Navigating Cooperation and Competition Among NGOs: A Game Theory Approach to Enhancing NGO Effectiveness in Delivering Humanitarian Aid

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This paper examines how game theory can be applied to enhance the dynamics of aid distribution among NGOs in the developing world, given the limited funding pool that hinders the impact of thousands of NGOs worldwide. Funding and decision-making issues prevent NGOs from expanding their reach and achieving a significant impact. This issue is prevalent in Mozambique, where hundreds of NGOs are present, yet most of the country still lacks access to electricity and clean water. A review of past research—which is fairly limited—makes it clear that there are many barriers to cooperation, and NGOs require certainty before cooperating. Moving on to game theory, which uses models to represent strategic interactions and considers the actions of all players, the prisoner's dilemma will be utilized to model the interactions between NGOs. Additionally, a decision tree can be used for backward induction—a method used to determine the best course of action by reasoning from the end of a game to the start. A visual graph makes it clear that as cooperation increases, so does the overall utility of an NGO. To further assist NGOs and the world, more empirical studies are needed to determine how game theory can be optimized to support NGOs most effectively.

Introduction

Globally, many non-governmental organizations (NGOs) aim to solve humanitarian crises by providing access to basic human rights. However, despite the humanitarian missions of these NGOs, these NGOs operate in silos and compete for the same limited pool of resources, resulting in minimal outcomes[1]. For instance, Mozambique is an example where access to funding has had minimal impact due to competition among NGOs. Despite more than two and a half billion US dollars[2] in investments and 300+ NGOs[3] working to solve the water crisis in Mozambique, 55% of the population lacks access to safe water services, and 31% lack basic sanitation facilities[4]. This situation has resulted in higher mortality, morbidity, malnutrition, and gender inequality, as well as limited economic growth than what it could be if NGOs cooperated[5,6]. Government agencies, such as the World Bank, the African Development Bank, and USAID, along with thousands of private investors[7] and over 300 NGOs, continue to work independently, resulting in minimal, unsustainable, or short-lived impacts due to the absence of longer-term solutions and efficient funding that leverages the collective and its complementary missions[8]. Economics and game theory can provide a lens to explore this issue further, as they offer insights into the interactions, resource allocations, and decision-making processes that influence NGO behavior and outcomes[9,10].

This paper aims to present a game theory-based* decision-making model to assist NGOs in understanding and navigating trade-offs among cooperation, competition, and bargaining as they seek funding or collaboration to achieve greater efficacy in their work. This paper is organized into the following sections: the Literature Review, which discusses past, relevant research; the Methodology section, which includes the game theory equation and model; the Results section, which provides a visualization of payoffs versus cooperation; the Discussion section, which includes an analysis on the equation's variables and the assumptions made concerning the equation; finally, the conclusion, which summarizes the key findings and provides an example of how a policymaker could utilize the equation and model.

Literature Review

Research on NGO competition and funding remains somewhat limited. Researchers Robert Wade (1988) and Mancur Olson[11] have differing theories on whether a large number of NGOs creates competition or cooperation. Wade argues that there is initial cooperation which gradually decreases over time, while Olson states that cooperation continuously decreases as agglomeration—referring to the concentration

* Game theory is the study of models to represent strategic interactions where the outcome for one player depends on the actions by other players

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of NGOs operating in the same area—increases. Resolving this dispute, researcher Dirk-Jan Koch[12] explains that "Outcomes indicate that willingness to cooperate among NGOs decreases when more of them work in the same area." This is in line with Olson's theory of collective action and consistent with the predictions of social psychologists. More recent research supports these findings as well; Panda[13] found that as more NGOs crowd into the same area, they shift farther away from collaboration and closer to survival, where their survival strategies continuously hinder cooperation, which is in line with both Olson's prediction and Koch's findings.

Thus, it is clear that there is often competition among NGOs, largely due "the nature of disaster relief." The nature of disaster relief includes limiting factors such as time constraints, logistical constraints, concerns about public image, fundraising costs, and more. Research by Saraiva and Iglesias[14] finds that time pressure increases competitive behavior among NGOs. Regarding logistics, Muggy and Stamm[15] identified key barriers to NGO cooperation in humanitarian logistics, including perceived ownership of logistics as a core competency, cultural differences and mutual mistrust, and incompatibility of systems. This research is supported by Wankmüller and Reiner[16], who found that a lack of resources, along with perception of the culture of an organization and transparency, hinders cooperation between NGOs. Concerning media exposure, Duckwitz and Zabel[17] write that research has shown that a productive public image increases donor support for an NGO; at the same time, the media also increases competition by forcing NGOs to compete for the media spotlight. Regarding fundraising costs, research by Frumkin and Kim[18] finds that fundraising is expensive for NGOs and is a major influencer for NGOs to compete for publicity and funds. Thornton and Harrison[19] support this idea, stating that fundraising costs are inefficiently high in crowded funding pools, where a plethora of NGOs are forced to compete with each other for funds.

