect the endowment available for public good contributions.

[5] Due to possible social preferences and equality concerns, participants may not be indifferent between all public good contribution amounts. Behaviourally, one also cannot exclude that their preferences are aligned to the incentives of the participant that pays them for the decision, even in a one-shot game. The reasoning would go along the lines of: "they pay me to make a decision, therefore I should do my best to repay them by maximising their payoff (I work for them)". In order to minimise this effect, we opted for automatic delegation, but accept that this may still be present.

Given this, our second hypothesis is as follows:

H2. Contributions in the *Variable* treatment will be smaller than those in *Fixed*.

4. Results

Table 2 contains summary statistics of the public good contributions across the three treatments and gives us a first glance at our results.

One can see that the mean contributions in the *Baseline* treatment are lower than the those in the two treatments with intermediaries. Two-sample two-sided *t*-tests show that *Fixed* and *Variable* pay mean contributions are statistically different from *Baseline* mean contributions below 1% significance level (*p-values* are *0.0026* and *0.0001,* respectively). Comparing *Fixed* and *Variable* pay mean contributions, we cannot reject the null hypothesis that the means are equal (*t*-test, *p-value* = *0.3196*). These results imply that having an intermediary decide on contributions increases them under both the *Fixed* and *Variable* treatments.

By construction, intermediaries' payoffs in the *Fixed* treatment are not connected to those of the direct beneficiaries in any way. The incentive structure in *Fixed* is not the same as in the *Baseline* nor as in any other social dilemma decision either as, structurally, there is no social dilemma decision in *Fixed*: being paid a fixed amount the intermediaries' payoff is not affected by their contribution choice. Due to this, the result of higher contributions compared to the *Baseline* may not be too surprising as no free-riding incentives exist under *Fixed.* With the negative effect on efficiency due to free-riding incentives being absent, intermediaries in the *Fixed* treatment have nothing to lose from contributing higher amounts. However, what makes for an interesting result is that while the *Variable* and *Baseline* treatments have an identical incentive structure, the contributions in *Variable* are significantly higher. The incentives of the intermediaries in the *Variable* case are completely aligned with those of the beneficiaries. This means that, a priori, there is no reason to expect that the mean contributions would be different across the two treatments. Nevertheless, we do observe that the mean contribution is significantly larger in *Variable*, and on-par with *Fixed*. It thus seems that, even though incentives are aligned, the framing of the decision problem matters: for the participants, simply being intermediaries may detract from the free-riding incentives. When making a social dilemma decision where the payment into the public good is not framed as directly coming from their own endowment, participants end up contributing more.

In the short survey we asked participants for additional information about themselves such as their gender, age, their household income levels and their political preferences, as well as personality-related questions. While personality-related questions are standard in experimental literature, the rest of the questions were chosen for their potential to explain contribution behavior. For example, in Figs. A1 and A2, in Appendix A, we depict the results of the mean contributions by whether participants belong to households that are above or below the US median national household income of $70k and whether they are female. Using a two-tailed Wilcoxon rank-sum test we find that there is no significant difference found in contributions by participants coming from higher income families, when combining all treatments. Similarly, when looking at the difference between male and female contributions, and using the same test, while males seem to contribute more in *Fixed*, we find no statistical significance. The result is just shy of being significant at the 5% level, both for the entire population and when looking at Fixed only, the latter of which is likely due to lack of power.

Table 2
Summary Statistics of Public Good Contributions.

Treatment	Mean	Std. Dev.	Min.	Max.	Freq.
Baseline	42.454	25.918	0	80	108
Fixed	52.733	23.251	0	80	105
Variable	55.872	21.831	0	80	101
All Treatments	50.207	24.388	0	80	314

We further ran Tobit regressions using individual contribution decisions as the dependent variable censored on upper and lower limits (see, Table 3), and the individual answers to the survey questions as independent variables. The first two columns include the entire data pooled together, further controlling for treatment and having the *Variable* treatment as our reference category. The remaining three columns depict the results when the regressions were run separately for each treatment. The coefficients of *Baseline* and *Fixed* treatments in the first two columns confirm the findings of Table 2: the *Baseline* treatment dummy coefficient is negative and significant at *1%* confidence level. This clearly indicates that the *Variable* treatment leads to significantly higher contributions to the public good compared to the *Baseline*. On the other hand, the coefficient of the *Fixed* treatment dummy is not statistically significant, implying that *Fixed* and *Variable* do not lead to significantly different contributions. This indicates that even in the presence of the non-beneficiary framing, free-riding incentives (which are still present in *Variable* but not in *Fixed*) do not decrease contributions. Age is never significant across all specifications. Furthermore, a dummy that represents a household income of greater than the national median (greater than $70k per year) is positive overall. The reason that the result is significant only when combining all treatments is likely due to only about one third of our participants coming from households that earn above the median household income.

