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Intergenerational sustainability dilemma and a potential solution: Future ahead and back mechanism

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Abstract

Intergenerational sustainability is pivotal for the survival of human societies. However, current economic and political systems based on capitalism and democracy might not be effective at considering future generations' needs, thereby compromising intergenerational sustainability (Schwartz, 2007, Shahrier et al., 2016, 2017). We design a new mechanism to improve intergenerational sustainability called the future ahead and back mechanism (FAB) and examine its effectiveness through field experiments consisting of intergenerational sustainability dilemma games (ISDGs). In such games, a lineup of consecutive generations is organized, and each generation can either maintain intergenerational sustainability (sustainable option) or maximize its own generation's payoff by irreversibly imposing a cost on future generations (unsustainable option). In a basic ISDG, generations make the decision through deliberative democracy. In the ISDG with FAB, each generation is first asked to consider the decision of the current generation as if it is in the position of the next generation. Second, the generation makes the actual decision from its original position as the current generation. The results reveal that deliberative democracy does not prevent a majority of proself people from choosing unsustainable options, which is the mirror image of the results demonstrated in Hauser et al. (2014), thereby compromising intergenerational sustainability in the basic ISDG. By contrast, FAB is demonstrated to enable proself people to change their individual opinions from unsustainable to sustainable options, inducing more generations to choose sustainable options. We argue that the memories and experiences of what and how people request (or role-playing) as future generations in FAB trigger more logic-based reasoning than norm-based reasoning, thereby enhancing intergenerational sustainability.

Key Words: Intergenerational sustainability dilemma; capitalism and democracy; culture and evolution; future ahead and back mechanism

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Contents

Nomenclature

FAB Future ahead and back mechanisms

IFG Imaginary future generation

ISDG Intergenerational sustainability dilemma game

ISDG with FAB Intergenerational sustainability dilemma game with future ahead and back mechanism

ISDG with IFG Intergenerational sustainability dilemma game with imaginary future generation

SVO Social value orientation

1 Introduction

Intergenerational sustainability is pivotal for the survival of human societies. However, maintaining intergenerational sustainability is one of the greatest challenges that we face because of its unidirectional nature in the sense that current generations affect future ones, but the opposite is not true (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). We have witnessed how environmental problems and overexploitation of natural resources were caused by rapid urbanization and economic growth, threatening the needs of subsequent generations (Milinski et al., 2006, Hauser et al., 2014, Steffen et al., 2015, Maxwell et al., 2016). Therefore, how to strike a balance between benefits and costs among different generations is a key question (Ostrom, 1990, Milinski et al., 2006, Hauser et al., 2014).

The current capitalist economic system is considered one of the best social regimes because it can efficiently allocate private goods, generating more innovative ideas and technologies through competition. However, capitalistic economic systems fail to ensure an efficient allocation of resources such as public goods, natural resources, and environmental goods and the intergenerational provision of these goods (Krutilla, 1967, Milinski et al., 2006, Hauser et al., 2014). In particular, the exclusion of the needs of future generations from consideration in the economic system and maximization of individual payoffs through competition seem to compromise intergenerational sustainability and incur an irreversible cost for future generations (Krutilla, 1967, Fisher et al., 2004, Ehrlich et al., 2012, Griggs et al., 2013, Kinzig et al., 2013, Costanza et al., 2014, Shahrier et al., 2016, 2017). Human history demonstrates that democracy fits best with capitalism, and thus, it has been established as the major collective decision-making process worldwide. However, as is in capitalism, the needs of future generations are not fully considered. Under democracy and capitalism, the current generation tends to choose actions that are to their benefit without considering future generations, which we call the "intergenerational sustainability dilemma." This research designs and institutes a new mechanism to solve this intergenerational sustainability dilemma and examine the effectiveness of this mechanism through field experiments.

Past studies theorize that cultural agents bring about changes in human behaviors and affect the evolution of human societies (see, e.g., Boyd and Richerson, 1985, Henrich and Mcelreath, 2003, Henrich et al., 2005, Tomasello et al., 2005, Dawkins, 2006, Richerson and Boyd, 2008, Wilson et al., 2009, Moya et al., 2015). Accordingly, empirical studies demonstrate how the economic environment, as a part of the culture, brings about changes in human behaviors. Schwartz (2007) documents that individuals express stronger preferences for values such as power and achievement, conformity, self-assertiveness, and the mastery of nature in more competitive and market-driven societies. Shahrier et al. (2016) show that people become more competitive as societies become more capitalistic and urbanized, and highly capitalistic societies consist of a majority of proself people.[1] Given this state

[1]We follow the definition of capitalism stated in Shahrier et al. (2016). They define the "ongoing modernization of competitive societies" as capitalism and address highly modernized and competitive societies capitalistic.

of affairs, new mechanisms or systems may be necessary to solve the intergenerational sustainability dilemma, especially as people become more proself in highly capitalistic and urban societies.

