Impact of Interventions amid Shocks: Evidence from Two Randomized Experiments in the Philippines

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Abstract

Natural disasters, known as covariate shocks, heavily affect poor Filipino households and farmers in rural areas. To alleviate poverty and increase agricultural productivity, the government and international organizations have implemented large-scale conditional cash transfers (CCT) and agricultural infrastructure rehabilitation. This dissertation investigates the behavioral responses to these interventions under climatic shocks, presented in two substantive chapters.

Chapter 2 evaluates the impact of a CCT program on risk mitigation and informal insurance systems among poor Filipino households during exposure to negative income shocks. CCT can reduce dependence on informal arrangements by increasing beneficiaries' income, making them more resilient to shocks and less reliant on informal networks. Conversely, it can reinforce informal arrangements by enhancing the financial capacity of eligible households, enabling them to lend money to others during shocks. Theoretical outcomes can thus be ambiguous. Using a sample of 1,415 households from 130 village clusters randomly assigned to treatment and control groups, intention-to-treat (ITT) estimates suggest that CCT has unintended consequences on risk mitigation and positive spillover effects on the informal system. Beneficiaries' medical expenses and borrowings from the informal system increased during shocks. Additionally, increased lending support was observed among ineligible households in treatment areas, along with a decrease in their borrowings from the informal system.

Chapter 3 investigates the impact of an irrigation rehabilitation scheme on rice productivity and water management practices during wet and dry planting seasons, using data from small-scale community irrigation systems in the Philippines. It examines whether rehabilitated irrigation infrastructure has reduced the risk of climatic events, such as waterlogging during floods and water scarcity during droughts. The study also explores if the intervention led farmers to sustain the management of communal water resources, ensuring sufficient water to improve rice productivity under extreme climatic conditions. Using a sample of 2,583 parcel-household levels from 113 community irrigation system clusters managed by irrigators' associations and random assignment to treatment and control groups, estimates suggest that rehabilitated irrigation infrastructure mitigated the effects of flooding and drought, leading to increased rice productivity. Farmers also demonstrated collective action through voluntary maintenance, particularly among those who attended water management training.

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Chapter 1: Introduction

The 2022 Sustainable Development Goals (SDGs) report highlights that medium- to large-scale disasters are projected to increase by 40% from 2015 to 2030. Climate variability and extremes, among other shocks, are hindering progress towards achieving zero hunger by 2030 (UN, 2022). Natural disasters, or covariate shocks, heavily impact poor households in both rural and urban areas, as well as farmers in rural areas across developing countries (Azam and Imai, 2012; Mazumdar et al., 2014; Haq, 2015; Ansah et al., 2021).

The Philippines is considered one of the most disaster-prone countries in the world, which serves as the primary motivation for this study. The Global Facility for Disaster Reduction and Recovery's 2017 report indicated that 74% of the Philippines' population is vulnerable to shocks from natural disasters, and 60% of the country's total land area is exposed to natural disasters such as typhoons, landslides, floods, volcanic eruptions, and earthquakes. Natural disasters are a major cause of poverty in the Philippines (ADB, 2009). Rural areas, where the majority of the population resides and depends on agriculture for income, are particularly affected. Natural disasters can devastate crops, especially when farm infrastructures like irrigation systems are weak, leading to significant income loss for farmers.

Given the country's high exposure to natural disasters and the lack of insurance or financial protection from catastrophic risks, poverty is exacerbated, and agricultural productivity is severely impacted. This dissertation, therefore, provides policy implications for poverty reduction, increased agricultural productivity, and natural disaster risk reduction in the Philippines.

According to the Philippine Statistics Authority, there were 872 extreme natural events and disasters between 2012 and 2022, causing an estimated PhP 497 billion in damages. Agriculture suffered the largest share of damages at 53% followed by infrastructure at 47%. The highest amount of damage was recorded in 2013 due to super typhoon Haiyan, locally known as Yolanda. The Department of Agriculture reported that Haiyan caused a loss of 147,000 MT of paddy rice over an affected area of 78,000 hectares, amounting to a production loss of PhP 2.4 billion (USD 55 million). The lack of diverse coping strategies is a significant problem for small-scale farmers in the Philippines, resulting in severe suffering in the aftermath of disasters (Israel and Briones, 2012).

Customarily, poor households resort to informal insurance as a risk coping mechanism during catastrophic events such as typhoons. In local communities, informal risk insurance is common, where social networks of relatives and friends share resources to help those in need during emergencies. In response to Typhoon Yolanda in 2013, the government scaled up the conditional cash transfer (CCT) program, known as the Pantawid Pamilyang Pilipino Program (4 Ps). Funding for the program increased by USD 12.5 million, with contributions from the World Food Program and the United Nations Children's Fund (World Bank, 2016). This initiative demonstrates the government's role in alleviating risks faced by the poor during calamities through development programs like the CCT.

The CCT program in the Philippines is one of the largest in the world in terms of population coverage. As of 2022, it benefits more than 4 million households nationwide. The program, which started in 2008, became a regular initiative of the Philippine government in 2019, serving as a human capital development program and a national poverty reduction strategy. While the primary goal of the CCT is to develop human capital among the poor, it also has the potential to manage risks by providing immediate financial support secured by government funding.

Given this potential, it is important to examine whether the CCT crowds out informal insurance during times of difficulty or shock. If so, further questions arise about how the CCT affects the informal insurance system. These questions are addressed in Chapter 2 of this dissertation. The crowding effect of the CCT on informal insurance is analyzed by examining the engagement of both eligible and ineligible households in informal insurance systems. Specifically, crowding-out effects are identified through the borrowing and lending behaviors of CCT-eligible and ineligible households within informal insurance networks. A reduced reliance on informal insurance, indicated by decreases in borrowing or lending among eligible or ineligible households, represents a crowding-out effect.

In Chapter 2, the ineligible households are described as "near poor," having been excluded from CCT eligibility due to criteria that prevented their participation. Using Proxy Means Test (PMT) scores available in the dataset, the study identifies households with incomes below and above the poverty threshold.

Chapter 3 discusses the impact of natural disasters on irrigation management. From 2010 to 2015, the Irrigated Rice Production Enhancement Project (IRPEP) was implemented by the International Fund for Agricultural Development (IFAD) to improve irrigation infrastructure, strengthen irrigator's associations (IAs), and enhance the marketing capacity of farmer beneficiaries in community irrigation systems (CISs). For farmers in rural areas, the financial strain from natural disasters can affect their ability to maintain the irrigation system, including paying irrigation fees. Additionally, weak irrigation infrastructure leaves crops vulnerable to damage during natural disasters. A cooperative system in irrigation management is essential, especially during natural disasters, to mitigate risks.

Cooperative systems of communal irrigation often provide training and capacity-building programs, helping farmers acquire the skills and knowledge needed to manage the irrigation system effectively and make informed decisions regarding water use. Given the IRPEP's aim to improve irrigation infrastructure, a key question is whether well-designed irrigation infrastructure can help control or manage water flow and reduce the risk of climatic events. The program includes capacity-building training, raising the question of whether training has improved water management practices, reduced water wastage, ensured water availability during droughts, and prevented waterlogging during floods. Furthermore, it is important to investigate whether the program has influenced farmers to fulfill their irrigation fee obligations and participate in maintenance activities, contributing to the sustainability of the irrigation system and improvements in rice productivity. These questions are addressed in Chapter 3 of this dissertation.

The questions regarding the CCT's effect on informal insurance and IRPEP's effect on water management and distribution are answered in Chapters 2 and 3, respectively. Both chapters utilize randomized experiments: (1) the CCT program implemented by the Philippine government and (2) the rehabilitation of irrigation systems implemented by an international organization. Both chapters estimate models comparing randomly assigned treatment and control groups. The interaction estimates between treatment and shock confirm whether the CCT undermines existing informal insurance within the community, as discussed in Chapter 2. They also confirm that improved irrigation infrastructure reduces the risk of climatic events such as waterlogging during floods and water scarcity during droughts, as discussed in Chapter 3.

To clearly understand the model setup for Chapter 2, the study focuses on the randomized control trial (RCT) participants of the CCT program. These participants are poor households vulnerable to risks and who engage in informal risk-sharing networks with friends and relatives during times of shock. The primary interest is to study the effects on their transactions within these informal networks. Therefore, the outcome indicators include the borrowing and lending behaviors of poor households under shocks. Chapter 2 finds an increase in both borrowings and lending among eligible households, while ineligible households show a decrease in borrowings and an increase in lending. These results suggest that the CCT improved the creditworthiness and financial capacity of eligible households, as evidenced by their increased borrowing and lending activities. Conversely, the CCT reduced the confidence of ineligible households in borrowing money due to uncertainty in their economic condition, while their trust in eligible households remained high, leading to increased lending towards eligibles.

The initial impact evaluation study on the CCT in the Philippines assessed and provided estimates of the intended outcomes on health and education (World Bank, 2014). Chapter 2 contributes to this by highlighting the unintended consequences of the CCT on strengthening existing informal safety nets and financial inclusion, as evidenced by the borrowing behavior of eligible households. Additionally, Chapter 2 explores the spillover effects of the CCT on ineligible households, examining whether their engagement in informal insurance was adversely affected.

For Chapter 3, the study covers household-farmers in communal irrigation systems in rural areas, focusing on parcels of land used for rice crop production in irrigated fields. The study aims to analyze whether the intervention has addressed water crises by mitigating the risks of climatic events. Thus, outcome variables related to water distribution and sufficiency are utilized. Additionally, to determine if the intervention led to better water management practices, outcome indicators related to collective action, such as maintenance time and fines, are examined.

Chapter 3 finds that rehabilitated irrigation infrastructure, combined with capacity-building training, mitigates the effects of extreme climatic events and promotes collective action. This is demonstrated through maintenance efforts and cost-sharing among farmers to distribute financial burdens and ensure the sustainability of the irrigation infrastructure. The main findings suggest that the rehabilitated irrigation system significantly mitigated the risks of flooding and drought by controlling soil erosion with drainage systems. This prevented waterlogging and maintained a sufficient water supply during dry spells.

For Chapter 3, an initial impact evaluation study on the rehabilitation of irrigation has been previously conducted to assess the intended outcomes of the project, including farmer income, agricultural productivity, and women's empowerment (Arsalan et al., 2018). Chapter 3 contributes to this body of knowledge by exploring the previously unexplored effects on collective action among farmers resulting from improved irrigation infrastructure and capacity-building training. While other studies have focused on institutions and agents governing large-scale irrigation facilities, Chapter 3 turns its focus to the behavior of farmers within small-scale communal irrigation systems. Contrary to the study by Arsalan et al. (2018), this research scrutinizes a more granular level of observation at the parcel-level unit, providing a more meaningful analysis aligned with the research objectives.

Review of Literature

CCT programs are at the forefront of social policy in developing countries, addressing poverty issues through investments in health, education, and nutrition. It is overwhelmingly clear from synthesized and refined literature that cash transfers and informal insurance interact, though the results have been mixed. Evidence of crowding in and out of cash transfers to informal insurance is found across various identification strategies such as difference-in-difference (Olinto et al., 2006), intent-to-treat (Evans and Kosec, 2020), and ANCOVA (Gulesci, 2020). The main factor influencing these interactions is the size of social program benefits.

Olinto et al. (2006) studied the CCT programs of Nicaragua (Red de Protección Social) and Honduras (PRAF-II). They assessed the link between these CCT programs and non-governmental organizations' food/money transfers. A crowding-out effect was found in Nicaragua, where food transfers in treatment areas were reduced compared to control areas, attributed to the large cash transfer size in Nicaragua. Similarly, Gulesci (2020) finds that BRAC's cash transfer program, which is relatively large, crowds out informal transfers because treated households share the transfer with other households in their village. This study also finds that beneficiaries reduced borrowing from out-of-village employers, an alternative transfer source for ultra-poor households, while increasing within-village reciprocal transfers. This alternative transfer from employers is typically reciprocated by ultra-poor households through working for lower wages. However, the program crowded out employer transfers, significantly reducing the likelihood of ultra-poor households receiving transfers from their employers. While the cash transfer improved the socio-economic conditions of ultra-poor households, it significantly reduced labor supply in the labor market.

Albarran and Attanasio (2003) also studied the crowding-out effect of the PROGRESA CCT, a large cash transfer program in Mexico. Their results suggest a crowding-out effect on private transfers in villages with lower income variance among households.

On the other hand, in the same study by Olinto et al. (2006), it was found that Honduras' cash transfer was too low to adversely affect private networks or informal insurance schemes. This is because the transfer amount averaged only 4% of household annual expenditures. Similarly, Evans and Kosec (2020) found that cash transfers had boosted trust and retained the informal safety net in Colombia, where the cash transfer amount was modest.

Chapter 2 of this dissertation contributes to the literature by examining the interaction of a covariate shock while investigating whether there is crowding out or in of the CCT program to informal insurance in the Philippines. The analysis of the crowding-out or in effect is conducted through the spillover effect to non-beneficiary households in treatment villages compared to control villages. None of the aforementioned literature has analyzed a similar approach to the study conducted in Chapter 2.

In connection to the interfering impact of covariate shock related to natural disasters in Chapter 2, such shocks also affect the irrigation system of the country. Improved irrigation infrastructure and effective irrigation practices are vital for maintaining irrigation systems in the Philippines. Mitigating the risk of climate variability supports the sustainability of water supply, essential for farmers to sustain crop production. Chapter 3 sheds light on the potential of improved irrigation infrastructure in minimizing the risk of climate change and underscores the importance of capacity-building training in fostering cooperative action among farmers.

Chapter 3 contributes to the literature on the climate risk mitigating effects of improved irrigation systems in developing countries. Established literature on irrigation has traditionally focused on institutional aspects such as rules, incentives, and collective action (Ostrom, 1993; Weissing and Ostrom, 1991; Bastakoti and Shivakoti, 2012; Benjamin et al., 1994). More recent literature has explored the relationship between irrigation and poverty alleviation (Hussain and Hanjra, 2004; Burney and Naylor, 2012;

Hussain and Hanjra, 2003; Huang et al., 2006; Smith, 2004). Some existing studies have also linked irrigation to water conservation (Ward, 2008; Fereres, 2003; Lecina et al., 2010; Jiang et al., 2016), while others have investigated its impact on agricultural productivity (Asher et al., 2022; Greaves, 2017; Jin et al., 2012; Dhehibi, 2016; Todkari, 2012; Owusu, 2016).

Concerns regarding the management and conservation of available water resources are critical for sustainable agricultural production. The Food and Agriculture Organization (FAO) affirms that climate change has significantly increased water demand for agriculture, projecting a rise in water needed for crop production by 2050 (Turral et al., 2011). Irrigation has provided a stable water supply, counteracting water shortages during dry spells and allowing smallholder farmers in rural areas to sustain agricultural production (Keswani et al., 2019; Garcia et al., 2020; Bhosale et al., 2012; Sekhri, 2014). Consequently, improving irrigation facilities leads to better water management and lessens the global water crisis for agricultural production (Hanjra and Qureshi, 2010).

Literature suggests that improved or rehabilitated irrigation results in a greater number of families benefiting from small irrigation schemes governed by farmers' cooperatives in villages, as observed in Mauritania (Mateos et al., 2010). Some studies have emphasized the favorable effect of farmer participation in maintaining irrigation systems, such as the rehabilitation project in Rajapur, India, which was one of the world's largest farmer-managed irrigation systems that suffered from flood damage (Howarth et al., 2002). Additionally, Rosegrant and Binswanger (1994) studied water management at the local level among smallholder farmers and found that the establishment of tradable water rights improves efficiency, equity, and sustainability of water use in developing countries.

Swallow et al. (2002) also found that payment for watershed management improved the flow, quality, or timing of water. However, water distribution can be compromised in cases of lack of maintenance, as observed in Mauritania (Mateos et al., 2010).

Chapter 3 of this dissertation assesses the implications for the sustainability of water supply for crop production by examining the effects of various forms of water user fees and maintenance. In addition to contributing to the literature, the chapter incorporates the effect of climatic events into the estimation model to determine whether rehabilitated infrastructure has mitigated their impact.

Chapter 2: Do cash transfers mitigate risks and crowd out informal insurance? Evidence from a randomized experiment in the Philippines

2.1 Introduction

Poor households in both rural and urban areas of low-income countries face a myriad of challenges arising from various types of shocks, including aggregate events like natural disasters, pest and disease outbreaks, as well as idiosyncratic shocks such as death (Dercon et al., 2006), illness (Gertler and Gruber, 2002; Mehmood, 2021), and job loss (Skoufias and Parker, 2006; Morduch, 1999). These adverse shocks can significantly diminish household incomes. In response, poor households employ a range of ex-ante and ex-post self-coping strategies, such as distress sales of assets, increased labor supply, migration for employment opportunities, reduced consumption by cutting back on non-essential expenses, and intertemporal resource allocation through borrowing and savings. However, these self-coping mechanisms often fall short in providing complete recovery from the impact of the shock.

Another common strategy adopted by households to cope with financial hardships is through informal arrangements within their social networks, commonly observed among extended families, ethnic groups, and neighborhoods (Dercon, 2002). For instance, Fafchamps and Lund (2003) examined risk-sharing arrangements, such as gifts, loans, and asset sales, among rural Filipino households in four villages in the Cordillera Mountains of the northern Philippines. Their research revealed that gifts and loans from friends and relatives served as effective risk-coping mechanisms during shocks, while informal insurance helped households manage the financial burden of funerals. However, these arrangements had limited impact on coping with shocks induced by crop failure, minor illnesses, or unemployment of household members other than the household head and spouse.

