Climate Adaptation, Gender Dynamics, and Decision-Making in Vulnerable Communities: Experimental Insights from Bangladesh

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Summary

Climate change poses severe challenges for climate-vulnerable regions of developing countries, such as coastal Bangladesh. The study area is Shyamnagar upazila of Satkhira District of Bangladesh. The study is situated in a highly climate-vulnerable coastal area of Bangladesh where natural disasters have historically been prevalent and have escalated due to climate change along with burgeoning freshwater scarcity. This study explores climate adaptation preferences and decision-making among affected communities in coastal Bangladesh. We summarize here findings from three distinct studies, each exploring different facets of decision-making. The first two chapters focus on climate change adaptation, providing a comprehensive overview of the intergenerational, gender-specific, and socio-economic dimensions of adaptation strategies in this region. The third chapter focuses on how unpaid care work and different socioeconomic variables affect women's decision-making agency in the study area.

Chapter 1 investigates preferences for climate change adaptation among individuals in climate-vulnerable regions of Bangladesh through experimental games. This research explores how individuals cooperate for donation to climate adaptation for present and future generations in the study area. It tries to understand how exposure to cooperative behaviors targeted at the current generation's adaptation influences the donation for adaptation for the benefit of future generations, and vice versa. Additionally, the study investigates the nature of the relationship between the levels of cooperation directed towards the adaptation of present generations and the adaptation for future generations. This research employs a multi-person Public Good Game with a threshold focused on the current generation and a multi-person Dictator Game with a threshold oriented towards future generations.

For this study, 316 respondents were selected from 10 unions of Shyamnaagr Upazilla using cluster sampling based on geography and stratified sampling based on gender. The sample selection details are based on unions and wards. The selection ensured a balanced representation, with 48.42% female (153 samples) and 51.58% male (163 samples) participants. Two groups were prepared which are Threshold Public Good Game First Group (TPGG first group) and the Threshold Dictator Game First Group (TDG first group). In total, 136 participants participated in the TPGG first group (80 male and 56 female). They played two rounds, where they first engaged in the public good game, followed by the dictator game

for future generations. A total of 180 participants, composed of 83 males and 97 females, played in the TDG first group. They also played two rounds, first engaging in a dictator game for future generations, followed by a public good game.

The study finds a significant relationship between investments in public good games and donations in dictator games, showing that individuals who are more altruistic tend to be more cooperative. The study utilizes the Network of Action Situations (NAS) approach to show that prior exposure to the dictator game, which focuses on future generations' adaptation, leads to less cooperation in the public good game for the present generation due to the spillover effect of the strategic uncertainty. Additionally, prior exposure to the public good game for the present generation did not significantly influence donations in the dictator game for future generations due to the learning effect resulting from the outcome revelation of the previous game. However, a dependency between investment behavior and the level of endowment was found to be significant.

Chapter 2 explores gender-specific cooperation and perceptions regarding climate change adaptation by utilizing experimental games in coastal Bangladesh. The study aims to investigate the impact of gender relations on decision-making related to climate change adaptation of individuals in a cooperative within a climate-vulnerable patriarchal society. It examines how men and women make decisions in both intragenerational and intergenerational adaptation with threshold public good game (TPGG) and threshold dictator game for future generation (TDGF), respectively. These games are organized based on the gender composition of the groups, which include single-sex groups and mixed-sex groups.

In the threshold public good game (TPGG), participants were distributed across three group compositions: 40 participants in 2 male-only groups, 24 participants in 1 female-only group, and 72 participants in 4 mixed-sex groups. In the threshold dictator game for future generations (TDGF), the allocation included 27 participants in 2 male-only groups, 54 participants in 3 female-only groups, and 99 participants in mixed-sex groups. The mixed-sex groups in the TDGF were further divided into subcategories: 48 participants in 2 male-dominated mix groups, 15 participants in 1 female-dominated mix group, and 36 participants in 2 groups with equal male and female representation.

Findings reveal that gender dynamics significantly influence cooperative behaviors. Men show greater optimism and higher investments in single-sex groups in the TDG, while both genders invest more in mixed-sex groups in the TPGG. The qualitative analysis highlighted societal norms and gendered perceptions as significant factors shaping these dynamics. Societal norms influence these behaviors, with men, perceived as primary earners, being expected to contribute more, while women often prioritize collective benefit over individual gain. Males in the TDGF were more optimistic about single-sex groups and pessimistic about mixed-sex groups. On the other hand, females' unconditional contributions to the TDGF reflect societal expectations of caregiving and intergenerational prioritization, as emphasized in feminist ecological economics.

Chapter 3, adopting a feminist ecological economics perspective, investigates the impact of unpaid care work and socio-economic factors on women's decision-making agencies in climate-vulnerable rural Bangladesh. The study collected data from 316 households in 2022 (153 women and 156 men) and 385 households in 2021 (52 women and 333 men) from Shyamnagar Upazila. Decision-making agency variables including economic, family, and social domains are analyzed. Economic domains include spending for oneself, spending for parents, economic participation, and land transactions. Family domains include children's education, participation in decision-making in family matters, and participation in family planning. The decision-making agency variables related to social domains are going out alone, participating in social work, and purchasing household goods.

The study identifies a positive correlation between unpaid care work and women's decision-making agency in all three social, economic, and family domains, emphasizing how caregiving responsibilities enhance their agency within households. However, entrenched patriarchal norms and climate-induced challenges exacerbate gender inequalities, limiting women's agency. By applying the Institutional Analysis and Development (IAD) framework, the study elucidates the intricate feedback loops between unpaid care work and decision-making agency, providing a nuanced understanding of women's roles in household and community-level adaptation strategies.

These studies underscore the complex interplay among intergenerational perspectives, gender dynamics, and socio-economic factors influencing decision-making and climate adaptation behaviors in coastal Bangladesh. They highlight the necessity of incorporating intergenerational equity, gender sensitivity, and socio-economic considerations into policy frameworks to enhance the effectiveness and sustainability of adaptation efforts in vulnerable regions.

Zusammenfassung

Der Klimawandel stellt enorme Herausforderungen für klimavulnerable Regionen in Entwicklungsländern wie die Küstengebiete Bangladeschs dar. Das Untersuchungsgebiet dieser Studie ist Shyamnagar Upazila im Satkhira-Distrikt von Bangladesch. Diese ist eine vom Klimawandel besonders betroffene Küstenregion, die von Naturkatastrophen geprägt ist. Diese haben sich durch den Klimawandel und die zunehmende Süßwasserknappheit verschärft. Die Studie untersucht Anpassungspräferenzen und Entscheidungsprozesse innerhalb der betroffenen Gemeinschaften in der Küstenregion Bangladeschs. In dieser Zusammenfassung werden die Ergebnisse aus drei verschiedenen Studien zusammengetragen, die jeweils unterschiedliche Aspekte der obengenannten Präferenzen und Prozesse beleuchten. Die ersten beiden Kapitel konzentrieren sich auf die Anpassung an den Klimawandel und bieten einen umfassenden Überblick über die intergenerationellen, geschlechtsspezifischen und sozioökonomischen Dimensionen der Anpassungsstrategien in der Untersuchungsregion. Das dritte Kapitel fokussiert sich auf die Beeinflussung unbezahlter Sorgearbeit und verschiedenen sozioökonomische Variablen auf die Entscheidungsbefugnis von Frauen in der Untersuchungsregion.

Kapitel 1 untersucht Präferenzen für Anpassungsmaßnahmen an den Klimawandel in klimavulnerablen Regionen Bangladeschs anhand verhaltensökonomischer Experimente. Die Studie erforscht, wie Individuen innerhalb der Untersuchungsregion kooperieren, um Spenden für Anpassungsmaßnahmen sowohl für die heutige als auch für zukünftige Generationen zu leisten. Sie analysiert, wie die Exposition gegenüber kooperativen Verhaltensweisen, die auf die Anpassung der gegenwärtigen Generation abzielen, die Spendenbereitschaft für die zukünftige Generation beeinflusst und umgekehrt. Zudem wird die Beziehung zwischen den Kooperationsniveaus für die Anpassung der heutigen und zukünftigen Generationen untersucht. Dabei werden ein Öffentliche-Güter-Spiel mit Schwellenwert (gegenwärtige Generation) und ein Diktator-Spiel mit Schwellenwert (zukünftige Generation) angewandt.

Für diese Studie wurden 316 Befragte aus 10 Unionsgemeinden von Shyamnagar Upazila mittels Cluster-Sampling nach geografischen Kriterien und geschichteter Stichprobenziehung nach Geschlecht ausgewählt. Die Stichprobe umfasste 48,42 % Frauen (153 Teilnehmerinnen) und 51,58 % Männer (163 Teilnehmer). Zwei Gruppen wurden gebildet: eine Gruppe, die

zuerst das Öffentliche-Güter-Spiel spielte, und eine Gruppe, die zuerst das Diktator-Spiel spielte.

Die Studie zeigt eine signifikante Beziehung zwischen Investitionen in Öffentliche-Güter-Spiele und Spenden in Diktator-Spielen, wobei altruistischere Personen tendenziell kooperativer sind. Mithilfe des "Network of Action Situations" (NAS)-Ansatzes wird aufgezeigt, dass eine vorherige Teilnahme am Diktator-Spiel, das auf die Anpassung zukünftiger Generationen abzielt, zu weniger Kooperation im Öffentliche-Güter-Spiel für die gegenwärtige Generation führt. Dies ist auf den Übertragungseffekt der strategischen Unsicherheit zurückzuführen. Darüber hinaus beeinflusste eine vorherige Teilnahme am Öffentliche-Güter-Spiel für die gegenwärtige Generation die Spenden im Diktator-Spiel für zukünftige Generationen nicht signifikant, was auf den Lerneffekt durch die Ergebnisoffenlegung des vorherigen Spiels zurückzuführen ist. Allerdings wurde eine signifikante Abhängigkeit zwischen dem Investitionsverhalten und dem Niveau der Ausstattung festgestellt.

Kapitel 2 beleuchtet geschlechterspezifische Kooperation und Wahrnehmungen zur Klimaanpassung durch experimentelle Spiele in Küstenregionen Bangladeschs. Es wird untersucht, wie Geschlechterverhältnisse Entscheidungsprozesse in patriarchalen Gesellschaften beeinflussen. In Öffentliche-Güter- und Diktator-Spielen wurden sowohl reine Männer- und Frauengruppen als auch gemischte Gruppen untersucht. Die Ergebnisse zeigen, dass geschlechtsspezifische Dynamiken das kooperative Verhalten stark beeinflussen, wobei soziale Normen und geschlechtstypische Erwartungen eine zentrale Rolle spielen.

Im Öffentliche-Güter-Spiel mit Schwellenwert (TPGG) wurden die Teilnehmenden auf drei Gruppenkompositionen verteilt: 40 Teilnehmende in 2 rein männlichen Gruppen, 24 Teilnehmende in 1 rein weiblichen Gruppe und 72 Teilnehmende in 4 gemischtgeschlechtlichen Gruppen. Im Diktator-Spiel mit Schwellenwert (TDGF) für zukünftige Generationen umfasste die Verteilung 27 Teilnehmende in 2 rein männlichen Gruppen, 54 Teilnehmende in 3 rein weiblichen Gruppen und 99 Teilnehmende in gemischtgeschlechtlichen Gruppen. Die gemischtgeschlechtlichen Gruppen im TDGF wurden weiter in Unterkategorien aufgeteilt: 48 Teilnehmende in 2 männlich dominierten gemischten Gruppen, 15 Teilnehmende in 1 weiblich dominierten gemischten Gruppe und 36 Teilnehmende in 2 Gruppen mit gleicher männlicher und weiblicher Vertretung.

Die Ergebnisse zeigen, dass Geschlechterdynamiken das kooperative Verhalten signifikant beeinflussen. Männer zeigen im Diktator-Spiel in ausschließlich männlichen Gruppen größere Zuversicht und höhere Investitionen, während beide Geschlechter im Öffentliche-Güter-Spiel mit Schwellenwert in gemischtgeschlechtlichen Gruppen mehr investieren. Die qualitative Analyse hebt hervor, dass soziale Normen und geschlechtsspezifische Wahrnehmungen bedeutende Faktoren sind, die diese Dynamiken prägen. Soziale Normen beeinflussen dieses Verhalten, indem Männer als Hauptverdiener wahrgenommen werden und von ihnen erwartet wird, mehr beizutragen. Frauen hingegen priorisieren häufig den kollektiven Nutzen über individuelle Vorteile.Männer im Diktator-Spiel mit Schwellenwert waren optimistischer gegenüber ihren eigenen rein männlichen Gruppen und pessimistischer gegenüber gemischtgeschlechtlichen Gruppen. Andererseits spiegeln die bedingungslosen Beiträge der Frauen im Diktator-Spiel mit Schwellenwert gesellschaftliche Erwartungen an Fürsorge und intergenerationale Priorisierung wider, wie sie in der feministischen ökologischen Ökonomie betont werden.

Kapitel 3 untersucht aus der Perspektive der feministischen ökologischen Ökonomie den Einfluss unbezahlter Sorgearbeit und sozioökonomischer Faktoren auf die Entscheidungsbefugnis von Frauen in klimavulnerablen ländlichen Regionen Bangladeschs. Die Datenerhebung umfasste 316 Haushalte im Jahr 2022 (153 Frauen und 156 Männer) sowie 385 Haushalte im Jahr 2021 (52 Frauen und 333 Männer) aus Shyamnagar Upazila. Untersucht wurden Entscheidungsvariablen in wirtschaftlichen, familiären und sozialen Bereichen: Zu den wirtschaftlichen Bereichen zählten persönliche Ausgaben, Ausgaben für Eltern, wirtschaftliche Teilhabe und Landtransaktionen. Familienbereiche umfassten die Bildung der Kinder, die Mitbestimmung in Familienangelegenheiten und die Familienplanung. Zu den sozialen Bereichen gehörten das Alleinausgehen, die Teilnahme an sozialen Aktivitäten und der Kauf von Haushaltswaren.

Die Studie zeigt, dass unbezahlte Sorgearbeit positiv mit der Entscheidungsbefugnis von Frauen in wirtschaftlichen, familiären und sozialen Bereichen korreliert. Wiederum schränken tief verwurzelte patriarchale Normen und klimabedingte Herausforderungen diese Entscheidungsfähigkeit erheblich ein.

Mithilfe des Institutional Analysis and Development (IAD) Framework werden die komplexen Rückkopplungsschleifen zwischen unbezahlter Sorgearbeit und Entscheidungsbefugnis aufgedeckt. Dies bietet ein differenziertes Verständnis der Rollen von Frauen in Anpassungsstrategien auf Haushalts- und Gemeindeebene.

Diese Studien unterstreichen die komplexen Wechselwirkungen zwischen intergenerationellen Perspektiven, Geschlechterdynamiken und sozioökonomischen Faktoren. Diese beeinflussen die Entscheidungsfindung sowie das Klimaanpassungsverhalten in der Küstenregion Bangladeschs. Sie betonen die Notwendigkeit, intergenerationelle Gerechtigkeit, Geschlechtersensibilität und sozioökonomische Überlegungen in politische Rahmenwerke zu integrieren, um die Wirksamkeit und Nachhaltigkeit von Anpassungsmaßnahmen in vom Klimawandel betroffenen Regionen zu verbessern.

Table of Content

Introduction

Climate change presents multifaceted challenges for climate vulnerable developing countries. Bangladesh, despite its minimal contribution to global greenhouse gas emissions, faces severe environmental consequences (Khan, 2013; IPCC, 2022). The impacts are not only immediate but also intergenerational, exacerbating climate injustice for both current and future generations. Moreover, rural women are disproportionately affected due to their responsibility for unpaid care work, including water collection, which climate change and water scarcity further intensify (Neumayer & Plümper, 2007;UN Women,2018).

In regions like coastal Bangladesh, adaptation to climate change is critical yet challenging due to high vulnerability and limited resources. For women, entrenched patriarchal norms and unequal access to resources create additional barriers to adaptation efforts (Neumayer & Plümper, 2007; UNDP, 2013). Women in such contexts are crucial actors in climate adaptation, given their central roles in managing household resources and responding to environmental stresses (Azcona et al., 2023; Masud-All-Kamal et al., 2021). In the study area, adaptation efforts are often led by local communities, with their success depending on collective cooperation across generations. This study investigates how individuals cooperate in groups for present and future generations' adaptation to climate change. It further explores how intergenerational cooperation impacts intergenerational cooperation and vice versa.

Gender perceptions and roles, shaped by economic and social constraints, significantly impact cooperative behavior and decision-making. Experimental studies reveal that gender influences donation behaviors, especially in contexts involving public goods and intergenerational equity (Perkins, 2007; Dasgupta & Mani, 2015).Women's decision-making agency, which is often limited by socio-economic factors and cultural norms, plays a critical role in shaping their adaptive responses and participation in cooperative efforts (Kabeer, 1999; Seymour & Peterman, 2018).

This study aims to address these complexities by exploring how gender dynamics and decision-making agency influence climate change adaptation strategies in coastal Bangladesh. Through experimental games and feminist ecological economics lens, we examine intra- and intergenerational cooperation, the impact of gender on adaptation behaviors, and the role of unpaid care work in shaping women's decision-making power. Thus, this study incorporates gender dynamics while analyzing the cooperation of people in groups, offering valuable implications for policy and practice.

Furthermore, the study explores how unpaid care work significantly enhances women's decision-making agency within households. Women's caregiving roles position them as key actors in resource management, increasing their bargaining power and decision-making agency across various domains. Feminist ecological economics is used in this study to reveal the interconnections between gender roles, household dynamics, and environmental vulnerabilities.

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Chapter 1: Experimental Game on Intragenerational and Intergenerational Aspects of Climate Change Adaptation in Coastal Bangladesh

by

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Abstract: This research investigates cooperation dynamics in climate adaptation by examining how individuals in climate-vulnerable regions of Bangladesh engage in behaviors benefiting present and future generations. Using experimental games—a multi-person Threshold Public Good Game (PGG) to represent intragenerational cooperation and a Threshold Dictator Game (DG) to represent intergenerational altruism—this study applies the Network of Action Situations (NAS) to analyze interconnected decision-making processes.

The study shows that prior exposure to the DG reduces cooperation in the PGG due to high strategic uncertainty. Conversely, participants exposed first to the PGG maintain altruistic behavior in the DG when the outcome of the former game is revealed, due to the learning effect and reduced strategic uncertainty. In a within-subject design, we find a significant positive predictive relationship between the DG and PGG, indicating that those who are altruistic for future generations tend to be more cooperative for their own generation. We also find that the positive correlation between the DG and PGG is stronger when individuals perceive high levels of social trust and lower levels of strategic uncertainty.

Keywords: Climate change adaptation, Experimental games, Network of Action Situations (NAS), Strategic uncertainty

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1.1 Introduction

The impact of climate change disproportionately affects vulnerable communities in developing countries, with its consequences escalating over time (Hamilton, 1999). This challenge extends beyond the current generation, highlighting inter- and intra-generational climate injustices, where past actions threaten the survival of future generations (Gardiner, 2006; Hurlstone, 2020; Böhm et al., 2020). Bangladesh, a Least Developed Country and a nano-emitter of greenhouse gasses (GHGs), faces severe and life-threatening consequences of climate change (Khan, 2013). Poor populations are systematically exposed to the most damaging climates due to their limited adaptive capacity and dependence on climate-sensitive livelihoods, both now and in the future (Kahn, 2005; Khan, 2013; Adger, 2006; Mondal, 2014; Intergovernmental Panel on Climate Change, 2014; UNDP, 2013). The study area is located in a highly climate-vulnerable and impoverished region of Bangladesh, where historically prevalent natural disasters and freshwater scarcity have worsened due to climate change (IPCC, 2022; Khan, 2013).

This study makes a unique contribution by integrating a multi-person Threshold Public Good Game (PGG) and a multi-person Threshold Dictator Game (DG) within the Network of Action Situations (NAS) framework. These games explore intragenerational cooperation, which refers to individuals cooperating for their own generation's adaptation, and intergenerational altruism, reflecting cooperation for future generations' climate adaptation, respectively. It offers a novel perspective on how sequential decision-making processes are influenced by strategic uncertainty and learning effects. Unlike prior studies that examine these games in isolation, this research highlights their interconnection through feedback loops and spillover effects, contributing to the understanding of cooperation dynamics in climate adaptation.

Implementing effective adaptation policies, programs, and measures can yield both immediate and future benefits (Smit and Pilifosova, 2001). Nonetheless, climate adaptation, inherently a public good, requires significant cooperation to overcome conflicts between individual and collective interests. Trust, belief, institutions, cultural norms, and conditional cooperation—where individuals contribute based on their expectations of others—are crucial for fostering successful cooperation (Ockenfels and Weimann, 1999; Henrich et al., 2005, 2010; Brosig-Koch et al., 2011; Cherry et al., 2005; Shahrier et al., 2017). However, strategic uncertainty—where individuals' decisions are influenced by their uncertainty about others' actions in cooperative settings—poses a major barrier to cooperative behavior. Strategic uncertainty suggests that outcomes are not solely determined by one's own actions but are significantly influenced by the behavior of others (Voigt, 2019). This study specifically addresses how strategic uncertainty affects intragenerational and intergenerational decision-making, revealing its implications for sustainable adaptation strategies.

This study uses the NAS framework to link the PGG and DG, focusing on two key dynamics: the spillover effect of strategic uncertainty between games and the role of revealed outcomes in reducing strategic uncertainty and promoting sustained cooperation. The NAS framework conceptualizes these interconnected decision-making processes, emphasizing the role of feedback loops and learning effects in shaping behavior.

This study investigates the effects of game sequencing on cooperation and altruism across present and future generations. The paper addresses how prior engagement in cooperative behavior for future generations' adaptation or DG influences subsequent cooperative behavior for the present generation's adaptation or PGG, due to the spillover effect of strategic uncertainty, originating in DG. The first research question examines how strategic uncertainty influences cooperation levels in sequential climate adaptation decisions.

Next, informational signaling reduces strategic uncertainty by revealing the outcome of the collective contributions and fostering alignment with group norms (Bénabou & Tirole, 2006). In sequential games, informational signals such as the payoffs and choices of others can enhance learning effects, allowing participants to adapt their strategies based on feedback and experience, thereby promoting cooperation and reducing strategic uncertainty (Camerer & Ho, 1999). Therefore, the study analyzes whether revealing the outcome of the first game reduces the spillover effect of strategic uncertainty and induces a learning effect. Therefore, the second research question addresses how revealing the outcome of the prior engagement in cooperative behavior in the PGG influences subsequent cooperation in the DG.

Notably, previous research in behavioral economics has not extensively investigated whether contributions in the dictator game, reflecting altruism, and contributions in the public good game, indicating group cooperation, are correlated or distinct from each other. However, both motives are highly relevant from the perspective of climate change adaptation. Only a few earlier studies have examined the correlation between these games; for instance, Chan et al. (2022) explored this issue and identified a weak relationship between contributions in these two games.

This study addresses this gap by examining how intragenerational cooperation in Public Good Games (PGG) relates to intergenerational altruism in Dictator Games (DG). The third research question investigates whether cooperation for present-generation adaptation predicts or correlates with cooperation for future generations' adaptation. Specifically, the study explores the predictive relationship to determine if higher cooperation levels in the PGG are associated with greater altruism in the DG, and the conditional relationship to understand how factors such as social trust and strategic uncertainty influence these dynamics.

1.2. Conceptual and Theoretical Framework:

This study uses experimental games to analyze cooperative behavior for climate adaptation, integrating the Network of Action Situations (NAS) framework. The NAS framework uniquely addresses interdependencies and feedback loops in sequential decision-making contexts, providing insights into how strategic uncertainty and learning effects shape cooperative behaviors. By connecting the Public Good Game (PGG) and the Dictator Game (DG) as adjacent action situations, this study examines their interconnected dynamics in fostering intragenerational and intergenerational cooperation.

Experimental Games

Public good games serve as key experimental paradigms for studying cooperative behavior in social dilemmas, while dictator games primarily examine altruistic decision-making. Multi-person threshold public good games involve participants contributing resources for a common good, benefiting multiple individuals. In contrast, in multi-person threshold dictator games, participants decide about an altruistic act—how to allocate resources between themselves and anonymous recipients (Chan et al., 2022; Edele et al., 2013). Thus, this game helps to understand how people cooperate for future generations' adaptation, where no personal gain is prevalent. Both these games require participants to reach a collective threshold, offering realistic simulations of climate adaptation challenges. Threshold-based games provide insights into how cooperation can be fostered or hindered in climate adaptation efforts, emphasizing the critical role of collective thresholds in shaping behavior (Cadsby & Maynes, 1998; Böhm et al., 2020).

Nonetheless, ensuring the welfare of future generations is crucial for maintaining the continuity of families, communities, and ecosystems, but it requires sacrifices from the present generation (Hauser et al., 2014; IPCC, 2022). Fisher et al. (2004) highlighted the intergenerational linkage of common pool resources, emphasizing altruism and cooperation across generations for resource sustainability (Haraway, 2016; Hauser et al., 2014). Findings from experimental games reveal a conflict between self-interest and social welfare, highlighting tendencies to prioritize immediate benefits over long-term sustainability (Guvurir & Booysen, 2019; Hurlstone et al., 2020; Hauser et al., 2014; Böhm et al., 2020; Funaki & Vesterlund, 2016 Fornwagner & Hauser, 2022; Timilsina et al., 2022). For instance, adaptation measures like unsustainable shrimp farming can have long-term negative consequences (Bull et al., 2021).

Institutional Analysis and Development (IAD) and Network of Action Situations (NAS)

The IAD framework focuses on bounded rationality, where decision-makers operate within constraints of information, cognitive capacity, and time, often prioritizing feasible solutions over optimal ones, within structured settings (Simon, 1955; Ostrom, 2005). The IAD framework defines action situations as contexts where individuals interact under specific rules, influenced by their environment, to collectively create an outcome, making it a valuable tool for analyzing common pool resources (Ostrom, 1990; Ostrom, 1999; Ostrom, 2005; Ostrom, 2011; Heikkila & Andersson, 2018). However, the IAD framework does not explicitly address interdependencies between sequential decision-making contexts.

Action situations that influence one another are termed adjacent action situations, highlighting how outcomes in one context impact subsequent interactions (McGinnis, 2011). This study acknowledges the Network of Action Situations (NAS), an extension of the IAD framework that explores the interconnectedness and feedback between sequential decision-making or adjacent action situations.

NAS highlights how feedback loops and spillover effects shape individual behavior and collective outcomes, particularly in socio-ecological systems (Kimmich et al., 2023; Kimmich & Villamayor-Tomás, 2019; Ostrom, 2010). The NAS framework is particularly suited for examining the interconnected dynamics of cooperation in experimental games, providing insights into how individuals navigate strategic uncertainty, feedback loops, and learning effects in sequential decision-making contexts. By viewing the Public Good Game (PGG) and Dictator Game (DG) as adjacent action situations, we explore how decisions in one game influence the other through feedback loops and spillover effects.

Key components of the NAS framework:

- **Action Situations (AS):** The PGG represents intragenerational cooperation, while the DG examines intergenerational altruism.

- **Feedback Loops:** Feedback loops refer to the sequential influence of one action situation's outcomes on another, as conceptualized in the NAS framework (Kurzban & Houser, 2001; Hamilton et al., 2022). For example, revealed outcomes in the PGG provide participants with information that reduces strategic uncertainty and fosters trust, influencing subsequent decisions in the DG.
- **Spillover Effects:** Strategic uncertainty in the DG often leads to risk-averse behavior in the PGG, reducing cooperative contributions. This spillover effect represents the challenges of sustaining cooperation across sequential games.
- **Learning Effects:** Learning effects occur when revealed outcomes in the PGG act as informational signals, enabling participants to adapt their decisions in the DG, reducing strategic uncertainty and fostering alignment with group norms.