There are many incentives to work together, such as creating greater efficiency in the use of funds by obtaining supplies at volume discounts, coordinating transportation, sharing resources, complementing skill gaps in each organization, and lowering overhead costs. Pertaining to supplies and transportation, research by Bagchi *et al.*[20] and Hasija[21] finds that NGOs that seek and provide these logistics often interact with each other. This research is supported by Moshatori et al (2024), stating that collaboration between NGOs results in the pooling of resources, knowledge, and capacity, ultimately creating greater coordination, effectiveness, and sustainability. Having a greater impact is a major influencer for NGOs to work together; Ergun et al. (2013) created a model for cooperation among NGOs inspired by a collaboration between the United Parcel Service and The Salvation Army in Haiti that resulted in an advancement in operations. Regarding improving an organization, McCardle et al. (2009) argue that collaborating NGOs can point out weaknesses by comparing certain aspects of their respective organizations. Similarly, Taylor *et al.*[22], found that partnering organizations are able to learn and "derive value" from the unique aspects of each other's organizations, not only providing an incentive to collaborate, but also setting up the partnership for success. Finally, research by Schulz and Blecken (2010) finds that partnering with NGOs can reduce costs by strengthening the agency, regularizing measurements, and creating widespread protocols. This claim is supported by Alderwick *et al.*[23], who found that collaborating NGOs are able to increase efficiency by decreasing certain costs.

Despite these potential incentives, it is clear that NGOs will only be willing to cooperate when benefits are guaranteed. This level of certainty is another barrier to cooperation; however, the dynamics of coordination and competition can be modeled as a game where NGOs can compete and bargain for resources to complete their projects. Research has shown that a game theory model can be beneficial in enhancing an NGO's understanding of the resource pool (funding, donors, and other NGOs) and what actions to take to achieve their desired result. Muggy and Stamm[15] assert that the Theory of Moves, defined by Brams (1994) and Wilson (1998) as a large game framework with many players (NGOs in this case) who change their strategy until all players agree to pass, is the perfect model to represent NGO funding dynamics. This model reflects the reality of offers and counteroffers during funding negotiations, and it has been used numerous times to model situations in different countries[15]. This model can help NGOs react to the moves of other NGOs and donors, and eventually come to a point of equilibrium among the players. Wankmüller and Reiner[16] asserted that simulation modeling would provide an appropriate medium to analyze NGO when competing for funding under different conditions. Therefore, game theory is crucial as it not only adds a mathematical component to the simulation, but it is also used for this exact type of interaction, where the outcome of one player depends on the action of another.

Methodology

Application of Game Theory to NGOs using the Prisoner's Dilemma and Decision Tree Model

Games that could model the dynamics of NGOs include the common-pool resource game, the ultimatum game, and the prisoner's dilemma. The common-pool resource game, developed by Elinor Ostrom and her colleagues in 1994[24], focuses on how individuals or groups manage shared resources that are competed for[25]. This game emphasizes the challenges of preventing resource depletion through cooperation. However, be-

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cause this game focuses more on resource depletion and management, it may not demonstrate the entirety of NGO interaction and decision-making processes. The ultimatum game, created in 1982 by Werner Güth and colleagues, generally involves two players but can be adapted to include multiple, revolves around the division of a sum of money where a player proposes a split and the other can accept or reject it[26]. The game illustrates negotiation and resource distribution among NGOs. Yet, the decision that the model seeks to answer is whether to request funding, so this game is not the best suited for the specific purpose. While these two games are useful, the prisoner's dilemma is the game that will be used in the simulation.

The prisoner's dilemma game was developed in 1950 by mathematicians Merrill Flood and Melvin Dresher during the Cold War to simulate strategic decisions between the United States and the U.S.S.R.[27]. The classic prisoner's dilemma game involves separated prisoners who must independently decide whether the prisoners will betray the other by confessing or remaining silent. There are three scenarios, as seen in Figure 1. First, if both prisoners betray each other and confess, they receive moderate prison sentences of 5 years, which is the worst outcome for both. This scenario is depicted in the upper left quadrant of Figure 1 below. Second, if one prisoner confesses and one remains silent, the betrayer is released and the silent prisoner receives 10 years in prison, as shown in the lower left and upper right quadrants of Figure 1. The third scenario is if both prisoners remain silent, they both receive a minimal prison sentence of one year each, depicted in the lower right quadrant of Figure 1. Even though cooperation leads to the best outcome for both prisoners, self-interest influences both players to betray the other, potentially producing a sub-optimal outcome for both.