Several past studies examine people's preferences for and decisions regarding intergenerational sustainability. Sherstyuk et al. (2016) reveal that maintaining dynamic externalities is more difficult in intergenerational settings than in a setting with infinitely lived decision makers. Fisher et al. (2004) find that an intergenerational link motivates individuals to sustain intergenerational common pool resources. Conducting an online experiment with an intergenerational goods game, Hauser et al. (2014) reveal that the existence of a few defectors causes overexploitation of intergenerational goods and, thus, voting or democracy can maintain intergenerational sustainability by resisting the defectors. Kamijo et al. (2017) design and implement an intergenerational sustainability dilemma game (hereafter, ISDG) and show that introducing an imaginary future generation improves intergenerational sustainability. Shahrier et al. (2017) conduct ISDG field experiments in rural and urban areas of Bangladesh, demonstrating that rural people choose much more intergenerationally sustainable options than urban people. Furthermore, contrary to Kamijo et al. (2017), urban people fail to maintain intergenerational sustainability even in the treatment with imaginary future generations. This is because a majority of urban people are proself, and generations of such proself people consistently choose unsustainable options irrespective of the treatments and conditions.[2]

None of the past studies seeks to find a mechanism that can induce proself people to consider future generations or maintain intergenerational sustainability in highly capitalistic societies. The literature indicates that societies will be more urbanized and competitive in the future, projecting that, by 2050, $66\,\%$ of the world's population will live in urban areas of developing countries. Specifically, cities in Asia and Africa 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). Considering the ongoing modernization and urbanization of competitive societies and the possible increase in the number of proself people as demonstrated in Shahrier et al. (2016), democracy may not be able to

[2]Approximately $60\,\%$ of student subjects in the ISDG laboratory experiments of Kamijo et al. (2017) are prosocial. The high proportion of prosocial students may be attributed to the location of Kochi University of Technology where Kamijo et al. (2017) conducted ISDG laboratory experiments. Kochi University of Technology is located in Kochi prefecture, which is not urban compared with Tokyo or Dhaka. By contrast, Shahrier et al. (2017) show that only $20\,\%$ of subjects are prosocial in the urban areas (Dhaka) of Bangladesh, leading to low intergenerational sustainability.

maintain intergenerational sustainability, and a new mechanism is necessary. Moreover, all past studies of intergenerational sustainability have been conducted in laboratories and in developed countries. However, to better understand human preferences for and behaviors related to intergenerational sustainability and given the drastic growth of urbanized and modernized societies in the developing world, studies of intergenerational sustainability should be conducted in developing countries (Henrich et al., 2005, 2010a,b).

We design and institute a new mechanism to improve intergenerational sustainability called the "future ahead and back mechanism" (FAB) and examine its effectiveness using field experiments consisting of the ISDG in a competitive and urban community, Dhaka, Bangladesh. A lineup of consecutive generations is organized, and each generation can either maintain intergenerational sustainability (sustainable option) or maximize its own generation's payoff by irreversibly imposing a cost on future generations (unsustainable option). In the basic ISDG, generations make the decision through deliberative democracy. In the ISDG with FAB, each generation is first asked to consider the decision of the current generation as if it is in the position of the next generation. Second, it makes the actual decision based on the original position of the current generation. The results reveal that deliberative democracy does not prevent a majority of proself people from choosing unsustainable options, which is the mirror image of the results demonstrated in Hauser et al. (2014), compromising intergenerational sustainability in the basic ISDG. However, FAB is demonstrated to enable proself people to change their individual choices from unsustainable to sustainable options. Therefore, more generations are induced to choose sustainable options in FAB. We argue that the memories and experiences of what and how people behave (or role-playing) as future generations in FAB trigger more logic-based reasoning than norm-based reasoning, thereby enhancing intergenerational sustainability.

2 Methods and materials

2.1 Study area

Our experiments were conducted in Dhaka, the capital city of Bangladesh. Dhaka is a highly capitalistic mega city and one of the most competitive societies in the world (Dewan and Corner, 2014).

Dhaka City is located between $23°55'$ and $24°81'$ north latitude, and $90°18'$ and $90°57'$ east longitude (Dewan and Corner, 2014) and covers the whole Dhaka metropolitan area (figure 1). The total land area, population and population density are $1371\,\mathrm{km}^2$, 14.51 million and $10\,484\,\mathrm{km}^{-2}$, respectively (Dewan and Corner, 2014). The population density in this region is almost 9 times higher than the national average. Dhaka is the most populous city in the world and the center of industrialization, businesses and services in Bangladesh (Dewan and Corner, 2014). Business, services and labor-intensive occupations, such as industrial labor, are the major occupations in Dhaka.

[Figure 1 about here.]

2.2 Experimental setup

We administered ISDGs, social value orientation (SVO) games and questionnaires (or individual interviews) in the field.

Intergenerational sustainability dilemma game

We implement a three-person ISDG, following the basic procedures of ISDG laboratory experiments employed in Kamijo et al. (2017) and Shahrier et al. (2017). In this game, a group of three subjects is called a generation, and each generation needs to choose between options A and B. By choosing option A, the generation receives a payoff of X, whereas the payoff from choosing option B is $X - 300$. After choosing between A and B, the generation is asked to split the payoff associated with the option that it choose among the generation's members. Each subject's payoff in the ISDG is the sum of her share of the generation's payoff plus the initial endowment of 300, and we apply an exchange rate to the experimental payoff in the ISDG to determine the real monetary payment. For instance, suppose that $X = 1200$. A generation earns 1200 ($X = 1200$) in experimental money from choosing A, while the generation earns 900 ($X - 300 = 1200 - 300 = 900$) from choosing B. Consequently, if members of this generation split the payoff equally among them, each individual earns 400 from choosing A and 300 from choosing B as her share of the generation's payoff. Each generation is allowed to discuss the decision between A and B for up to 5 minutes. After the generation makes its decision, its members determine how to split the payoff.