Strategic Uncertainty

This uncertainty is prevalent in both the DG and PGG, which are multi-person games due to the interdependence of players' decisions. In the DG, participants lack personal monetary incentives increasing strategic uncertainty about the impact of their altruistic decisions (Andreoni, 1998; Cherry et al., 2005; Croson & Marks, 2000). Besides, in the PGG, participants face uncertainty about whether others will contribute enough to reach the collective threshold, which can reduce trust and cooperation (Fischbacher et al., 2001; Croson & Marks, 2000; Van Huyck et al., 1990; Kocher et al., 2008).

Game theory provides a framework for analyzing situations where players make interdependent decisions. The outcomes for each player depend not only on their own choices but also on the choices made by others, creating strategic uncertainty and reduced cooperation as players must consider the potential actions of others when making their own decisions (Van Huyck et al., 1990). Therefore, understanding and addressing strategic uncertainty is crucial for designing mechanisms that encourage higher contributions and successful provision of public goods (Croson & Marks, 2000).

Learning Effects and Informational Signaling

Learning effects occur when participants gain information or insights from previous rounds or experiences that alter their behavior in subsequent rounds through direct feedback or observation. Learning effects can reduce strategic uncertainty by providing feedback on previous round's outcome, fostering trust, and promoting cooperative behavior in subsequent games (Bowles & Gintis, 2011; Peter & Andreas, 2010). Incorporating revealed outcomes into the design highlights the importance of informational signaling in reducing uncertainty and aligning group behavior.

Informational signaling, as explored by Bénabou and Tirole (2006), can enhance the learning effect by providing participants with meaningful information about collective contributions and outcomes. Cherry et al. (2002) show that revealing outcomes in experimental games clarifies normative expectations, aligning participants' behavior with group dynamics.

Revealing PGG outcomes allows participants to understand group behavior, reducing uncertainty and enabling them to align their subsequent decisions in the DG with observed norms. On the contrary, the absence of revealed outcomes limits informational signaling in the DG, maintaining higher levels of strategic uncertainty and leaving participants to rely on assumptions about group behavior.

However, strategic uncertainty can influence cooperation in public goods games by slowing the learning effect due to initial uncertainty about others' behavior (Keser & van Winden, 2000). Both strategic uncertainty and learning effects are crucial in cooperative games, as they can influence each other. The NAS framework demonstrates how feedback loops operate across action situations, illustrating how learning effects and strategic uncertainty interact to shape behavior in sequential games.

Initial Endowments and Social Trust

Higher initial endowments can foster cooperation by enhancing social trust and reducing strategic uncertainty. Earlier studies have found that higher initial endowments generally lead to higher contributions, though not proportionally (Engel, 2011). Thus, to understand whether people perceive high levels of social trust and lower levels of strategic uncertainty, the initial endowment can be applied as a reference point.

Individuals evaluate their choices relative to their reference point—typically, their current endowment (Thaler, 1978). When players in a game have higher or equal endowments compared to their initial endowment, it can foster a sense of trust and result in less strategic uncertainty. As players perceive that they are starting with a fair or advantageous position, they may be more inclined to cooperate, believing that others will also act in a cooperative manner.

The role of initial endowments aligns with the NAS framework by emphasizing their influence on perceptions of fairness and trust, which in turn affect cooperative behaviors across interconnected action situations. By reducing strategic uncertainty and fostering trust, endowments create a foundation for positive feedback mechanisms.

Linking Framework to Research Design

This framework highlights how strategic uncertainty and learning effects influence cooperative behaviors across sequential decision-making contexts. Building on these theoretical insights, the following section outlines the hypotheses that guide the experimental design and analysis.

1.3. Research Questions and Hypotheses

Research Questions

This study explores the dynamics of cooperation for climate adaptation through experimental games by addressing the following research questions:

1. How does strategic uncertainty influence cooperation levels in the Public Good Game (PGG) when individuals are first exposed to the Dictator Game (DG)?

2. How does prior engagement in cooperative behavior in the PGG influence subsequent cooperation in the DG when feedback is provided?

3. What is the relationship between cooperation levels in the PGG and DG, and how do social trust and strategic uncertainty shape this relationship?

Hypothesis 1: Strategic Uncertainty

The lack of direct reciprocity or personal benefit in the DG increases strategic uncertainty, which spills over into the subsequent PGG, reducing cooperative contributions. Participants who initially engage in cooperative behavior for future generations' adaptation (DG) exhibit reduced cooperative behavior for present generations' adaptation (PGG) due to the spillover effect of strategic uncertainty originating in the DG.

Feedback loops between Action Situation 1 (DG) and Action Situation 2 (PGG) capture the spillover effect, demonstrating how uncertainty in the DG influences cooperation in the PGG. Appendix Figure A.D2 visualizes this comparison. Figure 1.1 depicts the feedback loop of strategic uncertainty from AS1 (DG) to AS2 (PGG), showing the impact on cooperative behavior.

Hypothesis 2: Learning Effects

Participants who first engage in cooperative behavior in the PGG and receive feedback on collective outcomes exhibit similar cooperative behavior in the DG for future generations. The learning effect offsets the spillover effect of perceived strategic uncertainty.

Revealing PGG outcomes acts as an informational signal, creating a learning effect and reducing strategic uncertainty, and fostering trust, which aligns subsequent behavior with observed group norms. The NAS framework illustrates how feedback loops from Action Situation 1 (PGG) reduce strategic uncertainty and foster sustained cooperation in Action Situation 2 (DG).

Appendix Figure A.D3 portrays the visualization of the comparison of hypothesis 2, while Figure 1.1 demonstrates how revealed outcomes in AS1 (PGG), through fast feedback, reduce strategic uncertainty and influence the cooperative behavior in AS2 (DG).

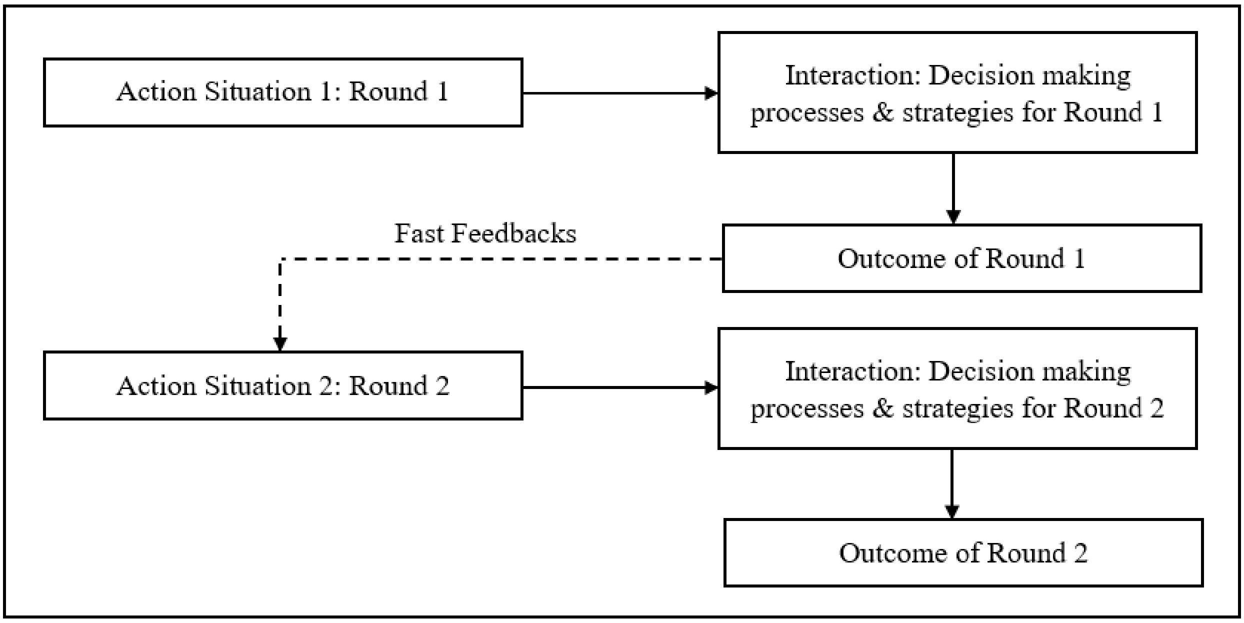

Figure 1.1: IAD framework with Network of Action Situation (Ostrom 2010)

Hypothesis 3: Intragenerational and Intergenerational Cooperation

1. **Predictive Relationship:** Higher cooperation levels in AS1 (PGG) are positively correlated with cooperation levels in AS2 (DG), suggesting that individuals who are cooperative in intragenerational contexts are likely to exhibit altruism toward future generations.

2. **Conditional Relationship:** The positive correlation between cooperation levels in AS1 and AS2 is stronger when individuals perceive high levels of social trust and lower levels of strategic uncertainty.

The NAS framework explains the correlation between AS1 (PGG) and AS2 (DG) through feedback loops and conditional effects. Social trust and reduced uncertainty amplify cooperative behavior across these interconnected action situations. Figure 1.2 shows the correlation between cooperation levels in AS1 (PGG) and AS2 (DG), emphasizing the role of trust and uncertainty in shaping cooperative dynamics.

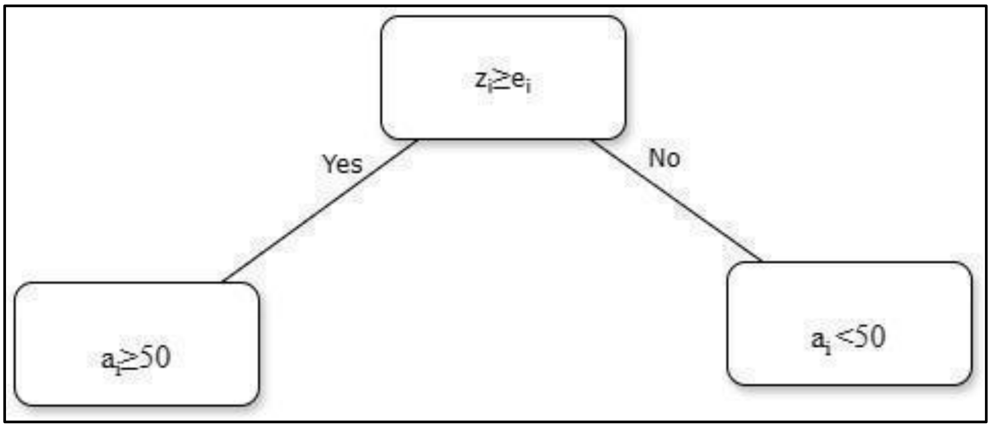

Figure 1.2: Conditional contribution in DG given the change in endowment

1.4. Study Area

The study area is situated in Shyamnagar Upazila, Satkhira District of Bangladesh, which is very significant due to its geographical location along with climate change vulnerabilities. The study area is extremely vulnerable to natural disasters, sea level rise, and climate change. These led to salinity intrusion in freshwater resources including river estuaries and freshwater aquifers resulting in freshwater scarcity (UNDP, 2013; Mimura, 2013). In Satkhira, the saline area is 3736.35 sq. km, which covers 95% of the total area (IUCN, 2015). Figure 1.3 represents the status of the salinity level of Satkhira during the year 2019. The livelihood of people is impacted by the salinity intrusion in that area due to the lack of fresh water. To obtain water, people often have to walk long distances, sometimes submerging themselves in floodwater.

Therefore, people in the study area often prioritize contribution in both autonomous and planned adaptation due to the urgency of it, often led by local people (Hasson et al., 2010). Planned adaptation, such as Community-Based Adaptation (CBA) or Locally Led Adaptation (LLA), involves actions by governmental and non-governmental actors with local community involvement, while autonomous adaptation refers to initiatives taken by affected individuals through cooperation (Smit and Pilifosova, 2001).

Furthermore, the study area is also situated adjacent to the world’s largest mangrove forest of Sundarbans (140,000 ha), which is an Ecological Critical Area (ECA) and World Heritage site declared by UNESCO (Department of Environment, 2015). The Sundarbans Mangrove forest is composed of highly salt-tolerant Mangroves (halophytes) which function as a natural adaptation against natural disasters such as cyclones, tsunami, and storms in the study area (Arifanti, 2020; Datta et al., 2012; Chandra et al., 2007; Parida et. al., 2010; Sakib, 2015; Sarker et al.,2016; Uddin et al., 2013). Climate change along with some natural and anthropogenic factors such as over-extraction of forest goods, dam construction, illegal urbanization, shrimp farming, top-dying disease, illegal wildlife poaching, pollution regular oil spills, etc. are degrading the mangrove ecosystem (Datta et al., 2012; Ellison et al.,2000; Rahman et al., 2015; Sarker et al.,2016). The forest of Sundarbans also provides provision services, as it supports the livelihood of 3.5 million coastal dwellers in India and Bangladesh (Sarker et al., 2016). People in the area are highly dependent on the natural resources of the Sundarbans forest for their livelihood, such as collecting fuel wood, timbers, fish, crabs, Golpata (Nypa sp.), wax, and honey (Chandra et al.,2007). Other main livelihoods of the people of Shyamnagar are agriculture, salt and freshwater fisheries, daily labor, etc. (Mondal, 2014).

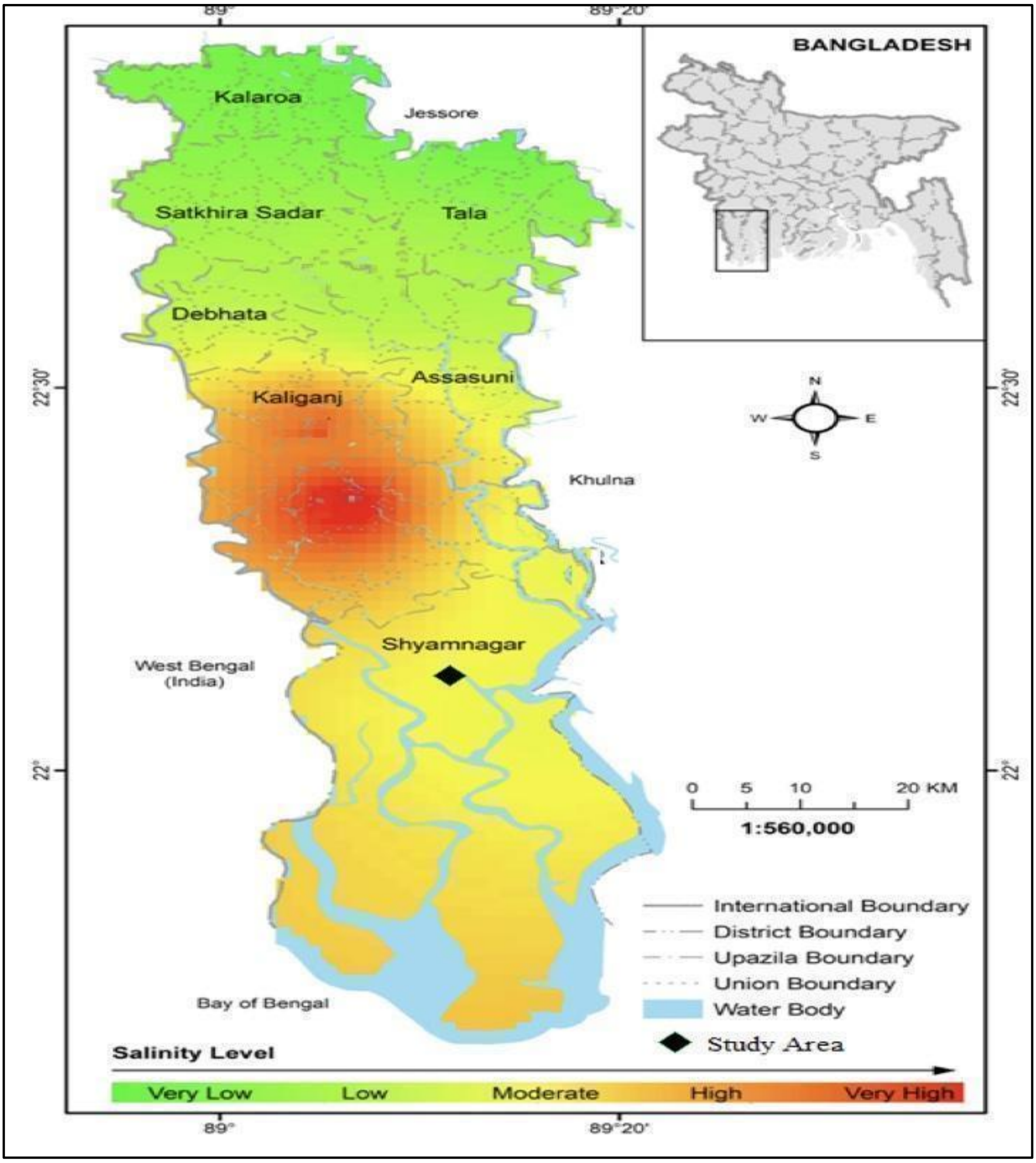

Figure 1.3: Salinity Level of Satkhira, Bangladesh in 2019.[Top Right box indicates the map of the country, Bangladesh, the rectangle box represents the study area.](Rahman & Uddin, 2021)

1.5. Experimental Design

1.5.1. Experimental Games: Selection and Framing

This study employs two experimental games—the Threshold Public Good Game (PGG) and the Threshold Dictator Game (DG)—to examine cooperative and altruistic behavior in climate adaptation scenarios. These games reflect real-world challenges requiring collective and intergenerational resource allocation under conditions of uncertainty and free-riding.

The PGG examines cooperation within the present generation by requiring participants to contribute towards a collective threshold for the benefit of the present generation. If the threshold is met, the group receives a collective benefit, but failure to meet the threshold results in the loss of all contributions. The DG, in contrast, focuses on altruism toward future generations, where participants allocate resources to ensure the sustainability of those generations without any personal gain.

Both games incorporate a threshold mechanism to reflect realistic funding conditions where collective efforts must meet a minimum standard to succeed, especially when uncertainty about the contributions of others exists (Croson & Marks, 2000). Participants were initially informed of the preset collective threshold and provided with an individual endowment, enabling them to calculate their personal threshold mentally. They then made contribution decisions based on their endowment. In this game, the threshold is determined as ¼ or 25% of the initial collective endowment, supporting the framework of Cadsby and Maynes (1998).

Framing was applied in both these games to mirror real-world climate adaptation scenarios. In the PGG, participants were told their contributions could fund temporary infrastructure projects, such as reverse osmosis (RO) water purification systems, pond sand filters (PSF), or road construction, which would primarily benefit their own generation. In the DG, contributors had to decide on a costly yet highly efficient adaptation meant exclusively for the benefit of future generations, which would require several years for implementation. Examples included investments in educational institutions or research, the reforestation of the Sundarbans forest, building expensive infrastructure such as advanced technology or dams to alleviate water scarcity after five decades. In the DG, subsequent players who would come to participate in the experiment represented future generations.

1.5.2. Group Setup

Participants were divided into two groups based on the sequence of games played. This design allowed for the analysis of spillover effects from strategic uncertainty and the role of revealed outcomes in influencing cooperative behavior across games. Appendix Figure A.D1 visualizes the group setup with its sequence.

In the TPGG-first group, participants played the Public Good Game (PGG) in the first round, followed by the Dictator Game (DG) in the second round. After completing the PGG, the outcomes were revealed to participants. This disclosure acted as an informational signal, reducing strategic uncertainty and enabling participants to align their decisions in the DG with observed group norms and collective outcomes (Bénabou & Tirole, 2006; Sutan & Willinger, 2009). This setup allowed for an investigation into the learning effects of revealed outcomes in shaping subsequent cooperative behavior.

In the TDG-first group, participants began with the Dictator Game (DG) in the first round, followed by the Public Good Game (PGG) in the second round. However, not all participants from this group proceeded to the PGG in the second round due to participant dropouts. Additionally, the outcomes of the DG were not revealed to participants before playing the PGG. This lack of feedback maintained high levels of strategic uncertainty, preventing participants from assessing others' contributions and influencing risk averse behavior in the PGG (Andreoni, 1998; Kocher et al., 2008). By comparing the TPGG-first group, where feedback was provided, and the TDG-first group, where feedback was withheld, this study examines how informational asymmetries and sequential decision-making influence contributions and cooperation across games.

1.5.3. Game Design and Parameter

This study employed a structured experimental design to investigate cooperative and altruistic behavior in climate adaptation. Each group comprised n =3 participants, each receiving an individual endowment (e_i=200 Taka). Participants made decisions independently without communication, ensuring that their choices were uninfluenced by others. Confidentiality was maintained to prevent strategic reputation-building, with the results of each round and final payments known only to the participant and the experimenter (Engelmann & Fischbacher, 2009).

Game parameters

The total endowment ($Et = ne_i$) was set at 600 Taka per group, with a collective threshold ($Tp= Ta$) set at 25% (¼ Et=150) for both the Public Good Game (PGG) and Dictator Game (DG). These thresholds ensured realistic conditions where collective contributions were necessary for success, reflecting adaptation funding scenarios (Cadsby & Maynes, 1998).

Threshold Public Good Game (PGG)

In the public good game, players are given e_i amount individually and they have to decide to contribute p_i amount in PGG with $0 \leq p_i \leq e_i$. Contribution profile, $p_i = (p_1,...,p_n)$ details of the action of each player i making choices simultaneously and independently. The joint contribution in the public good game is $Cp_i = \sum p_i$.

If the contribution Cp_i is equal to or higher than the threshold, i.e. $Tp \leq Cp_i$, then the contribution will be multiplied by the productivity factor β, whereas β=1.5.Then everyone gets an equal share of the benefit.

For instance, there are 3 members in the group. Each one of them is given an endowment of 200 taka. If participant A contributes 70 Taka and participants B and C each contribute 40 Taka, their joint contribution exceeds the threshold of 150 Taka. Their joint contributions are then multiplied by the productivity factor of 1.5, and each participant receives an equal share of the benefits.

If the contribution Cp_i is lower than this threshold, i.e., $Cp_i < Tp$, then all players from the game will lose their investment, the payoff from Cp_i becomes zero (0).

In TPGG first group, the individual payoff function for a player i is

$$z_i = \begin{cases} e_i - p_i + \dfrac{C_p \beta}{n}, & if\ C_p \geq T_p; \\ e_i - p_i, & otherwise. \end{cases}$$

Threshold Dictator Game (DG)

Participants faced the choice of investing in the DG or retaining their endowment to themselves. Although investing in the DG incurred costs for the present generation without immediate personal benefit, the failure to meet this threshold will collapse the future generations depriving them of any benefit.

Here, participants had to decide on the contribution amount 'a_i'. Contribution profile $a_i = (a_1, \ldots, a_n)$ details the action of each player i. The joint contribution in this game is $Ca_i = \sum a_i$. If the joint contribution Ca_i is higher than the threshold, i.e., $Ta \leq Ca_i$, then the contribution will ensure the sustainability of the future generation.

Further details on decision-making ranges, numerical examples, payoff matrix, and game setup are provided in Appendix A.C.

1.5.4. Sample Selection

For this study, 316 respondents were selected from 10 unions of Shyamnagar Upazilla using cluster sampling based on geography and stratified sampling based on gender. The sample selection details are based on unions and wards. The selection ensured a balanced representation, with 48.42% female (153 samples) and 51.58% male (163 samples) participants.

136 participants participated in the TPGG first group (80 male and 56 female). Players were given an initial endowment (e_i) and played the PGG, followed by DG. 180 samples composed of 83 males and 97 femalse have played the TDG first group. From TDG first group, all 180 players played the DG. Next only 153 players composed of 74 males and 79 females were selected to participate in the public good game. The reduction in sample size was due to participant dropouts, which occurred naturally during the experiment and were not related to game performance or thresholds.

Table 1.1: Group Types and Gender Composition in TPGG and TDGF

Game	Game played	Number of Groups	Male	Female	Total Participants
TPGG	PGG & DG	7 groups	80	56	136
TDGF	DG (Round 1)	10 groups	83	97	180
TDGF	PGG(Round 2)	8 groups	74	79	153

1.6. Results

1.6.1 Overview of Findings

The study found that strategic uncertainty in the dictator game (DG) significantly decreases subsequent cooperation in the public good game (PGG). This central finding highlights the spillover effect of strategic uncertainty from one game to another.

In terms of demographic characteristics, all groups had relatively similar mean ages, with the TDG-first group averaging 34.97 years and the TPGG-first group averaging 34.06 years (minimum age 18, maximum 68 years). Gender distribution revealed disparities, with the TPGG-first group comprising 58.82% female participants, compared to 46.11% female participants in the TDG-first group. Household income also varied, with the TPGG-first group displaying a mean income of 8,339.71 taka, while the TDG-first group's mean income was 9,433.89 taka.

Perceptions of water quality were consistent across groups, with 30% of the TDG-first group and 28.68% of the TPGG-first group considering their water as pure. Educational attainment averaged around 10 years for both groups. Summary statistics for the TPGG-first and TDG-first groups are presented in Appendix Tables A.A2.3 and A.A2.4, respectively.

In the DG, the TPGG-first group exhibited mean investments of 62.868 taka, compared to 58.417 taka in the TDG-first group. After adjusting for endowment, these mean investments were 28.648% of the initial endowment and 29.208% for the TPGG-first and TDG-first groups, respectively. This is consistent with prior literature, where 74% of their participants chose to donate and the mean was on average 28.35% (Kahneman et al., 1986; Engel, 2010).

In the PGG, the TPGG-first group invested an average of 76.544 taka (38.272% of the endowment), compared to 53.302 taka (26.651%) for the TDG-first group. This contrasts with prior literature, where contributions typically range from 40% to 60% of the endowment (Funaki et al., 2017; Ledyard, 1995). These findings underscore the complex interplay between individual characteristics and contribution behaviors across different game contexts.

1.6.2 Primary Results: Strategic Uncertainty and Game Sequencing

Impact of DG on PGG Cooperation

The central finding of the study is that strategic uncertainty in the DG significantly decreases subsequent cooperation in the PGG. Hypothesis 1 examines whether participants who initially engage in cooperative behavior for future generations' adaptation (in DG) will exhibit lower cooperative behavior for the present generation's adaptation (intragenerational cooperation) due to the spillover effect of strategic uncertainty originating in the DG.

Null Hypothesis (*H0*): There is no significant difference between the mean contribution in the PGG (p_i) in AS 1 of the TPGG first group and that of AS 2 of the TDG first group.

Alternative Hypothesis (*HA*): The mean contribution in the PGG (p_i) in AS 1 of the TPGG first group will be significantly higher than that of AS 2 of the TDG first group. Thus, we compare the p_i in the TPGG first group and the p_i in the TDG first group.

In the public good game, the TPGG-first group displayed a contribution that was 22.536 taka higher than that of the TDG-first group at a 1% significance level (Appendix Table A.A3). This finding suggests that we can reject the null hypothesis. This can be interpreted as participants who engage in cooperative behavior for future generations' adaptation in the TDG first group will exhibit lower cooperative behavior for the present generation's adaptation in TPGG first group due to the increased perceived strategic uncertainty. The perceived strategic uncertainty is increased due to the spillover effect of the DG in the TDG first group.

Impact of PGG on DG Altruism

Hypothesis 2 examines whether revealing PGG outcomes affects cooperative behavior in the DG. It posits that learning effects from outcome revelation offset the spillover effect of strategic uncertainty.

Null Hypothesis (H0): There is no significant difference between the mean investments in the dictator game (a_i) in AS 1 of the TDG first group and the endowment-adjusted mean contribution in the dictator game (l_i) in AS 2 of the TPGG first group.

Alternative Hypothesis (Ha): There is a significant difference between the mean contribution in the dictator game (a_i) in AS1 of the TDG first group and that of AS 2 of the TPGG first group.