Prisoner 1 \ Prisoner 2	Confession	No Confession
Confession	5 Years, 5 Years	0 Years, 10 Years
No Confession	10 Years, 0 Years	1 Year, 1 Year

Fig. 1 A classic prisoner's dilemma game[28]

The prisoner's dilemma game provides a medium to simulate and model the dynamics among NGOs. In this game, the players—the NGOs—have two choices: request funding or abstain. If both players request funding, then players will receive some of the funding they request, not the full amount, potentially preventing them from financing or completing a project. If one player chooses to request funding and the other player abstains, the player who requested will receive the complete funding, and the other player will receive nothing; if both players do not request, neither player will acquire funding. Similar to the classic prisoner's dilemma game, self-interest leads players to choose to request funding. If the collective funding requests exceed the funding pool, the players will not get the financing they need to fund their projects, halting their ability to effect change and have a meaningful impact.

Utility Function

We consider n number of NGOs, each as i and over a series of periods t. In this equation, U represents utility gained, in this case, successful output by the NGO. The other variables: F, k, l, t, B, z, n, C, E, and p, will be explained below. Assume that utility is a function of F and a function of cooperation.

In this model, there are n number of NGOs that make decisions in each round/period t about whether to request funding f and whether to form partnerships with other NGOs. NGOs each have a utility function (to be interpreted as the success of an NGO or the number of projects completed) which depends on funding, partnerships, and the terms of partnerships, costs (time, administrative costs, costs of partnerships, etc.). In particular, when NGOs decide to request funding f, it is assumed that they receive all of the funding that they requested, assuming this is feasible. For simplicity, it is also assumed that there is one funding source with limited resources. Therefore, if the funding requests are greater than the pool of funds, all NGOs will get an equal share of the funds, no matter what they request. Alternatively, NGOs can decide in any period not to request funding nf. It is assumed that the NGOs must use their received funds before the next round (i.e. no saving). Moreover, NGOs must fully fund a project for it to be successful.

NGOs have certain costs, such as administrative costs B_t, which are an average of 41% of the funding received. Administrative costs can be understood as the costs of running a system over time. The cost function for running a system as a solo NGO is found below.

$$\text{Solo system cost:} \quad \sum_{t=0}^{t} B_t \tag{1}$$

NGOs can partner with each other by sharing systems (data systems, transportation systems, etc.) In this equation, the variable B_t allows for the cost of switching systems to be compared to the baseline cost of keeping systems the same. Im-

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portantly, the administrative cost B_t—which is the cost of running a system during round t—is the same for all NGOs; however, it is liable to change (hence the subscript t). z is a measure of the efficiency of using the new shared system where $z \in (0,1]$. Note that as efficiency increases (i.e. z increases), the cost function decreases. n_t is the number of NGOs that are sharing systems during round t. Similarly, as the number of NGOs sharing systems increases, the cost of sharing systems decreases. k is the initial cost of switching—representing system integration, training, and operational alignment—and is only paid once for all individuals. The portion of k paid by NGO i is determined by leverage in negotiations, represented in the equation by l_i where $l_i \in (0,1]$ and $\sum_{i=1}^{i} l_i = 1$. Additionally, NGOs face an interaction cost C, which only occurs once when an interaction starts. This cost includes coordination meetings, MOUs, and legal fees, and can be modeled at 10% of the total funding, consistent with overhead allocation norms in NGO consortia[29]. If companies interact, stop, and then interact once more, they will face the interaction cost again.

$$\text{System sharing cost:} \quad k(l_i) + \sum_{t=0}^{t} \frac{B_t}{zn_t} + C_i \tag{2}$$

The variable E represents external constraint costs for NGO i in round t. External constraints include political, social, and environmental factors that can be solved through monetary means; examples are political interference, compliance costs, the need for social adaptation and trust-building, and environmental shocks. NGOs allocate 5% to 15% of the total project budget toward external shocks[30]. Finally, NGOs consider the time cost p^t, which increases exponentially as time progresses. Overall, the utility function for NGO i in round t is modeled by the equation found below.

$$U_{it} = F - \left(\min\left(k(l_i) + \sum_{t=0}^{t} \frac{B_t}{zn_t} + C_i, \sum_{t=0}^{t} B_t \right) \right) - \sum_{t=0}^{t} p^t - E \tag{3}$$