Each experimental session consists of a sequence of 6 generations. Each subject is randomly assigned to the 1st, 2nd, . . . and 6th generations, and members of the 6th generation never know that they are the last generation of the session. One generation's decision affects the subsequent generations such that subsequent generations' payoffs decline uniformly by 300 when a generation chooses option A and do not decline if B is chosen. Suppose that $X = 1200$ and the 1st generation chooses A. Then, the 2nd generation will face a game in which it can obtain 900 and 600 from choosing A and B, respectively. However, if the 1st generation chooses B, the next generation has the same decision environment as the 1st generation faced. When the 1st generation chooses B, the 2nd generation faces a game in which it can obtain 1200 and 900 by choosing A and B, respectively. Following the same rule, the game continues for the rest of the subsequent generations in each session. Hence, option B can be considered an intergenerationally sustainable option, while option A is the choice that compromises intergenerational sustainability and is an unsustainable option.

In each session, the 1st generation starts the ISDG game with $X = 1200$, implying that the 5th and 6th generations may face a game in which options A and B are associated with payoffs of zero and -300, respectively.[3] We conducted three types of ISDG in the field to identify an effective mechanism for maintaining intergenerational sustainability.

- Basic ISDG: In the basic ISDG, three members of each generation are asked to choose between A and B in a deliberative democratic environment and to determine how to split the generation's payoff. Each member possesses an equal right to participate in the discussion and decision making.

- ISDG with imaginary future generations (hereafter, ISDG with IFG): In the ISDG with IFG, we randomly assign one member of each generation to be a representative of or an agent for subsequent generations as a "ministry of the future." The subject playing the role of the "ministry of the future" is asked to consider not only her own generation but also subsequent generations in the discussion about and decision between options A and B. We introduce this treatment because

[3]When the 5th and 6th generations face the game in which options A and B are associated with a zero or a negative payoff of -300, the generation's members can equally divide their initial endowment of 300 to make the individual payoff be at least zero.

we are interested in how priming people to consider future generations can affect a generation's decision.

- ISDG with future ahead and back mechanism (hereafter, ISDG with FAB): In the ISDG with FAB, members of each generation are first asked to imagine that they are the members of the next generation. As if they are members of the next generation, they are asked to make a request of their previous generation regarding which option they want the previous generation to choose, A or B. In the second step, they return to their original position and make a decision between A and B from their original (or actual) position in the generational lineup. If the generation's request to the previous generation in the first step and their actual choice in the second step are the same such as A in the first step and A in the second, the choice becomes their final decision. However, if the generation's choices in the first and second steps are different, members of the generation are asked to make anonymous votes for A or B to finalize their generation's decision.

We also added a new element built upon the previous ISDG experiments but did so only to the ISDG with FAB treatment. We conducted individual interviews with each subject after he or she completed the generational decision-making task. The objective of the individual interviews was to elicit subjects' individual opinions before and after the deliberative discussion in FAB and to know whether proself people were successfully induced to change their individual opinions.[4] Obtaining this information on ex ante and ex post individual opinions enables us to identify the effect of deliberative democracy or FAB on individual opinion changes and generations' decisions.

Social value orientation games

We used the triple dominance method social value orientation (SVO) game developed by Van Lange et al. (1997, 2007) to characterize subjects' social preferences. This method categorizes individual value orientations into competitive, individualistic, prosocial and unidentified types depending on their choices in the SVO game. In this game, subjects are randomly paired and asked to make a choice among

[4]Given a failure to maintain intergenerational sustainability in the basic ISDG and ISDG with IFG, we recognized the necessity of new mechanisms to enable proself people to change their opinions. To determine whether we were successful with the new FAB mechanism, we decided to conduct individual interviews to elicit how individual opinions change before and after experiencing FAB.

three pairs of options where one is unknown to the subject. The two numbers in each option represent the outcomes for oneself and the other in the pair. Following Van Lange et al. (2007), one example of a triple dominance decomposed 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 person with a competitive orientation who maximizes the gap between is own and and the other's points ($500 - 100 = 400$); option (ii) is a person with a prosocial orientation who maximizes the joint outcome ($500 + 500 = 1000$). Finally, option (iii) characterizes an individualistic person who maximizes his own outcome 560 and is indifferent to the outcome of the other.

The triple dominance method of this SVO game contains 9 selection problems, each of which consists of three options introduced above with different numbers and orders. Subjects are asked to select one of the three options for each of the selections. If at least 6 of the 9 selections made by one subject are consistent with one of the orientations (competitive, prosocial and individualistic), he/she is categorized as a person with that orientation. Otherwise, the subject is considered "unidentified." We implemented our experiment with real monetary incentives. Subjects were informed that the units represented in this game are counted as points, and the more points that one subject gets, the more real money he/she will earn from this SVO game with some experimental exchange rate. To compute the payoff of the respondents from this game, we randomly match a respondent with another respondent as a pair. The experimental earnings in this SVO game are the summation of the points from 9 selections she made and 9 selections by her partner for her. We also explained the random matching of pairs and calculation of the payoff for the real monetary incentive to the subjects.

