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Abstract

We examine whether the future ahead and back (FAB) mechanism improves intergenerational sustainability (IS) in competitive societies, conducting lab-in-the-field experiments of IS dilemma games. In baseline, each generation of three members in a lineup decides between maintaining IS (sustainable option) and prioritizing their payoff by imposing costs on subsequent generations (unsustainable option). In FAB, members in each generation first role-play those in the next generation, requesting what they want the current generation to choose. Second, they decide between two options as the current generation. Results demonstrate that FAB enhances IS, changing generations of proself people to choose sustainable options.

Key Words: Intergenerational sustainability dilemma; proself people; future ahead and back mechanism

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Nomenclature

FAB Future ahead and back mechanism

IFG Imaginary future generation

IS Intergenerational sustainability

ISD Intergenerational sustainability dilemma

ISDG Intergenerational sustainability dilemma game

LMIS Labor market information system

SVO Social value orientation

1 Introduction

Intergenerational sustainability (IS) is pivotal for survival of human societies. People in the current and past generations have caused environmental problems and depletion of natural resources, compromising IS by incurring an irreversible cost for future generations (Krutilla, 1967, Fisher et al., 2004, Milinski et al., 2006, Ehrlich et al., 2012, Griggs et al., 2013, Kinzig et al., 2013, Costanza et al., 2014, Hauser et al., 2014, Steffen et al., 2015, Shahrier et al., 2016, Maxwell et al., 2016, Kamijo et al., 2017, Shahrier et al., 2017). Therefore, how to strike a balance between costs and benefits among generations is a key question (Ostrom, 1990, Milinski et al., 2006, Hauser et al., 2014). IS dilemma (ISD) is a situation of whether or not the current generation sacrifices her benefit by considering the needs of the future generations, being one of the greatest challenges for human societies (see, e.g., Shahen et al., 2021, Timilsina et al., 2022). It is due to the fact that the current generation unidirectionally affects future generations and tends to prioritize her benefit in ISD, endangering sustainability (Ehrlich et al., 2012, Kinzig et al., 2013, Griggs et al., 2013, Costanza et al., 2014, Hauser et al., 2014, Steffen et al., 2015, Maxwell et al., 2016). Such a negative consequence in ISD is consistent with the prediction of economic theory, and IS shall not be maintained without introducing new mechanisms (Dawes, 1980, Hauser et al., 2014, Shahrier et al., 2017, Timilsina et al., 2021). This research addresses how people and generations behave in ISD and the effectiveness of a newly designed mechanism to improve IS in employing economic field experiments.

Several past studies examine people's decisions for IS employing experiments of common pool resources, externality game, intergenerational goods game and ISD game (ISDG). First, we note findings from the studies that use experiments other than the ISDG. Fisher et al. (2004) find that an intergenerational link does not restrain subjects from overexploiting common pool resources, while it creates an expectation about the peers that they would bear the intergenerational responsibility. Hauser et al. (2014) find that the existence of a few defectors causes overexploitation of intergenerational goods and, thus, median voting or democracy can maintain IS by resisting the defectors. However, they suggest that median voting works only when there are not many defectors. Sherstyuk et al. (2016) reveal that maintaining dynamic externalities is more difficult in intergenerational settings than in settings with infinitely-lived decision makers. Overall, these studies indicate that sustaining IS is challenging as people are likely to maximize their own payoffs, and some mechanism should be necessary to uphold it.

Kamijo et al. (2017) design and implement an ISDG lab experiment with one generation of three subjects, asking each generation to decide between sustainable and unsustainable options through 10-minute deliberation. They present that introducing an imaginary future person as a representative for future generations (hereafter, IFG mechanism) in each generation's deliberation improves IS. Shahen et al. (2021) demonstrate that taking the perspective of future generations motivates subjects to choose a sustainable option for IS in a lab experiment of a one-person ISDG. Timilsina et al. (2021) demonstrate that urban society consists of a number of people with stable preferences over maximizing their own generation's payoffs, influencing others to follow them. Timilsina et al. (2022) explore that intragenerational deliberation does not lead to an opinion change towards maintaining IS in urban societies. All in all, some mechanisms, such as IFG, may be an effective way to improve IS. However, maintaining it in the urban areas seems to be more challenging than in the rural areas.

Shahrier et al. (2017) conduct ISDG field experiments in rural and urban areas of Bangladesh, demonstrating that rural people choose much more sustainable options than do urban people. Contrary to Kamijo et al. (2017), Shahrier et al. (2017) find that urban people fail to maintain IS even under IFG mechanism. Approximately $60\,\%$ of student subjects at the ISDG laboratory experiments in Kamijo et al. (2017) are prosocial, and generations with such prosocial subjects are identified to choose sustainable options under IFG. On the other hand, only $20\,\%$ of urban subjects are prosocial at the ISDG experiments in Shahrier et al. (2017), and generations with such proself subjects are identified to choose unsustainable options even under IFG. It appears that when proself people face ISD, they tend to be unsustainable even under median voting, deliberation or IFG.

The literature indicates that societies will be urbanized and the number of proself people will increase in the future, especially in developing countries. They project that, by 2050, $66\,\%$ of the global population will reside in urban cities, and the cities in developing countries of Africa and Asia will account for the $75\,\%$ urbanities in the world (American Association for the Advancement of Science, 2016, Wigginton et al., 2016, McDonnell and MacGregor-Fors, 2016). A number of studies demonstrate that people become more proself with ongoing urbanization in developing countries (Shahrier et al., 2016, 2017, Timilsina et al., 2017, 2019, 2021, Shahen et al., 2019, Jingchao et al., 2021). Considering the ongoing urbanization and the possible increase in the number of proself people in developing countries, a strong mechanism is necessary to maintain IS in the urbanized societies. Specifically, the mechanism should be able to induce a majority of proself people to change their opinions from choosing unsustainable options to sustainable options. The majority of the past IS studies have been demonstrated in developed countries and/or in laboratories. To deepen and generalize our understanding about human behaviors and decisions for IS, more studies of IS should be demonstrated in developing countries (Henrich et al., 2005, 2010a,b).

We design and institute a new mechanism, i.e., future ahead and back (FAB) mechanism, as a resolution to induce proself people to be sustainable, examining its effectiveness through conducting field experiments of ISDG in an urban city, Dhaka, Bangladesh. In basic ISDG, a lineup of generations, each consisting of three people, is organized, and each of them is asked to choose either maintaining IS (sustainable option) or maximizing her own generation's payoff by irreversibly imposing costs on subsequent generations (unsustainable option) through deliberation. With FAB, each generation is first asked to discuss and make a request to the current generation's decision as if she is in the position of the next generation. Second, she makes the actual decision from her original position as the current generation. The results reveal that deliberation does not prevent proself people from choosing unsustainable options in basic ISDG. In contrast, FAB is demonstrated to enable such proself people to change their individual opinions from unsustainable to sustainable options, thereby inducing a majority of generations to choose sustainable options. We argue that memories and experiences of role play as the next generation in FAB trigger individual other-regarding preferences for future generations, such as fellow feeling and indirect reciprocity, enhancing IS.

2 Methods and materials

2.1 Study area

Our experiments were conducted in Dhaka, the capital city of Bangladesh. Figure 1 in the appendix presents the location of the study area. Dhaka is a mega city, which is highly urbanized with high level of competition for survival (Shahrier et al., 2016). Our study area covers the whole Dhaka metropolitan. Dhaka is located in between $90°18'$ and $90°57'$ east longitude and $23°55'$ and $24°81'$ north latitude (Dewan and Corner, 2014). Total population, population density and total land area of Dhaka city are 14.51 million, $10\,484\,\mathrm{km}^{-2}$ and $1371\,\mathrm{km}^{2}$, respectively. The population density of Dhaka is the highest among all the cities in the world (Dewan and Corner, 2014). Businesses, industries and services in Bangladesh center around Dhaka, whereas farming activities are almost absent. Therefore, dwellers' major occupations are business, service, factory work and some other labor intensive occupations, such as rickshaw pulling.

2.2 Experimental setup

We administer three treatments, namely, basic ISDG, ISDG with imaginary future generations (IFG) and ISDG with future ahead and back mechanism (FAB), individual interviews, social value orientation (SVO) game and questionnaires surveys in the field.