There are a few important details to note about the utility function. First, the minimum operator exists because NGO i will act as rational economic agents and will minimize their costs. Additionally, NGOs will decide in each round of the game (starting at round $t = 0$) whether or not to request funding. $F = 0$ when NGOs decide not to request funding nf. Regarding the assumptions of the model, NGOs must spend the funds immediately and fully fund projects for them to be successful because of urgency and time constraints. The model does not include saving to give a more focused and primitive analysis of cooperation and competition for funding rather than intertemporal periods. For simplicity, the model has only one donor or pool of resources. Lastly, NGOs receive all the funds they request, assuming there are enough resources to support these requests. If there are not enough resources, requesting NGOs will only get an equal amount of the existing funds. For example, an NGO in Mozambique dealing with a funding issue would need to identify how costs can be reduced. Using this equation, the NGO could determine if cooperating with another NGO could reduce its costs. The NGO could also input different values into the equation to see what conditions would be best for cooperation and benefiting themselves. In the next section, there is an empirical simulation to demonstrate how this interaction could play out in a multi-NGO and multi-time period prisoner's dilemma game.

Simulation of the Prisoner's Dilemma Model

In this section, the simulation is a game situation with two players. In the game, it is assumed that the initial pool of funding is one million dollars[31]. However, the funding amount may change to reflect changing donor behavior and funding shocks. As an example, with a two-player game, let the players be Player A and Player B, where Player A is requesting 600k and Player B is requesting 550k. Player A requires a 360k payoff to fully fund a project and cover all the costs accumulated, while Player B requires 330k. All costs based on the amount of funding will be calculated using the initial amount of requested funding. Thus, if a player needs to request more funding throughout the game to offset costs, the cost will not rise along with the increased request. When the players request funding, they must consider the fact that the payoff accounts for the costs, which in this round are time p^t, where p is initially 5k for both players, and administrative costs B_t, which are 240k for Player A and 220k for Player B[†]. In this round, p^t is equal to one dollar (as this is the first round, $t = 0$), which is negligible and will not be included in the model below. Considering the administrative costs, the payoff would be less than the amount requested, which can be seen in the figure below. When a player requests funding, it will be shown as 'F'; when it does not, it will be shown as NF. Based on this model, when both players request funding, they are requesting more than is currently in the funding pool, and the funding will be split proportionally—Player A receives 522k and Player B receives 478k[‡]. Another outcome is when one player requests funding and the other does not; this results in the player who requested funding receiving the requested funds. Finally, when neither player requests funds, then no player gets any funding. This dynamic is represented in the payoff matrix shown below:

For the game to end, all players must accept the outcome of the round. If any player rejects the outcome of a round, the game will continue. Because the administration costs are

† Administrative costs can vary over rounds, but they are assumed generally similar over time.

‡ Calculations for the proportionally split costs: dividing the NGO's requested amount by the sum of the total requests, then multiplying it by the funding pool.

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Table 1 Summary of the payoff matrix of the first round of the two-player game, in thousands. Format of the payoffs is (Player A payoff, Player B payoff)

		Player B: F	Player B: NF
Player A	F	(282, 258)	(360, -220)
	NF	(-240, 330)	(-240, -220)

summed over time, players are incentivized to end the game as soon as possible. Players can negotiate (with an interaction cost that is modeled above) to attempt and end the game earlier.

Assume that in Round 1, both players requested funding and rejected the outcome. In the context of real-world NGOs, if NGOs want to be able to fund a project, then they cannot accept the outcome of receiving less funding than they need for a project, so they would need to get the funding in another round. Continuing the game, notice the payoffs in Round 2. Because costs are summed over time, and if NGOs reject the outcome, they receive no payoff, the cost from one period will be realized in the next. In the second round, both players decide to increase their funding request to offset their time cost and administrative costs in rounds one and two: Player A requests 840k, and Player B requests 740k. While the administrative costs stay the same, the time cost is now \$5k. Once again, the funding is split proportionally among the players, with Player A receiving 532k and Player B receiving 468k since their combined requests exceed the total funding amount. Unfortunately, this funding is insufficient to support their projects, and they are forced to reject the outcome. Notice the trend here: both players are incentivized to request funding, but are not getting the necessary funds. At this point, players may realize that cooperating may lead to them receiving the funding they need by one player not requesting funding one round and instead receiving the funding in the next round. This series of interactions models one game to get funds. Since this is a repeated game, there are many opportunities for the NGOs to alternate requests.