Further, we find that those supporting progressive taxation also increase contributions to the public good, but interestingly this result is significant only for the *Fixed* treatment (column Fixed Pay, Table 3). Similarly, as can also be seen in Fig. 2, although marginally significant, males give more than females in *Fixed*. We find no significance in the dummy variable for being classified as conservative (Right-Leaning) as opposed to liberal (Left-Leaning), and only conscientiousness was significantly important to one's contributions; high conscientiousness, which has been linked to one's work and school performance, leads to lower contributions.

The dummy variable *Conservative* in the regressions in Table 3, was constructed by combining two questions the participants were asked: *"On a scale of 0 to 10, 0 being very liberal and 10 being very conservative, where would you place yourself in terms of social issues?"* and *"On a scale of 0 to 10, 0 being very liberal and 10 being very conservative, where would you place yourself in terms of economic issues?"*. Respondents were classified as conservative if the sum of the two answers were greater than 11. Figs. A3 and A4 in the Appendix show quite interesting results. In *Baseline*, we see that participants who self-identify as either strongly liberal or strongly conservative contribute drastically less than participants who identify as more neutral. This, however, completely goes away in the *Fixed* and *Variable* treatments where beneficiaries do not make decisions on their own behalf. This further holds regardless of whether individual payoff is linked to the *Variable* or *Fixed* treatment. It's possible that the *framing* effect of the *Variable* treatment makes participants act as if they are not playing a public good game (they act similar to *Fixed*). We also find conscientiousness to be negatively correlated to public good contributions. All in all, our results reject both H1 and H2, as *Variable* treatment results in higher contributions relative to *Baseline* and not statistically different contributions relative to *Fixed.*

In Table 4 we show the mean payments for participants A and B in each of the three treatments. We see that the mean payoffs in the *Fixed* and *Variable* treatments are virtually identical (126.37 and 126.35), however they are lower than the mean payoffs in the *Baseline* treatment. This is to be expected as beneficiaries in these two treatments are the ones that pay the intermediary, whereas they do not pay them in *Baseline*. Most other experiments with intermediaries have them be part of the public good game or alternatively have them be paid by the experimenters. Hence, this result is obtained by construction.

A & B not earning as much as in *Baseline* is thus not problematic for three main reasons. First, we designed our experiment for the

Table 3
Tobit regression on public good contributions censored on lower and upper limits.

	All Treatments	All Treatments	Baseline Treatment	Fixed Pay Treatment	Variable Pay Treatment
Ref. Cat. - Variable Pay Treatment					
Baseline Treatment	−17.55***	−17.61***			
	(4.824)	(4.888)			
Fixed Pay Treatment	−1.801	−2.412			
	(4.861)	(4.898)			
Male	5.926	6.558	3.685	12.91*	3.487
	(4.118)	(4.024)	(7.556)	(6.517)	(6.943)
Age	−0.0161	−0.0551	0.0948	−0.241	−0.011
	(0.175)	(0.172)	(0.334)	(0.253)	(0.330)
Higher Income	11.42***	8.864**	4.049	9.855	11.29
	(4.225)	(4.191)	(7.502)	(6.928)	(7.408)
Conservative	−1.052	−1.900	−2.441	0.892	−6.388
	(4.291)	(4.231)	(8.060)	(6.818)	(7.236)
Progressive Taxation	5.680	5.390	2.390	12.68*	−0.501
	(4.519)	(4.443)	(8.087)	(7.102)	(7.944)
Extraversion	−0.924				
	(0.634)				
Agreeableness	0.0946				
	(0.879)				
Conscientiousness	−2.754***				
	(0.923)				
Neuroticism	−1.224				
	(0.800)				
Openness	0.341				
	(0.831)				
Constant	82.03***	53.93***	36.08**	49.28***	59.00***
	(15.69)	(9.164)	(15.96)	(12.59)	(16.81)
N	310	310	106	105	99

Notes: std. err. in parentheses.
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

Table 4
Mean payoffs by treatment and participant type.