Intergenerational sustainability dilemma game (ISDG)

We demonstrate a three-person ISDG and the basic structure is the same as the laboratory and field experiments implemented in Kamijo et al. (2017) and Shahrier et al. (2017). In this game, a lineup of group is organized which we call generations, each of the generations consists of three members. In the game, each generation needs to make a decision between maximizing her own-generation's payoff by choosing option A or maintaining IS by choosing option B. Compared to choosing option A, a generation receives 300 less when she chooses option B. That is, the payoff associated with option A is X and the payoff associated with option B is $X - 300$. After the generation payoff is determined by deciding between options A and B, members in the generation are obliged to split the generation payoff among themselves. A member's total payoff is the sum of her initial endowment of 300 plus 1.5 times the share from the generation payoff. For instance, a generation earns a payoff of 1200 ($X = 1200$) by choosing option A and a payoff of 900 ($X - 300 = 1200 - 300 = 900$) by choosing option B. If the members divide the generation payoff equally, each member earns a payoff of 400 (300) as the share from the generation payoff, when the generation's decision is option A (B). In this case, each member's total payoff is 900 (300 + 1.5 times 400) when the generation's decision is option A, and it is 750 (300 + 1.5 times 300) if the generation's decision is option B. We convert the total payoff of each member in ISDG into actual earning (cash in BDT) by applying an exchange rate of 2.5, i.e., every 2.5 payoffs received by a member in the game deserves to be 1 BDT.

A sequence of ISDG comprises a lineup of 6 generations. A member is randomly assigned to one of these 6 generations, and we do not let the members in the 6th generation know that they are the members in the last generation in a sequence. When a generation chooses option A, the subsequent generations' payoffs uniformly decline by 300. However, when a generation chooses option B, the subsequent generations' payoffs do not decline. For example, suppose that an ISDG starts with $X = 1200$, and the 1st generation chooses option A and receives 1200. In this case, the 2nd generation will have a different game from the 1st generation did, in which the 2nd generation will receive 900 by choosing option A and 600 by choosing option B, respectively. That is, when the 1st generation chooses option A, the 2nd generation suffers and her payoffs associated with options A and B uniformly decline by 300. On the other hand, suppose that the 1st generation chooses option B and receives 900 ($= X - 300 = 1200 - 300 = 900$). In this case, the 2nd generation will have the same game as the 1st generation did, in which the 2nd generation can receive 1200 and 900 by choosing options A and B, respectively. That is, when the 1st generation chooses option B, the 2nd generation does not suffer and her payoffs will not decline. The game continues with the same rules for any pair of two neighboring generations from 1st to 6th ones in a sequence of ISDG (See figure 1 for illustration of how ISDG proceeds with the rules). This means that by choosing option A, generations maximize their own payoffs, endangering IS, while by choosing option B, they can maintain IS. Hence, options A and B are unsustainable and sustainable options, respectively.

[Figure 1 about here.]

The 1st generation in each sequence starts the game with $X = 1200$ in which options A and B are associated with payoffs of 1200 and 900, respectively. Therefore, depending on the previous generation's choices, 5th and 6th generations might receive a zero or negative payoff by choosing option A or option B.[1] We conduct three treatments of ISDG to identify an effective mechanism for maintaining IS.

- Basic ISDG: In basic ISDG, three members in each generation are asked to choose between options A and B through 5-minute deliberation. By means of deliberation, members in a generation must agree upon choosing either option A or option B. After the generation payoff is fixed by deciding between option A and option B, members of the generation are asked to decide how to split it among themselves through 5-minute deliberation. Thus, in our experiments, basic ISDG is designed to examine whether deliberation can maintain IS.

- ISDG with imaginary future generations (hereafter, IFG): In IFG, each generation consists of two general members and one special member called "minister of future." One member in each generation is randomly selected as the "minister of future," and is asked to be the representative of future generations by considering not only her generation but also future generations in deliberations and decisions. However, she has neither obligations nor monetary incentives for playing the role. IFG mechanism is designed to examine whether or not priming people (or assigning a member as the representative) for future generations can maintain IS. Other than the "minister of future," the decision-making procedures in IFG are the same as those in basic ISDG. Members in each generation are allowed to deliberate for

[1]If one generation faces a game in which she receives negative payoffs, the members are asked to make the payoff zero by paying from their initial endowment of 300.

up to 5 minutes to choose between options A and B. After the generation payoff is fixed by deciding between options A and B, members of the generation are asked to decide how to split it among themselves through 5-minute deliberation. This mechanism is named as *imaginary future generations* since "the minister of future" is asked to be the representative of future generations by "imagining" their (future generations') needs and desires.

- ISDG with future ahead and back mechanism (hereafter, FAB): In FAB, members in each generation are first asked to imagine that they are the members in the next generation. As if they are the members in the next generation, they are asked to request their previous generation to choose either option A or option B by deliberating for up to 5 minutes as the first step.[2] As the second step, they return to their original (or actual) position in the generational lineup and choose between options A and B by deliberating for up to 5 minutes. If the generation's request to the previous generation in the first step and her choice in the second step are the same, such as option A (B) in the first step and option A (B) in the second, the choice of option A (B) becomes her final decision. However, if her request in the first step is different from her choice in the second step, such as option B (A) in the first step and option A (B) in the second step, three members are asked to make anonymous votes for option A or option B to finalize her decision. Thus, majority voting is applied only when the generation's request in the first step is different from her choice in the second step.[3] After the generation payoff is fixed by deciding between option A and option B, members are asked to decide how to split it among themselves through 5-minute deliberation.

Without any mechanism, each generation is predicted to choose option A in ISDG based on economic theory, prioritizing her benefit and consequently endangering IS. To maintain IS, we need new mechanisms that can trigger individual other-regarding preferences for future generations.

[2]Note that members in a generation do not request the previous generation directly by written or verbal forms in the first step. This is simply one step in the two-step processes for a generation to finalize her decision between options A and B.

[3]IFG is different from FAB as follows. In IFG, one member in each generation is randomly chosen to play a representative role for future generations from the standpoint of the current generation. In FAB, all the members in a generation are considered to role-play as the next generation before making a choice from their original position in the generational lineup.

FAB is built upon (i) fellow feeling, (ii) indirect reciprocity, and (iii) cognitive dissonance, the three channels that could trigger other-regarding preferences for future generations (Smith, 1976, Nowak and Sigmund, 1998, Nowak and Roch, 2007, Mujcic and Leibbrandt, 2018, Harmon-Jones, 2019, Shahen et al., 2021). Adam Smith in his book, *The Theory of Moral Sentiments*, explains the concept of "fellow feeling" as the basis of sociality (Smith, 1976). A person's affective state is influenced by her perception about that of others through fellow feelings, and she becomes sympathetic about others.

In FAB, role-playing as the next generation is considered to connect the affective states of the members in the current generation with those in the next generations, which may trigger other-regarding preferences of fellow feeling for future generations. Studies demonstrate that indirect reciprocity is one of the main reasons for human cooperation and prosociality. The role-playing as the next generation in the first step of FAB is a member's imaginary future self. In the second step, when she decides between options A and B as a member in the current generation, the memory of role-playing may activate reciprocity with her imaginary future self, which could trigger other-regarding preferences for the actual next generations. Studies show that the experience of two or more different cognitions in decision-making affects human decisions through cognitive dissonance. In FAB, members play roles of future and current generations, where the two generations' interests contradict. This dissonance can create psychological discomfort and motivate members to enhance IS to reconcile divergent interests. Overall, irrespective of the channels, members are likely to show prosocial behaviors for IS once they role-play as the next generation.

We also add a new element built upon the previous ISDG experiments but do so only in FAB. We conduct individual interviews with each member after she completes the generational decision-making task. The objective of the individual interviews is to elicit members' individual opinions before and after the deliberative discussion in FAB and to know whether proself members are successfully induced to change their individual opinions.[4] Obtaining this information on ex-ante

[4] As our past experiments find that a majority of proself members in highly competitive urban societies endanger IS under basic ISDG and IFG, we recognize the necessity of a new mechanism that can motivate proself members to change their opinions from choosing option A to option B. To examine whether FAB can induce proself members to change their initial opinion of choosing option A into choosing option B, we decide to conduct individual interviews

and ex-post individual opinions enables us to identify the effect of FAB on individual opinion changes and generations' decisions.

Social value orientation game

We demonstrate a social value orientation (SVO) game developed by Van Lange et al. (1997, 2007) to identify individual social preference. This game is called "triple dominance method SVO game," characterizing a subject as either prosocial, individualistic, competitive or unidentified. In the game, a subject is randomly paired with another subject and asked to make a choice among three pairs of options where the other subject of the pair is unknown to the subject. The two numbers in each option represent the outcomes for oneself and the other subject in the pair. An example of this game is given as a selection problem among the following three options: (i) you receive 500, and the other receives 100; (ii) you receive 500, and the other receives 500; and (iii) you receive 560, and the other receives 330. In this example, option (i) represents a competitive subject, who maximizes the gap between her and the other subject's payoff ($500 - 100 = 400$); subjects who choose option (ii) maximize joint outcome ($500 + 500 = 1000$) and are considered prosocial; and option (iii) represents a individualistic subject who prefers to maximize her own payoff and does not care about the other subject's payoff.

