Pay It Forward: Theory and Experiment

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Abstract

We experimentally investigate psychological motivations behind pay-it-forward behavior. We incorporate altruism, indirect reciprocity, and inequity aversion in the psychological game-theoretic model of Rabin (1993), Fehr and Schmidt (1999), and Dufwenberg and Kirchsteiger (2004). We find that altruism and indirect reciprocity spur people to pay kind actions forward, informing how kindness begets further kindness; inequity aversion limits giving even when one knows that her kindness will be paid forward. Our paper informs how kind behaviors get passed on among parties that never directly interact, which has implications for the formation of social norms and behavioral conduct within workplaces, neighborhoods, and communities.

Keywords: pay-it-forward, altruism, indirect reciprocity, inequity aversion, psychological game theory

JEL: C79, C90, C91

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1 Introduction

Pay-it-forward behavior is at the heart of a variety of social exchanges, ranging from the everyday to the life-saving. An employee who was mentored by a superior may elect to advise a new coworker in turn. In fast food drive-throughs, when a customer receives a free meal from the car before her in line, she is more likely to buy the meal of the car behind her; one such transaction in a Minnesota Dairy Queen culminated into a chain of giving that lasted 900 cars long (Ebrahimji, 2020). In organ exchange, individuals donate their kidneys to strangers if their loved ones receive a kidney from a compatible donor, creating exchange chains that save hundreds of lives (Roth et al., 2004).

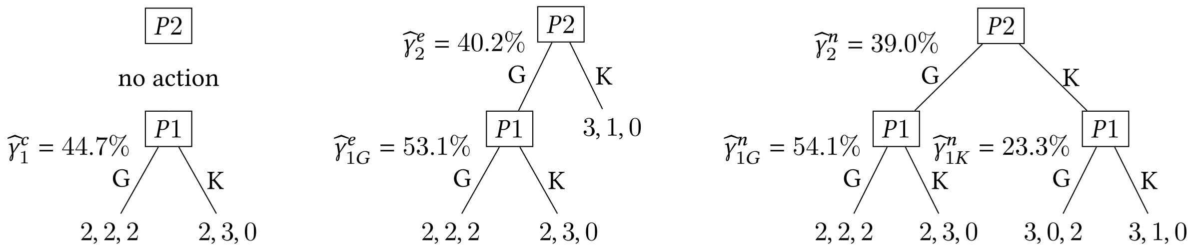
How do we start and maintain chains of giving? Maintaining these chains may be natural and automatic if receiving a gift makes you more likely to give to an unrelated third party. These chains will readily start if the knowledge that others may pay your gift forward, expanding your impact, increases the likelihood that you give. To test these hypotheses, we run a laboratory experiment and guide our observations with a psychological game-theoretic model. We are the first to do this. While prior work has established evidence for pay-it-forward behavior in lab and field settings (Ben-Ner et al., 2004; Bartlett and DeSteno, 2006; Desteno et al., 2010; Herne et al., 2013; Gray et al., 2014; Tsvetkova and Macy, 2014; van Apeldoorn and Schram, 2016; Mujcic and Leibbrandt, 2018; Simpson et al., 2018; Melamed et al., 2020), no one has investigated the psychological motivations that support it. Addressing the psychological underpinnings of pay-it-forward behavior is important for understanding key levers that promote the transmission of kindness.

Figure 1 depicts the three three-player games in the experiment. In all three games, players choose whether to pass a chip worth \$1 to the next player. Following the multiplier methods used for investment and public goods games, a chip passed is turned into \$2.[1] Each player's index denotes the number of players behind them in the chain: P0 is the last potential recipient, P1 is the last player to decide on giving, and P2, if allowed to give, is the penultimate player to decide on giving. Throughout the paper, we use γ to denote giving rates. As depicted in Figure 1, the superscript denotes game type, where c stands for control, e for exclusive, and n for nonexclusive. The subscript 1 denotes P1's action, and the subscript 2 denotes P2's action. The subscript G stands for P1's decision after P2 gives, and K for P1's decision after P2 keeps.

Figure 1a displays the *control game*, in which P2 is endowed with 2 chips and cannot give a chip, P1 is endowed with 3 chips, and P0 with no chip. Only P1 makes a giving decision. In the

[1]These multiplier methods are commonly used to represent the positive externalities that result when individuals engage in kind acts. For example, the act of donating a kidney to a stranger demonstrates that paired-kidney exchange can work, promoting public confidence in the allocation mechanism and motivating greater organ donation rates for future patients. These benefits accrue to society overall, beyond the private benefit to the organ recipient.

Figure 1: Games and giving rates in the experiment



(a) Control **(b)** Exclusive giving **(c)** Nonexclusive giving

Note: Material payoffs are (π_2, π_1, π_0). The $\widehat{\gamma}$s indicate the giving rates in our experiment. The superscript denotes game type, where c stands for control, e for exclusive, and n for nonexclusive. The subscript G stands for P1's decision after P2 gives, and K for P1's decision after P2 keeps.

treatment games depicted in Figures 1b and 1c, P2 is endowed with 3 chips, P1 with 1 chip, and P0 with no chip. P2 and P1 make giving decisions. P2 can give a chip to P1 so that P1 has 3 chips in total. If P2 gives, all three games have the interim allocation $(\pi_2, \pi_1, \pi_0) = (2, 3, 0)$ before P1 makes a giving decision. If P1 keeps, the game concludes with payoffs $(\pi_2, \pi_1, \pi_0) = (2, 3, 0)$, and if P1 gives, the game concludes with payoffs $(\pi_2, \pi_1, \pi_0) = (2, 2, 2)$. We thus keep payoff distributions the same in the three games, so that differences in P1's giving behavior across games cannot arise from absolute or relative allocation concerns.

In the treatment games, P2's decisions impact P1 directly and P0 indirectly. We vary the extent of P2's indirect impact on P0 in the *exclusive giving* and *nonexclusive giving* conditions. In the *exclusive* game depicted by Figure 1b, P1 cannot give P0 a chip unless P2 gives P1 a chip first. If P2 keeps, the game concludes with payoffs $(\pi_2, \pi_1, \pi_0) = (3, 1, 0)$. However, in the *nonexclusive game* depicted by Figure 1c, P1 can give P0 a chip regardless of whether P2 gives a chip to P1 first. If P1 chooses to keep after P2 keeps, the game concludes with payoffs $(\pi_2, \pi_1, \pi_0) = (3, 1, 0)$. If P1 gives even after P2 keeps, the game concludes with payoffs $(\pi_2, \pi_1, \pi_0) = (3, 0, 2)$.

We start by comparing the giving decisions of the Last Mover, P1, to establish evidence of pay-it-forward behavior: Receiving a gift makes one more likely to give to a third party. As shown by the empirical giving rates γ in Figure 1, P1 is most likely to give when P2 has given in the nonexclusive game ($\widehat{\gamma}_{1G}^n = 54.1\%$) or in the exclusive game ($\widehat{\gamma}_{1G}^e = 53.1\%$); less likely to give when P2 cannot give in control game ($\widehat{\gamma}_1^c = 44.7\%$); and least likely to give when P2 can give but decides not to in the nonexclusive game ($\widehat{\gamma}_{1K}^n = 23.3\%$). Compared with control, P1 is 8.4–9.4 percentage points (18–21%) more likely to give in the exclusive and nonexclusive games after receiving a chip from P2 ($p < 0.005$). The game structure holds income effects, distributional preferences, and social image concerns constant across games, enabling us to rule out these alternative explanations.

We next compare the behavior of First Movers, which are P2 in the treatment games and P1 in the control game. This allows us to investigate whether First Movers are motivated by the possibility that their beneficiary will pay forward their generosity, magnifying their impact. If so, we would expect giving to be greater among P2 in the treatment game than P1 in the control game. However, we find the opposite. P1's giving rate in the control game is 44.7%, which is significantly greater than P2's giving rates of 40.2% and 39.0% in the exclusive and nonexclusive games, respectively ($p < 0.05$). It appears that expectations about P1 paying forward P2's generosity play a negligible role in guiding P2's giving decision.

How can we explain these behaviors? We embed altruism, inequity aversion, and indirect reciprocity incentives as psychological components in a game-theoretic framework that extends Rabin (1993), Dufwenberg and Kirchsteiger (2004) and Fehr and Schmidt (1999).[2] We turn on or shut off each psychological component, generating eight predictions for eight models. This enables us to compare our models against i) the standard model when all factors are turned off; ii) Fehr and Schmidt (1999) with inequity aversion; and iii) Dufwenberg and Kirchsteiger (2004) with indirect reciprocity motives rather than direct reciprocity motives. We then assess the explanatory power of each model by comparing its prediction with subjects' behaviors in the experiment. These variations enable us to quantify the empirical importance of altruism, reciprocity, and inequity aversion in explaining empirical behavior.

We find that the model with altruism, reciprocity, and inequity aversion explains the behavior of 90% of subjects. Altruism and reciprocity are key to explaining why people are more likely to give after having received a gift. The model excluding altruism can only explain the behavior of 30% of subjects, while the model excluding reciprocity can only explain the behavior of 70% of subjects. In contrast, inequity aversion plays a marginal role and only helps explain why P2's giving does *not* rise in situations where P1 could pay her generosity forward. The model that excludes inequity aversion performs almost as well as the full model, in that it explains the behavior of 88% of subjects.

Overall, altruism and reciprocity have high explanatory power over pay-it-forward behavior, and can explain why chains of generosity propagate once started. However, our subjects were not motivated to give more based on the knowledge that their generosity will be paid forward. Our experimental evidence shows that chains of generosity are difficult to start.

Our contributions are threefold. First, we introduce a simple, novel experiment that establishes the role of indirect reciprocity motives in pay-it-forward behavior while controlling for al-

[2]We focus on upstream indirect reciprocity: Receiving past kindness motivates an agent to help a third party (Mujcic and Leibbrandt, 2018; van Apeldoorn and Schram, 2016). This form of indirect reciprocity is less studied compared to downstream indirect reciprocity, in which an agent is more likely to *receive* help after helping another (Bolton et al., 2005; Seinen and Schram, 2006; Zeckhauser et al., 2006; Berger, 2011; Charness et al., 2011; Heller and Mohlin, 2017; Gong and Yang, 2019; Gaudeul et al., 2021). Downstream indirect reciprocity focuses less on the psychological motivation of the potential helper and more on the reputation of the potential recipient of help, making it outside the scope of our paper.

ternative explanations. Many prior papers fail to determine if reciprocity motives truly motivate pay-it-forward behavior, since they cannot rule out the income effect, where the act of receiving a gift itself can make subjects more likely to give through increasing their wealth (Herne et al., 2013; van Apeldoorn and Schram, 2016; Simpson et al., 2018; Mujcic and Leibbrandt, 2018). Furthermore, to our knowledge our paper is the first to experimentally account for relative wealth differences, which could lead to pay-it-forward behavior if subjects exhibit inequity aversion. In addition, since subjects participate in our online experiment from their homes, without observation or communication from other subjects, we control for social image considerations, which Charness and Rabin (2002), Sobel (2005), and Cox et al. (2008) theoretically argue and Malmendier et al. (2014) experimentally find to be important in reciprocal interactions.

Second, most game-theoretic frameworks focus on direct reciprocity between two individuals who directly interact (Rabin, 1993; Dufwenberg and Kirchsteiger, 2004; Falk and Fischbacher, 2006; Seinen and Schram, 2006; Cox et al., 2007; Battigalli and Dufwenberg, 2009; Berger, 2011; Gong and Yang, 2019; Gaudeul et al., 2021), but cooperative communities frequently involve three or more individuals who do not necessarily directly interact.[3] To our knowledge, our paper is the first to develop a behavioral game-theoretic framework for the systematic investigation of indirect reciprocity, promoting reciprocal exchange in environments where not all parties directly interact. We find that altruism and reciprocity incentives can explain why kindness begets further kindness. By promoting the propagation of generosity, they help chains of giving continue once started. Inequity aversion, however, presents a barrier to starting these chains. Our paper has important ramifications for how to foster cultures of cooperation within workplaces, neighborhoods, and communities.

Third, our experiment and theory complement each other in exploring the roles of type-based, outcome-based, and intentionality-based models of fairness on pay-it-forward behavior in our experiment. Outcome-based models propose that fairness depends on players' relative payoffs, so inequity aversion and minimax preferences should drive how subjects allocate wealth between themselves and others (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000). Type-based models posit that giving behavior depends on one's innate prosocial parameters (Levine, 1998; Cox et al., 2007; Malmendier et al., 2014). Intentions-based models argue that utility also depends on beliefs about others' kindness intentions (Rabin, 1993; Dufwenberg and Kirchsteiger, 2004; Battigalli and Dufwenberg, 2009; Gul and Pesendorfer, 2016). We combine elements from these models to evaluate the importance of each in rationalizing subjects' behavior. Specifically, type-based components of our model allow us to fix subjects' structural prosocial parameters across various

[3] Wu (2018) and Jiang and Wu (2019) discuss models involving indirect interactions among more than two players. Reciprocal behavior has also been investigated in evolutionary biology (Nowak and Sigmund, 1998a,b; Ohtsuki and Iwasa, 2006; Iwagami and Masuda, 2010) and psychology (Hu et al., 2019; Nava et al., 2019).

nodes of the game. Eliciting subjects' full strategy sets then enables us to perform within-subject comparisons across different nodes of the game. Moreover, the within-subject design allows us to explicitly quantify the proportion of subjects whose strategies align with theoretical predictions, following methods in Charness and Rabin (2002).

The rest of the paper is organized as follows. Section 2 introduces the psychological game-theoretic framework and derives predicted equilibrium giving rates. Section 3 describes the experimental procedure. Section 4 compares our experimental results with theoretical predictions and evaluates the roles of altruism, fairness, and reciprocity in rationalizing experimental behavior. Section 5 presents results on credit. Section 6 concludes.

2 Theory

2.1 Model

To better understand the results from Figure 1, we formalize a notion of equilibrium that explains subjects' strategy profiles. The games in Figure 1 are all finite-action multistage games with observable actions and without moves of nature. Play proceeds in stages in which each player, along any path reaching that stage, (i) knows all preceding choices, (ii) moves exactly once, and (iii) obtains no information about other players' choices in that stage. Since we extend the direct reciprocity framework of Dufwenberg and Kirchsteiger (2004) and Rabin (1993), we adopt and modify their notation.

Let $N = \{1, \ldots, n\}$ denotes the set of players. Let h denote a history of preceding choices represented by a node in the extensive-form representation of games, and let H denote the set of histories of a game. Let S_i denote player i's pure strategy set, and $S = S_1 \times \cdots \times S_I$ the set of pure strategy profiles. The set of (potentially mixed) behavioral strategies of player $i \in N$ is denoted by Σ_i, where a strategy $\sigma_i \in \Sigma_i$ of player i assigns a probability distribution over the set of possible choices of player i for each history $h \in H$. Let $\Sigma = \prod_{i \in N} \Sigma_i$ denote the collection of behavioral strategy profiles σ of all players, and $\Sigma_{-i} = \prod_{j \in N \setminus \{i\}} \Sigma_j$ the collection of behavioral strategy profiles σ_{-i} of all players other than i. Let Σ'_{ij} be the set of beliefs of player i about the strategy of player j (i.e., i's first-order beliefs). Let Σ''_{ijk} be the set of beliefs of player i about the belief of player j about the strategy of player k (i.e., i's second-order beliefs). By definition, $\Sigma'_{ij} = \Sigma_j$ and $\Sigma''_{ijk} = \Sigma'_{jk} = \Sigma_k$.

With $\sigma_i \in \Sigma_i$ and $h \in H$, let $\sigma_i(h)$ denote the updated strategy that prescribes the same choices as σ_i, except for the choices that define history h. Note that $\sigma_i(h)$ is uniquely defined for any history h. For any beliefs $\sigma'_{ij} \in \Sigma'_{ij}$ or $\sigma''_{ijk} \in \Sigma''_{ijk}$, define updated beliefs $\sigma'_{ij}(h)$ and $\sigma''_{ijk}(h)$ analogously.

Player i's utility function depends on strategies, first-order beliefs, and second-order beliefs, which we summarize by a vector $\vec{\sigma} \equiv (\sigma, \sigma', \sigma'')$. These strategies and beliefs in turn determine the expected payoffs of players, which comprise of her own material payoff and three psychological components: (i) the altruistic payoff, (ii) the reciprocity payoff, and (iii) the equity payoff. The utility function takes the following form:

$$\begin{aligned} u_i(\vec{\sigma}) \quad = \quad & \pi_i(\sigma) + \underbrace{A_i \sum_{j \neq i} \pi_j(\sigma)}_{\text{altruism}} + \underbrace{\sum_{j \neq i} Y_i \lambda_{iji}(\vec{\sigma}) \kappa_{ij}(\vec{\sigma})}_{\text{direct reciprocity}} + \underbrace{\sum_{j \neq i, k \neq i, j \neq k} Z_i \lambda_{ijk}(\vec{\sigma}) \kappa_{ij}(\vec{\sigma})}_{\text{indirect reciprocity}} \qquad (1) \\ & \underbrace{- \sum_{s \in S} \sigma(s) \Bigg[\overbrace{\alpha_i \frac{1}{n-1} \sum_{j \neq i} \max\{\pi_j(s) - \pi_i(s), 0\}}^{\text{disadvantageous inequity aversion}} + \overbrace{\beta_i \frac{1}{n-1} \sum_{j \neq i} \max\{\pi_i(s) - \pi_j(s), 0\}}^{\text{advantageous inequity aversion}} \Bigg]}_{\text{inequity aversion}}, \end{aligned}$$

where $\pi_i(\sigma)$ is i's material payoff; $A_i \in [0, 1]$ is i's altruistic factor that dictates how much utility i derives from the material payoffs of other players regardless of the distribution of relative wealth; Y_i is i's direct reciprocity parameter; and Z_i is i's indirect reciprocity parameter. From Fehr and Schmidt (1999), we incorporate inequity aversion parameters α and β. Player i receives disutility α_i for each unit of lower payoff than others ("disadvantageous inequity aversion") and disutility β_i for each unit of higher payoff than others ("advantageous inequity aversion"), where $\alpha_i \geq \beta_i$ and $0 \leq \beta_i \leq 1$.

The function $\kappa_{ij} : \Sigma_i \times \prod_{j \neq i} \Sigma'_{ij} \to \mathbb{R}$ is i's kindness to j from choosing strategy σ_i while other players choose σ_{-i}:

$$\kappa_{ij} \left(\sigma_i(h), (\sigma'_{ij}(h))_{j \neq i} \right) = \pi_j \left(\sigma_i(h), (\sigma'_{ij}(h))_{j \neq i} \right) - \pi_j^{Q_i} \left((\sigma'_{ij}(h))_{j \neq i} \right),$$

where $\pi_j^{Q_i}((\sigma'_{ij})_{j \neq i}) = \frac{1}{2} \left[\max_{\sigma_i \in \Sigma_i} \pi_j(\sigma_i, (\sigma'_{ij})_{j \neq i}) + \min_{\sigma_i \in \Sigma_i} \pi_j(\sigma_i, (\sigma'_{ij})_{j \neq i}) \right]$ is player j's *equitable payoff* with respect to i. It is the average between j's lowest and highest possible material payoff based on i's strategy. Since kindness is defined relative to j's equitable payoff, i's kindness is positive (negative) if i chooses an action that gives a strictly higher (lower) expected payoff for j than j's equitable payoff.

The function $\lambda_{iji} : \Sigma'_{ij} \times \prod_{k \neq j} \Sigma''_{ijk} \to \mathbb{R}$ is i's belief of j's kindness to i given i's belief of j's belief of other players' strategies:

$$\lambda_{iji}(\sigma'_{ij}(h), (\sigma''_{ijl}(h))_{l \neq j}) = \pi_i \left(\sigma'_{ij}(h), (\sigma_{ijl}(h))_{l \neq j} \right) - \pi_i^{Q_j} \left((\sigma''_{ijl}(h))_{l \neq j} \right).$$

Both κ_{ij} and λ_{iji} are defined as in Dufwenberg and Kirchsteiger (2004). However, there are three modifications. First, we incorporate an altruistic payoff component. Second, we substitute the direct reciprocity component for an indirect reciprocity component in which subjects can only reciprocate kind acts by helping a third party, rather than their benefactors.[4] Third, we follow Fehr and Schmidt (1999) and incorporate inequity aversion parameters.

Below, we define alternative specifications of the utility function in which some psychological components are assumed away. We formulate key predictions based on these alternative utility specifications and test them against our experimental results in Section 4.

Definition 1. ***Altruistic, inequity averse, and reciprocal (AIR) utility*** assumes that $A_i \geq 0$, $\alpha_i \geq 0$, $\beta_i \geq 0$, and $Z_i \geq 0$ for all i. ***Standard/selfish (S) utility*** ignores psychological components and assumes that $A_i = 0$, $\alpha_i = 0$, $\beta_i = 0$, $Y_i = 0$, and $Z_i = 0$ for all i. ***Altruistic (A)***, ***Reciprocal (R)***, ***Inequity averse (I)***, ***AI***, ***AR***, and ***IR*** utilities respectively assume the relevant utility components to be nonnegative and other utility components to be zero. See the top rows of Table 1 for the complete parametric specification of each utility function.

Note that the reciprocity utility component depends on strategies, beliefs, and other players' material payoffs. Therefore, the equilibrium is defined with respect to both strategies and beliefs.

Definition 2. Strategies and beliefs $\vec{\sigma}$ constitute a ***dynamic reciprocity equilibrium*** if and only if (i) (consistency) players have correct beliefs about other players' actions, i.e., $\sigma = \sigma'_i = \sigma''_{ij}$ for any players i and j; and (ii) (utility maximization) strategy profile σ maximizes players' utilities at each information set given first-order and second-order beliefs σ'_i and σ''_{ij}.

Theorem 1. *A dynamic reciprocity equilibrium always exists.*[5]

As Section 3 will discuss, we elicit full strategy sets. The model specifies that the central belief parameters are first-order and second-order beliefs about P1's likelihood of giving to P0. We elicit beliefs experimentally and show that elicited beliefs match empirical giving rates, a condition that must be satisfied in our equilibrium.

2.2 Giving decisions

To simplify the exposition of giving rates, we define the following notation.

Definition 3. For any real number $x \in \mathbb{R}$, define $[\![x]\!]$ to be 1 if x is bigger than 1, x if x is between 0 and 1, and 0 if x is smaller than 0. Mathematically, $[\![x]\!] \equiv \max\{0, \min\{1, x\}\}$.

[4]Our model is able to incorporate the direct reciprocity factors from Dufwenberg and Kirchsteiger (2004). However, because direct reciprocity does not play a role in our games, we omit them from the utility specifications for simplicity.

[5]In general, a dynamic reciprocity equilibrium is not necessarily unique. However in our games, except for a measure zero set of parameters, equilibrium strategies are uniquely determined. For a measure zero set of parameters, a player may be indifferent between giving and keeping, and hence any probability of giving can constitute an equilibrium, resulting in multiple equilibria.

2.2.1 The control game

First, consider the control game (Figure 1a). P2 is endowed with 2 chips, P1 with 3 chips, and P0 with 0 chips. P2 cannot decide on anything in this game, and exists to keep relative payoffs similar to the treatment games. P1 can either keep all 3 chips so that P0 has 0 chips, or pass 1 chip to P0 so that P0 has 2 chips. P0 cannot decide on anything, and can only receive chips from P1.

Lemma 1. *In the control game, P1 prefers giving if and only if* $2 \cdot A_1 + 2 \cdot \beta_1 \geq 1$.

P1 can either keep 1 chip (so that P0 gains no chips) or give up 1 chip (so that P0 gains 2 chips). When P1 gives up one chip, the material payoffs change from $(\pi_2, \pi_1, \pi_0) = (2, 3, 0)$ to $(\pi_2, \pi_1, \pi_0) = (2, 2, 2)$. By giving, she lowers her material payoff by 1 unit, but increases her altruistic payoff by $2 \cdot A_1$ units as P0's payoff increases from 0 to 2. Moreover, because inequity aversion gives P1 disutility from having more chips than other players, she gains $2 \cdot \beta$ from giving and equalizing payoffs across all three players. Overall, the psychological gain of giving by P1 is

$$2 \cdot A_1 + 2 \cdot \beta_1. \tag{2}$$

Figure 3a depicts P1's equilibrium giving rate as A_1 varies. In equilibrium, there is no mixed strategy except for when $2 \cdot A_1 + 2 \cdot \beta_1 = 1$, so the equilibrium giving rate can be represented by an indicator function: $\gamma_1^c = 1_{2 \cdot A_1 + 2 \cdot \beta_1 \geq 1}$.[6] P1 is more inclined to give the higher her altruistic factor A_1 and the higher her advantageous inequity aversion β_1 (that is, the more she dislikes having more than other players). Pure altruism and/or advantageous inequity aversion—but not disadvantageous inequity aversion or reciprocity—helps rationalize giving by P1 in the control game.

2.2.2 Exclusive game

Second, consider a three-player game in which P1 can only give to P0 if P2 gave to P1 first (Figure 1b). P2 is endowed with 3 chips, P1 with 1 chip, and P0 with 0. P2 can either keep all 3 chips or give 1 chip to P1 so that P1's chip count increases from 1 to 3. Only upon receiving additional chips can P1 choose to give. If P1 gives 1 chip, P0 gets 2 chips. If P1 keeps, P2 gets 0.

Lemma 2. *In the exclusive game, P2 prefers giving if* $1 + (1 - \gamma_{1G}^e) \cdot \alpha_2/2 \leq (2 + \gamma_{1G}^e) \cdot A_2 + (3/2 + \gamma_{1G}^e) \cdot \beta_2$*, and P1 gives with probability* $\gamma_{1G}^e = [\![(2 \cdot A_1 + 2 \cdot \beta_1 - 1)/Z_1 + 2]\!]$.

[6] When $2 \cdot A_1 + 2 \cdot \beta_1 = 1$, P1 is indifferent between giving and keeping, since the change in material payoffs balances out the change in psychological payoffs. In equilibrium, P1 can choose to give with any probability $\gamma_1^c \in [0, 1]$. Without loss of generality, we assume that P1 chooses to give.