CCT programs also function as a form of coping mechanism. Conceptually, CCTs entail government subsidies for education, health, and food, contingent upon compliance with certain conditions related to improvements in health and educational outcomes. These cash transfers have been shown to mitigate various shocks, such as dropout rates from school (de Janvry et al., 2006) and teenage pregnancies (Baird et al., 2010). However, the spending of these transfers is ultimately at the discretion of the household. Indeed, evidence indicates that cash transfers can serve as safety nets during adverse events, such as negative weather shocks affecting agricultural production, as seen in countries like Zambia (Lawlor et al., 2019; Asfaw, 2017), Niger (Premand and Stoeffler, 2020), Kenya (Dietrich and Schmerzeck, 2019), and Indonesia (Christian et al., 2018).

While there is ample evidence supporting the positive effects of CCTs on risk mitigation, recent studies have raised concerns about potential unintended adverse consequences. For example, Filmer et al. (2021) identified a negative externality on the health outcomes of non-beneficiary children in the Philippines, attributed to an increase in the price of perishable foods in local markets. Similarly, Olinto et al. (2006) observed that CCTs potentially crowded out private food transfers and money/food transfers from non-governmental organizations in Nicaragua, particularly in instances where CCTs were sufficiently large, thereby affecting private networks and informal insurance schemes. This crowding-out phenomenon arises from households withdrawing from existing risk-sharing arrangements, particularly when informal insurance mechanisms are weak (Morduch, 1999). Consequently, it is essential to examine the impact of cash transfer programs on the pre-existing informal support networks provided by family, friends, and community members.

In examining the case of the Philippines, our study seeks to determine whether CCTs can effectively mitigate the negative income shocks experienced by poor households. Additionally, we aim to investigate whether CCTs have the potential to alter existing informal risk-sharing arrangements between beneficiaries and non-beneficiaries of cash transfer programs in the presence or absence of negative income shocks. Specifically, while Filmer et al. (2021) attribute negative consequences for non-beneficiaries to higher food prices in treated areas, we explore another potential channel whereby negative outcomes for non-beneficiaries are exacerbated through the reduction of informal risk-sharing in treated areas.

Our approach is aligned with several studies that have investigated similar phenomena. For instance, Olinto et al. (2006) examine two scenarios of cash transfer programs: one where the CCT program is substantial enough to influence private transfers, and another where the CCT program is too small to impact private transfers significantly. They identify two distinct effects on private transfers, including remittances and transfers from non-governmental organizations. In our analysis, we focus specifically on the crowding-out effects of CCTs, particularly considering the conditions under income shocks. Furthermore, we delve into the impact of informal arrangements within networks of friends and community members, as opposed to private transfers from NGOs, as informal safety nets have been shown to effectively protect poor households from irreversible shocks, as evidenced by studies in the Philippines (Fafchamps and Lund, 2003), Ethiopia, and Tanzania (Dercon et al., 2006).

The main findings of our study suggest that CCTs have the potential to strengthen the informal support system. We observe an increase in borrowings and lending among eligible households, indicating that CCTs have improved the creditworthiness and financial capacity of these households. Conversely, we find a decrease in borrowings and an increase in lending among ineligible households, suggesting that CCTs have diminished the confidence of ineligible households in borrowing money due to uncertainty regarding their economic conditions. Nevertheless, the trust in eligible households to repay debts remains high, leading to an increase in lending from ineligible households to eligibles within the informal system.

Our study contributes to several strands of literature. First, while existing studies have explored the impact of public transfers on informal transfers, the findings have been mixed. In contrast to some previous research, our study reveals that CCT recipients actually increased their borrowing. Theoretically, CCTs could enhance households' self-financing capacity, potentially reducing their reliance on informal arrangements. However, CCTs may also bolster households' financial standing, prompting them to support neighbors and friends, thereby reinforcing informal arrangements. This latter effect is particularly pronounced when norms of sharing are strong. Much of the evidence suggests that replacing informal risk protection mechanisms with government cash transfers in low- and middle-income countries could lead to social welfare losses (Nikolov and Bonci, 2020). However, in contexts such as rural Suriname and French Guiana, public transfers strengthened informal insurance systems when informal risk-sharing arrangements proved insufficient in addressing persistent adverse conditions like physical disabilities (Heemskerk et al., 2004). Similarly, in Tanzania, a formal cash transfer program did not crowd out informal safety nets; instead, it encouraged beneficiary households to engage with them (Evans and Kosec, 2020). While acknowledging this evidence, our study adds to the literature by examining the impact of the Philippines CCT program to determine whether it leads to crowding-out effects or generates positive spillover effects in informal social safety nets.

Second, the literature identifies the presence of unintended consequences of cash transfers, such as stunting among non-beneficiary children in the Philippines (Filmer et al., 2021), child labor in Mexico (de Janvry et al., 2006), and teenage pregnancies in Malawi (Baird et al., 2010). Our study contributes to this growing literature by providing insights into the differential effects of cash transfer programs on beneficiaries and non-beneficiaries. While Albarran and Attanasio (2003) evaluated the impact of a cash transfer program in Mexico, they assumed that the crowding effect was consistent for both beneficiaries and non-beneficiaries. In contrast, our study analyzes the disparity in the average outcomes of the program for beneficiary and non-beneficiary groups.

Finally, we emphasize the effects of CCTs on risk events or shocks, particularly harvest failure. Our findings indicate that while negative income shocks impact consumption levels in poor households in the Philippines, CCTs have a risk-mitigating impact on recipient households. Additionally, we observe a positive spillover effect among ineligibles in treated areas when covariate shocks occur, as they increase lending support to informal insurance and decrease borrowings to avoid exhausting the resources of the informal risk-sharing network. The decrease in borrowings from the informal network among ineligibles suggests that during shocks, their confidence in their ability to repay loans may diminish due to uncertainty about their economic conditions, leading them to be reluctant to borrow from informal insurance systems. Therefore, ineligibles may perceive that excessive borrowing could deplete the network's resources, rendering it unsustainable and ineffective during shocks. Thus, our findings suggest that CCTs have the potential to strengthen the informal system, and these results remain robust across various specifications.

2.2 Background and RCT setting

As large-scale cash transfer programs gained traction in Latin America and Africa, similar initiatives emerged in Southeast Asia, including Indonesia and the Philippines. The Pantawid Pamilyang Pilipino Program (4Ps) was introduced by the Philippines government's Department of Social Welfare and Development (DSWD) in 2008 as a response to the food, fuel, and global financial crises. A randomized experiment was conducted to evaluate the program's impact on health and educational outcomes. The eligibility criteria for the program's treatment group included households with children aged 0–18 years and/or pregnant household members. Household poverty status was determined using scores from the PMT, which predicts household income based on socioeconomic indicators such as household demographics, education, occupation, housing conditions, access to basic services, asset ownership, and location. Households with PMT scores below the poverty threshold were classified as poor and listed in a population database known as *Listahanan. Listahanan* serves as a registry of poor households and is utilized in various government programs, including the PhilHealth Universal Health Care program.

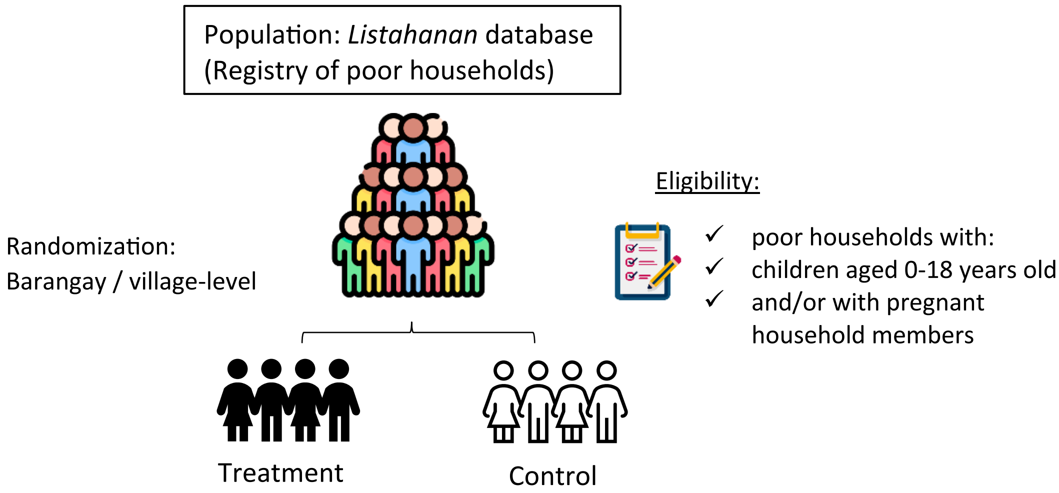

Figure 2.1 RCT design

Similar to CCT programs in other countries, eligible households under 4 Ps are required to meet specific conditions to receive cash grants. These conditions include ensuring immunization of children, monitoring their weight and deworming, receiving pre- and postnatal care, accessing delivery services from skilled health professionals for pregnant mothers, and ensuring 85% school attendance for children attending kindergarten, elementary, and high school. Parents are also required to attend monthly family development seminars aimed at promoting family and community development. Once these conditions are met, the eligible household receives various benefits, including a school fee allowance for up to three children, a budget for basic maternal and child health services, and a rice subsidy. Specifically, the household receives 300 pesos per child attending kindergarten and elementary school, 500 pesos for children attending high school, 500 pesos for basic maternal and child health services, and 500 pesos for rice subsidies on a monthly basis.

Initially, the program was piloted in selected areas before being gradually expanded nationwide through a phased implementation approach. Unlike CCT programs in other countries, the initial implementation of 4Ps did not involve the development of baseline data. Instead, three rounds of ex-post sample surveys were conducted with the head of households serving as the main respondent in 2011, 2013, and 2017–18 to assess the program's impact on various health, education, and behavioral outcomes[1]. While an initial randomized controlled trial (RCT) design was employed in 2011 with random assignment of the program at the village level, ethical concerns arising from the experiment led to a later implementation stage adopting a non-RCT-based framework.

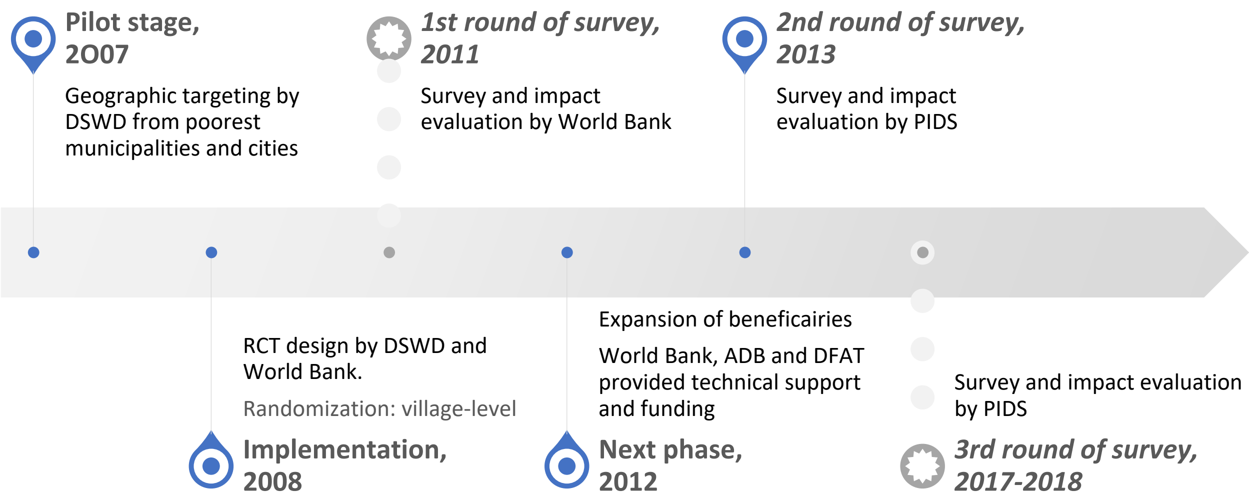

Figure 2.2 Timeline of implementation

[1] However, implementing an RCT for this program necessitates technical support from academia, government, and international organizations to guide the program implementer in executing the experiment properly. Therefore, the absence of baseline data may not have been a significant issue.

2.3 Data and Sample Survey

For this study, we extensively utilize data collected in 2011 from a population of 376,000 households covered during the initial phase of the program's implementation in 2008. The sample encompasses households both below and above the PMT poverty threshold in treated and control villages, which were either assigned to participate in the program or not. The total sample consists of 1,415 households from 130 villages, spanning 8 municipalities and 4 provinces across 3 major islands of the Philippines. Specifically, eligible households below the PMT poverty threshold represent 581 observations from randomly assigned program (treated) villages, and 608 observations from non-program (control) villages. In contrast, the sample size of ineligible households (those above the PMT poverty threshold) includes 120 observations from the treatment village and 106 observations from the control village. We exclusively utilize the 2011 data, as follow-up surveys employ a regression discontinuity design for impact evaluation, which is not suitable for examining the differential impacts of CCT on eligible and ineligible households.

Overall, the sample comprises 130 village clusters from eight municipalities across the three major islands of the Philippines. The dataset also provides information regarding the proportion of eligible households in the treatment village receiving benefits from the cash transfer, which closely aligns with the program assignment at 94%.

The survey employed separate instruments for household heads, mothers, female household members with partners, school-aged children, school principals, rural health officers, barangay officials, and local government mayors. Questionnaires collected data on various socioeconomic characteristics, reproductive history and contraception, school participation and child labor, health and nutrition, anthropometric measurements of children aged 0–5 years, cognitive assessment tests, barangay characteristics, and local government characteristics.

2.4 Estimation strategy

Our goal is to maintain homogeneity among groups, so we separately examine the impacts of the program for eligible and ineligible households, leveraging the advantages of an RCT design. We compared households with PMT scores below the poverty threshold in the treatment village to those with PMT scores below the poverty threshold in the control village, applying the same approach for ineligible households, considering the randomized treatment assignment at the village level.

First, we assessed if the program could mitigate negative income shocks. To estimate the program's risk-mitigation effects, we conducted an intention-to-treat (ITT) estimation using the following equation:

$$Cons_{ij} = \beta_0 + \beta_1 T_j + \beta_2 (T_j \times IS_{ij}) + \beta_3 IS_{ij} + \boldsymbol{X}_{ij}\theta + \epsilon_{ij}, \quad (1)$$

where $Cons_{ij}$ represents the outcome indicator of household i's consumption in village j, separately estimated for eligible (below PMT poverty threshold) and ineligible (above PMT poverty threshold) households. We assessed per capita consumption, decomposed into food products (e.g., dairy, meat, alcohol) and non-food products (e.g., education, medical expenditures). Dairy and meat consumption indicates potential improvement in living standards (because dairy products and meat are relatively expensive), while alcohol consumption reflects changes in temptation goods. Total consumption, education, and medical expenditure per capita were transformed using natural logarithmic functions, while dairy, meat, and alcohol consumption per capita were transformed using inverse hyperbolic sine functions, which accommodate zero-valued observations.

T_j denotes the random treatment assignment in the program, while IS_{ij} is an income shock variable proxied by harvest failure due to typhoons, floods, and other weather-related disasters, considered exogenous. We excluded idiosyncratic shocks (e.g., illness, death of family members) from our estimations due to their likely endogeneity. $\boldsymbol{X}_{ij}$ is a vector of controls including household head's demographic characteristics (e.g., age, gender), household characteristics (e.g., size, durable asset index), barangay characteristics (e.g., natural disaster index, log of barangay population and number of households), and fixed effects at the municipal level.

β_2 is the main coefficient of interest, estimating the differential impact of aggregate shocks on consumption between the treatment and control groups. It quantifies the risk-mitigation effects of program assignment. β_3 provides the estimate of the average impact of shocks on the control group's consumption, while β_1 measures the impact of the program on the consumption of households in the treatment group when there is no shock.

Second, to more directly examine evidence of spillover effects on informal arrangements, we estimated two models to compare the impact of receiving grants from the CCT program. The first model is given by Equation (2). This allowed us to examine the average effect on the informal system and to explore if CCT potentially improves informal risk-sharing through an increase in the overall available funds in a community.

$$Informal_{ij} = \beta_0 + \beta_1 T_j + \boldsymbol{X}_{ij}\theta + \epsilon_{ij}, \qquad (2)$$

The dependent variable $Informal_{ij}$ represents money borrowed and lent by households i in village j, excluding gifts received and given (e.g., church donations), migrant remittances, borrowing from moneylenders (e.g., Bombay 5-6)[2] or borrowing against land as collateral. This is measured by continuous variables, such as the amount of money borrowed from and lent to neighboring households or relatives. Borrowing and lending are estimated separately to better understand the inflow and outflow of transactions in the informal system. We focused on the impact of informal borrowing and lending because gifts are minimal and are not received regularly. $\boldsymbol{X}_{ij}$ is a vector of controls including the household head's characteristics (e.g., age, gender, marital status, nature of employment, having a bank account, and having a loan), household characteristics (e.g., size, durable asset index, social insurance index including life, health, housing, and other social insurance schemes), barangay characteristics such as health facility index (including barangay health station, rural health center, traditional birth attendant, private clinic, government hospital, private hospital, barangay pharmacy, and private pharmacy), barangay population, and fixed effects at the municipal level.