2.3 Experimental procedure

Random sampling was implemented based on the proportion of each occupation in the total population (Bangladesh Bureau of Statistics, 2013). After determining the required number of subjects for each type of occupation, we randomly selected a number of organizations. Next, we contacted the organizations, and based on their compliance, we randomly selected and invited individuals from these organizations. For low-income occupations and occupations that require frequent movement within a city, we arbitrarily selected subjects from the slums and invited them to participate in the experiments. We conducted the experiments at the Institute of Information Technology at Dhaka University. In total, we conducted 22 sessions, and 396 subjects participated in our experiment. Therefore, the 396 respondents were grouped into 132 generations. Of the 22 sessions, 7, 7 and 8 were assigned to the basic ISDG, ISDG with IFG and ISDG with FAB, respectively. Each session of the ISDG experiment takes approximately 3 hours. The maximum and average payment to each of the respondents was $800\,\mathrm{BDT}$ ($\approx 10\,\mathrm{USD}$) and $670\,\mathrm{BDT}$ ($\approx 8.53\,\mathrm{USD}$), respectively, including a fixed show-up fee of $350\,\mathrm{BDT}$ ($\approx 4.46\,\mathrm{USD}$). In the ISDG game, subjects were paid $250\,\mathrm{BDT}$ ($\approx 3.18\,\mathrm{USD}$) at maximum and $180\,\mathrm{BDT}$ ($\approx 2.29\,\mathrm{USD}$) on average. Whereas the payment for SVO was $200\,\mathrm{BDT}$ ($\approx 2.55\,\mathrm{USD}$) at maximum and $140\,\mathrm{BDT}$ ($\approx 1.78\,\mathrm{USD}$) on average.

In each experimental session, we provided printed experimental instructions to all subjects in their native language, Bengali. In addition, we verbally explained the rules of the game and double-checked respondents' understanding of the game. Thereafter, we randomly assigned subjects to generations by asking each subject to pick a card with an ID number from a bag. Subjects were not allowed to look at the ID number on the cards. To maintain anonymity across generations, we placed the 6 generations in 6 separate rooms by asking each subject to sit in a specific room according to their ID. Hence, each subject could communicate only with the members of his/her own generation. Thereafter, we elicited each generation's choice between A and B in an ascending order from the 1st generation to the 6th generation. We informed participants of which generation they belonged to and the payoffs associated with options A and B. Therefore, each generation was able to calculate how many times A and B were chosen by the previous generations since the subjects knew which generation they belonged to and the initial game that the 1st generation faced. Individual interviews were performed after each generation's decision in ISDG with FAB. In the interviews, each subject in the generation was asked about her personal opinions regarding her support for A or B "before and after" the generation's discussion and decision in ISDG with FAB. Following the ISDG games, we started the SVO game and ensured the subjects' understanding using printed instructions and a verbal presentation. Subsequently, we elicited respondents' SVO choices and socio-economic information through questionnaires.

3 Results

Table 1 presents the frequencies and percentages of generations' choices for the unsustainable option A and the intergenerationally sustainable option B in basic ISDG, ISDG with IFG and ISDG with FAB. Approximately $30.95\,\%$, $29.57\,\%$ and $85.42\,\%$ of the generations chose the sustainable option B in basic ISDG, ISDG with IFG and ISDG with FAB, respectively.[5] These results suggest that, in both basic ISDG and ISDG with IFG, a majority of the generations chose the unsustainable option A. However, in ISDG with FAB, a majority of the generations chose the sustainable option B, and only $14.58\,\%$ of the generations chose A. To examine whether the distributions of A and B are independent of the treatments, we performed pairwise chi-squared tests. The null hypothesis is that the frequency distributions of options A and B are 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 and IFG; however, it rejects the hypothesis for Basic vs. FAB and IFG vs. FAB at the $1\,\%$ significance level. This implies 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 people choose to maximize their own generation's payoff even when the collective decision is made in a deliberative democratic environment on the basis of the results from the basic ISDG. Moreover, introducing imaginary future generations (IFG) into the game fails to maintain intergenerational sustainability since the frequency of choosing A in ISDG with IFG becomes even higher than that in the basic ISDG. The results appear to suggest the necessity of a stronger institution to maintain intergenerational sustainability in highly capitalistic societies. Fortunately, however, FAB appears to be successful in maintaining intergenerational sustainability even in one such highly capitalistic society, Dhaka. Approximately $85.42\,\%$ of the generations chose the option to maintain intergenerational sustainability B in ISDG with FAB (table 1).

We characterize the determinants of generations' choices for intergenerational sustainability and how FAB affects individual members' and generations' decisions. Past studies show that an individual social preference is one of the important determinants of intergenerational sustainability and the

[5] Some data we have analyzed in this paper partially overlap with those in Shahrier et al. (2017).

sustainability of common pool resources (Shahrier et al., 2016, 2017, Timilsina et al., 2017). Specifically, these studies show that an increase in the number of prosocial people in a generation or group is associated with higher probabilities of maintaining intergenerational sustainability and common pool resources. These studies also demonstrate that highly capitalistic societies might have greater tendencies to compromise intergenerational sustainability and common pool resources, as a majority of people are proself members (competitors and individualists).

[Table 2 about here.]