Results reveal no significant relationship between the TPGG-first and TDG-first groups in terms of contributions to the DG (Appendix Table A.B1). This indicates that the spillover effect of strategic uncertainty from the PGG does not persist in subsequent games due to the learning effect, supporting the null hypothesis.

1.6.3 Relationship between PGG and DG

Hypothesis 3 is formulated to understand if there is any relationship between the PGG and DG in a within-subject design. Thus, two sub-hypotheses have been formulated here.

Predictive Relationship

First, hypothesis 3.1 determines the predictive relationship, examining whether higher cooperation in (DG) is positively correlated with cooperation levels for present generations' adaptation in Action Situation 2 (PGG), suggesting that individuals who are cooperative in intragenerational contexts are also likely to exhibit altruism toward future generations.

Null Hypothesis (H0): There is no correlation between altruistic behavior in DG and cooperative behavior in PGG. Specifically, the same individuals who donated higher amounts in the DG (a_i) don't exhibit higher investments in the PGG (p_i) in the TDG first group.

Alternative Hypothesis (Ha): There is a positive correlation between altruistic behavior in DG and cooperative behavior in PGG. The same individuals who donated higher amounts in the dictator game (a_i) also made higher investments in the PGG (p_i) in the TDG first group.

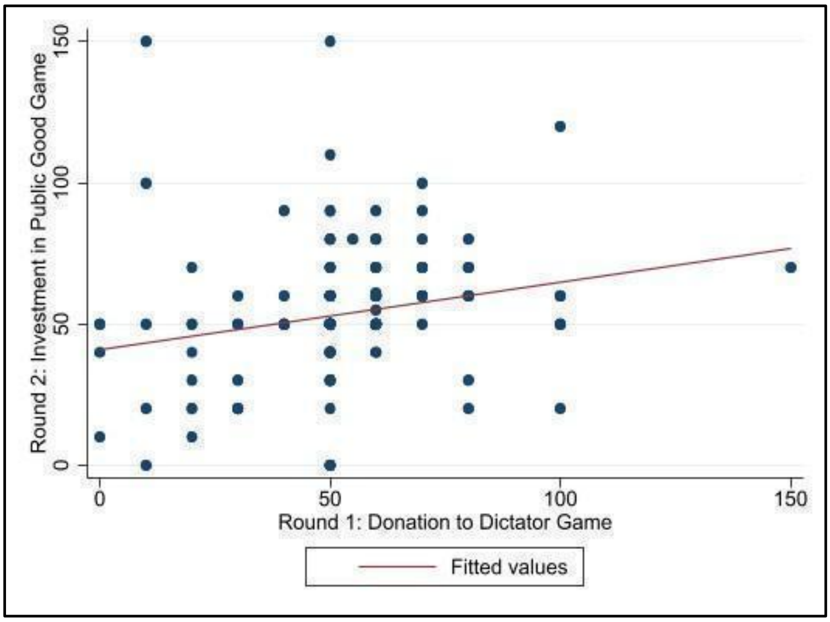

Figure 1.4: Contribution to DG and PGG. Fit line: public_good *game*= 40.7816+ 0.240(contribution in dictator game). Here the R^2=4.6%.

Result 3.1: The relationship between PGG and DG is illustrated in Figure 1.4 and Appendix Table B2. If the cooperation level in PGG settings was perfectly correlated with the cooperation level in DG settings, then we should find a strong linear trend in this graph. Here, we see that there is indeed a positive association between the two (slope of 0.24 with $p < 0.01$), indicating that for 1 (one) taka increase in the contribution in DG, the dependent variable contribution in PGG increases by approximately 0.24 taka. Thus, those who invest in the PGG are also highly likely to donate to the DG. However, we see that the plot has a low R^2 (0.046), indicating that contribution in PGG only explains a very small fraction of the variation in contribution in the dictator game, and vice versa.

Figure 1.4 and Appendix Table A.B2 show a positive association (slope of 0.24, $p < 0.01$), with each 1-taka increase in DG contributions associated with a 0.24-taka increase in PGG contributions. However, the low R^2 (0.046) indicates limited explanatory power.

Sensitivity analyses with dummy variables confirm this relationship. The dummy variable t_i is coded as 1 if the contribution in the dictator game equals or exceeds the individual threshold ($\frac{Ta}{n}$) of 50 taka or if $a_i \geq 50$, and 0 otherwise. Individuals meeting the 50-taka threshold in the DG contribute 9.919 taka more in the PGG (see Appendix Table A.B2). Despite statistical significance, the model's overall explanatory power remains limited ($R^2 = 0.028$).

Conditional Relationship: Role of Social Trust and Strategic Uncertainty

Here, we explore the conditional influence of the positive correlation between cooperation levels for present and future generations' adaptation. This hypothesis states that the positive correlation is stronger when individuals perceive high levels of social trust and lower levels of strategic uncertainty in their community. The initial endowment is used as a proxy to represent these perceptions.

To test this hypothesis, two binary dummy variables t_i and k_i are applied. The dummy variable, k_i is coded as 1 if $z_i \geq e_i$, and 0 otherwise. The coefficient associated with k_i indicates the change in the likelihood of making a contribution in the dictator game (t_i).

Null Hypothesis (H0): The likelihood of contributing in the dictator game (t_i =1) is independent of whether an individual's endowment (z_i) equals or exceeds their initial endowment (e_i), indicating that t_i =1 is independent of the value of k_i.

Alternative Hypothesis (Ha): The likelihood of contributing in the dictator game (t_i =1) is significantly higher when an individual's endowment (z_i) equals or exceeds their initial allocation (e_i), which implies that t_i =1 is dependent on the value of k_i.

Table 1.2: Logistic Regression of Adjusted endowment from PGG and contribution in DG in TPGG first group

Independent Variable	t_i (dummy variable 0 or 1)
k_i (dummy variable 0 or 1)	0.990* (0.538)
Age	0.045 (0.028)
Household income	0.000 (0.000)
Water Quality(0 or 1)	0.344 (0.602)
Gender	0.358 (0.531)
Education	0.152** (0.065)
Land ownership (0 or 1)	1.125** (0.554)
Constant	-2.984* (1.524)
Observations	136
Pseudo R^2	0.1551

Notes: Robust standard errors in parentheses.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Result 3.2: The logistic regression results indicate that in the TPGG first group, there is a significant relationship between the adjusted endowment from the preceding PGG (k_i) and contribution behavior in the DG (t_i). Specifically, individuals who receive an endowment at least equal to their initial allocation in the PGG are significantly more likely to make investments in the dictator game compared to those whose endowment falls below their initial allocation. For each unit increase in k_i, the log-odds of contributing to the dictator game increase by approximately 0.990 taka.

The robustness checks affirm that the main findings are consistent across a range of alternative model specifications, highlighting the stability of the relationship between adjusted endowment and contribution behavior (see Appendix Table A.B3). While the significance of some control variables, particularly land ownership, underscores their importance, the overall association between k_i and t_i remains robust, supporting the validity of our conclusions.

These findings support the conditional relationship that individuals are more inclined to invest in the dictator game when provided with an endowment at least equal to their initial allocation, suggesting a dependency between contribution behavior and the level of endowment.

1.7. Discussion

This study applies the Network of Action Situations (NAS) framework to analyze cooperative behavior in experimental games that simulate real-world adaptation challenges. The findings offer insights into strategic uncertainty, learning effects, and intergenerational altruism, with implications for both theory and practice.

The results highlight the significant influence of game sequencing on cooperative behavior. Participants in the TDG-first group exhibited lower contributions in the PGG, supporting Hypothesis 1. This finding demonstrates the spillover effect of strategic uncertainty from the DG to the PGG, reflecting the challenges of decision-making and reaching the threshold under uncertainty (Van Huyck et al., 1990; Kocher et al., 2008; Andreoni, 1998; Anderies 2015)**.** Despite the potential benefits of contributing to the PGG, participants exhibited risk-averse behavior under high uncertainty, deviating from rational decision-making (Kahneman & Tversky, 1979; Tversky & Kahneman, 1991). Conversely, in the TPGG-first group, revealed outcomes in the PGG reduced uncertainty, fostering consistent altruistic behavior in the DG, supporting Hypothesis 2. These outcomes align with the literature on learning effects and the role of informational signals in enhancing cooperative tendencies (Bénabou & Tirole, 2006).

The application of the NAS framework highlights how strategic uncertainty in one action situation (DG) spills over to influence behavior in subsequent action situations (PGG)**.** This spillover effect was more pronounced in the TDG-first group, where the absence of revealed outcomes in the DG heightened uncertainty about others' contributions, leading to risk-averse behavior and lower PGG contributions. Survey data supports this, as in the TPGG-first group, around 40.44% believed others would invest in the PGG, compared to 34.64% in the TDG-first group, indicating higher perceived strategic uncertainty in the latter group. Besides, only 19.85% of the respondents in the TPGG first group and 20.00% in the TDG first group stated that they expect others will donate to the DG. In the DG, the perceived uncertainty is not increased, as the outcomes of the PGG were already revealed in the TPGG-first group.

However, the DG inherently exhibited higher uncertainty compared to the PGG, as the lack of personal benefit in the DG amplified uncertainty, while the collective benefits of the PGG fostered higher expectations of cooperation. These differences reflect how the framing and nature of the games shaped participants' perceptions of uncertainty (Mesa-Vázquez et al., 2021).

Hypothesis 3.2 emphasizes the conditional nature of cooperation. Contributions in the DG were influenced by initial endowments, with higher endowments fostering greater trust and lower strategic uncertainty. This conditional relationship highlights how trust-building mechanisms and perceived fairness influence intergenerational altruism.

Figure 1.5 demonstrates that exposure to AS1 (PGG) has no direct impact on AS2 (DG contributions) when results are revealed. However, a conditional relationship emerges, where higher endowment levels correlate with perceived high social trust and lower strategic uncertainty.

This underscores the importance of present-generation cooperation as a foundation for achieving long-term intergenerational sustainability. Moreover, the NAS framework effectively illustrates how strategic uncertainty shapes decision-making processes and cooperative outcomes.

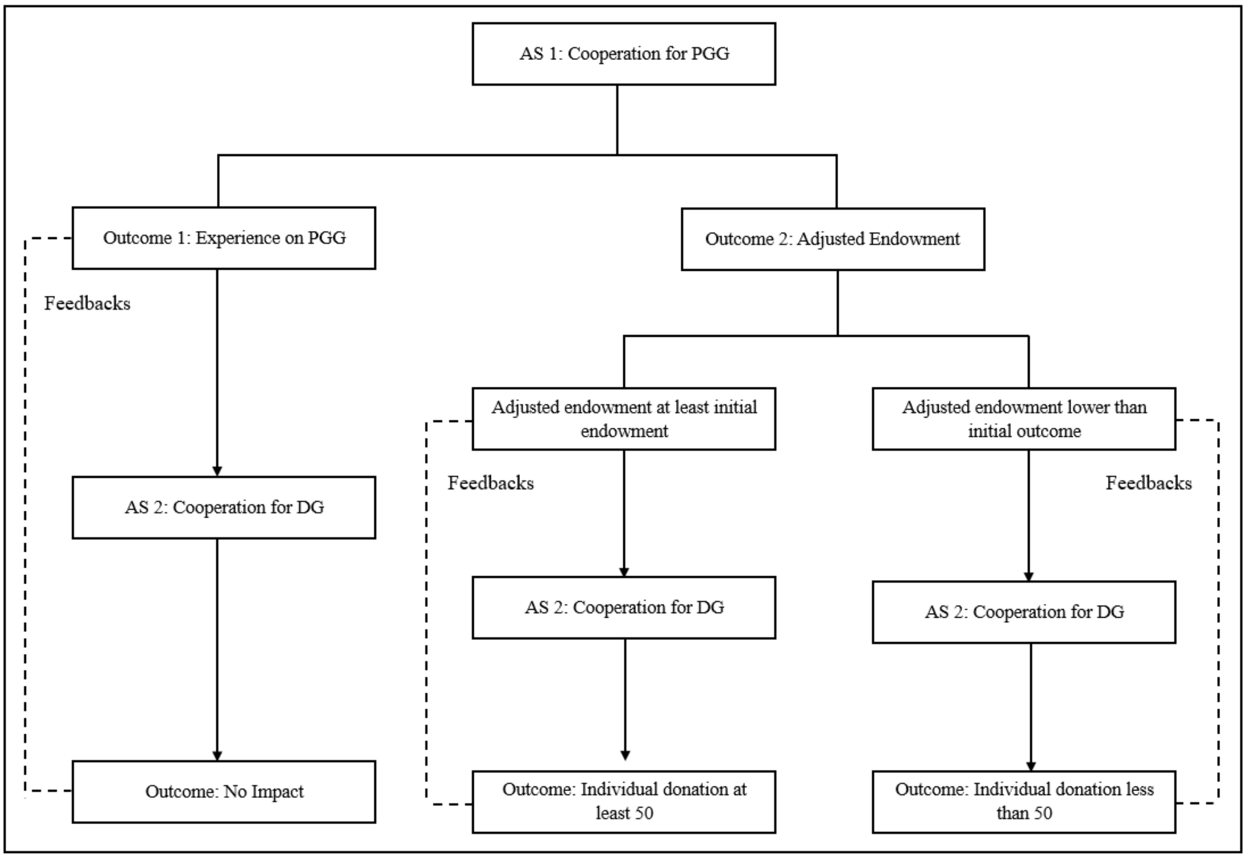

Figure 1.5: Network of Action situation (NAS) Framework in TPGG first group (Ostrom, 2010)

This study provides valuable insights into cooperative behavior under conditions of strategic uncertainty and learning effects; however, several limitations must be acknowledged. First, the controlled experimental setting may not fully capture the complexities of real-world decision-making, where additional social, cultural, and environmental factors often interact. Second, the sample is drawn from a specific climate-vulnerable region in Bangladesh, limiting the generalizability of the findings to other contexts, particularly those with different cultural or socio-economic dynamics. Addressing these limitations in future research will enhance the applicability and robustness of the findings.

The differences in framing and the nature of the games may influence participants' perceptions and decisions, limiting alignment with real-life scenarios. While designed to reflect practical challenges, the specific examples and thresholds used may not fully capture the diverse contexts encountered in climate adaptation efforts.

A potential limitation of this study is the issue of endogeneity, particularly regarding the interdependent relationships between the PGG and DG. While dummy variables and robustness checks were used to explore the relationships, unobservable factors, such as intrinsic altruism, risk preferences, or cultural norms, may confound the results.

Future studies should investigate how varying levels of uncertainty and trust-building interventions influence cooperation in diverse cultural and socio-economic contexts. Additionally, exploring the role of institutional mechanisms and feedback systems in reducing strategic uncertainty could provide valuable insights. Testing these findings in broader policy contexts will enhance external validity.

The findings emphasize the importance of reducing strategic uncertainty and building trust to enhance cooperation in climate adaptation efforts. Transparent feedback mechanisms, such as revealing collective outcomes, can foster alignment in decision-making, while participatory processes and equitable resource distribution can support sustained cooperation across generations. Finally, while the games were framed to reflect adaptation challenges, their simplicity may oversimplify the nuanced and multifaceted nature of policy contexts.

1.8. Conclusion

This study applies the Network of Action Situations (NAS) framework to investigate the interplay between strategic uncertainty, learning effects, and cooperation in sequential action situations. The findings demonstrate that strategic uncertainty in one action situation, such as the Dictator Game (DG), can spill over to influence decision-making in subsequent action situations, such as the Public Good Game (PGG). The most significant insight is how feedback mechanisms reduce strategic uncertainty and foster trust, which in turn sustains cooperative behavior. In the TPGG-first group, revealed outcomes in the PGG provided informational signals, enabling participants to align their decisions and sustain cooperative behavior in the DG. Conversely, in the TDG-first group, the absence of feedback led to amplified uncertainty, risk aversion behavior, and lower contributions.

While experimental settings simplify real-world scenarios, these findings provide valuable insights into community-based adaptation efforts. Cooperation is more likely when immediate and financial benefits are visible, as in the PGG. In contrast, strategic uncertainty is heightened in contexts like the DG, which requires altruistic behavior without direct personal gain. These dynamics underscore the need to address trust and uncertainty in designing effective climate adaptation strategies.

These findings provide actionable insights for structuring climate adaptation programs. Locally led climate adaptation programs should adopt a structured approach, starting with community-based initiatives that provide visible benefits to the present generation, such as shared water resource systems or immediate disaster preparedness projects. These programs build trust and establish cooperative norms. Once momentum is established, programs can transition to longer-term projects, like mangrove restoration or infrastructure development for future flood mitigation and addressing water scarcity, ensuring sustainable intergenerational cooperation.

By focusing on strategic uncertainty, feedback mechanisms, and trust building, this study contributes to the broader understanding of cooperative behavior in resource allocation challenges. Future research should explore these dynamics across diverse socio-cultural contexts to enhance external validity and provide actionable insights for designing resilient and adaptive climate strategies.

The study observes strong evidence of pure altruism for future generations, as individuals contributed towards meeting the adaptation needs of future generations. Findings suggest a positive yet limited association between cooperation in the PGG and DG, indicating that those who are altruistic are also cooperative.

The findings suggest high social trust and low strategic uncertainty increase cooperation. Therefore, reduced strategic uncertainty and enhanced trust in the PGG appear to create conditions that support cooperative tendencies in the DG. This highlights how fostering present-generation cooperation may help to establish the social and institutional groundwork necessary for intergenerational altruism. High trust, a reflection of higher social capital and well-being, leads to successful adaptation for both current and future generations.

Therefore, our study emphasizes the need for further research to delve deeper into these complexities. Examining how strategic uncertainty, learning effects, and social dynamics influence decision-making can provide detailed insights into cooperation and sustainability.

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Chapter 2: Gender Dynamics in Climate Change Adaptation: Experimental Study in Coastal Bangladesh

by

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Abstract: This study investigates gender-specific cooperation and perceptions in climate change adaptation within the context of experimental games conducted in coastal Bangladesh. It explores how men and women make decisions in intragenerational and intergenerational scenarios using a threshold public good game (TPGG) and a threshold dictator game for future generations (TDGF).

The findings reveal that both genders contribute more in mixed-sex TPGG groups, reflecting societal beliefs about gender roles in cooperation. However, in the TDGF, men demonstrate higher contributions and optimism in single-sex groups but are more pessimistic about mixed-sex groups. These behaviors are shaped by cultural norms, conditional expectations of others' contributions, and gendered perceptions.

This research highlights the importance of addressing gender norms and societal expectations in designing inclusive climate adaptation strategies. It also contributes to feminist ecological economics by emphasizing the need for structural changes to promote equity and cooperation in climate-vulnerable regions.

Keywords: Experimental games, Gender dynamics, Climate change adaptation, Cooperative behavior, Gender norms and perception

JEL Code: J16, C93, Q54

2.1. Introduction

Climate change's impact is notably uneven, affecting genders disparately, with the poorest women in developing countries often experiencing the most severe consequences. Bangladesh is a developing country that is highly vulnerable to climate change, particularly due to increased exposure to flooding, erosion, and typhoons, combined with mounting population density and poverty (Khan, 2013). Climate change and rising sea levels threaten the country's freshwater resources, leading to saltwater intrusion into rivers and aquifers (UNDP, 2013; Mimura, 2013; Mahmuduzzaman et al., 2014). Rural women are disproportionately affected by climate change due to limited resources and adaptive capacities, unpaid carework responsibilities such as water collection, and their physical vulnerability to climate-induced natural disasters (Neumayer & Plümper, 2007; UNDP, 2013; Denton, 2002; UN Women, 2018).

Adaptation strategies are vital to mitigating these impacts, especially for rural communities that depend on natural resources. Therefore, poor communities in high-risk areas adopt private adaptive measures due to limited external support (Hasson et al., 2010; Mondal, 2014). Women are crucial in this effort, leveraging their collective knowledge and resources to establish resilient systems, particularly in natural resource-dependent economies (Gicheru et al., 2024; Dankelman, 2002; Djoudi et al., 2016). Women’s inclusion in decision-making has enhanced equitable benefit-sharing and forest conservation outcomes (Vollan & Henry, 2019). Therefore, the feminist approach emphasizes women's critical decision-making role as collectors, protectors, and managers of natural resources, particularly water (Azcona et al., 2023). In climate-vulnerable regions of Bangladesh, adaptation strategies such as Community-Based Adaptation (CBA) and Locally Led Adaptation (LLA) emphasize female local leadership in decision-making (Masud-All-Kamal et al., 2021; Mirza et al., 2023; Masud-All-Kamal & Nursey-Bray, 2024).

Despite their essential contributions, variations in expectations, beliefs, and social norms often limit women’s access to resources and decision-making opportunities, leading to allocative inefficiencies in adaptation efforts (Deschênes et al., 2020; Agarwal, 1997; Greig and Bohnet, 2009). In Bangladesh’s patriarchal society, pervasive gender disparities in income, assets, and education shaped by traditional social values and unequal power dynamics, limit women’s contributions to household and community decisions (Asaduzzaman, 2016; Agarwal, 1997; Kabeer 2024; Pearse, 2016). Addressing these barriers requires a deeper understanding of how social norms, cultural practices, and gender perceptions shape cooperative behavior in adaptation contexts. Therefore, this research aims to explore how social norms and cultural expectations shape gender-specific cooperation patterns in climate adaptation initiatives.

However, while significant research has explored the roles of social norms, culture, and gender disparities in decision-making, there remains a gap in understanding the specific gendered dynamics of cooperative behavior in climate change adaptation. This study addresses this gap by investigating differences in contribution behavior across genders concerning climate change adaptation, focusing on how individuals prioritize their current needs versus the needs of future generations. A threshold public good game (TPGG) was employed to analyze how people cooperate to meet the present generation's adaptation needs. Additionally, a threshold dictator game for future generations (TDGF) was used to explore whether women are more cooperative in supporting the needs of future generations. Through these two experimental threshold games, the research examines cooperation in climate change adaptation across diverse gender group compositions. The research question addresses how gender dynamics and expectations influence cooperative behavior in TPGG and TDGF, particularly in single-sex versus mixed-sex group settings, within the context of climate change adaptation.

2.2. Conceptual and Theoretical Framework

This study draws on two major theoretical perspectives—social identity theory and conditional social preferences—to explore the dynamics of gendered cooperation in climate change adaptation. Social identity theory explains how individuals' behavior is influenced by their identification with social groups, such as gender, which influences their preferences and expectations about cooperation within in-group and out-group settings (Tajfel & Turner, 1979). Conditional social preferences focus on how individuals' expectations of others' contributions influence their willingness to cooperate, influencing cooperative behavior. These theories suggest that group composition, gendered roles, and expectations jointly influence cooperative behavior in climate adaptation scenarios, forming the basis for the subsequent hypotheses.

While the primary focus is on social identity theory and conditional social preferences to explain behavioral patterns, the principles of feminist ecological economics (FEE) complement the insights derived from them. FEE emphasizes the intersection of gender, economy, justice, and environmental equity, highlighting how structural barriers and normative expectations shape cooperative behavior (Faber, 2008). Cooperative action is central to feminist ecological economics, as it reduces women's vulnerability by addressing their needs and promoting social equity (Perkins, 2007; Langley & Mellor, 2002). In Bangladesh, women’s caregiving responsibilities, such as managing water resources and household welfare during crises, influence their cooperative behavior (Cannon, 2002). By focusing on intergenerational equity and the long-term consequences of environmental decisions, FEE offers a valuable framework for interpreting the gendered contributions observed in this study (Perkins, 2007; Resurrección, 2013).

Feminist ecological economics thus provides a lens to understand how structural and normative barriers shape women’s ability to participate in cooperative behaviors in climate-vulnerable contexts. In patriarchal societies like Bangladesh, structural challenges, including unequal caregiving responsibilities and restricted decision-making autonomy often hinder women’s involvement in climate adaptation strategies (Mondal, 2014; McGinn & Oh, 2017; Aguilar, 2008). Feminist economists argue that addressing these inequities is critical to fostering women’s participation in planning, production, household security, and reforming social structures (Łapniewska, 2016).

Additionally, feminist ecological economics supports the idea that women with greater decision-making agency tend to contribute more to family welfare. This aligns with findings that empowered women improve outcomes in areas such as health, education, and family welfare (Dasgupta & Mani, 2015; Holland & Rammohan, 2019; Datt & Jolliffe, 2005; Imai et al., 2014; Kabeer, 1999; Quisumbing & Maluccio, 1999; Udry et al., 1995; Udry, 1996; Duflo & Udry, 2003; Lundberg and Pollak, 2003; Lundberg et al., 1997; Kabeer, 2024). Therefore, feminist ecological economics is applied to understand how structural barriers can influence norms and perceptions and limit women’s decision-making agency and participation in cooperative behaviors.

Moreover, institutions and policies that recognize social norms, reciprocity, and cultural practices are more likely to succeed (Ostrom, 1999). Therefore, CBA and LLA approaches consider various social traits, including social norms, preferences, culture, indigenous knowledge, social capital, and the capabilities of local communities (Masud-All-Kamal & Nursey-Bray, 2024). Furthermore, in Bangladesh, microfinance institutions often target women as clients due to their higher repayment rates (Anderson & Baland, 2002; Pitt et al., 2006). However, adaptation projects aimed at societal transformation through building social capital have often failed due to insufficient analysis of local norms, realities, and power relations (Masud-All-Kamal et al., 2021; Masud-All-Kamal & Nursey-Bray, 2024).

Gender roles and social expectations profoundly influence cooperative behavior, with women often seen as more communal and altruistic, reflecting societal expectations of relational, empathic, and care-oriented tendencies. In contrast, men are typically perceived as more competitive (Gilligan, 1982; Chodorow, 1978; Dasgupta & Mani, 2015; Vyrastekova et al., 2015). For instance, in South Delhi, women displayed greater altruism in decision-making, aligning with societal norms of nurturing choices (Dasgupta & Mani, 2015; Brickell & Chant, 2010). Simultaneously, group heterogeneity often interacts with these norms, influencing the extent of cooperation (Vollan & Hayo, 2012). Gendered expectations, shaped by societal norms and group composition, influence cooperation in single-sex and mixed-sex groups, where women are often expected to contribute more (Greig & Bohnet, 2009).

Various experiments have been conducted to understand the dynamics of gender-based cooperation, leading to conflicting results. Some studies indicate that women show higher levels of cooperation in public good games (Nowell & Tinkler, 1994; Sell, 1997), while others suggest that men may contribute more, particularly in contexts that involve heroic or chivalrous acts (Brown-Kruse & Hummels, 1993; Eagly & Crowley, 1986). However, gender differences in cooperative behavior may result from divergent value systems (Cadsby & Maynes, 1998) or expectations, as seen in Kenyan Harambee activities, where women are often pivotal contributors (Kilavuka, 2003; Greig & Bohnet, 2009). This research utilizes feminist ecological economics to examine how societal norms and cultural expectations shape divergent behaviors in cooperative settings.

This study investigates whether gender differences influence cooperation in the threshold public good game (TPGG) and threshold dictator game for future generation (TDGF), and seeks to elucidate the underlying rationale. While social identity theory and conditional social preferences provide a theoretical basis for exploring how group composition and expectations drive cooperative behaviors, feminist ecological economics informs how norms and perceptions related to different gender roles and structural barriers shape these behaviors.

Social identity theory predicts that individuals will favor in-group dynamics, such as same-sex groups, due to shared values and trust, which aligns with Hypothesis 1**.** Nonetheless, individuals may favor their in-group (e.g., same-sex group) and have different expectations of cooperation based on social group membership. Therefore, this study explores whether people in the study area are more cooperative with their own sex unconditionally or whether their cooperation is based on the conditional expectation that others will invest. Conversely, out-group bias may influence expectations about others' behavior in mixed-sex groups, shaped by societal norms and stereotypes (Bowles & Gintis, 2011).