β_1 indicates whether the program crowds in or out informal arrangements. A positive β_1 denotes that the program increases the household's total available funds (supply), and community demand provides positive spillover effects to households belonging to informal risk-sharing schemes, while a negative β_1 suggests the opposite. Regarding borrowing outcomes, a negative coefficient implies that CCT is effective in reducing

[2] The variable for borrowings from money lenders is included to illustrate another typical coping mechanism among poor households in the Philippines.

financial vulnerability by making eligible households less reliant on borrowing. Conversely, a positive coefficient may indicate that CCT has improved the creditworthiness of eligible households, encouraging ineligible households in the informal network to lend money to them, anticipating that the borrowings will be repaid in the future.

As it is not possible to identify if program-eligible households increase or decrease informal arrangements with ineligible households within a village, we again estimated Equation (2) separately for eligible households (those below the PMT threshold) and ineligible households (those above the PMT threshold), We expect that when we observe a positive β_1 for outflows among eligible households, we will also see a positive β_1 for inflows among ineligible households in the case of positive spillovers.

Out of the 1,189 observations that fall below the PMT, 636 observations (53% of poor households) reported positive borrowing from, and 46 observations (4% of poor households) reported positive lending to informal systems, respectively, through friends and relatives. In contrast, among the sample size of 226 observations that fall above the PMT, 128 observations (only 57% of "near-poor" households) reported borrowings from, and 26 observations (7% of "near-poor" households) lent to informal systems, respectively, through friends and relatives.

As it is not possible to take the log for these observations due to the significant number of zeros, we used the inverse hyperbolic sine or arcsine transformation. For outcomes using the inverse hyperbolic sine transformation, we consistently employed Tobit regression to censor the outcome variables at lower limits. The estimates from this Tobit regression presents the coefficients or the effect of the independent variables on the latent variable y_i^* which has values censored at lower limits. It does not represent the effect of independent variables on the probability of being censored or the expected value of the observed outcome variables. Hence, the coefficients are not marginal effects.

We used the second model to examine if the program promotes households in treated villages to (1) leave, (2) stay but reduce their engagement, or (3) stay and engage in the informal insurance system when there is an income shock, represented by harvest failures. This helped us identify the mechanism by which the program reduces vulnerability to common shocks through engagement in risk-sharing activities. The estimation model is given by

$$Informal_{ij} = \alpha_0 + \alpha_1 T_j + \alpha_2 (T_j \times IS_{ij}) + \alpha_3 IS_{ij} + \boldsymbol{X}_{ij}\theta + \epsilon_{ij}, \quad (3)$$

In this model, α_2 captures the ITT spillover effects of the program on informal arrangements. We expect CCT-eligible households to contribute to the informal system in which poor households are likely to adopt risk-coping mechanisms when covariate shocks occur. It is also likely that program eligibles will reduce their reliance on the informal insurance system, contingent on the strength or enforceability of the sharing norm. A positive coefficient, α_2, can be expected from an increase in lending from CCT eligibles, largely driven by cash flows received from the program. It can also be expected from an increase in borrowings after proving their credibility for debt repayment. Debt repayment credibility within a community positively influences an individual's ability to better access and manage credit. However, it can also be possible that there will be no change in the lending or borrowing transactions if the cash received from the program is sufficient to mitigate the risk from covariate shocks.

We specifically consider the following conceptual framework:

a) Borrowing from informal insurance among eligible households increases if creditworthiness improves due to the regular cash transfers received from CCT. In such cases, ineligibles within the informal network are motivated to lend to eligibles, especially in times of need. The anticipation and assurance that borrowings will be repaid by the eligibles in the future facilitate an increase in their borrowings.
b) Borrowing from informal insurance among eligible households decreases if: (1) CCT eligibles experience improved economic conditions due to the benefits they receive from CCT, enabling them to reduce borrowing from informal insurance. Experiencing financial stability due to CCT benefits leads the eligibles to diminish the need for borrowing from informal insurance. (2) Improved creditworthiness among CCT eligibles, resulting from CCT benefits, may grant them access to formal financial resources such as bank loans, reducing their reliance on informal insurance.
c) Lending to informal insurance among eligible households increases if: (1) CCT increases the financial capacity of eligibles, allowing them to lend money to others in times of shock. (2) Eligibles aim to diversify risk during shocks, leading to increased lending to the collective fund in the informal insurance.
d) Lending to informal insurance among eligible households decreases if: (1) CCT eligibles invest more in opening small businesses since CCT program

implementers assist them in creating their own businesses. Consequently, instead of putting their money into the informal network through lending, they may reduce lending and allocate funds to their businesses as investments. (2) During shocks, eligibles may experience a sudden loss of income, limiting their ability to contribute to informal insurance. In such instances, if there is an increased demand for immediate cash during shocks, eligibles might prioritize basic needs, medical costs, and other necessities over contributing to communal funds in the informal network.

e) Borrowings from informal insurance among ineligible households increase if: (1) CCT eligibles in the informal network may lend support to ineligibles to help them manage risk when they face financial challenges or require immediate assistance from informal networks. (2) Other forms of coping mechanisms such as illegal money lending (e.g., loan sharks) or microfinance may not lend money to ineligibles, as these lending systems may prefer eligibles. In such cases, the only option for ineligibles may be informal insurance. (3) During shocks, ineligibles may require cash for house repairs, medical costs, and purchasing essential goods, especially when regular income is disrupted.

f) Borrowings from informal insurance among ineligible households decrease if during shocks, the ineligibles' confidence in their ability to repay loans is low due to uncertainty in their economic condition. In such cases, they may be reluctant to borrow from informal insurance systems.

g) Lending to informal insurance among ineligible households increases if ineligibles trust CCT eligibles in the informal network because they receive benefits from CCT. Consequently, lending by ineligibles in the informal network increases.

h) Lending to informal insurance among ineligible households decreases if: (1) CCT results in upward pressure on prices of goods and services in the local market, negatively affecting ineligibles' income, leading to a decrease in lending to the informal network. (2) During shocks, ineligibles may face economic hardship, leading to a reduction in disposable income. Hence, their limited income may be redirected towards immediate personal needs rather than contributions to informal insurance systems.

Since the theoretical consequences are not unique, this is an empirical question. Again, we estimated Equation (3) separately for eligible (PMT below the threshold) and ineligible (PMT above the threshold) households.

2.5 Summary statistics

Table 2.1 presents the mean differences between treatment and control households, separately for samples below and above the PMT threshold in 2011. A detailed description of the variables used can be found in Appendix C. The null hypothesis of equal means was rejected for 4 of the 21 and 5 out of 21 pre-determined characteristics used in the estimation model for samples below the PMT threshold and samples above the PMT threshold, respectively. These differences may be attributed to the small sample variation at the provincial level, as it covers only four provinces. However, these four provinces are representative of the three major islands in the Philippines: Luzon, Visayas, and Mindanao. Among the covariate shock variables, the household-level shock shows balance, but the village-level shocks such as flood and drought show imbalance between the treatment and control groups. The means of flooding and drought are higher in the treatment group, suggesting a possibility that treatment villages are more prone to flooding and drought than control villages for both the below and above PMT groups. To address this concern, a sub-group analysis will be presented after the main analysis.

Table 2.1 Balance on demographic characteristics, shocks, consumption outcome and lending, and borrowings outcomes: means, standard errors in brackets, and p-value on t-test of equality of means

Below PMT					
		(1)		(2)	(3)
Variable	N	Treatment Mean [SE]	N	Control Mean [SE]	t-test Difference (1)-(2)
Household head characteristics					
Age	581	43.114	608	43.400	-0.286
		[0.435]		[0.440]	
Gender (1=Female)	581	0.16	608	0.17	-0.01
		[0.02]		[0.02]	
Educational attainment (1=High school graduate)	555	5.90	585	5.87	0.03
		[0.15]		[0.14]	
Marital status (1=Married)	575	0.91	600	0.92	-0.01
		[0.021]		[0.01]	
Nature of employment (1=Permanent)	527	0.59	526	0.55	0.04
		[0.02]		[0.02]	
Household characteristics					
Household size	581	6.40	608	6.30	0.10
		[0.09]		[0.09]	
Durable asset index	581	1.30	608	1.41	-0.12
		[0.06]		[0.06]	
Has an outstanding loan (1=Yes)	581	0.52	608	0.55	-0.04
		[0.02]		[0.02]	
Has bank account (1=Yes)	573	0.07	595	0.08	-0.01
		[0.01]		[0.01]	
Insurance index (health, life, housing, and other social insurance)	581	0.95	608	0.77	0.18***
		[0.03]		[0.02]	
Barangay characteristics					
Health facility index (rural health center, clinic, hospital, pharmacy etc.)	581	1.85	608	1.84	0.02
		[0.06]		[0.05]	
Log of barangay population	558	7.27	566	7.33	-0.07
		[0.04]		[0.03]	
Log of number of households in barangay	558	5.66	562	5.76	-0.10**
		[0.03]		[0.03]	
Covariate shocks					
Harvest failure (household-level)	578	0.16	608	0.15	0.01
		[0.02]		[0.02]	
Flood (village-level)	581	0.587	608	0.510	0.077***
		[0.020]		[0.020]	
Earthquake (village-level)	581	0.621	608	0.635	-0.014

		[0.020]		[0.020]	
Drought (village-level)	581	0.484	608	0.411	0.072**
		[0.021]		[0.020]	
Natural disaster intensity (1=more than 2 disasters) (village-level)	581	0.549	608	0.536	0.013
		[0.021]		[0.020]	
Location characteristics					
Municipality (1=Basay)	581	0.076	608	0.082	-0.007
		[0.011]		[0.011]	
Province (1=Lanao Del Norte)	581	0.344	608	0.301	0.043
		[0.020]		[0.019]	
Outcome variables					
Household consumption					
Per capita consumption	581	14,284.845	608	14,097.627	187.218
		[462.755]		[402.919]	
Per capita education expenditure	579	379.363	607	382.947	-3.585
		[42.559]		[40.904]	
Per capita medical expenditure	578	281.613	608	245.736	35.878
		[33.093]		[32.863]	
Per capita of dairy consumption	579	496.929	608	428.041	68.888
		[37.746]		[36.614]	
Per capita of meat consumption	580	634.493	608	713.540	-79.047
		[40.224]		[43.449]	
Per capita of alcohol consumption	580	93.294	608	153.584	-60.289***
		[11.258]		[19.034]	
Total borrowings and lending to friends and relatives	581	3,299.324	608	2,090.155	1209.169*
		[478.562]		[517.152]	
Borrowings to friends and relatives	581	4,017.757	608	3,923.434	94.323
		[491.255]		[658.130]	
Borrowings to money lender	581	918.072	608	1900.220	-982.148**
		[209.745]		[423.449]	
Lending to friends and relatives	581	192.754	608	66.447	126.307
		[108.288]		[17.584]	
Borrowings to friends and relatives (1=Yes)	581	0.516	608	0.553	-0.036
		[0.021]		[0.020]	
Borrowings to money lender (1=Yes)	581	0.102	608	0.138	-0.037*
		[0.013]		[0.014]	
Lending to friends and relatives (1=Yes)	581	0.041	608	0.036	0.005
		[0.008]		[0.008]	
Bank borrowings	581	1,206.540	608	1,473.487	-266.946
		[415.359]		[550.828]	
Above PMT					
Household head characteristics					
Age	119	46.345	106	44.670	1.675
		[1.261]		[1.333]	
Gender (1=Female)	120	0.275	106	0.151	0.124**
		[0.041]		[0.035]	
Educational attainment (1=High school graduate)	120	0.233	106	0.189	0.045
		[0.039]		[0.038]	
Marital status (1=Married)	120	0.758	105	0.848	-0.089*
		[0.039]		[0.035]	
Nature of employment (1=Permanent)	90	0.578	86	0.453	0.124
		[0.052]		[0.054]	
Household characteristics					
Household size	120	4.600	106	4.462	0.138
		[0.178]		[0.169]	
Durable asset index	120	3.292	106	3.349	-0.057
		[0.205]		[0.247]	
Has an outstanding loan (1=Yes)	120	0.550	106	0.585	-0.035
		[0.046]		[0.048]	

Has bank account (1=Yes)	118	0.280	101	0.188	0.092
		[0.041]		[0.039]	
Insurance index (health, life, housing, and other social insurance)	120	1.200	106	0.868	0.332***
		[0.081]		[0.076]	
Barangay characteristics					
Health facility index (rural health center, clinic, hospital, pharmacy etc.)	120	2.158	106	2.274	-0.115
		[0.125]		[0.135]	
Log of barangay population	120	7.530	95	7.510	0.020
		[0.093]		[0.079]	
Log of number of households in barangay	120	5.813	97	5.821	-0.009
		[0.077]		[0.075]	
Covariate shocks					
Harvest failure (household-level)	120	0.150	106	0.085	0.065
		[0.033]		[0.027]	
Flood (village-level)	120	0.658	106	0.462	0.196***
		[0.043]		[0.049]	
Earthquake (village-level)	120	0.617	106	0.717	-0.100
		[0.045]		[0.044]	
Drought (village-level)	120	0.492	106	0.321	0.171***
		[0.046]		[0.046]	
Natural disaster intensity (1=more than 2 disasters) (village-level)	120	0.567	106	0.519	0.048
		[0.045]		[0.049]	
Location characteristics					
Municipality (1=Basay)	120	0.100	106	0.057	0.043
		[0.028]		[0.023]	
Province (1=Lanao Del Norte)	120	0.217	106	0.189	0.028
		[0.038]		[0.038]	
Outcome variables					
Household consumption					
Per capita consumption	120	28,762.549	106	32,902.831	-4140.282
		[2763.593]		[3978.807]	
Per capita education expenditure	120	1,382.998	106	992.498	390.500
		[470.779]		[222.719]	
Per capita medical expenditure	120	2,024.836	106	899.277	1125.559
		[1254.856]		[283.392]	
Per capita of dairy consumption	120	896.433	106	991.619	-95.186
		[140.584]		[162.618]	
Per capita of meat consumption	120	1,679.531	106	1,729.406	-49.875
		[195.289]		[318.328]	
Per capita of alcohol consumption	120	138.886	106	505.766	-366.881**
		[29.733]		[150.959]	
Total borrowings and lending to friends and relatives	120	2,116.000	106	3,790.566	-1674.566
		[523.742]		[1029.648]	
Borrowings to friends and relatives	120	377.750	106	413.208	-35.458
		[177.413]		[298.123]	
Borrowings to money lender	120	1,095.833	106	9,048.113	-7952.280
		[391.448]		[5749.650]	
Lending to friends and relatives	120	2,750.750	106	12,283.962	-9533.212*
		[601.821]		[5793.592]	
Borrowings to friends and relatives (1=Yes)	120	0.550	106	0.585	-0.035
		[0.046]		[0.048]	
Borrowings to money lender (1=Yes)	120	0.300	106	0.415	-0.115*
		[0.042]		[0.048]	
Lending to friends and relatives (1=Yes)	120	0.083	106	0.057	0.027
		[0.025]		[0.023]	
Bank borrowings	120	6,600.000	106	2,000.000	4600.000*
		[2185.527]		[1021.688]	

Note: Insurance index, health facility index and natural disaster index are created by summing multiple variables for each observation. Insurance index covers health, life, housing, and other social insurance (index ranged from 0 to 4). Health facility index covers the presence of barangay health station, rural health unit, traditional birth attendant, private clinic, government hospital and pharmacy in the barangay or village (index ranged from 0 to 6). Natural disaster intensity is equal to 1 if village suffered from more than 2 disasters which covers either flood, earthquake, or drought).
The values displayed for t-tests are the mean differences across the groups.
***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

2.6 Empirical results

2.6.1 Estimates of risk-mitigating effects

Table 2.2 presents the estimates of the program effect, covariate shocks, and risk-mitigating effects of the program on the natural logarithmic forms of total consumption per capita, education cost per capita, medical cost per capita, and the inverse hyperbolic transformations of dairy, meat, and alcohol consumption per capita. Panels A and B provide the results for eligible and ineligible households, respectively.

In Panel A, the results show that the program significantly increased the log of total consumption per capita and education expenditure per capita for eligible households. The consumption of dairy and meat products separately indicated an increase in food consumption, with high protein serving as a proxy for better living standards among the poor. Rice is the dominant staple in the Filipino diet, particularly in rural households. Protein-rich foods, such as dairy and meat, are relatively expensive for the poor; thus, improved income levels will likely increase the consumption of meat and dairy products (e.g., eggs, milk, butter, cheese). The program exhibits a positive consumption effect over virtuous or healthy products (e.g., dairy) and a negative effect on the consumption of vice or unhealthy products (e.g., alcohol in Panel A and Panel B).

These results are consistent with Hoddinott and Skoufias (2004), where they found that PROGRESA in rural Mexico enabled its beneficiaries to "eat better" by focusing on dietary quality rather than food quantity. The study further found a positive spillover to non-beneficiaries in the treatment localities due to the free flow of information within the community regarding good dietary practices.