The distributions of generations with respect 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 of the 132 total generations, $51.79\,\%$, $30.03\,\%$, $15.15\,\%$ and $3.03\,\%$ consist of zero prosocial (or three proself), one prosocial, two prosocial and three prosocial people 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 people) in a capitalistic city, Dhaka, which is in line with our past work (Shahrier et al., 2016). Table 3 presents the percentage of generations choosing B with respect to the number of prosocial members per generation (see the "overall" column in 3). It shows that when generations consist of only proself people, $23.53\,\%$ of the generations chose B (see the cell of "overall" column and "0" row). However, as the number of prosocial members in a generation increases, the percentage choosing B rises (see the "overall" column). For example, $60\,\%$, $100\,\%$, $100\,\%$ of the generations chose B when the generation consisted of one prosocial, two prosocial and three prosocial members, respectively.

[Table 3 about here.]

To check whether the distributions of generations choosing B are independent of the number of prosocial members per generation, we perform pairwise chi-squired tests. The null hypothesis is that the distributions of generations choosing B are the same for any pair of generations in terms of the number of prosocial members per generation (Prosocials $= 0$ vs. Prosocials $= 1$, Prosocials $= 0$ vs. Prosocials $= 2$, Prosocials $= 0$ vs. Prosocials $= 3$, Prosocials $= 1$ vs. Prosocials $= 2$, Prosocials $= 1$

vs. Prosocials $= 3$, Prosocials $= 2$ vs. Prosocials $= 3$). The test rejects the null hypothesis for any pair at the $1\,\%$ significance level, except for the pair Prosocials $= 2$ vs. Prosocials $= 3$. Overall, these results suggest that generations' choices between A and B are dependent on the number of prosocial members per generation or individual social preferences.

This result is in line with our past studies, indicating that individual social preferences might be one of the strongest determinants of generations' decisions regarding intergenerational sustainability (Shahrier et al., 2017). It appears that when generations consist of only proself people in the basic ISDG and ISDG with IFG, a majority of them choose the unsustainable option A (see the "Basic" and "IFG" columns of table 3). When the number of prosocial members per generation increases, the sustainable option B is more likely to be chosen. The findings from the basic ISDG and ISDG with IFG suggest that a new mechanism must be developed to induce proself people to change generations' choices from A to B, especially when a majority of people in a generation consist of proself people in capitalistic societies, such as Dhaka. Table 3 also provides the percentage of generations choosing B in FAB when generations consist of zero prosocial, one prosocial, two prosocial and three prosocial members. In FAB, $80.00\,\%$ and $60.00\,\%$ of the generations chose B even when the generations consisted of zero and one prosocial member, respectively. This is in sharp contrast with the results in the basic ISDG and ISDG with IFG, possibly demonstrating that FAB is effective at maintaining intergenerational sustainability by affecting proself people in ISDG.

To characterize the findings in table 3, we estimate three probit regression models by taking a generation's choice of B as a dependent variable. In the first model, we include only the data from the basic ISDG and use the number of prosocial members in each generation as the only independent variable. The second model uses the data from the basic ISDG and ISDG with IFG along with the number of prosocial members, and we include the IFG treatment as another independent dummy variable. Finally, the third model uses the complete data set from the basic ISDG, ISDG with IFG and FAB. In the third model, we also include dummy variables for IFG and FAB, the interaction term for the number of prosocial members per generation times IFG and the number of prosocial members per generation times FAB as independent variables. We estimate three regression models in this way to illustrate the robustness of our regression results. We do not include any sociodemographic variables in the regression because they are not found to to be significant or practically influential. Finally, the detailed definition of each variable is given in table 4.

[Table 4 about here.]

Table 5 reports the marginal effects of the independent variables on the likelihood of a generation choosing B calculated from the probit regressions. Overall, we see that the number of prosocial members per generation in models 1 and 2, the FAB dummy and the interaction term of the FAB dummy and the number of prosocial members in model 3 appear to be economically and statistically significant in affecting the likelihood of a generation choosing B to achieve intergenerational sustainability. However, the IFG dummy in models 2 and 3 and the interaction term of the IFG dummy and the number of prosocial members per generation are insignificant. The overall results from the probit regressions are quite consistent with the chi-squared tests and summary statistics.

[Table 5 about here.]

Model 1 in table 5 indicates that an increase in the number of prosocial members per generation increases the probability of choosing B by $42.9\,\%$ relative to the probability of choosing A. In model 2, the number of prosocial members remains a strong predictor of a generation's choice between A and B. An increase in the number of prosocial individuals per generation is associated with a $49.2\,\%$ increase in the probability of choosing B relative to the probability of choosing A. However, the IFG mechanism appears to be ineffective at achieving intergenerational sustainability since the IFG dummy is not significant, even at the $10\,\%$ level, in model 2. Instead, the inclusion of the IFG dummy in the model makes the effect of the number of prosocial members stronger than that in model 1. In other words, the addition of the IFG dummy brings about a $6.3\,\%$ ($= 0.492 - 0.429$) increase in the positive association between the number of prosocial members per generation and the likelihood of choosing the sustainable option B, implying that IFG play no role in determining generations' decisions. In summary, the IFG mechanism fails to motivate generations to choose the sustainable option B, while individual social preferences remain the strongest determinant in both models 1 and 2.