Treatment	Participant Type	Mean
Baseline	A & B	141.23
	X & Y	40.00
	Total	90.84
Fixed	A & B	126.37
	X & Y	60.00
	Total	93.18
Variable	A & B	126.35
	X & Y	60.96
	Total	94.13

intermediaries to be paid directly by the beneficiaries, with a ratio of 1 beneficiary to 1 intermediary. This was to test the *weakest* version of the mechanism. Our design does not allow for coordination on the Nash equilibrium due to the manner in which X and Y make the decisions and are paid, unlike experiments where all decisions are allocated to a single decision-maker. It possibly creates a psychological and contractual link between the participants. For example, X may be more inclined to act in A's interest (as opposed to society's) even if their incentives are not aligned. Now that the worst-case version of the mechanism has been proven to increase contributions, in future studies/implementations, intermediaries do not have to be paid directly by beneficiaries, but rather by a social planner (an external agent possibly interested in efficiency say, the experimenter in future studies or a local government if implementing in the field) which should significantly increase efficiency. Further, the ratio of intermediaries to beneficiaries does not need to be 1:1 (just like the ratio of tax advisors or accountants to clients in the field is not 1:1), thereby decreasing the cost to either beneficiaries or the social planner.

Second, in the *Fixed* treatment contributions are significantly higher than in the *Baseline*. This allows for the lowering the fixed payoff of intermediaries in *Fixed* until the payoff of the beneficiaries in the treatment matches the one in *Baseline*; this is feasible at scale (where the ratio of intermediaries to beneficiaries is not 1:1), but not in an online experiment where you want participants to leave the experiment with a meaningful amount. Finally, the goal of this research is not to see whether the introduction of intermediaries would make A & B better off, but whether it would increase contribution amounts into the public good, which we confirm. In a similar vein, alternative mechanisms that resolve social dilemmas, such as contests and lotteries, are often much more inefficient.[6] Ultimately, given that public good contribution in both *Fixed* and *Variable* treatments are higher than *Baseline*, and the intermediaries earn at least 50% more in *Fixed* and *Variable*, indicates that having A & B not earn less than in *Baseline* is only a matter of parametrization.

To sum up, our results reveal an interesting finding: that intermediaries can alleviate the free-riding problem inherent in social dilemma problems such as the public good game. The mere presence of intermediaries increases the level of contributions to the public good. Even when the incentives are aligned between intermediaries and direct beneficiaries and therefore freeriding incentives still exist, intermediaries are contributing more than what the beneficiaries would

[6] The British National Lottery is one such example which in the fiscal year 2021-2022 awarded 57% of its gross ticket sales to prizes and 22.26% to fund "good causes" in the UK, which does not include the 12% of gross ticket sales that goes directly to the British Government through the lottery duty (Camelot, 2022). One major issue with contests as a solution to the public good problem is that contributions need to fund the large and enticing prize of the winners as well as fund the social planner (pay for the administrative costs of organizing the contests), which can render them inefficient and not always feasible on a smaller or local scale.

contribute themselves, hinting towards a framing effect. Furthermore, our regression analysis has shed light on some potential determinants of contributing behavior (income, gender, attitude towards progressive taxation and conscientiousness).

5. Discussion and conclusions

While the social dilemma inherent in public good games is well known and many mechanisms to address it have been proposed, some aspects of public goods are not yet well studied. For example, access to many public goods is limited due to many reasons (for example, the city or county one resides in). Given restrictions on accessibility many public goods are local in nature. An important feature of these goods is that the final decision to provide them is not made directly by beneficiaries but by (elected or appointed) intermediaries (local councilors for example).

In this paper we examine this mechanism and allow for the incentives of the intermediaries to be aligned with those of the beneficiaries of the public good, or not. Regardless of incentive alignment, we find that compared to the case where beneficiaries themselves make the contribution decision, decision making by intermediaries results in higher contributions towards the public good. The fact that we found a positive effect of public good contributions under both setups, makes us confident as regards to its efficacy. Having intermediaries act on behalf of the beneficiaries may make them care more about the social optimum which is especially true when intermediaries' payoffs do not depend on the beneficiaries' payoffs. The intermediaries seem to internalize their role, and this may change the nature of decision making. That is, intermediaries focus more on social gains, rather than personal ones, thus rendering the social dilemma less prevalent.