The program reduces alcohol consumption because the eligible households focused on spending for education and health expenditures as conditionalities of the program. Moreover, continuous check-ups may have led to a lifestyle change. The Family Development Seminar (FDS) of the CCT program may train the eligibles to reduce spending on non-essential items and prioritize meeting basic needs such as food, health, and education as an incentive to sustain the benefits from the program. Similarly, Panel B also found a negative effect on the consumption of alcohol among the treatment group, suggesting the flow of information from eligibles to ineligibles regarding reduced spending on non-essential items, consistent with Hoddinott and Skoufias's (2004) findings.

Table 2.2 Risk-mitigating effects

	Log transformation of per capita			**Arcsine transformation of per capita consumptions in**		
	Total Consumption	Education cost	Medical cost	Dairy	Meat	Alcohol
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Eligible (below PMT)						
Program assignment (w/out covariate shock)	0.07*	0.42*	0.24	0.50***	0.05	-0.54***
	(0.04)	(0.22)	(0.26)	(0.17)	(0.22)	(0.20)
Covariate shock (proxied by harvest failure)	-0.02	-0.20	-0.37	-0.63*	-0.88**	-0.92***
	(0.08)	(0.40)	(0.46)	(0.33)	(0.38)	(0.29)
Program assignment X Covariate shock	-0.11	0.05	1.32**	0.18	0.65	0.62

	(0.10)	(0.51)	(0.60)	(0.43)	(0.50)	(0.46)
Constant	9.35***	3.80***	-0.59	5.91***	6.33***	1.97**
	(0.24)	(1.38)	(1.64)	(1.01)	(1.32)	(0.97)
Observations	1,102	1,100	1,099	1,100	1,101	1,101
Pseudo R^2	0.150	0.0256	0.0198	0.0363	0.0239	0.0215
			Panel B: Ineligible (above PMT)			
Program assignment (w/out covariate shock)	-0.13	0.52	0.06	0.20	-0.18	-1.18***
	(0.08)	(0.67)	(0.51)	(0.34)	(0.39)	(0.40)
Covariate shock (proxied by harvest failure)	-0.15	-1.13	-0.94	0.22	0.09	-1.02
	(0.20)	(2.74)	(1.39)	(1.09)	(0.50)	(1.20)
Program assignment X Covariate shock	0.41	0.56	1.95	0.27	-0.19	1.49
	(0.26)	(3.05)	(1.78)	(1.25)	(0.74)	(1.37)
Constant	10.14***	0.45	2.36	7.86***	8.81***	4.40*
	(0.39)	(4.00)	(2.73)	(1.71)	(2.03)	(2.63)
Observations	211	211	211	211	211	211
Pseudo R^2	0.221	0.0725	0.0368	0.0422	0.0483	0.0297

Standard errors in parentheses are clustered by village. All regressions include controls for household head's characteristics—age, gender, and educational attainment; household characteristics—size and durable asset index; barangay characteristics—natural disaster index, log of barangay population and log of number of households; and fixed effect at municipality-level. Dependent variables per capita total consumption, education cost and medical cost took the natural logarithmic transformations $ln(x) = log(x)$ to approximate normal distribution. Dependent variables per capita consumptions on dairy, meat and alcohol took the inverse hyperbolic sine transformation expressed as $\text{arcsinh}(x) = ln\left(x + \sqrt{x^2 + 1}\right)$ to retain the zero-valued observations. *p<.01; **p<.05; ***p<.001

The program's risk-mitigating effects, represented by the interaction term, are apparent in the cost of medical care such as drugs and medicines, hospital room charges, medical and dental charges, and other medical expenses of treated households when exposed to covariate shocks. Harvest failure substantially increased medical costs because it can lead to food shortages, causing malnutrition for residents in the village. A lack of essential nutrients makes individuals susceptible to disease or infection, thereby driving up medical costs for households. Given that health insurance coverage is limited in the Philippines, individuals often incur significant health costs, resulting in high out-of-pocket expenditures. The additional cash from the program may help alleviate the burden of medical expenses on poor Filipino households.

2.6.2 Estimates of informal transfers

Turning to the impacts on informal transfers, Table 2.3 presents the results of the spillover effects of CCT on the borrowing and lending behaviors of eligible and ineligible households. The model was also fitted for borrowing from formal sources to compare the spillover effects of CCT between informal and formal systems. Control variables, comprising household and barangay characteristics, and fixed effects at the municipal level were included in the model.

The inclusion of these control variables resulted in the omission of a few observations, further decreasing the number of observations to 966 below the poverty threshold and 161 above the poverty threshold. Approximately 19% of the observations were lost due to missing values on some covariates. To address this attrition problem, we examined if the omitted observations were random and found systematic differences in the average characteristics between the remaining and omitted observations. Thus, we estimated the non-attrition probit and used the inverse of the predicted value of non-attrition as weights (inverse probability weighting: IPW) to address the potential estimation bias (see Appendix A for the non-attrition probit estimation result).

The results suggest that CCT increased the engagement of its eligibles in informal borrowing and lending systems, as evidenced by the significant increase in total lending and borrowing in the informal system among eligible households. Eligibles of CCT significantly increased their borrowings from formal banks (column 5), indicating that

CCT may have improved their capability and credibility to borrow money from financial institutions.

On the other hand, CCT seems to have adversely affected the informal sharing schemes of ineligible households, as shown by the significant decrease in borrowing from friends. This result is also consistent with borrowings from moneylenders, commonly known in the Philippines as “loan sharks” or “5-6,” which are informal in nature. Hence, while ineligibles decrease their borrowings in the informal insurance system, they simultaneously reduce vulnerability to predatory lending practices, which are often illegal, as lenders from this illegal lending often take advantage of borrowers through excessive interest rates.

The inverse probability weighting (IPW) estimates show consistent results in Panels A and B. In Panel A, the IPW estimate for total borrowings and lending in the informal insurance and formal borrowing are positive and significant, which are consistent with the unweighted Tobit estimate. Likewise in Panel B, the IPW estimate for borrowings from friends is negative, which is consistent with the unweighted Tobit estimate.

Table 2.3 Spillover effects of CCT on informal systems and other coping mechanisms

	Informal borrowings and lending			**Other coping mechanisms**	
	Total Lending and Borrowings	Lending to friends and relatives	Borrowings from friends and relatives	Borrowings from money lender	from bank
VARIABLES	(1)	(2)	(3)	(4)	(5)
			Panel A: Eligible (below PMT)		
Program assignment (w/out covariate shock)	1.48**	2.73	-0.05	-3.05**	3.34*
	(0.65)	(2.27)	(0.48)	(1.49)	(1.82)
Constant	-21.93***	-102.05***	-38.96***	-80.77***	-119.03***
	(3.01)	(22.00)	(2.52)	(6.01)	(10.48)
Observations	966	966	966	966	966
Pseudo R^2	0.161	0.0756	0.264	0.142	0.186
			IPW estimates		

Program assignment					
(w/out covariate shock)	1.43**	2.97	-0.14	-4.45**	3.79**
	(0.68)	(2.26)	(0.50)	(1.74)	(1.75)
Constant	-23.61***	-107.96***	-35.88***	-27.27***	-119.76***
	(3.35)	(26.78)	(2.68)	(7.45)	(11.16)
			Panel B: Ineligible (above PMT)		
Program assignment					
(w/out covariate shock)	-0.60	3.63	-2.97*	-5.04*	3.06
	(2.16)	(4.39)	(1.67)	(3.00)	(3.98)
Constant	-17.70**	-3.65	-48.67***	-76.73***	-110.36***
	(7.40)	(15.29)	(7.04)	(14.27)	(15.71)
	160	160	160	160	160
Observations	0.0891	0.164	0.248	0.180	0.282
Pseudo R^2	-0.60	3.63	-2.97*	2.18	3.06
			IPW estimates		
Program assignment					
(w/out covariate shock)	-2.41	2.28	-3.47**	-6.68*	3.63
	(2.07)	(4.66)	(1.50)	(3.81)	(3.94)
Constant	-15.92**	1.64	-178.34***	-5.45	-103.46***
	(7.45)	(15.84)	(54.05)	(11.24)	(15.74)

Standard errors in parentheses are clustered by village. All regressions include controls for household head's characteristics—age, gender, if married, nature of employment, has bank account and loan; household characteristics—size, durable asset index and social insurance index (includes life, health, housing and other social insurance); barangay characteristics—health facility index (includes barangay health station, rural health center, traditional birth attendant, private clinic, government hospital, private hospital, barangay pharmacy, private pharmacy) and barangay population; and fixed effect at municipal-level. Dependent variables took the inverse hyperbolic sine transformation expressed as $\text{arcsinh}(x) = ln\left(x + \sqrt{x^2 + 1}\right)$ to retain the zero-valued observations. IPW=inverse probability weighting.
*p<.01; **p<.05; ***p<.001

Table 2.4 presents the results for Equation (3). The inclusion of the shock variable and controls from Equation (2) to Equation (3) has resulted in the omission of a few more observations, reducing the sample size to 963 for households below the poverty threshold and maintaining the same sample size of 161 for households above the poverty threshold. This result is consistent with the findings from Table 2.3, indicating that CCT has a positive and significant impact on total lending and borrowing in informal and formal borrowing among eligible households.

Table 2.4 Spillover effects of CCT on informal systems and other coping mechanisms in the presence of shocks

	Informal borrowings and lending			Other coping mechanisms	
	Total Lending and Borrowings	Lending to friends and relatives	Borrowings from friends and relatives	Borrowings from money lender	from bank
VARIABLES	(1)	(2)	(3)	(4)	(5)
Panel A: Eligible (below PMT)					
Program assignment (w/out covariate shock)	1.13*	2.01	-0.39	-3.96**	4.46**
	(0.67)	(2.45)	(0.47)	(1.56)	(1.93)
Covariate shock (proxied by harvest failure)	-2.09	-4.61	-2.13**	-2.41	1.13
	(1.50)	(5.03)	(0.98)	(2.59)	(3.82)
Program assignment X Covariate shock	2.70	6.32	2.63*	6.99*	-10.92*
	(2.29)	(6.62)	(1.49)	(3.63)	(5.75)
Constant	-21.23***	-100.72	-38.08***	-79.74***	-113.87***
	(3.06)	(0.00)	(2.56)	(6.28)	(9.79)
Observations	963	963	963	963	963
Pseudo R^2	0.162	0.0771	0.265	0.144	0.192
IPW estimates					
Program assignment (w/out covariate shock)	1.53	1.93	-0.28	-4.45**	5.55**
	(1.08)	(3.63)	(0.45)	(1.74)	(2.53)
Covariate shock (proxied by harvest failure)	-4.81*	-8.17	-1.68*	-1.66	3.84
	(2.78)	(8.31)	(0.91)	(2.90)	(4.57)
Program assignment X Covariate shock	9.29**	17.75**	2.43*	6.41	-19.96***
	(3.98)	(7.52)	(1.44)	(4.18)	(6.41)
Constant	-29.70***	-33.13***	1.06	-27.27***	-43.26***
	(5.01)	(10.95)	(2.15)	(7.45)	(9.00)
Panel B: Ineligible (above PMT)					
Program assignment (w/out covariate shock)	-1.38	-0.05	-2.33	-4.84	2.48
	(2.16)	(4.51)	(1.73)	(3.23)	(4.01)
Covariate shock (proxied by harvest failure)	-2.95	3.45	5.32**	-3.06	-40.60***
	(5.25)	(9.32)	(2.58)	(9.64)	(7.83)
Program assignment X Covariate shock	8.12	18.29	-9.31**	-0.33	41.98***
	(5.76)	(11.45)	(4.68)	(11.81)	(9.08)
Constant	-18.81**	4.01	-47.42***	-74.85***	-104.17***
	(7.71)	(14.92)	(7.05)	(15.54)	(15.05)
Observations	160	160	160	160	160
Pseudo R^2	0.0922	0.197	0.252	0.181	0.287

IPW estimates					
Program assignment (w/out covariate shock)	-2.90	-1.26	-2.88*	-5.30	3.00
	(2.03)	(4.59)	(1.51)	(3.93)	(4.07)
Covariate shock (proxied by harvest failure)	-4.39	0.30	4.28*	-1.55	-40.72***
	(4.99)	(9.92)	(2.25)	(9.56)	(7.81)
Program assignment X Covariate shock	8.90	22.64*	-7.78*	-9.39	44.68***
	(5.71)	(12.40)	(3.95)	(12.32)	(9.19)
Constant	-18.12**	7.93	-42.08***	-2.96	-104.16***
	(7.38)	(15.40)	(6.15)	(13.06)	(15.46)

Standard errors in parentheses are clustered by village. All regressions include controls for household head's characteristics—age, gender, if married, nature of employment, has bank account and loan; household characteristics—size, durable asset index and social insurance index (includes life, health, housing and other social insurance); barangay characteristics—health facility index (includes barangay health station, rural health center, traditional birth attendant, private clinic, government hospital, private hospital, barangay pharmacy, private pharmacy) and barangay population; and fixed effect at municipal-level. Dependent variables took the inverse hyperbolic sine transformation expressed as $\text{arcsinh}(x) = ln(x + \sqrt{x^2 + 1})$ to retain the zero-valued observations. IPW = inverse probability weighting.
*p<.01; **p<.05; ***p<.001

Panel A of Table 2.4 confirms the positive effect of CCT on the informal system among eligible households, wherein eligibles increase their borrowing during income shocks (column 3). Eligibility to receive money from the government may improve eligibles' borrowing credibility in informal risk-sharing because they are expected to consistently pay off their debt over time. CCT also seems to attract loan sharks during shocks as borrowing from money lenders increased. The influx of cash into the community seems to attract the attention of loan sharks and gives them the opportunity to exploit the eligibles of CCT because of their access to more funds coming into the community through CCT. IPW estimates show a positive and significant increase in lending to friends and relatives, and total lending and borrowing show positive coefficients during shocks. This suggests that CCT increases the financial capacity of eligibles, allowing them to lend money to others when there is a shock. CCT eligibles may also diversify risk during shocks, leading to an increase in lending to collective funds in the informal insurance system. In contrast, program participation has a crowding-out effect on bank borrowing, as evidenced by the negative and significant decrease in bank borrowing in column 5 during the income shock. Therefore, during covariate shocks, the program eligibles engage with the informal system through positive borrowing and lending, thus keeping the informal system thriving. However, the CCT program, through eligibles, crowds out formal bank borrowing during shocks and attracts informal money lenders, indicating that the eligibles prefer the informal insurance system and money lenders over bank borrowing in times of emergencies brought about by natural disasters.

Panel B of Table 2.4 shows the regression results for ineligible household samples. Performing the same Tobit regression and set of controls, the results show that ineligible households in the treated areas significantly decrease their borrowing from friends during shocks. This may be partly because the ineligibles' confidence about their ability to repay loans is low due to uncertainty in their economic condition during shocks. This low confidence leads them to reluctantly borrow more money from the informal insurance system. However, according to IPW estimates, among the above PMT group, the program significantly increases informal lending during covariate shocks. It appears that the program enhances informal transactions driven by lending from the "near poor" household. This means that ineligibles trusted CCT eligibles by lending money in the informal network because eligibles receive benefits from CCT. Since it is unlikely that eligibles, who are typically less wealthy, are lending money to relatively more wealthy ineligibles, the result suggests that eligibles increased borrowing from ineligibles.

2.6.3 Estimates on sub-groups analysis

This section aims to analyze the imbalance found in the village-level shock index of natural disasters in Table 2.1. To investigate whether pre-treatment imbalance affects our results, we examine the top three natural disasters reported by the barangay captain: flood, drought, and earthquake. Earthquake was reported as the highest among the natural disasters with more than 60% on average, followed by flood with almost 60%, and drought with more than 40%. Among the three natural disasters, flood and drought show significant mean differences between treatment and control groups, while earthquake remains balanced between the two groups. This may suggest that treatment villages are more prone to flooding and drought than control villages, although it was not explicitly mentioned in the implementation procedure. Given that possibility, we further examine if the villages that are more prone to natural disasters have stronger informal safety nets and social capital.

A natural disaster index was created covering the top three natural disasters mentioned above. The measurement represents an index assigned to each village ranging from 0 to 3, with 0 being the lowest and 3 being the highest. Next, a natural disaster intensity is created based on the natural disaster index, which is equal to 1 if there are two or more natural disasters occurring in the village and 0 otherwise. Separating the villages into two subgroups describing high and low intensities of climate risk is a more sensible approach and straightforward to interpret. Table 2.1 shows balance in means in treatment and control groups for the natural disaster intensity variable for the below and above PMT groups. This means that the two groups are now balanced and comparable, allowing us to test the hypothesis that CCT mitigates climatic risks and affects informal safety nets. It is expected that highly intensive natural disasters may damage infrastructure hugely and broadly affect a large number of residents in the village, making them incapable of helping their neighbors.

The result of the sub-group analysis of high and low natural disaster intensities in Table 2.5 suggests that CCT mitigates climatic risks and affects informal safety nets in villages with low intensities of climate risk. Under the assumption that CCT could mitigate climate risks and affect informal insurance in local communities where the financial system is operating and coordination and monitoring are possible, the results in Table 2.5 confirm it. The result from Panel A and C describing high-intensity natural disasters measured by two or more natural disasters confirms that CCT could improperly work to mitigate the climatic risk. This is especially true when the natural disaster is severe enough to devastate the local community by damaging infrastructure, making CCT challenging to implement in the locality. When there is no shock, CCT increases formal borrowing in intensively high natural disaster villages, as shown by positive and significant bank borrowing in Panel A. This confirms that the financial system may not operate well in intensively high climatic risk areas.

