Farmer Constraints and Relational Contracts: Evidence From Agricultural Value Chains in East Africa

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Submitted for the degree of Doctor of Philosophy

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University of Sussex

July 2022

Declaration

I hereby declare that this thesis has not been and will not be submitted in whole or in part to another University for the award of any other degree.

I hereby also declare that chapter 1 is co-authored with Barry Reilly and chapter 3 with Rocco Macchiavello and Iris Steenkamp. In both cases, I drafted the chapters on my own with guidance from my supervisors and co-authors. For chapter 1, I was responsible for data collection, developing the research question, empirical analysis, and writing the results. Regarding chapter 3, I co-designed the intervention with my co-authors. Nevertheless, I was responsible for data collection, developing the empirical strategy, conducting the data analysis, and writing the results.

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Summary

This thesis focuses on farmer constraints and relational contracts in three different agricultural value chains in East Africa. The first chapter examines the impacts of a business plan competition on mitigating credit constraints among horticulture farmers in Rwanda. In a regression discontinuity framework, the chapter provides empirical evidence that the competition effectively improved formal funding, business inputs and outcomes. The relevant effects are mediated more through existing rather than new businesses. The second paper focuses on cash constraints and savings commitment devices between dairy farmers in Kenya. Based on a difference-in-differences with multiple periods and administrative data on more than 48,000 dairy farmers, results reveal that softening deferred payments by offering a cash-in-advance service enhances relational contracts (i.e., daily milk delivery) between farmers and dairy cooperatives. The chapter also provides evidence about impacts' heterogeneity in terms of gender and the method of financial transactions. The third chapter investigates how to build and maintain long-term relationships between coffee farmers and washing stations in Rwanda. Specifically, it assesses the effects of being invited to a farmer development program and the impacts of several organisational interventions on relational practices with farmers using experimental and quasi-experimental designs. The conclusion is that the farmer development program successfully affected short-term outcomes such as awareness and take-up of good agricultural practices, sessions attendance, trust towards the Partner, and coffee delivery.

Acknowledgements

I am grateful to everyone who contributed to my journey to complete this thesis. I am indebted to my first supervisor, Prof Barry Reilly, for his patience, guidance, and encouragement. I would not have reached this stage without his genuine support. I am also thankful to him for the technical and interpersonal skills I developed during the PhD. Likewise, my special thanks extend to my second supervisor, Dr Annemie Maertens, for her continuous support. She has always been willing to help and guide me through my PhD and beyond. The faculty at the Department of Economics at the University of Sussex were also supportive. Thanks also to Rocco Macchiavello for allowing me to join his research project in Rwanda.

This thesis also benefited from the scholarship from the Department of Economics at the University of Sussex and the RES COVID Academic Support fund. I would not have completed the PhD without these financial resources. I am also grateful to the IFAD's Research and Impact Assessment Division and Heifer International for allowing me to use their impact evaluation datasets.

The PhD journey was full of ups and downs, and I would not have got through it without my PhD colleagues: Amal Shalayan M Alghanmi, Fjolla Kondirolli, and Lilia Garcia Manrique. I am grateful to our friendship, especially during the COVID pandemic. They made Brighton home away from home. To all research conversations, coffee breaks, cooking sessions, cycling rides, beach walks, dining experiences, and beyond with them. To Anuja Bajaj, Erendira Leon Bravo, and Pia Iocco Barias goes my gratefulness and appreciation for the genuine support. I can't forget the support I got from other colleagues: Sweta Gupta, Wiktoria Tafesse, Maika Schmidt, Juan Manuel Del Pozo Segura, Nick Jacob, Eugenia Go, Mattia DiUbaldo, Amrita Saha, Rashaad Chowdhury, and Daniele Guariso. Thanks also to my friend and co-author, Iris Steenkamp, for all the conversations and coffee breaks at LSE. To my housemate and (landlord), Duc Lam Duong (David), goes respect for being considerate and supportive.

I would also like to thank my friends who supported me from a distance and always believed in me: Neha Paliwal, Mohammed Hassanien, Radwa Abo Shady, Basma Tawifuk, Marwa El-Abhar, Mohamed Karam, and Mohamed Hesham. To Benjamin Wood goes all appreciation and respect for his continuous support.

To the love and support I received from my parents and siblings. To Mom (Laila) and Dad (Ali) for doing their best to give me better opportunities in life. To my siblings, Sara, Maha, Doaa and Omar for the unconditional love. Finally, devotion goes to Adrian for the joy and hope he brought into my life.

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Introduction

Rural populations in developing countries confront many constraints that preclude them from reaching their potential in agricultural production and thus realizing high economic returns. These include credit, cash/savings and information challenges. Credit constraints can negatively affect welfare and income (Barry and Robison, 2001; Karlan et al., 2014; Banerjee et al., 2015). Boucher et al. (2009) differentiates between ex-ante and ex-post credit constraints. The former reduces welfare by preventing individuals from undertaking desired activities that might lead to higher income, whereas the latter through hindering individuals from borrowing to smooth consumption after investment implementation (Eswaran and Kotwal, 1989). Similarly, cash/savings constraints can impede business growth (Dupas and Robinson, 2013a), the use of agricultural inputs (Brune et al., 2016), agricultural investments and income (Flory, 2018), and the ability to exploit intertemporal arbitrage opportunities (Burke et al., 2018). Along the same lines, information frictions can result in inefficient outcomes in agricultural markets (Allen, 2014; Jensen, 2007).