The game comprises 9 questions, each question contains three options of competitive, prosocial and individualistic orientations. Subjects select one option in each question. When a subject make at least 6 selections that consistently match with one orientation among the competitive, prosocial and individualistic, she is classified as a subject with that orientation. However, if a subject makes less than the 6 selections that consistently match with any orientation, she is considered "unidentified." A subject's total payoff is the sum of her payoffs from the 9 selections she made for herself and the payoffs she receives from the 9 selections the other subject in the pair made for "the other."[5] Finally, we converted the total payoff of each subject into actual earning (cash

to elicit how individual opinions change before and after experiencing the deliberation under it.

[5]One possible payment method in SVO games is a strategy method, which may change subjects' incentives in experimental decision making, as suggested by Azrieli et al. (2018). However, we confirm that the payment procedure we use in SVO game is a standard practice for experimental research to characterize individual social preferences in

in BDT) by applying an exchange rate of 38.04, i.e., every 38.04 payoffs received by a subject deserves to be 1 BDT.

2.3 Experimental procedures

We were interested in including subjects from all types and socioeconomic classes of people in the Dhaka metropolitan area. However, we could not implement household-based randomization since obtaining a list of subjects and the data of household numbers from city offices in Dhaka was not feasible. We also conjectured that the response rate would be very low because of the lack of credibility about the experiments and experimenters if we invite subjects by sending invitation letters. Besides, it was impossible to include subjects from less-income occupations (elementary occupations) who reside in slums, through household-based randomization. Therefore, we implemented a stratified random sampling based on occupational categories. First, following the number of people with different occupations, we divided the entire population of Dhaka metropolitan into several occupation based strata (occupational strata henceforth). Hereafter, we proportionally determined a necessary number of subjects from each of the occupational strata to be included in our experiments.

From the labor market information system (LMIS), 2015 data (Bangladesh Bureau of Statistics, 2015), we obtained the percentage of people by occupations in the urban areas of Bangladesh. However, from these statistics, we could not get the exact occupational statistics of the Dhaka metropolitan area. Therefore, the percentage of subjects from different occupational strata in our experiments does not exactly match these statistics. We oversampled and undersampled from several occupational strata, given the real scenario of different occupations in Dhaka city. For instance, the LMIS statistics show that in the urban areas of Bangladesh, $11.50\,\%$ of the people are skilled agricultural, forestry and fishery workers. However, in reality, no agricultural, forestry or fishery workers were found in the Dhaka metropolitan. Therefore, we did not include any subject

psychology and economics (Van Lange et al., 1997, 2007, Park, 2000, Kanagaretnam et al., 2009, Brizi et al., 2015, Shahrier et al., 2016, 2017).

from this stratum. We undersampled from the stratum of elementary occupation, since including subjects from this stratum was challenging due to the floating nature of these types of occupations. We oversampled from several occupational strata such as managers, professionals, technicians and associate professionals, given the actual scenario of a high percentage of people with these occupations in Dhaka city. A list of occupational strata, the percentage of people by occupational strata in the urban areas (LMIS statistics) and the percentage of subjects from each occupational stratum in our experiments are presented in table 1 in the appendix.

Once we decided on the necessary number of subjects from each of the occupational strata, we randomly picked several organizations associated with these occupations. For inviting subjects from those organizations, we distributed written invitation letters and flyers with our contact information among the employees, upon the consent of the organizations. The experimenter (the first author) and the research assistants carried out invitation letters. Besides, we also invited subjects through Facebook by creating an event. Hereafter, based on the proportion of people with different occupational strata, we arbitrarily chose and invited subjects from those who contacted us and expressed their interest to participate in the experiments. To include subjects from elementary occupational stratum with the nature of frequent movement within the city, we used human connections. Through human connections, we randomly picked and invited them from several slums. The show-up rate among those invited was approximately $80\,\%$.

We administered 22 sequences of ISDG and in total 396 subjects took part in the experiments. Hence, 132 generations were arranged with 396 subjects. Out of the 22 sequences, 7, 7 and 8 were assigned to basic ISDG, IFG and FAB, respectively. Each session of the basic ISDG and IFG experiments took approximately 2.5 hours, while a session of FAB took approximately 3 hours. The maximum and average payments to the subjects were 810 BDT (≈ 10.13 USD) and 630 BDT (≈ 7.88 USD), respectively, including a fixed show-up fee of 200 BDT (≈ 2.50 USD). In the ISDG game, subjects were paid 360 BDT (≈ 4.50 USD) at maximum and 280 BDT (≈ 3.13 USD) on average. Whereas, the payment for SVO was 250 BDT (≈ 1.88 USD) at maximum and 150 BDT (≈ 1.88 USD) on average. We conducted the experiments at the Institute of Information Technology, University of Dhaka. The basic ISDG and IFG (FAB) experiments were conducted between January 2015 and March 2015 (June 2016 and September 2016).[6] In 2016, average household income per month of Bangladesh was 15 988 BDT ($\approx$ 200 USD), and thus, it was 532.93 BDT ($\approx$ 6.66 USD) per day (Bangladesh Bureau of Statistics, 2019). The average payment in our experiments was 1.18 times of the average household income per day in 2016.

In one session of the experiments, we gathered $18 \sim 27$ subjects (called members in ISDG) in a hall and their native language Bengali was used for instruction and presentation. In the first part of a session, we administered SVO game, and the instructions were provided to the subjects in addition to the verbal presentation made by the experimenter (the 1st author). After confirming subjects' understanding of the game through utilizing quizzes, we elicited their choices in the game. In the second part of a session, we conducted ISDG. Experimental instructions for ISDG were provided to the members, and the experimenter demonstrated a verbal presentation and confirmed members' understanding of the ISDG rules through utilizing the quizzes. Each of the $18 \sim 27$ members was randomly assigned to one of the 1st, 2nd, 3rd, . . . , 6th, 7th, . . . generations under sequences 1 and 2 in ISDG as denoted by M1, M2, M3, . . . , M6, N1, N2, . . . (see figure 2 in the appendix). Sequence 2 further continued in another session until a lineup of 6 generations played the game. For randomly assigning members to one of the generations, we asked them to select a card with an ID from a bag.[7] We prepareed $6 \sim 9$ separate rooms for the $6 \sim 9$ generations. According to the IDs picked by the members, we asked them to go and sit in a specific room. Therefore, the members in a generation would only be in touch with their generation members. They were informed that the game would continue and no information was provided regarding how many generations there were in a sequence. Moreover, since we organized more than 6 generations in a session, the members in the 6th generation in a sequence would not figure out that they were the members in the last generation in a sequence. To maintain anonymity within and across generations, we confirmed the proportional representation of members from each of the occupational strata in each sequence of

[6] The data of the basic ISDG and IFG were used in Shahrier et al. (2017).

[7] We did not use the word "generation." Instead, "generations" were mentioned as "groups" in the instruction and verbal presentation.

ISDG.

Hereafter, we elicited each generation's decision between options A and B and how the members split generation payoff among themselves, one by one from 1st generation to 6th generation in an ascending order. We let the members in a generation know their generation number and the payoffs corresponding to options A and B for their generation. Hence, they would work out the number of options A and B chosen by the previous generations since the experimental instructions included the information regarding payoffs associated with options A and B for the 1st generation.[8] We instructed the members not to start the deliberation before we ask them to do so. Members in a generation started the deliberation once we presented them the payoffs associated with options A and B for their generation and asked them to start the deliberation. Individual interviews were performed after each generation's decisions in FAB were being made. In the interviews, each member in a generation was asked about her personal opinions regarding the support for option A or option B "before and after" the generation's deliberations and decisions in FAB. Hereafter, we collected sociodemographic information from the subjects by questionnaires survey. Finally, subjects returned to the hall to receive the payment (cash in BDT) from the ISDG and SVO game including the show-up fee.