Model 3 in table 5 reveals the effects of the IFG and FAB treatments and of the number of prosocial people on the probability of choosing the sustainable option B. In this model, an increase in the number of prosocial members per generation is associated with a $50.4\,\%$ greater probability of choosing B than choosing A, holding all other factors fixed. The IFG dummy and the interaction term of IFG and the number of prosocial members remain insignificant, even at the $10\,\%$ level, implying that the IFG treatment is unable to maintain intergenerational sustainability. Finally, the FAB dummy is economically and statistically significant, showing that the generations in the FAB treatment are $80.6\,\%$ more likely to choose B than A compared with those under the basic ISDG. In addition, the interaction term of FAB times the number of prosocial individuals is economically and statistically significant, with a coefficient of -0.377, such that an increase in the number of prosocial people per generation in the FAB treatment induces generations to choose the sustainable option B but only by $12.7\,\%$ ($= 50.4\,\% - 37.7\,\%$). This $12.7\,\%$ increase under FAB is less than the $50.4\,\%$ obtained under the basic ISDG. This result can be interpreted as indicating that the FAB mechanism enables a generation of proself people to support the sustainable option B without relying on prosocial people.

It can now be hypothesized that FAB affects proself individuals' opinions of and decisions between options A and B in a way that maintains intergenerational sustainability. To examine this hypothesis, we interviewed each subject about whether he/she personally supported A or B before and after the FAB treatment. The interviews in FAB clarify how individual opinions change in the FAB treatment in relation to individual social value orientations. There are four possible pairs of individual opinion changes before and after FAB treatment: (i) a subject initially supported B and still supports B after the FAB treatment (hereafter, BB); (ii) a subject initially supported A and still supports A after the FAB treatment (hereafter, AA), (iii) a subject initially supported A but supports B after the FAB treatment (hereafter, AB), and (iv) a subject initially supported B but supports A after the FAB treatment (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 6 about here.]

Table 6 presents the percentage of these four types of individual opinion changes for each of the value orientations in the FAB treatment. Approximately $82.93\,\%$ of prosocial subjects follow BB, whereas $0.00\,\%$, $5.36\,\%$ and $7.14\,\%$ of the competitors, individualists and the unidentified individual follow BB, respectively. In contrast, AA is the lowest for prosocial individuals ($4.88\,\%$), followed by individualists ($23.21\,\%$) and by competitors ($45.45\,\%$). No subject in any value orientation follows BA. Finally, $71.43\,\%$, $57.14\,\%$, $54.55\,\%$ and $12.20\,\%$ of the individualistic, unidentified, competitor and prosocial subjects follow AB, respectively. It appears that a considerable portion of the individualists, the competitors and the unidentified change their individual opinions from A to B after the FAB treatment. To statistically establish this, we perform pairwise chi-squared tests to examine whether the three types of opinion changes are statistically independent of the value orientations. The null hypothesis is that the distributions of opinion changes are the same for any two types of value orientations. The examination rejects the null hypothesis at the $1\,\%$ level for all pairs of value orientations, confirming that the three types of opinion changes are dependent on value orientations.

[Table 7 about here.]

To empirically characterize this finding, we regress an opinion change from A to 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 subject changes her opinion from A to B through FAB), 0 otherwise. A set of independent variables includes the SVO dummies (Base group $=$ Prosocial) and socioeconomic variables such as income, education, and family structure. Table 7 summarizes the detailed definitions of variables included in the regression. Since no opinion changes of the sequence BA were found, this regression is simplified to analyze the probability of the opinion change from A to B (or AB) relative to the probability of no opinion change (AA or BB) under FAB. Table 8 shows the marginal effects of the independent variables on the probability of opinion changes from A to B. The marginal effects of the SVO dummies exactly follow the summary statistics of the opinion changes for each value orientation. This reveals that individualists, unidentified and competitors are $53.8\,\%$, $45.8\,\%$ and $38.1\,\%$ more likely to change their opinions from A to B compared with prosocial persons, holding all other factors fixed. This regression result confirms that FAB can clearly induce a large number of the individualistic, unidentified and competitive subjects to change individual opinions from A to B. Consequently, more generations are induced to choose the sustainable option B under FAB.

[Table 8 about here.]

Recall that members of a generation need to finalize their decision by anonymously voting for A or B if they do not have the same request and decision in the first and second steps. Of the 48 generations in ISDG with FAB, 9 made their final decision by such anonymous votes. Among these 9 generations, 7 voted for A. Thus, voting does not appear to have been effective in achieving intergenerational sustainability in our field experiments. Moreover, from the data of individual opinion changes under the FAB treatment, we find that 106 subjects out of 144 initially supported A before group discussions, implying that such people are likely to choose option A if they are in a simple deliberative democratic environment. In summary, along with the results from the basic ISDG, the outcomes of voting and opinion changes observed in the FAB treatment provide additional evidence that deliberative democracy fails to maintain intergenerational sustainability when societies consist of a majority of proself people.

The findings in this section can be interpreted as a mirror image of the results demonstrated in Hauser et al. (2014). They show that voting or democracy is effective at maintaining the intergenerational provision of goods when a majority of people are not "selfish." In their experiments of intergenerational goods games, overharvesting by a few defectors is what endangers the sustainability of intergenerational goods. Therefore, determining the harvests by median votes improves sustainability since voting or democracy enables a large number of cooperators to prevent a minority of defectors from depleting intergenerational goods. However, in our experiments, a majority of subjects are proself and prioritize their own payoffs. Thus, generations consisting of a majority of proself members can easily compromise intergenerational sustainability when they make the decisions in a deliberative democratic process such as in basic ISDG.