Compared to keeping, giving lowers P2's material payoff but increases her utility from altruism and from having an equitable distribution of payoffs among all players in the group. The left-hand side of the inequality in Lemma 2 represents the two ways P2 loses from giving. Compared to keeping, giving lowers P2's material payoff by 1. P2 may also suffer utility loss from disadvantageous inequity, since P1 may keep after she gives, making her material payoff lower than P1's. More precisely, if P1 keeps after P2 gives, P2 incurs utility loss from disadvantageous inequity of $(3-2) \cdot \alpha_2/2 = \alpha_2/2$. Because P1 keeps with probability $1-\gamma_{1G}^e$ after P2 gives, giving would lower P2's expected utility by $(1-\gamma_{1G}^e) \cdot \alpha_2/2$.

The right-hand side of the inequality represents the two ways P2 gains from giving. Giving increases P2's altruistic payoff by $A_2 \cdot (2+\gamma_{1G}^e)$ in expectation. Giving also rectifies inequality aversion, in that P2 is less likely to have more than other players. If P2 keeps, she suffers disutility of $[(3-1)+(3-0)] \cdot \beta_2/2 = 5 \cdot \beta_2/2$ from advantageous inequity, since she will have higher payoffs compared to P1 and P0. If P2 gives, two scenarios can happen. If P1 gives, P2 suffers no inequity aversion since all players will have 2 chips. If P1 keeps (which happens with probability $1-\gamma_{1G}^e$), then P2 suffers $(2-0) \cdot \beta_2/2 = \beta_2$ from getting more than P0. Hence, by giving, P2 gains in expectation $5 \cdot \beta_2/2 - (1-\gamma_{1G}^e) \cdot \beta_2 = (3/2+\gamma_{1G}^e) \cdot \beta_2$. In summary, altruism and inequity aversion motivate P2 to give.

Upon receiving 2 chips from P2, P1 faces the following trade-off. If P1 gives, P1 loses one unit of material payoff, but gains in the three psychological components. A 2-chip gain for P0 gives P1 an altruistic payoff gain of $2 \cdot A_1$ and $2 \cdot \beta_1$ from equalizing payoffs. Furthermore, P1's kind action of giving earns P1 an indirect reciprocity payoff of $Z_1 \cdot (2-\gamma_{1G}'')$, where γ_{1G}'' is P1's belief of P2's belief of P1's probability of giving. Altogether, P1's psychological gain from giving after P2 gives is

$$2 \cdot A_1 + 2 \cdot \beta_1 + Z_1 \cdot (2-\gamma_{1G}''). \tag{3}$$

In equilibrium, P1's second-order belief must equate with her strategy ($\gamma_{1G}'' = \gamma_{1G}^e$). Hence, if $2 \cdot A_1 + 2 \cdot \beta_1 + Z_1 \geq 1$, then $\gamma_{1G}^e = 1$; if $2 \cdot A_1 + 2 \cdot \beta_1 + 2 \cdot Z_1 \leq 1$, then $\gamma_{1G}^e = 0$. Otherwise, P1 gives with a probability strictly between 0 and 1 that makes her indifferent between giving and keeping: $\gamma_{1G}^e = (2 \cdot A_1 + 2 \cdot \beta_1 - 1)/Z_1 + 2$. P1's inclination to give increases with altruism A_1, advantageous inequity aversion β_1, and indirect reciprocity Z_1. Figure 3b depicts how P1's equilibrium giving rate in the exclusive game varies with altruism A_1.

2.2.3 Nonexclusive game

Finally, consider a three-player game in which P0's channel of receiving chips is nonexclusive (Figure 1c). P2 is endowed with 3 chips, P1 with 1, and P0 with 0. P2 can either keep all the chips so that P1's chip count remains unchanged, or give away 1 chip so that P1's chip count increases by 2. Regardless of P2's decision, P1 can keep all the chips or give away 1 chip so that P0's chip count increases by 2.

Lemma 3. *In the nonexclusive game, P2 prefers giving if and only if* $1 + (1/2 - \gamma^n_{1G}/2) \cdot \alpha_2 \leq (2+\gamma^n_{1G}-\gamma^n_{1K}) \cdot A_2 + (3/2+\gamma^n_{1G}-\gamma^n_{1K}/2) \cdot \beta_2$*, P1 gives with probability* $\gamma^n_{1G} = [\![(2 \cdot A_1 + 2 \cdot \beta_1 - 1)/Z_1 + 2]\!]$ *after P2 gives, and P1 gives with probability* $\gamma^n_{1K} = [\![(2 \cdot A_1 - 3 \cdot \alpha_1/2 - \beta_1/2 - 1)/Z_1 - 1]\!]$ *after P2 keeps.*

P2's gains from giving are similar to those in the exclusive game. The only difference is that after P2 keeps, P1 gives 1 chip with probability γ^n_{1K}, and 1 new chip gets created from P1's gift to P0. P2 then gains A_2 from altruism and $\beta_2/2$ since payoffs become more equal after P0 gains 2 chips. Since the psychological penalty to keeping is less severe for P2 in the nonexclusive game, the net benefit of giving is smaller in the nonexclusive game than the exclusive game by $(A_2 + \beta_2/2) \cdot \gamma^n_{1K}$.

If P2 chooses to give, then P1 faces the same trade-off as in the exclusive game. Therefore, the equilibrium giving rate γ^n_{1G} in the nonexclusive game is characterized in the same way as in the exclusive game. If P2 chooses to keep, reciprocity motives will make P1 more inclined to keep. If P1 gives instead, her reciprocity motives will generate a utility loss of $Z_1 \cdot (2 - \gamma''_{1K})$. In addition, by giving, P1 changes the material payoffs from $(\pi_2, \pi_1, \pi_0) = (3, 1, 0)$ to $(3, 0, 2)$, which results in $3 \cdot \alpha_1/2$ units increase in disadvantageous inequity aversion and β_1 units of increase in advantageous inequity aversion.Overall, the psychological gain of giving by P1 after P2 keeps is

$$2 \cdot A_1 - 3 \cdot \alpha_1/2 - \beta_1/2 - Z_1 \cdot (2 - \gamma''_{1G}). \tag{4}$$

Figure 3c depicts P1's giving rates in the nonexclusive game. If P1 gives after P2 keeps, then her decision can only be justified by altruism. Note that there is no simultaneous mixing of both giving decisions in equilibrium under any combination of parameters. This is because the conditions for indifference are different at the two decision nodes, when P1 is indifferent between giving and keeping at one decision node, she is not indifferent at the other.

2.3 Giving comparisons

To illustrate how our model disciplines our predictions, we now describe predicted giving rates under AIR utility ($A_i > 0$, $\alpha_i > 0$, $\beta_i > 0$, and $Z_i > 0$). Our results center on giving rates comparisons, and we say that one is more inclined to give than another in the following sense.

Definition 4. Player i is ***more inclined*** to take action s at node H than player j to take action s' at node H', $\sigma_i(s|H) \succ \sigma_j(s'|H')$, if for $\alpha_i = \alpha_j$ and $Z_i = Z_j$, $\sigma_i(s|H) \geq \sigma_j(s'|H')$ for all parameters, and the inequality holds strictly for some parameters.

2.3.1 Giving by Last Movers

P1 is the last mover in all three games. Figure 4 shows P1's equilibrium giving rates for different altruistic factors. The comparisons are unambiguous: $\gamma_{1G}^{e} \sim \gamma_{1G}^{n} \succ \gamma_{1}^{c} \succ \gamma_{1K}^{n}$. We discuss the pairwise comparisons of these giving decisions in the following five propositions.[7]

First, compare P1's two giving decisions in the nonexclusive game, after P2 gives versus after P2 keeps. Regardless of P2's choice, P1 incurs the same material loss (1 unit) and altruistic gain ($2 \cdot A_1$ units) from giving. However, if P1 chooses to give after P2 keeps, she incurs a larger inequity aversion loss and reciprocity loss than if she chooses to give after P2 gives.

Prop 1. *In the nonexclusive game, P1 is more inclined to give after P2 gives than after P2 keeps.*

Since there is no simultaneous mixed strategy in equilibrium (as argued in the previous section), Proposition 1 implies that when P1 chooses to give after P2 keeps, P1 must also give after P2 gives. When P1 chooses to keep after P2 gives, P1 must also keep after P2 keeps. It is possible that P1 gives after P2 gives and keeps after P2 keeps, but never possible for P1 to keep after P2 gives and give after P2 keeps.

Now compare the psychological gain of giving in the control game to that in the exclusive game. The choice for P1 is the same in terms of material payoffs: either $(2, 2, 2)$ by giving or $(2, 3, 0)$ by keeping. If subjects have reciprocity motives, a gift from P2 increases P1's giving rate in the exclusive game.

Prop 2. *P1 is more inclined to give in the exclusive game after P2 gives than in the control game.*

Similarly, a gift from P2 increases P1's giving rate in the nonexclusive game relative to the control game.

Prop 3. *P1 is more inclined to give in the nonexclusive game after P2 gives than in the control game.*

However, both reciprocity motives and inequity aversion would decrease P1's giving inclination after P2 keeps in the nonexclusive game.

Prop 4. *P1 is less inclined to give in the nonexclusive game after P2 keeps than in the control game.*

Finally, P1's inclination to give is the same in the exclusive and nonexclusive games after P2 gives, and this result holds for all utility preferences we consider.

Prop 5. *P1 is equally inclined to give after P2 gives in the nonexclusive game and the exclusive game.*

[7] There are $4 \times 3/2 = 6$ different pairwise comparisons for the four decisions. We do not directly compare γ_{1G}^{e} and γ_{1K}^{n}, but discuss the other five pairwise comparisons in the five propositions.

Note that it is possible that a player is indifferent between giving and keeping in equilibrium in the exclusive and nonexclusive games, because she mixes between giving and keeping in equilibrium. Hence, when subjects are observed to give in one game and keep in another, the difference in observed behavior neither validates nor invalidates the prediction that they are equally likely to give. We discuss this prediction further in Section 4.5.

2.3.2 Giving by First Movers

We next compare the first movers in these games: P1 in the control game and P2 in the treatment games. To summarize, the initial mover's giving rate is higher in the exclusive game than in the nonexclusive game, but it is unclear whether the initial mover is more inclined to give in the control game than in the treatment games, since altruism pushes for greater giving while inequity aversion pushes for lower giving in the treatment games.

First, P2's incentives to give are greater in the exclusive than the nonexclusive game. In the exclusive game, P2 knows that keeping will prevent P1 from giving, while in the nonexclusive game P2 knows that P1 can still give even if she kept. In particular, knowing that P1 can give even after P2 keeps in the nonexclusive game will increase P2's expected utility from keeping by $\gamma^n_{1K} \cdot A_2$ from altruism and $\gamma^n_{1K} \cdot \beta_2/2$ from having more equal payoffs. Figure 5 depicts the comparison of giving rates for initial movers.

Prop 6. *P2 in the exclusive game is more inclined to give than P2 in the nonexclusive game.*

Next, compare the giving rates of P1 in the control game and P2 in the exclusive game. Since we compare the giving decisions for the same subject, we can assume that all psychological parameters are the same for the subject across games and player roles: $A_1 = A_2 \equiv A$, $\alpha_1 = \alpha_2 \equiv \alpha$, $\beta_1 = \beta_2 \equiv \beta$, and $Z_1 = Z_2 \equiv Z$. Here, altruism and inequity aversion might work in opposite directions. By giving, P1 in the control game gets an altruistic payoff of $2 \cdot A$, and P2 in the exclusive game gets an altruistic payoff of $(2 + \gamma^e_{1G}) \cdot A$, because P1 in the exclusive game generates additional $\gamma^e_{1G} \cdot A$ units of altruistic payoff for P2 by passing to P0. Therefore, by altruism alone,P2 in the exclusive game would be more inclined to give than P1 in the control game.

However, inequity aversion would create the opposite effect. P2 does not have a sure chance of equalizing payoffs in the exclusive game since P1 may choose to keep after P2 gives, while in the control game P1 will certainly equalize payoffs by giving. This uncertainty decreases expected utility from giving for P2 in the exclusive game compared to P1 in the control game. Furthermore, if P1 keeps, P2's inequity aversion causes her to suffer disutility $(3 - 2) \cdot \alpha/2 = \alpha/2$ from having a lower payoff than P1. Since this occurs with probability $1 - \gamma^e_{1G}$ and results in material payoffs $(\pi_2, \pi_1, \pi_0) = (2, 3, 0)$, the expected loss is $(1 - \gamma^e_{1G}) \cdot \alpha/2$.

Prop 7. *P1 in the control game is more inclined to give than P2 in the exclusive game if and only if* $(1-\gamma^e_{1G}) \cdot \alpha/2 \geq \gamma^e_{1G} \cdot A + (\gamma^e_{1G} - 1/2) \cdot \beta$.

The comparison between P1 in the control game and P2 in the nonexclusive game is similar to the logic above. A higher altruistic payoff incentivizes P2 in the nonexclusive game to give more, since her gift could improve payoffs for both P1 and P0. But, P1 can equalize payoffs with certainty in the control game whereas P2 cannot in the nonexclusive game. In summary, altruism alone would drive greater giving by P2 in the nonexclusive game, but inequity aversion would drive greater giving by P1 in the control game.

Prop 8. *P1 in the control game is more inclined to give than P2 in the nonexclusive game if and only if* $(1/2 - \gamma^n_{1G}/2) \cdot \alpha \geq (\gamma^n_{1G} - \gamma^n_{1K}) \cdot A + (\gamma^n_{1G} - \gamma^n_{1K} - 1/2) \cdot \beta$.

2.4 Summary of predictions

Table 1 summarizes the eight predictions under each of the utility functions listed in Definition 1, which turn on or off each of the three psychological components we consider. The giving rate is denoted by γ, as discussed above and in the table notes.

Rows 1–5 of Table 1 evaluates the strategy of the Last Mover, which is P1 in all games. In the most general utility specification with altruism, reciprocity, and inequity aversion (AIR utility, Column 8), the giving rates by the Last Mover are ordered: $\gamma^e_{1G} \sim \gamma^n_{1G} \succ \gamma^c_1 \succ \gamma^n_{1K}$ (Predictions 1-5 in Column 8). P1's giving rates should be similar in the exclusive and nonexclusive games after P2 gives (Prediction 5 in Column 8). These giving rates will be higher than P1's giving rate in the control game (Predictions 2 and 3 in Column 8), which will in turn be higher than P1's giving in the nonexclusive game after P2 keeps (Prediction 4 in Column 8).

A standard model without the aforementioned psychological components predicts no giving under any circumstance (Column 1), since giving strictly decreases subjects' material payoffs. We start by considering the predictions with alternative utility specifications in which only one psychological component is considered at a time (Columns 2-4). Under altruism alone (Column 2), P1 would give in all five nodes where she has a giving decision, since her gift will enable P0 to have \$2 rather than \$0 in all cases (Predictions 1-5 in Column 2). Under inequity aversion alone, P1 is equally likely to give at all nodes where she received \$3 (in the treatment games after P2 gives or in the control game), since giving ensures that all players receive \$2 (Predictions 2, 3, and 5 in Column 3). Under reciprocity motives alone (Column 4), P1 will be inclined to give only after receiving a gift from P2. P1's giving rates will be greater after P2 gave in the treatment games than in the control game, even though P1 would have \$3 in all cases (Predictions 2 and 3 in Column 4, $\gamma^e_{1G} > \gamma^c_1$ and $\gamma^n_{1G} > \gamma^c_1$).

Table 1: Predicted pairwise comparisons of giving

	(1) S Standard	(2) A Altruism	(3) I Inequity	(4) R Reciprocity	(5) AI Altruism Inequity	(6) IR Inequity Reciprocity	(7) AR Altruism Reciprocity	(8) AIR Altruism Inequity Reciprocity
A_i	$= 0$	> 0	$= 0$	$= 0$	> 0	$= 0$	> 0	> 0
α_i, β_i	$= 0$	$= 0$	> 0	$= 0$	> 0	> 0	$= 0$	> 0
Z_i	$= 0$	$= 0$	$= 0$	> 0	$= 0$	> 0	> 0	> 0
	Last Movers							
1	$Y^n_{1G} \sim Y^n_{1K} \sim 0$	$Y^n_{1G} \sim Y^n_{1K} \succ 0$	$Y^n_{1G} \succ Y^n_{1K} \sim 0$	$Y^n_{1G} \sim Y^n_{1K} \sim 0$	$Y^n_{1G} \succ Y^n_{1K} \succ 0$	$Y^n_{1G} \succ Y^n_{1K} \sim 0$	$Y^n_{1G} \succ Y^n_{1K} \succ 0$	$Y^n_{1G} \succ Y^n_{1K} \succ 0$
2	$Y^e_{1G} \sim Y^c_1 \sim 0$	$Y^e_{1G} \sim Y^c_1 \succ 0$	$Y^e_{1G} \sim Y^c_1 \succ 0$	$Y^e_{1G} \succ Y^c_1 \sim 0$	$Y^e_{1G} \sim Y^c_1 \succ 0$	$Y^e_{1G} \succ Y^c_1 \succ 0$	$Y^e_{1G} \succ Y^c_1 \succ 0$	$Y^e_{1G} \succ Y^c_1 \succ 0$
3	$Y^n_{1G} \sim Y^c_1 \sim 0$	$Y^n_{1G} \sim Y^c_1 \succ 0$	$Y^n_{1G} \sim Y^c_1 \succ 0$	$Y^n_{1G} \succ Y^c_1 \sim 0$	$Y^n_{1G} \sim Y^c_1 \succ 0$	$Y^n_{1G} \succ Y^c_1 \succ 0$	$Y^n_{1G} \succ Y^c_1 \succ 0$	$Y^n_{1G} \succ Y^c_1 \succ 0$
4	$Y^c_1 \sim Y^n_{1K} \sim 0$	$Y^c_1 \sim Y^n_{1K} \succ 0$	$Y^c_1 \succ Y^n_{1K} \sim 0$	$Y^c_1 \sim Y^n_{1K} \sim 0$	$Y^c_1 \succ Y^n_{1K} \succ 0$	$Y^c_1 \succ Y^n_{1K} \sim 0$	$Y^c_1 \succ Y^n_{1K} \succ 0$	$Y^c_1 \succ Y^n_{1K} \succ 0$
5	$Y^n_{1G} \sim Y^e_{1G} \sim 0$	$Y^n_{1G} \sim Y^e_{1G} \succ 0$	$Y^n_{1G} \sim Y^e_{1G} \succ 0$	$Y^n_{1G} \sim Y^e_{1G} \succ 0$	$Y^n_{1G} \sim Y^e_{1G} \succ 0$	$Y^n_{1G} \sim Y^e_{1G} \succ 0$	$Y^n_{1G} \sim Y^e_{1G} \succ 0$	$Y^n_{1G} \sim Y^e_{1G} \succ 0$
	First Movers							
6	$Y^e_2 \sim Y^n_2 \sim 0$	$Y^e_2 \succ Y^n_2 \succ 0$	$Y^e_2 \sim Y^n_2 \succ 0$	$Y^e_2 \sim Y^n_2 \sim 0$	$Y^e_2 \succ Y^n_2 \succ 0$	$Y^e_2 \sim Y^n_2 \succ 0$	$Y^e_2 \succ Y^n_2 \succ 0$	$Y^e_2 \succ Y^n_2 \succ 0$
7	$Y^e_2 \sim Y^c_1 \sim 0$	$Y^e_2 \succ Y^c_1 \succ 0$	X	$Y^e_2 \sim Y^c_1 \sim 0$	X	X	$Y^e_2 \succ Y^c_1 \succ 0$	X
8	$Y^n_2 \sim Y^c_1 \sim 0$	$Y^n_2 \sim Y^c_1 \succ 0$	X	$Y^n_2 \sim Y^c_1 \sim 0$	X	X	$Y^n_2 \succ Y^c_1 \succ 0$	X

Note: X indicates that predictions depend on inequity aversion parameters.

We also consider predictions when one psychological component is omitted (Columns 5-7). Without reciprocity (Column 5), P1 would be equally inclined to give in the control game and after P2 gives in the treatment games (Predictions 2, 3, and 5 in Column 5). Without altruism, P1 would never give after P2 keeps in the nonexclusive game (Predictions 1 and 4 in Column 7). Without inequity aversion (Column 7), predictions for P1's behavior are the same as in the general AIR model. Note that this means inequity aversion does nothing to explain Last Mover P1's behavior in our model.

Rows 6–8 of Table 1 summarize predictions for First Movers: P1 in the control game and P2 in the treatment games. Under the utility specification that incorporates altruism, inequity, and reciprocity (AIR), P2's giving rate is higher in the exclusive game than the nonexclusive game (Prediction 6 in Column 8), since failure to give precludes all subsequent giving in the exclusive game. However, it is unclear whether P2 in the treatment games would be more inclined to give than P1 in the control games, since altruism pushes for greater giving and inequity aversion pushes for lower giving in the treatment games (Predictions 7 and 8 in Column 8).

Columns 2–4 consider the isolated role of each psychological component. If our subjects were only motivated by altruism, giving by First Movers would be highest in the exclusive game, since the failure to give would preclude any giving by downstream players (Predictions 6 and 7 in Column 2). If only inequity aversion motivated our subjects, P2 would be equally inclined to give in the exclusive and nonexclusive games, since she knows that failure to give on her part would leave either P1 or P0 with nothing (Prediction 6, Column 3). If only reciprocity drove behavior, P1 would only give after P2 gave and not after P2 kept in the nonexclusive game (Prediction 4 in

Column 3). This would make the nonexclusive and exclusive games effectively the same to P2, so P2 would be equally inclined to give in the two games (Prediction 6 in Column 3).

Columns 5–7 each omit one psychological component from the full model. Column 5 shows that without reciprocity, giving by P2 is greater in the exclusive than the nonexclusive game (Prediction 6). P2 knows that failing to give in the exclusive game precludes P1 from giving to P0, which is undesirable since she is altruistic over P0 and averse to inequity. However, in the nonexclusive game, the consequences of failing to give are less certain, since P1 technically can still give to P0 even if P2 did not give. Column 6 shows that without altruism, P2 is equally likely to give in the exclusive and nonexclusive games (Prediction 6). P2 knows that her gift will increase P1's likelihood of giving via reciprocity motives. This means in both the exclusive and nonexclusive games, her gift generates the same likelihood of achieving equal payoffs of $2 for all players. Finally, Column 7 shows that without inequity aversion, the First Mover would be more inclined to give in the treatment games than in the control game, since her gift would affect more downstream players (Predictions 7 and 8). The predictions of our eight models allow us to determine the psychological motivations behind subjects' behaviors in the experiment, which we describe next.

3 Experimental procedure and data

3.1 Implementation

Experimental sessions were implemented on Amazon Mechanical Turk (MTurk), an online platform commonly used by experimental social scientists to collect information about choices, attitudes, and opinions. The study was administered between February 23 and March 26 of 2021.[8] It has been approved by the Institutional Review Board at Michigan State University.

Since our study involved three-player games, we held sessions of 9 subjects each for a total of 43 sessions.[9] A total of 408 subjects received payment for the study, but only 403 responded to all questions and were counted in the full sample. All MTurk users were eligible to participate; we chose to not restrict our sample of participants based on prior performance at MTurk tasks. However, we use quality check questions to monitor subject attention and comprehension before almost all games (discussed below).

We conducted the experiment using Qualtrics software. Recruitment materials informed subjects that they would receive $3 for completing the study and up to $5 in bonus payments. Subjects could preview all experimental materials before choosing to participate. Experimental materials

[8]The experiment was conducted online since it took place during the Covid pandemic, and nonessential in-person studies were prohibited by Michigan State University.

[9]The exception was our first session, which was held with 30 subjects.

informed subjects that upon study completion, they would be randomly assigned to a game and a group with other players from their session. Their bonus earnings were calculated based on their giving decisions, as well as the giving decisions of their group mates. Subjects received their payments via MTurk within 24 hours of study completion.

3.2 Experimental procedure

We used the strategy method to elicit subjects' actions at all nodes of each game. For example, in the nonexclusive game we asked subjects whether they would give as P1 in the case that P2 gave *and* whether they would give in the case that P2 kept. We leverage this within-subject variation to examine how each subject's actions differ across player roles and across games. Importantly, subjects made their giving decisions after being told how they would be compensated but before they knew which game, group, or player role they would be compensated for. Subjects could not contact each other or know with whom they would be playing when they made their decisions.

All subjects proceeded through the experiment as follows. First, they were taken to the consent page, which described their rights as study participants. Next, they viewed a video that described the study and all games. Prior to the beginning of each game, subjects viewed the extensive-form diagram of the game they were about to play, which contained information about endowments and payoffs for each realization of the game. Throughout the session, they could click on a link that displayed the extensive-form diagram and video describing the relevant game. To check subject comprehension, we asked questions about the game rules before the exclusive and nonexclusive games. Subjects were informed they would earn an additional $0.50 per game if they answered all questions for the game correctly on their first attempt.

All subjects played the control game first. After the control game, the order of the exclusive and nonexclusive games was randomized. Each game asked subjects whether they would keep or pass their chip in each player role and each node of the extensive form game. After subjects made their giving decisions in the treatment games, we asked them about their first- and second-order beliefs regarding whether P1 would give. We discuss the details of these questions further in Section 4.6, where we assess whether we can evaluate our results under dynamic reciprocity equilibrium based on subjects' reported beliefs. At the end of the study, subjects completed a demographic questionnaire. Further details of the experiment, including screenshots, are available in Online Appendix D.

Table 2 displays summary statistics. The top panel summarizes subject performance. Bonus payments ranged from $0 to $5, with a median payment of $3 and an average payment of $2.55. In the full sample, the average number of quality check questions answered incorrectly on the first try out of four was 2.16, with a median of 1. However, the distribution is positively skewed:

Of 403 total subjects, 140 had no incorrect questions, 87 had one incorrect question, and 97 had two incorrect questions on the first try. The remaining 78 had 3 or more incorrect questions on the first try. It is likely that those who answered more than two questions incorrectly did not understand the games, so their choices may not reflect their true preferences. To exclude subjects who demonstrably struggled with the quality check questions, we define a separate subsample of subjects who answered two or more questions correctly on the first try, called the *accurate responders* sample. We present summary statistics for the full sample in the first column ($N = 403$) and the accurate responders sample in the second column ($N = 324$). In robustness checks, we show that our results hold even when we limit the sample to only subjects who answered every question correctly on the first try ($N = 140$).