By applying social identity theory, this study examines whether single-sex or mixed-sex group compositions influence cooperative behavior, as well as how expectations within these groups are conditioned by social and cultural norms.

Hypothesis 1: In the TPGG and TDGF, it is hypothesized that individuals, regardless of gender, will contribute more when participating in single-sex groups compared to mixed-sex groups.

Conditional social preferences explain variations in contributions based on expectations of others' behavior, forming the basis for Hypothesis 2. People may contribute more when optimistic about others' contributions or less when pessimistic, particularly in contexts where norms and cultural expectations about gender roles shape perceptions of cooperation (Fehr & Schmidt, 1999; Bowles & Gintis, 2011). Conditional social preferences provide a mechanism for understanding how societal expectations and optimism or pessimism about group dynamics influence cooperative behaviors.

Hypothesis 2: The difference in contribution between single-sex groups and mixed-sex groups is conditional on individuals' expectations of others' contributions. This conditional expectation may be influenced by two factors:

- Hypothesis 2 (a): Individuals may be more optimistic about the contribution of their single-sex group or mixed-sex group, leading to higher expectations of cooperation within single-sex groups.

- Hypothesis 2(b): Conversely, individuals may be pessimistic about the contribution of their single-sex group or mixed-sex group, resulting in lower expectations of cooperation within groups.

The integration of these frameworks allows for a comprehensive analysis, with feminist ecological economics highlighting structural barriers, social identity theory explaining group-based preferences, and conditional social preferences addressing the role of expectations in shaping cooperative behavior.

2.3. Study Area

The study is undertaken in the climate-vulnerable area of Shyamnagar upazila[1] of Satkhira district[2] of Khulna division[3], which is the largest upazila of Bangladesh. In Satkhira, the saline area is 3736.35 sq. km which covers 95% of the total area (IUCN, 2015). Salinity intrusion and natural disasters are severely hindering the livelihood of the residents. In the study area, people collect water mainly from ponds, rivers, pond sand filters (PSF), deep tube wells (DTW), shallow tube wells (STW), and rainwater harvesting.

In the study area, 68.63% of the women are homemakers, primarily engaged in non-marketed household activities such as cooking, cleaning, caregiving, homestead gardening, fisheries, daily labor, shrimp fry collection, and collecting potable water (Mondal, 2014). Increased salinity and water scarcity, exacerbated by climate change and frequent natural disasters, have significantly increased the time and effort required for water collection. Women spend an average of 1 to 1.5 hours daily securing potable water, as nearby sources have become saline (FGDs and IDIs, 2022). These challenges amplify the burden of unpaid care work on women, who serve as primary caregivers and resource managers, often traveling long distances or wading through floodwaters to secure water (Cannon, 2002; HYSAWA, 2018; Neumayer & Plümper, 2007).

The critique of the 'feminization of vulnerability' in climate change studies emphasizes that women should not be framed solely as passive victims but also as agents of change who actively resist and reshape societal norms (Djoudi et al., 2016; Denton, 2002; Pearse, 2016). In the context of coastal Bangladesh, where women play critical roles in managing natural resources and leading adaptation strategies, this perspective underscores their agency. This highlights the

[1] Upazila is an administrative division in Bangladesh, functioning as a sub-unit of a district.
[2] District is an administrative division in Bangladesh, functioning as a sub-unit of a division.
[3] Divisions are the first-level administrative divisions in Bangladesh.

potential for adaptation to serve as an emancipatory pathway, challenging existing social hierarchies and fostering gender equality.

In the study area, FGDs, and IDIs reveal that structural barriers for women persist, with land and financial resource management predominantly controlled by male family members. This dynamic directly affects resource allocation and limits women's decision-making power.

2.4. Experimental Framework

a) Game design

Two threshold games were conducted: the threshold public good game (TPGG) and the threshold dictator game for future generation (TDGF). In these games, threshold levels were specified in advance. Participants had to decide whether to invest from their given endowment. The games were designed to simulate decision-making in the context of climate change adaptation, with realistic framing to enhance engagement. This study compares how different genders cooperate in a TPGG, which benefits their own generation, versus whether they donate enough in the TDGF, for the benefit of future generations, with no personal gain.

The threshold dictator game was chosen to measure altruism toward future generations, as it is designed to assess 'pure altruism' (Chan et al., 2022). In a typical dictator game, a subject or dictator is given to divide a sum of money (which has not been earned by any of the agents) between himself and a recipient. Furthermore, the recipient has no option to reject the offer but to accept it (Edele et al., 2013).

In this threshold dictator game for future generations (TDGF), participants must decide about a very costly but highly efficient adaptation for future generations, which will take many years to implement affecting only future generations' outcomes. This contribution would not benefit the current participants but would come at a cost to their generation. However, failure to invest would result in future generations facing unsustainability and collapse. Here, participants were given the option either to invest in the game and /or keep money to themselves from their given endowment. However, the group must reach a threshold to ensure the sustenance of future generations. If they fail to achieve it, future generations will not benefit. In this game, freeriding is the equilibria and the Nash equilibrium is donating zero (0).

Furthermore, previous literature has used threshold public good games to simulate real-world climate change scenarios (Cadsby and Maynes, 1998; Böhm et al., 2020). Thus, this research follows a similar threshold public good game focusing on climate change adaptation. Public good games generate equal profit for all group members in a cooperative setting given their cumulative contribution (Chan et al. 2022). In the TPGG, individuals must decide about costly but temporary adaptations for their own generation that will benefit themselves. Similar to TDGF, in the TPGG participants were given some endowment from which they could either keep endowment for themselves and/ or they could invest in the game. There is a predefined threshold, which needs to be reached as a group. If the threshold was either reached or exceeded, each player received an identical monetary reward, regardless of his or her contributions in a TPGG. On the other hand, if they don't reach the threshold, then the contributions are not returned to the players.

b) Experimental Design

At the start of the experiment, participants were assigned unique identification numbers. A computer-based randomization tool was used to allocate participants into groups. This ensured that group composition was determined randomly without influence from the researchers or participants. For mixed-sex groups, the gender balance was maintained by stratifying participants by gender before randomization to ensure an equal representation of males and females.

316 respondents participated in the study from 10 (ten) unions[4] of Shyamnagar Upazila. Cluster sampling based on geography and stratified sampling based on gender were applied.153 participants were female (48.42%) and 163 (51.58%) were male.

Out of 316 participants, 180 individuals (97 female and 83 male) engaged in the TDGF, while 136 individuals (80 male and 56 female) participated in the TPGG. Games were organized based on the gender composition of the groups, which included male-only, female-only, and mixed-sex groups. All participants were divided into three-player groups.

In the TPGG, 40 participants were assigned to male-only groups, 24 to female-only groups, and 72 individuals to mixed-sex groups (Table 2.4). The mixed-sex groups were characterized

[4] Union the smallest rural administrative and local government unit in Bangladesh.

by equal gender representation, maintaining an average ratio of approximately 44.44% female and 55.56% male participants per group, with a minimum of 40% female representation.

In contrast, in the TDGF, 27 participants were allocated to male-only groups, 54 to female-only groups, and 99 participants to mixed-sex groups. To explore the potential influence of gender composition on contribution behavior, mixed-sex groups in the TDGF were subdivided into three categories. Groups where at least two-thirds (⅔) of the members were male, were designated as male-dominated mixed (48 participants), those where at least two-thirds were female were termed female-dominated mixed (15 participants), while the remaining were considered equal mixed groups (36 participants) (Table 2.4).

Table 2.4: Gender Composition and Group Types in TPGG and TDGF

Game	Group Type	Number of Groups	Total Participants	Gender Composition
TPGG	Male-only	2 groups	40	100% Male
	Female-only	1 groups	24	100% Female
	Mixed-sex (balanced)	4 groups	72	~44% Female, ~56% Male
TDGF	Male-only	2 groups	27	100% Male
	Female-only	3 groups	54	100% Female
	Mixed-sex (subdivided):		99	
	-Male-dominated	2 groups	48	≥66% Male
	-Female-dominated	1 group	15	≥66% Female
	-Equal representation	2 groups	36	50% Male, 50% Female

c) Experimental group setup

Group 1: Threshold Public Good Game (TPGG)

The subjects in the group played a TPGG, where they experienced the needs of their own generation and they were given the option to invest for their own generation or keep money to themselves. Within each experimental group, there are n participants. At the beginning of the game, each player received an endowment e_i. They could either keep the money for themselves and/ or they could invest an amount p_i in the TPGG. The contribution profile, $p_i = (p_1 \ldots p_n)$ details the action of each player, who makes choices simultaneously and independently. The joint contribution in TPGG is $Cp_i = \sum p_i$. If a group reaches the threshold, they would benefit from it with a productivity factor of β. Thus, if the contribution is higher than this threshold, i.e. $Tp \leq Cp_i$, then the contribution will be multiplied by β, whereas $\beta > 1$. If the contribution Cp_i is lower than this threshold, i.e., $Cp_i < Tp$, then all players from the game will lose their contribution, and the payoff from Cp_i becomes zero 0.

In TPGG, the payoff function for a player i is

$$z_i = \begin{cases} e_i - p_i + \dfrac{C_p \beta}{n}, & if\ C_p \geq T_p; \\ e_i - p_i, & otherwise. \end{cases}$$

For instance, there are 3 members in the group. Each one of them is given an endowment of 200 taka. If participant A contributes 70 Taka and participants B and C each contribute 40 Taka, the group exceeds the threshold of 150 Taka. Their joint contributions are then multiplied by the productivity factor, and each participant receives an equal share of the benefits.

Group 2: Threshold Dictator Game for Future Generation (TDGF)

The subjects in the group played a TDGF, where they were exposed to the needs of the future generation from the perspective of climate change adaptation. At the beginning of the game, each player received an endowment of e_i. They were given the option either to keep the money for themselves and/or they can invest an amount a_i in the TDGF, whereas $0 \leq a_i \leq e_i$. Contribution profile $a_i = (a_1 \ldots a_n)$ details the action of each player i.

Moreover, in the game a certain limit or threshold (Ta) is needed to invest in ensuring the sustainability of future generations as a group. The joint contribution in TDGF is $Ca_i = \sum a_i$. If the contribution Ca_i is higher than this threshold, i.e. $Ta \leq Ca_i$, then the contribution will ensure the sustainability of the future generation. However, if $Ta > Ca_i$, then future generations will not arrive. The threshold, Ta, is revealed to participants before the game starts. In the TDGF, the payoff function for player i is $u_i = e_i - a_i$.

Participants in the TDGF were explicitly informed that subsequent players in the experiment represented future generations. This framing aimed to enhance engagement by making the intergenerational concept more tangible and relatable. Therefore, the continuation of the game for future generations is contingent upon the sufficient resource allocation by the preceding generation. Consequently, failure to meet the threshold results in an equal number of participants from the next group being unable to participate, receiving only the attendance fee as compensation. Participants in the TDGF were informed that their decisions simulated investments in future generations' well-being, similar to real-world measures such as reforestation or educational advancements.

For instance, there are 3 members in the group. Each one of them is given an endowment of 200 taka. If Participant A contributes 70 Taka and Participants B and C each contribute 40 Taka, the group exceeds the threshold of 150 Taka. Their pooled contributions would ensure the next 3 participants to come and play in the game, failing to do so will terminate the opportunity for 3 players to play.

d) Game Parameter:

Within each experimental group, there are n participants. At the beginning of the game, each player received an endowment of e_i. Let $Et = ne_i$ be the sum of endowments at the beginning of the game. In both these games, the threshold is determined as ¼ or 25% of the initial endowment (e_i) of the game both individually and collectively supporting the framework of Cadsby and Maynes, 1998. The contribution threshold for TPGG equals Tp and the contribution threshold for TDGF equals Ta.

There is an exogenously given threshold level of $0 < Ta < Et$ for TDGF and $0 < Tp < Et$ for TPGG. In this game $n=3$, $e_i = 200$, thus the total endowment, $Et=600$, and the contribution thresholds $Ta=Tp=150$. Additionally, the productivity factor β is introduced in the TPGG, representing the multiplier applied to the collective contribution when the threshold is met or exceeded. Here, $\beta=1.5$ was chosen as it typically represents moderate productivity gains in public good games, reflecting realistic scenarios of collective benefit.

e) Mixed-Methods Approach to Analyzing Social Norms and Cooperative Behavior

This research employed a mixed-methods approach to analyze social norms and cooperative behavior, integrating qualitative and quantitative methods for a comprehensive understanding. Qualitative methods, including post-game surveys, focus group discussions (FGDs), and individual in-depth interviews (IDIs), were conducted to gain insights into societal norms, perceptions, and factors influencing cooperative behavior. A total of 10 FGDs and 20 IDIs were conducted in 2022. Quantitative research includes post-game surveys and experimental games. All 316 participants were introduced to either the TDGF or the TPGG to explore social norms and cultural dynamics.

Subsequently, 289 participants were engaged in post-game surveys. These surveys were conducted after the completion of the games to gather participants' perceptions of the game, gender-based contributions, and the rationale behind their beliefs. Participants were asked non-group-specific questions about their perceptions of contribution patterns. For instance, they were asked, "Whom do you think contributed more: males, females, both equally, or no idea?" This question captured broader perceptions of gender-based contributions rather than focusing on specific experimental group dynamics. Participants were also asked to explain their motivations for investing in the games and their perceptions of others' contributions. Those who contributed any amount greater than zero (0) were asked what motivated their investment, while those who did not invest were asked why they chose not to.

This study's qualitative data collection methods were designed to provide nuanced insights into the social dynamics and individual motivations underpinning cooperative behaviors in experimental games. These qualitative findings complement the quantitative analysis, enriching the understanding of gender differences and conditional social preferences in decision-making processes.

2.5. Results

2.5.1. Summary Statistics

In terms of age, all groups have relatively similar mean ages, with TDGF at 34.97 years, TPGG at 34.06 years with a minimum age of 18 and a maximum of 68 years old. However, there are disparities in gender distribution, with the TPGG having 58.82% female, followed by the TDGF having 46.11% female. Household income with TPGG displays a mean income of 8,339.71 taka, while the TDGF has a mean income of 9,433.89 taka. Water quality perceptions, whether it is considered pure, are relatively consistent across the groups, with TDG first group at 30%, and TPGG at 28.68%. Similarly, educational attainment is around 10 years for both groups.

In TDGF, the male group, comprising 27 participants, had an average contribution of 80.37 taka. The female group, with 54 participants, averaged a contribution of 58.15. In the mixed group of 99 participants, the mean contribution was 52.58 taka. Among the mixed subgroups, participants in the equal mixed group (36 members) had an average contribution of 59.58 taka. The male-dominated mixed group (48 members) averaged 49.17, while the female-dominated mixed group (15 members) averaged 46.67. Across all groups in the TDGF, male participants (83 in total) had an overall mean contribution of 61.87 taka, and female participants (97 in total) averaged 55.46 taka. The overall TDGF average contribution was 58.42 taka (See Table B.A2.1 for the details). In TDGF, only 4 people (2.22%) did not invest anything.

In TPGG, the male group, with 40 participants, had an average contribution of 67.25 taka. The female group of 24 participants averaged a contribution of 51.67 taka. The mixed group of 72 participants had a higher average contribution of 90.00 taka. Across all TPGG groups, male participants (80 in total) had a mean contribution of 82.13 taka, while female participants (56 in total) averaged 68.57 taka. The overall average contribution in the TPGG was 76.54 taka (See Table B.A2.1 for the details). In TPGG, only 3 people (2.21%) did not invest anything.

2.5.2. Contribution Motivations and Behavioral Insights

Post-game surveys highlighted distinct motivations for investing in the TDGF and TPGG.

- **TDGF**: The majority of participants (82.96%) stated that their primary motivation was to benefit future generations, indicating altruistic tendencies. Additionally, 20.26% cited a belief that others would contribute as a motivating factor. Gender dynamics also influenced decisions, with 11.25% citing the presence of more females in their group and 8.68% citing the presence of more males.

- **TPGG**: In contrast, 36.71% of participants reported investing because they believed others would also invest, while 12.59% invested despite believing others would not. Some participants (43.36%) aimed to increase personal earnings, while 29.72% sought to enhance group earnings. Gender dynamics played a role, with 10.84% citing the presence of more males in the group and 8.65% citing the presence of more females.

2.5.3. Main treatment effects

In the TPGG and TDGF, multiple regression analysis was employed to assess the difference in contribution behavior between single-sex and mixed-sex groups. The dependent variable was the contribution amount in the TPGG and contribution in TDGF, while the independent variables included group composition (male group and female group, whereas mixed group is the reference).

In TPGG: regression analysis indicated that compared to the mixed group, the male group invested 22.75 taka less at a significance level of 5%, while the female group invested 38.33 taka less at a significance level of 1%. Further examination of gender differences revealed that females tended to invest 29.58 taka more in mixed-sex groups at a significance level of 5%, whereas males invested 29.75 taka more in mixed-sex groups at a significance level of 1% (see Appendix Table B.A3.2). These findings suggest that both males and females exhibit higher contribution levels in mixed-sex settings. Consequently, Hypothesis 1, which posited that individuals would contribute more in single-sex groups compared to mixed-sex groups is rejected for the TPGG.

In the TDGF, results showed that the male group invested 27.79 taka more at the 1% significance level than the mixed-sex group. Further examination of gender differences revealed that males tended to invest 27.42 taka less in mixed-sex groups at a significance level of 1%, whereas no significant contribution difference was found for females in mixed-sex groups. These findings suggest that only males exhibit higher contribution levels in mixed-sex settings (see Appendix Table B.A3.2). Therefore, Hypothesis 1 can not be rejected for males in the TDGF, as they are more cooperative in single-sex groups than in mixed-sex groups. However, the female group did not demonstrate a significant difference in contribution behavior between mixed-sex and single-sex groups, indicating indifference (refer to Table 2.5.1 Therefore, Hypothesis 1 cannot be rejected for females.

Table 2.5.1: Regression analysis of contribution in TPGG and TDGF

Group Composition	Contribution in TPGG (Reference Mixed group)	Contribution in TDGF (Reference Mixed Group)	Contribution in TDGF (Reference Female Group)
Male group	-22.75**	27.79***	22.22**
	(8.21)	(9.49)	(9.94)
Female group	-38.33***	-5.57	
	(7.69)	(4.43)	
Mixed group			-5.57
			(4.43)
Constant	90.00***	52.58***	58.15***
	(7.10)	(2.34)	(3.76)
Observations	136	180	180
R^2	0.10	0.10	0.010

Notes: Robust standard errors in parentheses.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Result 1: In the TPGG, both genders tend to invest more in mixed-sex groups than single-sex groups supporting the gender perception of people and rejecting hypothesis 1. In the TDGF, males are more cooperative in single-sex groups than in mixed-sex groups, whereas females are indifferent between these two groups. Therefore, hypothesis 1 is rejected for females in the TDGF, while it cannot be rejected for males.

2.5.4. Conditional Cooperation in TPGG

The analysis explores the role of expectations in shaping contributions in the TPGG. The findings highlight that optimistic expectations about others' behavior lead to higher contribution, while pessimistic expectations result in reduced contribution, aligning with the hypothesis that group dynamics influence cooperative behavior.

Conditional Cooperation under Pessimistic Expectations:

In the TPGG, the female group invested 38.33 taka less than the mixed group, a statistically significant difference at the 1% significance level. Conversely, female participants in the mixed group invested 29.58 taka more compared to their counterparts in the single-sex group, also significant at the 1% level (see Table B.A3.2).

This perception led to a statistically significant decrease of 26.66 taka in contributions among those who believed "others will not invest" (refer to Appendix Table B.A4.1). These findings suggest that females demonstrate pessimism regarding the contribution levels of the single-sex group, supporting Hypothesis 2(b).

Conditional Cooperation under Optimistic Expectations:

Conversely, within mixed-sex groups, a positive correlation is observed between the expectation of others' contributions and actual contributions. Participants expressing optimism about others' contributions tend to invest 38.21 taka more than their counterparts, significant at a 5% level (Appendix Table B.A4.1). Further, disaggregation by gender reveals that male participants in the mixed-sex group who anticipated that others would contribute more were found to invest 52.73 taka more than other groups at a 5 % significance level (Appendix Table B.A4.1). Thus, males are more optimistic in mixed-sex groups than in single-sex groups, aligning with Hypothesis 2(a).

Result 2: Distinct gender-based expectations shape contribution dynamics in the TPGG. In the TPGG, females are pessimistic about the single-sex group, whereas, males are more optimistic about the mixed-sex group than the single-sex group.

2.5.5 Conditional Cooperation in TDGF

In the TDGF, which prioritizes future generations' well-being, the results reveal distinct gender-based dynamics driven by altruism and conditional cooperation. Male participants demonstrated greater cooperation in single-sex groups than in mixed-sex groups, while female participants showed no significant difference in contributions between single-sex and mixed-sex groups. This analysis focuses on males to test Hypothesis 2, which posits that disparities in contributions are contingent upon expectations of others' behavior.

Expectations of Contributions by Gender

To explore the role of expectations in driving contributions, we first examined participants' beliefs about others' contributions. Less than 1% of males believed that females would invest more in the TDGF, whereas 31.65% of males believed that other males would invest more (Figure 2.1). In contrast, a nearly equal proportion of females expected higher contributions from either males (13.61%) or females (15.51%), resulting in their contributions showing no significant preference between mixed-sex and single-sex groups.

Optimistic View on own sex:

Regression analysis reveals that males contributed 27.42 taka more in single-sex groups than in mixed-sex groups with a significance level of 1% (see Appendix Table B.A3.2). Furthermore, males in the male-only groups contributed 22.22 taka more than the female-only group (significant at 5%, Table 2.5.1). This behavior reflects optimism regarding the cooperative tendencies of males in single-sex groups, supporting Hypothesis 2(a).

Pessimistic view on other sex:

However, although the male group contributes more on average than the female group, regression analysis of contributions in the TDGF, with gender as a factor, does not reveal any statistically significant difference in contribution levels between males and females overall (see Appendix Table B.A3.1). To investigate whether males hold a pessimistic view towards mixed-sex groups, we conducted additional analysis by categorizing mixed-sex groups into male-dominated, female-dominated, and equal-mixed groups.

Table 2.5.2 presents the results of a regression analysis examining contributions in the TDGF for participants in a mixed-sex group, with the equal mixed group as the reference category for group composition. Results reveal that males contribute less in female-dominated mixed groups, investing 20.28 taka less than in equal mixed groups, significant at the 5% level. However, male contributions in male-dominated groups do not significantly differ from equal mixed groups. This finding supports Hypothesis 2(b), which posits that individuals may exhibit pessimism about the contributions of opposite-sex group members, leading to reduced cooperation in such settings.

Result 3: Results indicate that in the TDGF, unlike females, males display greater optimism regarding contribution in single-sex groups compared to mixed-sex groups. Additionally, males exhibit pessimism regarding contributing to groups where the opposite sex is prevalent. These differences in contribution are largely driven by men's expectations, highlighting the role of gender beliefs in influencing cooperative behavior. Therefore, it can be stated that females cooperate unconditionally without gender belief in the TDGF.

Table 2.5.2: Regression analysis on contribution in the mixed-sex group in TDGF

Group Composition	Contribution (Reference Equal Mixed)	Contribution Male (Reference Equal Mixed)
Male dominated	-10.42*	-0.28
	(5.30)	(6.75)
Female dominated	-12.92**	-20.28**
	(5.54)	(8.31)
Constant	59.58***	55.28***
	(4.04)	(5.43)
Observations	99	56
R^2	0.05	0.08

Notes: Robust Standard errors in parentheses.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

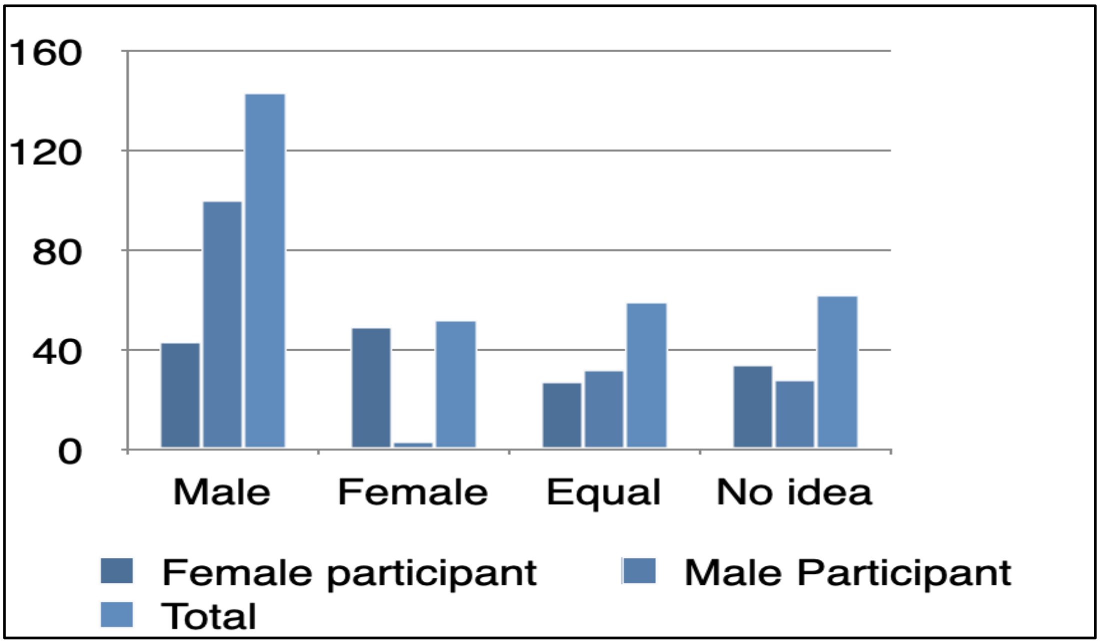

Figure 2.1: Gender perception on who contributed more to TDGF

2.6. Discussion

This section delves into the nuanced dynamics underlying gender differences in contribution behavior observed in both the TPGG and TDGF. By analyzing the patterns of cooperation exhibited by participants, this study highlights the critical influence of societal norms, gendered perceptions, and structural barriers in shaping decision-making within these experimental games.

To delve more into these issues of the behavior of males and females in the decision-making within these games, we further explore beliefs, norms, and culture. From the regression analysis of Appendix Table B.A3.1, it is found that although the gender difference in contribution in both TPGG and TDGF is insignificant, the contribution of both genders varies based on group composition.

Heterogeneous Effects of Gender Perception

The analysis reveals that gender perceptions significantly influence contribution behavior, particularly across different group compositions. Norms and beliefs about gender-based contributions influence how individuals navigate cooperative settings. Survey data and focus group discussions (FGDs) provided mixed insights into these perceptions.

In TPGG, mixed-sex groups tended to contribute more, with a significant proportion believing in equal contributions from both genders (Figure 2.2). They were asked who invested more—male, or female, both of them invested equally, or they didn't have any idea. Conversely, results from the TDGF indicate gender-specific differences in perceptions and behavior (Figure 2.1), with males exhibiting a pessimistic outlook on the other gender's contribution and demonstrating greater cooperation within single-sex groups. On the other hand, in TDGF, women’s contribution is not found to be significant in mixed-sex groups and single-sex groups, reflecting unconditional contribution.

Therefore, it can be stated that in TDGF, where the main motivation for contribution for the majority of the respondents is for the future generation to survive, women showed unconditional contribution. The unconditional contributions observed among women in the TDGF align with feminist ecological economics' emphasis on caregiving roles and prioritization of intergenerational well-being. This perspective highlights how societal expectations of women as nurturers shape their cooperative behaviors, especially in contexts prioritizing the well-being of future generations.