3 Results

Table 1 presents the frequency and percentage of generations' choices of unsustainable option, A and sustainable option B in basic ISDG, IFG and FAB. It appears that approximately $30.95\,\%$, $28.57\,\%$ and $81.25\,\%$ of the generations choose sustainable option B in basic ISDG, IFG and FAB, respectively. These results suggest that, both in basic ISDG and IFG, a majority of the generations choose unsustainable option A. However, in FAB, a majority of the generations choose sustainable option B, and only $18.75\,\%$ of the generations choose option A. To examine whether distributions of the proportion of generations that choose option B per sequence are independent of the treat-

[8] In FAB, information regarding a generation's request in the first step and her choice in the second step was not provided to the previous and next generations.

ments, we perform Mann-Whitney tests for the observations in each pair of two treatments. We consider the proportion of generations that choose option B per sequence as the unit of comparison since subsequent generations' decisions are not independent of previous generations' decisions in a sequence. The null hypothesis is that the distribution of the proportion of generations that choose option B per sequence is the same for any pair of treatments (basic vs. IFG, basic vs. FAB and IFG vs. FAB). Our examination fails to reject this hypothesis for basic vs. IFG at $5\,\%$ significance level; however, it rejects the hypothesis for basic vs. FAB and IFG vs. FAB at $1\,\%$ significance level. The results in the Mann-Whitney tests are: (i) basic ISDG *vs* IFG $(Z = 0.07, p = 1.00)$, (ii) basic ISDG *vs* FAB $(Z = -3.10, p = 0.00)$ and (iii) IFG *vs* FAB $(Z = -3.29, p = 0.00)$. The results in the tests and the frequency of generations' choices of options A and B under each treatment in table 1 suggest that FAB induces more generations to choose option B than any other treatment.

[Table 1 about here.]

The results in table 1 can be interpreted as indicating that members choose to maximize their own generation's payoff when the collective decisions are made through deliberation in the basic ISDG. Moreover, introducing imaginary future generations (IFG) into the deliberation fails to maintain IS since the frequency of choosing option A in IFG becomes even higher than that in the basic ISDG. The results appear to suggest the necessity of a stronger mechanism to maintain IS in highly competitive urban societies. Fortunately, however, FAB appears to be successful in maintaining IS even in one such highly competitive urban society, Dhaka. Approximately $81.25\,\%$ of the generations choose option B to maintain IS in FAB.[9]

We characterize the determinants of generations' choices for IS and how FAB affects individual members' opinions and generations' decisions. Past studies show that an individual social preference or social value orientation (categorized by SVO games) is one of the important determinants of IS and the sustainability of common pool resources (Shahrier et al., 2016, 2017, Timilsina et al.,

[9]We do not present any statistics for the divisions of the generation payoffs, since all the generations split them equally among the members in every treatment.

2017, 2019, 2021). Specifically, these studies show that an increase in the number of prosocial members in a generation is associated with high probabilities of maintaining IS and common pool resources. These studies also demonstrate that highly urbanized societies might have greater tendencies to compromise IS, as a majority of members are proself (competitors and individualists) in such societies.

[Table 2 about here.]

Distributions of generations in relation to the number of prosocial members (categorized by SVO games) per generation for each treatment are summarized in table 2. From table 2, we see that out of the 132 total generations, $51.79\,\%$, $30.03\,\%$, $15.15\,\%$ and $3.03\,\%$ consist of zero prosocial (or three proself members), one prosocial, two prosocial and three prosocial members per generation, respectively (see the "overall" column in table 2). It appears that a majority of the generations consist of only competitors and individualists (proself members) in the highly competitive urban society, Dhaka, which is in line with our past studies (Shahrier et al., 2016, 2017). In total, the percentage of proself subjects in our experiments is identified to be approximately $76.8\,\%$. Table 3 presents the percentage of generations that choose option B with respect to the number of prosocial members per generation (see the "overall" column in table 3). It shows that when generations consist of only proself members, $23.53\,\%$ of the generations chose option B (see the cell of "overall" column and "0" row in table 3). However, as the number of prosocial members per generation increases, the percentage of choosing option B rises (see the "overall" column in table 3). For example, $60\,\%$, $100\,\%$, $100\,\%$ of the generations chose option B when the generation consist of one prosocial, two prosocial and three prosocial members, respectively. This result is consistent with our past studies, indicating that individual social preferences might be one of the strongest determinants of generations' decisions regarding IS (Shahrier et al., 2017).

[Table 3 about here.]

Table 3 also presents the percentage of generations that choose option B with respect to the number of prosocial members per generation under each treatment. In basic ISDG and IFG, only

$11.54\,\%$ ($14.29\,\%$) and $3.70\,\%$ ($50.00\,\%$) of the generations respectively choose option B when the generations consist of zero prosocial (one prosocial) member (see the "basic ISDG" and "IFG" columns of table 3). The findings from basic ISDG and IFG suggest that a new mechanism must be developed to induce proself members to change generations' choices from option A to option B, especially when a majority of generations consist of proself members in a society. It appears that FAB can be one such mechanism in that $80.00\,\%$ and $76.00\,\%$ of the generations chose option B under it even when the generations consisted of zero and one prosocial member, respectively (see the"FAB" columns of table 3). To examine whether the distributions of generations that choose option B with respect to the number of prosocial members per generation are the same for any pair of treatments, we run chi-squared tests. The null hypothesis is that the percentages of generations' choices for option B over the number of prosocial members per generation are independent between two treatments. Tests fail to reject the null hypothesis for basic ISDG *vs* IFG, but reject it for basic ISDG *vs* FAB and IFG *vs* FAB at $1\,\%$ significance level (see the results of chi-squared tests at the bottom of table 3). The results of the chi-squared tests demonstrate that possibly FAB is effective at maintaining IS by affecting proself members' decisions in ISDG.

To characterize the findings in table 4, we estimate three models of probit regressions by taking a generation's choice of option B as the dummy dependent variable (When a generation chooses option B, it is unity. Otherwise, zero). Clustered standard errors on sequences have been computed in all models since a generation's decision for IS might not be independent of previous generations' choices of options A and B within a sequence. The three regression models are estimated for checking some possibility of a posttreatment bias. The posttreatment bias exists if in a regression, we include treatments and other independent variables that are affected by the treatments (Montgomery et al., 2018, Hernuryadin et al., 2020). Recall that in a sequence of ISDG, members in some generations participated in SVO game after playing the ISDG for time management. The outcomes in SVO game may be influenced by the treatments in ISDG. The existence of a posttreatment bias may be claimed when we include the number of prosocial members per generation and IFG and FAB mechanisms as independent variables in one regression. Therefore, in model 1, we only include the number of prosocial members per generation as the independent variable. In model 2, only the IFG and FAB dummies are incorporated as the two independent variables. Finally, model 3 comprises all the independent variables, i.e., the number of prosocial members per generation, the proportion of previous generations that chose option A in a sequence, dummy variables for IFG and FAB, the interaction terms between the number of prosocial members per generation and IFG as well as between the number of prosocial members per generation and FAB. The detailed definition of each variable is given in Table 4's table notes.[10]

Table 4 reports the coefficients and marginal effects of the independent variables on the likelihood for a generation to choose option B, being calculated from the probit regressions. Overall, we see that the number of prosocial members per generation in models 1 and 3, the FAB dummy in models 2 and 3 and the interaction term of the FAB times the number of prosocial members per generation in model 3 appear to be economically and statistically significant in affecting the likelihood for a generation to choose option B in ISDG. However, the IFG dummy in models 2 and 3, and the proportion of previous generations that chose option A in a sequence and the interaction term of the IFG times the number of prosocial members per generation in model 3 are insignificant in affecting the probability of a generation choosing option B. The overall results from the probit regressions are quite consistent with the chi-squared tests and summary statistics in tables 2 and 3.

[Table 4 about here.]

Model 1 of table 4 indicates that an increase in the number of prosocial members per generation is associated with a 33.7 percentage point higher probability of choosing option B. This suggests that the likelihood of maintaining IS rises with an increase in the number prosocial members per generation. Model 2 presents the effect of IFG and FAB mechanisms on the probability of choosing sustainable option B. The FAB dummy is identified to be economically and statistically significant. The generations in the FAB mechanism are 44.1 percentage point more likely to choose option B

[10] Past studies confirm that people's SVOs are stable over time and they do not change in the short run (Van Lange et al., 1997, 2007, Bruhin et al., 2019). Therefore, a posttreatment bias is unlikely to exist even when we include the number of prosocial members per generation and IFG and FAB dummies as independent variables in a regression. Even if some researchers claim that SVO is a posttreatment variable, we resolve the concern about the presence of a posttreatment bias by estimating three different regression models.

than those in basic ISDG, impling that FAB mechanism successfully improves IS. On the other hand, the IFG mechanism appears to be ineffective at achieving IS since the IFG dummy is not significant even at $10\,\%$ level. In summary, findings in models 1 and 2 imply that an increase in the number of prosocial members per generation and the FAB improves IS, while the IFG fails in motivating generations to maintain IS.[11]

Model 3 in table 4 reveals the effects of the IFG and FAB mechanisms and the number of prosocial members per generation on the probability of choosing sustainable option B and examines the robustness of the findings in models 1 and 2. In this model, an increase in the number of prosocial members per generation is associated with a 18.8 percentage point greater probability of choosing option B, holding all other factors fixed. IFG mechanism is identified not to improve IS in that the IFG dummy and the interaction term between IFG and the number of prosocial members per generation remain insignificant even at $10\,\%$ level. Finally, the FAB dummy is identified to be economically and statistically significant, demonstrating that the generations in the FAB mechanism are 41.0 percentage point more likely to choose option B than those in basic ISDG. The coefficient on the interaction term of FAB dummy times the number of prosocial members per generation is estimated to be -0.957 at $5\,\%$ level and the marginal effect of the number of prosocial members per generation is 18.8 percentage point in model 3 (it is 33.7 percentage point in model 1). The estimation in model 3 demonstrates that the likelihood for a generation to choose option B becomes less dependent on the number of prosocial members per generation in FAB than in basic ISDG. Therefore, FAB may be effective at maintaining IS without relying on prosocial members per generation by possibly enabling each of them to support sustainable option B.