In the full sample, subjects took 28-29 minutes on average to complete the study. Although the study was designed to be completed within an hour, two subjects took 69.53 and 124.90 minutes. Twenty-eight subjects took between 45 and 60 minutes. As Section 4.4 will show, excluding these 30 subjects does not appreciably change results.

Responses to the demographic questionnaire reveal no significant difference across the two main analysis samples (bottom panel). Less than a third of subjects (27.5%) are women, 80-83% have at least an associate's degree, and over 90% are employed full- or part-time. Around 67-68% are US citizens, 70-73% are US residents, and over 75% are native English speakers. In terms of race and ethnicity, about half of subjects are white, 30% are Asian, 10-13% are Black, 5% are Hispanic, and the remaining 3% are categorized as other race or ethnicity. In terms of age, half of the subjects are 26-35 years old, 22-23% are 36-45 years old, 15-16% are 16-25 years old, and about 10% of subjects are 46-65 years old. Only 1.2-1.5% of subjects are 65 or older.

4 Results

We first assess our experimental results against the eight propositions using the paired one-tailed t-test results summarized in Tables 3 and 4. We then calculate the proportion of subjects whose behaviors align with model predictions in Figure 2. Although the two methods evaluate subject behavior in different ways, they arrive at the same conclusion. Tables 3 and 4 compare aggregate giving rates at different nodes, while Figure 2 focuses on the number of subjects that choose a given set of strategies. Both methods demonstrate the roles of altruism, reciprocity, and inequity aversion in explaining our experimental results.

In Tables 3 and 4, panel a uses the full sample of 403 subjects and panel b restricts the sample to accurate responders. We first compare the actions of Last Movers (P1) across games in Section 4.1, which establishes the generalized reciprocity effect and points to the role of both altruism and reciprocity incentives in explaining pay-it-forward behavior. We then compare the actions of First Movers (P1 in the control game and P2 in the treatment games) in Section 4.2, which demonstrates that inequity aversion can explain P2's relatively low giving rates. In particular, we find that the knowledge that P1 could magnify P2's impact by paying P2's generosity forward does *not* increase P2's giving likelihood. Rather, the ability to ensure equal payoffs for all players can explain why P1 is more likely to give control game compared to P2 in the treatment games.

4.1 Giving rates by Last Movers

Table 3 reports the results of behaviors by Last Movers, P1 in all three games. Propositions 2 and 3 establish the generalized reciprocity effect. They compare P1's behavior in the control game versus the treatment games after P2 gave. We find that P1's giving rates are 52.5-53.1% in the exclusive game and 54.1-56.2% in the nonexclusive game after P2 gave. Both values are significantly greater than P1's giving rate of 44.7-45.2% in the control game ($p < 0.01$ in both the full sample and the accurate responders sample). The pattern of giving establishes that reciprocity incentives are necessary in explaining behavior in our games, since it contradicts the predictions of all models that exclude reciprocity. In all cases, P1 chooses between payoffs of (2,2,2) if she were to give and (2,3,0) if she were to keep. The game design holds constant social concerns, the number of players behind P1, P1's own income, and the relative payoffs across all players. The only difference between the treatment and control conditions is that P1's endowment is attributable to P2's kindness, rather than experimental conditions. Receiving the gift increases P1's giving likelihood by 15-21%, indicating that benefiting from another person's kindness makes subjects more likely to pay it forward. Therefore, only Models R, AR, IR, and AIR generate predictions that are consistent with subjects' behavior.

Proposition 1 then compares P1's giving in the nonexclusive game after P2 gives versus after P2 keeps. Across the two samples, P1's giving likelihoods are 54.1-56.2% after P2 gives and 19.8-23.3% after P2 keeps, with the difference significant at the 1% level. We note that P1 has a positive probability of giving even when P2 keeps ($\widehat{\gamma}^n_{1K} > 0$). Only altruism can explain this behavior, so we further rule out the R and IR models. Only the AR and AIR models remain as candidate explanations.

We then move on to explain why P1 would give more after P2 gave than after P2 kept ($\widehat{\gamma}^n_{1G} > \widehat{\gamma}^n_{1K}$). Reciprocity incentives can explain this behavior, since they make P1 more likely to give after P2 gave and to keep after P2 kept. However, inequity aversion can also explain this behavior. If P1 wishes to equalize payoffs for all players, she can only do so by giving to P0 after P2 gave. If P2 kept, P1 cannot equalize payoffs by giving. Inequity aversion could thus make P1 more likely to give after P2 gave than after P2 kept. Proposition 1 shows the necessary role of altruism in explaining P1's behavior in the nonexclusive game, but cannot distinguish whether reciprocity incentives, inequity aversion, or both contribute to P1's greater giving likelihood after P2 gave than after P2 kept.

So far, comparing Last Movers' decisions in Propositions 1-3 leads us to reject all models except AR and AIR. Reciprocity is necessary to explain why P1 gives more in the treatment games after P2 gives than in the control game, while altruism is necessary to explain why P1 would give after P2 kept in the nonexclusive game. Under Propositions 4-5, subjects' behaviors align with predictions from the AR and AIR models but fail to distinguish between the two. We therefore turn to First Movers' decisions to determine the role of inequity aversion in explaining subject behaviors.

4.2 Giving rates by First Movers

Table 4 reports the giving decisions of First Movers, which comprise of P2 in the treatment games and P1 in the control game. We begin with Propositions 7 and 8, which compare P1's giving in the control group with P2's giving in the treatment groups. We originally hypothesized that P2 will give more in the treatment games than P1 in the control game. Our rationale was that P2's giving should increase with the knowledge that her gift would make P1 more likely to give. However, our results show the opposite pattern. We find significantly greater giving by P1 in the control game than P2 in the treatment games ($p < 0.05$). In the control game, P1's giving rate is 44.7-45.4%. In the exclusive and nonexclusive games, P2's giving rates are 40.2-44.1% and 39.0-40.7%, respectively. The experimental results go against the predictions of all models that do not incorporate inequity aversion. Propositions 7 and 8 thus show that including inequity aversion can align theoretical predictions with the behavior of First Movers. Intuitively, P1 in the control game knows that by giving, she can equalize everyone's payoffs. However, P2 in the treatment games cannot equalize everyone's payoffs, since she cannot control what P1 will do after she gives. Inequity aversion would therefore push subjects to give more as P1 in the control game than P2 in the treatment games.

Next, Proposition 6 compares P2's giving in the exclusive and nonexclusive games. Results differ between the full sample and the accurate responders sample. In the full sample, giving rates are not statistically different, with P2's giving propensity equal to 40.2% in the exclusive game and 39.0% in the nonexclusive game. These results only align with the inequity aversion model (I) and the inequity aversion and reciprocity model (IR). We have already rejected both models, since they cannot explain why P1 would give after P2 kept (Proposition 1). In contrast, in the sample of accurate responders in panel b, P2 is more likely to give in the exclusive game compared with the nonexclusive game (44.1% versus 40.7%, $p < 0.05$), which is consistent with all models that incorporate altruism. Intuitively, P2 knows that keeping in the exclusive game shuts down giving by P1, and therefore definitely harms P0. However, in the nonexclusive game P1 can theoretically still give even if P2 were to keep, leading to less expected harm to P0. If P2 had altruistic concerns for P1 and P0, she should be more likely to give in the exclusive game than in the nonexclusive game. Based on the accurate responders sample, we conclude that the AIR model performs slightly better than the AR model in rationalizing the totality of subjects' behaviors.

4.3 Summary of t-test results

Tables 3 and 4 report how aggregate giving rates align with theoretical predictions. Reciprocity motives explain why P1 is more likely to give to P0 after receiving a gift from P2, controlling for income effects, distributional payoffs across all players, social concerns, and the number of players behind P1 in the chain (Propositions 2 and 3). However, knowing that P1 may pay forward P2's generosity does not increase P2's chances of giving. Rather, inequity aversion explains why P2's giving rates are lower in the treatment games than P1's giving in the control game (Propositions 7 and 8). Lastly, altruism alone can explain why P1 would give in the nonexclusive game even after P2 kept (Proposition 1). Thus, the model which incorporates altruism, inequity aversion, and reciprocity (AIR) best explains behavior for both the full sample and the accurate responders sample.

These three psychological components account for behavior in different ways. For the manager seeking to promote helping behavior in the workplace, our results suggest that appealing to reciprocity and altruism will mainly affect how people pay forward help they have received in the past—how chains of generosity continue after they are launched. Meanwhile, inequity considerations may impede launching the chain of generosity in the first place. A supervisor considering whether to mentor one subordinate over others may be concerned about exhibiting favoritism, and therefore mentor no one. This could then lower the likelihood that her subordinates "pay forward" the mentoring in future years, after they have become supervisors themselves.

4.4 Robustness checks

We conduct a number of robustness checks by examining results across different samples. Tables 3b and 4b show results for subjects who answered at least half of the accuracy check questions correctly on the first try. We next present t-test results for subjects who answered all questions correctly on the first try. The results, presented in Appendix Table C1a, show that almost all findings hold even though the sample reduces to only 140 subjects. The exception is that the difference in P2's giving across treatments becomes directional ($p = 0.1292$, Proposition 6), which could be due to the small sample size.

As a related robustness check, in Appendix Table C1b we restrict the sample to subjects who submitted six or fewer incorrect *answers*. The number of incorrect answers differs from the number of questions answered incorrectly, since a subject can submit multiple incorrect answers to the same question. For example, someone who submits four incorrect answers to one question but answers every other question correctly on the first try would count as having one question answered incorrectly and four incorrect answers. Again, we find that this alternative restriction does not change our main results in Tables 3b and 4b.

Next, we explore whether time spent on the study affects results. We designed the study to be comfortably completed within an hour, and almost all subjects finished within 45 minutes. Excluding the 30 subjects who took more than 45 minutes from the sample of accurate responders brings the sample to 298. Despite the small sample size, our results do not change, as shown in Table C1c.

Lastly, we investigate whether the order of games affects behavior. After subjects played the control game, game order was randomized. Roughly half of the subjects were shown the nonexclusive game and then the exclusive game, and the other half played the games in the opposite order. Separately assessing the results based on order of games cuts the sample in half, yet our findings barely change. Table C1d shows results for accurate responders who saw the nonexclusive game first, while Table C1e shows results for accurate responders who saw the exclusive game first. Empirical results are identical to those in Tables 3b and 4b, except that the comparison regarding Proposition 6 becomes directional for subjects who saw the exclusive game first.

4.5 Within-subject comparisons

In this section, we compute the proportion of subjects whose choices are consistent with each model's predictions. This alternate way of assessing model performance has two advantages over the paired t-tests in Tables 3 and 4. First, it better leverages within-subject variation by counting the number of subjects that choose a given strategy, rather than computing aggregate giving likelihoods at each node. It generates slightly different results from Tables 3 and 4 for Propositions 7 and 8, which depend on subject-level altruism and inequity aversion parameters (A, α, β). Second, it allows us to quantify the importance of each psychological component in explaining empirical choices. We find that altruism is most important, reciprocity second most important, and inequity aversion least important in explaining subject behavior.

Recall that Table 1 predicts which strategies are permissible under each model by comparing giving behavior at the two specified decision nodes. At these two decision nodes, subjects can choose among four strategies: (give, give), (give, keep), (keep, give), and (keep, keep) , where the first element denotes the action taken at the red node and the second element denotes the action taken at the blue node. When the prediction is ~ 0, the model predicts that giving rates at both decision nodes will be statistically indistinguishable from 0, so subjects should play (keep, keep). When the prediction is $\sim$, the model predicts equivalent actions at the two decision nodes: (give, give) or (keep, keep). Third, when the prediction is $\succ 0$, the model predicts that giving at the red node would be strictly greater than giving at the blue node, which would be equivalent to 0. The only action that aligns with such a prediction is (give, keep). Lastly, when the prediction is $\succ$, the model predicts greater giving rates at the red node than the blue node. This means subjects may give at both nodes, keep at both nodes, or give at the red node and keep at the blue node. The only action inconsistent with the prediction of $\succ$ is (keep, give).

The exceptions to this method are Propositions 5, 7, and 8. Proposition 5 predicts that P1's giving rate after P2 gives will not significantly differ between the exclusive and nonexclusive games. This does not restrict how P1's mixed strategy gets realized. Subjects who choose to give at one node and keep at the other node do not definitively violate Proposition 5, since it is possible that they are indifferent between the two decisions and choose at random. Hence, all strategies can occur even when P1's giving rate is the same in the two games. Under any model incorporating inequity aversion, Propositions 7 and 8 depend on altruism and inequity aversion parameters (A, α, β). Depending on the specific values (A, α, β) take on, all strategies are plausible.

Figure 2 plots the proportion of subjects whose strategies align with different model predictions. Aggregate numbers are summarized in Appendix Table C2. Each proposition is listed at the bottom of the graph, and each model is listed at the top of the graph. The bars represent the proportion of subjects whose behavior is consistent with a proposition under a given model.

Model S, which assumes that subjects only care about material payoffs, can only explain 35-36% of decisions by P1s, since it predicts that P1 would always play keep. Similarly, models that exclude altruism (I, R, and IR) fail to explain behavior for the majority of subjects. Only incorporating reciprocity (Model R) explains behavior for 19% subjects regarding Propositions 2 and 3, since it predicts that P1 must play give in the treatment games if P2 gave and keep in the control game. If reciprocity alone motivated P1's behavior, she would always give after receiving a gift from P2 in the treatment games. She would never give in the control game, where she does not benefit from someone else. This prediction is inconsistent with the behaviors of the 80.6% of P1s who give in the control game or keep after receiving a gift from P2 in the treatment games. Models I and IR explain behavior for 31% of subjects with respect to Proposition 4, since they predict that subjects must play give in the control game and keep in the nonexclusive game after P2 keeps. Without altruism, P1 would never give if P2 kept in the nonexclusive game. But, inequity aversion would lead P1s to give in the control game to equalize payoffs for all players.

Models I and IR fail to explain the behaviors of the 61% of subjects who keep in the control game or give in the nonexclusive game after P2 keeps. Together, these results establish the importance of altruism in generalized reciprocity games.

Excluding reciprocity motives would also fail to explain behavior by a large fraction of subjects. The model with only altruism (Model A) can explain behavior for 50% of subjects with respect to Proposition 1, since it predicts that altruistic P1s would be equally likely to give independent of whether P2 gave or kept in the nonexclusive game. P1 would either always give or always keep at these two nodes. Model A cannot explain behavior for the other 50% who choose to give at one node but to keep at the other. The model with altruism and inequity aversion (Model AI) performs comparatively better, but only explains the decisions of 70% of subjects with respect to Propositions 2 and 3. It predicts that, absent reciprocity motives, giving rates by P1 in the control game and the treatment games after P2 gave should be equal. It cannot explain the behavior of the 30% of subjects that choose different actions at these nodes.

We are then left with the model with altruism and reciprocity (Model AR) and the model with altruism, reciprocity, and inequity aversion (Model AIR). The two models generate identical predictions for P1's behavior (Propositions 1-5), but the AIR model performs slightly better in explaining 93% of P2's behavior (Propositions 6-8). The AR model explains 88-89% of P2's behavior with respect to Propositions 7 and 8. It predicts that in the absence of inequity aversion, P2's giving in the treatment games should be greater than P1's giving in the control game. These predictions are at odds with the t-test results from Table 4, where aggregate giving rates are higher for P1 in the control game than P2 in the treatment games. They cannot explain the 10-12% of subjects that keep in the treatment games but give in the control game. The AIR model better rationalizes the behavior of these subjects, since inequity aversion can explain why they give in the control game but not in the treatment games given individual parameters (A, α, β).

We now evaluate the relative importance of altruism, reciprocity, and inequity aversion in explaining our behavior. Taking into account all propositions, models without altruism can only explain 19.35-34.73% of subjects' behavior. Models without reciprocity can explain 30.77-69.73% of subjects' behavior, and models without inequity aversion can explain 19.35-87.59% of subjects' behavior. By comparison, the AIR model can explain behavior for 89.08% of subjects. This means that adding altruism to the IR model increases the proportion of subjects whose behavior can be explained by 89.08-30.77=58.31%, or 235 subjects. Adding reciprocity to the AI model increases explanatory power from 69.73% to 89.08% of subjects, a gain of 19.35% or 78 subjects. Adding inequity aversion to the AR model increases explanatory power from 87.59% to 89.08%, a gain of 1.49% or 6 subjects. Altruism and reciprocity substantially increase model performance, while there is only a marginal improvement from incorporating inequity aversion.

As with the t-test results in Tables 3 and 4, we note that different psychological components explain behavior for different players. Altruism and reciprocity are key for describing P1's behavior, and therefore explain why receiving help might lead one to help an unrelated third party Inequity aversion plays no role, as the AR and AIR models both explain 89.08% of behavior by P1s. Rather, inequity aversion helps explain P2's experimental behavior. P2 is less likely to give in the treatment games than P1 in the control game, since in the latter case P1 can equalize payoffs across all players while in the former case P2 cannot. Incorporating inequity aversion raises our predictive power from 87.59% to 93.55% of P2s.

4.6 Beliefs

Beliefs about P1's giving are key to informing players' strategies in our dynamic reciprocity equilibrium (see Online Appendix A). We therefore elicit both first- and second-order beliefs regarding P1's likelihood of giving to P0. After subjects made their giving decisions for each treatment game, we asked them to enter the likelihood that P1 would give to P0. To elicit first-order beliefs, we asked subjects to assume the role of P2. From the role of P2, they would then enter an integer between 0 to 100 to represent the likelihood that they believed P1 would give to P0. To elicit second-order beliefs, we asked subjects to assume the role of P1. From the role of P1, they would enter an integer between 0 to 100 to represent their belief of P2's belief that they would give to P0. This enables us to verify whether generalized reciprocity motives truly drive P1's pay-it-forward behavior. In the case where P2 gave, generalized reciprocity would only motivate P1 to give if P1 believed that P2 believed that P1 was likely to give to P0.

Beliefs are summarized in Table 5. In the exclusive game among the full sample, first- and second-order beliefs regarding P1's likelihood of giving are 54.2% and 57.2%, respectively. This is fairly close to the true giving rate of 53.1%. In the nonexclusive game, first- and second-order beliefs regarding P1's likelihood of giving after P2 gave are 53.4% and 54.2% respectively, which are close to the empirical giving rate of 54.1%. If P2 kept, first- and second-order beliefs are 31.80% and 31.34%, which are a little higher than the empirical giving rate of 23.3%. The fact that subjects state beliefs which match empirical giving rates allows us to evaluate subjects' full strategy sets within our concept of dynamic reciprocity equilibrium.

To be clear, our belief data do not rule out the possibility that subjects may be playing out of equilibrium. This would only impact our assessments regarding the role of generalized reciprocity, which is the only psychological component that depends on beliefs about other players' behavior.[10] Even in this case, P1's empirical behaviors would only be explained by the full AIR model, coupled with the belief that P2 is altruistic over P0's payoff when giving to P1. If P1 had no generalized reciprocity motives, she should be equally inclined to give in the treatment games

[10] Altruism and inequity aversion only depend on outcomes.

after P2 gave and in the control game. If P1 possessed generalized reciprocity motives but did not believe that P2 was altruistic over P0's payoff, she should be *equally or less* inclined to give after P2 gave in the treatment games than in the control game. This is because if P1 believed P2 did not care about P0's payoff, P1 would not be reciprocating P2's kindness by giving to P0. In fact, if P1 believed that P2 only cared about P1's payoff, the best way to reciprocate P2's gift would be for P1 to keep, rather than to give to P0.

We further explore the beliefs of subjects based on whether they were consistent with Propositions 2 and 3, the two propositions that establish the role of generalized reciprocity in pay-it-forward behavior. Table 5 shows that second-order beliefs are significantly higher among subjects whose strategy profiles are consistent with Propositions 2 and 3. In other words, P1s who are (weakly) more inclined to give after P2 gave in the treatment games than in the control game have higher average beliefs that P2 believed they would give. Online Appendix Table C3 reports the significant positive relationship between second-order beliefs and consistency with Propositions 2 and 3, controlling for subject-level demographics. Together, the evidence supports the idea that generalized reciprocity motives drive this pay-it-forward behavior, since the P1s who exhibit this behavior have stronger beliefs that P2 expected them to give to P0 after P2 gave.

5 Credit attribution

Since inequity aversion only marginally improves the proportion of subjects whose behavior can be rationalized, we explore another explanation behind First Movers' behavior. It is possible that subjects are motivated by how others perceive their actions. In the treatment games, P2 directly impacts P1's payoff and indirectly impacts P0's payoff, since P1's likelihood of giving to P0 is influenced by P2. P2 may therefore receive credit for impacting both P1 and P0's payoffs. However, the degree of credit attributed to each player should differ between the exclusive and nonexclusive games, since P2 uniquely enables P1 to give in the exclusive game.

We develop a model which defines credit as each player's second-order beliefs regarding the kindness attributed to her actions by others. We experimentally elicit credit. After subjects make their giving decisions in each game, we ask: "What percentage of Player X's payoff is due to Player Y?" where $X, Y \in \{P0, P1, P2\}$. Subjects then entered an integer between 0 and 100, with the stipulation that the total amount of credit allocated across all Player Y sum up to 100 (see Online Appendix D for screenshots of this question).

The utility function takes the form

$$u_i(\vec{\sigma}) = \pi_i(\sigma) + \underbrace{A_i \sum_{j \neq i} \delta_{ij} \pi_j(\sigma)}_{\text{altruism}} + \underbrace{\sum_{j \neq i, k \neq i, j \neq k} Z_i \delta_{ij} \lambda_{ijk}(\vec{\sigma}) \kappa_{ij}(\vec{\sigma})}_{\text{generalized reciprocity}} \tag{5}$$

where $\delta_{ij} \in [0, 1]$ is i's belief of the kindness attributed to her decision regarding giving to j. All other objects are defined as in Equation 1. Appendix A develops the predictions of this model. For brevity, we report here the simple predictions.

- For P1 in all games, the likelihood of giving will be positively correlated with P1's belief of the credit she will receive for giving to P0.
- For P2 in the exclusive game, the likelihood of giving is positively correlated with P2's belief of her credit for P1's payoff, her credit for P0's payoffs, and her beliefs about P1's likelihood of giving.
- For P2 in the nonexclusive game, the likelihood of giving is positively correlated with P2's belief of her credit for P1's payoff, her credit for P0's payoffs, and the difference in her belief about P1's likelihood of giving if P2 gave versus if P2 kept.

To obtain empirical predictions we incorporate subjects' reported beliefs about credit, reported in Table 6. There are three main predictions. First, based on summary statistics of P1's credit in the control game compared to P2's credit in the treatment games, the model predicts greater giving by P1 in the control game than P2 in the treatment games. This is consistent with our experimental results, where P1 in the control group is 4.5 percentage points more likely to give than P2 in the exclusive game ($p < 0.05$) and 5.7 percentage points more likely to give than P2 in the nonexclusive game ($p < 0.01$, Table 4 Propositions 7 and 8).

Second, Table 6 reports 5.87% greater credit for P2 over P0's payoffs in the exclusive game compared to the nonexclusive game ($p < 0.01$). Combining this with data on P2's beliefs of P1's likelihood of giving, the model predicts greater giving by P2 in the exclusive compared to the nonexclusive games. We fail to find systematic evidence of this. The difference in P2's giving rates is insignificant in the full sample and significant in the Accurate Responders sample ($p < 0.05$). The robustness checks in Appendix show that this difference is usually insignificant or marginally significant across the various subsamples we test. We conclude that there is insufficient evidence to prove this prediction for P2's behavior from the credit-based model.

Third, Table 6 reports greater credit for P1 over P0's payoff in the nonexclusive compared to the exclusive game by 4.90% ($p < 0.01$). Our model predicts that this would lead to greater giving rates for P1 in the nonexclusive compared to the exclusive games. As with our second prediction, we fail to find systematic evidence. In the full sample, the difference in giving rates is small and insignificant; the difference is marginally significant in the Accurate Responders sample ($p < 0.10$). When examining our robustness checks, we find that the difference is marginally significant in some but not all subsamples. We do not find compelling evidence that credit concerns drive giving behavior for P1.

Finally, we employ a Oaxaca-Blinder decomposition. The decomposition exploits within-subject variation, better accounting for heterogeneity in subject beliefs. It captures whether differences in giving are driven by subjects who believe that P1 and P2 deserve different levels of credit in the exclusive versus the nonexclusive games. Based on the results of Equation 5, P1's behavior depends on credit over P0's payoffs. The regression equation is therefore

$$\begin{aligned}\text{P1 gives}^N - \text{P1 gives}^E = \alpha_0^N - \alpha_0^E + \alpha_1^N[\text{P1's credit for P0}^N - \text{P1's credit for P0}^E] + \\ (\alpha_1^N - \alpha_1^E)[\text{P1's credit for P0}^E] + u^N - u^E \quad (6)\end{aligned}$$

where P1 gives^g is whether P1 gave in game $g \in \{E, N\}$ after P2 passed and u^g is the error term in the regression on giving in game g. The term $\alpha_1^N[\text{P1's credit for P0}^N - \text{P1's credit for P0}^E]$ represents the impact of the difference in credit on the difference in giving between the nonexclusive and exclusive games. The term $(\alpha_1^N - \alpha_1^E)[\text{P1's credit for P0}^E]$ captures whether credit motivates giving to differing degrees across games.

The model's predictions regarding P2's behavior involve more terms, but rely on the same underlying premise. It predicts that P2's giving depends on credit for P1's payoff, credit for P0's payoff, and beliefs about whether P1 would give. The Oaxaca decomposition follows the specification

$$\begin{aligned}\text{P2 gives}^E - \text{P2 gives}^N = \beta_0^E - \beta_0^N + \\ \beta_1^N[\text{credit for P1}^E - \text{credit for P1}^N] + (\beta_1^E - \beta_1^N)[\text{credit for P1}^E] + \\ \beta_2^N[\text{credit for P0}^E - \text{credit for P0}^N] + (\beta_2^E - \beta_2^N)[\text{credit for P0}^E] + \\ \beta_3^N[\text{belief P1 will give}^E - \text{belief P1 will give if P2 passes}^N] + (\beta_3^E - \beta_3^N)[\text{belief P1 will give}^E] \\ - \beta_4^N[\text{belief P1 will give if P2 keeps}^N] + \epsilon^E - \epsilon^N \quad (7)\end{aligned}$$

where P2 gives^g is whether P2 gave in game $g \in \{E, N\}$ and ϵ^g is the error term in the regression on giving in game g.