Table 2 Summary of the payoff matrix of the second round of the two-player game

		Player B: F	Player B: NF
Player A	F	(47, 23)	(355, -445)
	NF	(-485, 295)	(-485, -445)

Unfortunately, the players are once again forced to reject the outcome because their funding needs are not met. In Round 3, the donor increases the funding pool from \$1,000,000 to \$1,250,000 in response to the environmental crisis, reflecting common donor practices of reallocating or expanding budgets by 10–25% during emergencies[32]. This shift provides additional incentive for NGOs to adopt cooperative strategies, as a single requesting NGO can now fully meet its project needs while covering environmental shock costs. This cost falls under variable E; assuming a 10% allocation, Player A will pay 84k, and Player B will pay 74k, based on the previous funding round.

At this stage, both players recognize that costs are compounding at an exponential rate. Although the funding pool has increased, rejecting the outcome again would carry the rapidly increasing costs to the next round. To break the cycle and fund a project, they agree to cooperate. Player A switches their systems because they get to request their full amount of funding during this game, with the assumption that over the next couple of games, Player B will request funding until they recoup any losses. However, the negotiations are still not equal. Player B has previously established local governance relationships and community trust, reducing their dependence on Player A and saving Player A time and money. This external advantage gives Player B more negotiating power, forcing Player A to shoulder a greater portion of the switching cost (k): Player A covers 75% of the 20k system integration cost, paying 15k, while Player B pays 5k to cover the remaining 25%. Because they are cooperating for the first time, there is an additional interaction cost (C) of 60k for Player A and 55k for Player B to cover any legal and consulting fees associated with the collaboration. The administrative cost is now half of what it was previously, as the two players are now collaborating and sharing systems. The time cost also changes and is now 25k, due to the exponential increase of the variable p^t. All of the costs over the rounds bring Player A's expense to 764k. To offset the costs from all three rounds and have enough funds to pay for the project, Player A must request 1,124k, bringing their payoff to 360k, the exact payoff they need to fully fund their project. The remaining 126k will go to Player B to mitigate the financial burden of the accumulated costs. Although Player B takes a 563k loss, this is only a short-term loss and will request full funding over the next few games.

Since both players accept the outcome of the round, the game ends here. This result demonstrates an example where both NGOs cooperate and are content with the terms.

Table 3 Summary of the payoff matrix of the third round of the two-player game

		Player B: F	Player B: NF
Player A	F	(360, -563)	(360, -689)
	NF	(-764, 330)	(-764, -689)

The outcomes from the first model can be mapped as a decision tree diagram, shown below. This model displays the possible rounds over time and when the game might end. The further the game goes down the decision tree, the higher the time and administrative costs will be. Notice that this model continues the trend of more rounds causing lower payoffs. The decision tree allows players to trace back their decisions. Seeing which decisions lead to certain outcomes allows players to change their strategy initially. As this is a repeated game, players can figure out which early decisions lead to the best payoff over many games.

To reflect potential, real-world NGO dynamics and costs in the model, cost ratios were drawn from research-based ranges rather than arbitrary values. For example, administrative costs were modeled using a study that found NGO averages of 40% of total budgets, and environmental shocks were found to take up 5–15% of the funding. While these percentages differ by organization, size, and regional context, relative scaling makes the model broadly applicable. Outputs are expressed in payoffs, allowing the results to inform decision-making across various NGO scenarios. A caveat is that these cost ratios may not always be linear across project sizes. However, assuming proportionality provides a clear and interpretable framework for strategic comparison.

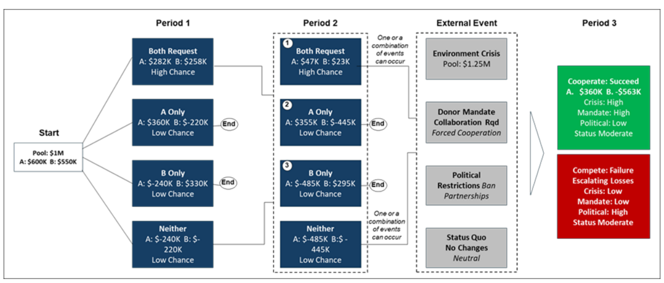

Fig. 2 Decision tree diagram of the simulation

To more accurately reflect real-world unpredictability, the decision tree includes stochastic forks that simulate uncertainty in outcomes. For example, even if an NGO chooses to cooperate, the outcome may still change due to political pressure, social issues, donor volatility, or crises such as environmental disasters. Although there is already a variable E in the utility function, not all external constraints are solvable through financial means. Factors legal barriers, ideological resistance, geopolitical instability, reputational concerns, or the ones in the decision tree can sometimes override monetary solutions. Although only the environmental crisis occurred in the simulation, the decision tree also includes other external constraints to demonstrate the uncertain and unpredictable conditions. The qualitative labels, written as "High Chance," for example, allow the model to account for randomness and unforeseen issues in strategic decision-making environments.