Furthermore, research on group heterogeneity emphasizes the critical role of structured interactions and clear norms in fostering cooperation within diverse groups (Hayo & Vollan, 2012). This underscores how group composition, shaped by norms and perceptions, profoundly influences cooperative behavior in the study area.

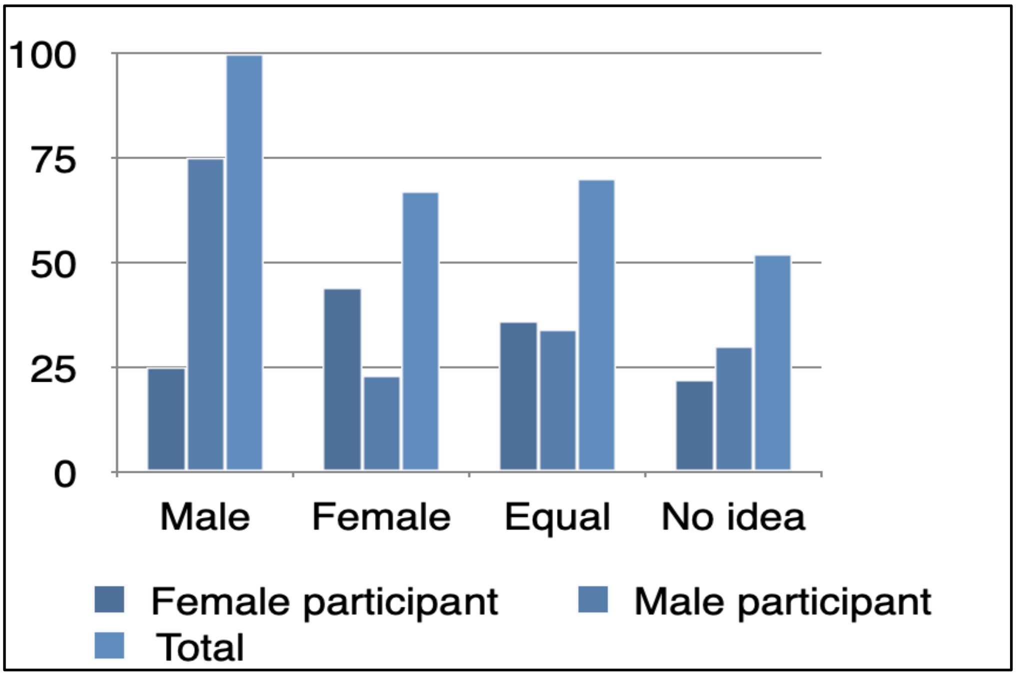

Figure 2.2: Gender perception on who contributed more to TPGG

Gendered Norms and Economic Behavior

Qualitative research reveals societal perceptions and norms surrounding gendered economic behaviors, highlighting the expectation that primary male earners should make larger contributions to experimental games like the TDGF. Conversely, females may refrain from donating, despite receiving the same endowment, reflecting societal norms prioritizing collective or family benefit over individual gain (Dasgupta & Mani, 2015; Dwyer & Bruce, 1988).

Participants in surveys and focus group discussions (FGDs) often stated that as males tend to earn more, they contribute more to the TDGF. By contrast, females are perceived as having limited income or financial independence, and are less likely to contribute, even when provided with the same resources. This perception aligns with findings from Dasgupta and Mani (2015), which show that when entitlement to resources is weak, it is socially appropriate for men to use funds for personal gain, while women are expected to prioritize joint or family benefits. Similarly, the gender ideology identified by Dwyer and Bruce (1988) across multiple countries underscores that men are often perceived as having a right to personal spending, while women's income is reserved for collective purposes. These gendered norms provide men with greater freedom to utilize financial resources, regardless of the strength of their entitlement to those resources.

Feminist ecological economics provides a valuable lens to interpret these gendered norms and behaviors. FEE emphasizes that societal norms and cultural expectations assign specific roles and responsibilities to men and women, influencing their actions in cooperative contexts (Perkins, 2007). The optimism exhibited by males in single-sex groups and the unconditional contributions of females in the TDGF can be understood through FEE's focus on gendered expectations. These norms often position men as dominant decision-makers, and controllers of resources, whereas women as caregivers prioritize collective well-being and intergenerational equity. By acknowledging these normative influences, FEE underscores the importance of challenging traditional gender roles to enhance cooperation.

Additionally, studies on female leadership in community-based water management in rural Namibia show that despite greater representation and education, traditional gender roles often limit women’s agency and leadership impact (Steimanis et al., 2020). This provides a context for understanding how gender norms may influence cooperation in climate adaptation strategies, even when women are involved in decision-making processes. While women may be present in leadership positions, their effectiveness in encouraging cooperation could be limited by cultural and social expectations.

Structural Inequities and Their Influence on Female Contributions

Further analysis into the perception that females invest less reinforces these findings. Participants who stated they invest more because they earn money exhibited a significant bias. In the TDGF and TPGG, those who attributed contribution behavior to earning money were significantly more likely (47% and 38% respectively at the 1% significance level) to claim that men invest more (Table B.A4.2 and Table B.A4.3). This bias highlights how structural inequality and societal norms shape perceptions of economic behavior, often equating earning capacity with the right to contribute.

When women have control over resources such as land and financial capital, they can make decisions that are more autonomous and engage more effectively in collective decision-making, such as adaptation strategies (Djoudi et al., 2016; Agarwal, 1997; Denton, 2002).

Women's limited control over these resources is reflected in their pessimism about single-sex groups. Therefore, promoting equitable access to these resources and decision-making opportunities for women is crucial for enhancing their roles in climate adaptation and cooperative dynamics.

These findings resonate with the principles of feminist ecological economics, which emphasizes in patriarchal societies like Bangladesh, structural inequities—including limited financial independence, restricted decision-making authority, and unequal access to resources— profoundly limit women's ability to participate in cooperative initiatives. FEE emphasizes that these structural challenges not only limit women's ability to contribute financially but also perpetuate norms that undervalue their contributions in cooperative settings. This aligns with the observed pessimism by women in single-sex TPGG groups. Addressing these systemic issues, as advocated by FEE, is crucial for fostering equitable participation in climate adaptation strategies

2.7. Conclusion

The research reveals key gender-specific dynamics in cooperative behavior across the TPGG and TDGF, shaped by societal expectations, perceptions, and decision-making agencies. The findings emphasize the importance of conditional cooperation, as contributions were influenced by their expectations about others' behavior, revealing gender-specific patterns of optimism and pessimism in both experimental settings.

The results show that mixed-sex groups exhibit higher contributions in the TPGG for both genders, suggesting increased cooperative behavior in gender-diverse settings. In the TDGF, males present higher contributions and optimism within single-sex groups but exhibit greater pessimism about the other gender's contributions in mixed-sex settings. Conversely, females exhibit behavior consistent with unconditional contribution, showing no significant variation across group types. These findings underscore the influence of social norms and cultural expectations on cooperative behavior and highlight the importance of understanding local contexts when designing interventions.

Methodologically, this study provides a mixed-methods approach to illuminate the interplay between quantitative contributions and qualitative perceptions, offering a deeper understanding of how beliefs and norms shape cooperative behaviors. The findings emphasize that social norms, while deeply entrenched, are flexible and can be renegotiated through inclusive and structured group interactions, empowering women to challenge traditional norms (Agarwal, 1997; Ostrom, 1999).

The study advocates for greater inclusion of women in cooperative decision-making processes, reflecting their significant role in enhancing climate adaptation initiatives (GenderCC, 2008). While mixed-sex groups emerge as optimal for current-generation adaptation strategies in the TPGG, gender-specific differences in the TDGF suggest that male-only or equal-mixed groups may be more effective for future-generation-focused initiatives.

Adaptation processes can empower women by enhancing their roles in decision-making and resource management (Djoudi et al., 2016). Actively participating in adaptation strategies allows women to challenge traditional power dynamics and gain new roles within their households and communities. This empowerment can lead to improved negotiation power and influence over resources.

This research contributes to feminist ecological economics by highlighting how structural barriers, such as gendered expectations and cultural norms, influence women's participation in cooperative actions. Feminist ecological economics emphasizes intergenerational equity, social justice, and the need to challenge entrenched power dynamics that marginalize women in decision-making processes. Gender-equitable adaptation strategies empower women, foster trust, and enhance cooperative behavior through inclusive policies and practices (de Brauw et al., 2012; Denton, 2002).

Adaptation policies should be inclusive and consider the specific needs and capacities of women (Djoudi et al. 2016). Therefore, future research should focus on two critical areas: first, evaluating how economic empowerment initiatives for women can improve cooperative dynamics; and second, exploring how targeted interventions can challenge entrenched gender norms to promote equitable decision-making. By addressing these research gaps, scholars can advance policy design and intervention strategies that align with local social dynamics, paving the way for more targeted and effective climate change adaptation frameworks.

Overall, this study contributes valuable insights into how gender norms shape cooperative behavior in experimental games and provides actionable recommendations for designing inclusive adaptation strategies. Further studies should deepen understanding of the mechanisms driving these gender dynamics and explore cross-cultural contexts to generalize findings.

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Chapter 3: Feminist Ecological Economics Lens: Understanding Unpaid Care Work and Decision-Making Agency of Women in Rural Bangladesh

by

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Abstract: This study explores how unpaid care work and socio-economic and environmental factors such as family land ownership, age, education, and water quality influence women's decision-making in climate-vulnerable rural Bangladesh.

The study reveals a significant positive correlation between unpaid care work and women's decision-making agency. Women’s caregiving responsibilities position them as central figures in managing household resources, eventually increasing their bargaining power and overall decision-making agency. However, patriarchal norms, and social practices, along with climate change and water scarcity perpetuate gender inequalities, limiting women's agency.

By applying the Institutional Analysis and Development (IAD) framework and its feedback mechanism, the paper unveils the interconnection among the women’s decision-making agency, action situations of unpaid care work, and other external variables. This framework enriches our understanding of the underlying mechanisms driving women's decision-making agency in climate-vulnerable areas.

Keywords: Unpaid care work, IAD framework, decision-making agency, feminist ecological economics, climate change

JEL Classification: J16, J24, O13

3.1. Introduction

In Bangladesh, patriarchal norms are deeply embedded in society, resulting in unequal gender dynamics that place women in subordinate roles within families and communities (Asaduzzaman, 2016). These norms restrict women's decision-making roles in households and often limit their access to resources while increasing their burden of domestic and caregiving duties (Denton, 2002; Pearse, 2016; Cannon, 2002; World Bank, 2011). In particular, economic activities are shaped by gendered power structures, as societal expectations and norms influence how resources and responsibilities are distributed between genders (Nelson, 2006). However, the entrenched social norms, power structures, and gender roles along with the lack of resources such as adaptive capacities restrict women's roles and opportunities, making them more vulnerable to climate change (Ahmed & Eklund, 2021; Resurrección, 2013). The intersectionality of climate change and gender inequality further exacerbates the vulnerabilities faced by rural women in Bangladesh (Azcona et al., 2023; Ahmed & Eklund, 2021).

Intersectionality recognizes that individuals are not defined by a single identity but possess multiple identities (such as gender, race, class, and religion). These identities interact with one another, which further exacerbates systemic and structural discrimination (Crenshaw, 1989). Djoudi et al. (2016) emphasize that these interactions are not static but dynamic, shaped by socio-economic and environmental contexts. They argue that intersectionality provides a nuanced lens to understand how power dynamics and systemic inequalities influence agency and vulnerability across different levels of society. For instance, women in coastal Bangladesh may face heightened vulnerability due to their gender, along with factors such as poverty, lack of education, responsibility to provide care work, and cultural norms (Ahmed & Eklund, 2021).

Care work within households is heavily gendered, where women do the majority of the work for the family welfare encompassing productive, reproductive, and community roles without monetary compensation (Mondal, 2014; United Nations et al., 2008). This work, though essential for household well-being, remains unpaid and often goes unrecognized. Therefore, in this paper, the terms 'care work' and 'unpaid care work' are used interchangeably to refer to caregiving tasks performed without monetary compensation. Addressing this unequal division of labor is important as it not only contributes to gender inequality within households but also has significant impacts on women's well-being and opportunities (Denton, 2002; Pearse, 2016; Cannon, 2002; World Bank, 2011; McGinn and Oh, 2017).

Agency is fundamental to human well-being, as it enables individuals to exercise control over their lives (World Bank, 2011). Agency refers to an individual's ability to achieve desired outcomes in economic, social, and political domains (World Bank, 2011; Kabeer, 1999; Sen, 1999), and operates across individual, household, and community levels (Donald et al., 2020). A woman's agency, her capacity to make and act upon her decisions, is often constrained from childhood, limiting her life opportunities (Asaduzzaman, 2016; Kabeer, 1999). Furthermore, women's empowerment and their decision-making agency are found to be significantly related in social, economic, and political domains (Tabassum et al., 2019).

As the household is the core unit of economic activities, it is crucial to understand women's decision-making agency within it. Research indicates a strong link between women's decision-making agency and household welfare, where women with greater decision-making power tend to contribute more significantly to family well-being (Dasgupta & Mani, 2015; Datt & Jolliffe, 2005; Imai et al., 2014; Kabeer, 1999; Quisumbing & Maluccio, 1999; Udry et al., 1995; Duflo & Udry, 2003). The level of involvement in intra-household decision-making reflects their agency, which is an important aspect of understanding empowerment (Seymour & Peterman, 2018).

The objective of this research is to explore the relationship between the intra-household decision-making agency of women and the care work provided by them, along with socioeconomic and environmental factors in rural Bangladesh. This paper addresses two research questions. First, it examines whether there is a relationship between unpaid care work and women's decision-making agency across economic, family, and social domains within rural communities. Second, it explores how socio-economic and environmental factors—such as family land ownership, age, religion, household income, water quality, and education—affect women's decision-making agency within households in these rural areas.

While existing literature has examined care work and decision-making agencies separately, few studies have addressed their relationship by considering intersectionality within patriarchal, climate-vulnerable rural contexts. This study fills this gap by analyzing how care work shapes women's agency within these settings, thus advancing our understanding of gendered household dynamics.

To analyze household decision-making and cooperation dynamics, this study applies the Institutional Analysis and Development (IAD) framework. The IAD framework provides a structured approach to understanding households as institutions, engaged in collective action where gendered power dynamics influence cooperation, decision-making, and resource allocation (Doss and Meinzen-Dick, 2015).

This approach allows us to view care work as a collective action determined by society and family for sustaining household welfare. Situating care work within this framework enables us to examine how social norms and resource allocations influence women's agency within the household, thus offering a nuanced understanding of household dynamics and gendered inequalities in decision-making processes.

3.2. Study Area

This research was conducted in Shyamnagar Upazila[5], Bangladesh, a rural community residing beside the Sundarbans mangrove forest, a UNESCO World Heritage Site. The forest of Sundarbans serves as a crucial source of livelihood for the local population, providing resources such as honey, wood, fish, and crabs (Giri et al., 2008). However, saltwater intrusion due to rising sea levels threatens these resources and leads to higher human-tiger conflicts followed by higher numbers of tiger widows[6] (Deka et al., 2023). Additionally, limited freshwater availability caused by salinity intrusion and increased natural disasters due to climate change are the major livelihood challenges in the study area (IUCN, 2015).

Agriculture, saltwater fisheries, and daily wage labor are primary occupations, while women, primarily homemakers, handle household chores. Women in Shyamnagar, much like in other developing countries, play a pivotal role in household and community resource management, particularly in water collection and care work (Neumayer & Plümper, 2007; Azcona et al, 2023; Pearse,2016). In the study area, people collect water mainly from ponds, rivers, pond sand filters (PSF), deep tube wells (DTW), shallow tube wells (STW), and rainwater harvesting.

The study area, located in rural Bangladesh, is highly patriarchal, reflecting entrenched cultural practices such as women providing care work and the prevalence of dowry, as revealed in the

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[5] Second lowest tier of regional administration consists of Upazila.

[6] Women whose husbands died in tiger attacks.

Focus Group Discussions (FGDs). Although dowry was not traditionally widespread in Bangladesh, it has evolved into a necessity for securing a marriage (Kabeer, 2024). The growing demands for dowry impose significant financial burdens on families, particularly in rural and low-income households.

The study area provides an ideal setting for investigating how gender dynamics, environmental vulnerabilities, and socioeconomic norms intersect to influence women's lives, particularly caregiving responsibilities and decision-making agency. Recent shifts in social norms in Bangladesh, as highlighted by Kabeer (2024), reflect increasing investments in girls' education and a rising preference for female children among parents, driven by the recognition of daughters' value in supporting parents during old age. This study examines these evolving dynamics, focusing on how gender, environment, and cultural norms collectively influence caregiving responsibilities and decision-making agency.

3.3. Conceptual and Analytical Framework

Conceptual Framework

Feminist Ecological Economics: Principles and Gender Relations

The major values inherent in feminist ecological economics draw from the combined principles of feminist economics and ecological economics. According to Perkins (2007), the central pillars of ecological economics are directly relevant to feminist ecological economics. These are restraining economic scale, redefining economic efficiency and value, seeking insights from natural science theories, adopting pluralistic and interdisciplinary approaches, and acknowledging immediate policy implications considering the global significance of ecological constraints on economic growth. Feminist ecological economics, which emphasizes intergenerational equity, the irreversibility of environmental change, and the promotion of sustainable development, derives its core value from ecological economics encompassing nature, justice, values, and time (Faber, 2008). Perkins (2007) delineates the essence of the feminist ecological economics approach to comprehending economic relationships through four principles: the centrality of household and community production, the suitability of production techniques within social and ecological contexts, the consideration of time, and active community engagement fostering social change.

Pearse (2016) highlighted the critical role of gender relations in climate-related social transformations, emphasizing the need for gender-sensitive approaches in ecological and economic analyses. Feminist ecological economics expands on this by addressing the interconnectedness of women, ecosystems, and economies (Perkins, 2007). To promote sustainable development and women's well-being during the climate crisis, societal paradigms must be challenged by prioritizing care-based and ecological prosperity while addressing systemic inequalities such as those shaped by care work and ecological constraints (Salleh, 2009).

Gender and Care work

Gender represents the socially constructed relationship between men and women (FAO, 1997), which significantly affects planning, production, family well-being, household security, and other aspects of life (Łapniewska, 2016). In patriarchy, housewifization is widely practiced, which refers to the institutionalization of women's roles as homemakers, limiting their economic opportunities and reinforcing financial dependence on men (Mies, 1998).

A crucial aspect of this gendered relationship is found within care work, which is highly demanding due to its time- and labor-intensive nature, unpredictability in demands, and the urgency it often requires (Abel & Nelson, 1990; Mies, 1998; Folbre, 1994; Jochimsen & Knobloch, 1997; Folbre, 2006; Jochimsen, 2003; Bauhardt & Harcourt, 2018). Feminist ecological economics frames care work as occurring in "biological time" rather than clock time, emphasizing multitasking and its deep connection to personal relationships, experiential knowledge, and volition (Brennan, 1997).

These unequal care burdens are further reinforced by societal stereotypes that portray women as cooperative and nurturing, emphasizing communal traits, while men are seen as agentic and achievement-oriented (Dasgupta & Mani, 2015; Vyrastekova et al., 2015). Such stereotypes influence real-life behaviors, with women frequently driven by altruism in their choices, while men tend to prioritize self-interest (Brickell & Chant, 2010; Eagly & Crowley, 1986; Dwyer & Bruce, 1988).

The Interconnectedness of Economic Systems and Maintenance Economy

The current economic system is rooted in the 'maintenance economy,' which encompasses ecosystem services and care work (Dengler & Lang, 2021; Jochimsen & Knobloch, 1997). Despite the indispensable role of nature in sustaining economic activity, traditional economic thought often neglects its value. The household economy, central to the broader economy, produces goods and services vital for meeting human needs but often goes unrecognized in monetary terms (Binswanger, 1991; Mies, 1998; Pietilä, 1997). The devaluation of non-market contributions, such as care work and ecological services, within conventional economic frameworks reflects the dominance of a male-centric value system that prioritizes monetary metrics (Binswanger, 1991; Akbulut, 2017; Abel & Nelson, 1990). This also neglects to understand the origins, interrelations, and post-usage trajectories of economic agents, including women's pivotal role in caregiving work (Nelson, 1997; Jochimsen & Knobloch, 1997).

The ICE model developed by Jochimsen and Knobloch (1997) illustrates the interrelations between industrial economic thought (I), caring activities (C), and ecological processes (E), showing how caregiving and ecological systems sustain the mainstream economy but are undervalued and negatively impacted by it.

Feminist ecological economics fundamentally regards materially independent growth as the foundation for development, recognizing the significance of environmental contributions and unpaid labor (Perkins, 2007). Feminist and ecological perspectives challenge prevailing modes of thinking that isolate human identity, emphasizing their detrimental effects on human-nature relationships and gender dynamics (Jochimsen & Knobloch, 1997; Nelson, 1997; Pearse, 2016). Nelson (1997) highlights the symbolic hierarchy in which women are associated with nature and confined to bodily and natural roles, while rationality and intelligence are attributed to masculinity. By challenging these dualistic perceptions, feminist thought advocates for more equitable relationships between genders and a deeper integration of humanity with nature.

Common and Care work

Commons, which are typically defined as non-excludable but rival resources, rely on collective action for their maintenance, reproduction, and regeneration (Ostrom, 1990). Earlier literature shows that commons are not only defined as a type of good or resource but rather social relations between commoners within a community (Caffentzis & Federici, 2014; Dengler &

Lang, 2021). Care work within the household can also be considered a common resource, sustained through collective action, much like the management of natural commons. Agarwal's (1997) work underscores that care work, much like natural commons, is deeply influenced by social relations within households and communities. Her analysis of intra-household bargaining highlights how caregiving responsibilities can enhance women's bargaining power but simultaneously reinforce traditional gender roles, perpetuating gender inequalities.

Furthermore, Dengler & Lang (2021) suggested "commonization of care", which indicates care work as a communal, unpaid, and socially recognized activity rather than one mediated by the market, the state, or traditional family structures. This integrates care into the commons, where communities that are egalitarian and democratic, collectively manage care. Historical examples, such as the establishment of *comedores populares* (popular kitchens) by local communities in Chile after the Pinochet coup, illustrate how care work can be organized as a commons, providing vital support like cooking food for all and particularly offering meals to those who could not afford to feed themselves (Fisher, 1993). Thus, care work and commons are intricately relevant to each other. Similar to other nature-based common resources, care work is often undervalued and it is difficult to exclude household members from benefiting from it (Dengler & Lang, 2021).

Analytical Framework

The Institutional Analysis and Development (IAD) framework of Elinor Ostrom is developed to comprehend the interactions among individuals, institutions, different socio-economic variables, and ecological conditions. Within this framework, household cooperation and resource allocation are influenced by multiple factors, including resource conditions, community attributes, institutional arrangements, and social bargaining (Ostrom, 1990; Doss & Meinzen-Dick, 2015). In this research, the IAD framework is applied to understand how different factors can influence women's decision-making agencies in rural Bangladesh through provisioning unpaid care work.

According to the IAD framework, institutions can be defined as the shared concepts or prescriptions used by humans to organize all forms of repetitive and structured situations organized by rules, norms, and strategies, including those within families, neighborhoods, markets, firms, sports (Ostrom 2007; Ostrom 2005). Institutions such as household patriarchy, norms, socioeconomic conditions, and societal practices are considered here. In the study by

Doss and Meinzen-Dick (2015), the IAD framework was applied to household settings, examining how multiple actors with varying preferences and resources interact within households to achieve collective outcomes. It elaborated on the processes of decision-making through negotiation and bargaining, cooperation in resource allocation, and the sharing of responsibilities within the household, while also considering the influence of external factors such as rules, norms, conditions, and other socio-economic variables.

Intra-household bargaining power refers to the ability of individuals within a household to negotiate and influence decisions regarding the allocation of resources, responsibilities, and benefits among household members (Agarwal, 1997). Studies indicate that the intra-household bargaining power between men and women is often different, affecting the overall welfare outcomes of families (Lundberg & Pollak, 2003; Sen, 1999; Dasgupta & Mani, 2015; Lundberg et al., 1997). Intra-household bargaining power aligns with the IAD Framework as it represents an action situation where individuals negotiate decisions and allocate resources within the household. These interactions are influenced by evolving rules, norms, and roles, which ultimately shape welfare outcomes.

Agarwal (1997) emphasizes that caregiving responsibilities can strengthen women’s bargaining power by making them central to household resource management. In the study area, the division of labor within households places primary responsibility for care work on women. As an institutional arrangement, it structures how resources such as time and labor are allocated for caregiving. Analyzing the care work through the lens of common resources, which require collective action, reveals how these institutional arrangements either support or undermine women’s agency.

The IAD framework's key components, such as the action situation of providing care work, actors, rules-in-use, biophysical conditions, and community attributes, provide a comprehensive view of how all these jointly affect the women's decision-making agency (Ostrom, 2005). The action situation is the allocation and performance of "Unpaid Care Work" within households by women. The IAD framework focuses on action situations where individuals or groups interact to make decisions. In households, these action situations involve members negotiating over resource allocation, responsibilities, and decision-making processes.

Biophysical conditions focus on the physical characteristics of the resource to be managed collectively. In the study area, water resources and natural disasters are becoming harder to manage due to climate change. Community attributes are the socioeconomic characteristics of the group to manage the resources. Djoudi et al. (2016) emphasize the importance of a multilevel perspective, exploring how household caregiving responsibilities intersect with community norms, such as dowry practices, and influence broader community and institutional dynamics.

As institutional dynamics can perpetuate gender inequalities, the IAD framework can be applied to identify potential areas for policy intervention to enhance gender equality and empower women (Ostrom, 2005; Poteete et al., 2010). Thus, this framework is applied to show how institutions influence women's decision-making agencies in rural Bangladesh through provisioning care work. In this study, the IAD framework is utilized to portray intersectionality by recognizing the complex interaction among environmental vulnerability, various socioeconomic conditions, care work provided by women, and their impact on women's well-being and agency (Crenshaw, 1989).

Furthermore, decision-making in the family is non-stationary, which means that changing conditions and rules can affect the bargaining power and decision-making processes of individuals (Lundberg & Pollak, 2003). Feedback mechanisms within the IAD framework play a critical role in this dynamic, demonstrating how women's roles and empowerment evolve in response to their decisions and the socio-economic context. Feedback mechanisms can be categorized into fast and slow, as well as positive and negative (Ostrom, 2010).

Fast feedback mechanisms entail immediate reactions that swiftly influence behavior and decision-making, either reinforcing or disrupting existing norms or practices. Conversely, slow feedback mechanisms operate over prolonged periods, gradually shaping institutional dynamics and behaviors. Positive feedback amplifies specific behaviors or outcomes, creating reinforcing loops that strengthen initial actions, potentially leading to rapid changes and growth in certain behaviors or institutional norms. Negative feedback reduces or reverses particular behaviors or outcomes, creating a loop that can even challenge the existing system (Ostrom,2010).

3.4. Methodology

This study employed a mixed-methods approach to gain a comprehensive understanding of women's experiences. Stratified and clustered sampling techniques were used to ensure representativeness across different unions[7] and socio-economic groups within Shyamnagar Upazila.

Data Collection Overview

Quantitative data was collected using two surveys, while qualitative data was gathered through observation, in-depth interviews (IDIs), semi-structured interviews, key informant interviews (KIIs) and FGDs conducted in 2021 and 2022. The 2021 wave focused on collecting broad baseline data on socio-economic conditions, gender norms, and environmental factors affecting women's lives. The 2022 wave expanded on these findings,focusing on unpaid care work and decision-making agency.