Table 7 reports results for both P1 (panel A) and P2 (panel B). We start with the simpler case of P1's giving. Panel A reports that those who state greater credit for P1 in the nonexclusive game compared to the exclusive game are more likely to give in the nonexclusive game. One percentage point more credit in the nonexclusive game corresponds to about a 0.2 percentage point greater likelihood of giving as P1 in the nonexclusive game compared to the exclusive game.

Panel B presents similar results with respect to P2's giving. We find that those who report greater credit for P2 over P1's payoffs in the exclusive game than the nonexclusive game are more likely to give as P2 in the exclusive game. One percentage point more credit in the exclusive game corresponds to a 0.3 percentage point greater likelihood of giving as P2 in the exclusive game compared to the nonexclusive game. However, we find that differences in P2's credit over P0's payoffs do not predict differences in P2's giving across games. The results are especially puzzling given that Table 6 reports significant differences in P2's credit over P0's payoffs across treatment games, but not P2's credit over P1's payoffs.

Taking in the totality of evidence, we conclude that credit concerns are not large enough to generate differences in P1's and P2's behavior across treatment conditions. It is possible that First Movers' behavior are explained by inequity aversion, credit concerns, or both. However, the evidence is more consistent with inequity aversion, since not all predictions generated by the credit model pan out in the experimental data.

6 Conclusion

Our study evaluates the importance of generalized reciprocity, altruism, and inequity aversion in motivating pay-it-forward behavior. We establish a psychological game-theoretic framework which formulates predictions for giving behavior under different models of prosocial behavior. We then test these predictions using a novel experiment that demonstrates the existence of generalized reciprocal exchange while controlling for alternate explanations such as income effects, relative payoffs, and social image considerations. The experimental design, coupled with the theoretical framework, enable us to exploit within-subject variation when comparing across various game nodes. That is, by assuming that subjects have constant prosocial preferences across games, we isolate distinct patterns in giving behavior in different games and player roles. We find that generalized reciprocity incentives are critical to explain the pay-it-forward behavior, where receiving a gift makes P1 more likely to give. However, knowledge that P1 may pay forward P2's generosity does not appear to encourage giving by P2, even though P2's generosity would have been magnified by P1's pay-it-forward behavior. Rather, inequity aversion provides one explanation as to why P2 is *less* likely to give, making the transmission of generosity unlikely to start in the first place.

Our findings address the question of how generosity spreads within communities, which has been documented by prior work (Fowler and Christakis, 2010) but is not well understood. We provide experimental evidence that people pay forward kind acts to unrelated others; namely, that kindness engenders further kindness. However, the knowledge that others may pay forward your kindness does not make you more likely to help. Chains of generosity easily continue once started, but are relatively difficult to start. These results speak to the stability of culture across different contexts. In a workplace where a new employee is mentored and helped, she is likely to help other newcomers in the future. In contrast, if she entered a workplace where she was left to fend for herself, she may not think to help newcomers in the future even when she could. The tendency of subjects to reciprocate help with help (and its absence with no help) can contribute to the formation of social norms and behavioral conduct within organizations, neighborhoods, and other communities.

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Figures & Tables

Table 2: Summary statistics of study subjects

	Full Sample	Accurate Responders
Study Characteristics		
% saw exclusive game first	0.522	0.519
	(0.0249)	(0.0278)
study duration (minutes)	28.73	29.02
	(0.543)	(0.630)
median study duration (minutes)	26.75	26.77
bonus payment	2.553	2.731
	(0.0692)	(0.0768)
median bonus payment	3	3
wrong answers	2.157	1.324
	(0.117)	(0.0878)
median wrong answers	1	1
Demographics		
% female	0.275	0.275
	(0.0223)	(0.0248)
% college graduate	0.829	0.802
	(0.0188)	(0.0222)
% employed	0.931	0.917
	(0.0127)	(0.0154))
Citizenship/residency/language fluency		
% US citizen	0.684	0.673
	(0.0234)	(0.0263)
% native English speaker	0.763	0.755
	(0.0213)	(0.0240)
% US resident	0.727	0.701
	(0.0222)	(0.0255)
Race/ethnicity		
% Black	0.129	0.0988
	(0.0167)	(0.0166)
% Asian	0.293	0.306
	(0.0227)	(0.0256)
% Hispanic	0.0496	0.0494
	(0.0108)	(0.0121)
% White	0.501	0.515
	(0.0249)	(0.0278))
% Other race/ethnicity	0.0273	0.0309
	(0.00813)	(0.00962)
Age		
% 16-25 years old	0.159	0.160
	(0.0182)	(0.0204)
% 26-35 years old	0.496	0.491
	(0.0249)	(0.0278)
% 36-45 years old	0.223	0.219
	(0.0208)	(0.0230)
% 46-55 years old	0.0670	0.0648
	(0.0125)	(0.0137)
% 56-65 years old	0.0422	0.0494
	(0.0100)	(0.0121)
% 65 or older	0.0124	0.0154
	(0.00552)	(0.00686)
Observations	403	324

Notes: Standard errors in parentheses.

Table 3: Experimental results of giving rates, Last Movers

(a) Full sample, $N = 403$

Prop	Experimental result		Consistent with predictions?							
	proportion	p-value	S	A	I	R	AI	IR	AR	AIR
1	$\widehat{\gamma}^n_{1G} = 54.1\%$ $> \widehat{\gamma}^n_{1K} = 23.3\%$	$p < 0.0001$	No	No	No	No	Yes	No	Yes	Yes
2	$\widehat{\gamma}^e_{1G} = 53.1\%$ $> \widehat{\gamma}^c_1 = 44.7\%$	$p = 0.0010$	No	No	No	No	No	Yes	Yes	Yes
3	$\widehat{\gamma}^n_{1G} = 54.1\%$ $> \widehat{\gamma}^c_1 = 44.7\%$	$p = 0.0002$	No	No	No	No	No	Yes	Yes	Yes
4	$\widehat{\gamma}^c_1 = 44.7\%$ $> \widehat{\gamma}^n_{1K} = 23.3\%$	$p < 0.0001$	No	No	No	No	Yes	No	Yes	Yes
5	$\widehat{\gamma}^n_{1G} = 54.1\%$ $\sim \widehat{\gamma}^e_{1G} = 53.1\%$	$p = 0.3402$	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

(b) Accurate Responders Sample, $N = 324$

Prop	Experimental result		Consistent with predictions?							
	proportion	p-value	S	A	I	R	AI	IR	AR	AIR
1	$\widehat{\gamma}^n_{1G} = 56.2\%$ $> \widehat{\gamma}^n_{1K} = 19.8\%$	$p < 0.0001$	No	No	No	No	Yes	No	Yes	Yes
2	$\widehat{\gamma}^e_{1G} = 52.2\%$ $> \widehat{\gamma}^c_1 = 45.4\%$	$p = 0.0057$	No	No	No	No	No	Yes	Yes	Yes
3	$\widehat{\gamma}^n_{1G} = 56.2\%$ $> \widehat{\gamma}^c_1 = 45.4\%$	$p = 0.0001$	No	No	No	No	No	Yes	Yes	Yes
4	$\widehat{\gamma}^n_{1K} = 19.8\%$ $< \widehat{\gamma}^c_1 = 45.4\%$	$p < 0.0001$	No	No	No	No	Yes	No	Yes	Yes
5	$\widehat{\gamma}^n_{1G} = 56.2\%$ $> \widehat{\gamma}^e_{1G} = 52.2\%$	$p = 0.0562$	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Giving rate is denoted by γ. The superscript denotes game type, where c stands for control, e for exclusive, and n for nonexclusive. The subscript G stands for P1's decision after P2 gives, and K for P1's decision after P2 keeps. S - standard model; A - altruism; R - reciprocity; I - inequity aversion.

Table 4: Experimental results of giving rates, First Movers

(a) Full sample, $N = 403$

Prop	Experimental result		Consistent with predictions?							
	proportion	p-value	S	A	I	R	AI	IR	AR	AIR
6	$\widehat{\gamma}_2^e = 40.2\%$ $\sim \widehat{\gamma}_2^n = 39.0\%$	$p = 0.2542$	No	D	Yes	D	D	Yes	D	D
7	$\widehat{\gamma}_2^e = 40.2\%$ $< \widehat{\gamma}_1^c = 44.7\%$	$p = 0.0156$	No	No	Yes	No	Yes	Yes	No	Yes
8	$\widehat{\gamma}_2^n = 39.0\%$ $< \widehat{\gamma}_1^c = 44.7\%$	$p = 0.0043$	No	No	Yes	No	Yes	Yes	No	Yes

(b) Accurate Responders Sample, $N = 324$

Prop	Experimental result		Consistent with predictions?							
	proportion	p-value	S	A	I	R	AI	IR	AR	AIR
6	$\widehat{\gamma}_2^e = 44.1\%$ $> \widehat{\gamma}_2^n = 40.7\%$	$p = 0.0429$	No	Yes	No	No	Yes	No	Yes	Yes
7	$\widehat{\gamma}_2^e = 44.1\%$ $\sim \widehat{\gamma}_1^c = 45.4\%$	$p = 0.2781$	No	No	Yes	No	Yes	Yes	No	Yes
8	$\widehat{\gamma}_2^n = 40.7\%$ $< \widehat{\gamma}_1^c = 45.4\%$	$p = 0.0160$	No	No	Yes	No	Yes	Yes	No	Yes

Note: Giving rate is denoted by γ. The superscript denotes game type, where c stands for control, e for exclusive, and n for nonexclusive. The subscript G stands for P1's decision after P2 gives, and K for P1's decision after P2 keeps. S - standard model; A - altruism; R - reciprocity; I - inequity aversion. D indicates that the experimental results are directionally but not significantly consistent with predictions.

Table 5: Beliefs regarding P1's likelihood of giving

	Exclusive	Nonexclusive
First-Order Beliefs		
P2's belief that P1 will give if P2 gave	54.19 (1.22)	53.38 (1.20)
P2's belief that P1 will give if P2 kept		31.85 (1.27)
Second-Order Beliefs		
P1's belief of P2's belief that P1 will give if P2 gave	57.14 (1.27)	54.22 (1.40)
Strategy is consistent with Proposition 2	58.11 (1.36)	
Strategy is inconsistent with Proposition 2	49.39 (3.30)	
Difference	8.73 (4.06)**	
Strategy is consistent with Proposition 3		55.54 (1.48)
Strategy is inconsistent with Proposition 3		42.33 (3.94)
Difference		13.22 (4.65)***
P1's belief of P2's belief that P1 will give if P2 kept		31.38 (1.351)
Strategy is consistent with Proposition 3		30.97 (1.43)
Strategy is inconsistent with Proposition 3		34.65 (4.12)
Difference		-3.68 (4.53)

Notes: Full sample of 403 subjects. Standard errors in parentheses. First-order beliefs are P2's belief that P1 will give. Second-order beliefs are P1's belief of P2's belief that P1 will give. See Online Appendix D for the specific question text about how beliefs are elicited.
Under the AIR model, Proposition 2 predicts that P1's giving will be greater in the exclusive game than the control game. 359 subjects specify a strategy profile that is consistent with Proposition 2 and 44 subjects specify a strategy profile that is inconsistent with Proposition 2.
Under the AIR model, Proposition 3 predicts that P1's giving will be greater in the nonexclusive game after P2 gives than the control game. 363 subjects specify a strategy profile that is consistent with Proposition 3 and 40 subjects specify a strategy profile that is inconsistent with Proposition 3.

Table 6: Credit

				T-tests			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Control	Exclusive	Non-Exclusive	Exc vs. Nonexc	Control vs. Exc	Control vs. Nonexc	Obs.
P2's credit over P2's payoff		59.34	59.19	0.16			403
		(1.46)	(1.48)	(2.07)			
P2's credit over P1's payoff	21.99	44.41	43.31	1.10	-22.42***	-21.33***	403
	(0.89)	(0.95)	(0.87)	(1.29)	(1.31)	(1.25)	
P2's credit over P0's payoff	22.31	40.78	34.90	5.87***	-18.47***	-12.59***	403
	(0.96)	(0.94)	(0.94)	(1.32)	(1.33)	(1.34)	
P1's credit over P2's payoff		21.98	22.28	-0.30			403
		(0.85)	(0.90)	(1.23)			
P1's credit over P1's payoff	56.81	36.85	36.58	0.27	19.96***	20.23***	403
	(1.45)	(0.78)	(0.80)	(1.12)	(1.65)	(1.66)	
P1's credit over P0's payoff	54.45	37.61	42.51	-4.90***	16.84***	11.94***	403
	(1.50)	(0.95)	(1.21)	(1.53)	(1.78)	(1.93)	
P0's credit over P2's payoff		18.67	18.53	0.14			403
		(0.87)	(0.87)	(1.23)			
P0's credit over P1's payoff	21.20	18.74	20.10	-1.37	2.47**	1.10	403
	(0.92)	(0.88)	(0.93)	(1.28)	(1.27)	(1.31)	
P0's credit over P0's payoff	23.24	21.61	22.58	-0.97	1.63	0.66	403
	(1.05)	(1.07)	(1.08)	(1.52)	(1.50)	(1.50)	

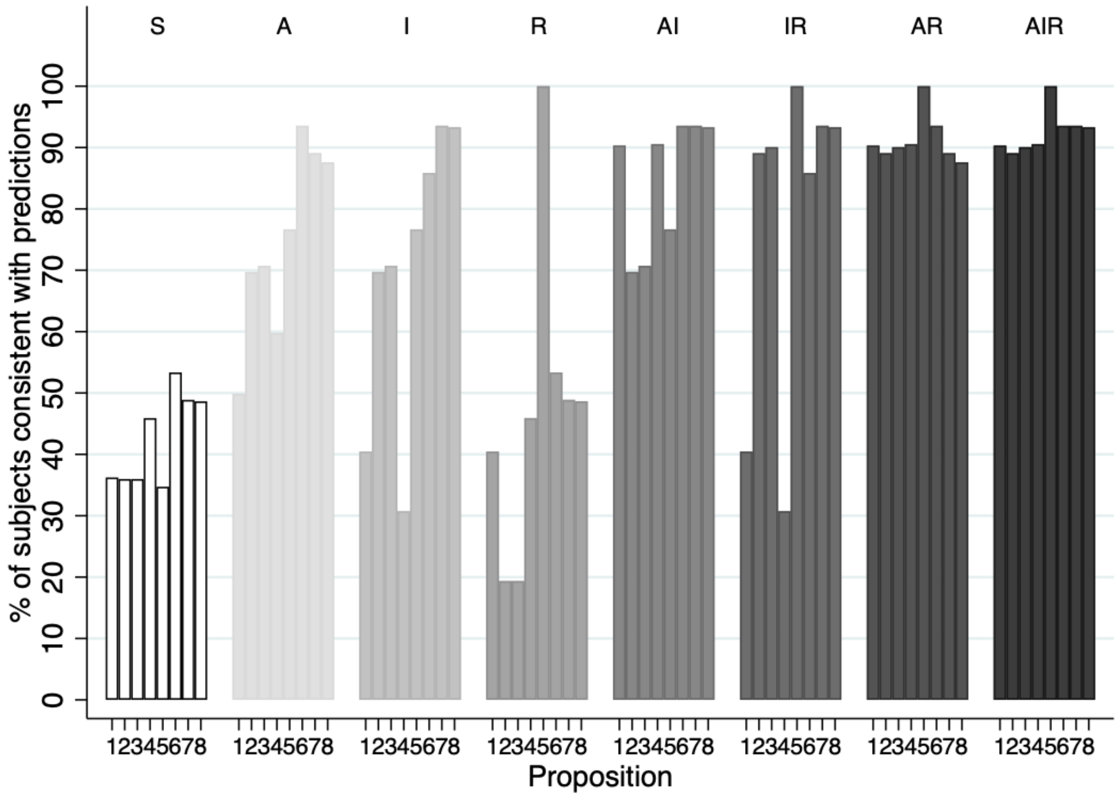
Notes: Standard errors in parentheses. Stars denote significant differences across games. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Oaxaca Decomposition: Relationship between Credit and Giving

	Full Sample	Accurate Responders
	(1)	(2)
	A: Difference in P1's Giving, N-E	
Diff in P1's credit for P0's payoff (N - E)	0.245**	0.232*
	(0.122)	(0.127)
P1's credit for P0's payoff (E)	0.124	0.047
	(0.130)	(0.129)
Observations	403	324
	B: Difference in P2's Giving, E-N	
Diff. in P2's credit for P1's payoff (E - N)	0.300**	0.328**
	(0.131)	(0.142)
Diff. in P2's credit for P0's payoff (E - N)	-0.064	-0.114
	(0.111)	(0.113)
P2's credit for P1's payoff (E)	-0.231	-0.234
	(0.142)	(0.142)
P2's credit for P0's payoff (E)	0.266**	0.256*
	(0.133)	(0.135)
Diff in P2's belief that P1 will give if P2 gives (E - N)	0.141	0.111
	(0.087)	(0.089)
Diff in P2's belief that P1 will give if P2 keeps (E - N)	0.053	-0.097
	(0.082)	(0.087)
P2's belief that P1 will give if P2 gives (E)	-0.163	-0.154
	(0.100)	(0.101)
P2's belief that P1 will give if P2 keeps (E)	0.000	0.000
	(0.000)	(0.000)
Observations	403	324

Notes: Oaxaca decomposition results based on Equations 6 and 7. Regressions conducted at subject level. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure 2: Assessing predictive power of each model



Notes: Bars represent the proportion of subjects whose behavior can be explained under each model. S - standard model; A - altruism; R - reciprocity; I - inequity aversion.

Online appendix

A Omitted proofs

A.1 Remark on efficient strategies

For technical reasons, when we define kindness we ignore Pareto-inefficient strategies and focus on Pareto-efficient ones. In our experiments, players do not have inefficient strategies. For the sake of completeness for the theory and to be consistent with previous theories, we keep this assumption. Intuitively, a strategy is inefficient if another strategy provides (i) no lower material payoff for any player for any history of play and the subsequent choices of others and (ii) a strictly higher payoff for some player for some history of play and subsequent choices by the others. Formally, player i's set of efficient strategies is

$$\Sigma_i^e := \Bigg\{ \sigma_i \in \Sigma_i \Bigg| \nexists \widehat{\sigma}_i \in \Sigma_i \text{ such that } \forall h \in H, \sigma_{-i} \in \Sigma_{-i}, k \in N,$$

$$\pi_k(\widehat{\sigma}_i(h), \sigma_{-i}(h)) \geq \pi_k(\sigma_i(h), \sigma_{-i}(h)) \quad \text{with strict inequality for some } (h, \sigma_{-i}, k) \Bigg\}.$$

A.2 Proof of the theorem on equilibrium existence

Proof of Theorem 1. Let $\Sigma_i(h)$ denote i's set of (potentially random) choices at history $h \in H$. For any $s \in \Sigma_i(h)$, let $\sigma_i(h, s)$ denote player i's strategy that specifies the choice s at h, but is the same as $\sigma_i(h)$ otherwise—i.e., at every history in $H \backslash \{h\}$. Define correspondence $\beta_{i,h} : \Sigma \to \Sigma_i(h)$ by

$$\beta_{i,h}(\sigma) = \underset{x \in X_i(h)}{\arg\max}\, u_i(\sigma_i(h, s), (\sigma_j(h), (\sigma_k(h))_{k \neq j})_{j \neq i}),$$

and define correspondence $\beta : \Sigma \to \Pi_{(i,h) \in N \times H} \Sigma_i(h)$ by

$$\beta(\sigma) = \prod_{(i,h) \in N \times H} \beta_{i,h}(\sigma).$$

The set $\prod_{(i,h) \in N \times H} \Sigma_i(h)$ is topologically equivalent to the set Σ, so $\beta : \Sigma \to \Pi_{(i,h) \in N \times H} \Sigma_i(h)$ is equivalent to a correspondence $\gamma : \Sigma \to \Sigma$ (which is a direct redefinition of β). Every fixed point of γ is an equilibrium. To see this, note that a fixed point $\beta_{i,h}$ satisfies utility maximization under consistent beliefs. Here, because $\beta_{i,h}$ specifies the optimal choices at each $h \in H$, altogether, $\beta_{i,h}$ specifies the optimal strategies in $\Sigma_i(h, s)$. Hence, β and γ are combined best-response correspondences. Since γ is a correspondence from Σ to Σ, it is amenable to fixed-point analysis.

It remains to show that γ possesses a fixed point. Berge's maximum principle guarantees that

$\beta_{i,h}$ is nonempty, closed-valued, and upper hemicontinuous, since $\Sigma_i(h)$ is nonempty and compact and u_i is continuous (since π_i, κ_{ij}, and λ_{ijk} are all continuous). In addition, $\beta_{i,h}$ is convex-valued, since $\Sigma_i(h)$ is convex and u_i is linear—and hence quasiconcave—in i's own choice. Hence, $\beta_{i,h}$ is nonempty, closed-valued, upper hemicontinuous, and convex-valued. These properties extend to β and γ. Hence, it follows by Kakutani's fixed-point theorem that γ admits a fixed point. □

A.3 Proof of lemmas on equilibrium giving strategy

Proof of Lemma 1. P1's choice is between giving, which yields material payoffs $(\pi_2, \pi_1, \pi_0) = (2, 2, 2)$, and keeping, which yields material payoffs $(\pi_2, \pi_1, \pi_0) = (2, 3, 0)$. P1's utility from giving is $u_1(g_1) = 2+4\cdot A_1$. P1's utility from keeping is $u_1(k_1) = 3+A_1\cdot 2-\beta_1\cdot(3-2)/2-\beta_1\cdot(3-0)/2 = 3+2\cdot A_1-2\cdot\beta_1$. P1 prefers giving if and only if $u_1(g_1) = 2+4\cdot A_1 \geq u_1(k_1) = 3+2\cdot A_1-2\cdot\beta_1$, that is, $2\cdot A_1+2\cdot\beta_1 \geq 1$. □

Proof of Lemma 2. Suppose P1 believes that P2 believes that P1 gives with probability γ''_{1G}. The equitable payoff of P1 is $(1+3-\gamma''_{1G})/2 = 2-\gamma''_{1G}/2$, so giving by P2 to P1 shows a kindness of $3-\gamma''_{1G}-(2-\gamma''_{1G}/2) = 1-\gamma''_{1G}/2$. P1's utility from giving, which results in material payoffs $(\pi_2, \pi_1, \pi_0) = (2, 2, 2)$, is $u_1(g_{1G}, \gamma''_{1G}) = 2+4\cdot A_1+Z_1\cdot(+1)\cdot(1-\gamma''_{1G}/2)$, and P1's utility from keeping, which yields material payoffs $(\pi_2, \pi_1, \pi_0) = (2, 3, 0)$, is $u_1(k_{1G}, \gamma''_{1G}) = 3+2\cdot A_1-2\cdot\beta_1+Z_1\cdot(-1)\cdot(1-\gamma''_{1G}/2)$. Therefore, P1's utility from giving with probability γ_{1G} is $u_1(\gamma_{1G}, \gamma''_{1G}) = \gamma_{1G}\cdot[-1+2\cdot A_1+2\cdot\beta_1+Z_1\cdot(2-\gamma''_{1G})]+3+2\cdot A_1-2\cdot\beta_1-Z_1\cdot(1-\gamma''_{1G}/2)$. If $2\cdot A_1+2\cdot\beta_1+Z_1 \geq 1$, then $\gamma_{1G} = 1$. If $2\cdot A_1+2\cdot\beta_1+2\cdot Z_1 \leq 1$, then $\gamma_{1G} = 0$. If $2\cdot A_1+2\cdot\beta_1+Z_1 < 1 < 2\cdot A_1+2\cdot\beta_1+2\cdot Z_1$, then $-1+2\cdot A_1+2\cdot\beta_1+Z_1\cdot(2-\gamma_{1G}) = 0$, which rearranges to $\gamma_{1G} = 2-(1-2\cdot A_1-2\cdot\beta_1)/Z_1$. Therefore, in equilibrium, $\gamma^e_{1G} = [\![2+(2\cdot A_1+2\cdot\beta_1-1)/Z_1]\!]$.

Suppose P2 believes that P1 gives with probability γ'_{1G}. P2's expected utility from giving, which yields material payoffs $(\pi_2, \pi_1, \pi_0) = (2, 2, 2)$ with probability γ'_{1G} and $(\pi_2, \pi_1, \pi_0) = (2, 3, 0)$ with probability $1-\gamma'_{1G}$, is $\gamma'_{1G}\cdot(2+4\cdot A_2)+(1-\gamma'_{1G})\cdot(2+3\cdot A_2-\alpha_2/2-\beta_2) = 2+4\cdot A_2-(1-\gamma'_{1G})\cdot(A_2+\alpha_2/2+\beta_2)$. P2's utility from keeping, which yields material payoffs $(\pi_2, \pi_1, \pi_0) = (3, 1, 0)$, is $3+1\cdot A_2-\beta_2\cdot(3-1)/2-\beta_2\cdot(3-0)/2 = 3+A_2-5\cdot\beta_2/2$. P2 prefers giving if $2+4\cdot A_2-(1-\gamma'_{1G})\cdot(A_2+\alpha_2/2+\beta_2) \geq 3+A_2-5\cdot\beta_2/2$, which is simplified to $3\cdot A_2+5\cdot\beta_2/2-(1-\gamma'_{1G})\cdot(A_2+\alpha_2/2+\beta_2) \geq 1$. In equilibrium, $\gamma'_{1G} = \gamma_{1G}$, so the inequality is rearranged to $(2+\gamma_{1G})\cdot A_2-(1-\gamma_{1G})\cdot\alpha_2/2+(3/2+\gamma_{1G})\cdot\beta_2 \geq 1$. □

Proof of Lemma 3. Suppose P1 believes that P2 believes that P1 gives with probability γ''_{1G} when P2 gives, and gives with probability γ''_{1K} when P2 keeps. First, suppose P2 keeps. P0's equitable payoff is 1, and P1's equitable payoff is $[(1-\gamma''_{1K})+(3-\gamma''_{1G})]/2 = 2-\gamma''_{1K}/2-\gamma''_{1G}/2$.