In this research, we propose two mechanisms, IFG and FAB, that could enhance intergenerational sustainability, and FAB is shown to be effective even when a majority of people are proself. Along with our current study, past works such as Shahrier et al. (2016), Shahrier et al. (2017) and Timilsina et al. (2017) show that with the maturation of capitalism and the further modernization of societies, people become more competitive or proself. In the future, highly capitalistic societies will be composed of a majority of proself people. In such a situation, choosing competitive or self-maximizing outcomes, including prioritizing one's own generation's payoff by irreversibly costing future generations, may emerge as a norm (as demonstrated in this research) and be deeply ingrained in individual belief systems. Therefore, in the basic ISDG and ISDG with IFG, proself people choose to maximize their own generation's payoff (following the norm), thereby compromising intergenerational sustainability in highly capitalistic societies such as the present one (Evans, 2008, Evans and Stanovich, 2013, Howarth et al., 2016, Shahrier et al., 2016).

Studies in brain science suggest that an experience or a memory of projecting future events can affect brain function and, potentially, current decisions (Schultz et al., 1997, Gilbert and Wilson, 2007, Gerlach et al., 2014, Szpunara et al., 2014). We conjecture that due to the experience of role-playing as a future generation in the ISDG with FAB, members of a generation feel the pain of being negatively affected by previous generations prior to making their actual decision from their original position. Moreover, in the actual decision, they are naturally induced to synchronize or link their request as a future generation with the actual decision as the current generation through their own logic, as human decisions are known to be made primarily through two channels: logic-based reasoning and norm-based reasoning (Evans, 2008, Evans and Stanovich, 2013, Howarth et al., 2016). The effect of projecting oneself into the future and the requirement of such synchronization in FAB between future and current generations seem to influence individuals to choose intergenerationally sustainable options through logic-based reasoning in the ISDG with FAB rather than through norm-based reasoning (Evans, 2008, Evans and Stanovich, 2013, Howarth et al., 2016).[6]

Past studies depict the rapid growth of urbanization, especially in Asia and Africa; they project that by 2050, $66\,\%$ of the global population will reside in cities and $75\,\%$ of the major cities will be in Africa and Asia (American Association for the Advancement of Science, 2016, Wigginton et al., 2016, McDonnell and MacGregor-Fors, 2016). The results of this and our past studies demonstrate that democracy fails to maintain intergenerational sustainability in highly capitalistic societies in which a majority of people are proself. Consistent with this result, we observed several failures by the global community to solve intergenerational problems, such as controlling carbon emissions and global warming even under democratic institutions (Barrett, 2008, Falkner, 2016). Given the literature and empirical

[6]Since a majority of subjects in Dhaka, Bangladesh are proself, these subjects tend to choose or support option B based on norm-based reasoning. For such proself subjects, the norm in both SVO and the basic ISDG is to behave selfishly or to prioritize their own payoffs.

findings that people become more proself in capitalistic societies (Shahrier et al., 2016, 2017, Timilsina et al., 2017), the development and implementation of new mechanisms in place of democracy seem to be necessary to maintain intergenerational sustainability.

We design and institute a new mechanism, namely, the future ahead and back mechanism (FAB), by conducting field experiments in a highly capitalistic environment in a developing country. The examination shows that FAB can maintain intergenerational sustainability in field experiments and can be a potential solution for intergenerational problems. To the best of our knowledge, our study is the first to demonstrate that voting or democracy is not effective at achieving intergenerational sustainability when a majority of people are proself. Furthermore, it is the first to suggest an effective mechanism for maintaining intergenerational sustainability through field experiments in a highly competitive society in a developing country, Dhaka, Bangladesh. We believe that FAB can be used in two ways to solve intergenerational sustainability problems. First, FAB can be applied as an alternative democratic institution in collective decision-making processes addressing questions of intergenerational sustainability. Second, FAB could be applied at an individual level rather than the collective level as part of education or training to change individual ways of thinking toward being future-oriented (Wilson et al., 2014).

4 Conclusion

Maintaining intergenerational sustainability is a necessary condition for the continued existence of humankind on earth. However, our current economic and political systems under capitalism and democracy are not particularly well designed to consider the needs of future generations. Consequently, we have seen how faster economic growth under democratic political systems and capitalism causes the overexploitation of natural resources and environmental problems, compromising intergenerational sustainability. Past studies show that the economic environment, as part of culture, affects human preferences and behaviors such that, with the maturation of capitalism and further modernization in societies, people become more proself (Shahrier et al., 2016, Timilsina et al., 2017). Building upon such past literature, this research demonstrates that democracy might fail to maintain intergenerational sustainability in capitalistic societies in which a majority of people are proself, suggesting the need for new mechanisms.

We design and institute a new mechanism to improve intergenerational sustainability called the future ahead and back (FAB) mechanism. We compare the outcome under FAB with that under deliberative democratic settings by implementing field experiments of the intergenerational sustainability dilemma game (ISDG) in Dhaka, Bangladesh. The results reveal that generations compromise intergenerational sustainability in the basic ISDG since a majority of proself people tend to prioritize their own generation's payoff. By contrast, the FAB mechanism successfully maintains intergenerational sustainability in that a large number of proself individuals are induced to support the sustainable option B despite that such proself subjects initially supported the unsustainable option A. We argue that FAB instills the effect of projecting future events into current generations' decisions and induces more logic-based reasoning in individual brains.