While this model and simulation do not directly simulate evolving cooperation in games after the players reached a point of equilibrium, it does provide a visualization for how cooperation arose over the rounds as costs increased and the behaviors of both the NGOs and the donor changed. Specifically, NGOs did not behave cooperatively in the initial rounds. However, as rounds went on, costs exponentially increased, and external constraints influenced all the actors in the game, the players realized that they needed to collaborate. Future models could take this simulation and extend it to explore the possibility of evolving cooperative equilibria, or whether non-cooperative equilibria are more likely after reaching a point of equilibrium.

The decision tree visibly depicts the many possible outcomes as multiple rounds of the game occur. This visualization allows for "backward induction," or the process of solving for the best decision today by examining potential outcomes in future rounds.

In the real world, an NGO could utilize the equation, a prisoner's dilemma model, and a decision tree diagram to optimize its decision-making process and maximize its impact in the world. By applying the utility function, equation 3, and inputting their costs and numbers, NGOs can evaluate the outcomes of different strategies, such as requesting funding, forming partnerships, or other actions that can change certain costs and variables. The prisoner's dilemma framework allows an NGO to understand the outcomes of different decisions from both themselves and others. The decision tree creates a visual representation of the values from the equation and the prisoner's dilemma over multiple rounds. Using the decision tree diagram, NGOs can gain an advantage in the funding process, especially in early rounds, since they cannot only see what has worked well in past games but also predict potential outcomes based on decisions made by themselves and other players.

Results of the Simulation

If there is sufficient expected utility from cooperation, an NGO will cooperate. Therefore, each of the components of the equation ultimately determines the likelihood that an NGO will choose to cooperate. Note that these components are usually perceived values in reality, as NGOs might not know the exact costs and benefits, but only perceive these numbers based on the information they have. If the parameters are seen to offer lower utility, then NGOs will cooperate less frequently (simulation 1), and the overall benefits to the collective are lower. If the parameters are seen to offer higher potential utility, then more cooperation is engaged. Then there is a higher pay-off for all. As a visualization of games, the graph, shown below, plots different frequencies of cooperation that can affect the payoff in an eight-round game.

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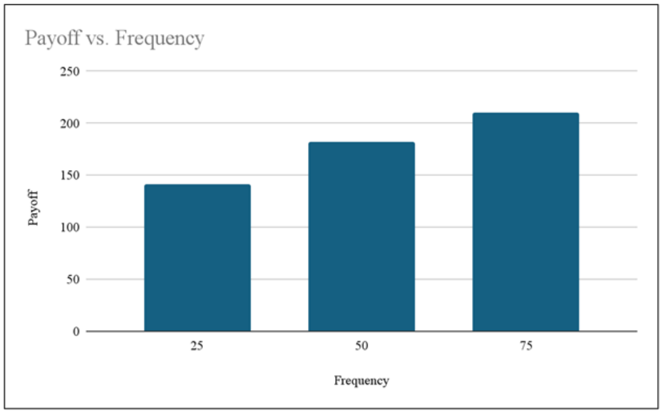

Fig. 3 How the average payoff changed with different frequencies

The figure above depicts the relationship between cooperation and payoffs. When NGOs cooperate 25% of the time, the average payoff of an NGO in an eight-round game is 141. When the frequency of cooperation is increased to 50%, the average payoff is approximately 182. Finally, at a 75% frequency, the average payoff after eight rounds is 210. Overall, the three figures above show that when the cooperation frequency increases, the overall utility for NGOs also increases (measured on the y-axis). The purpose of this visualization is not to analyze the actual values, as these are arbitrary units, but rather the relative change in scale. This general finding of more cooperation between NGOs is consistent with the model's prediction on strategic partnerships and shared costs that result in better social outcomes in resource-constrained environments. A case study, written by Gould and Love[31], that confirms these findings is the Emergency Capacity Building (ECB) Project, a joint project initiated by six large NGOs: CARE, Oxfam, Save the Children, World Vision, Mercy Corps, and Catholic Relief Services. Although normally competing for funds, the NGOs involved collaborated on joint fundraising, shared governance, and collaborative emergency preparedness in order to attain greater efficiency, effectiveness, and overall impact. The ECB Project showed that cooperation bred through transparent cost-sharing and harmonized goals can lead to more effective aid delivery and enhanced fundraising success. This example demonstrates that cooperation is not only theoretically optimal but empirically viable, even for large competitive players. In support of the simulation, the ECB Project justifies numerous elements of this model. For example, the NGOs involved had to contend with administrative costs, time pressures, and donor pressure, all reflected in the equation and the decision tree. Their use of a memorandum of understanding and governance committees, demonstrating a formal process of collaboration that requires fees and payments to complete, satisfies the model's assumption of bargaining, switching, and interaction costs. The agreement to pool resources and take turns leading fundraising is similar to the alternating funding requests and sharing of resources and past agreements modeled in the prisoner's dilemma framework, which was a key reason that the players were able to cooperate and remain financially stable.