Grounded theory analysis was applied in 2021 to identify emerging themes and concepts directly from the collected data. This iterative process, involving open-ended questions, coding, and data analysis, aimed to generate a nuanced understanding of the factors influencing women's decision-making agency and the impact of unpaid care work. The participants included both men and women, including women from particularly vulnerable groups such as tiger widows and members of indigenous Munda communities. Data collection was carried out across 10 unions: Atulia, Padmapukur, Bhurulia, Burigoalini, Gabura, Ishwaripur, Munshiganj, Ramjannagar, Shyamnagar, and Kashimari.

2021 Data Collection

- Participants**:** 385 households, including 52 women and 333 men.
- Methods**:** A survey, 7 FGDs, 10 semi-structured interviews,4 KIIs and 10 IDIs were conducted. Grounded theory analysis was used.
- Focus**:** The survey gathered socio-economic data, such as the primary decision-maker in households, perceptions of water quality, and the impacts of natural disasters and climate change. Qualitative research explored broad concepts, including household decision-making, patriarchal norms, care work, water collection duties and time, natural disasters, and gendered vulnerabilities to climate change.

[7] Third lowest tier of regional administration in Bangladesh popularly known as Union Parishad.

2022 Data Collection

- Participants**:** 316 households, including 153 women and 156 men.
- Methods**:** A survey, 10 FGDs, and 20 IDIs were conducted.
- Focus**:** The data addressed household decision-making agency, perceptions, norms, and care work in detail. Time-use surveys, FGDs, and IDIs measured unpaid care work in terms of hours spent, multitasking, and engagement in various unpaid activities. Care work was measured and adjusted in terms of the number of hours, multitasking, and involvement in different unpaid activities. Multitasking was found to be highly significant among women, reflecting the complexity related to the valuation of care work due to overlapping productive activities (Waring 1998, 2018).

Decision-Making Agency Measurement

Measuring decision-making agency poses methodological challenges, as it often fails to capture the intricate power dynamics within households (Alkire et al., 2013; Anderson & Eswaran, 2009). Conventional approaches tend to ignore the contextual understanding and rationale behind it or how perception, norms, constraints, and individual variation influence agency (Alkire et al., 2013; Anderson & Eswaran, 2009; Twyman et al., 2015; Doss, 2013). This study aims to understand the intrahousehold decision-making agency of women by measuring different aspects and acknowledging external factors such as societal perception, culture, and norms.

Categorical variables were used to measure the level of decision-making agency among women in Survey 2022. Furthermore, Exploratory Factor Analysis (EFA) was employed to identify the key factors related to decision-making.

3.5. Results

3.5.1. Summary Statistics

The 148 women who were surveyed in 2022, on average, were 33.05 years old, with a standard deviation of 8.71, ranging from 18 to 65 years. Approximately 44.6% of the sample came from families that owned land, while 32.4% reported having access to pure water. The average number of children per household was 1.61, ranging from 0 to 4 children. In terms of education, respondents had an average of 9.39 years of schooling, with a minimum of 0 and a maximum of 20 years (See Appendix Table C.A3 for details).

Of the 84 Hindus, 9 were Munda, while the remaining 64 were Muslim. 122 women stated that they have at least one child. 120 women were married, 18 of them were single, 6 of them were divorced or separated, 4 of them were widows, whereas one of them was a tiger widow. The majority of them were engaged as full-time homemakers, with 83 participants (54.2%). Other occupations included agriculture and aquaculture, daily labor, students, working homemakers, and job holders.

3.5.2. Gender Disparities in Unpaid Labor

From the qualitative survey of 2021 and 2022, a substantial disparity in the distribution of unpaid labor within households in the study area was revealed. A total of nine types of care work were identified. These included home cleaning, cooking, child-rearing, water collection, homestead gardening, purchasing household goods, taking care of siblings, taking care of the elderly, and taking care of household animals. In FGDs, IDIs, and surveys, almost all people stated that women contribute more time and effort to care work compared to men.

Nonetheless, the gendered division of labor reflected traditional roles, where women were primarily responsible for caregiving while men controlled financial resources. Of the 296 survey respondents (148 male and 148 female), who participated in the 2022 time-use survey**,** a clear gender disparity emerged, with women providing the majority of the work. Female respondents collectively contributed 1,113 hours (75.97%) of care work, while male respondents contributed 352 hours (24.03%) per day. This supports Charmes (2019) finding that women in developing countries shoulder 75 percent of care work. Women, on average, spent around 8 hours daily in care work, ranging between 3 to 12 hours.

Women primarily took on responsibilities such as child-rearing, elderly care, cooking, and cleaning, contributing 96.1% of cooking hours, 95.8% of child-rearing hours, and 75.8% of home-cleaning hours. In elderly care, females spent 94 hours (78.3%) compared to 26 hours (21.7%) for males, which supported the finding that women are also the major caregivers of the elderly (Abel & Nelson, 1990). However, qualitative research revealed that in the study area, men hardly cooked as it was viewed as an exclusive feminine duty. In terms of water collection, females spent 122 hours (67.0%) and males 60 hours (33.0%). Men were more involved only in purchasing household goods, likely due to their better access to markets and financial resources. For detailed insights into the distribution of unpaid household work between men and women, refer to Appendix Table C.A2.1.

3.5.3. Intra-household Decision-Making Agency

In the 2022 survey, we examined decision-making dynamics among 225 married individuals, comprising 125 women and 100 men. Participants were asked about who makes daily consumption decisions in their households. Figure 3.1 represents the gender-based response to the question of who makes the decision related to purchasing household goods for consumption in your house. Interestingly, 30.40% of female participants indicated that their spouses mostly make these decisions, while only 4% of men reported the same about their spouses. Conversely, the majority of men (54%) stated that they alone make the decisions in the households, whereas only 9.60% of women claimed to be the sole decision-makers. Furthermore, the majority (54.40%) of women and 20% of the men stated that both husband and wife do the decision-making.

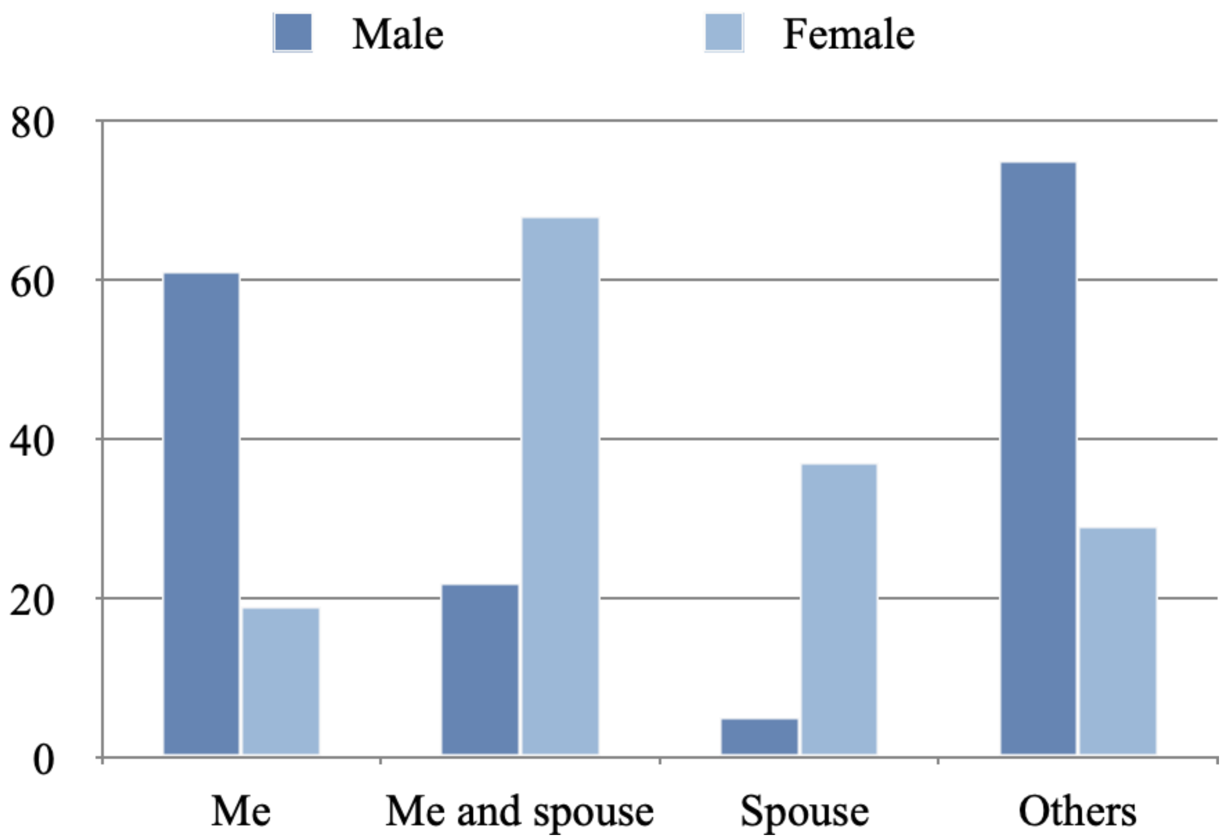

Figure 3.1: Who makes the decision to purchase household goods for your household

In the 2022 survey, 148 women were asked to assess their decision-making agency, including their present or past involvement in the issue, and whether they would be expected to participate in a similar situation in the future. They rated their decision-making agency on a scale ranging from 'Never' (1), 'Rare' (2), 'Sometimes' (3), 'Most of the time' (4), to 'Always' (5). These ratings were used as categorical variables to reflect the frequency of their involvement.

Ten decision-making agency-related variables were analyzed including economic, family, and social domains. The economic domain included spending for yourself, spending for parents, economic participation, and land transactions (buy or sell). The family domain included children's education, participation in decision-making in family matters, and participation in family planning. The social domain included movement outside the home and social involvement, which were reflected in decision-making agency variables such as going out alone, participating in social work, and purchasing household goods.

The responses centered around a mean value of approximately 3 in most cases, indicating "sometimes" or some involvement in decision-making. The findings, detailed in Appendix Tables C.B1.2 and C.B1.3, provide insights into the frequency and extent of their involvement in decision-making processes.

Women exhibited a moderate level of autonomy in the economic domain, except for land transactions, where they were rarely involved or expected to participate. Similarly, moderate agency was observed across all three variables related to the family domain. In the social domain, women played a significant role in purchasing household goods, while demonstrating moderate agency in going out alone and participating in social work.

3.5.4. Relationship between Decision-making Agency and Care Work

Ordinary Least Squares (OLS) regressions were conducted for each dependent variable (decision-making agency in economic, family, and social domains) to assess relationships with care work (hours) and socio-economic variables. The following regression model was specified to quantify these relationships:

$$Y_i=\beta_0+\beta_1 CareWork_i+\beta_2 Age_i+\beta_3 Education_i+\beta_4 Income_i+\beta_5 Children_i+\beta_6 Land_i+\beta_7 WaterQuality_i+\beta_8 Religion_i+\epsilon_i$$

The model examined the decision-making agency Y_i as the dependent variable, influenced by several factors. The key independent variable, $CareWork_i$, represented the number of hours spent on care work. Other explanatory Age_i variables included (age of the respondent), $Education_i$ (years of formal education), and $Income_i$ (household income), which captured individual and economic characteristics. $Children_i$ measured the number of children, while $Land_i$ (1 if the family owns land, 0 otherwise) reflected asset ownership. $WaterQuality_i$ (1 for pure water, 0 for not pure) accounted for access to clean water, and $Religion_i$ (1 for Hindu, 0 for Muslim) controlled for religious affiliation. The error term ϵ_i captured unobserved influences on decision-making agency.

The Variance Inflation Factor (VIF) values, all below 2 with an average VIF of 1.38, indicated low multicollinearity among predictor variables, ensuring stable and reliable coefficient estimates in the regression model in Appendix Table C.B2.

Tables 3.5.1, 3.5.2, and 3.5.3 depict the results of regression analyses of decision-making agencies with unpaid care work and socioeconomic variables in economic, family, and social domains.

Relationship between Decision-making Agency in the Economic Domain and Care Work

Table 3.5.1 shows the relationship between decision-making agencies in the economic domain and care work along with other socioeconomic variables. The analysis portrayed a statistically significant positive relationship between care work and women's decision-making agency in various economic aspects within households. It was found that as the care work increased, women's agency in economic decision-making also increased. This was evident across all four agencies related to economic participation, land transactions, spending for parents, and spending for yourself.

Water quality (an indicator of whether water is pure) was positively and significantly associated with agency related to economic participation, spending for parents, and spending for oneself. Age had a slightly positive relationship with economic participation and land transactions. Conversely, both family land ownership and the number of children significantly reduced women's decision-making agency in spending for their parents, whereas education enhanced their decision-making in this area. Besides, the variable religion was slightly negatively associated with decision-making in economic participation.

Table 3.5.1: Relationship between Decision-Making Agency in the Economic Domain and Care work

	(1) Economic participation	(2) Land transaction	(3) Spending for parents	(4) Spending for yourself
Care work (hours)	0.202***	0.254***	0.273***	0.226***
	(0.062)	(0.060)	(0.060)	(0.065)
Age	0.031*	0.033*	0.022	0.003
	(0.016)	(0.018)	(0.014)	(0.016)
Family land (1=owns, 0= does not own)	0.265	0.255	-0.402*	-0.160
	(0.225)	(0.250)	(0.240)	(0.230)
Household Income	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
No. of children	-0.096	-0.173	-0.467***	-0.207
	(0.154)	(0.150)	(0.141)	(0.150)
Education	0.050	0.021	0.071**	0.034
	(0.031)	(0.038)	(0.031)	(0.031)
Water quality (1=pure, 0=not pure)	0.777***	0.116	0.985***	0.625**
	(0.267)	(0.265)	(0.257)	(0.273)
Religion (1=Hindu, 0= Muslim)	-0.367*	-0.320	-0.123	-0.140
	(0.221)	(0.214)	(0.229)	(0.237)
Constant	0.419	-0.949	0.501	1.706*
	(0.828)	(0.857)	(0.717)	(0.877)
N	148	148	148	148
R^2	0.179	0.149	0.369	0.206

Notes: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Relationship between Decision-Making Agency in the Family Domain and Care Work

Table 3.5.2 shows the relationship between decision-making agencies in the family domain and care work along with other socioeconomic variables. The regression analysis in Table 3.5.2 showed a significant positive relationship between care work and all three women's decision-making agencies in the family domain.

However, the regression analysis results revealed that family land ownership negatively affected women's decision-making in family planning, suggesting a reduction in women's agency in this area. Unsurprisingly, higher education was positively associated with family planning. As Kabeer (2024) argued, education equipped women with the tools to challenge patriarchal constraints, enabling them to participate in family planning and decision-making about children’s education. The findings of this study supported her argument,, showing that educated women in Shyamnagar Upazila tended to have fewer children and were more involved in their children's education.

The coefficient for water quality was 1.462 for the decision-making agency related to children’s education, indicating a highly significant positive relationship. This suggested that improved water quality reduced the time spent on water collection and household chores, enabling parents—especially mothers—to be more involved in educational decisions.

Table 3.5.2: Relationship between Decision-Making Agency in the Family domain and Care work

	(1) Decision-making in family matter	(2) Children education	(3) Family planning
Care work (hours)	0.200***	0. 191***	0.262***
	(0.063)	(0.063)	(0.066)
Age	-0.001	-0.002	0.005
	(0.015)	(0.019)	(0.017)
Family land (1= owns, 0=does not own)	-0.265	-0.316	-0.556**
	(0.235)	(0.262)	(0.265)
Household Income	0.000*	0.000*	0.000
	(0.000)	(0.000)	(0.000)
No. of children	-0.039	0.102	0.111
	(0.149)	(0.204)	(0.177)
Education	0.043	0.041	0.077***
	(0.0325)	(0.037)	(0.033)
Water quality (1= pure, 0 = not pure)	-0.032	1.462***	0.051
	(0.277)	(0.258)	(0.287)
Religion (1=Hindu, 0=Muslim)	-0.213	0.237	-0.002
	(0.240)	(0.245)	(0.252)
Constant	1.363*	1.083	0.206
	(0.784)	(1.049)	(0.948)
N	148	122	120
R^2	0.138	0.345	0.232

Notes: Robust standard errors in parentheses.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Relationship between Decision-Making Agency in the Social Domain and Care Work

Table 3.5.3 shows the relationship between decision-making agencies in the social domain, care work, and other socioeconomic variables. Regarding the social domain, care work was significantly positively related to all three examined agencies: going out alone, social work, and purchasing household goods. Age was positively related to the ability to go out alone, indicating that older women may have more autonomy. This aligns with research suggesting that older women are more involved in family decision-making (Kabir & Jahan, 2013; Haque et al., 2011). In rural societies, gender norms and traditional expectations often grant older women more social acceptance to leave home alone, as their age and established roles are perceived as conforming to societal norms. Besides, higher education increases autonomy in going out alone. The variable religion was negatively associated with decision-making in going out alone. Finally, family land ownership decreased the agency for social work significantly.

Water quality had mixed results, as the coefficient for water quality in relation to the decision-making agency of purchasing household goods was significantly positive. However, it showed that when the water was not pure, women's decision-making agency related to going out alone increased, as women had more urgency to go out alone to fetch water.

Table 3.5.3: Relationship between Decision-Making Agency in the Social Domain and Care work

	(1) Going out alone	(2) Social work	(3) Purchasing household good
Care work	0.114*	0.219***	0.463***
	(0.063)	(0.057)	(0.042)
Age	0.030*	0.005	0.009
	(0.017)	(0.014)	(0.012)
Family land (1= owns, 0=does not own)	0.380	-0.692***	-0.207
	(0.242)	(0.223)	(0.178)
Household Income	0.000	0.000***	0.000
	(0.000)	(0.000)	(0.000)
No. of children	0.047	-0.015	-0.091
	(0.151)	(0.136)	(0.099)
Education	0.062**	0.041	0.006
	(0.029)	(0.030)	(0.024)
Water quality (1= pure, 0= not pure)	-1.044***	-0.043	0.999***
	(0.293)	(0.265)	(0.186)
Religion (1=Hindu, 0=Muslim)	-0.492**	-0.232	-0.201
	(0.233)	(0.219)	(0.162)
Constant	0.849	1.373*	-0.224
	(0.825)	(0.767)	(0.588)
N	148	148	148
R^2	0.259	0.184	0.564

Notes: Robust standard errors in parentheses.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

3.6. Discussion

3.6.1. Care Work and Decision-Making Agencies

In this study, it was found that care work had a strong positive relationship with women's decision-making agencies. This indicated that though care work was undervalued and could perpetuate unequal gender roles, it could paradoxically empower women by providing them with higher decision-making agency. The rationale behind this was supported by the previous literature, which shows that the inherent economic value of unpaid care work is quite substantial, as it provides a necessary foundation for the monetary economy (Folbre, 2012; Dengler & Lang, 2021).

Through providing care work, women became the managers of household resources and needs, which made them indispensable and increased their decision-making agency in areas related to economic participation and household spending (Folbre, 2012; Hochschild & Machung, 2012). The previous studies of Kabeer (1999) and Agarwal (1997) further supported this notion, indicating that care work and control over household aspects could enhance women's intra-household bargaining power and decision-making agency.

Djoudi et al. (2016) argue that agency is not limited to individual actions within the household but also extends to the community and institutional levels. This study found that caregiving responsibilities positioned women as central figures in household resource management, enhancing their bargaining power and decision-making agency. Furthermore, care work could build social capital by creating higher trust, bondages, and cooperation among members of the community, which could further enhance women’s influence within the household and community (Putnam, 2000; Esquivel, 2014). Moreover, women’s roles in resource management positioned them as critical actors in household and community decision-making (Kabeer, 2024). Therefore, care work not only enhanced women's decision-making agency but also positioned them as essential managers of household resources, contributing to their overall well-being.

As Kabeer (2024) argued, the agency didn’t emerge in the absence of constraints but rather within and against them. This study found similar patterns, where women’s caregiving roles in rural households enhanced their bargaining power, allowing them to influence household decisions despite restrictive patriarchal norms. In this study, women's caregiving roles extended beyond immediate household welfare to intergenerational aspects as they had better agency over the children’s education. These findings underscored the complex interplay among care work, structural barriers, and individual agency in shaping gendered decision-making processes.

3.6.2. Community Attributes, Norms and Household Decision-Making

In the study area, the socioeconomic factors such as age, gender, family land ownership, educational attainment, household income levels, and number of children affected women's bargaining power in household decision-making. Addressing these sociocultural constraints was essential for fostering women's empowerment and reshaping decision-making dynamics (Djoudi et al., 2016).

Social norms, individual resources (such as income, education, and property), social expectations, and household dynamics restricted intra-household bargaining power of women (Agarwal, 1997). Household decisions were made collectively, highlighting the complexity of interpersonal dynamics, including differing preferences and power structures within households (Munro et al., 2008). In Bangladesh, these patriarchal norms deeply influenced societal expectations, portraying women as individuals who must sacrifice personal needs for family and community welfare. According to the survey, 78.80% of respondents stated that women tend to sacrifice more than men in their lives. This societal perception underscored the broader societal context within which women's decision-making agency operated, shaped by deeply ingrained cultural and gendered expectations.

Household Decision-Making: Rules-in-Use

Vertical rules refer to institutional structures and broader societal norms, such as patriarchy, which reinforce horizontal rules. Patriarchy determined unequal care work, restricted land ownership for women, and enforced marriage practices like dowry and patrilocality.

Horizontal rules refer to norms, conventions, and informal agreements that directly influence women's decision-making agency within the household. For instance, norms about who was the major decision maker in the household, who controlled financial resources, and who was responsible for household chores shape intrahousehold power dynamics. Furthermore, informal agreements within households shaped the division of labor. In the study area, norms often resulted in women shouldering caregiving responsibilities while men made most financial and major household decisions.

Marriage, Care Work, and Power Hierarchy

Marriage held significant importance in the study area, with dowry playing a crucial role. Men typically controlled dowry, often considered the “price” of the groom, which further disempowered women (Jayachandran, 2015). Surveys and FGDs revealed that factors such as dowry amount, age, physical appearance, and the ability to provide care work were prioritized for marriage over women's education.

In one IDI, a 24-year-old woman shared that, although she had completed her master’s degree, getting married in her community required her to pay a substantial dowry. Moreover, after marriage, she was expected to become the primary caregiver in her in-laws’ family. This aligned with our findings on the pervasive influence of dowry and patrilocality in limiting women’s agency, despite their significant contributions to care work. The dowry system places economic pressure on families and devalues women’s roles in marriage, reducing their contributions to caregiving (Kabeer, 2024). Decisions made within marriage, particularly those that influence future bargaining power (e.g., caregiving) often result in inefficient outcomes due to unequal power dynamics (Lundberg and Pollak, 2003).

Patrilocality, a common practice in the study area, dictates that women move into their husbands’ households, further reinforcing their caregiving responsibilities. This is reflected in a common Bengali proverb: "*Ma, ami tomar jonno dashi ante jacchi*," meaning "Mother, I am bringing you a servant." Here, the wife is explicitly referred to as a servant of the in-laws.

From qualitative research, it was found that societal norms dictated that women in the family would carry out the care work, whether they were mothers, sisters, daughters, or daughters-in-law. Before the marriage of the son, the mother was in charge of taking care of the household, followed by the unmarried sisters. However, after the son got married, it was the primary responsibility of the daughter-in-law to take care of her husband’s household. In terms of cooking, the responsibilities were often shared between the mother-in-law and daughter-in-law, whereas the sister-in-law often played a secondary role.

The gender hierarchy within the household intersected with age and life course: older women were in positions of authority over younger women, mothers-in-law dominated their daughters-in-law, and wives of older brothers dominated the wives of younger brothers (Kabeer, 2024). This reflected the findings of Lundberg and Pollak (2003), who argued that bargaining power imbalances could affect the outcomes of household decisions and might prevent equitable resource distribution, ultimately leading to decisions that do not maximize overall welfare.

Family Land Ownership

As household bargaining power is shaped by resources each member control, limited control on family land further diminishes women's ability to make financial and household decisions. In the study area, land was mostly controlled and owned by male family members, limiting women's access to and control over key economic resources and constraining their decision-making agency. Lundberg and Pollak (2003) supported this assertion by demonstrating that unequal bargaining power within households could lead to inefficient resource allocation, particularly putting women at a disadvantage. Similarly, Agarwal (1997) argued that patriarchal norms acted as vertical rules, shaping bargaining outcomes and constraining women's ability to negotiate within households.

3.6.3. Biophysical Condition and Care Economy

Degradation of the environment, a critical component of the maintenance economy, directly affected the care economy. As Karl Polanyi (1944) stated, the economy is embedded within society, which is embedded within the environment. The degradation of ecological systems, such as water scarcity, directly affected the care economy, intensifying burdens on women and underscoring the interdependence of ecological, social, and economic systems (Figure 3.2).

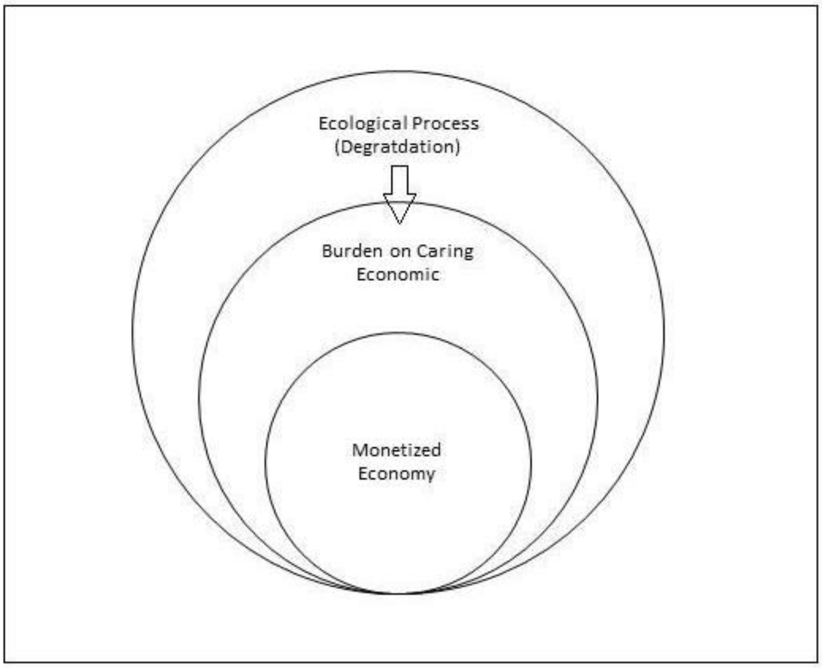

Figure 3.2: Ecological process degradation increases the caregiving burden on women (adapted from the figure of Karl Polanyi,1944)

In the study area, the degradation of water sources, increased salinity and frequent natural disasters significantly extended the time and distance required to collect safe water (Ashrafuzzaman et al., 2023; Pearse, 2016). On average 1 to 1.5 hours were needed to collect water, while in some unions, such as Gabura and Padmapukur, this could take up to 2 hours. Besides, as water sources became scarce, women might walk longer distances, whereas men more often relied on bicycles or motorbikes. For example, a woman from Kashimari Union shared that salinity had rendered their shallow tubewell unusable, forcing her to walk approximately 5 kilometers every day to a Pond Sand Filter (PSF) for water collection.

Gendered expectations could limit women's opportunities to engage in other activities, such as education or paid work, particularly in the face of climate-related challenges (Pearse, 2016). As the regression analysis (Table 3.5.1, Table 3.5.2, and Table 3.5.3) demonstrated, reduced time and energy spent on water collection significantly enhanced women’s decision-making agency, enabling greater participation in economic activities, childcare, and household decision-making.