With the results in table 4, it can now be hypothesized that FAB affects proself members' opinions and generation decisions between options A and B to maintain IS. To examine this hypothesis, we interviewed each member about whether she personally supported option A or option B be-

[11] As part of the robustness check, we estimated three models of panel probit regression with the same set of dependent and independent variables used in the three probit regression models in table 4. They exhibited the same qualitative findings reported in table 4. We do not present the outcomes of panel probit regressions as our main results since a generation in a sequence of ISDG does not provide multiple observations over dependent and independent variables.

fore and after the deliberation under FAB. The interviews in FAB clarify how individual opinions change due to the deliberation under it in relation to individual social value orientations. There are four possible pairs of individual opinion changes before and after FAB mechanism: (i) a member initially supported option B and still supports option B after the FAB mechanism (hereafter, BB); (ii) a member initially supported option A and still supports option A after the FAB mechanism (hereafter, AA), (iii) a member initially supported option A but supports option B after the FAB mechanism (hereafter, AB), and (iv) a member initially supported option B but supports option A after the FAB mechanism (hereafter, BA). Among these four possible pairs, BB and AA represent no change in individual opinions, while AB and BA represent changes in individual opinions.

[Table 5 about here.]

Table 5 presents the percentages of these four types of individual opinion changes for each of the value orientations in FAB. Approximately $82.93\,\%$ of prosocial members follow BB, whereas $0.00\,\%$, $5.36\,\%$ and $7.14\,\%$ of the competitors, individualists and the unidentified members follow BB, respectively. In contrast, AA is the lowest for prosocial members ($4.88\,\%$), followed by individualists ($23.21\,\%$) and by competitors ($45.45\,\%$). No member in any value orientation follows BA. Finally, $71.43\,\%$, $57.14\,\%$, $54.55\,\%$ and $12.20\,\%$ of the individualistic, unidentified, competitor and prosocial members follow AB, respectively. It appears that a considerable portion of the individualists, the competitors and the unidentified change their individual opinions from option A to option B after the deliberation under FAB. We perform chi-squared tests to examine whether the opinion changes (AB) and no opinion changes (BB and AA) are statistically independent of the value orientations. As none of the members change their opinions from option B to option A, we consider that AB corresponds to opinion changes, while BB and AA represent no opinion changes. The null hypothesis is that the distributions of opinion changes (AB) are the same between two types of value orientations. The examination rejects the null hypothesis at the $1\,\%$ level for all pairs of value orientations except for competitive vs. unidentified and individualistic vs. unidentified (see the results for the chi-squared tests at the bottom of table 5). This examination confirms that opinion changes are dependent on value orientations.

To empirically characterize this finding, we regress an opinion changes from option A to option B as a dependent variable on value orientations and individual socioeconomic variables as independent variables, using a probit regression. We define the dependent variable of opinion changes as follows: the variable takes value 1 for AB (when a member changes her opinion from option A to option B through FAB), 0 otherwise. A set of independent variables includes SVO dummies (Base group $=$ Prosocial) and socioeconomic variables such as income, education and family structure. The detailed definitions of variables included in the regression are given in table 6's table notes. Since no opinion changes of the sequence BA are found, this regression is simplified to analyze the probability of the opinion changes from option A to option B (or AB) relative to the probability of no opinion changes (AA or BB) under FAB.

Table 6 shows the marginal effects of the independent variables on the probability of opinion changes from option A to option B. The marginal effects of SVO dummies exactly follow the summary statistics of the opinion changes for each value orientation in table 5. This reveals that individualists, unidentified and competitors are respectively 53.8, 45.8 and 38.1 percentage point more likely to change their opinions from option A to option B compared to prosocial members, holding all other factors fixed. This regression result confirms that FAB can induce a large number of the individualistic, unidentified and competitive members to change individual opinions from option A to option B. Therefore, it can be argued that more generations of proself members are induced to choose sustainable option B under FAB.

[Table 6 about here.]

Recall that in FAB, members in a generation need to finalize their decision by majority voting for option A or option B if they do not have the same request and choice in the first and second steps. Out of the 48 generations in FAB, 9 made their final decision by such anonymous votes (majority voting). Among these 9 generations, 7 voted for option A. Thus, voting does not appear to have been effective in achieving IS in our field experiments. Moreover, from the data of individual opinion changes under the FAB mechanism, we find that 106 members out of the total 144 initially supported option A before deliberation, implying that such members are likely to choose option

A if they make the decision through a simple deliberation or majority voting. In summary, along with the results from the basic ISDG, the outcomes of voting and opinion changes observed in FAB mechanism provide evidence that simple deliberation or voting may fail to maintain IS when societies consist of a majority of proself members. Overall, the main results in this research reveal that deliberation does not prevent proself people from choosing unsustainable options in basic ISDG and IFG is not effective enough. In contrast, FAB is demonstrated to enable such proself people to change their individual opinions from unsustainable to sustainable options, thereby inducing a majority of generations to choose sustainable options.

FAB is built upon three possible channels that trigger other-regarding preferences for future generations: fellow feeling, indirect reciprocity and cognitive dissonance. Based on the members' deliberation/discussion in our experiments, we believe that fellow feeling is the primary channel that induces them to choose sustainable options. When the members discuss their choice between sustainable and unsustainable options in the second step after role-playing as the next generation in the first step under FAB, they frequently use the terms related to "sympathy for future generations." We conjecture that such discussions indicate certain operations of fellow feeling in their decision-making processes. In addition, a large number of them mention that they feel some obligation or responsibility to choose the same option they requested in the first step. It indicates the possibility of the activation of indirect reciprocity and/or cognitive dissonance in decision-making.[12] Overall, we believe that role-playing or perspective-taking of future generations in FAB triggers prosociality or other-regarding preferences for future generations mainly through fellow feelings. However, indirect reciprocity and cognitive dissonance may also influence their decisions.

FAB can be used in two ways to resolve IS problems. First, it can be introduced as part of an alternative democratic institution when taking collective decisions that come with an intertemporal nature over generations. For instance, to determine the upper limit of greenhouse gas emission,

[12] It is challenging to distinguish between the impacts of indirect reciprocity and cognitive dissonance since they are not mutually exclusive. Members may choose sustainability for the actual future generation as the members of the current generation due to reciprocating with the imaginary future self (in the first step role-playing) through indirect reciprocity. However, the dissonance, i.e., the contradictory interests of current and future generations, and associated psychological discomfort may influence the cognitive state of the activation of indirect reciprocity in decision-making.

FAB can be introduced. First, the stakeholders should be assumed to be the members in future generations. They should discuss, determine and write their requests about the allowable amount of greenhouse gas emission to the current generation as if they are the members in the future generation. In the second step, they will return to their actual position of the current generation, discuss and choose the amount of greenhouse gas emission, considering what they request in the first step. Second, FAB can be applied in youth education and training programs to change individual behaviors toward being future-oriented. Role-playing has been emerging as one of the prominent techniques for youth education and training in national and international contexts (Comer, 2005, Craciun, 2010, McConville et al., 2017, Moreno-Guerrero et al., 2020). For instance, there are several youth training programs, such as "Model UN" by the United Nations Association of the USA, the parliament role-play educational programs in Australia and Canada as well as the United Nations Children's Parliament through role-playing of future generations to understand and practice some decision-making process through democratic participation. The role-playing in FAB as the member in future generations shall be considered one new approach in education and youth training programs as mentioned above to trigger future-oriented behaviors that lead to sustainability. Past studies demonstrate that a change in culture and institutions affects human behaviors and decisions (Henrich et al., 2005, Richerson and Boyd, 2008, Wilson et al., 2009).