Discussion

Variables in the Equation

In the model above, the variables included each impact the payoff and influence the decisions of an NGO. First, administrative costs: this variable impacts whether an NGO should switch systems, which is a factor in cooperation. If this variable is high, it may be more cost-efficient in the long run for an NGO to form a partnership. The initial cost to switch: When this variable is high, it will increase the total cost to switch, potentially preventing an NGO from changing systems. When the variable is low, it will decrease the total cost to switch systems, encouraging an NGO to change systems. Number of players sharing systems: When this variable is higher, it will distribute the cost of running a system between more players, lowering the cost. When this variable is lower, it will not distribute the cost among as many players; while the cost to run the system is still lower, it is not as low as it would be with a higher number of players. Efficiency of sharing: When this variable is higher, it will lower the cost of running the system, and when it is lower, it will increase the cost. Time costs: Since this variable increases exponentially, it will always add to the total cost. This drastic increase encourages players to end the game quickly because, as more rounds pass, the cost becomes higher. If neither player decides to request funding, the game will continue, and the time cost will increase, so the players are incentivized to cooperate and agree on terms to end the game. Interaction costs: Since this cost only occurs when NGOs begin an interaction, this will only add to the total cost in one round. This variable encourages NGOs to strategically choose when to interact because if NGOs continue to make new interactions, then the cost will appear again. Therefore, if NGOs interact when needed, then the possibility for cooperation increases, since both NGOs are choosing to interact at an optimal time. Cost to fund a project: When this variable is higher, the NGO needs to request more funding to offset the total costs and pay for the project. When this variable is lower, then the NGO can request less funding since they do not need to pay as much for the cost. Additionally, a low cost to fund a project may allow an NGO to fully fund a project without cooperating. While it is not possible to perfectly model any situation, these variables cover the vast majority of the major decision-making points for NGOs. Ultimately, these variables

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help an NGO decide when it is best to cooperate with another NGO, as it helps demonstrate when it is more cost-efficient to work alone or with a partner.

Assumptions

In the methodology section, several assumptions were intentionally made to maintain simplicity and clarity in the model and reflect constraints faced by NGOs. However, these assumptions may not fully reflect the reality of many NGOs. This subsection will justify the assumptions and give reasoning as to why they were included in the model. These are the assumptions that were deliberately included in the model: NGOs cannot save funding for future rounds, only two NGOs are involved, the funding pool amount is the same every round, and the funding is evenly split between the players if both choose to request funding, and the time cost is exponential. First, NGOs cannot save funding for future rounds. This assumption was made to focus the analysis on immediate decisions instead of long-term planning, forcing the players to try and achieve the maximum possible funding in a given round. Additionally, it reflects a real-world scenario where NGOs often face urgent timelines and must use funds immediately to achieve project success and have an impact. This assumption is consistent with the Emergency Capacity Building (ECB) Project, where funds were allocated and expended in real time to meet urgent preparedness and response targets. The project showed that NGOs operating in emergencies often cannot defer spending, reinforcing the model's immediate decision framework. Second, only two NGOs are involved in the prisoner's dilemma model. The primary reason for this decision was to simplify the model and place more focus on the cooperation and competition dynamics between the NGOs. However, it is valuable to model a game with multiple agents that are modeled as one-to-one interactions instead of having one interaction with numerous agents. This way, a thorough analysis can be conducted on the effects of an NGO having to deal with more than one NGO at a time. Ideas that can be explored with this method are how cooperation would change with more players, how costs would be impacted, how funding is distributed, how long it would take for an NGO to receive sufficient funding to bankroll a project, and what would happen if there is an uncooperative agent amid cooperative ones. This modeling could be done in a common-pool resource game. Fourth, the funding pool is the same every round. Having a constant funding amount each round provides a stable atmosphere to analyze the decision-making of NGOs regarding funding requests, partnerships, and other elements of cooperation and competition in the funding process. Additionally, if the funding pool expands so that both NGOs can obtain the funding they both need, then there is no need for the model, and if the funding pool shrinks, then the NGOs either still compete and use the model or are forced to lower their funding request. Despite real-world funding pools constantly changing, the model would show that through their funding requests. The simulation did not call for a fluctuating pool since it would have been arbitrary as to when the pool would change and would add negligible value. Finally, the time cost is exponential. Similar to the reasoning for the first assumption, the exponential time cost simulates the increasing urgency and pressure on NGOs to make decisions quickly. This assumption is consistent with the Emergency Capacity Building (ECB) Project, where funds were allocated and expended in real time to meet urgent preparedness and response targets. The project showed that NGOs operating in emergencies often cannot defer spending, reinforcing the model's immediate decision framework.