Table 2.5 Sub-group analysis: Villages with high and low natural disaster intensity

	Informal borrowings and lending			**Other coping mechanisms**	
	Total Lending and Borrowings	Lending to friends and relatives	Borrowings from friends and relatives	Borrowings from money lender	from bank
VARIABLES	(1)	(2)	(3)	(4)	(5)
Panel A: Eligibles in high natural disaster intensity villages					
Program assignment (w/out covariate shock)	0.22	0.08	-0.19	-0.23	0.39*
	(0.28)	(0.14)	(0.25)	(0.27)	(0.22)
Covariate shock (proxied by harvest failure)	-0.94**	-0.04	-0.66	0.30	0.64*
	(0.46)	(0.14)	(0.42)	(0.46)	(0.33)

Program assignment X Covariate shock	1.01	0.07	0.38	-0.60	-1.39**
	(0.82)	(0.35)	(0.80)	(0.54)	(0.56)
Constant	-0.64	0.12	-1.80*	-1.19	-1.97**
	(1.20)	(0.45)	(0.99)	(0.76)	(0.93)
Observations	511	511	511	511	511
Pseudo R^2	0.0837	0.0129	0.156	0.0410	0.0597
Panel B: Eligibles in low natural disaster intensity villages					
Program assignment (w/out covariate shock)	0.94**	-0.03	-0.11	-1.04***	0.34
	(0.44)	(0.09)	(0.32)	(0.34)	(0.22)
Covariate shock (proxied by harvest failure)	-0.26	-0.51	-0.81	-0.89	-0.22
	(0.70)	(0.34)	(0.81)	(0.57)	(0.60)
Program assignment X Covariate shock	0.43	0.48	1.75*	2.05**	-0.70
	(1.04)	(0.33)	(0.93)	(0.80)	(0.56)
Constant	-4.20***	0.35	-4.07***	-0.10	-1.70**
	(1.17)	(0.69)	(1.28)	(1.07)	(0.78)
Observations	452	452	452	452	452
Pseudo R^2	0.0836	0.0310	0.150	0.0378	0.0317
Panel C: Ineligibles in high natural disaster intensity villages					
Program assignment (w/out covariate shock)	-1.57*	-0.55	-2.03**	-1.80**	1.34
	(0.86)	(0.60)	(0.82)	(0.77)	(0.84)
Covariate shock (proxied by harvest failure)	-0.76	0.78	0.29	-0.48	-0.57
	(1.41)	(1.58)	(1.71)	(2.39)	(1.07)
Program assignment X Covariate shock	1.35	0.08	-2.25	-1.15	1.78
	(1.74)	(1.60)	(2.07)	(2.57)	(1.39)
Constant	1.52	2.30*	0.05	0.74	-1.36
	(2.90)	(1.33)	(1.84)	(2.25)	(1.87)
Observations	89	89	89	89	89
Pseudo R^2	0.0598	0.0525	0.157	0.0717	0.149
Panel D: Ineligibles in low natural disaster intensity villages					
Program assignment (w/out covariate shock)	1.46	0.69	-0.33	-0.66	1.03
	(1.02)	(0.58)	(0.97)	(0.74)	(0.92)
Covariate shock (proxied by harvest failure)	-3.36	0.27	-3.71*	-3.81*	0.07
	(2.01)	(0.98)	(2.05)	(1.93)	(2.52)
Program assignment X Covariate shock	4.24**	2.56***	4.10**	4.46***	-1.45
	(1.64)	(0.95)	(1.79)	(1.58)	(2.29)
Constant	6.38	3.48	1.09	-0.00	-3.11
	(3.87)	(2.27)	(2.33)	(1.60)	(2.61)

Observations	71	71	71	71	71
Pseudo R^2	0.0934	0.110	0.123	0.0597	0.0984

Standard errors in parentheses are clustered by village. All regressions include controls for household head's characteristics—age, gender, if married, nature of employment, has bank account and loan; household characteristics—size, durable asset index and social insurance index (includes life, health, housing and other social insurance); barangay characteristics—health facility index (includes barangay health station, rural health center, traditional birth attendant, private clinic, government hospital, private hospital, barangay pharmacy, private pharmacy) and barangay population; and fixed effect at municipal-level. Dependent variables took the inverse hyperbolic sine transformation expressed as $\text{arcsinh}(x) = ln(x + \sqrt{x^2 + 1})$ to retain the zero-valued observations. IPW=inverse probability weighting.
*p<.01; **p<.05; ***p<.001

2.7 Conclusion

This study employed a randomized experimental design to assess the impact of the CCT program, focusing on its risk-mitigating and spillover effects on informal insurance systems in the Philippines, where poor households frequently contend with income shocks from natural disasters. An ITT analysis was utilized to estimate the model with the program assignment.

The findings reveal the risk-mitigating effects of CCT on eligible households' medical expenses during covariate shocks such as harvest failure. The CCT program led to eligibles significantly increasing their borrowing in the informal risk-sharing system during shocks, opting for informal support over formal banking or microfinance options.

Furthermore, CCT potentially strengthened the informal insurance system, as ineligibles in the treatment areas increased their lending support in response to shocks. This can be attributed to CCT improving the trust and creditworthiness of eligibles who receive regular cash transfers, thus fostering positive reputations within the informal network. The decrease in ineligibles' borrowings from the informal network may also suggest a positive spillover effect of CCT to informal insurance, as CCT's eligible household share the values of saving and mutual support with ineligibles, thereby avoiding overexploitation of resources within the informal insurance system. This is because as the CCT program, through the monetary and other benefits, alters the behavior of eligibles, creating a broad impact on the entire informal network, which in turn affects the ineligibles as well, given the high social capital within informal networks, where members share common goals and values. Overall, this study sheds light on the unintended consequences of CCT programs in the Philippines and contributes to related studies on CCTs in Africa and Latin America.

However, the study has limitations. It only analyzed the risk-mitigating effects of CCT for covariate shocks proxied by harvest failure, while informal risk-sharing arrangements often prove more effective during idiosyncratic shocks such as illnesses, death, and unemployment. Unfortunately, examining the impact of idiosyncratic shocks in the study model creates endogeneity issues. The bias is introduced by other factors that influence the individual's decision to participate in informal risk-sharing arrangements. For example, individuals with poor health or those who face high mortality risk are more likely to participate in informal risk-sharing arrangements, but healthy individuals are less likely to do so. Therefore, the decision to join or leave a risk-sharing network is not an arbitrary or chance event, but is based on one's health status. The same is true for unemployment, where the decision to participate in informal insurance may be influenced by employment conditions, such as job loss, rather than a random choice. Therefore, instrumental variables are required to control for endogeneity; however, they are presently unavailable. Future studies should aim to address these limitations by identifying detailed channels through which public transfers affect existing informal arrangements, using instrumental variables to control for endogeneity.

Chapter 3: The mitigation effects of irrigation rehabilitation on climate variability and water scarcity: Evidence from a randomized experiment in the Philippines

3.1 Introduction

Farmers in rural areas of low-income countries confront significant challenges due to extreme climate events caused by irregular rainfall patterns. Mounting evidence suggests that events such as droughts and floods have severely and adversely affected crop production worldwide, including in countries like Bangladesh (Sarker et al., 2012), Pakistan (Ali et al., 2017), India (Guntukula, 2020), Kenya (Kabubo-Mariara and Karanja, 2007), and Central Zimbabwe (Makuvaro et al., 2018). The development of irrigation facilities holds promise in alleviating these problems by providing reliable and sufficient water supplies for crop production, thereby enhancing yields and agricultural productivity. However, appropriate maintenance often presents challenges due to coordination failures. Numerous field and experimental studies have shown that irrigation, as a local public good, often fails to achieve collective action, particularly in terms of maintenance (Dayton-Johnson, 2000; Fujiie et al., 2005; Nagrah et al., 2016; Araral, 2009; Sawada et al., 2013; Cardenas et al., 2011). Rehabilitation schemes have the potential to improve coordination and facilitate maintenance among farmers, especially when they develop a sense of ownership over irrigation systems through participatory irrigation management training (Vermillion, 1987; Meinzen-Dick, 2014). Indeed, many irrigation projects worldwide, previously operated and managed by centralized governments and then transferred to local farmers, have reported positive impacts on service area, cropping intensity, and yields (Mishra et al., 2011; Rap, 2006; Howarth, 2002; Reddy et al., 2018).

This study revisits this issue and examines the effect of irrigation rehabilitation on improving water resource management in small-scale irrigation systems in the Philippines. We particularly focus on its impact under climate risks represented by flooding and drought because the Philippines is one of the most disaster-prone countries globally, posing challenges for farmers in raising agricultural productivity. Our empirical data are drawn from a foreign-funded irrigation rehabilitation project called the Irrigated Rice Production Enhancement Project (IRPEP), implemented by the IFAD in partnership with the Department of Agriculture and the National Irrigation Administration of the Philippine government since 2010. The project aims to improve rice productivity, smallholder farmer incomes, and women's empowerment in their communities and households. The intervention components include strengthening canal irrigation infrastructure of community irrigation systems, improving the capacity of IAs that manage the CISs, and providing support services for marketing farmers' harvests. Program beneficiaries are farmer households selected from CIS lists based on eligibility criteria covering baseline productivity, land size, water supply, poverty incidence, irrigation potential, and the capacity of local government to provide complementary support. Arsalan et al. (2018) conducted an impact assessment of the project after its completion. Their findings, using an Inverse Probability Weighted Regression Adjustment model, suggest that the program intervention significantly increased rice productivity, farmers' incomes, and female participation within the CIS. Additionally, the project led to improvements in household nutrition, driven by supplemental livestock support from the program, resulting in extra income and dietary diversity for households.

This study complements the work of Arsalan et al. (2018) by investigating potential pathways through which farmers' management and maintenance of rehabilitated irrigation infrastructure affect water supply and availability during flooding. We utilized parcel-level data with a sample size of 2,583 to estimate a model that assesses the impact of the intervention, natural shocks, and their interaction. Estimates were calculated separately for wet and dry seasons and for sub-groups of trained and untrained farmers to explore seasonal effects and behavioral responses. The key findings indicate that the rehabilitation of irrigation has mitigated the effects of negative climate events, particularly flooding and drought, in the wet season, resulting in increased rice productivity. This effect is attributed to farmers' engagement, knowledge, and awareness gained about water management and preventative measures against potential risks. Notably, better collective action was observed among farmers who received maintenance training, suggesting that participatory communal irrigation training has fostered social capital.

This study contributes to the literature examining the impact of irrigation infrastructure rehabilitation on crop production and climate change risk mitigation. Prior studies have highlighted the importance of water distribution and infrastructure maintenance (Banerji et al., 2012; Aggarwal and Narayan, 2004; Jacoby et al., 2004; Rosegrant and Binswanger, 1994; Swallow et al., 2002; Chaudhry, 2018), as well as the role of improved infrastructure in reducing water loss and mitigating climate change impacts (Hornbeck and Keskin, 2014; Nikolaou et al., 2020; Misra, 2014; Chartzoulakis, 2015). The first strand of literature suggests that water distribution could be compromised by lack of maintenance while the second proposes that improvements in irrigation infrastructure reduce water loss in irrigation, thus, minimizing the impact of climate change. Our study builds on this literature by examining the impact of irrigation infrastructure rehabilitation on rice productivity, specifically linking it to water crisis phenomena and farmers' water management practices in small-scale community irrigation systems. Unlike previous studies focusing on large-scale groundwater irrigation infrastructure, we emphasize the participatory management approach in small-scale canal irrigation systems. Additionally, by analyzing heterogeneous effects under wet and dry seasons and considering sub-groups of trained and untrained farmers, we shed light on differences in water management practices between treatment and control CISs. Furthermore, our focus on flooding and drought as negative climatic events, given their frequency in the Philippines, adds nuance to previous assessments of the sustainability of irrigated agriculture primarily under drought conditions.

The remainder of the paper is structured as follows: Section 2 provides background information and describes the study data. Section 3 outlines the impact analysis of irrigation rehabilitation, and Section 4 presents the empirical results.

3.2 Background and Data

3.2.1 IRPEP implementation and the RCT setting

From 2010 to 2015, the IFAD implemented the IRPEP in the Philippines, focusing on rehabilitating CISs. The project aimed to enhance irrigation facilities by cementing canals to reduce water loss and providing training to farmers in crop and water management, as well as leadership training for IAs responsible for managing the CIS. CISs are small-scale irrigation systems managed collectively by local farmers' associations in communities. The construction of CISs aimed to increase participation among local farmers in decision-making and maintenance activities, fostering a sense of ownership expected to improve agricultural yields and socio-economic conditions at the local level.

IRPEP was implemented across seven provinces in the Philippines, spanning three regions (VI, VII, and X). The eligibility criteria for CIS inclusion in the project are that the farm should have an average landholding size below 0.76 ha, a baseline annual average paddy productivity below 3.78 t/ha, low and/or inadequate water supply, high poverty incidence, potential for irrigation, feasible implementing agency support, and willingness and capacity of local government for timely counterpart funding. The beneficiaries of the project were smallholder rice farmers covered by eligible CISs assigned to receive the treatment. Randomization of treatment and control CISs was conducted at the province level. Among the seven selected provinces, two were designated as pure treated provinces, comprising all beneficiary CISs, while another two were pure control provinces with no beneficiary CISs. The remaining three provinces were mixed, containing both treated and control CISs (see Figure 1). This resulted in a total of 58 CISs in the treatment group and 55 CISs in the control group across the seven provinces. Smallholder rice farmers in the 58 treatment CISs from Aklan, Capiz, Samar, Leyte, and Bukidnon received the irrigation rehabilitation intervention, with some receiving training and others not, while smallholder rice farmers in the 55 control CISs from Antique, Northern Samar, Samar, Leyte, and Bukidnon did not receive any intervention.

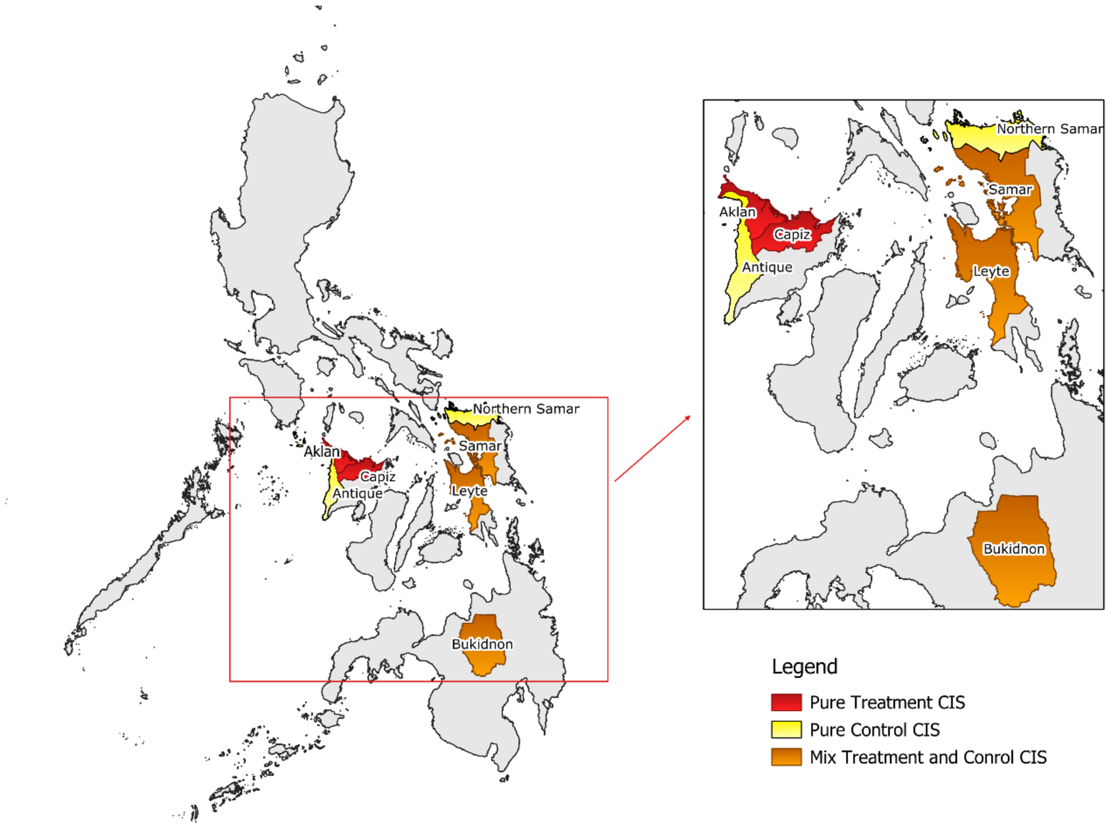

Figure 3.1 Location of the Irrigated Rice Production Enhancement Project's experimental study in the Philippines

3.2.2 Flooding and drought in the Philippines and crop damages

Flooding in the Philippines stems from various factors, including meteorological events like tropical cyclones or typhoons, the country's topography characterized by mountainous terrain leading to rapid runoff and flash floods, especially in deforested areas, and human activities such as deforestation. Typhoons are particularly significant contributors to flooding in the country.