During disasters, water scarcity becomes critical, further challenging access to safe water. Gendered roles and cultural constraints increased women’s vulnerability to climate impacts, causing physical and mental strain and exposing them to risks such as gender-based violence when traveling longer distances, especially during disasters (Pearse, 2016; Cannon, 2002). A man from Padmapukur Union recounted the impact of Cyclone Aila in 2009, recalling how, at eight years old, he and his mother were swept away by floodwaters and survived by holding onto a tree, while male family members were away working. He also described the acute shortage of clean water during that time and his mother's sole responsibility for collecting water while caring for him. This reflected Cannon's (2002) findings that cultural and structural constraints often compelled women to prioritize caregiving and water collection over their own safety during disasters.

3.6.4. Interactions and Outcomes of Women's Decision-Making Agency

Decision-making agency within the Institutional Analysis and Development (IAD) framework represents both the interaction processes and outcomes that shape women's agency within households. These variables, influenced by care work, socio-economic factors, and entrenched norms, dynamically interact to determine women's decision-making roles.

The outcomes of these interactions revealed that care work significantly enhances women's decision-making agency across economic, social, and family domains. The study of Djoudi et al. (2016) showed similar patterns, where women's caregiving responsibilities positioned them as key actors in collective water resource management, extending their agency beyond the household. Agarwal's (1997) insights emphasized that caregiving roles can enhance women's bargaining power, positioning them as essential contributors to household welfare and decision-making processes.

However, entrenched patriarchal norms and unequal resource distribution such as family land ownership could limit their agency, particularly in economic and family-related decisions. Nevertheless, education was found to be an important factor that enhanced women's ability to negotiate within families and communities, providing them with greater autonomy and decision-making power in Bangladesh (Kabeer, 2024). Therefore, understanding these dynamics is essential for comprehending the complex interplay of factors that influence and constrain women's decision-making autonomy within household contexts.

To understand the interrelationship among these ten variables related to the decision-making agency of women, exploratory factor analysis was applied, with direct oblimin rotation[8] to allow for correlated factors (see Appendix C.C). Two factors were identified as the outcome variables. Factor 1, or Outcome 1, was economic and family decision-making, while Factor 2, or Outcome 2, was social autonomy and involvement.

Outcome 1: Economic and decision-making agency related to children

This outcome represented activities related to economic participation and decision-making agencies regarding children's education, including spending for yourself, purchasing household goods, spending for parents, economic participation, family planning, and children's education. Individuals scoring high on this outcome were likely to have greater economic agency and be more involved in decision-making related to children.

Outcome 2: Social Autonomy and personal decision-making

Outcome 2 appeared to encapsulate social autonomy and personal decision-making activities. It included going out alone, land transactions, and decision-making in family matters and social work, which could imply decision-making on personal issues or social engagement. Individuals scoring high on this outcome were likely to have greater social autonomy and higher personal decision-making agency. This factor highlighted the importance of social engagement and personal independence in decision-making processes.

3.6.5. Fast and Slow Feedback Mechanisms in the IAD Framework

Feedback mechanisms within the IAD framework illustrate the intricate relationships among its components. In this study, the feedback mechanism represented how various factors interacted to influence women's decision-making agency within households, particularly concerning care work and socio-economic variables. Fast and slow feedback, along with positive and negative influences, shaped the evolving roles and empowerment of women in this community.

[8] Direct oblimin rotation is applied when factors are expected to be correlated, as is the case with decision-making agency, where economic, social, and household dimensions are interrelated.

Feedback loops in the IAD framework do not only emerge from outcomes, but can also from various components such as action situations, rules-in-use, attributes of the community, and biophysical conditions. These loops illustrate how different factors reinforce or challenge existing dynamics, ultimately influencing women's empowerment and decision-making agency in the context of care work. For instance, control over household resources can initiate positive feedback loops, where increased decision-making power improves social and economic outcomes, further reinforcing empowerment (Cunningham et al., 2015). Figure 3.3 visualizes the feedback mechanism of the IAD framework within this context.

Additionally, the dynamics of these feedback mechanisms are not static; they are influenced by the nonstationary nature of the environment in which they operate. As societal norms evolve and external conditions change, the feedback loops can shift, leading to new opportunities or challenges for women's empowerment.

The interplay of fast and slow feedback mechanisms within the IAD framework illustrated the complex dynamics that influenced women's decision-making agency in households. By recognizing the multifaceted nature of these feedback loops—stemming from interactions and outcomes, community attributes, rules-in-use, biophysical conditions, and intergenerational bargains—we can better understand the pathways through which women's empowerment can be achieved and sustained. This understanding is essential for developing effective strategies to promote gender equality and enhance women's roles in care work and decision-making processes within their communities. The feedback mechanism is explained below.

1. Interactions and outcomes:

Women's involvement in care work positively affected their decision-making agency within the household. This can immediately reinforce traditional gender roles, thereby promoting care work—an example of a positive fast feedback mechanism. Furthermore, higher decision-making agencies of women can create a strong negative feedback loop by challenging the patriarchy and changing the attributes of society.

2. Attributes:

Changes in attributes of the community can directly affect the outcome variable. Agarwal argues that social norms are not fixed and they can be subject to negotiation and change (1997).

Education and employment opportunities, particularly increased access to education for girls in Bangladesh, have played a transformative role in challenging and altering traditional gender norms and expectations while enhancing women's decision-making agency and promoting their empowerment (Kabeer, 2024). Empowered women with higher decision-making agencies often challenge patriarchal norms, creating a robust negative feedback loop that alters societal attributes. Besides, access to resources such as land and financial capital can empower women and create a negative feedback loop challenging the patriarchy (Djoudi et al. 2016). Conversely, lack of control over financial resources and economic dependency on male counterparts perpetuate existing feedback loops. Furthermore, empowering women through participating in community-level activities and engaging in collective resource management can lead to greater recognition of their contributions, while creating a negative feedback loop that alters societal attributes (Denton, 2002; Djoudi et al., 2016; Kabeer, 2024).

In this study, change in attributes of the community can create both a fast and slow feedback loop that directly influences the outcome variable decision-making agency of women, as depicted in Figure 3.3.

3. Rules-in-Use and Norm Reinforcement:

Over time, continued adherence to traditional gender roles maintains and strengthens the status quo, leading to a slow but persistent reinforcement of these norms. If rules-in-use are unchanged, this leads to a long-term process of gradual evolution and reinforcing patriarchy through slow, positive feedback mechanisms.

On the other hand, legal frameworks that protect women's rights and promote gender equality are essential for empowerment. Access to legal resources and support can help women assert their rights and challenge discriminatory practices, which can create a negative and slow feedback mechanism (Djoudi et al., 2016).

4. Biophysical Condition:

Climate change, water scarcity, and natural disasters affect the action situation as the burden of care work increases. This increased burden affects women's decision-making agency over time as they spend more effort securing water resources while sacrificing time for productive work as well as other care work. As found in Tables 3.5.1, 3.5.2, and 3.5.3, impure water quality decreases the majority of the decision-making agencies for women. Thus, this creates a slow and positive feedback loop reinforcing patriarchy.

5. Intergenerational Bargains:

Changes in attributes, such as increased access to education, not only influence immediate decision-making agency but also foster intergenerational shifts by enabling women to invest in their children’s education and health, challenging patriarchal norms over time. Previous studies have shown that empowered women with higher decision-making agency contribute more to the education and health of both male and female children, fostering a more educated future generation and reinforcing women's empowerment (Lundberg & Pollak, 1996; Cunningham et al., 2015; Pitt & Khandker, 1998; Holland, 1999).

Moreover, as the fertility rate in Bangladesh has declined due to policy intervention, and the preference for sons has decreased due to changes in social norms, female education has significantly increased, leading to higher decision-making agency among women (Kabeer, 2024). Therefore, the empowered women in rural Bangladesh prioritize their daughters' education and health, fostering gradual shifts in societal attributes, and creating a strong, slow, and negative feedback loop to existing patriarchal values. This intergenerational aspect is crucial, as it highlights how women's empowerment can lead to sustained changes in societal norms and expectations, ultimately challenging the patriarchal structures that have historically limited their agency. Through these intergenerational investments, care work becomes a form of resistance and empowerment.

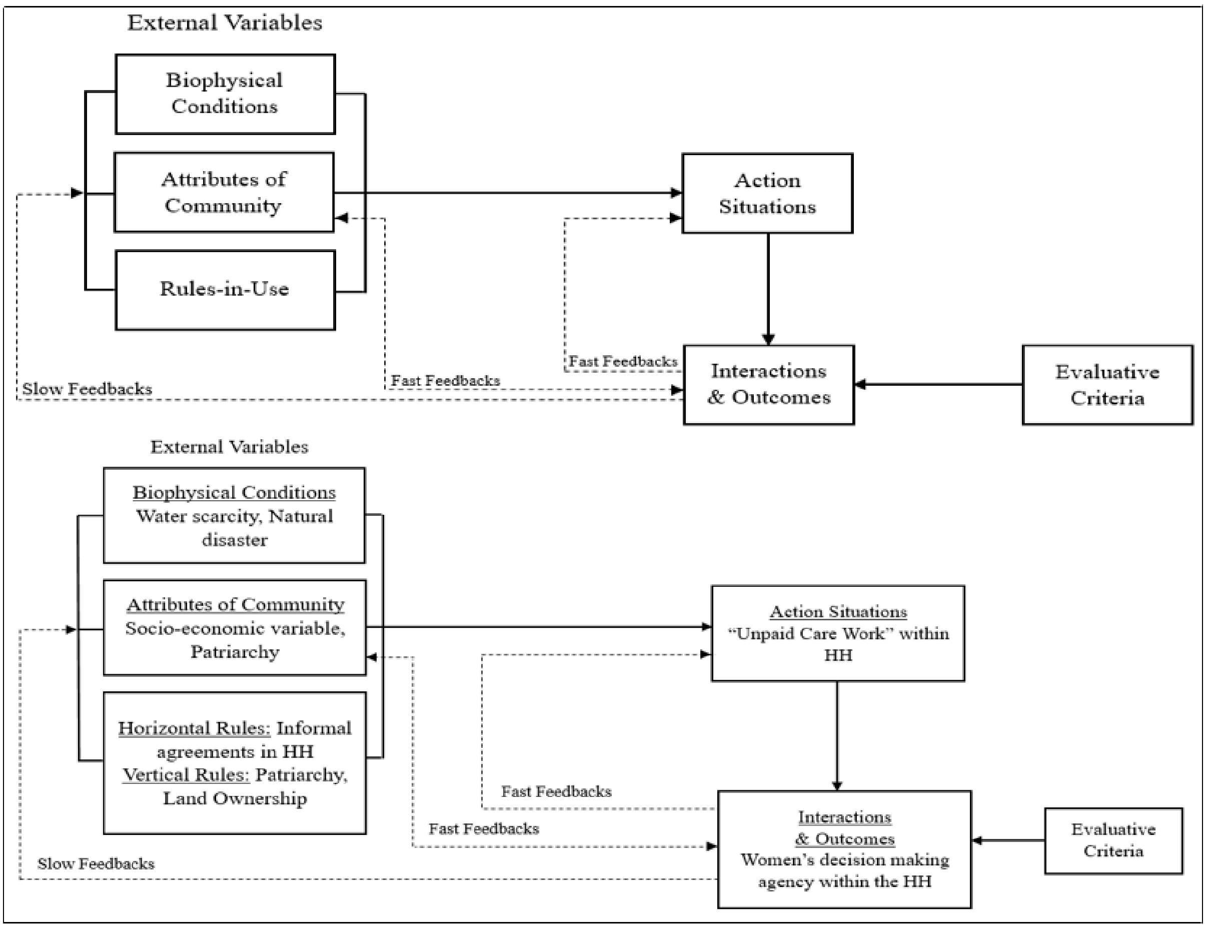

Figure 3.3: The upper figure represents the adapted IAD framework, a general feedback control system (Ostrom, 2011). The lower figure represents the same framework in the study area. The dotted lines indicate the fast or slow feedback. (HH represents Household).

3.7. Conclusion

This study delves into the complex relationship between women's unpaid care work, decision-making agency, and socio-economic and environmental factors within households, particularly in the climate-vulnerable Shyamnagar Upazila of Bangladesh. The research discovers a significant positive correlation between care work and women's decision-making agency across economic, family, and social domains. By providing care work and managing household resources, women not only contribute significantly to the economy but also become key decision-makers in the household. These findings support the existing literature on the empowering effects of care work.

Nevertheless, our findings also show the pervasive influence of patriarchal norms and socio-economic factors in constraining women's agency. Practices such as dowry, patrilocality, and male-dominated family land ownership perpetuate gender inequalities, limiting women's agency and reinforcing existing power structures within households. Moreover, environmental degradation, exacerbated by climate change and natural disasters, exacerbates the burden of care work on women in that area, emphasizing the need for gender-sensitive interventions.

Utilizing the IAD framework, our research sheds light on how care work and other external variables can empower and constrain women in this specific context and social structures governed by patriarchy. Feminist Ecological Economics challenges traditional economic systems that undervalue care work and the critical role of women in sustaining both households and ecosystems. This perspective aligns with the findings of the study, demonstrating that addressing women's care work burden and improving their decision-making agency is not only a matter of gender equity but also crucial for fostering sustainable and inclusive development in climate-vulnerable regions.

Several recommendations are proposed for policymakers, practitioners, and community leaders. Targeted interventions, such as investing in infrastructure and modern technology to alleviate water-related vulnerabilities, can significantly reduce the burden of care work on women. Besides, structural changes such as incorporating gender-sensitive disaster preparedness measures, including accessible and safe shelters and community-based resource management, to address the compounded vulnerabilities faced by women are very important (Cannon, 2002). Integrating these measures with strategies to redistribute care work can enhance women's resilience and agency.

Furthermore, by using a transformative feminist approach that challenges patriarchal norms and cultures—such as dowry, child marriage, and gender stereotypes—and by reducing the care work burden on women, we can achieve gender equity. Empowering rural women requires increasing awareness regarding critical gender issues such as property rights, educational inequalities, and violence against women (ILO, 2000; Praveen, 2007). Valuing and supporting women's contributions in caregiving roles, while addressing structural barriers such as ensuring equal rights to assets like land, can significantly improve their condition.

It is crucial to advocate for policies and initiatives that prioritize women's empowerment including access to education, and employment and providing them with adequate opportunities. Furthermore, addressing deeply ingrained biases, increasing awareness, and ensuring equitable participation in decision-making processes are essential for promoting gender equality and empowering women at all levels of society.

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Appendix A (Chapter 1)

Appendix A.A- Additional Tables

Table A.A1: Description of Independent Variable

Variables	Description
Age	Numeric Variable
Gender	Dummy variable of 1 when the participant is male, others 0
Household income	Household income (in BDT per month)
Water quality	Dummy variable of 1 when the participant state water quality is pure, otherwise 0
Education (years)	Years of schooling for Participant
Land area	Total land for each household (in katha)
Land ownership	Dummy variable of 1 when the participant state they own land, otherwise 0
Number of Family members	Number of Family members in a household
Treatment	Dummy variable of 1 when the participant play in TDG first group, otherwise 0

Table A.A2.1: Summary statistics of contribution on Dictator Game and endowment adjusted Dictator Game

Group Name	Endowment	Observation	Mean	Mode	Standard deviation
TPGG first group	Not adjusted	136	62.868	50	41.507
	Adjusted	136	57.296 (28.648%)	-	36.891
TDG first group	Initial	180	58.417 (29.208%)	50	30.851

Table A.A2.2: Summary statistics of contribution in Public good game

Group Name	Endowment	Observation	Mean	Mode	Standard deviation
TPGG first group	-	136	76.544 (38.272%)	50	48.555
TDG first group	-	156	53.302 (26.651%)	50	23.839

Table A.A2.3: Summary statistics of socioeconomic variables of TDG first group

Independent variable	Obs.	Mean	Standard deviation	Min	Max
Age (years)	180	34.972	10.963	18	70
Gender (male=1, female=0)	180	0.461	0.499	0	1
Household income(bdt)	180	9433.889	9015.357	0	70000
Water quality (pure=1, not pure= 0)	180	0.3	0.459	0	1
Education (no of years)	180	10.067	4.415	0	21
Land area (katha)	180	22.669	39.653	0	200
Number of participant/session	180	18.000	4.243	9	24

Table A.A2.4: Summary statistics of socioeconomic variables of TPGG first group

Independent variable	Obs.	Mean	Standard deviation	Min	Max
Age (years)	136	34.058	12.685	18	70
Gender (male=1, female= 0)	136	0.588	0.493	0	1
Household income(bdt)	136	8339.706	9064.806	0	80000
Water quality(pure=1, not pure= 0)	136	0.286	0.453	0	1
Education	136	10.713	4.831	0	19
Land area(katha)	136	31.275	66.084	0	400
Number of participant/session	136	19.705	2.464	18	24

Table A.A2.5: Summary statistics of socioeconomic variables of TDG first group (Who played PGG in Round 2)

Independent variable	Observation	Mean	Standard deviation	Min	Max
Age (years)	153	34.470	10.257	18	68
Gender (male=1, female=0)	153	0.483	0.501	0	1
Household income(bdt)	153	8716.34	8122.358	0	70000
Water quality(pure=1, not pure= 0)	153	0.274	0.447	0	1
Education (no of years)	153	9.797	4.243	0	20
Land area (katha)	153	22.643	37.990	0	200
Number of participant/session	153	19.125	3.182	15	24

Table A.A3: Regression analysis of PGG contribution in TPGG first group vs TDG first group

Independent variable	Contribution in PGG
Treatment (1=TPGG first group, 0 =TDG first group)	22.536***
	(4.371)
Age	0.395*
	(0.215)
Household Income	-0.000
	(0.000)
Number of Household member	2.220
	(1.461)
Land area	-0.081*
	(0.043)
Gender (male=1, female=0)	10.943**
	(4.482)
Education	0.605
	(0.546)
Water Quality(pure= 1, not pure=0)	-9.555*
	(4.973)
Number of people in each session	-1.850**
	(0.795)
Constant	61.514***
	(19.192)
N	289
R^2	0.134

Notes: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix A.B- Robustness Check and Sensitivity Analysis

Two-Sample T-Test

Table A.B1: Two-Sample T-Test Results for contribution in DG (With Endowment Adjustment)

Group	TDG first group (a_i)	TPGG first group (l_i)	Combined
Observations	136	180	316
Mean	57.296	58.416	57.934
Std. Error	3.163	2.299	1.886
Std. Deviation	36.891	30.851	33.533
95% Conf. Interval	(51.040, 63.553)	(53.878, 62.954)	(54.223, 61.646)
Difference (diff)	-1.120		
t-Statistic	-0.294		
p-Value	0.385		
Degrees of Freedom	314		

Interpretation:

Given the p-value for the two-tailed test is 0.385, which is not significantly less than the standard alpha level of 0.05, we fail to reject the null hypothesis. There is no strong evidence to suggest that there is a statistically significant difference in means between the two groups. The confidence interval for the difference in means ranges from -1.481 to -0.202. These results indicate that the mean contribution in the TPGG first group (57.296) is not significantly different from the mean contribution in TDG first group (58.416) in the Dictator Game with endowment adjustment.

Additional Robustness Check: Welch's t-test was performed to assess the robustness of the results. The Welch's t-test yielded similar conclusions to the standard t-test, indicating no significant difference in means between the two groups.

Sensitivity Analysis

Table A.B2: Regression Analysis of contribution in PGG with respect to contribution in DG and other socio economic variables

Independent Variable	Contribution in PGG	Contribution in PGG	Contribution in PGG
Contribution in dictator game (a_i)	0.244***	0.240**	
	(0.089)	(0.109)	
t_i (Dummy variable 0 or 1)			9.919*
			(5.772)
Age	-0.236		
	(0.200)		
Education	-0.583		
	(0.472)		
Water quality	1.504		
	(4.381)		
Household Income	0.000		
	(0.000)		
Gender(male=1, female=0)	8.014**		
	(3.954)		
Number of participant in a session	1.168*		
	(0.643)		
Household member	1.597		
	(1.431)		
Constant	21.220	40.78***	45.333***
	(16.938)	(6.446)	(5.426)
N	153	153	153
R^2	0.118	0.046	0.028

Notes: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.B3: Logistic Regression of Adjusted endowment from PGG and contribution in DG in TPGG first group

Independent Variable		t_i (dummy variable 0 or 1)			
k_i (0 or 1)	0.862*	0.938*	0.965*	0.777	0.985*
	(0.480)	(0.555)	(0.545)	(0.569)	(0.558)
Age		-0.241*	0.009	0.045**	-0.254*
		(0.142)	(0.017)	(0.022)	(0.138)
Household income		-0.000	-0.000	-0.000	-0.000
		(0.000)	(0.000)	(0.000)	(0.000)
Water quality(pure=1, not pure=0)		0.267	0.264	-0.157	0.259
		(0.527)	(0.549)	(0.533)	(0.530)
Gender (male=1, female=0)		0.015	0.735	0.690	-0.046
		(0.579)	(0.518)	(0.514)	(0.568)
Education		0.157***		0.160***	0.153***
		(0.057)		(0.059)	(0.057)
Land ownership		1.227**	1.198**		1.296**
		(0.548)	(0.519)		(0.551)
Age_squared		0.004**			0.004**
		(0.002)			(0.002)
No of household members					0.152
					(0.120)
Constant	0.747*	2.008	-0.465	-2.402*	1.766
	(0.405)	(2.727)	(0.866)	(1.265)	(2.718)
N	136	136	136	136	136
Pseudo R^2	0.023	0.185	0.111	0.123	0.192

Notes: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Appendix A.C- Experimental Protocol

1. Participant Arrival and Randomization

Participants are asked to arrive at least 15 minutes before the scheduled start time. Upon arrival, participants receive a random player number. Cards with participant IDs corresponding to seat numbers are prepared for random seat allocation. If the number of participants is not divisible by three, one or two participants will be randomly selected to be allocated twice in the group. Participants were informed that in each group there will be three (3) participants. Participants are assigned seats according to their player numbers.

2. Instructions

General Instructions

Participants receive a 150 Taka show-up fee. They are briefed on the nature of the experiment and informed that their final earnings will be determined by their performance in the games. Anonymity is assured for all responses and decisions. They were informed that the experiment will last approximately two hours and participants must stay for the entire duration unless they notify the experimenter in advance.

Participants were informed at the beginning of the game that they would play either one (1) or two (2) separate games or two (2) interrelated games. If two separate games were played then only one (1) would be chosen at random for payments.

Game Instructions and procedure

At the beginning of the experiment, participants are given an endowment of 200 Taka. Threshold for both games is determined as 150 taka.

In the TPGG first group, they play the public good game first. If the group's total contribution meets the threshold, the contribution is multiplied and the benefit is distributed equally. They then proceed to the dictator game with the adjusted endowment.

In the TDG first group, participants start with the dictator game. Their decisions are kept confidential until they play the public good game. Contributions in the dictator game are subtracted from their initial endowment. In the public good game, their contributions are assessed, and if the threshold is met, the collective benefit is distributed.

TDG group first

Round 1: Dictator Game

- Endowment: Each participant receives an endowment of 200 Taka.
- Decision: Participants decide how much of their endowment to contribute to the group project addressing the future generation. They will keep the remainder.
- Examples and Framing: Participants are given examples to illustrate how contributions affect the threshold.

Round 2: Public good game

- Endowment: Each participant starts with 200 Taka.
- Contribution Decision: Participants decide how much to contribute to a public goods project for the current generation.
- Project Multiplier: The total contribution is multiplied by 1.5, if threshold is reached as a group.

TPGG first group

Round 1: Public good game

- Endowment: Each participant starts with 200 Taka.
- Contribution Decision: Participants decide how much to contribute to a public goods project for the current generation.
- Project Multiplier: The total contribution is multiplied by 1.5, if threshold is reached as a group.

Round 2 : Dictator Game

- Endowment: Remaining Taka from Round 1 is used.
- Decision: Participants decide how much of the remaining Taka to contribute to the Dictator Game project.

Control Question

Participants answer control questions to confirm their understanding of the game rules and payoff calculations.

Parameters:

- Initial Endowment (e_i): 200 taka, Multiplier (β): 1.5, Number of Players (n): 3
- Public Good GameThreshold (Tp)= Dictator Game Threshold (Ta)= 150 taka
- Individual Threshold (mental calculation): 50 taka per person $\frac{Tp}{n} = \frac{Ta}{n} = \frac{150}{3}$

Payoff Matrix and Final Payment

Public Good Game (PGG):

If the Total Contribution (Cp_i) Meets or Exceeds the Threshold *(Tp) or* $Cp_i \geq 150$ taka:

Then payoff, $z_i = e_i - p_i + \frac{Cpiß}{n}$

If the Total Contribution (Cp_i) is Less Than the Threshold (Tp) or $Cp_i < 150$:

Then payoff for each player i: $z_i = e_i - p_i$

- Where: e_i=200 taka, p_i= Contribution of player i, β=1.5
  - Total Contribution in public good game: $Cp_i=(p_1) +(p_2) +(p_3)$

Dictator Game (DG):

In the TDG first group, at the beginning every participant is given an endowment of e_i. In the TDG first group, 'a_i' contribution ranges from 0 to 'e_i ', whereas, $0 \leq a_i \leq e_i$. In this group, the payoff function for a player i is $u_i=e_i-a_i$.

In the TPGG first group, participants played the DG in Round 2, after playing the public good game in Round 1. Thus, in the DG, they played with the adjusted endowment of z_i, which represents their individual earning from the public good game. Thus, in the TPGG first group, 'a_i' contributions range from 0 to z_i (whereas, $0 \leq a_i \leq z_i$). In this group, the payoff function for a player i is $u_i= z_i-a_i$.

- e_i=200 taka, z_i= Payoff from the public good game, a_i = Amount donated by player i
  - Total Contribution in dictator game : $Ca_i=(a_1) +(a_2) +(a_3)$

After the games, participants complete a post-experiment questionnaire, and final payments are calculated based on the randomly selected game outcomes. Payment receipts are provided, and confidentiality is maintained throughout the process.

Appendix A.D- Theoretical Models

This appendix provides a detailed explanation of the Network of Action Situations (NAS) framework and its feedback loops, as applied in this study. The NAS framework emphasizes interconnected decision-making processes, highlighting how outcomes from one action situation influence subsequent decisions through feedback dynamics.

D1. NAS Feedback Dynamics

The NAS framework extends the Institutional Analysis and Development (IAD) framework, emphasizing the interdependencies between adjacent action situations. In this study, two key action situations were examined:

1. **Public Good Game (PGG)**: Intragenerational cooperation where participants contribute to a shared resource benefiting their generation.

2. **Dictator Game (DG)**: Intergenerational altruism where participants allocate resources to future generations without direct reciprocity.

Feedback Loops in the Experimental Design

- **TPGG-First Group**:
    - **Sequence**: PGG → DG
    - **Mechanism**: Revealed outcomes from the PGG provided informational signals, reducing strategic uncertainty and fostering cooperative behavior in the subsequent DG.
    - **Result**: Learning effects mitigated the spillover of strategic uncertainty, leading to sustained cooperation.
- **TDG-First Group**:
    - **Sequence**: DG → PGG
    - **Mechanism**: Lack of feedback from the DG amplified strategic uncertainty, which spilled over in the subsequent PGG, leading towards risk averse behavior .
    - **Result**: Reduced contributions due to increased uncertainty and risk aversion.