Conclusion

Scaling the Model

Though this simulation uses a two-NGO structure to demonstrate basic dynamics, the model can be expanded to reflect interactions among many NGOs from the same funding source. The utility function is built to scale, as it is already defined over nn n agents, and the funding mechanism reflects shared costs and proportionate allocation, something that can be scaled to numerous players. To further stretch the prisoner's dilemma logic, the model might move toward a multiplayer common-pool resource scenario, in which NGOs make independent decisions about whether to seek funding each round. If too many do so at once, the collective pool is diluted, reproducing the issue in actual aid systems and also reflecting the issue that arose during the simulation: Both players were requesting too much and were not receiving the funds they needed, costing them time and money. The decision tree could then be restructured into a larger, connected web, where each node represents aggregated decisions of subsets of NGOs, and probabilistic and stochastic forks in order to reflect group-level uncertainty. For example, the two nodes would represent one group of NGOs choosing to request funding, and another node for the NGOs that abstained from funding. Although visual complexity increases, the strategic logic of the model that cooperation lowers costs and non-cooperation compounds costs is still present.

How a Policymaker Could Utilize the Equation and Models

The equation and models are by no means limited to NGOs. Investors, policymakers, and government agencies like the World Bank can apply the equation and model to enhance NGO effectiveness and collaboration in various ways. By

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analyzing simulations, these stakeholders can determine what systems and incentives must be altered or created. Incentives are especially crucial since, as stated in the literature review, there are abundant barriers to cooperation, stagnating NGO projects, and aid delivery. An example of a potential system that could be created is a reputation system. This system would rate NGOs based on their collaboration history and project outcomes. Higher scores could lead to better publicity, bringing in more funding from donors and the public, and making an NGO more attractive to collaborate with. Overall, this system may increase cooperation and project success. An example of a potential incentive that could be created is a collaboration incentive. This incentive would implement a tiered funding system where NGOs that collaborate receive higher priority in grants. This incentive would also provide extra funding that would be split among NGOs that cooperate. The potential of extra financing may allow NGOs to look past the reasons to compete instead of collaborate, ultimately increasing their ability to improve the world.

Key Findings

The first key finding concerns the initial rounds and cooperation: NGOs are more likely to request funding independently in early games and rounds, leading to suboptimal outcomes where funds are spread thinly. As costs accumulate, particularly time and administrative costs, NGOs recognize the benefits of cooperation. Second, the model showed a prisoner's dilemma and how equitable sharing of funds increased the success of both players. One way that NGOs can cooperate in the game is by alternating funding requests. NGOs can achieve better outcomes over time when they cooperate by alternating funding requests and sharing systems. For instance, in a two-player scenario, alternating funding requests allow each NGO to fully fund projects in different rounds, maximizing overall utility and impact. Finally, the costs increased over time: As time progresses and costs (particularly time and administrative costs) increase, NGOs are incentivized to end the game sooner by accepting the outcomes of rounds earlier, ending the game. Delays in decision-making may lead to exponentially growing costs and diminishing returns, emphasizing the importance of timely cooperation. Competition among NGOs results in piecemeal funding allocations and limited humanitarian outcomes, as evidenced in Mozambique's water crises[33]. NGOs should consider an approach that embraces cooperation and collaboration for funding and resources that would catalyze greater reach, impact, and sustainable change in providing humanitarian aid. This paper demonstrates the potential for game theory applications to support such an approach. Applying a game theory-based decision model for funding and collaboration options among NGOs would capture the complementary values of the parties involved (e.g., a potential collaboration of three NGOs) and deliver exponential outcomes in funding, resources, and mission outcomes while enabling a greater impact on humanity. Therefore, applying the game theory model would enable NGOs to determine when to make certain decisions, such as when to request funding, cooperate with another NGO, and how much funding to request, among others. To further assist NGOs in navigating the resource-constrained funding pool, empirical studies should be conducted to evaluate the validity and performance of the theories presented in this paper, potentially identifying which model is best suited for NGOs.

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