Finally, we cite some limitations of this research and suggest potential future research. Our study does not analyze the detailed pathways of how and why FAB affects individual motivations, decisions and group behaviors on questions of intergenerational sustainability in relation to subjects' social network, social capital and brain images. With an additional experimental design or further field experiments, future studies should be able to identify how these factors are interrelated and affect individual opinions and the decision-making process. In particular, we should examine such details regarding the pathways that determine how and why "proself" people might change their opinions on intergenerational sustainability. Unfortunately, in this project, we could not conduct this type of research due to time and budget constraints, leaving such matters to future study. These caveats notwithstanding, it is our belief that this study is the first step toward identifying a new FAB mechanism to solve the intergenerational sustainability dilemma in highly capitalistic societies in which a majority of people are proself and deliberative democracy fails. As mentioned above, we conjecture that FAB can be used in two ways to solve intergenerational sustainability problems. First, FAB can be applied as an alternative democratic institution in collective decision-making processes on matters of intergenerational sustainability. Second, FAB could be applied at the individual level rather than the collective level as part of education or training to change individual ways of thinking toward being future-oriented (Wilson et al., 2014).

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Figure 1: The study area: Dhaka

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

	A	B	Overall
Basic ISDG	29 (69.05 %)	13 (30.95 %)	42 (100 %)
ISDG with IFG	30 (71.43 %)	12 (29.57 %)	42 (100 %)
ISDG with FAB	7 (14.58 %)	41 (85.42 %)	48 (100 %)

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

Number of prosocial members in one generation	Number of generations (percentage)			Overall
	Basic	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 %)
Subtotal	42 (100 %)	42 (100 %)	48 (100 %)	132 (100 %)

Table 3: Percentage of generations choosing B with respect to the number of prosocial members per generation under each treatment: Basic, IFG and FAB.

# of prosocial members in one generation	Percentage of choice B			Overall
	Basic	IFG	FAB	
0	$11.54\,\%\ \left(\approx \frac{3}{26}\right)$	$3.85\,\%\ \left(\approx \frac{1}{27}\right)$	$80.00\,\%\ \left(= \frac{12}{15}\right)$	$23.53\,\%\ \left(\approx \frac{16}{68}\right)$
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	$100.00\,\%\ \left(= \frac{2}{2}\right)$	$100.00\,\%\ \left(= \frac{2}{2}\right)$	-	$100.00\,\%\ \left(= \frac{4}{4}\right)$
Subtotal	$30.95\,\%\ \left(\approx \frac{13}{42}\right)$	$29.57\,\%\ \left(\approx \frac{12}{42}\right)$	$85.42\,\%\ \left(\approx \frac{41}{48}\right)$	$50.00\,\%\ \left(= \frac{66}{132}\right)$

Table 4: Descriptions of variables included in regressions

Variables	Descriptions
Generation choice B	A dummy variable that takes value 1 if the generation chooses option B, 0 otherwise.
# of prosocials	The number of prosocial members in each generation.
IFG	A dummy variable that takes value 1 when the IFG treatment is administered to one session consisting of 6 generations, 0 otherwise.
FAB	A dummy variable that takes value 1 when the FAB treatment is administered to one session consisting of 6 generations, 0 otherwise.
IFG $\times$ # of prosocials	An interaction term of IFG times the number of prosocial members in each generation.
FAB $\times$ # of prosocials	An interaction term of FAB times the number of prosocial members in each generation.

Table 5: Marginal effects of probit regressions for a generation's choice of B

Variable	Marginal effect		
	Model 1	Model 2	Model 3
# of prosocial members	0.429***	0.492***	0.504***
	(0.133)	(0.113)	(0.134)
IFG dummy		−0.016	−0.178
		(0.127)	(0.219)
FAB dummy			0.806***
			(0.184)
IFG × # of prosocials			0.267
			(0.249)
FAB × # of prosocials			−0.377**
			(0.189)

***significant at the 1 percent level, **significant at the 5 percent level

Table 6: Social value orientations and changes in individual opinion by percentage in ISDG with FAB

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

Table 7: Descriptions of variables included in regressions for individual opinion change

Variables	Descriptions
Opinion change	A dummy variable that takes value 1 if a respondent's opinion changes from A to B, 0 otherwise.
Household income	Household income per month in $1000\,\mathrm{BDT}$.
Gender	A dummy variable that takes value 1 when a respondent is a female, 0 otherwise.
Age	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.
Education	Years of schooling.
Family structure	Joint family structures are coded as 1, 0 (single family) otherwise.
SVO dummy variables (Base group = Prosocial)	
Competitive	A dummy variable that takes value 1 when a respondent's value orientation is competitive, 0 otherwise.
Individualistic	A dummy variable that takes value 1 when a respondent's value orientation is individualistic, 0 otherwise.
Unidentified	A dummy variable that takes value 1 when a respondent's value orientation is unidentified, 0 otherwise.

Table 8: Marginal effects of probit regressions for opinion changes from A to B or AB under FAB

Variable	Marginal effect
Household income (in $1000\,\mathrm{BDT}$)	-0.001
	(0.001)
Gender	0.177
	(0.150)
Age	0.032
	(0.044)
Education	0.001
	(0.009)
Family structure	-0.009
	(0.087)
SVO dummy (base group = Prosocial)	
Competitive	0.381***
	(0.093)
Individualistic	0.538***
	(0.064)
Unidentified	0.458***
	(0.119)

***significant at the 1 percent level, **significant at the 5 percent level