We end our discussion by comparing our results regarding democracy/voting and IFG treatment with two important previous works of Hauser et al. (2014) and Kamijo et al. (2017), respectively. Our study finds that deliberation is not effective at maintaining IS, and the result appears to be contradictory with Hauser et al. (2014). They claim that median voting Pareto improves and ensures sustainability, especially when a majority of the subjects are not "proself."[13] However, it should be noted that our study differs from theirs. In our experiments, members deliberate and choose between sustainable and unsustainable options in ISD where every allocation is Pareto efficient. In their experiments, the median "take" among five members is the basis for the group "take" where an allocation of Pareto improvement over generations exists. Due to the difference, subjects in their

[13]We elicit an SVO for each subject with monetary incentives, while Hauser et al. (2014) do not elicit it as data.

experiments are likely to identify and choose actions towards Pareto improvement and sustainability through the voting, as compared to those in our experiments facing "IS dilemma." However, the result in Hauser et al. (2014) is interpreted to be consistent with ours in that determining the harvests by median votes shall compromise sustainability when a majority of the subjects are "proself" as in the case of our study. Regarding the outcome of IFG between ours and Kamijo et al. (2017), we need to note about subject pools. Kamijo et al. (2017) use a subject pool of university students and a majority of the subjects are prosocial (more than $60\,\%$) by SVOs, while we use a subject pool of general people in Bangladesh and a majority of the subjects are proself (more than $70\,\%$). Since prosocials are likely to approve and choose sustainable options in ISDG by nature, the priming effect of IFG is considered to easily become effective among such prosocial subjects as in the case of Kamijo et al. (2017). IFG is considered not to work in our study, because it does not become convincing or strong enough to induce a majority of proself people to approve and choose sustainable options.

4 Conclusion

Intergenerational sustainability (IS) is pivotal for survival of human societies. However, IS gets compromised because societies are rapidly urbanized especially in developing countries and people's orientations become proself with such urbanization (Berenguer et al., 2005, Schwartz, 2007, Huddart-Kennedy et al., 2009, Shahrier et al., 2016, 2017, Jingchao et al., 2021, Timilsina et al., 2021). When proself people face IS dilemma (ISD) of whether to choose being sustainable by sacrificing themselves for future generations or unsustainable by prioritizing their benefits, they tend to choose being unsustainable (Hauser et al., 2014, Sherstyuk et al., 2016, Shahrier et al., 2017, Shahen et al., 2021, Timilsina et al., 2022). We design and institute a new mechanism, i.e., future ahead and back (FAB) mechanism, as a resolution to induce proself people to be sustainable, examining its effectiveness through conducting ISD game (ISDG) field experiments in an urban city, Dhaka, Bangladesh. In basic ISDG, a lineup of generations, each consisting of three members, is organized, and each of them is asked to choose either maintaining IS (sustainable option) or maximizing her own generation's payoff by irreversibly imposing costs on subsequent generations (unsustainable option) through deliberation. With FAB, each generation is first asked to discuss and make a request to the current generation's decision as if she is in the position of the next generation. Second, she makes the actual decision from her original position as the current generation. The results reveal that deliberation does not prevent proself members from choosing unsustainable options in basic ISDG. In contrast, FAB is demonstrated to enable such proself members to change their individual opinions from unsustainable to sustainable options, thereby inducing a majority of generations to choose sustainable options. We argue that memories and experiences of role play as the next generation in FAB trigger individual other-regarding preferences for future generations, such as fellow feeling and indirect reciprocity, enhancing IS.

Finally, we note some limitations and future avenues of research. First, we do not examine the details regarding the pathways that determine how and why "proself" people change their opinions on IS. Further researches, such as deliberative analyses of the transcribed deliberations, neuroimaging and/or a different type of experiments with new designs, may be able to clarify such pathways. Second, our research is oriented towards how people's decisions and behaviors can be affected to be sustainable by FAB in experimental settings. And thus, it is not sufficient to answer how often people need to practice FAB in their daily life for a persistent behavioral change towards acting prosocially to future generations. To answer this question, randomized control trials and social experiments with FAB should be implemented. Third, this research does not investigate how discussions under FAB concretely affect individual opinion changes. To this end, future research should be able to design new FAB experiments that enable us to observe the opinion changes under various settings, such as anonymous, online and face-to-face ones. These caveats notwithstanding, we believe that this study is the first step toward identifying a new mechanism as a potential resolution to ISD in highly competitive societies, especially when a majority of people are proself.

Ethical review

The ethics committee (institutional review board) of Kochi University of Technology approved the study (protocol code: 38-C2; approval date: 03.10.2016). We demonstrated the study following the guidelines of the Declaration of Helsinki.

Informed Consent

We obtained the informed consent from each experimental subject in written form.

References

American Association for the Advancement of Science (2016). Rise of the city. *Science*, 352:906–907.

Azrieli, Y., Chambers, C., and Healy, P. (2018). Incentives in experiments: A theoretical analysis. *Journal of political economy*, 126:1472–1503.

Bangladesh Bureau of Statistics (2015). Labour market information system, Bangladesh. Technical report, Bangladesh Bureau of Statistics.

Bangladesh Bureau of Statistics (2019). Final report on household income and expenditure survey 2016. Technical report, Bangladesh Bureau of Statistics.

Berenguer, J., Corraliza, J., and Martin, R. (2005). Rural-urban differences in environmental concern, attitudes, and actions. *European journal of psychological assessment*, 21:128–138.

Brizi, A., Giacomantonio, M., Schumpe, B., and Mannetti, L. (2015). Intention to pay taxes or to avoid them: The impact of social value orientation. *Journal of economic psychology*, 50:22–31.

Bruhin, A., Fehr, E., and Schunk, D. (2019). The many faces of human sociality: Uncovering the distribution and stability of social preferences. *Journal of the European economic association*, 17:1025–1069.

Comer, S. (2005). Patient care simulations: Role playing to enhance clinical understanding. *Nursing education perspectives*, 26:357–361.

Costanza, R., Kubiszewski, I., Giovannini, E., Lovins, H., McGlade, J., Pickett, K., Ragnarsdottir, K., Roberts, D., Vogli, R., and Wilkinson, R. (2014). Time to leave GDP behind. *Nature*, 505:283–285.

Craciun, D. (2010). Role-playing as a creative method in science education. *Journal of science and arts*, 10:175–182.

Dawes, R. (1980). Social dilemmas. *Annual review of psychology*, 31:169–193.

Dewan, A. and Corner, R. (2014). *Dhaka megacity: Geospatial perspectives on urbanisation, environment and health*. Springer.

Ehrlich, P., Kareiva, P., and Daily, G. (2012). Securing natural capital and expanding equity to rescale civilization. *Nature*, 486:68–73.

Fisher, M., Irlenbusch, B., and Sadrieh, A. (2004). An intergenerational common pool resource experiment. *Journal of environmental economics and management*, 48:811–836.

Griggs, D., Stafford-Smith, M., Gaffney, O., Rockström, J., Öhman, M., Shyamsundar, P., Steffen, W., Glaser, G., Kanie, N., and Noble, I. (2013). Sustainable development goals for people and planet. *Nature*, 495:305–307.

Harmon-Jones, E., editor (2019). *Cognitive dissonance: Reexamining a pivotal theory in psychology*. American Psychological Association.

Hauser, O., Rand, D., Peysakhovich, A., and Nowak, M. (2014). Cooperating with the future. *Nature*, 511:220–223.

Henrich, J., Boyd, R., Bowles, S., Camerer, C., Fehr, E., Gintis, H., McElreath, R., Alvard, M., Barr, A., Ensminger, J., Heinrich, N., Hill, K., Gil-White, F., Gurven, M., Marlowe, F., Patton, J., and Tracer, D. (2005). "Economic man" in cross-cultural perspective: Behavioral experiments in 15 small-scale soceities. *Behavioral and brain sciences*, 28:795–855.

Henrich, J., Ensminger, J., McElreath, R., Barr, A., Barrett, C., Bolyanatz, A., Cardenas, J., Gurven, M., Gwako, E., Henrich, N., Lesorogol, C., Marlowe, F., Tracer, D., and Ziker, J. (2010a). Markets, religion, community size, and the evolution of fairness and punishment. *Science*, 327:1480–1484.

Henrich, J., Heine, S., and Norenzayan, A. (2010b). The weirdest people in the world? *Behavioral and brain sciences*, 33:61–83.

Hernuryadin, Y., Kotani, K., and Saijo, T. (2020). Time preferences of food producers: Does "cultivate and grow" matter? *Land economics*, 96:132–148.