During the IRPEP implementation from 2010 to 2015, the Philippines experienced four typhoons that caused significant flooding and damage to rice fields. In December 2011, Typhoon Sendong brought heavy rainfall and strong winds, resulting in severe flooding and landslides in the Visayas and Mindanao regions, causing extensive damage to rice crops. In November 2013, Typhoon Yolanda, one of the strongest recorded typhoons, classified as a "super" typhoon, struck during the rice harvest season, devastating the Visayas region. In December 2014, Typhoon Hagupit hit the Philippines, affecting the same region as Typhoon Yolanda. In October 2015, Typhoon Lando brought sustained heavy rainfall, leading to extensive flooding and landslides in Luzon, damaging rice and corn fields. Given the significant damage caused by typhoons, the rehabilitation of irrigation infrastructure in CISs and capacity building of IAs and farmers are expected to have substantial positive impacts.

Moreover, the Philippines has experienced several significant El Niño-induced droughts, notably in 1997-1998, 2009-2010, and 2015-2016. El Niño events in the country are monitored by the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA). The 1997-1998 El Niño, considered the most severe globally, resulted in substantial losses in rice production and water shortages. In 2009-2010, another strong El Niño phenomenon led to drought across the country, characterized by decreased rainfall and dry conditions, resulting in reduced water supply and crop yields. In 2015-2016, the Philippines experienced its strongest El Niño on record, prompting the government to declare a state of calamity due to food and water insecurity. Drought and heatwaves during this period caused water scarcity and considerable crop damage.

3.2.3 Conceptual framework

Rice farming in the Philippines faces vulnerability to climatic phenomena such as El Niño, characterized by prolonged dry spells and higher temperatures, affecting water availability for irrigation and rice productivity. Additionally, the country experiences frequent challenges from monsoons and typhoons, leading to concerns for rice farmers due to flooding caused by these climatic events. The combined approach of rehabilitating irrigation systems and providing farmer training offers strategies for enhancing rice productivity and water management during both drought and flooding conditions, for the following reasons:

Enhanced water efficiency and flood resilience: Rehabilitated irrigation systems improve water efficiency during drought conditions and make the infrastructure more resilient to flooding. During the dry season, water stored in small ponds or reservoirs provides a supplementary water supply for irrigation, ensuring continued crop growth. Additionally, measures such as lining canals to reduce water seepage minimize water loss, crucial during El Niño events when water supply is limited. Furthermore, the inclusion of small ponds or reservoirs in the improved irrigation infrastructure allows for the capture and storage of rainwater for irrigation use during critical periods of the crop cycle.

Improved drainage systems: Rehabilitation efforts often include enhancements to drainage systems, crucial for flood resilience. Efficient drainage capacity ensures that water does not stagnate in rice fields, preventing crop diseases and pest infestations that can harm rice productivity. Particularly during the wet season when rainfall is frequent, improved drainage systems help prevent waterlogging and crop damage caused by excessive rainfall.

Farmer training in water management: Rehabilitation projects often incorporate training sessions focused on water management practices and technologies for water-saving techniques. Farmers participating in these programs are educated on the adoption of drought-resistant rice seed varieties tailored to conditions during El Niño events. These varieties are capable of surviving with less water while still yielding reasonable crop outputs. Moreover, proper irrigation practices, including irrigation scheduling to optimize water usage, are emphasized during training sessions, particularly crucial for controlling and managing water usage during drought periods. Additionally, water user associations (WUAs) receive training to effectively manage and allocate irrigation water, especially during times of water scarcity, such as the dry season when rainfall is minimal or unpredictable.

In the Philippines, water scarcity often follows flood events. Therefore, farmers undergo training to understand when and how to drain fields, along with techniques for conserving water once floodwaters recede. This training equips farmers with essential water management skills, enabling them to effectively manage water resources during flooding events. Such knowledge is vital during the wet season when there is a need to remove excess water from agricultural fields to prevent waterlogging and crop damage.

3.2.4 Data

The data utilized in this study consists of cross-sectional data collected by the IFAD team 18 months after the completion of the IRPEP project in 2015[3]. It includes samples of beneficiary and non-beneficiary household-farmers from the IRPEP[4]. The survey

[3] No baseline data was collected prior to project implementation; however, the research team rigorously randomized using several pre-determined characteristics and local project staff knowledge. Therefore, we believe any potential estimation bias will be minimized.

[4] Data collection was conducted by the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), a research organization based in the Philippines, contracted by the IFAD.

encompassed 113 community irrigation systems (CISs), with 58 CISs in the treatment group and 55 CISs in the control group. The desired sample size, based on power calculation, aimed for 19 households per CIS from both treatment and control groups, totaling approximately 2,100 observations. Therefore, the initial target number of households for the treatment and control groups was 1,102 and 1,045, respectively[5]. However, due to some CISs having fewer than 19 household members, a slight oversampling was conducted in larger CISs within the same region, resulting in a total of 2,104 households, with 1,082 in the treatment group and 1,022 in the control group. It's important to note that 872 households reported having more than one parcel producing rice crops. Consequently, the sample size for plot-level analysis increased to 1,317 and 1,266 in the treatment and control groups, respectively. To ensure the representation of the underlying population, sampling weights adjustment was applied to the samples.

3.3 Impact analysis of irrigation rehabilitation

3.3.1 Empirical strategy

As previously outlined, Arsalan et al., (2018) examined the primary intended impacts of the rehabilitation scheme, such as rice productivity and women's empowerment, demonstrating generally positive effects. Our objective is to complement their study by investigating the treatment effect of rehabilitated irrigation infrastructure on water management practices in the presence and absence of flooding and droughts. We evaluate the collective action of farmers within the CIS by focusing on their responsibilities in managing the CIS. Specifically, we utilize information regarding the time allocated by

[5] The sample size was determined according to the IRPEP plan to detect an 11% change in the baseline mean of rice yield, which represents the minimum expected change in the outcome variable.

farmers for maintaining irrigation, which includes tasks such as setting up water delivery, collecting water user fees by IAs, and fines paid by farmers to the IAs. These indicators serve as domains of collective action in terms of labor and financial contributions. We analyze these practices in relation to the improvement of rice productivity under varying conditions of flooding and drought. Additionally, we disaggregate our regression analysis for dry and wet seasons to capture seasonal changes in water availability. The estimated model can be specified as follows:

$$Y_{ipmj} = \beta_0 + \beta_1 T_{mj} + \beta_2 (T_{mj} \times Shock_{ipmj}) + \beta_3 Shock_{ipmj} + \boldsymbol{X}_{ipmj}\theta + v_m + \epsilon_{ipmj}, \quad (1)$$

Y_{ipmj} represents the outcome indicator of farmer i's rice productivity, water supply or crisis, and water management or collective action of the communal irrigation at parcel p in municipal m in CIS j. Rice productivity is measured by the logarithm of ton of rice production per hectare. Water supply or crisis is measured by water distribution in months within a cropping season (either dry or wet), and self-reported sufficiency in water supply at the household level, represented by a dummy variable equal to 1 if the answer is yes for sufficient water supply and 0 otherwise. Water management or collective action indicator is measured at the household level per season by the logarithm of maintenance time in hours, water user fee in pesos, and fines to IAs in pesos. Water distribution and self-reported sufficiency in water supply is expected to indicate whether the rehabilitation has solved water shortage throughout each wet and dry season. Maintenance time, water user fee, and fines to IAs are expected to represent incentives for saving water and maintaining common resources as collective action in terms of labor and money. Water user fee is based on the amount of water used. Paying the water user fee incentivizes farmers due to the anticipation of long-term improvements in the irrigation system and involvement in decision making. IAs collect water user fee and use it to spend and invest on improvements of irrigation system. This incentivizes the farmers to pay the water user fee because of the anticipation that the irrigation system will be improved. Additionally, consistent payment signifies active membership, offering incentives for holding positions within the association, which allows for greater influence in decision-making. Fines promote fairness among CIS members, disincentivizing non-compliance with maintenance and unauthorized water use, ensuring equitable participation and resource utilization.

T_{mj} denotes the random treatment assignment of CISs in the rehabilitation program. $Shock$ is an indicator of natural disasters representing the log transformation of flood and drought frequencies, describing the number of times floods and droughts occurred. Missing values are replaced by zero. $\boldsymbol{X}_{ipmj}$ is a vector of controls that include household head's characteristics such as age, gender, education, labor market participation; land characteristics such as land owned, land area, location from irrigation, distance from the house to the land field, and distance from irrigation to the land field; irrigation association participation characteristics such as position, voting rights, and year of membership. v_m represents municipal fixed effects, and ϵ_{ipmj} is the error term.

β_2 is the coefficient of interest that captures the climate risk mitigating effects of the treated irrigation. β_1 measures the impact of the intervention in the treatment area without the effect of natural disaster shock, while β_3 gives the estimate of the average impact of natural disaster shock on the control group's outcomes. These estimates will be provided for sub-groups of wet and dry planting seasons to understand the seasonal effects of the intervention on the outcome of interest. While flooding in the dry season in the

Philippines is not common, the strongest typhoons that struck the Philippines occurred during the months of the dry season, causing severe flooding. On the other hand, drought during the wet season is induced by the El Niño phenomenon, which is a climate pattern that occurs due to warming of ocean temperatures in the central and eastern Pacific Ocean.

In this model, we cluster the standard error at the level of randomization of the study design, which is at the province level. In doing so, we follow the assumption of independence of observations by accounting for the likelihood of correlation of IRPEP beneficiaries within the same province-cluster, as they are more likely to be similar to each other than to IRPEP beneficiaries across other province-clusters. However, the assumptions required for a consistent cluster-robust variance estimator (CRVE) are that 1) the number of clusters goes to infinity; 2) within-cluster error correlations are the same for all clusters; and 3) each cluster contains an equal number of observations (MacKinnon and Webb, 2017). The study design has limitations for the first and third assumptions given that there were only a few province-clusters (7) chosen for this study. To address this limitation, a wild cluster bootstrap (WCB) technique was applied, as proposed by Cameron and Miller (2015), which works well under a small number of clusters. In traditional bootstrapping techniques, samples are drawn multiple times with replacement from the original dataset. In wild bootstrapping, resampling is done at the cluster level, therefore, the entire clusters from the original dataset are sampled with replacement rather than individual observations. For each bootstrapped sample, a random parameter is drawn from a distribution with mean zero and finite variance. This random bootstrapped sample is then applied in the fixed effect model that fits a linear regression absorbing one categorical variable, which in this case, is the municipalities or cities variable within the province.

3.3.2 Descriptive statistics

Table 3.1 presents the variables used in our study, covering household-, parcel-, and CIS-level variables for overall, wet planting, and dry planting samples. At the household level, the average age of household heads is 57 years old, with approximately 15% of households headed by females and around 80% classified as married households. Nearly all household heads (98%) have attended school, and 94% are economically active.

At the parcel level, the average size of one parcel is approximately 1 ha, and farmers own land averaging 1 ha. Half of the irrigation canals are located downstream, with parcels situated an average distance of 12 minutes by walking from the house and approximately 4 kilometers from the irrigation source. On average, each parcel experiences one instance of flooding and drought. About 43%-45% of farmers plant during the wet season, while the remaining farmers plant during the dry season.

At the CIS level, 77% of farmers have been members of the IAs for 10 years. Approximately 66-67% of IA members hold general member positions, and 69-70% have the right to vote for staff appointments within the IA.

Regarding outcome variables, rice productivity, measured in tons per hectare, averages approximately 3.2 tons per hectare at the parcel level, indicating eligibility for intervention. Water distribution across parcels averages approximately 2 months within a cropping season for both treatment and control groups. Sufficient water supply is reported at the household level, with 75% and 71% of households reporting sufficient water supply in the treatment and control areas, respectively. Maintenance time, measured at the household level, averages approximately 12 and 13 hours within a cropping season in the treatment and control groups, respectively. The water user fee represents CIS-level information, with an average fee of 2,000 pesos for the entire cropping season for both treatment and control groups. Fines are reported at the household level, with average amounts of 12 pesos and 20 pesos for the entire cropping season in the treatment and control groups, respectively.

The last column of the table shows the t-statistics for the mean differences between the two groups. This indicates that pre-determined household, land area, and IA participation characteristics, as well as flooding not influenced by the program, are well balanced between the treatment and control groups. However, some post-treated outcomes, such as sufficient water supply and water user fees, show differences in means. Upon dividing the samples into wet planting (1,137) and dry planting (1,446) seasons, we observe that the two groups remain well-balanced in terms of pre-determined characteristics, except for gender in the wet planting season. Differences in means for post-treated outcomes are evident, except for rice productivity, which is expected to be balanced as it is one of the eligibility criteria.

Table 3.1 Balance on household, land, and irrigation association participation characteristics, shocks, rice productivity, water logging, supply and management outcomes: means, standard errors in brackets, and p-value on t-test of equality of means

Variable	N	(1) Treatment Mean [SE]	N	(2) Control Mean [SE]	(1)-(2) t-test Difference
		Overall			
Household characteristics					
Age	1317	57.057 [0.331]	1266	57.119 [0.365]	-0.062

Gender (1=Female)	1317	0.144 [0.010]	1266	0.150 [0.010]	-0.007
Married (1=Yes)	1317	0.797 [0.011]	1266	0.775 [0.012]	0.022
Attended school (1=Yes)	1317	0.979 [0.004]	1266	0.979 [0.004]	0.001
Economically active (1=Yes)	1317	0.945 [0.006]	1266	0.937 [0.007]	0.008
Land area field characteristics					
Size of the parcel (in hectares)	1317	0.887 [0.028]	1266	0.910 [0.024]	-0.023
Land owned (in hectares)	1317	0.984 [0.025]	1266	0.970 [0.019]	0.014
Location from irrigation canal (1=downstream)	1317	0.498 [0.014]	1266	0.500 [0.014]	-0.002
Distance from house to land field (minutes)	1317	12.568 [0.392]	1266	11.991 [0.378]	0.577
Distance from irrigation to land field (km)	1317	4.535 [1.428]	1266	3.413 [0.812]	1.122
Irrigators' association participation					
Years of membership (1=10 years)	1317	0.769 [0.012]	1266	0.765 [0.012]	0.004
Position in IA (1=general member)	1317	0.670 [0.013]	1266	0.656 [0.013]	0.013
Right to vote (1=Yes)	1317	0.702 [0.013]	1266	0.682 [0.013]	0.020
Natural shocks					
flood and drought	1317	1.236 [0.021]	1266	1.224 [0.024]	0.012
Planting season					
Wet season	1317	0.454 [0.014]	1266	0.426 [0.014]	0.028
Outcome variables					
Rice productivity (ton per ha)	1317	3.126 [0.120]	1266	3.205 [0.117]	-0.079
Erosion controlled (1=drainage)	1317	0.010 [0.003]	1266	0.005 [0.002]	0.005
Water distribution (months)	1317	2.008 [0.034]	1266	2.058 [0.036]	-0.049
Sufficient water supply (1=Yes)	1317	0.750 [0.012]	1266	0.710 [0.013]	0.040**
Maintenance time (hours)	1317	12.420 [0.550]	1266	13.111 [1.434]	-0.691
Water user fee (Php)	1317	2,047.906 [108.993]	1266	1,570.441 [77.410]	477.465***
Fines (Php)	1317	12.117 [5.610]	1266	20.850 [7.150]	-8.733
Wet planting season					
Household characteristics					
Age	598	58.744 [0.474]	539	58.963 [0.596]	-0.219
Gender (1=Female)	598	0.135 [0.014]	539	0.180 [0.017]	-0.045**
Married (1=Yes)	598	0.781 [0.017]	539	0.744 [0.019]	0.037
Attended school (1=Yes)	598	0.987 [0.005]	539	0.980 [0.006]	0.007
Economically active (1=Yes)	598	0.931 [0.010]	539	0.929 [0.011]	0.002
Land area field characteristics					
Size of the parcel (in hectares)	598	0.789 [0.043]	539	0.825 [0.040]	-0.037
Land owned (in hectares)	598	0.913 [0.041]	539	0.934 [0.034]	-0.020