First, consider when P2 keeps. P1's utility from giving, which yields material payoffs $(\pi_2, \pi_1, \pi_0) = (3, 0, 2)$, is $u_1(k_2, g_{1K}, \cdots) = 0+5\cdot A_1-\alpha_1\cdot(3-0)/2-\alpha_1\cdot(2-0)/2+Z_1\cdot(+1)\cdot(\gamma''_{1G}/2-$

$1-\gamma''_{1K}/2) = 5\cdot A_1 - 5\cdot\alpha_1/2 + Z_1\cdot(\gamma''_{1G}/2 - 1 - \gamma''_{1K}/2)$, and P1's utility from keeping, which yields material payoffs $(\pi_2, \pi_1, \pi_0) = (3, 1, 0)$, is $u_1(k_2, k_{1K}, \cdots) = 1 + 3\cdot A_1 - \alpha_1\cdot(3-1)/2 - \beta_1\cdot(1-0)/2 - Z_1\cdot(\gamma''_{1G}/2 - 1 - \gamma''_{1K}/2) = 1 + 3\cdot A_1 - 3\cdot\alpha_1/2 - \beta_1/2 - Z_1\cdot(\gamma''_{1G}/2 - 1 - \gamma''_{1K}/2)$. Fixing γ''_{1G} and γ''_{1K}, we have $u_1(k_2, g_{1K}, \cdots) - u_1(k_2, k_{1K}, \cdots) = -1 + 2\cdot A_1 - 3\cdot\alpha_1/2 - \beta_1/2 + 2\cdot Z_1\cdot(\gamma''_{1G}/2 - 1 - \gamma''_{1K}/2) = -1 + 2\cdot A_1 - 3\cdot\alpha_1/2 - \beta_1/2 - Z_1\cdot(2 - \gamma''_{1G} + \gamma''_{1K})$.

Second, consider when P2 gives. Regarding the reciprocity payoff, the only change is in the flip of the sign of λ_{121}. P1's utility of giving, which yields material payoffs $(\pi_2, \pi_1, \pi_0) = (2, 2, 2)$, is $u_1(g_2, g_{1G}, \cdots) = 2 + 4\cdot A_1 + Z_1\cdot(1 - \gamma''_{1G}/2 + \gamma''_{1K}/2)$. P1's utility of keeping, which yields material payoffs $(\pi_2, \pi_1, \pi_0) = (2, 3, 0)$, is $u_1(g_2, k_{1G}, \cdots) = 3 + 2\cdot A_1 - \beta_1\cdot(3-2)/2 - \beta_1\cdot(3-0)/2 - Z_1\cdot(1 - \gamma''_{1G}/2 + \gamma''_{1K}/2) = 3 + 2\cdot A_1 - 2\cdot\beta_1 - Z_1\cdot(1 - \gamma''_{1G}/2 + \gamma''_{1K}/2)$. Hence, $u_1(g_2, g_{1G}, \cdots) - u_1(g_2, k_{1G}, \cdots) = -1 + 2\cdot A_1 + 2\cdot\beta_1 + Z_1\cdot(2 - \gamma''_{1G} + \gamma''_{1K})$.

Comparing the net benefit of giving after P2 gives and that after P2 keeps, we have

$$u_1(g_2, g_{1G}, \cdots) - u_1(g_2, k_{1G}, \cdots) \geq u_1(k_2, g_{1G}, \cdots) - u_1(k_2, k_{1G}, \cdots).$$

Hence, whenever P1 decides to give after P2 keeps, she will also choose to give after P2 gives. In other words, P1 is more inclined to give after P2 gives than after P2 keeps: $\gamma_{1G} \geq \gamma_{1K}$. Given this inequality, there are five possible cases regarding γ_{1G} and γ_{1K}.

1. Strategies $\gamma_{1G} = 1$ and $\gamma_{1K} = 1$ are supported in equilibrium when and only when $2\cdot A_1 - 3\cdot\alpha_1/2 - \beta_1/2 - 2\cdot Z_1 \geq 1$.

2. Strategies $\gamma_{1G} = 1$ and $0 < \gamma_{1K} < 1$ are supported in equilibrium when and only when $2\cdot A_1 - 3\cdot\alpha_1/2 - \beta_1/2 - 2\cdot Z_1 \leq 1 \leq 2\cdot A_1 - 3\cdot\alpha_1/2 - \beta_1/2 - Z_1$. In this case, $2\cdot A_1 - 3\cdot\alpha_1/2 - \beta_1/2 - Z_1\cdot(1+\gamma_{1K}) = 1$, which is rearranged to $\gamma_{1K} = (2\cdot A_1 - 3\cdot\alpha_1/2 - \beta_1/2 - 1 - Z_1)/Z_1$.

3. Strategies $\gamma_{1G} = 1$ and $\gamma_{1K} = 0$ are supported in equilibrium when and only when $2\cdot A_1 - 3\cdot\alpha_1/2 - \beta_1/2 - Z_1 \leq 1 \leq 2\cdot A_1 + 2\cdot\beta_1 + Z_1$.

4. Strategies $0 < \gamma_{1G} < 1$ and $\gamma_{1K} = 0$ are supported in equilibrium when and only when $2\cdot A_1 + 2\cdot\beta_1 + Z_1 \leq 1 \leq 2\cdot A_1 + 2\cdot\beta_1 + 2\cdot Z_1$. In this case, $2\cdot A_1 + 2\cdot\beta_1 + Z_1\cdot(2-\gamma_{1G}) = 1$, which is rearranged to $\gamma_{1G} = 2 + (2\cdot A_1 + 2\cdot\beta_1 - 1)/Z_1$.

5. Strategies $\gamma_{1G} = 0$ and $\gamma_{1K} = 0$ are supported in equilibrium when and only when $2\cdot A_1 + 2\cdot\beta_1 + 2\cdot Z_1 \leq 1$.

In summary, in the nonexclusive game, P1 gives with probability $\gamma^n_{1G} = [\![(2\cdot A_1 + 2\cdot\beta_1 - 1)/Z_1 + 2]\!]$ after P2 gives, and gives with probability $\gamma^n_{1K} = [\![(2\cdot A_1 - \alpha_1 - \beta_1/2 - 1)/Z_1 - 1]\!]$ after P2 keeps.

Consider P2's action next. Suppose P2 believes that P1 gives with probability γ'_{1G} and γ'_{1K} when P2 gives and keeps, respectively. P2's expected utility from giving, which yields material payoffs $(\pi_2, \pi_1, \pi_0) = (2, 2, 2)$ with probability γ'_{1G} and $(\pi_2, \pi_1, \pi_0) = (2, 3, 0)$ with probability $1-\gamma'_{1G}$, is $(2+4\cdot A_2)\cdot\gamma'_{1G}+(2+3\cdot A_2-\alpha_2/2-\beta_2)\cdot(1-\gamma'_{1G}) = 2+(3+\gamma'_{1G})\cdot A_2-(1-\gamma'_{1G})\cdot(\alpha_2/2+\beta_2)$. P2's expected utility from keeping, which yields material payoffs $(\pi_2, \pi_1, \pi_0) = (3, 0, 2)$ with probability γ'_{1K} and $(\pi_2, \pi_1, \pi_0) = (3, 1, 0)$ with probability $1-\gamma'_{1K}$, is $\gamma'_{1K}\cdot[3+2\cdot A_2-\beta_2\cdot(3-0)/2-\beta_2\cdot(3-2)/2]+(1-\gamma'_{1K})\cdot[3+A_2-\beta_2\cdot(3-0)/2-\beta_2\cdot(3-1)/2] = 3+(1+\gamma'_{1K})\cdot A_2-(5-\gamma'_{1K})\cdot\beta_2/2$. P2 prefers giving if and only if $2+(3+\gamma'_{1G})\cdot A_2-(1-\gamma'_{1G})\cdot(\alpha_2/2+\beta_2) \geq 3+(1+\gamma'_{1K})\cdot A_2-(5-\gamma'_{1K})\cdot\beta_2/2$, which, as $\gamma_{1G} = \gamma'_{1G}$ and $\gamma_{1K} = \gamma'_{1K}$ in equilibrium, is rearranged to $(2 + \gamma_{1G} - \gamma_{1K}) \cdot A_2 - (1/2 - \gamma_{1G}/2) \cdot \alpha_2 + (3/2 + \gamma_{1G} - \gamma_{1K}/2) \cdot \beta_2 \geq 1$. □

A.4 Proofs of propositions on equilibrium giving comparisons

Proof of Prop 1. In the nonexclusive game, P1 gives with probability $\gamma^n_{1G} = [\![(2 \cdot A_1 + 2 \cdot \beta_1 - 1)/Z_1 + 2]\!]$ after P2 gives, and P1 gives with probability $\gamma^n_{1K} = [\![(2\cdot A_1-3\cdot\alpha_1/2-\beta_1/2-1)/Z_1-1]\!]$ after P2 keeps. Since $(2 \cdot A_1 + 2 \cdot \beta_1 - 1)/Z_1 + 2 > (2 \cdot A_1 - 3 \cdot \alpha_1/2 - \beta_1/2 - 1)/Z_1 - 1$ for any combination of nonnegative parameters A_1, α_1, β_1, and Z_1, $\gamma^n_{1G} \geq \gamma^n_{1K}$, and the inequality is strict as long as $Z_1 \neq 0$. □

Proof of Prop 2. Explicitly, P1's equilibrium probability of giving in the control game is

$$\gamma^c_1 = \begin{cases} 1 & \text{if } 2 \cdot A_1 + 2 \cdot \beta_1 > 1, \\ 0 & \text{if } 2 \cdot A_1 + 2 \cdot \beta_1 < 1, \end{cases}$$

and P1's equilibrium probability of giving in the exclusive game is

$$\gamma^e_{1G} = \begin{cases} 1 & \text{if } 2 \cdot A_1 + 2 \cdot \beta_1 + Z_1 > 1, \\ (2 \cdot A_1 + 2 \cdot \beta_1 - 1)/Z_1 + 2 & \text{if } 2 \cdot A_1 + 2 \cdot \beta_1 + 2 \cdot Z_1 \geq 1 \geq 2 \cdot A_1 + 2 \cdot \beta_1 + Z_1, \\ 0 & \text{if } 2 \cdot A_1 + 2 \cdot \beta_1 + 2 \cdot Z_1 < 1. \end{cases}$$

When $Z_1 = 0$, the condition for $\gamma^e_{1G} = 1$ and the condition for $\gamma^c_1 = 1$ coincide, and the condition for $\gamma^e_{1G} = 0$ and the condition for $\gamma^c_1 = 0$ also coincide. When $Z_1 > 0$, the set of parameters for $\gamma^e_{1G} = 1$ is a strict superset of that for $\gamma^c_1 = 1$, and the set of parameters for $\gamma^e_{1G} = 0$ is a strict subset of that for $\gamma^c_1 = 0$. For the set range of parameters for $0 < \gamma^e_{1G} < 1$, $\gamma^c_1 = 0$. Hence, $\gamma^e_{1G} \geq \gamma^c_1$ for any combination of parameters. Hence, $\gamma^e_{1G} \succ \gamma^c_1$ □

Proof of Prop 3. The proof mimics the proof of Proposition 2, with superscripts *e* replaced by superscripts *n*. Alternatively, by Proposition 5, $\gamma^e_{1G} \sim \gamma^n_{1G}$, so by transitivity of the inclination,

$\gamma_{1G}^n \succ \gamma_1^c$. $\square$

Proof of Prop 4. Explicitly, P1's equilibrium probability of giving in the control game is

$$\gamma_1^c = \begin{cases} 1 & \text{if } 2 \cdot A_1 + 2 \cdot \beta_1 > 1, \\ 0 & \text{if } 2 \cdot A_1 + 2 \cdot \beta_1 < 1, \end{cases}$$

and P1's equilibrium probability of giving after P2 keeps in the nonexclusive game is

$$\gamma_{1K}^n = \begin{cases} 1 & \text{if } 2 \cdot A_1 - 3 \cdot \alpha_1/2 - \beta_1/2 - 2 \cdot Z_1 > 1, \\ (2 \cdot A_1 - 3 \cdot \alpha_1/2 - \beta_1/2 - 1)/Z_1 - 1 & \text{if } 2 \cdot A_1 - 3 \cdot \alpha_1/2 - \beta_1/2 - 2 \cdot Z_1 \leq 1 \\ & \quad \leq 2 \cdot A_1 - 3 \cdot \alpha_1/2 - \beta_1/2 - Z_1 \\ 0 & \text{if } 2 \cdot A_1 - 3 \cdot \alpha_1/2 - \beta_1/2 - Z_1 < 1. \end{cases}$$

When $\alpha_1 = \beta_1 = Z_1 = 0$, the two decisions coincide. When $\alpha_1 > 0$, $\beta_1 > 0$, and/or $Z_1 > 0$, the set of parameters for $\gamma_1^c = 1$ is a strict superset of that for $\gamma_1^{1K} = 1$, and the set of parameters for $\gamma_1^c = 0$ is a strict subset of that for $\gamma_1^{1K} = 0$. Hence, $\gamma_1^c \succ \gamma_{1K}^n$. $\square$

Proof of Prop 5. P1 gives with probability $\gamma_{1G}^e = [\![(2 \cdot A_1 + 2 \cdot \beta_1 - 1)/Z_1 + 2]\!]$ after P2 gives in the exclusive game. Equally, P1 gives with probability $\gamma_{1G}^e = [\![(2 \cdot A_1 + 2 \cdot \beta_1 - 1)/Z_1 + 2]\!]$ after P2 gives in the nonexclusive game. Hence, P1 is equally inclined to give in the two treatment games after P2 gives. $\square$

Proof of Prop 6. As shown by the inequality condition in Lemma 2 that characterizes P2's preference for giving, P2's net benefit of giving over keeping in the exclusive game is $B^e \equiv (2 + \gamma_{1G}^e) \cdot A_2 - (1/2 - \gamma_{1G}^e/2) \cdot \alpha_2 + (3/2 + \gamma_{1G}^e) \cdot \beta_2 - 1$. Similarly, by the inequality condition in Lemma 3 that characterizes P2's preference for giving, P2's net benefit of giving over keeping in the nonexclusive game is $B^n \equiv (2 + \gamma_{1G}^n - \gamma_{1K}^n) \cdot A_2 - (1/2 - \gamma_{1G}^n/2) \cdot \alpha_2 + (3/2 + \gamma_{1G}^n - \gamma_{1K}^n) \cdot \beta_2 - 1$. By Proposition 5, $\gamma_{1K}^n = \gamma_{1G}^n$. Then, $B^e - B^n = \gamma_{1K}^n \cdot A_2 + \gamma_{1K}^n \cdot \beta_2$. Since $A_1 \geq 0$ and $\beta_1 \geq 0$ in the general AIR utility function, and $\gamma_{1K}^n > 0$ in equilibrium, $B^e - B^n \geq 0$. The higher net benefit of giving over keeping in the exclusive game implies a higher inclination of giving in the exclusive game than the nonexclusive game. $\square$

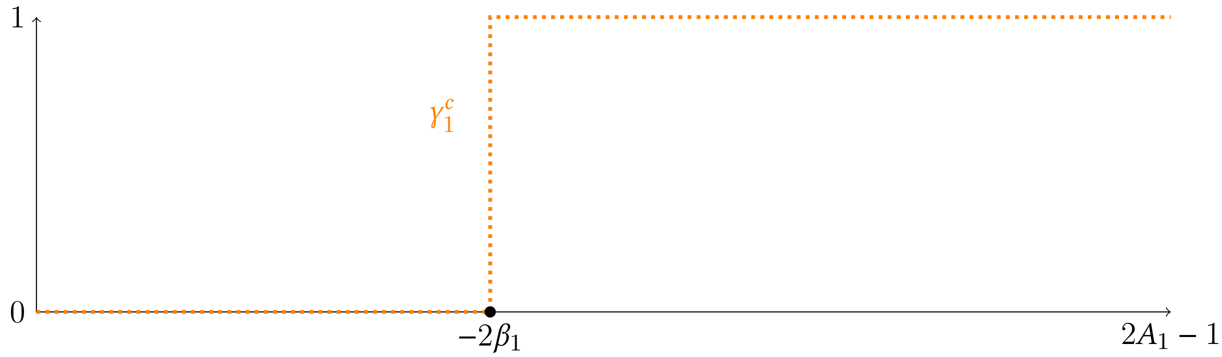
Proof of Prop 7. By the inequality condition in Lemma 1 that characterizes P1's preference for giving, P1's net benefit of giving over keeping in the control game is $B^c \equiv 2 \cdot A_1 + 2 \cdot \beta_1 - 1$. As shown by the inequality condition in Lemma 2 that characterizes P2's preference for giving, P2's net benefit of giving over keeping in the exclusive game is $B^e \equiv (2 + \gamma_{1G}^e) \cdot A_2 - (1/2 - \gamma_{1G}^e/2) \cdot \alpha_2 + (3/2 + \gamma_{1G}^e) \cdot \beta_2 - 1$. For the same subject, i.e., $A_1 = A_2 \equiv A$, $\alpha_1 = \alpha_2 \equiv \alpha$, $\beta_1 = \beta_2 \equiv \beta$,

$Z_1 = Z_2 \equiv Z$, the difference in the net benefits is $B^e - B^c = \gamma^e_{1G} \cdot A - (1 - \gamma^e_{1G}) \cdot \alpha/2 + (\gamma^e_{1G} - 1/2) \cdot \beta$. Therefore, P1 in the control game is more inclined to give than P2 in the exclusive game, if and only if $B^e - B^c \leq 0$, that is, $\gamma^e_{1G} \cdot A + (\gamma^e_{1G} - 1/2) \cdot \beta \leq (1 - \gamma^e_{1G}) \cdot \alpha/2$. □

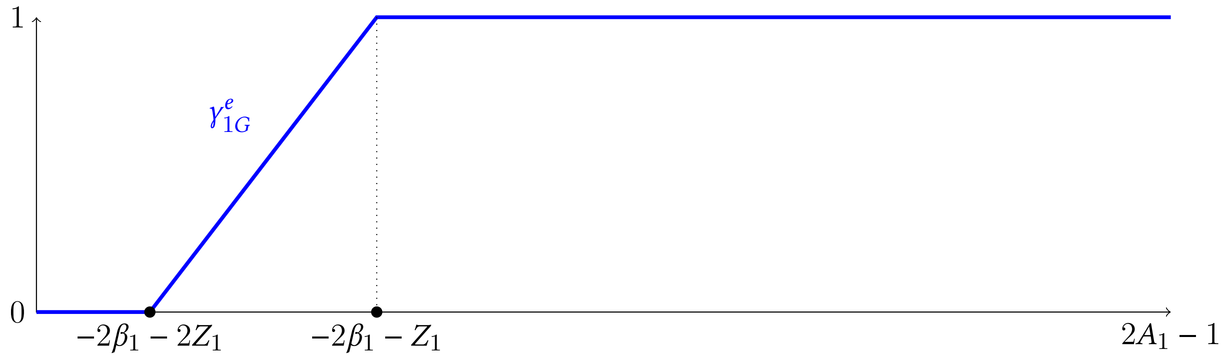
Proof of Prop 8. By the inequality condition in Lemma 1 that characterizes P1's preference for giving, P1's net benefit of giving over keeping in the control game is $B^c \equiv 2 \cdot A_1 + 2 \cdot \beta_1 - 1$. By the inequality condition in Lemma 3 that characterizes P2's preference for giving, P2's net benefit of giving over keeping in the nonexclusive game is $B^n \equiv (2 + \gamma^n_{1G} - \gamma^n_{1K}) \cdot A_2 - (1/2 - \gamma^n_{1G}/2) \cdot \alpha_2 + (3/2 + \gamma^n_{1G} - \gamma^n_{1K}) \cdot \beta_2 - 1$. For the same subject, i.e., $A_1 = A_2 \equiv A$, $\alpha_1 = \alpha_2 \equiv \alpha$, $\beta_1 = \beta_2 \equiv \beta$, $Z_1 = Z_2 \equiv Z$, the difference in the net benefits is $B^n - B^c = (\gamma^n_{1G} - \gamma^n_{1K}) \cdot A - (1/2 - \gamma^n_{1G}/2) \cdot \alpha + (\gamma^n_{1G} - \gamma^n_{1K} - 1/2) \cdot \beta$. Therefore, P1 in the control game is more inclined to give than P2 in the nonexclusive game, if and only if $B^n - B^c \leq 0$, that is, $(\gamma^n_{1G} - \gamma^n_{1K}) \cdot A + (\gamma^n_{1G} - \gamma^n_{1K} - 1/2) \cdot \beta \leq (1/2 - \gamma^n_{1G}/2) \cdot \alpha$. □

Figure 3: P1's equilibrium giving rates in different games

(a) P1's equilibrium giving rate γ_1^c in the control game



(b) P1's equilibrium giving rate γ_{1G}^e in the exclusive game



(c) P1's equilibrium giving rates γ_{1G}^n and γ_{1K}^n in the nonexclusive game

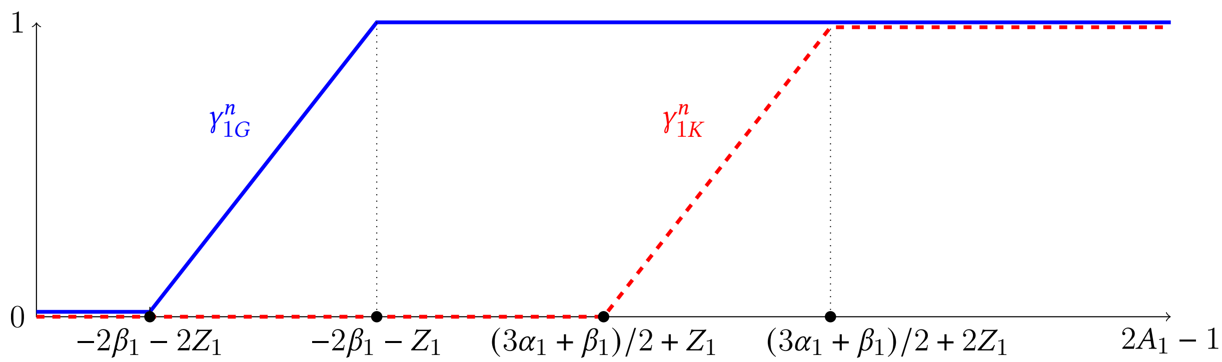


Figure 4: Last movers' equilibrium giving rates comparisons

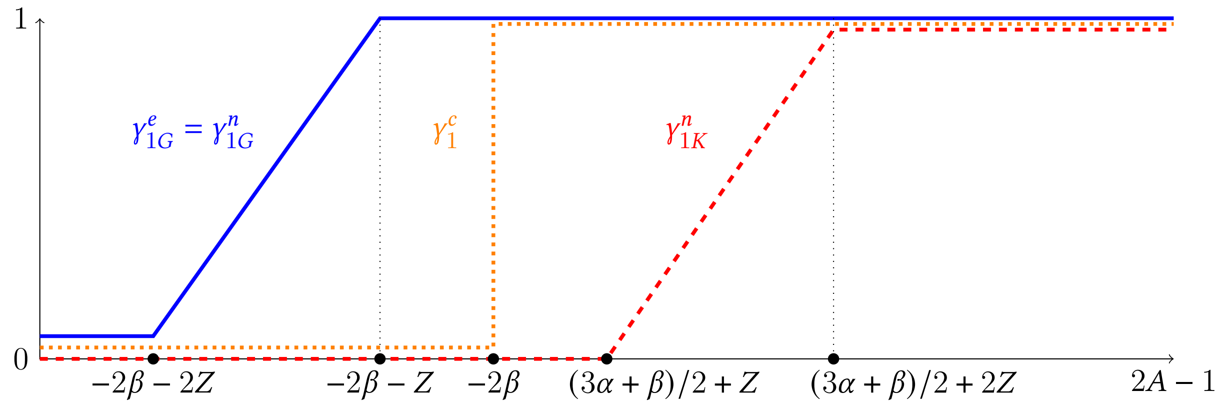
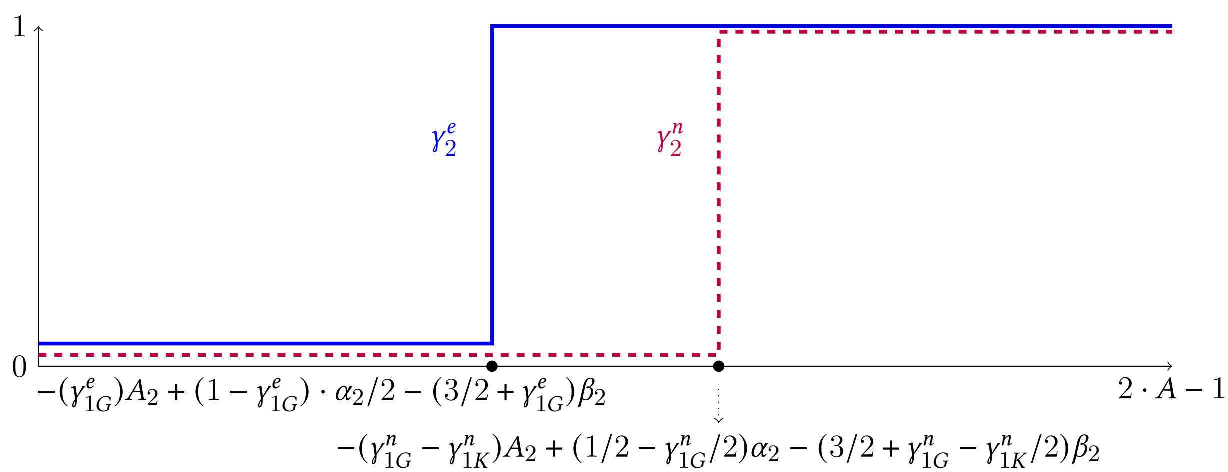