Huddart-Kennedy, E., Beckley, T., McFarlane, B., and Nadeau, S. (2009). Rural-urban differences in environmental concern in Canada. *Rural sociology*, 74:309–329.

Jingchao, Z., Kotani, K., and Saijo, T. (2021). Are societies becoming proself? A topographical difference under fast urbanization in China. *Environment, development and sustainability*, 23:12976–12993.

Kamijo, Y., Komiya, A., Mifune, N., and Saijo, T. (2017). Negotiating with the future: Incorporating imaginary future generations into negotiations. *Sustainability science*, 12:409–420.

Kanagaretnam, K., Mestelman, S., Nainar, K., and Shehata, M. (2009). The impact of social value orientation and risk attitudes on trust and reciprocity. *Journal of economic psychology*, 30:368–380.

Kinzig, A., Ehrlich, P., Alston, L., Arrow, K., Barrett, S., Buchman, T., Daily, G., Levin, B., Levin, S., Oppenheimer, M., Ostrom, E., and Saari, D. (2013). Social norms and global environmental challenges: The complex interaction of behaviors, values, and policy. *BioScience*, 63:164–175.

Krutilla, J. (1967). Conservation reconsidered. *American economic review*, 57:777–786.

Maxwell, S., Fuller, R., Brooks, T., and Watson, J. (2016). Biodiversity: The ravages of guns, nets and bulldozers. *Nature*, 536:143–145.

McConville, J., Rauch, S., Helgegren, I., and Kain, J.-H. (2017). Using role-playing games to broaden engineering education. *International journal of sustainability in higher education*, 18:594–607.

McDonnell, M. and MacGregor-Fors, I. (2016). The ecological future of cities. *Science*, 352:936–938.

Milinski, M., Semmann, D., Krambeck, H., and Marotzke, J. (2006). Stabilizing the earth's climate is not a losing game: Supporting evidence from public goods experiments. *Proceedings of the National Academy of Sciences of the United States of America*, 103:3994–3998.

Montgomery, J., Nyhan, B., and Torres, M. (2018). How conditioning on posttreatment variables can ruin your experiment and what to do about it. *American journal of political science*, 62:760–775.

Moreno-Guerrero, A.-J., Rodríguez-Jiménez, C., Gómez-García, G., and Navas-Parejo, M. (2020). Educational innovation in higher education: Use of role playing and educational video in future teachers' training. *Sustainability*, 12:2558.

Mujcic, R. and Leibbrandt, A. (2018). Indirect reciprocity and prosocial behaviour: Evidence from a natural field experiment. *Economic journal*, 128:1683–1699.

Nowak, M. and Roch, S. (2007). Upstream reciprocity and the evolution of gratitude. *Proceedings of the royal society B: Biological sciences*, 274:605–610.

Nowak, M. and Sigmund, K. (1998). Evolution of indirect reciprocity by image scoring. *Nature*, 393:573–577.

Ostrom, E. (1990). *Governing the commons: The evolution of instituions for collective actions*. Cambridge university press.

Park, E. (2000). Warm-glow versus cold-prickle: A further experimental study of framing effects on free-riding. *Journal of economic behavior and organization*, 43:405–421.

Richerson, P. and Boyd, R. (2008). *Not by genes alone: How culture transformed human evolution*. University of Chicago press.

Schwartz, S. (2007). Cultural and individual value correlates of capitalism: A comparative analysis. *Psychological inquiry*, 18:52–57.

Shahen, M., Kotani, K., and Saijo, T. (2021). Intergenerational sustainability is enhanced by taking the perspective of future generations. *Scientific reports*, 11:2437.

Shahen, M., Shahrier, S., and Kotani, K. (2019). Happiness, generativity and social preferences in a developing country: A possibility of future design. *Sustainability*, 11:5256.

Shahrier, S., Kotani, K., and Kakinaka, M. (2016). Social value orientation and capitalism in societies. *PLoS ONE*, 11:e0165067.

Shahrier, S., Kotani, K., and Saijo, T. (2017). Intergenerational sustainability dilemma and the degree of capitalism in societies: A field experiment. *Sustainability science*, 12:957–967.

Sherstyuk, K., Tarui, N., Ravago, M., and Saijo, T. (2016). Intergenerational games with dynamic externalities and climate change experiments. *Journal of the association of environmental and resource economists*, 3:247–281.

Smith, A. (1976). *The theory of moral sentiment*. Oxford university press.

Steffen, W., Richardson, K., Rockström, J., Cornell, S., Fetzer, I., Bennett, E., Biggs, R., Carpenter, S., Vries, W., de Wit, C., Folke, C., Gerten, D., Heinke, J., Mace, G., Persson, L., Ramanathan, V., Reyers, B., and Sörlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science*, 347:1259855.

Timilsina, R., Kotani, K., and Kamijo, Y. (2017). Sustainability of common pool resources. *PLoS ONE*, 12:e0170981.

Timilsina, R., Kotani, K., and Kamijo, Y. (2019). Generativity and social value orientation between rural and urban societies in a developing country. *Futures*, 105:124–132.

Timilsina, R., Kotani, K., Nakagawa, Y., and Saijo, T. (2021). Concerns for future generations in societies: A deliberative analysis of the intergenerational sustainability dilemma. *Journal of behavioral and experimental economics*, 90:101628.

Timilsina, R., Kotani, K., Nakagawa, Y., and Saijo, T. (2022). Intragenerational deliberation and intergenerational sustainability dilemma. *European journal of political economy*, 73:102131.

Van Lange, P., Bekkers, R., Shuyt, T., and Vugt, M. (2007). From games to giving: Social value orientation predicts donation to noble causes. *Basic and applied social psychology*, 29:375–384.

Van Lange, P., Bruin, E., Otten, W., and Joireman, J. (1997). Development of prosocial, individualistic, and competitive orientations: Theory and preliminary evidence. *Journal of personality and social psychology*, 73:733–746.

Wigginton, N., Fahrenkamp-Uppenbrink, J., Wible, B., and Malakoff, D. (2016). Cities are the future. *Science*, 352:904–905.

Wilson, D., O'Brien, D., and Sesma, A. (2009). Human prosociality from an evolutionary perspective: Variation and correlations at a city-wide scale. *Evolution and human behavior*, 30:190–200.

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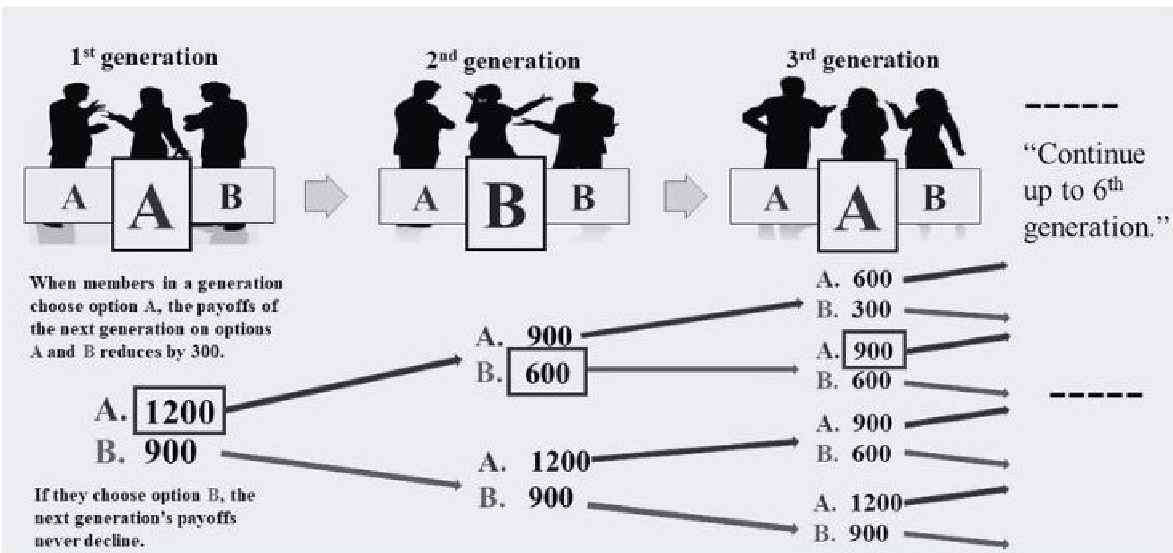

Figure 1: The intergenerational sustainability dilemma game (ISDG) for illustration of how one generation's decision affects the subsequent generations' payoffs

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Table 1: Frequency and percentage of generations' choices of options A and B in basic ISDG, IFG and FAB

	A	B	Overall
Basic ISDG	29 (69.05 %)	13 (30.95 %)	42 (100 %)
IFG	30 (71.43 %)	12 (28.57 %)	42 (100 %)
FAB	9 (18.75 %)	39 (81.25 %)	48 (100 %)

Table 2: Distributions of generations with respect to the number of prosocial members per generation for each mechanism: Basic ISDG, IFG and FAB.