Location from irrigation canal (1=downstream)	598	0.585 [0.020]	539	0.627 [0.021]	-0.042
Distance from house to land field (minutes)	598	10.418 [0.525]	539	9.818 [0.457]	0.600
Distance from irrigation to land field (km)	598	2.824 [1.121]	539	4.150 [1.546]	-1.326
Irrigator's Association participation					
Years of membership (1=10 years)	598	0.824 [0.016]	539	0.850 [0.015]	-0.025
Position in IA (1=general member)	598	0.696 [0.019]	539	0.659 [0.020]	0.037
Right to vote (1=Yes)	598	0.632 [0.020]	539	0.601 [0.021]	0.031
Natural Shocks					
flood and drought	598	1.149 [0.025]	539	1.191 [0.027]	-0.042
Outcome variables					
Rice productivity (ton per ha)	598	2.742 [0.140]	539	2.903 [0.172]	-0.161
Erosion controlled (1=drainage)	598	0.013 [0.005]	539	0.009 [0.004]	0.004
Water distribution (months)	598	2.334 [0.045]	539	2.067 [0.052]	0.268***
Sufficient water supply (1=Yes)	598	0.796 [0.016]	539	0.668 [0.020]	0.128***
Maintenance time (hours)	598	8.331 [0.608]	539	12.273 [1.856]	-3.942**
Water user fee (Php)	598	1,727.237 [84.824]	539	1,151.214 [84.924]	576.023***
Fines (Php)	598	20.239 [12.242]	539	9.187 [2.823]	11.052
Dry planting season					
Household characteristics					
Age	719	55.654 [0.455]	727	55.752 [0.450]	-0.099
Gender (1=Female)	719	0.150 [0.013]	727	0.128 [0.012]	0.022
Married (1=Yes)	719	0.809 [0.015]	727	0.798 [0.015]	0.012
Attended school (1=Yes)	719	0.974 [0.006]	727	0.978 [0.005]	-0.004
Economically active (1=Yes)	719	0.955 [0.008]	727	0.942 [0.009]	0.013
Land area field characteristics					
Size of the parcel (in hectares)	719	0.969 [0.037]	727	0.972 [0.030]	-0.003
Land owned (in hectares)	719	1.042 [0.032]	727	0.996 [0.020]	0.046
Location from irrigation canal (1=downstream)	719	0.426 [0.018]	727	0.406 [0.018]	0.020
Distance from house to land field (minutes)	719	14.356 [0.563]	727	13.602 [0.558]	0.754
Distance from irrigation to land field (km)	719	5.958 [2.444]	727	2.866 [0.827]	3.091
Irrigator's Association participation					
Years of membership (1=10 years)	719	0.723 [0.017]	727	0.703 [0.017]	0.020
Position in IA (1=general member)	719	0.648 [0.018]	727	0.655 [0.018]	-0.007
Right to vote (1=Yes)	719	0.761 [0.016]	727	0.743 [0.016]	0.018
Natural Shocks					
flood and drought	719	1.309 [0.032]	727	1.249 [0.037]	0.060

Outcome variables					
Rice productivity (ton per ha)	719	3.446	727	3.429	0.017
		[0.187]		[0.159]	
Erosion controlled (1=drainage)	719	0.007	727	0.001	0.006*
		[0.003]		[0.001]	
Water distribution (months)	719	2.106	727	2.274	-0.168**
		[0.055]		[0.054]	
Sufficient water supply (1=Yes)	719	0.712	727	0.741	-0.029
		[0.017]		[0.016]	
Maintenance time (hours)	719	15.821	727	13.733	2.087
		[0.851]		[2.085]	
Water user fee (Php)	719	2,582.967	727	2,182.538	400.430*
		[186.148]		[127.741]	
Fines (Php)	719	5.362	727	29.497	-24.135*
		[1.369]		[12.268]	

The value displayed for t-tests are the differences in the means across the groups.
***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

3.4 Empirical results

3.4.1 Overall results

The overall results from model estimation indicate that the rehabilitated irrigation system has significantly mitigated the risks of flood and drought events (see Column 1 of Panel A in Table 3.2). During climatic events, the treatment area significantly controlled soil erosion through drainage, which is crucial for preventing flooding (see Column 2), and provided sufficient water supply, critical during dry spells (see Column 4). Furthermore, during these shocks, there was an increase in water user fees to the IAs, essential for sustaining the management of water resources in the CIS (see Column 6). Additionally, fines were significantly reduced during shocks, indicating compliance by farmers with the rules for managing the CIS (see Column 7). Without shocks, maintenance time is positive and significant (see Column 5). However, with shocks, maintenance time remains positive but not significant. This may suggest that farmers may have a hard time coping with other personal responsibilities, reducing their effort in maintaining the CIS during disasters.

The coefficients of flood and drought shocks are negative and significant across all outcomes except for erosion control and fines, indicating that shocks have a negative effect on average without treatment. A positive and significant effect of shocks on fines in the control group suggests that without treatment, farmers tend to ignore the rules of IAs within CISs.

3.4.2 Seasonal effects

The results from model estimation suggest that the rehabilitated irrigation system has non-identical effects in the wet and dry planting seasons (Panel B and C of Table 3.2). During the wet planting season, treated areas show better drainage that controls erosion, as indicated by the positive and significant coefficient (see Column 2), and positive and significant farmers' satisfaction with water sufficiency (see Column 3). There is a negative and significant effect on fines, perhaps because treated areas have better access to irrigation water, reducing the need to pay fines. Flooding and drought also have negative and significant impacts on drainage that controls erosion, sufficiency in water supply, and water user fees in the control areas. Flooding may damage the drainage system due to the strong pressure of water flow and accumulated debris carried by water, potentially disrupting water supply. Drought may also cause clogs in drainage channels when there is no water to flush away debris. Damage to the drainage system disrupts water supply, while drought-related health issues such as heatstroke and flood-related damage to farmers' houses may divert attention from water user fees due to personal priorities. Nevertheless, the results suggest that the intervention has mitigated adverse flooding and drought effects and has encouraged farmers to maintain the irrigation system, as shown by the positive and significant estimates of interaction terms on water distribution, water supply sufficiency, and water user fees.

In the dry planting season, maintenance time is positive and significant among treated areas, consistent with the overall result. This may imply that dry weather or less rain provides a more stable condition for maintenance work, with less likelihood of disruption. The disaster risk-mitigating effects of the treatment are more pronounced in the dry planting season, as shown by the positive and significant effects on rice productivity (Column 1 of Panel C of Table 3.2). During the dry season, the Philippines is susceptible to water scarcity due to insufficient rain, posing challenges for rice production. However, the results show that erosion is positively and significantly controlled under climatic shocks in the treatment area, potentially helping to store water during the dry season and boost rice productivity. Although flooding during the dry season can potentially alleviate water scarcity by providing water to the soil, adverse effects may still occur, especially in the case of flash floods caused by typhoons. Nonetheless, more collective action is evident among treated farmers during the dry season through maintenance, reflecting a response to water scarcity. During flooding and drought in the treatment area, maintenance time and water user fees show positive and significant effects, while fines are negative and significant, suggesting collective action in times of disaster during the dry season. The opposite is observed in the control group during flooding and drought, where maintenance time and water user fees are negative and significant, while fines are positive and significant. A positive and significant effect on fines in the control group might imply less cooperation with IAs in the management of the irrigation system, leading to penalties. The interaction of treatment and flooding shows negative and significant effects on fines, suggesting group compliance in the treatment group when faced with shocks or unexpected phenomena. Hence, when a water crisis occurs in the dry season, farmers cooperate with obligations even in the face of shock. Moreover, in the control group, water distribution and sufficiency in water supply are negative and insignificant, likely resulting from a lack of collective action.

Since outcomes vary only at the household level for columns (3), (4), (5), and (6), we also run regressions using household-level observations. The results shown in Appendix D, Table 2.4. A1, are mostly consistent with the main results in Table 3.2.

Table 3.2 Climate risk mitigating effects of rehabilitation on productivity and water control, scarcity, and management

		Water logging	**Water supply (Crisis)**		**Water management (Collective action)**		
	Rice productivity (ton per ha)	Erosion controlled (1=drainage)	Water distribution (months)	Sufficient water supply (1=Yes)	Maintenance time (hour)	Water user fee (Php)	Fines (Php)
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
			Panel A: Overall				
T	0.01	0.01	-0.06	0.01	0.14**	-0.01	-0.22
	(0.07)	(0.01)	(0.03)	(0.04)	(0.05)	(0.07)	(0.13)
Flood and drought	-0.04*	0.00	-0.05**	-0.13***	-0.22*	-0.27**	0.52***
	(0.02)	(0.00)	(0.02)	(0.02)	(0.10)	(0.09)	(0.08)
T X flood and drought	0.12**	0.03**	0.06	0.07**	0.03	0.31*	-0.41***
	(0.05)	(0.01)	(0.03)	(0.02)	(0.07)	(0.13)	(0.10)
Constant	-0.48	-0.03	0.41	0.22**	1.36**	6.29***	0.48**
	(0.33)	(0.08)	(0.22)	(0.07)	(0.46)	(0.33)	(0.16)
Observations	2,583	2,583	2,583	2,583	2,583	2,583	2,583
R^2	0.41	0.10	0.22	0.18	0.25	0.93	0.16
			Panel B: Wet planting season				
T	0.04	0.01***	-0.20**	0.11***	0.45	-0.03	-0.22**
	(0.07)	(0.00)	(0.07)	(0.02)	(0.84)	(0.02)	(0.07)
Flood and drought	-0.00	-0.02***	-0.17	-0.26***	-0.28	-0.14***	0.31
	(0.02)	(0.00)	(0.19)	(0.01)	(1.24)	(0.03)	(0.23)
T X flood and drought	0.03	0.01	0.33*	0.12***	0.14	0.14**	-0.14
	(0.04)	(0.01)	(0.14)	(0.03)	(2.38)	(0.05)	(0.22)
Constant	0.59	0.02	2.80***	0.74***	-3.35	9.19***	0.31**
	(0.33)	(0.03)	(0.60)	(0.11)	(8.76)	(0.30)	(0.10)

Observations	1,137	1,137	1,137	1,137	1,137	1,137	1,137
R^2	0.43	0.07	0.14	0.19	0.12	0.94	0.14
Panel C: Dry planting season							
T	0.02	0.00	-0.09	-0.03	0.23***	0.02	-0.26
	(0.08)	(0.00)	(0.07)	(0.02)	(0.05)	(0.05)	(0.17)
Flood and drought	-0.03	-0.00	-0.05*	-0.09*	-0.47***	-0.29***	0.68***
	(0.02)	(0.01)	(0.02)	(0.04)	(0.09)	(0.06)	(0.07)
T X flood and drought	0.18**	0.04***	0.07	0.06	0.13*	0.35***	-0.63***
	(0.05)	(0.01)	(0.06)	(0.05)	(0.06)	(0.06)	(0.11)
Constant	0.54*	0.08***	0.55	0.67***	-0.07	11.59***	0.73*
	(0.25)	(0.02)	(0.40)	(0.06)	(0.56)	(0.13)	(0.35)
Observations	1,446	1,446	1,446	1,446	1,446	1,446	1,446
R^2	0.45	0.09	0.23	0.13	0.44	0.78	0.21

Standard errors in parentheses are robust and clustered by province. Wild cluster bootstrapping with areg regression was applied. All regressions include controls for household characteristics— age of the head of household, gender of household head (1=female), whether household head is married (1=yes), whether household head attended school (1=yes), and household head is economically active (1=Yes); land area characteristics – size of parcel (ha), land owned (ha), location from irrigation (1=downstream) and distance from house to land field; distance from irrigation to land field; and irrigator's association participation – years of membership (1=10 years), position in IA (1=general member), right to vote (1=Yes). The absorbed categorical variable is municipality classifications. Dependent variables are transformed into natural logarithmic functions. Wet planting season refers to rice planted from April to September. Dry planting season refers to rice planted from October to March. Months of planting season are based on calendar set by the Department of Agriculture (DA).
*p<.01; **p<.05; ***p<.001

3.4.3 Heterogenous treatment effects

The previous section describes the treatment effect through the strengthening of infrastructure. However, the intervention also includes participatory training aimed at fostering a sense of ownership and facilitating collective action. One component of the IRPEP's irrigation system rehabilitation is training provided to farmers and IAs of the CIS. The training covers skills related to irrigation system management and water management practices. Of the 596 farmers who attended training, 375 were from the treatment and 221 from the control group. Of the 375 farmers in the treatment group, 123 planted in the wet season and 252 in the dry season. Of the 221 farmers in the control group, 90 planted in the wet seasons and 131 in the dry season. The treatment group was provided training as part of the IRPEP, while the control group received training from local government units and other non-government organizations. In 2010, the Philippine

Rice Research Institute (PhilRice) implemented the Farmer Field Schools (FFS) program to achieve the Philippine government's target of 100% rice self-sufficiency. The FFS is a training initiative for rice farmers in seed-planting, water use, and technologies, among others. FFS training was provided to the control group of the IRPEP.

In this subsection, we examine whether supplemental training has fostered social learning and collective action among farmers. We separately analyze the trained and untrained sub-groups in the wet and dry planting seasons to understand the training effects in different seasons. The wet planting season samples consist of 213 trained and 924 untrained individuals, while the dry planting season comprises 383 trained and 601 untrained individuals.

Table 3.3 presents the estimated results of the training intervention for the two seasons. These results complement those from Table 3.2, shedding light on the role of training in promoting better collective action. Panel A shows that during the wet season, the trained group in the treatment area reported sufficient water supply, as indicated by the positive and significant coefficient. Cooperative action is also observed, as evidenced by the positive and significant coefficient in water user fees. Conversely, in Panel B, the untrained group in the treatment area reported negative and significant water supply sufficiency during the wet season. However, they still displayed cooperative behavior, as indicated by the positive and significant water user fees and negative and significant fines.

In Panel C, the trained group during the dry season reported negative and significant water supply sufficiency. However, these results are comparable to those in Panel C of Table 3.2, suggesting risk-mitigating effects of flooding and drought, resulting in positive and significant rice productivity and controlled erosion through drainage. A reduction in fines is also observed among the trained group in the dry season, consistent with Panel C of Table 3.2, suggesting compliance. A positive and significant sufficiency in water supply is also observed among the trained group in the treatment area during shocks in the dry season.

In Panel D, among the group who did not receive training, a positive and significant result for maintenance time is still observable in the treatment area. However, when no training related to water management practices is provided during the dry season in the treatment area, the effect seems ineffective in mitigating climate risk, leading to negative rice productivity. The results are also negative and significant for sufficiency in water supply and water user fees, although fines are significantly negative, suggesting compliance when there is a shock. In the control group, water user fees and fines are positive and significant when there is a shock, possibly aiding spending for drainage as erosion control. However, there seems to be no voluntary collective action in the control area among the untrained group, as indicated by the negative and significant maintenance time leading to negative and significant water distribution and water supply sufficiency.

This emphasizes the importance of knowledge on proper water management practices, as without it, improved irrigation will not be effective or sustainable in mitigating the risk of climatic events such as floods and droughts. Hence, participatory training is crucial to enhancing individual capacity in maintaining the irrigation system through compliance with obligations to IAs. A combined capacity-building training with improved irrigation infrastructure contributes to increased rice productivity, as farmers can better apply practices and techniques on the improved infrastructure compared to infrastructure that is not rehabilitated.

Table 3.3 Effect of supplemental training on water management

		Water logging	Water supply (Crisis)		Water management (Collective action)		
	Rice productivity (ton per ha)	Erosion controlled (1=drainage)	Water distribution (months)	Sufficient water supply (1=Yes)	Maintenance time (hour)	Water user fee (Php)	Fines (Php)
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Trained group (Wet season)							
T	0.28	-0.09	0.04	0.23**	0.31	0.02*	-0.37
	(0.44)	(0.10)	(0.22)	(0.09)	(7.40)	(0.01)	(0.23)
Flood and drought	0.04	-0.00	0.82	-0.11	-0.80	-0.02	0.33
	(0.12)	(0.02)	(0.72)	(0.25)	(10.37)	(0.03)	(0.58)
T X flood and drought	0.04	0.03	0.61	0.15	4.11	-0.02	-0.65
	(0.18)	(0.06)	(0.65)	(0.18)	(9.81)	(0.02)	(0.52)
Constant	-0.04	0.18*	1.71***	0.01	19.02	-0.03	0.30
	(0.38)	(0.07)	(0.37)	(0.78)	(32.02)	(0.11)	(0.55)
Observations	213	213	213	213	213	213	213
R^2	0.58	0.27	0.38	0.36	0.54	0.06	0.41
Panel B: Untrained group (Wet season)							
T	-0.03	0.05***	0.20	-0.04**	0.01	0.21***	-0.27**
	(0.06)	(0.01)	(0.11)	(0.01)	(0.10)	(0.05)	(0.09)
Flood and drought	-0.05	0.03	0.04	-0.30***	-0.09	0.16	0.40
	(0.06)	(0.04)	(0.27)	(0.03)	(0.06)	(0.16)	(0.29)
T X flood and drought	-0.02	-0.04	-0.11	0.08	0.07	-0.18	-0.09
	(0.12)	(0.05)	(0.34)	(0.09)	(0.15)	(0.17)	(0.30)
Constant	-0.45	-0.21**	2.42***	0.60**	0.23	8.26***	0.35
	(0.30)	(0.06)	(0.18)	(0.16)	(0.63)	(0.18)	(0.24)
Observations	924	924	924	924	924	924	924
R^2	0.41	0.12	0.17	0.17	0.32	0.96	0.14
Panel C: Trained group (Dry season)							
T	0.06	0.00	-0.22	-0.10***	0.14	0.90	0.04
	(0.18)	(0.01)	(0.33)	(0.02)	(0.10)	(1.65)	(0.06)
Flood and drought	-0.08	0.02*	-0.07	-0.02	-0.43	0.19	1.49***
	(0.05)	(0.01)	(0.13)	(0.07)	(0.44)	(0.52)	(0.22)
T X flood and drought	0.56***	0.07***	0.01	0.16**	0.25	0.38	-1.09***
	(0.07)	(0.02)	(0.17)	(0.06)	(0.30)	(0.90)	(0.23)
Constant	0.07	0.02	3.53**	1.37***	2.97*	-2.15	0.23