Figure 5: First movers' equilibrium giving rates



B Additional experimental results

Table C1: Experimental results of giving rates comparisons, robustness checks

(c) All accurate answers, $N = 104$

Prop	Experimental result		Consistent with predictions?							
	proportion	p-value	S	A	I	R	AI	IR	AR	AIR
1	$\widehat{\gamma}^n_{1G} = 69.3\% > \widehat{\gamma}^n_{1K} = 14.3\%$	$p < 0.0001$	No	No	No	No	Yes	No	Yes	Yes
2	$\widehat{\gamma}^e_{1G} = 65\% > \widehat{\gamma}^c_1 = 61.4\%$	$p = 0.0989$	No	No	No	No	No	Yes	Yes	Yes
3	$\widehat{\gamma}^n_{1G} = 69.3\% > \widehat{\gamma}^c_1 = 61.4\%$	$p = 0.0079$	No	No	No	No	No	Yes	Yes	Yes
4	$\widehat{\gamma}^n_{1K} = 14.3\% < \widehat{\gamma}^c_1 = 61.4\%$	$p < 0.0001$	No	No	No	No	Yes	No	Yes	Yes
5	$\widehat{\gamma}^n_{1G} = 69.3\% > \widehat{\gamma}^e_{1G} = 65.0\%$	$p = 0.0790$	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6	$\widehat{\gamma}^e_2 = 59.3\% > \widehat{\gamma}^n_2 = 57.1\%$	$p = 0.1292$	No	Yes	No	No	Yes	No	Yes	D
7	$\widehat{\gamma}^e_2 = 59.3\% \sim \widehat{\gamma}^c_1 = 61.4\%$	$p = 0.1292$	No	No	Yes	No	Yes	Yes	No	Yes
8	$\widehat{\gamma}^n_2 = 57.1\% < \widehat{\gamma}^c_1 = 61.4\%$	$p = 0.0287$	No	No	Yes	No	Yes	Yes	No	Yes

(b) $\leq$ **6 incorrect answers (**$N = 378$**)**

Prop	Experimental result		Consistent with predictions?							
	proportion	p-value	S	A	I	R	AI	IR	AR	AIR
1	$\widehat{\gamma}^n_{1G} = 54.5\% > \widehat{\gamma}^n_{1K} = 22.2\%$	$p < 0.0001$	No	No	No	No	Yes	No	Yes	Yes
2	$\widehat{\gamma}^e_{1G} = 51.3\% > \widehat{\gamma}^c_1 = 45.0\%$	$p = 0.0092$	No	No	No	No	No	Yes	Yes	Yes
3	$\widehat{\gamma}^n_{1G} = 54.5\% > \widehat{\gamma}^c_1 = 45.0\%$	$p = 0.0002$	No	No	No	No	No	Yes	Yes	Yes
4	$\widehat{\gamma}^n_{1K} = 22.2\% < \widehat{\gamma}^c_1 = 45.0\%$	$p < 0.0001$	No	No	No	No	Yes	No	Yes	Yes
5	$\widehat{\gamma}^n_{1G} = 54.5\% > \widehat{\gamma}^e_{1G} = 51.3\%$	$p = 0.0954$	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6	$\widehat{\gamma}^e_2 = 42.3\% > \widehat{\gamma}^n_2 = 39.7\%$	$p = 0.0829$	No	Yes	No	No	Yes	No	Yes	Yes
7	$\widehat{\gamma}^e_2 = 42.3\% \sim \widehat{\gamma}^c_1 = 45.0\%$	$p = 0.1022$	No	No	Yes	No	Yes	Yes	No	Yes
8	$\widehat{\gamma}^n_2 = 39.7\% < \widehat{\gamma}^c_1 = 45.0\%$	$p = 0.0068$	No	No	Yes	No	Yes	Yes	No	Yes

(c) Accurate responders, < 45 **min (**$N = 298$**)**

Prop	Experimental result		Consistent with predictions?							
	proportion	p-value	S	A	I	R	AI	IR	AR	AIR
1	$\widehat{\gamma}^n_{1G} = 57.7\% > \widehat{\gamma}^n_{1K} = 19.5\%$	$p < 0.0001$	No	No	No	No	Yes	No	Yes	Yes
2	$\widehat{\gamma}^e_{1G} = 54.0\% > \widehat{\gamma}^c_1 = 46.0\%$	$p = 0.0020$	No	No	No	No	No	Yes	Yes	Yes
3	$\widehat{\gamma}^n_{1G} = 57.7\% > \widehat{\gamma}^c_1 = 46.0\%$	$p < 0.0001$	No	No	No	No	No	Yes	Yes	Yes
4	$\widehat{\gamma}^n_{1K} = 19.5\% < \widehat{\gamma}^c_1 = 46.0\%$	$p < 0.0001$	No	No	No	No	Yes	No	Yes	Yes
5	$\widehat{\gamma}^n_{1G} = 57.7\% > \widehat{\gamma}^e_{1G} = 54.0\%$	$p = 0.0797$	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

6	$\widehat{\gamma}_2^e = 45.6\% > \widehat{\gamma}_2^n = 42.3\%$	$p = 0.0524$	No	Yes	No	No	Yes	No	Yes	Yes
7	$\widehat{\gamma}_2^e = 45.6\% \sim \widehat{\gamma}_1^c = 46.0\%$	$p = 0.4395$	No	No	Yes	No	Yes	Yes	No	Yes
8	$\widehat{\gamma}_2^n = 42.3\% < \widehat{\gamma}_1^c = 46.0\%$	$p = 0.0506$	No	No	Yes	No	Yes	Yes	No	Yes

(d) Accurate responders, saw nonexclusive game first ($N = 156$)

Prop	Experimental result		Consistent with predictions?							
	proportion	p-value	S	A	I	R	AI	IR	AR	AIR
1	$\widehat{\gamma}_{1G}^n = 55.1\% > \widehat{\gamma}_{1K}^n = 16.7\%$	$p < 0.0001$	No	No	No	No	Yes	No	Yes	Yes
2	$\widehat{\gamma}_{1G}^e = 48.7\% > \widehat{\gamma}_1^c = 41.7\%$	$p = 0.0506$	No	No	No	No	No	Yes	Yes	Yes
3	$\widehat{\gamma}_{1G}^n = 55.1\% > \widehat{\gamma}_1^c = 41.7\%$	$p = 0.0015$	No	No	No	No	No	Yes	Yes	Yes
4	$\widehat{\gamma}_{1K}^n = 16.7\% < \widehat{\gamma}_1^c = 41.7\%$	$p < 0.0001$	No	No	No	No	Yes	No	Yes	Yes
5	$\widehat{\gamma}_{1G}^n = 55.1\% > \widehat{\gamma}_{1G}^e = 48.7\%$	$p = 0.0339$	No	No	No	No	No	No	No	No
6	$\widehat{\gamma}_2^e = 41.7\% > \widehat{\gamma}_2^n = 35.8\%$	$p = 0.0302$	No	Yes	No	No	Yes	No	Yes	Yes
7	$\widehat{\gamma}_2^e = 41.7\% \sim \widehat{\gamma}_1^c = 41.7\%$	$p = 0.5000$	No	No	Yes	No	Yes	Yes	No	Yes
8	$\widehat{\gamma}_2^n = 35.9\% < \widehat{\gamma}_1^c = 41.7\%$	$p = 0.0359$	No	No	Yes	No	Yes	Yes	No	Yes

(e) Accurate responders, saw exclusive game first ($N = 168$)

Prop	Experimental result		Consistent with predictions?							
	proportion	p-value	S	A	I	R	AI	IR	AR	AIR
1	$\widehat{\gamma}_{1G}^n = 57.1\% > \widehat{\gamma}_{1K}^n = 22.6\%$	$p < 0.0001$	No	No	No	No	Yes	No	Yes	Yes
2	$\widehat{\gamma}_{1G}^e = 55.4\% > \widehat{\gamma}_1^c = 48.8\%$	$p = 0.0239$	No	No	No	No	No	Yes	Yes	Yes
3	$\widehat{\gamma}_{1G}^n = 57.1\% > \widehat{\gamma}_1^c = 48.8\%$	$p = 0.0064$	No	No	No	No	No	Yes	Yes	Yes
4	$\widehat{\gamma}_{1K}^n = 22.6\% < \widehat{\gamma}_1^c = 48.8\%$	$p < 0.0001$	No	No	No	No	Yes	No	Yes	Yes
5	$\widehat{\gamma}_{1G}^n = 57.1\% \sim \widehat{\gamma}_{1G}^e = 55.4\%$	$p = 0.3117$	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6	$\widehat{\gamma}_2^e = 46.4\% \sim \widehat{\gamma}_2^n = 45.2\%$	$p = 0.3194$	No	No	Yes	No	No	Yes	No	D
7	$\widehat{\gamma}_2^e = 46.4\% \sim \widehat{\gamma}_1^c = 48.8\%$	$p = 0.1863$	No	No	Yes	No	Yes	Yes	No	Yes
8	$\widehat{\gamma}_2^n = 45.2\% \sim \widehat{\gamma}_1^c = 48.8\%$	$p = 0.1129$	No	Yes	Yes	No	Yes	Yes	No	Yes

Note: Giving rate is denoted by γ. The superscript denotes game type, where c stands for control, e for exclusive, and n for nonexclusive. The subscript G stands for P1's decision after P2 gives, and K for P1's decision after P2 keeps.

Table C2: Comparing empirical strategies to model predictions ($N = 403$)

Prop	LHS,RHS	(1) GG	(2) GK	(3) KG	(4) KK	(5) S	(6) A	(7) I	(8) R	(9) AI	(10) IR	(11) AR	(12) AIR
		strategies				subjects with consistent behavior							
1	Y^n_{1G} Y^n_{1K}	55	163	39	146	146 (36.23%)	201 (49.88%)	163 (40.45%)	163 (40.45%)	364 (90.32%)	63 (40.45%)	364 (90.32%)	364 (90.32%)
2	Y^e_{1G} Y^c_1	136	78	44	145	145 (35.98%)	281 (69.73%)	281 (69.73%)	78 (19.35%)	281 (69.73%)	359 (89.08%)	359 (89.08%)	359 (89.08%)
3	Y^n_{1G} Y^c_1	140	78	40	145	145 (35.98%)	285 (70.72%)	285 (70.72%)	78 (19.35%)	285 (70.72%)	363 (90.07%)	363 (90.07%)	363 (90.07%)
4	Y^c_1 Y^n_{1K}	56	124	38	185	185 (45.91%)	241 (59.80%)	124 % (30.77 %)	185 (45.91%)	365 (90.57%)	124 (30.77%)	365 (90.57%)	365 (90.57%)
5	Y^n_{1G} Y^e_{1G}	169	49	45	140	140 (34.73%)	309 (76.67%)	403 (76.67%)	403[a] (100%)	309 (76.67%)	403[a] (100%)	403[a] (100%)	403[a] (100%)
6	Y^e_2 Y^n_2	131	31	26	215	215 (53.35%)	377 (93.55%)	346 (85.86%)	215 (53.35%)	377 (93.55%)	346 (85.86%)	377 (93.55%)	377 (93.55%)
7	Y^e_2 Y^c_1	136	26	44	197	197 (48.88%)	359 (89.08%)	377[b] (93.55%)	197 (48.88%)	377[b] (93.55%)	377[b] (93.55%)	359[b] (89.08%)	377[b] (93.55%)
8	Y^n_2 Y^c_1	130	27	50	196	196 (48.64%)	353 (87.59%)	376[b] (93.30%)	196 (48.64%)	376[b] (93.30%)	376[b] (93.30%)	353 (87.59%)	376[b] (93.30%)

Columns (1)-(4) tabulate subjects that choose give or keep at the two nodes corresponding to (LHS, RHS). P-values from a one-sided Fisher's exact test for all propositions except Proposition 5, which reports results from a two-sided test given the AIR model predictions from Tables 1 and 1. Columns (5)-(12) tabulate the number of subjects whose strategies are consistent with predictions under each model we consider.

[a]Players can play mixed strategies, so all strategy combinations can comply with the predictions.

[b]Violators play either GK or KG, depending on the parameters of the model. We report the lower percentage of violators in the table.

Table C3: Second-order beliefs and consistency with generalized reciprocity motives

	(1)	(2)	(3)	(4)
Consistent with	Prop 2	Prop 2	Prop 3	Prop 3
P1's belief of P2's belief that P1 will give if P2 gave	0.130^{**}	0.109^{*}	0.158^{***}	0.146^{***}
	(0.0607)	(0.0646)	(0.0530)	(0.0563)
P1's belief of P2's belief that P1 will give if P2 kept			-0.0673	-0.0846
			(0.0550)	(0.0581)
Constant	0.816^{***}	0.957^{***}	0.836^{***}	0.860^{***}
	(0.0380)	(0.176)	(0.0347)	(0.167)
Observations	403	403	403	403
R^2	0.011	0.071	0.023	0.082
Subject-Level Controls		✓		✓

Notes: Regression of consistent behaviors on second-order beliefs. Standard errors in parentheses. Subject-level controls: gender, college graduate, full-time employment, U.S. citizen, native English-speaker, Race Dummies (Black, Asian, Hispanic, White), 10-year Age Dummies, order of treatment games. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

C Credit attribution

C.1 Games

In the claims and proofs of the claims below, we assume that δ_{ij} could differ for all combinations of i and j. They incorporate the case when $\delta_{ij} = 1$ for all i and j as a special case. The claims regarding unweighted kindness in the main text are based on the assumption that $\delta_{ij} = 1$ for all i and j, so their proofs follow the general proofs presented below.

LemC 1. *In the control game, P1 prefers giving if and only if $A_1 \geq A_1^b \equiv 1/(2 \cdot \delta_{10}^b)$.*

Proof of LemC 1. P1's utility function is $u_1(\gamma_1) = \pi_1(\gamma_1) + A_1 \cdot \delta_{10}^b \cdot \kappa_{10}(\gamma_1)$, where A_1 is P1's altruistic factor, δ_{10}^b can be interpreted as P1's credit assigned by P0 perceived by P1, and γ_1 is P1's probability of giving. P0's equitable payoff from P1 is $\pi_0^e(\gamma_1) = \frac{1}{2}[\max_{\gamma_1 \in [0,1]} \pi_0(\gamma_1) + \min_{\gamma_1 \in [0,1]} \pi_0(\gamma_1)] = \frac{1}{2}(2+0) = 1$. P1's kindness to P0 from giving is $\kappa_{10}(g_1) = 2-1 = 1$, and P1's kindness to P0 from keeping is $\kappa_{10}(k_1) = 0-1 = -1$. P1's utility from giving is $u_1(g) = 2+A_1 \cdot \delta_{10}^b \cdot 1$, and P1's utility from keeping is $u_1(k) = 3 + A_1 \cdot \delta_{10}^b \cdot (-1)$. Therefore, P1 gives if $u_1(g_1) \geq u_1(k_1)$, so $2 \cdot A_1 \cdot \delta_{10}^b \geq 1$. □

LemC 2. *In the exclusive game, P2 prefers giving if $A_2 \geq A_2^e \equiv 1/\left[2 \cdot \delta_{21}^e + (2 \cdot \delta_{20}^e - \delta_{21}^e) \cdot \gamma_{1G}^e\right]$, and P1 gives with probability $\gamma_{1G}^e = [\![(2 \cdot A_1 - 1/\delta_{10}^e)/Z_1 + 2]\!]$.*

Proof of LemC 2. P2's utility function is $u_2(\gamma_2, \gamma'_{1G}) = \pi_2(\gamma) + A_2 \cdot \delta_{21}^e \cdot \kappa_{21}(\gamma_2, \gamma'_{1G}) + A_2 \cdot \delta_{20}^e \cdot \kappa_{20}(\gamma_2, \gamma'_{1G})$, where γ'_{1G} is P2's belief of P1's probability of giving. P1's utility function is $u_1(\gamma_{1G}, \gamma''_{1G}) = \pi_1(\gamma_{1G}) + A_1 \cdot \delta_{10}^e \cdot \kappa_{10}(\gamma_{1G}) + Z_1 \cdot \delta_{10}^e \cdot \lambda_{121}(\gamma_{1G}, \gamma''_{1G}) \cdot \kappa_{10}(\gamma_{1G})$, where γ_{1G} is P1's probability of giving conditional on P2 giving and γ''_{1G} is P1's belief of P2's belief of P1's probability of giving.

Suppose P1 believes that P2 believes that P1 gives with probability γ''_{1G}. The equitable payoff of P1 is $(1+3-\gamma''_{1G})/2 = 2-\gamma''_{1G}/2$, so giving by P2 to P1 shows a kindness of $3-\gamma''_{1G}-(2-\gamma''_{1G}/2) = 1-\gamma''_{1G}/2$. P1's utility from giving is $u_1(g_{1G}, \gamma''_{1G}) = 2 + A_1 \cdot \delta_{10}^e \cdot (+1) + Z_1 \cdot \delta_{10}^e \cdot (+1) \cdot (1-\gamma''_{1G}/2)$, and P1's utility from keeping is $u_1(k_{1G}, \gamma''_{1G}) = 3 + A_1 \cdot \delta_{10}^e \cdot (-1) + Z_1 \cdot \delta_{10}^e \cdot (-1) \cdot (1-\gamma''_{1G}/2)$. Therefore, P1's utility from giving with probability γ_{1G} is $u_G(\gamma_{1G}, \gamma''_{1G}) = 3 - \gamma_{1G} + (2\gamma_{1G}-1) \cdot \delta_{10}^e \cdot [A_1 + Z_1 \cdot (1-\gamma''_{1G}/2)] = 3 - \delta_{10}^e \cdot [A_1 + Z_1 \cdot (1-\gamma''_{1G}/2)] + \gamma_{1G} \cdot [2 \cdot \delta_{10}^e \cdot [A_1 + Z_1 \cdot (1-\gamma''_{1G}/2)] - 1]$. Hence, if $\delta_{10}^e \cdot [2 \cdot A_1 + Z_1 \cdot (2-\gamma''_{1G})] - 1 \geq 0$, P1 gives. That is, P1 gives with probability 1 if $\delta_{10}^e \cdot (2 \cdot A_1 + Z_1) \geq 1$, which rearranges to $2 \cdot A_1 \geq 1/\delta_{10}^e - Z_1$. P1 gives with probability 0 if $\delta_{10}^e \cdot (2 \cdot A_1 + 2 \cdot Z_1) - 1 \leq 0$, that is, $2 \cdot A_1 \leq 1/\delta_{10}^e - 2 \cdot Z_1$. Finally, if $1/\delta_{10}^e - Z_1 < 2 \cdot A_1 < 1/\delta_{10}^e - Z_1$, then $\delta_{10}^e \cdot [2 \cdot A_1 + Z_1 \cdot (2-\gamma''_{1G})] = 1$, which arranges to $\gamma''_{1G} = 2 - (1/\delta_{10}^e - 2 \cdot A_1)/Z_1$.

Suppose P2 believes that P1 gives with probability γ'_{1G}. Equitable payoff of P1 is $(1 + 3 - \gamma'_{1G})/2 = 2 - \gamma'_{1G}/2$, and the equitable payoff of C is $(0 + 2 \cdot \gamma'_{1G}) = \gamma'_{1G}$. If P2 keeps, P2 gets

$\pi_2(\gamma_2,\gamma'_{1G}) = 3+A_2\cdot\delta^e_{21}\cdot[1-(2-\gamma'_{1G}/2)]+A_2\cdot\delta^e_{20}\cdot(0-\gamma'_{1G}) = 3+A_2\cdot\delta^e_{21}\cdot(-1+\gamma'_{1G}/2)+A_2\cdot\delta^e_{20}\cdot(-\gamma'_{1G})$. P2's utility of giving is $2+A_2\cdot\delta^e_{21}\cdot[3-\gamma'_{1G}-(2-\gamma'_{1G}/2)]+A_2\cdot\delta^e_{20}\cdot(2\gamma'_{1G}-\gamma'_{1G}) = 2+A_2\cdot\delta^e_{21}\cdot(1-\gamma'_{1G}/2)+A_2\cdot\delta^e_{20}\cdot\gamma'_{1G}$. Therefore, P2 prefers giving to keeping if $A_2\cdot[\delta^e_{21}\cdot(2-\gamma'_{1G})+2\cdot\delta^e_{20}\cdot\gamma'_{1G}] \geq 1$, which simplifies to $A_2 \geq 1/[2\cdot\delta^e_{21}+(2\cdot\delta^e_{20}-\delta^e_{21})\cdot\gamma'_{1G}]$. □

LemC 3. *In the nonexclusive game, P2 prefers giving if* $A_2 \geq A^n_2 \equiv 1/[2\cdot\delta^n_{21}+(2\cdot\delta^n_{20}-\delta^n_{21})\cdot(\gamma^n_{1G}-\gamma^n_{1K})]$, *P1 gives with probability* $\gamma^n_{1G} = [\![(2\cdot A_1 - 1/\delta^n_{10})/Z_1+2]\!]$ *when P2 gives, and P1 gives with probability* $\gamma^n_{1K} = [\![(2\cdot A_1 - 1/\delta^n_{10})/Z_1 - 1]\!]$ *when P2 keeps.*

Proof of LemC 3. P2's utility function is $u_2(\gamma_2,\gamma'_{1G},\gamma'_{1K}) = \pi_2(\gamma)+A_2\cdot\delta^n_{21}\cdot\kappa_{21}(\gamma_2,\gamma'_{1G},\gamma'_{1K})+A_2\cdot\delta^n_{20}\cdot\kappa_{20}(\gamma_2,\gamma'_{1G},\gamma'_{1K})$, where γ'_{1G} and γ'_{1K} are P2's beliefs of P1's probability of giving conditional P2 giving and keeping, respectively. P1's utility function is $u_1(\gamma_2,\gamma_{1G},\gamma_{1K},\gamma''_{1G},\gamma''_{1K}) = \pi_B(\gamma_2,\gamma_{1G},\gamma_{1K})+A_1\cdot\delta^n_{10}\cdot\kappa_{10}(\gamma_2,\gamma_{1K},\gamma_{1G})+Z_1\cdot\lambda_{121}(\gamma_2,\gamma_{1G},\gamma_{1K},\gamma''_{1G},\gamma''_{1K})\cdot\delta^n_{10}\cdot\kappa_{10}(\gamma_2,\gamma_{1K},\gamma_{1G})$, where γ_2 is P2's probability of giving, γ_{1G} and γ_{1K} are P1's probabilities of giving when P2 gives and keeps, respectively, and γ''_{1G} and γ''_{1K} are P1's belief of P2's belief of P1's probability of giving when P2 gives and keeps, respectively.

Suppose P1 believes that P2 believes that P1 gives with probability γ''_{1G} when P2 gives, and gives with probability γ''_{1K} when P2 keeps. First, suppose P2 keeps. C's equitable payoff is 1, and P1's equitable payoff is $[(1-\gamma''_{1K})+(3-\gamma''_{1G})]/2 = 2-\gamma''_{1K}/2-\gamma''_{1G}/2$. Hence, P1's utility of giving when P2 keeps is $u_1(k_2,\gamma_{1G},g_{1K},\gamma''_{1G},\gamma''_{1K}) = 0+A_1\cdot\delta^n_{10}\cdot(+1)+Z_1\cdot(+1)\cdot\delta^n_{10}\cdot(\gamma''_{1G}/2-1-\gamma''_{1K}/2)$, and P1's utility of keeping when P2 keeps is $u_1(k_2,\gamma_{1G},k_{1K},\gamma''_{1G},\gamma''_{1K}) = 1+A_1\cdot\delta^n_{10}\cdot(-1)+Z_1\cdot(-1)\cdot\delta^n_{10}\cdot(\gamma''_{1G}/2-1-\gamma''_{1K}/2)$. Fixing γ''_{1G} and γ''_{1K}, we have $u_1(g_2,\cdot,g_{1K},\cdots)-u_1(k_2,\cdot,k_{1K},\cdots) = 2\cdot A_1\cdot\delta^n_{10}+2\cdot Z_1\cdot\delta^n_{10}\cdot(\gamma''_{1G}/2-1-\gamma''_{1K}/2)-1 \geq 0$, which simplifies to $2\cdot A_1+Z_1\cdot(\gamma''_{1G}-\gamma''_{1K}-2) \geq 1/\delta^n_{10}$. Second, when P2 gives, the only change in the expression is that the sign of λ_{121} flips, so the inequality $u_1(g_2,g_{1G},\cdots) \geq u_1(g_2,k_{1G},\cdots)$ becomes $2\cdot A_1 - Z_1\cdot(\gamma''_{1G}-\gamma''_{1K}-2) \geq 1/\delta^n_{10}$. Because $\gamma''_{1G}-\gamma''_{1K}-2 < 0$, $u_1(g,\cdot,g_{1K},\cdots)-u_1(k,\cdot,k_{1K},\cdots) \leq u_1(g,g_{1K},\cdots)-u_1(g,k_{1K},\cdots)$, so P1 is more inclined to give when P2 gives than when P2 keeps: $\gamma_{1K} \leq \gamma_{1G}$. There are five possible cases of γ_{1G} and γ_{1K}.

1. Strategies $\gamma_{1G} = 1$ and $\gamma_{1K} = 1$ are supported in equilibrium only when $2\cdot A_1+2\cdot Z_1 \geq 1/\delta^n_{10}$ and $2\cdot A_1-2\cdot Z_1 \geq 1/\delta^n_{10}$; because $Z_1 \geq 0$, the two inequalities are simplified to $2\cdot A_1+2\cdot Z_1 \geq 1/\delta^n_{10}$.

2. Strategies $\gamma_{1G} = 1$ and $0 < \gamma_{1K} < 1$ are supported in equilibrium only when $2\cdot A_1+(1+\gamma_{1K})\cdot Z_1 \geq 1/\delta^n_{10}$ and $2\cdot A_1-(1+\gamma_{1K})\cdot Z_1 = 1/\delta^n_{10}$, which hold only when $1/\delta^n_{10}+Z_1 < 2\cdot A_1 < 1/\delta^n_{10}+2\cdot Z_1$ and $\gamma_{1K} = (2\cdot A_1-1/\delta^n_{10})/Z_1-1$.

3. Strategies $\gamma_{1G} = 1$ and $\gamma_{1K} = 0$ are supported in equilibrium only when $2\cdot A_1+Z_1 \geq 1/\delta^n_{10}$ and $2\cdot A_1-Z_1 \leq 1/\delta^n_{10}$, which simplify to $1/\delta^n_{10}-Z_1 \leq 2\cdot A_1 \leq 1/\delta^n_{10}+Z_1$.

4. Strategies $0 < \gamma_{1G} < 1$ and $\gamma_{1K} = 0$ are supported in equilibrium only when $2 \cdot A_1 - Z_1 \cdot (\gamma_{1G} - 2) = 1/\delta_{10}^n$ and $2 \cdot A_1 + Z_1 \cdot (\gamma_{1G} - 2) < 1/\delta_{10}^n$, which hold only when $1/\delta_{10}^n - 2 \cdot Z_1 \leq 2 \cdot A_1 \leq 1/\delta_{10}^n - Z_1$ and $\gamma_{1G} = 2 + (2 \cdot A_1 - 1/\delta_{10}^n)/Z_1$.