In terms of immediate practical implications, we believe that our setup is perfectly applicable to locally accessible public goods, such as parks, community centers, or sports facilities: the intermediaries, for example, individual members of a city council, who decide whether to build a particular park may not necessarily be the ones to enjoy it, while the ones who will enjoy it will be the ones who, through taxation, will end up paying for it. Similarly, employees of property management companies may be used to deciding how much to charge and how to spend maintenance fees collected from residents or property owners, precisely because they are not residents themselves.

We should point out that we aimed to test the weakest version of the mechanism. By having each intermediary be solely responsible for only one beneficiary and be paid directly by them (rather than by somebody else like a social planner). There is thus a possibility that a psychological and contractual link is created between the participants, even if their incentives are not aligned. As discussed in the previous section, this is the most extreme case of the use of intermediaries and unlikely to be used in such a manner at scale.

This research could be of great interest to multiple stakeholders, including government officials, policymakers, and managers in non-profit sectors who oversee the provision and funding of local public goods. Governments and local authorities may use these findings to spark further research and ultimately to revise how decisions about local public goods are made, potentially incorporating intermediaries more systematically into these processes. We also believe that the implications of our results are broader. Although we utilize the local public good setup, as it allows us to study the case where the intermediary is a clear non-beneficiary (non-local), our findings concerning contributions when intermediaries have similar incentives as the beneficiaries indicate that the result would likely persist in the standard public good setup as well. That is, when using intermediaries, public good contributions could increase even when their incentives are aligned to the beneficiaries (i.e., to the public good game). We leave this for future research.

CRediT authorship contribution statement

Andrej Angelovski: Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Praveen Kujal:** Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Conceptualization. **Christos Mavridis:** Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Formal analysis, Conceptualization.

Data availability

Data will be made available on request.

Appendix A

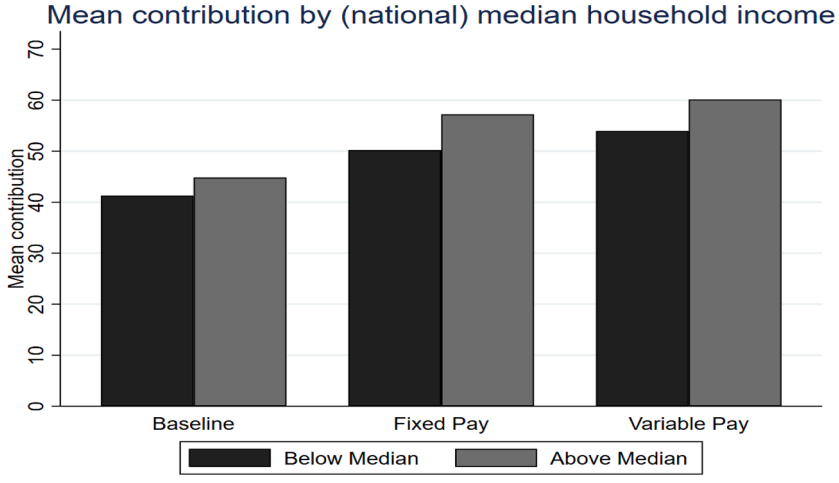

Fig. A1. Mean contribution to the public good by median household income.

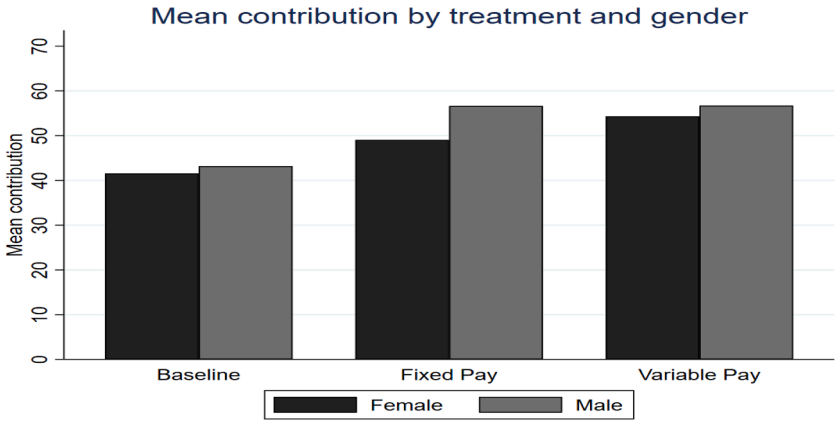

Fig. A2. Mean contribution to the public good by gender.