Number of prosocial members per generation	Number of generations (percentage)			Overall
	Basic ISDG	IFG	FAB	
0	26 (61.90 %)	27 (64.29 %)	15 (31.25 %)	68 (51.79 %)
1	7 (16.67 %)	8 (19.05 %)	25 (52.08 %)	40 (30.03 %)
2	7 (16.67 %)	5 (11.90 %)	8 (16.67 %)	20 (15.15 %)
3	2 (4.76 %)	2 (4.76 %)	0 (0.00 %)	4 (3.03 %)
Total	42 (100 %)	42 (100 %)	48 (100 %)	132 (100 %)

Table 3: Percentages of generations that choose option B with respect to the number of prosocial members per generation under Basic ISDG, IFG and FAB.

# of prosocial members per generation	Percentage of choice B			Overall
	Basic ISDG	IFG	FAB	
0	$11.54\,\%\ \left(\approx \frac{3}{26}\right)$	$3.70\,\%\ (\approx \frac{1}{27})$	$80.00\,\%\ (= \frac{12}{15})$	$23.53\,\%\ \left(\approx \frac{16}{68}\right)$
1	$14.29\,\%\ \left(\approx \frac{1}{7}\right)$	$50.00\,\%\ \left(= \frac{4}{8}\right)$	$76.00\,\%\ \left(= \frac{19}{25}\right)$	$60.00\,\%\ \left(= \frac{24}{40}\right)$
2	$100.00\,\%\ \left(= \frac{7}{7}\right)$	$100.00\,\%\ \left(= \frac{5}{5}\right)$	$100.00\,\%\ \left(= \frac{8}{8}\right)$	$100.00\,\%\ \left(= \frac{20}{20}\right)$
3	$100.00\,\%\ \left(= \frac{2}{2}\right)$	$100.00\,\%\ \left(= \frac{2}{2}\right)$	-	$100.00\,\%\ \left(= \frac{4}{4}\right)$
Total	$30.95\,\%\ \left(\approx \frac{13}{42}\right)$	$28.57\,\%\ \left(\approx \frac{12}{42}\right)$	$81.25\,\%\ \left(\approx \frac{39}{48}\right)$	$50.00\,\%\ \left(= \frac{66}{132}\right)$

We have run chi-squared tests with the null hypothesis that the percentages of generations' choices for option B over the number of prosocial members per generation are independent between two treatments. The results are (i) basic ISDG *vs* IFG ($\chi^2(3) = 3.10, p = 0.38$), (ii) basic ISDG *vs* FAB ($\chi^2(3) = 14.22, p = 0.00$) and (iii) IFG *vs* FAB ($\chi^2(3) = 10.40, p = 0.01$).

Table 4: Models 1, 2 and 3: Coefficients and marginal effects of independent variables on the likelihood of a generation choosing option B in probit regressions

Choice of option B[1]	Model 1 ($N = 132$)		Model 2 ($N = 132$)		Model 3 ($N = 132$)	
	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect
# of prosocial members[2]	1.216***	0.337***			1.278***	0.188***
	(0.196)	(0.022)			(0.357)	(0.022)
Proportion of A[3]					-0.164	-0.033
					(0.304)	(0.060)
IFG dummy[4]			-0.069	-0.022	-0.438	-0.003
			(0.266)	(0.085)	(0.579)	(0.060)
FAB dummy[5]			1.384***	0.441***	1.971***	0.410***
			(0.276)	(0.062)	(0.515)	(0.098)
IFG × # of prosocials[6]					0.647	-
					(0.632)	
FAB × # of prosocials[7]					-0.957**	-
					(0.398)	
Constant	-0.784***		-0.497***		-1.313***	
	(0.234)		(0.181)		(0.479)	
Wald χ^2	38.480***		33.060***		56.580***	

***significant at the 1 percent level, **significant at the 5 percent level.
Clustered standard errors on sequences in parenthesis.

1 A dummy variable that takes value 1 if the generation chooses option B, 0 otherwise.
2 The number of prosocial members per generation.
3 The proportion of previous generations that chose option A in a sequence.
4 A dummy variable that takes value 1 when the IFG mechanism is administered to one sequence consisting of 6 generations, 0 otherwise.
5 A dummy variable that takes value 1 when the FAB mechanism is administered to one sequence consisting of 6 generations, 0 otherwise.
6 An interaction term of IFG times the number of prosocial members per generation.
7 An interaction term of FAB times the number of prosocial members per generation.

Table 5: Social value orientations and changes in individual opinion by percentage in FAB

Opinion change	Social value orientation				Overall
	Competitive	Prosocial	Individualistic	Unidentified	
BB	$0.00\,\%\ \left(\approx \frac{0}{33}\right)$	$82.93\,\%\ \left(\approx \frac{34}{41}\right)$	$5.36\,\%\ \left(\approx \frac{3}{56}\right)$	$7.14\,\%\ \left(\approx \frac{1}{14}\right)$	$26.39\,\%\ \left(\approx \frac{38}{144}\right)$
AA	$45.45\,\%\ \left(\approx \frac{15}{33}\right)$	$4.88\,\%\ \left(\approx \frac{2}{41}\right)$	$23.21\,\%\ \left(\approx \frac{13}{56}\right)$	$35.71\,\%\ \left(\approx \frac{5}{14}\right)$	$24.31\,\%\ \left(\approx \frac{35}{144}\right)$
AB	$54.55\,\%\ \left(\approx \frac{18}{33}\right)$	$12.20\,\%\ \left(\approx \frac{5}{41}\right)$	$71.43\,\%\ \left(\approx \frac{40}{56}\right)$	$57.14\,\%\ \left(\approx \frac{8}{14}\right)$	$49.31\,\%\ \left(\approx \frac{71}{144}\right)$
BA	-	-	-	-	-
Total	$100.00\,\%\ \left(\approx \frac{33}{33}\right)$	$100.00\,\%\ \left(\approx \frac{41}{41}\right)$	$100.00\,\%\ \left(\approx \frac{56}{56}\right)$	$100.00\,\%\ \left(\approx \frac{14}{14}\right)$	$100.00\,\%\ \left(\approx \frac{144}{144}\right)$

We have run chi-squared tests with the null hypothesis that the percentage distributions of opinion changes (AB) is the same for any two types of value orientations. The results are (i) Competitive *vs* Prosocials ($\chi^2(1) = 15.31, p = 0.00$), (ii) Competitive *vs* Individualistic ($\chi^2(1) = 2.61, p = 0.10$), (iii) Competitive *vs* Unidentified ($\chi^2(1) = 0.03, p = 0.87$), (iv) Prosocial *vs* Individualistic ($\chi^2(1) = 33.39, p = 0.00$), (v) Prosocial *vs* Unidentified ($\chi^2(1) = 11.68, p = 0.00$), (vi) Individualistic *vs* Unidentified ($\chi^2(1) = 1.06, p = 0.30$)

Table 6: Marginal effects of probit regressions for opinion changes from option A to option B or AB under FAB ($N = 144$)

Opinion Change[1]	Marginal effect
Household income (in 1000 BDT)[2]	-0.001
	(0.001)
Gender[3]	0.177
	(0.150)
Age[4]	0.032
	(0.044)
Education[5]	0.001
	(0.009)
Family structure[6]	-0.009
	(0.087)
SVO dummy (base group = Prosocial)	
Competitive[7]	0.381***
	(0.093)
Individualistic[8]	0.538***
	(0.064)
Unidentified[9]	0.458***
	(0.119)
Log Likelihood	-79.308

***significant at the 1 percent level

[1] A dummy variable that takes value 1 if a member's opinion changes from option A to option B, 0 otherwise.

[2] Household income per month in 1000 BDT

[3] A dummy variable that takes value 1 when a member is a female, 0 otherwise.

[4] Categorical variable that takes value $\{0, 1, 2, 3, 4, 5\}$ when ages are between 20 and 29, 30 and 39, 40 and 49, 50 and 59, 60 and 69, and 70 or more, respectively.

[5] Years of schooling.

[6] Joint family structures are coded as 1, 0 (single family) otherwise.

[7] A dummy variable that takes value 1 when a member's value orientation is competitive, 0 otherwise.

[8] A dummy variable that takes value 1 when a member's value orientation is individualistic, 0 otherwise.

[9] A dummy variable that takes value 1 when a member's value orientation is unidentified, 0 otherwise.