5. Strategies $\gamma_{1G} = 0$ and $\gamma_{1K} = 0$ are supported in equilibrium only when $2 \cdot A_1 + 2 \cdot Z_1 \leq 1/\delta_{10}^n$ and $2 \cdot A_1 - 2 \cdot Z_1 \leq 1/\delta_{10}^n$; because $Z_1 \geq 0$, the two inequalities are simplified to $2 \cdot A_1 \leq 1/\delta_{10}^n - 2 \cdot Z_1$.

For P2, suppose P2 believes that P1 gives with probability γ'_{1G} and γ'_{1K} when P2 gives and keeps, respectively. When P2 keeps and gives, the payoff for P1 is $1 - \gamma'_{1K}$ and $3 - \gamma'_{1G}$, respectively, and the payoff for P0 is $2 \cdot \gamma'_{1K}$ and $2 \cdot \gamma'_{1G}$, respectively. Therefore, $\delta_{21}^n \cdot \kappa_{21} + \delta_{20}^n \cdot \kappa_{20}$ equals $(1 - \gamma'_{1K}) \cdot \delta_{21}^n + 2 \cdot \gamma'_{1K} \cdot \delta_{20}^n - X$ when P2 gives, and equals $(3 - \gamma'_{1G}) \cdot \delta_{21}^n + 2 \cdot \gamma'_{1G} \cdot \delta_{20}^n - X$, where $X = \delta_{21}^n \cdot (2 - \gamma'_{1K} - \gamma'_{1G}) + \delta_{20}^n \cdot (\gamma'_{1K} + \gamma'_{1G})$ is a constant that depends on the equitable payoff. Therefore, the utility difference between giving and keeping is $u_2(g_2, \cdots) - u_2(k_2, \cdots) = A_2 \cdot [2 \cdot \delta_{21}^n + (2 \cdot \delta_{20}^n - \delta_{21}^n) \cdot (\gamma'_{1G} - \gamma'_{1K})] - 1$. P2 prefers giving if and only if $A_2 \geq 1/[2 \cdot \delta_{21}^n + (2 \cdot \delta_{20}^n - \delta_{21}^n) \cdot (\gamma'_{1G} - \gamma'_{1K})]$. □

C.2 Predictions

PropC 1. *In the nonexclusive game, P1 after P2 gives is more inclined to give than P1 after P2 keeps. That is,* $\gamma_{1G}^n \geq \gamma_{1K}^n$.

Proof of PropC 1. P1 gives with probability $\gamma_{1G}^n = [\![(2 \cdot A_1 - 1/\delta_{10}^n)/Z_1 + 2]\!]$ after P2 gives in the nonexclusive game, and P1 gives with probability $\gamma_{1K}^n = [\![(2 \cdot A_1 - 1/\delta_{10}^n)/Z_1 - 1]\!]$ after P2 keeps in the nonexclusive. Because $(2 \cdot A_1 - 1/\delta_{10}^n)/Z_1 + 2 > (2 \cdot A_1 - 1/\delta_{10}^n)/Z_1 - 1$, we have $\gamma_{1G}^n \geq \gamma_{1K}^n$ regardless of δs. □

PropC 2. *P1 is more/equally/less inclined to give in the nonexclusive game than in the exclusive game after P2 gives, if* $\delta_{10}^n > / = / < \delta_{10}^e$.

Proof of PropC 2. P1 gives with probability $\gamma_{1G}^e = [\![(2 \cdot A_1 - 1/\delta_{10}^e)/Z_1 + 2]\!]$ after P2 gives in the exclusive game, and P1 gives with probability $\gamma_{1G}^n = [\![(2 \cdot A_1 - 1/\delta_{10}^n)/Z_1 + 2]\!]$ after P2 gives in the nonexclusive game. Therefore, if $\delta_{10}^e = \delta_{10}^n$, then $\gamma_{1G}^e = \gamma_{1G}^n$.

In general, $\gamma_{1G}^e \geq \gamma_{1G}^n$ if and only if $\delta_{10}^e \geq \delta_{10}^n$, and $\gamma_{1G}^n \geq \gamma_{1G}^e$ if and only if $\delta_{10}^n \geq \delta_{10}^e$. □

PropC 3. *P1 after P2 gives in the exclusive game is more (less) inclined to give than P1 in the control game if* $1/\delta_{10}^b \geq 1/\delta_{10}^e - Z_1$ *(if* $1/\delta_{10}^b \leq 1/\delta_{10}^e - 2 \cdot Z_1$*).*

Proof of PropC 3. P1 gives with probability $\gamma_1^b = \lim_{\epsilon \to 0^+} [\![(2 \cdot A_1 - 1/\delta_{10}^b)/\epsilon]\!]$ in the control game. P1 gives with probability $\gamma_{1G}^e = [\![(2 \cdot A_1 - 1/\delta_{10}^e)/Z_1 + 2]\!]$ after P2 gives in the exclusive game. Explicitly,

$$\gamma_1^b = \begin{cases} 1 & \text{if } 2 \cdot A_1 > \frac{1}{\delta_{10}^b} \\ 0 & \text{if } 2 \cdot A_1 < \frac{1}{\delta_{10}^b} \end{cases}$$

and

$$\gamma_{1G}^e = \begin{cases} 1 & \text{if } 2 \cdot A_1 \geq \frac{1}{\delta_{10}^e} - Z_1 \\ 2 + (2 \cdot A_1 - 1/\delta_{10}^e)/Z_1 & \text{if } \frac{1}{\delta_{10}^e} - 2 \cdot Z_1 < 2 \cdot A_1 < \frac{1}{\delta_{10}^e} - Z_1 \\ 0 & \text{if } 2 \cdot A_1 \leq \frac{1}{\delta_{10}^e} - 2 \cdot Z_1 \end{cases}.$$

Hence, when $\delta_{10}^e = \delta_{10}^b$, the range of A_1 for $\gamma_{1G}^e = 1$ coincides with the range of A_1 for $\gamma_1^b = 1$ when $Z_1 = 0$, and is strictly greater than the range of A_1 for $\gamma_1^b = 1$ when $Z_1 > 0$. In addition, $\gamma_1^b = 0$ elsewhere, whereas $\gamma_{1G}^e \geq 0$ elsewhere. Therefore, we can say that $\gamma_{1G}^e \geq \gamma_1^b$ whenever $\delta_{10}^e = \delta_{10}^b$ and $Z_1 \geq 0$. In general, $\gamma_{1G}^e \geq \gamma_1^b$ whenever $\frac{1}{\delta_{10}^b} \geq \frac{1}{\delta_{10}^e} - Z_1$. Similarly, $\gamma_{1G}^e \leq \gamma_1^b$ whenever $\frac{1}{\delta_{10}^b} \leq \frac{1}{\delta_{10}^e} - 2 \cdot Z_1$. When $\frac{1}{\delta_{10}^e} - 2 \cdot Z_1 < \frac{1}{\delta_{10}^b} < \frac{1}{\delta_{10}^e} - Z_1$, the comparison between γ_{1G}^e and γ_1^b is ambiguous and depends on the range of parameters. □

PropC 4. *P1 after P2 gives in the nonexclusive game is more (less) inclined to give than P1 in the control game if* $1/\delta_{10}^b \geq 1/\delta_{10}^n - Z_1$ *(if* $1/\delta_{10}^b \leq 1/\delta_{10}^n - 2 \cdot Z_1$*).*

Proof of PropC 4. The proof mimics the Proof of PropC 3, with superscripts e replaced by superscripts n. In general, $\gamma_{1G}^n \geq \gamma_1^b$ whenever $\frac{1}{\delta_{10}^b} \geq \frac{1}{\delta_{10}^n} - Z_1$, and $\gamma_{1G}^n \leq \gamma_1^b$ whenever $\frac{1}{\delta_{10}^b} \leq \frac{1}{\delta_{10}^n} - 2 \cdot Z_1$. When $\frac{1}{\delta_{10}^n} - 2 \cdot Z_1 < \frac{1}{\delta_{10}^b} < \frac{1}{\delta_{10}^n} - Z_1$, the comparison between γ_{1G}^e and γ_1^b is ambiguous and depends on the range of parameters. □

PropC 5. *P1 after P2 keeps in the nonexclusive game is less inclined to give than P1 in the control game if* $1/\delta_{10}^b \leq 1/\delta_{10}^n + Z_1$ *(if* $1/\delta_{10}^b \geq 1/\delta_{10}^n + 2 \cdot Z_1$*).*

Proof of PropC 5. P1 gives with probability $\gamma_1^b = \lim_{\epsilon \to 0^+} [\![(2 \cdot A_1 - 1/\delta_{10}^b)/\epsilon]\!]$ in the control game. P1 gives with probability $\gamma_{1K}^n = [\![(2 \cdot A_1 - 1/\delta_{10}^n)/Z_1 - 1]\!]$ after P2 gives in the exclusive game. Explicitly,

$$\gamma_1^b = \begin{cases} 1 & \text{if } 2 \cdot A_1 > \frac{1}{\delta_{10}^b} \\ 0 & \text{if } 2 \cdot A_1 < \frac{1}{\delta_{10}^b} \end{cases}$$

and

$$\gamma_{1K}^n = \begin{cases} 1 & \text{if } 2 \cdot A_1 \geq \frac{1}{\delta_{10}^n} + 2 \cdot Z_1 \\ (2 \cdot A_1 - 1/\delta_{10}^n)/Z_1 - 1 & \text{if } \frac{1}{\delta_{10}^n} + Z_1 < 2 \cdot A_1 < \frac{1}{\delta_{10}^n} + 2 \cdot Z_1 \\ 0 & \text{if } 2 \cdot A_1 \leq \frac{1}{\delta_{10}^n} + Z_1 \end{cases}.$$

When $\delta_{10}^n = \delta_{10}^b$, the range of A_1 for $\gamma_1^b = 0$ is a subset of the range of A_1 for $\gamma_{1K}^n = 0$, and is a strict subset whenever $Z_1 > 0$. In addition, $\gamma_1^b = 1$ elsewhere, but $\gamma_{1K}^n \leq 1$ elsewhere. Therefore, $\gamma_{1K}^e \leq \gamma_1^b$ whenever $\delta_{10}^n = \delta_{10}^b$ and $Z_1 \geq 0$. In general, $\gamma_{1K}^e \leq \gamma_1^b$ holds whenever $\frac{1}{\delta_{10}^b} \leq \frac{1}{\delta_{10}^n} + Z_1$. □

PropC 6. *P2 in the exclusive game is more/equally/less inclined to give than P2 in the nonexclusive game if* $2 \cdot \delta_{21}^e + (2 \cdot \delta_{20}^e - \delta_{21}^e) \cdot \gamma_{1G}^e \geq 2 \cdot \delta_{21}^n + (2 \cdot \delta_{20}^n - \delta_{21}^n) \cdot (\gamma_{1G}^n - \gamma_{1K}^n)$.

Proof of PropC 6. P2 in the exclusive game prefers giving if $A_2 \geq A_2^e = 1/[2 \cdot \delta_{21}^e + (2 \cdot \delta_{20}^e - \delta_{21}^e) \cdot \gamma_{1G}^e]$. P2 in the nonexclusive game prefers giving if $A_2 \geq A_2^n = 1/[2 \cdot \delta_{21}^n + (2 \cdot \delta_{20}^n - \delta_{21}^n) \cdot (\gamma_{1G}^n - \gamma_{1K}^n)]$. Hence, P2 in the exclusive game is more/equally/less inclined to give than P2 in the nonexclusive game if $A_2^e < / = / > A_2^n$, or equivalently, $2 \cdot \delta_{21}^e + (2 \cdot \delta_{20}^e - \delta_{21}^e) \cdot \gamma_{1G}^e > / = / < 2 \cdot \delta_{21}^n + (2 \cdot \delta_{20}^n - \delta_{21}^n) \cdot (\gamma_{1G}^n - \gamma_{1K}^n)$.

□

PropC 7. *P2 in the exclusive game is more/equally/less likely to give than P1 in the control game if* $2 \cdot \delta_{21}^e + (2 \cdot \delta_{20}^e - \delta_{21}^e) \cdot \gamma_{1G}^e > / = / < 2 \cdot \delta_{10}^b$.

Proof of PropC 7. P2 in the exclusive game prefers giving if $A_2 \geq A_2^e = 1/[2 \cdot \delta_{21}^e + (2 \cdot \delta_{20}^e - \delta_{21}^e) \cdot \gamma_{1G}^e]$. P1 in the control game prefers giving if $A_1 \geq A_1^b = 1/(2 \cdot \delta_{10}^b)$. Therefore, P2 in the exclusive game is more/less/equally inclined to give than P1 in the control game if $A_2^e < / = / > A_1^b$, which is equivalent to $2 \cdot \delta_{21}^e + (2 \cdot \delta_{20}^e - \delta_{21}^e) \cdot \gamma_{1G}^e > / = / < 2 \cdot \delta_{10}^b$.

□

PropC 8. *P2 in the nonexclusive game is more/equally/less likely to give than P1 in the control game if* $2 \cdot \delta_{21}^n + (2 \cdot \delta_{20}^n - \delta_{21}^n) \cdot (\gamma_{1G}^n - \gamma_{1K}^n) > / = / < 2 \cdot \delta_{10}^b$.

Proof of PropC 8. P2 in the nonexclusive game prefers giving if $A_2 \geq A_2^n = 1/[2 \cdot \delta_{21}^n + (2 \cdot \delta_{20}^n - \delta_{21}^n) \cdot (\gamma_{1G}^n - \gamma_{1K}^n)]$. P1 in the control game prefers giving if $A_1 \geq A_1^b = 1/(2 \cdot \delta_{10}^b)$. Therefore, P2 in the nonexclusive game is more/less/equally inclined to give than P1 in the control game if $A_2^n < / = / > A_1^b$, or equivalently, $2 \cdot \delta_{21}^n + (2 \cdot \delta_{20}^n - \delta_{21}^n) \cdot (\gamma_{1G}^n - \gamma_{1K}^n) > / = / < 2 \cdot \delta_{10}^b$.

□

D Experimental materials

Below we show screenshots of the experiment, implemented online in Qualtrics. To make the experiments easier for subjects to understand, P2 was Player A, P1 was Player B, and P0 was Player C in the treatment games. In the control game, P1 was Player A, P0 was Player B, and P2 was Player C. This does not change the fundamental components of the games which allow us to compare between the control and treatment games. The entire Qualtrics study can be found at https://msu.co1.qualtrics.com/jfe/form/SV_0HZMAjUMD5cPx5A.

Decision-Making Study

Protocol Number: STUDY00004248
Michigan State University
msuhrlrecon@gmail.com

You are invited to participate in this research study about economic decision-making. Your participation is entirely voluntary, which means you can choose whether or not to participate. No matter what you decide, there will be no loss of benefits to which you are otherwise entitled. Before you make a decision, you will need to know the purpose of the study, the possible risks and benefits of being in the study, and what you will be asked to do if you decide to participate.

If you decide to participate, you will be asked to continue with the study after reading this form and your continuation will indicate your consent. If you do not understand what you are reading, please do not continue with the study. If there is anything you do not understand, please ask the researcher to explain by typing your question into the chatbox on Zoom or e-mailing them at the e-mail address from which you received the link to this survey.

Please read through the consent form at your own pace.

What is the purpose of the study? The purpose of the research is to help understand why people make economic decisions.

What will my participation involve? If you decide to participate in this research, you will be asked to make economic decisions and answer some questions about yourself. We may also collect demographic information from you.

How long will I be in the study? How many other people will be in the study? Your participation will last about half an hour and require 1 session only. You will be one of potentially 2,000 people in the study.

Are there any benefits to me? You are not expected to benefit directly from participating in this study. Your participation in this research study may benefit other people by helping us learn more about how individuals make decisions.

Will I be paid for my participation? You will be paid at the end of the experiment. The amount of money earned depends upon your decisions.

Are there any risks to me? The only risk of taking part in this study is that your study information could become known to someone who is not involved in performing or monitoring this study. This study will not ask sensitive information about you.

How will my privacy be protected? As required by law, the research team will make every effort to keep the information obtained during this study strictly confidential. Data from the experiment are recorded using randomly assigned identification numbers, so individually identifiable subject choices will not be stored. The data will be stored indefinitely on a secure location on campus in a faculty member or graduate student computer. The information collected from you during this study will be used by the research team at Michigan State University. It will not be shared with others.

Is my permission voluntary and may I change my mind? Your permission is voluntary. You do not have to provide consent to participate and you may refuse to do so. If you refuse to provide consent, you cannot take part in this research study. You may completely withdraw from the study at any time without penalty.

Who should I contact if I have questions? Please take as much time as you need to think over whether or not you wish to participate. If you have any questions, concerns, or complaints regarding your participation in this research study or if you have any questions about your rights as a research subject, you may contact the Human Research Protection Program at Michigan State University by calling 517-355-2180 or by visiting their website.

Agreement to participate: I have read this consent and authorization form describing the research study procedures, risks, and benefits. I have had a chance to ask questions about the research study, and I have received answers to my questions. I agree to participate in this research study.

By continuing with this study, you are consenting to participate.

← →

Page 2

The video below will describe the games you will play in this study. The button to proceed will appear when the video finishes playing.

←

Page 3

Game Information

In this study, you will play multiple games. You will receive $2 for completion of all games.

Your **endowment** is the number of chips (money) that you have at the start of the game.
Your **payoff** is the number of chips (money) that you have when the game concludes.

Standard Rules

The rules of each game are a little different, but some are the same across all games. In all games:

- There are blue chips and white chips.
- Each chip (of either color) is worth $1.
- White chips can be passed to other people, but blue chips cannot be passed.
- If a white chip is passed, it turns into two chips for the recipient.
- Each person is assigned at most one recipient to whom they can pass one white chip.

Additional Rules

At the start of each game, you will see additional rules that are specific to that game.

← →

Page 4

We will now begin a new game.

We want you to **carefully consider** your decisions, but please make your decisions in a timely manner.

← →

Page 5

There are three Players. Here are the chips that each Player starts with:

Player	Endowments
A	2 blue chips, 1 white chip
B	Nothing
C	2 blue chips

Standard Rules

The rules of each game are a little different, but some are the same across all games. In all games:

- There are blue chips and white chips.
- Each chip (of either color) is worth $1.
- White chips can be passed to other people, but blue chips cannot be passed.
- If a white chip is passed, it turns into two chips for the recipient.
- Each person is assigned at most one recipient to whom they can pass one white chip.

Additional Rules

- If a white chip is passed, it turns into 2 blue chips for the recipient.
- Player A can pass a white chip to Player B.
- Player B cannot pass to any other player.

The payoffs are:

If Player A keeps their white chip:

- Player A: 2 blue chips and 1 white chip ($3)
- Player B: Nothing ($0)
- Player C: 2 blue chips ($2)

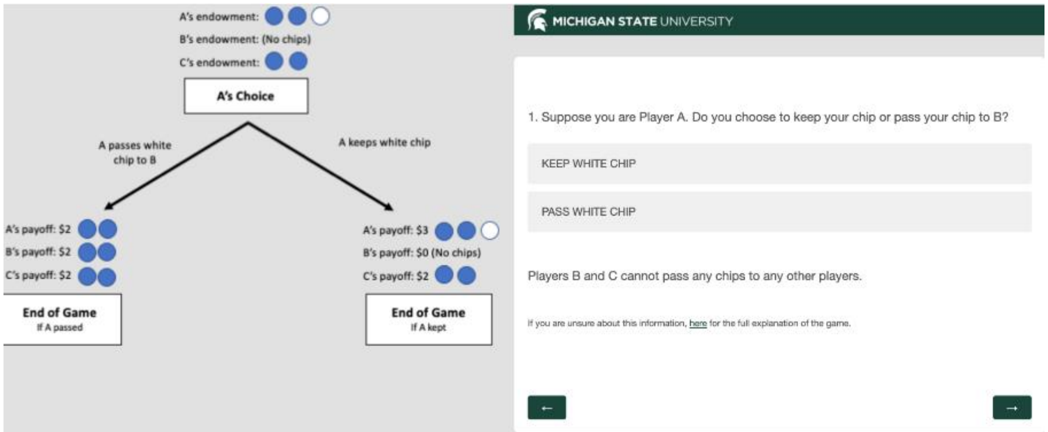
If Player A passes their white chip to Player B:

- Player A: 2 blue chips ($2)
- Player B: 2 blue chips ($2)
- Player C: 2 blue chips ($2)

The following figure conveys the same information as above.

← →

Page 6



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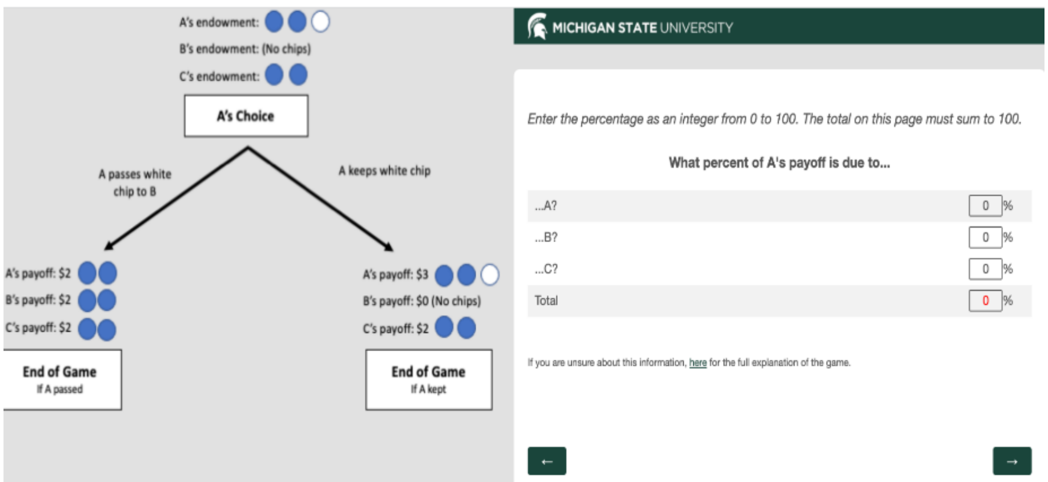

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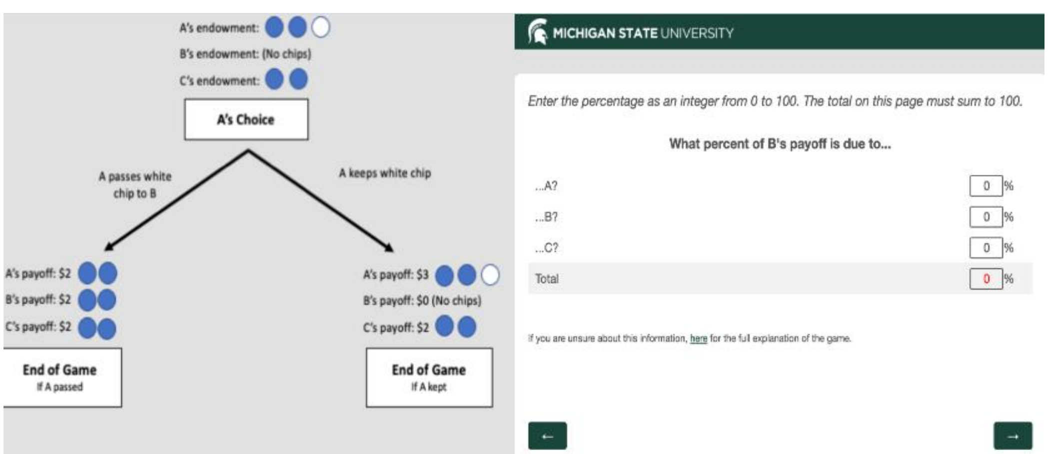

Page 9

We will now begin a new game.

We want you to **carefully consider** your decisions, but please make your decisions in a timely manner.

→

Page 10

There are three Players. Here are the chips that each Player starts with:

Player	Endowments
A	2 blue chips, 1 white chip
B	1 blue chip
C	Nothing

Standard Rules

The rules of each game are a little different, but some are the same across all games. In all games:

- There are blue chips and white chips.
- Each chip (of either color) is worth $1.
- White chips can be passed to other people, but blue chips cannot be passed.
- If a white chip is passed, it turns into two chips for the recipient.
- Each person is assigned at most one recipient to whom they can pass one white chip.

Additional Rules

- If a white chip is passed, it turns into 1 blue chip and 1 white chip for the recipient.
- Player A can only pass to Player B.
- Player B can pass a white chip to Player C <u>only if</u> Player A has passed a white chip to Player B.
- Player C cannot pass to any other player.

<u>**The payoffs are:**</u>
If Player A keeps their white chip:

- Player A: 2 blue chips and 1 white chip ($3)
- Player B: 1 blue chip ($1)
- Player C: Nothing ($0)

If Player A passes their white chip to Player B, and Player B keeps their white chip:

- Player A: 2 blue chips ($2)
- Player B: 2 blue chips and 1 white chip ($3)
- Player C: Nothing ($0)

If Player A passes their white chip to Player B, and Player B passes their white chip to Player C:

- Player A: 2 blue chips ($2)
- Player B: 2 blue chips ($2)
- Player C: 1 blue chip and 1 white chip ($2)

The following figure conveys the same information as above.