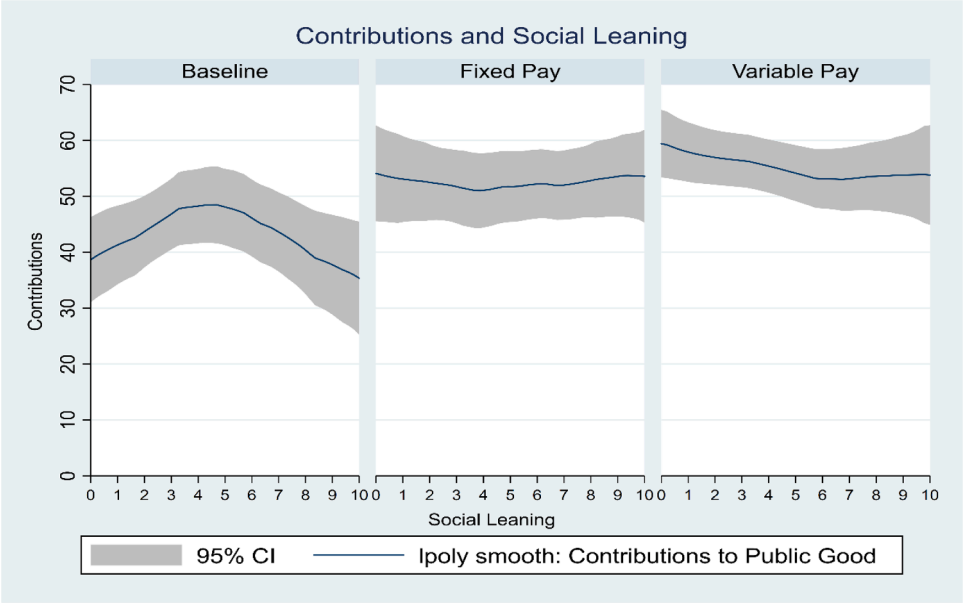

Fig. A3. Kernel-weighted local polynomial smoothing of contributions to the public good on social leaning.

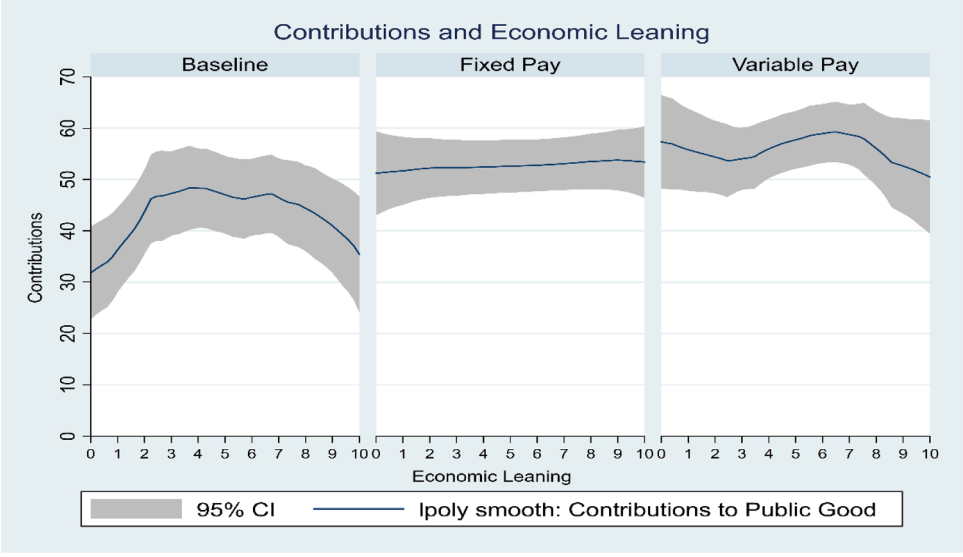

Fig. A4. Kernel-weighted local polynomial smoothing of contributions to the public good on economic (fiscal) leaning.

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