	(0.44)	(0.02)	(1.35)	(0.25)	(1.47)	(1.85)	(0.48)
Observations	383	383	383	383	383	383	383
R^2	0.54	0.27	0.34	0.23	0.32	0.49	0.35
Panel D: Untrained group (Dry season)							
T	0.10	0.02	0.07	0.03	0.35***	0.32	-0.30
	(0.07)	(0.01)	(0.11)	(0.08)	(0.09)	(0.30)	(0.27)
Flood and drought	0.08	0.01*	-0.23***	-0.09**	-0.62***	0.20*	0.38***
	(0.05)	(0.01)	(0.04)	(0.03)	(0.02)	(0.09)	(0.08)
T X flood and drought	-0.17**	0.01	-0.04	-0.11***	0.18	-0.23*	-0.48**
	(0.06)	(0.02)	(0.04)	(0.03)	(0.11)	(0.11)	(0.16)
Constant	-0.05	-0.02	0.37	0.52***	0.62	1.79	1.09
	(0.11)	(0.02)	(0.29)	(0.11)	(0.35)	(0.96)	(0.60)
Observations	601	601	601	601	601	601	601
R^2	0.47	0.16	0.34	0.25	0.42	0.56	0.24

Standard errors in parentheses are robust and clustered by province. Wild cluster bootstrapping with areg regression was applied. All regressions include controls for household characteristics— age of the head of household, gender of household head (1=female), whether household head is married (1=yes), whether household head attended school (1=yes) and household head is economically active (1=Yes); land area characteristics – size of parcel (ha), land owned (ha), location from irrigation (1=downstream); distance from house to land field and distance from irrigation to land field; and irrigator's association participation – years of membership (1=10 years), position in IA (1=general member), right to vote (1=Yes). The absorbed categorical variable is municipality classifications. Dependent variables are transformed into natural logarithmic functions.
*p<.01; **p<.05; ***p<.001

3.5 Conclusion

This study investigated the seasonal effects of the treatment rehabilitation of irrigation infrastructure on rice productivity, water logging, water crisis, and water management. Additionally, we explored the training component of the treatment to provide insights into the mechanisms supporting our findings. Using a parcel-level dataset and employing a wild bootstrapping technique, we estimated the effects of the treatment, natural shocks, and the interaction of treatment and shocks on the outcomes of interest. Our analysis revealed novel findings not captured by Arsalan et al., (2018). Specifically, we found that the rehabilitated irrigation infrastructure in the treatment area has effectively mitigated the effects of shocks—flooding and drought—resulting in increased productivity of farmers' rice crop production. Moreover, we observed collective action among farmers under the auspices of IAs in the CIS, particularly in response to water scarcity and waterlogging. This collective action was more pronounced among farmers who received training in water management. Therefore, the participatory approach to communal irrigation system management not only improved rice productivity and mitigated the risks of negative climatic events through treatment rehabilitation but also fostered social capital through capacity-building training. These findings have significant policy implications, supporting smaller communal irrigation schemes managed by farmers under IAs. They suggest that support measures such as capacity-building training can facilitate social learning and group dynamism, leading to stronger collective action toward the sustainable use of water resources and increased agricultural productivity.

Chapter 4: Conclusion

This dissertation comprises two chapters investigating randomized experiments in the Philippines using household and parcel-level datasets. It offers empirical evidence into the behavioral responses of intervention beneficiaries in the face of natural disaster-related shocks. These responses were analyzed to discern the effects on informal insurance for CCT and collective action for the IRPEP. The studies' novelty lies in their exploration of the crowding-out effects of CCT on informal insurance, CCT spillover effects to ineligible individuals, unintended consequences of CCT on financial inclusion, and unexplored hypotheses regarding the IRPEP's impact on collective action and climate risk mitigation under shocks—a critical consideration in disaster-prone developing countries like the Philippines.

Chapter 2 illuminates the intricate relationship between CCT and informal insurance, crucial coping mechanisms for impoverished individuals to manage risks and alleviate poverty. Chapter 3 highlights how infrastructure improvements and training can incentivize farmers to maintain irrigation systems, ensuring sustainability and continuous water supply. Given the inherent risks farmers face from disasters, incentives for irrigation investment through maintenance activities are paramount. Collective action becomes indispensable during water scarcity and when irrigation infrastructure is fragile. Without such collective action in community irrigation systems, water supply becomes unsustainable, potentially leading to conflicts among farmers.

Both substantive chapters employ estimation models incorporating random treatment assignment, interaction of treatment and shock variables, shock effects, and a set of control variables. This modeling approach enables robust estimates while controlling for selection bias inherent in randomized control trials. Potential biases were addressed through various methodologies and validation tests, including adjustments to datasets, particularly data processing by transformation into inverse hyperbolic sine (Chapter 2), assignment of sampling weights (Chapter 3), use of appropriate regression specifications such as fixed effects (Chapters 2 and 3), and use of appropriate techniques, such as WCB (see Chapter 3), to handle correlation in small clusters. Validation tests such as IPW are conducted (see Chapter 2) to prove the randomization of study, given the lack of a baseline and Probit model for attrition bias.

The main findings offer valuable policy implications. Chapter 2 suggests potential poverty alleviation through cash transfers to targeted beneficiary households, with positive spillover effects on informal insurance networks. Chapter 3 underscores the importance of capacity-building programs to enhance farmers' skills and knowledge in irrigation system management. It also advocates for policies promoting community participation, emphasizing local communities' involvement in decision-making processes related to irrigation projects, leveraging local knowledge for more effective project design and implementation.

Lastly, both studies yield common policy implications, particularly regarding the integration of climate risk insurance mechanisms within the CCT and IRPEP programs. This integration can provide a safety net for vulnerable households in the face of climate-induced shocks, ensuring financial protection against disasters. Additionally, environmental policy implications emerge from both studies. Policies should aim to mitigate the negative effects of climate change by building resilient infrastructure, implementing disaster risk reduction measures, and participating in community-based early warning systems.

However, both chapters also have limitations. In Chapter 2, the analysis only covers a single time period for borrowings and lending, failing to capture the long-term effects of CCT on informal insurance fully. Exploring the long-term impact may reveal additional spillover effects, such as analyzing changes at the extensive margin. Furthermore, there's a lack of information about additional borrowings beyond the initial amount, and exploring other coping mechanisms, like low-wage employment, could provide further insights into the poverty trap among impoverished households. Chapter 3 faces limitations due to the limited dataset and indicators available for analysis. Consequently, certain issues such as conflicts among farmers and knowledge transfer remain underexplored. Future studies focusing on these aspects would be meaningful, particularly in the context of developing countries vulnerable to natural disasters. Expanding the scope of analysis could provide valuable insights into the dynamics of collective action and risk management within community irrigation systems.

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Appendices

Appendix A. Inverse Probability Weighting (IPW) Estimation and the Non-attrition Probit Model

This section explains the procedure for estimating Equations 2 and 3 using IPW to address the loss of observations caused by missing data in the covariates $\boldsymbol{X}_{ij}$. First, we used the probit model for Equations 1 and 2 to predict the outcomes using samples without missing data. We then generated the inverse of the probability weights for each individual. The probability of non-attrition is given by:

$$P(T = 1|\, \boldsymbol{X}_{ij})$$

Next, we re-estimated the models using the generated inverse probability weights. Table 2.6.A1 shows the estimates for the non-attrition probit model, covering the samples from the covariates in Models 2 and 3 with non-missing values.

Table 2.6.A1 Estimation results for the non-attrition probit model

VARIABLES	Non-attrition =1
Age	-0.01*
	(0.01)
Gender (1=Female)	-1.12***
	(0.14)
Married (1=Yes)	0.20
	(0.19)
Nature of employment (1=Permanent)	1.64***
	(0.17)
Household size	0.02
	(0.03)
Durable Asset Index	-0.02
	(0.04)
Has a loan (1=Yes)	0.23*
	(0.13)

Has a bank account (1=Yes)	0.09
	(0.26)
Barangay population	0.00
	(0.00)
Insurance index (health, life, housing, and other social insurance)	0.17
	(0.10)
Health facility index (rural health center, clinic, hospital, pharmacy etc.)	-0.03
	(0.05)
Municipality 2	0.02
	(0.30)
Municipality 3	0.44
	(0.29)
Municipality 4	0.27
	(0.29)
Municipality 5	0.47
	(0.44)
Municipality 6	0.31
	(0.40)
Municipality 7	0.06
	(0.32)
Municipality 8	-0.18
	(0.32)
Constant	0.65
	(0.50)
Observations	1,124

Reference dummy for Municipality is Municipality 1. *p<.01; **p<.05; ***p<.001

Appendix B. Study Design of Chapter 1.

Figure A.1 below illustrates the study design of Chapter 1, highlighting the randomization of treatment and control groups from the village clusters across the country. The study includes 1,415 households from 130 village clusters, with 701 households in treatment villages and 714 households in control villages. In the treatment villages, 581 households have PMT scores below the poverty threshold, and 120 households have PMT scores above the poverty threshold. In the control villages, 608 households have PMT scores below the poverty threshold, and 106 households have PMT scores above the poverty threshold. Households with PMT scores above the threshold are considered "near poor" because their scores are just above the poverty threshold.

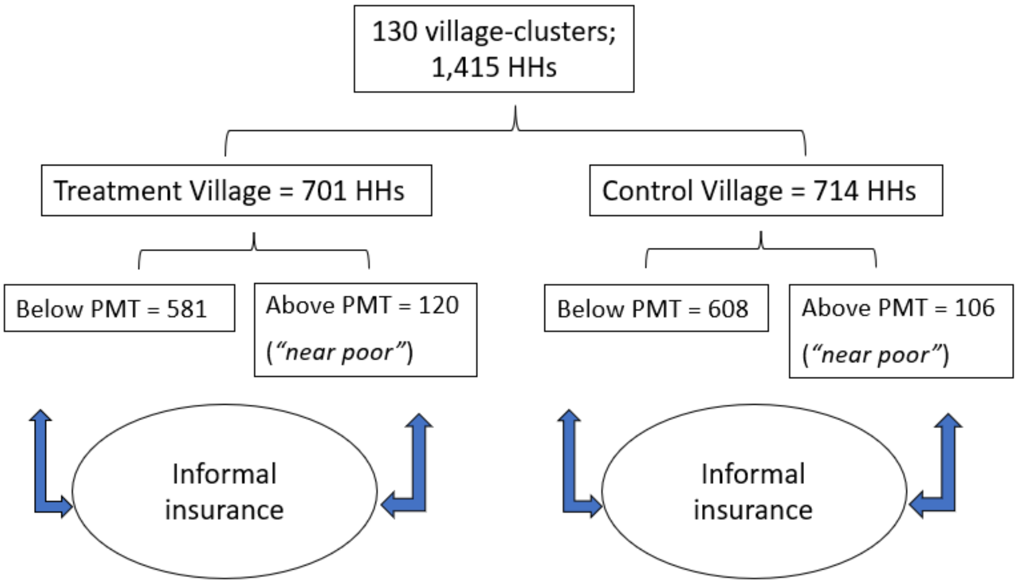

Figure A.1 Study design of Chapter 1

Appendix C. List of Variables and Their Definitions

Variables	Definition
Age	Age of the household head
Gender	Gender of the household head
Educational attainment	Educational attainment of the household head
Marital status	Household head that is married
Nature of employment	Household head that is permanently employed
Household size	The number of family members in a household
Durable asset index	Assets owned by the household which covers the following: 1) Television set 2) VTR/VHS/VCD/DVD 3) Stereo / CD player 4) Refrigerator / freezer 5) Washing machine 6) Air conditioning 7) Living room or sala set 8) Dining set 9) Car or jeepney

10) Telephone or mobile phone
11) Personal computer
12) Microwave oven
13) Motorcycle

Has an outstanding loan	Currently has an outstanding loan
Has bank account	At least one of the household members has opened a bank account and it is active or usable.
Insurance index	At least one of the household members has any of the following social insurance programs: 1) Government Service Insurance System (GSIS) 2) Social Security System 3) Philippine Health Insurance Corporation (PhilHealth) 4) Health insurance from private company 5) Life insurance
Harvest failure	The household experienced harvest failure and financial instability in the past 12 months.
Per capita consumption	Household's annual per capita consumption of all food and non-food items consumed, including purchases made in cash or on credit, gifts received, or items own-produced, over the past six months.
Per capita education expenditure	Household's annual education expenditure per child, covering tuition fees, graduation fees, allowances, books, school supplies, etc. These expenditures represent actual disbursements made, whether paid in cash or on credit, or received as gifts, over the past six months.
Per capita medical expenditure	Household's annual actual expenditures on medical care, including drugs & medicines, hospital room charges, medical

	and dental charges, other medical goods & supplies, herbal medicines, etc. These expenditures encompass payments made whether in cash or on credit, or received as gifts, over the past six months.
Per capita of dairy consumption	Household's annual per capita consumption of dairy products, including eggs, milk, ice cream, butter, cheese, fresh eggs, salted eggs, and duck eggs, consumed from purchases made whether in cash or on credit, or received as gifts, or self-produced during the past six months.
Per capita of meat consumption	Household's annual per capita consumption of meat and meat preparations, such as fresh chicken, fresh beef, fresh pork, corned beef, goat's meat, luncheon meat, meat loaf, vienna sausage, longanisa, chorizo, hotdog, tocino, tapa, etc., consumed from purchases made whether in cash or on credit, or received as gifts, or self-produced during the past six months.
Per capita of alcohol consumption	Household’s annual per capita consumption of alcoholic beverages, such as beer, tuba, basi, lambanog, brandy, whisky, rum, etc., consumed from purchases made whether in cash or on credit, or received as gifts, or self-produced during the past six months.
Total borrowings and lending to friends and relatives	The total amount of money currently borrowed and lent from friends and relatives
Borrowings to friends and relatives	The amount of money currently borrowed from friends and relatives
Borrowings to money lender	The amount of money currently borrowed from money lenders

Lending to friends and relatives	The amount of money lent to friends and relatives
Bank borrowings	The amount of money borrowed from banks.
Barangay population	The population of the barangay or village, as reported by the barangay or village captain.
Households in barangay	The number of households in the barangay or village, as reported by the barangay or village captain.
Health facility index	Whether flooding occurred in the barangay or village (which includes barangay health station, rural health unit / center, traditional birth attendant or "hilot," private clinic, government hospital, private hospital, barangay pharmacy, private pharmacy). This information is provided by the barangay or village captain.
Flood	Whether flooding occurred in the barangay or village in the last five years that caused widespread disaster to most residents. This information is provided by the barangay or village captain.
Earthquake	Whether an earthquake occurred in the barangay or village in the last five years that caused widespread disaster to most residents. This information is provided by the barangay or village captain.
Drought	Whether a drought occurred in the barangay or village in the last five years that caused widespread disaster to most residents. This information is provided by the barangay or village captain.
Natural disaster intensity	Classified into two categories: high and low intensities. High intensity means that the barangay or village experiences two or more natural disasters, including floods, droughts, or earthquakes. Low intensity means that the barangay or village

experiences not more than one natural disaster, whether floods, droughts, or earthquakes.

Appendix D. Household-Level Estimates of Climate Risk-Mitigating Effects of Rehabilitation on Water Scarcity and Management

Table 3.4.A1 Climate risk-mitigating effects of rehabilitation on water scarcity and management (household level)

	Water supply (Crisis)	**Water management (Collective action)**		
	Sufficient water supply (1=Yes)	Maintenance time (hour)	Water user fee (Php)	Fines (Php)
VARIABLES	(1)	(2)	(3)	(4)
Panel A: Wet planting season				
T	0.10***	0.15	0.15*	-0.21*
	(0.02)	(0.09)	(0.07)	(0.09)
Flood and drought	-0.27***	0.02	0.00	0.36
	(0.00)	(0.10)	(0.19)	(0.30)
T X flood and drought	0.14**	0.01	0.04	-0.23
	(0.05)	(0.18)	(0.19)	(0.29)
Constant	0.76***	1.20*	7.25***	0.23
	(0.11)	(0.58)	(0.36)	(0.12)
Observations	910	910	910	910
R^2	0.20	0.31	0.95	0.15
Panel B: Dry planting season				
T	-0.03	0.20**	0.12	-0.19
	(0.02)	(0.07)	(0.12)	(0.11)
Flood and drought	-0.07	-0.44***	0.02	0.74***
	(0.05)	(0.12)	(0.25)	(0.08)
T X flood and drought	0.04	0.16*	-0.05	-0.63***
	(0.07)	(0.07)	(0.22)	(0.09)
Constant	0.62***	0.13	8.61***	0.44***
	(0.06)	(0.56)	(0.36)	(0.08)
Observations	1,194	1,194	1,194	1,194
R^2	0.14	0.45	0.72	0.13

Standard errors in parentheses are robust and clustered by province. Wild cluster bootstrapping with areg regression was applied. All regressions include controls for household characteristics— age of the head of household, gender of household head (1=female), whether household head is married (1=yes), whether household head attended school (1=yes) and household head is economically active (1=Yes); land area characteristics – size of parcel (ha), land owned (ha), location from irrigation (1=downstream); distance from house to land field and distance from irrigation to land field; and irrigator's association participation – years of membership (1=10 years), position in IA (1=general member), right to vote (1=Yes). The absorbed categorical variable is municipality classifications.

Dependent variables are transformed into natural logarithmic functions. Wet planting season refers to rice planted from April to September. Dry planting season refers to rice planted from October to March. Months of planting season are based on calendar set by the Department of Agriculture (DA).
*p<.01; **p<.05; ***p<.001