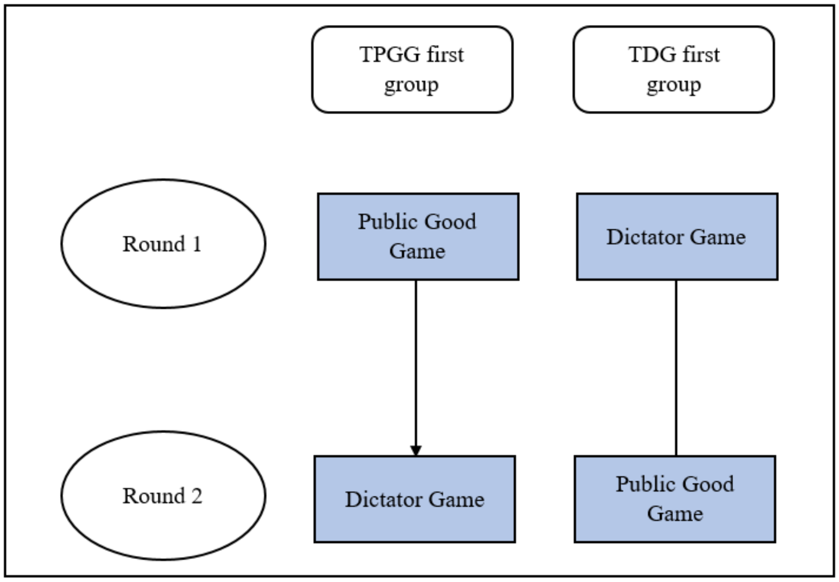

Figure A.D1: Group setup with rounds. (↓) arrow indicates the link to the previous game with the adjusted endowment. (Round 1 and Round 2 also represent Action situation 1 and Action situation 2, respectively.)

Hypotheses

1. **Hypothesis 1**:

    ○ In the hypothesis, the comparison between PGG in the TPGG first group and TDG first group is done, as shown in Figure A.D2. Feedback loops demonstrate the spillover effect of strategic uncertainty from the DG to the PGG.

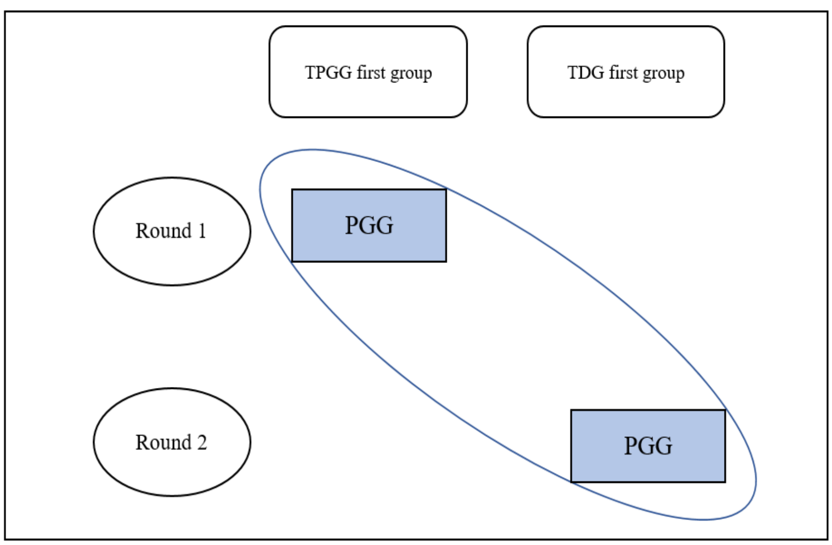

Figure A.D2: Comparing the contribution in the PGG in TPGG first group and TDG (The oval shape shows the comparison between the groups)

Hypothesis 2:

- Revealed outcomes in the PGG foster learning effects that counteract strategic uncertainty in the DG.Figure A.D3 shows the comparison between DG in TPGG first group and TDG first group.

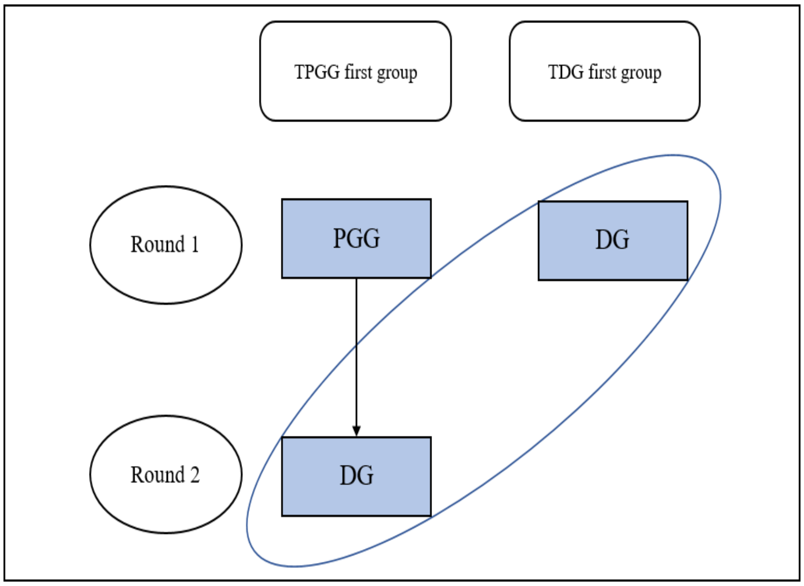

Figure A.D3: Comparison between the contribution in TDG first group and TPGG first group. (The transparent oval shape indicates the comparison between the games).

Hypothesis 3:

- In hypothesis 3 the relationship between the DG and PGG was analyzed as shown in Figure A.D4. In Hypothesis 3.2, it is shown that the trust and reduced strategic uncertainty amplify cooperative behavior, emphasizing conditional relationships between games.

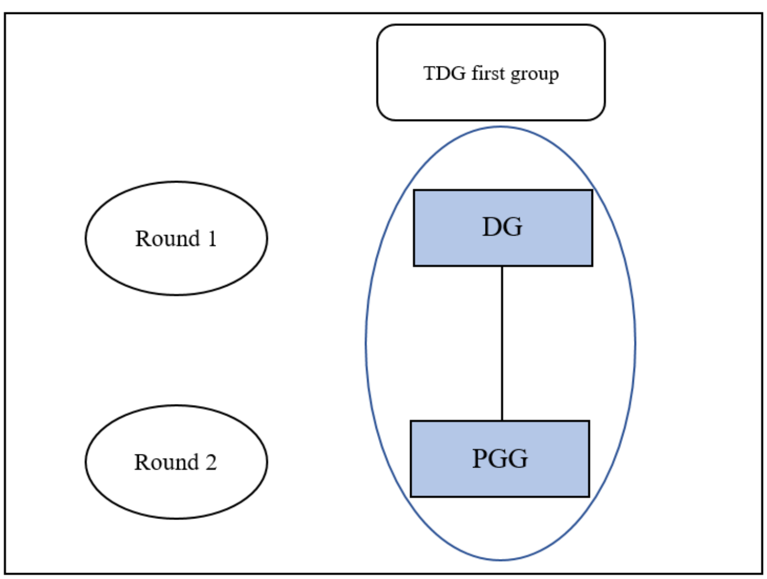

Figure A.D4: Relationship between the contribution in the DG with contribution in the PGG. (The transparent oval shape indicates the predictive relationship between the games).

D2. Nash Equilibria in PGG and DG

The PGG exhibits two distinct pure strategy Nash equilibria. The first equilibrium, known as the strong free-riding equilibrium, involved each player contributing zero (0). The second pure strategy equilibrium involved the group contributing precisely enough to fulfill the threshold requirement without surpassing it.

The Nash equilibrium in the DG is for players to contribute zero(0), representing a standard freeriding outcome.

Theoretical baselines for the games suggest minimal contributions in the DG and threshold-driven contributions in the PGG. However, observed deviations indicate the influence of social preferences and trust.

Appendix B (Chapter 2)

Appendix B.A- Additional Tables

Table B.A1: Description of variables

Variable	Description
Household income	Household income (in taka per month)
Land area	Total cultivable land for each household (in katha)
Age	Numeric Variable
Education (years)	Years of schooling for Participant
Number of Family members	Number of Family members in a household
Water quality	Dummy variable of 1 when the participant state water quality is pure, otherwise 0
Gender	Dummy variable of 1 when the participant is male, others 0
No of participant/session	Number of participant on each session
Ca_i	Contribution in TDGF
Cp_i	Contribution in TPGG

Table B.A 2.1: Summary Statistics of Contribution in TDGF and TPGG

Group	Group Composition	Obs	Mean	Std Dev	Min	Max
TDGF	Male Group	27	80.370	48.316	40	200
	Female Group	54	58.148	27.682	0	180
	Mixed group	99	52.575	23.183	0	150
	Equal Mixed	36	59.583	24.213	0	150
	Male dominated mix	48	49.167	23.595	0	150
	Female dominated mix	15	46.667	14.960	20	60
	Total Male	83	61.867	35.361	0	200
	Total Female	97	55.464	26.221	0	180
	Total	180	58.416	30.851	0	200
TPGG	Male Group	40	67.25	26.115	0	150
	Female Group	24	51.667	14.646	20	100
	Mixed Group	72	90	59.977	0	200
	Total Male	80	82.125	48.514	0	200
	Total Female	56	68.571	47.918	0	200
	Total	136	76.544	48.555	0	200

Table B.A2.2: Summary statistics of socio-economic variables of TDGF

Independent variable	Obs.	Mean	Std Dev	Min	Max
Age (years)	180	34.972	10.963	18	70
Gender (Male=1, Female=0)	180	0.461	0.499	0	1
Household income(bdt)	180	9433.889	9015.357	0	70000
Water quality (Pure=1, Not pure= 0)	180	0.3	0.459	0	1
Education (no of years)	180	10.067	4.415	0	21
Land area (katha)	180	22.669	39.653	0	200
Number of participant/session	180	18.00	4.243	9	24

Table B.A2.3: Summary statistics of Socioeconomic variables of TPGG

Independent variable	Obs.	Mean	Std dev	Min	Max
Age (years)	136	34.058	12.685	18	70
Gender (Male=1, Female=0)	136	0.588	0.493	0	1
Household income (bdt)	136	8339.706	9064.806	0	80000
Water quality(Pure=1, Not pure= 0)	136	0.286	0.453	0	1
Education	136	10.713	4.831	0	19
Land area(katha)	136	31.275	66.084	0	400
Number of participant/session	136	19.705	2.464	18	24

Table B.A3.1: Regression on TDGF and TPGG for socioeconomic variable

Independent Variable	TPGG	TDGF
	All Group	All group
Age	1.237***	0.345
	(0.367)	(0.212)
Gender (Male=1, Female= 0)	0.610	4.295
	(8.805)	(4.518)
Education	2.794***	0.910*
	(1.001)	(0.528)
Land area(katha)	-0.153**	-0.009
	(0.062)	(0.057)
Family Income	-0.000	0.000
	(0.000)	(0.000)
Water Quality	-18.49**	-4.211
	(8.774)	(4.876)
No. participant /session	-7.206***	-2.905***
	(1.659)	(0.609)
Constant	158.0***	90.030***
	(36.870)	(16.776)
Observations	136	180

Notes:Standard errors in parentheses,* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.A3.2: Regression analysis of the contribution of the Mixed-sex group

Group Composition	Contribution in TPGG		Contribution in TDGF	
	Male participant	Female participant	Male participant	Female participant
Mixed group	29.75^{***}	29.58^{**}	-27.42^{***}	-6.055
	(10.385)	(10.937)	(9.722)	(5.269)
Constant	67.25^{***}	51.67^{***}	80.37^{***}	58.148^{***}
	(4.129)	(2.980)	(9.236)	(3.771)
Observations	80	56	83	97
R^2	0.095	0.095	0.134	0.013

Notes:Robust Standard errors in parentheses,* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.A4.1: Rationale for contribution decisions in the TPGG by Group and Gender

	Contribution in TPGG				
Reason why did you invest	Male Group	Female Group	Mix Group	Mixed Group (male)	Mixed Group (female)
Others will invest	-10.864	-3.644	38.210**	52.726**	16.232
	(8.208)	(6.901)	(15.639)	(22.797)	(28.721)
Others will not invest	-11.818	-26.664**	26.810	48.268	9.445
	(16.457)	(10.561)	(23.796)	(35.770)	(37.526)
To increase the earning of the team	-5.841	-0.951	22.619	30.027	21.614
	(9.188)	(6.460)	(15.883)	(25.284)	(24.551)
To increase self earning	-0.842 (9.188)	10.160 (7.223)	-15.850 (16.756)	4.219 (25.910)	-24.524 (24.551)
More male in team	11.249		-24.546	-7.288	-20.709
	(9.821)		(25.812)	(46.191)	(39.996)
More female in team		- 1.684	-24.243	-45.997	24.332
		(7.551)	(27.433)	(36.0415)	(50.883)
Constant	75.440***	52.139***	76.1485***	60.925***	84.26079***
	(7.284)	(6.646)	(17.985)	(29.142)	(29.440)
Observations	39	24	71	40	31

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.A4.2: Regression who invested more and the reason for investing in TPGG

Independent variable(binary)	Who invested more in TPGG (dependent binary variable)		
PGG reason why they invested more	Male	Female	Both gender equally
They care about the group	0.045	-0.170***	0.125*
	(0.066)	(0.063)	(0.068)
They earn money	0.385***	-0.372***	-0.0136
	(0.068)	(0.064)	(0.070)
They are altruistic	-0.277***	0.089	0.187***
	(0.070)	(0.066)	(0.071)
They are responsible towards people	-0.114	-0.023	0.137*
	(0.072)	(0.068)	(0.073)
They can earn through game	-0.220**	0.247**	-0.0265
	(0.108)	(0.102)	(0.111)
They are more cooperative in a group	-0.048	-0.141	0.189*
	(0.108)	(0.102)	(0.110)
They trust other members in the team	0.011	-0.205**	0.195*
	(0.108)	(0.102)	(0.110)
They are religious	-0.134	0.102	0.0317
	(0.110)	(0.104)	(0.113)
Constant	0.401***	0.450***	0.149**
	(0.061)	(0.058)	(0.063)
Observations	219	219	219

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.A4.3: Who and the reason for investing more in TDGF (binary variable)

Independent variable	Who invested more in TDGF (dependent variable)		
Reason for contribution (Dummy variable)	Male	Female	Both gender equally
They care about future generation	0.046	-0.174***	0.128**
	(0.058)	(0.054)	(0.055)
They earn money	0.470***	-0.409***	-0.061
	(0.064)	(0.059)	(0.060)
They are altruistic	-0.289***	-0.0685	0.357***
	(0.067)	(0.062)	(0.063)
They are more responsible	-0.024	-0.025	0.049
	(0.066)	(0.062)	(0.062)
They are more cooperative in a group	-0.008	-0.036	0.044
	(0.092)	(0.086)	(0.087)
They trust other members in the team	-0.073	-0.092	0.165**
	(0.083)	(0.077)	(0.078)
They are religious	-0.274**	0.226**	0.048
	(0.116)	(0.107)	(0.109)
Constant	0.468***	0.471***	0.061
	(0.062)	(0.058)	(0.058)
Observations	230	230	230

Notes: Standard error in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix B.B-Statistical Test

Results of Two-Sample t-test for Male and Female contribution Comparison in TPGG

Sample Description:

Male group (n = 80):Mean contribution = 82.125, Std. Err. = 5.424, Std. Dev. = 48.515

Female group (n = 56):Mean contribution = 68.571, Std. Err. = 6.403, Std. Dev. = 47.917

T-test Results: t-value = 1.6115, Degrees of Freedom = 134

Null Hypothesis (Ho): There is no difference in contribution amounts between male and female groups.

Alternative Hypotheses (Ha):

Ha: diff < 0 (one-tailed): Pr(T < t) = 0.945

Ha: diff != 0 (two-tailed): Pr(|T| > |t|) = 0.109

Ha: diff > 0 (one-tailed): Pr(T > t) = 0.055

Results of Two-Sample t-test for Male and Female contribution Comparison in TDGF

Sample Description:

Male group (n = 83):Mean contribution = 61.867, Std. Err. = 3.881, Std. Dev. = 35.361

Female group (n = 97): Mean contribution = 55.463, Std. Err. = 2.662, Std. Dev. = 26.221

T-test Results: t-value = 1.392, Degrees of Freedom = 178

Null Hypothesis (Ho): There is no difference in contribution amounts between male and female groups in the TDGF.

Alternative Hypotheses (Ha):

Ha: diff < 0 (one-tailed): Pr(T < t) = 0.917

Ha: diff != 0 (two-tailed): Pr(|T| > |t|) = 0.166

Ha: diff > 0 (one-tailed): Pr(T > t) = 0.083

We fail to reject the null hypothesis for both TDGF and TPGG at a 5% significance level.

Appendix B.C-Experimental procedure

The experiment followed a standardized procedure to ensure subject anonymity and session uniformity. Each experimental session included the provision of printed instructions in Bengali, the native language of the participants, along with verbal explanations of the game rules and visual demonstrations. Participants were randomly assigned to groups while controlling for gender composition, forming three-player groups where individuals were unaware of the identities of the other members. Decisions were made independently without communication among group members to analyze individual contribution behavior and gender perceptions under different gender compositions. This non-communication strategy aimed to prevent strategic reputation building through contribution, with game results kept confidential between the player and the experimenter.

Upon completion of the experimental game, earnings were tabulated, and payment envelopes labeled with participant numbers were prepared. Enumerators conducted individual surveys with all participants, and payment included earnings from the game as well as a 150 taka participant fee.

Framing and Contextualization of Experimental Games

The framing of the TPGG emphasizes the immediate needs of the current generation, highlighting examples of public goods essential for addressing current water scarcity and natural disasters which wouldn't last longer for the future generation. Participants are introduced to the concept of collective contribution and the importance of surpassing a predetermined threshold to unlock benefits for all, whereas failure to do so would result in the loss of all contributions. It illustrates principles of non-excludability and collective action.

In this experiment, the threshold for the TPGG is set at 150 taka. Meeting or exceeding this threshold ensures that the collective contribution is multiplied by 1.5 times, with equal benefits distributed among all participants, regardless of individual contributions, exemplifying the principle of non-excludability. Conversely, if the threshold is not met, all collective contributions are forfeited.

The framing of the TDGF in this study revolves around the intergenerational concept, emphasizing that the actions of the present generation significantly impact the well-being of future generations, particularly concerning climate change adaptation related to water resources and natural disaster management. Participants are informed that contributions made in the TDGF do not yield immediate benefits for the current generation; instead, they incur costs but offer advantages to future generations. Examples provided include contributions to educational institutions or research for future generations, afforestation initiatives, advancements in technology, and the construction of infrastructure such as dams, aimed at addressing water scarcity or enhancing resilience to natural disasters in the long term, with benefits expected to manifest after approximately 50 years.

Appendix C (Chapter 3)

Appendix C.A-Additional Tables

Table C.A1:Description of variables

Variable	Description
Household income	Household income (in bdt per month)
Family Land (dummy variable)	Dummy variable of 1 when family owns the land, otherwise 0
Age	Numeric variable
Religion(dummy variable)	Dummy variable of 1 when religion is Hindu, otherwise 0
Water Quality (dummy variable)	Dummy variable of 1 if water quality is pure, otherwise 0
Education (years)	Years of schooling for Participant

Table C.A2.1:Unpaid household work of men vs women (2022)

Household work distribution	Female respondent (hours)	Male respondent (hours)	Total household work (hours)
Home cleaning	113 (75.8%)	36	149(100%)
Child rearing	384(95.8%)	17(4.2%)	401(100%)
Cooking	272(96.1%)	11(3.9%)	283(100%)
Water collection	122(67.0%)	60(33.0%)	182(100%)
Homestead gardening	43(45.3%)	52(54.7%)	95(100%)
Purchasing household goods	50(27.6%)	131(72.4%)	181(100%)
Take care of siblings	15(51.7%)	14(48.3%)	29(100%)
Take care of elderly people	94(78.3%)	26(21.7%)	120(100%)
Taking care of household animal	20(80.0%)	5(20.0%)	25(100%)
N	148	148	296
Total hour of care work	1113 (75.973%)	352(24.027%)	1465(100%)

Table C.A2.2: Water collection duty

Who collect water for household	No of people stated (2022)	No of people stated (2021)
Only women	171 (66.02%)	149 (47.76%)
Only men	32 (12.35%)	66 (21.15%)
Both men and women	56 (21.62%)	97 (31.09%)
N	259	312

Table C.A3: Summary statistics of the socio-economic variable

Variable	Obs	Mean	Std. Dev.	Min	Max
Age	148	33.054	8.714	18	65
Family Land (dummy variable)	148	0.446	0.499	0	1
Water quality (dummy variable)	148	0.324	0.470	0	1
Care work(hr)	148	7.777	1.833	3	12
Household Income (bdt)	148	8102.027	7714.978	0	50000
No. of children	148	1.608	1.021	0	4
Education	148	9.385	4.571	0	20

Appendix C.B-Tables and Analysis

Table C.B1.1: Who makes consumption decisions in your family (married person)?

Decision making	Male	Female
Me	54(54%)	12(9.60%)
My spouse	4(4%)	38(30.40%)
Me and my spouse	20(20%)	68(54.40%)
Other	22(22%)	7(5.60%)
Observations	100	125

Table C.B1.2: Can you make decisions on your own in the following matters? (Never=1, Rare=2, Sometimes=3, Most of the time=4, Always=5)

Decision making variable	Obs.	Mean	Standard deviation	Min	Max
Spending for yourself	148	3.373	1.376	1	5
Spending for parents from own earning	148	3.294	1.568	1	5
Involvement in economic activities	148	3.373	1.376	1	5
Going outside home alone	148	3.013	1.433	1	5
Purchase household good	148	3.699	1.358	1	5
Involvement in social work	148	3.418	1.370	1	5

Table C.B1.3: Do you take part in these decisions? (Never=1, Rare=2, Sometimes=3, Most of the time=4, Always=5)

Decision-making variable	Obs.	Mean	Std Dev	Min	Max
Family decision making	148	3.236	1.367	1	5
Family planning	130	3.162	1.334	1	5
Children education	122	3.311	1.478	1	5
Land transaction	153	1.973	1.309	1	5

Table C.B2: Variance Inflation Factor (VIF) Analysis for Independent Variables in the Decision-making and Care Work Model

Variable	VIF	1/VIF
Care Work	1.06	0.947
Age	1.57	0.636
Family Land	1.26	0.791
Household Income	1.12	0.893
Number of Children	1.86	0.537
Education	1.70	0.588
Water Quality	1.30	0.771
Religion	1.17	0.857
Mean VIF	1.38	

Appendix C.C- Exploratory Factor Analysis

Eigenvalues and Factor Retention Criteria

Method: Principal-Component Factors

Number of Observations: 153

Number of Parameters: 19

Eigenvalues and Proportion of Variance Explained:

Table C.C1.1: Exploratory factor analysis of decision-making agency of women

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor 1	3.859	2.271	0.386	0.386
Factor 2	1.588	0.321	0.159	0.545
Factor 3	1.267	0.552	0.127	0.671
Factor 4	0.715	0.074	0.072	0.743
Factor 5	0.641	0.136	0.064	0.807
Factor 6	0.505	0.039	0.050	0.858
Factor 7	0.467	0.105	0.047	0.904
Factor 8	0.362	0.025	0.036	0.940
Factor 9	0.337	0.078	0.034	0.974
Factor 10	0.259	.	0.026	1.000

Factor Analysis After Rotation

Method: Principal-Component Factors
Rotation Method: Orthogonal Oblimin (Kaiser Off)
Number of Observations: 153
Retained Factors: 2
Number of Parameters: 19

Table C.C1.2 Variance Explained by Retained Factors:

Factor	Variance	Difference	Proportion	Cumulative
Factor 1	3.266	1.085	0.327	0.327
Factor2	2.181	.	0.218	0.545

LR Test: Independent vs. Saturated:

$\chi 2$ (45) = 540.12

Prob > $\chi 2$ = 0.000

Table C.C1.3: Rotated Factor Loadings (Pattern Matrix) and Uniqueness:

Variable	Factor 1	Factor2	Uniqueness
Going out alone	-0.186	0.674	0.511
Spending for yourself	0.719	0.114	0.470
Purchase household good	0.781	0.110	0.379
Land transaction	0.402	0.536	0.552
Family planning	0.491	0.383	0.613
Decision making in family matter	0.207	0.809	0.303
Social work	0.281	0.762	0.340
Spending for parents	0.715	0.115	0.476
Economic participation	0.620	0.139	0.596
Children education	0.829	0.003	0.314

Retained Factors:

- Factor 1 and Factor 2 were retained based on the criteria of eigenvalues greater than 1 and the cumulative proportion of variance explained, which totals approximately 54.47%.

Rotated Factor Loadings:

- Factor 1 is heavily loaded with variables such as spending for yourself, purchasing household goods, spending for parents, economic participation, and children's education.

- Factor 2 is heavily loaded with variables such as going out alone, decision-making in family matters, and social work.

Figure C.C1 shows the variables loading to Factor 1 and Factor 2. Factor 1 indicates outcome 1 and factor 2 indicates outcome 2. This figure shows how the decision-making agency variables are positioned based on loadings.

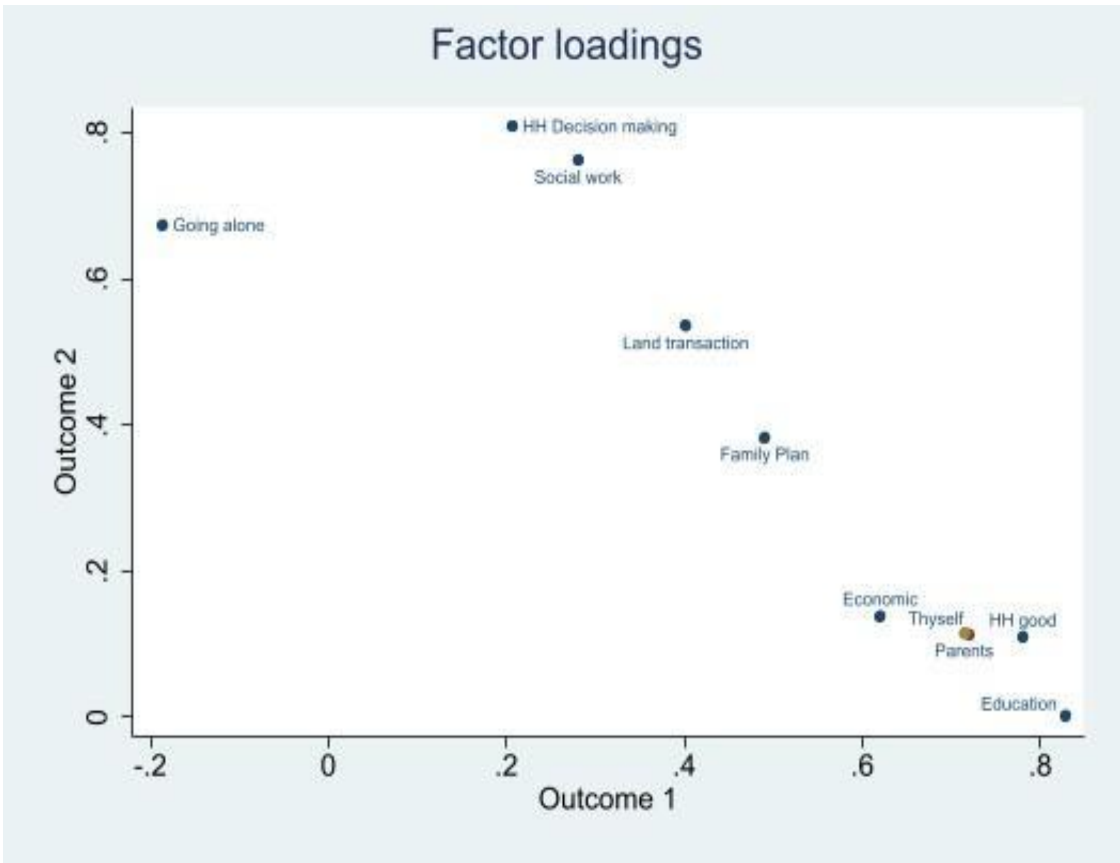

Figure C.C1: Factor loading representing Outcome 1 and Outcome