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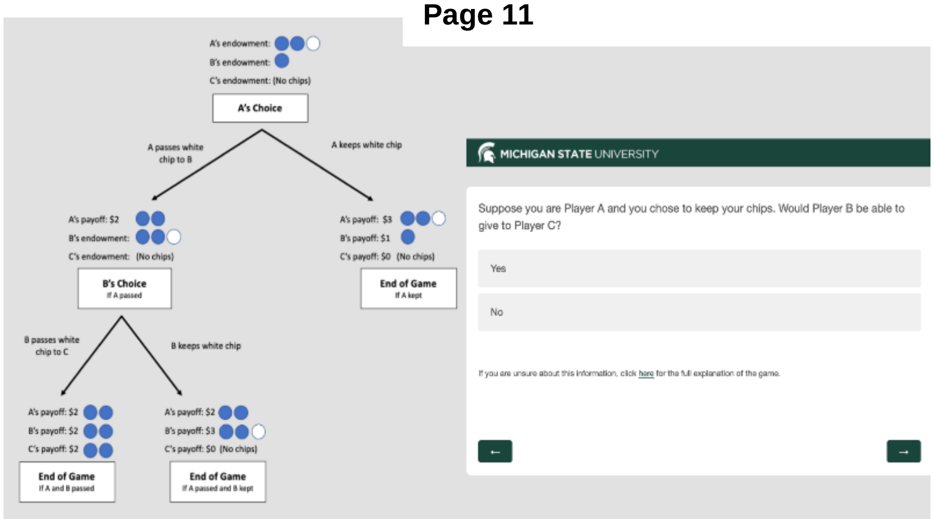

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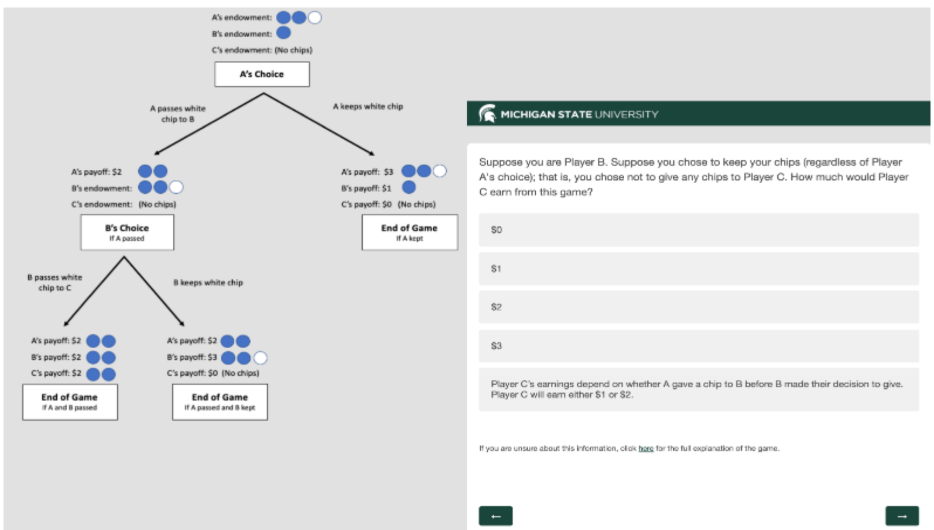

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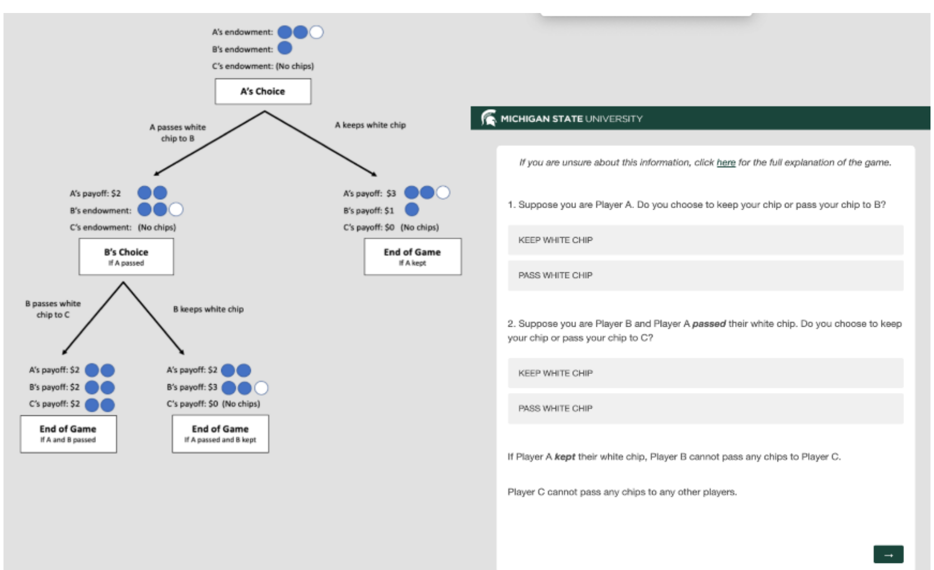

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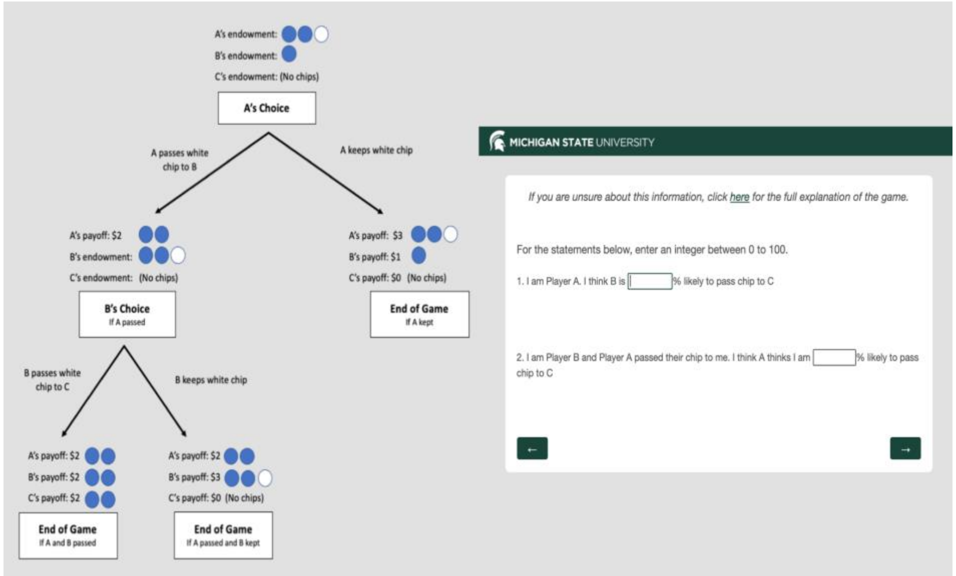

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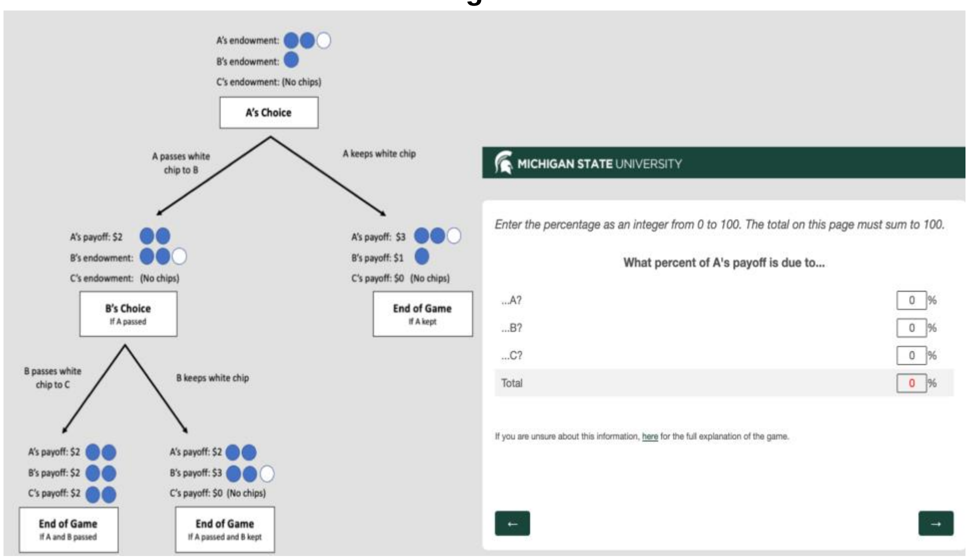

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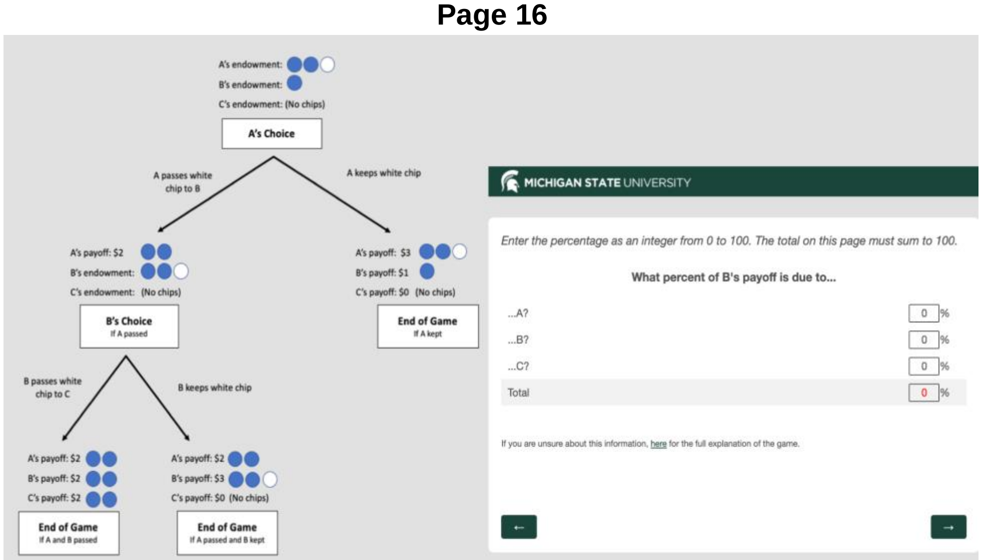

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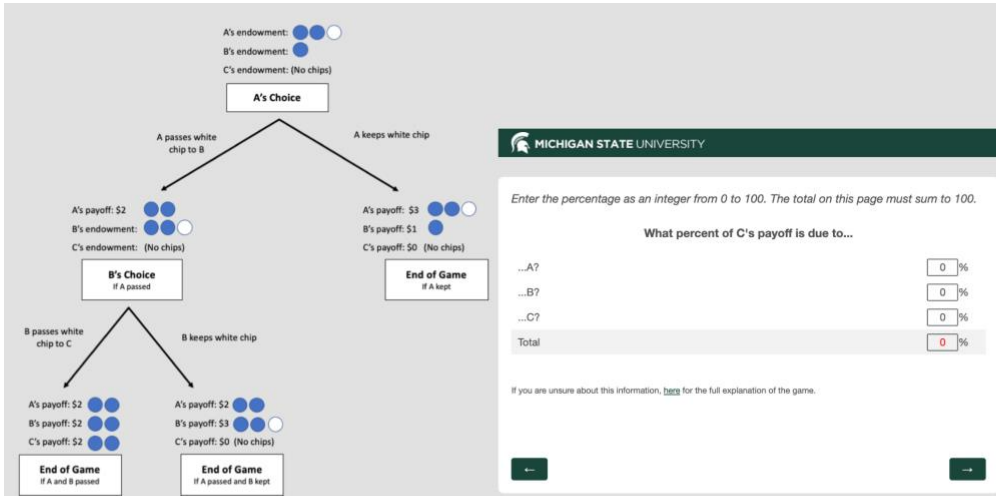

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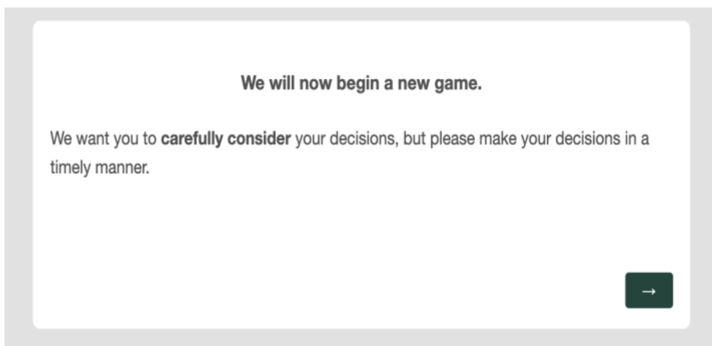

There are three Players. Here are the chips that each Player starts with:

Player	Endowments
A	2 blue chips, 1 white chip
B	1 white chip
C	Nothing

Standard Rules

The rules of each game are a little different, but some are the same across all games. In all games:

- There are blue chips and white chips.
- Each chip (of either color) is worth $1.
- White chips can be passed to other people, but blue chips cannot be passed.
- If a white chip is passed, it turns into two chips for the recipient.
- Each person is assigned at most one recipient to whom they can pass one white chip.

Additional Rules

- If a white chip is passed, it turns into 2 blue chips for the recipient.
- Player A can only pass a white chip to Player B.
- Player B can only pass a white chip to Player C. Player B can pass to Player C regardless of Player A's actions.
- Player C cannot pass to any other player.

<u>The payoffs are:</u>

If Player A keeps their white chip, and Player B keeps their white chip:

- Player A: 2 blue chips and 1 white chip ($3)
- Player B: 1 white chip ($1)
- Player C: Nothing ($0)

If Player A keeps their white chip, and Player B passes their white chip to Player C:

- Player A: 2 blue chips and 1 white chip ($3)
- Player B: Nothing ($0)
- Player C: 2 blue chips ($2)

If Player A passes their white chip to Player B, and Player B keeps their white chip:

- Player A: 2 blue chips ($2)
- Player B: 2 blue chips and 1 white chip ($3)
- Player C: Nothing ($0)

If Player A passes their white chip to Player B, and Player B passes their white chip to Player C:

- Player A: 2 blue chips ($2)
- Player B: 2 blue chips ($2)
- Player C: 2 blue chips ($2)

The following figure conveys the same information as above.

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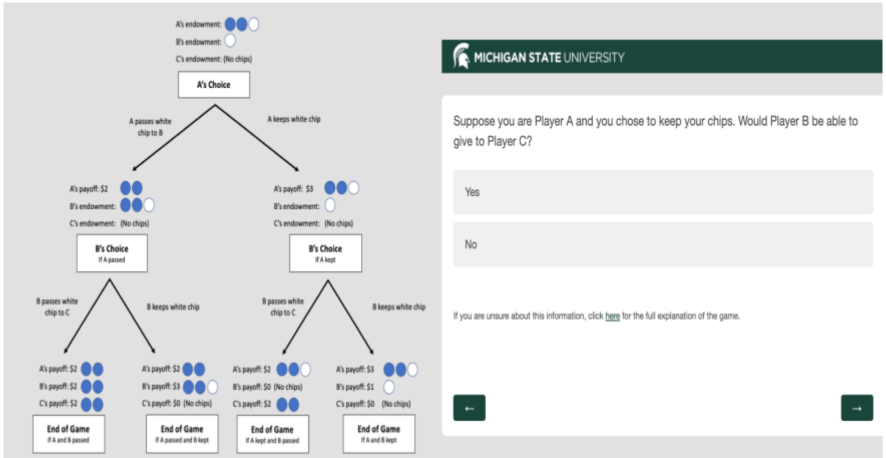

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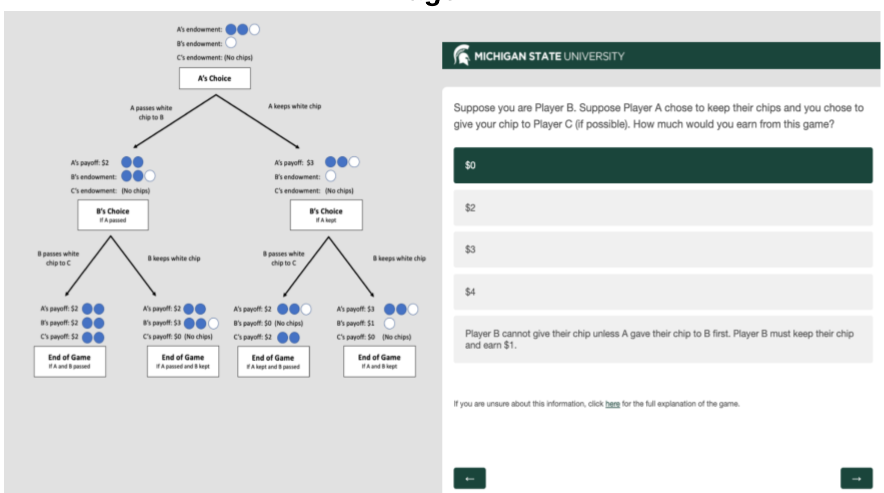

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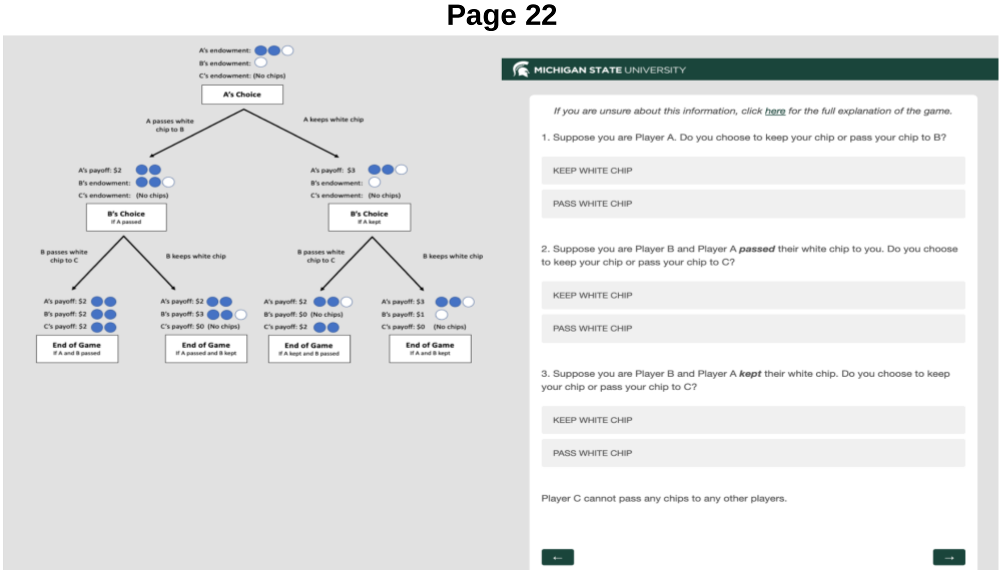

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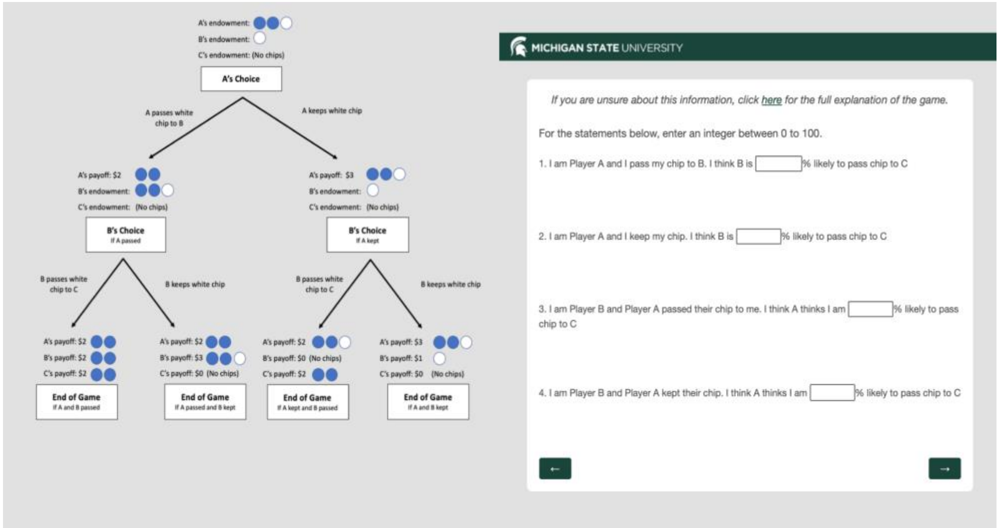

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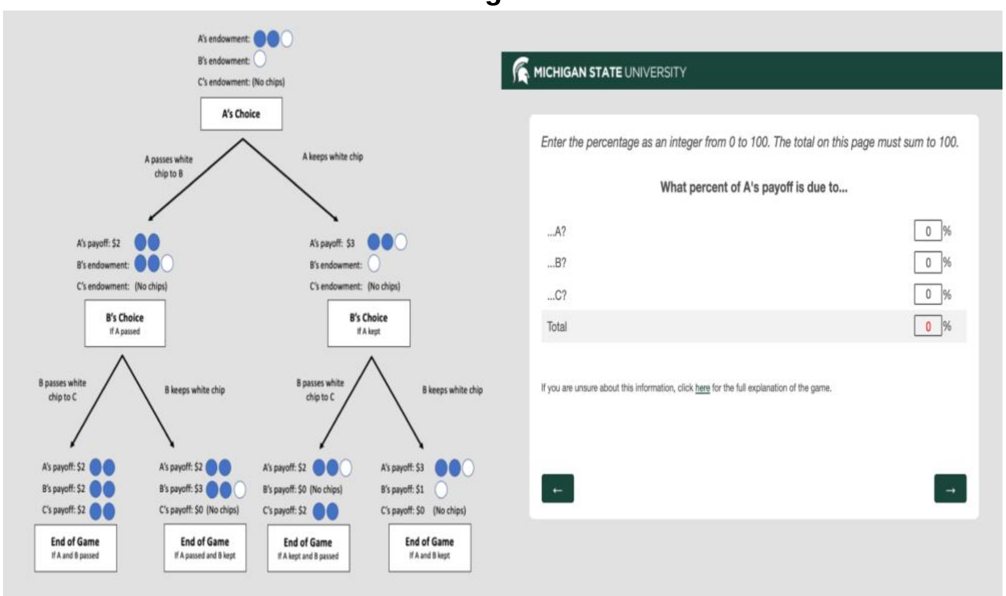

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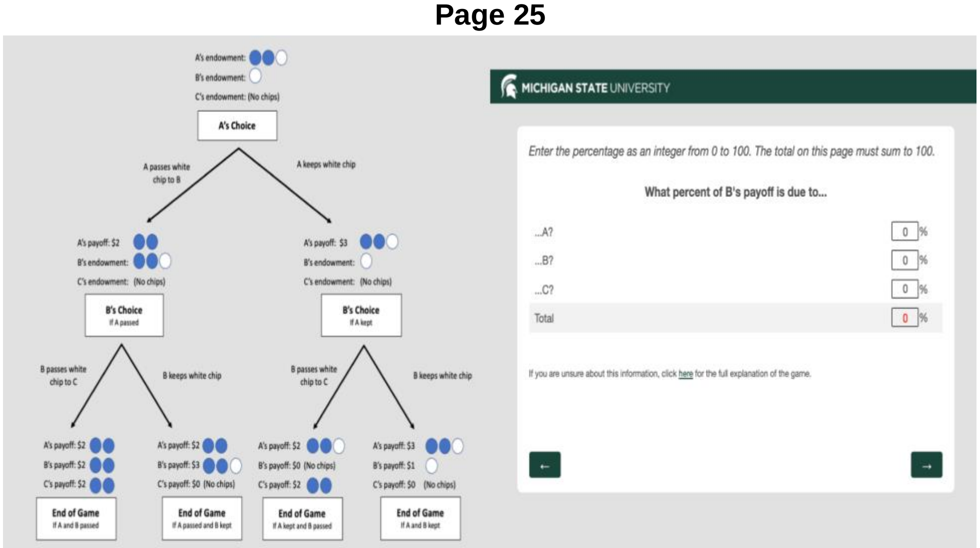

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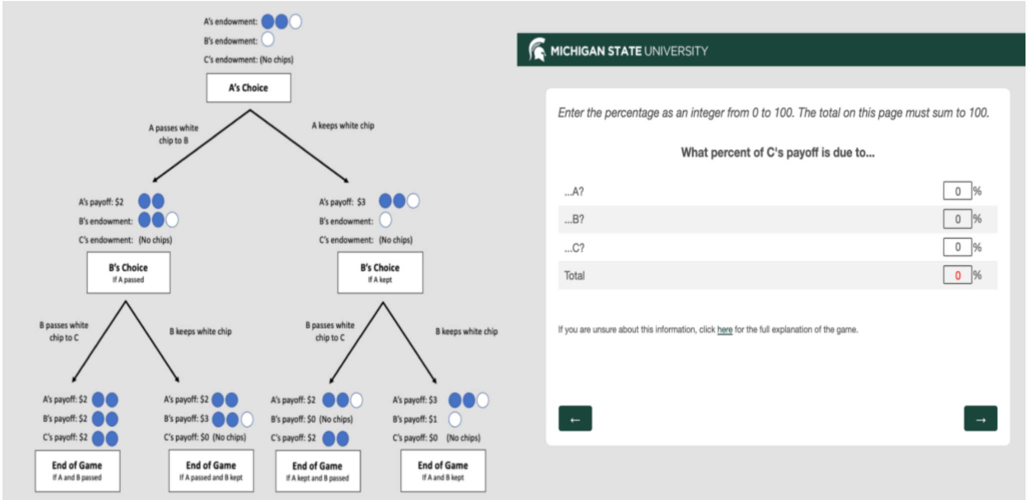

Note: 4-player games are omitted for brevity. To see the 4 player games, please see Qualtrics link.

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Demographic Questionnaire

Please answer these questions honestly. Your answers will not affect your earnings. Your answers will remain anonymous.

What is your age range?

- 16-25 years old
- 26-35 years old
- 36-45 years old
- 46-55 years old
- 56-65 years old
- 65 or older
- Other

What is your highest educational attainment?

- Less than high school
- High school diploma
- Vocational degree
- Associate's degree
- Some college
- Bachelor's degree
- Graduate degree (including Master's, J.D., M.D., D.O., Ph.D)

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Do you volunteer or donate at least once a year? (This includes donations of any form - e.g., money, professional services, blood/plasma, etc.)

No

Yes

What gender do you identify as?

Male

Female

Non-binary

Other

What is your employment status?

Unemployed

Part-time

Full-time

Student

Are you an American citizen?

No

Yes

Is English your native language?

No

Yes

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What is your country of residence?

What is your ethnicity?

Decline to Identify

White (Not of Hispanic origin)

Asian/Pacific Islander

African American/Black

American Indian/Alaskan Native

Hispanic

Other

→

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Do you have any comments regarding this study?

← →

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Thank you for participating in our experiment on decision-making. Your responses have been recorded. We will randomly select one game for payment. We will randomly assign you to a group and to a player role.

Your payment will depend on your decisions in that player role, as well as the decisions of other players in your group. Your payment will also depend on your responses to the questions you were asked throughout the experiment.

You will receive your payment within 48 hours. If you have any questions or concerns, please send an e-mail to msuhrlrecon@gmail.com.