In addition, markets in developing countries are often characterized by imperfect contract enforcement. Contractual agreements in agricultural value chains have the potential to enhance farmer welfare through mitigating coordination problems between farmers and processors/ buyers as well as market imperfections (Casaburi et al., 2014; Minot and Sawyer, 2016). Yet, Deb and Suri (2013) conclude that these contracts are more likely to succeed in the absence of an outside option for farmers (e.g. informal traders); otherwise markets would be characterized by weak contract enforcement. This leads to a setting where relational contracts are crucial to realize the benefits of contract farming (see, e.g., Michler and Wu (2020) and Macchiavello (2022) for reviews focusing on agricultural chains and development).[1]

[1]Relational contracts are informal agreements that depend on trust and long-term relationships (Baker et al., 1994; Levin, 2003; Halac, 2012). A relational contract is sustainable if the associated dynamic incentive compatibility constraints are satisfied (i.e., if the future value of the relationship is sufficiently high to deter parties' short-term temptations to deviate). Recent research has calibrated and tested the implications of dynamic incentive compatibility constraints, thereby expanding understanding of the conditions that sustain relational contracting in practice (see, e.g., Macchiavello and Morjaria (2015b), Blouin and Macchiavello (2019), Casaburi and Macchiavello

This thesis explores the relationships between the above-mentioned farmer constraints and relational contracts with a focus on three agricultural value chains in East Africa. It covers credit constraints among horticulture farmers in Rwanda, cash constraints facing dairy farmers in Kenya, and information constraints among coffee farmers in Rwanda. It evaluates the impacts of selected interventions addressing these constraints on farmer outcomes or/and relational practices. The latter reflects the strengths between farmers and buyers along the value chains.

The first chapter assesses the impact of a business plan competition on mitigating credit constraints among horticulture farmers in Rwanda. Business plan competitions can play a crucial role in boosting entrepreneurship through the alleviation of credit constraints (McKenzie, 2017). However, the existing literature does not address the impact of these competitions on farmers (see, e.g., McKenzie and Sansone (2019); Howell (2019); Coad and Srhoj (2019)). In this paper, I address this aspect by studying the impact of winning a business plan competition on selected outcomes of interest using data drawn from a sample of horticulture farmers in Rwanda. A regression discontinuity design (RDD) framework is exploited and the empirical findings reveal that the competition positively impacts certain household business outcomes and inputs. Specifically, winning the competition raises the likelihood of securing formal funding and increases the income obtained from seasonal horticultural crops. However, the competition proved more effective when selecting proposals that expanded an existing business rather than those starting a *de novo* business.

The second chapter evaluates whether mitigating cash constraints by offering a cash-in-advance service strengthens contractual agreements between dairy farmers and cooperatives in the Kenyan dairy sector. Deferred payments are prevalent in agricultural value chains in developing countries. In some settings, trading parties appreciate such payments as a commitment savings device (Casaburi and Macchiavello, 2019; Kramer and Kunst, 2019). However, the challenge arises when trading parties encounter cash shocks without the capacity to absorb them (Burke et al., 2018). Such cash constraints can threaten contractual agreements between parties, especially in weak institutionalized settings. In this paper, I study whether softening deferred payments as a commitment device by providing a cash-in-advance service strengthens contractual agreements between dairy farmers and cooperatives in the Kenyan dairy sector. I address this research question using administrative data on milk deliveries of 48,000 farmers using a difference-in-differences framework. The chapter provides evidence that the cash-in-advance service is associated with increases in milk deliveries to cooperatives through two main complementary mechanisms: a monthly milk

(2019), and Macchiavello and Miquel-Florensa (2019)) income target and farmer loyalty. It also provides suggestive evidence that the treatment effects are heterogeneous along certain dimensions.

The emphasis of the third chapter is on how to build and maintain long-term relationships with coffee farmers in Rwanda. Agricultural supply chains in developing countries are often characterized by imperfect markets and contract enforcement (Bardhan, 1991). Under those circumstances, buyers and sellers benefit from long-term relationships based on mutual trust (Baker et al., 2002). While recent research has made progress in understanding the functioning of these relationships, little is known about how successful relationships can be established, organized and deployed at scale to benefit farmers in a cost effective way. I explore how to build and manage relationships with farmers in the context of the Rwandan coffee chain. I study a *Farmer Development Program* (FDP) that was co-designed and evaluated in close partnership with one of the world's leading coffee multinationals (hereafter, Partner). Based on a combination of experimental and RDD designs, the chapter explores two interconnected questions: (1) What is the impact of the FDP on relational practices between farmers and coffee washing stations (CWSs)? and (2) Are relationship managers and communication strategies effective in establishing trusting relationships with farmers? The analysis reveals that the FDP successfully affected relational practices, including the awareness and take-up of agricultural practices, session attendance, trust towards the Partner, and coffee deliveries.

The thesis contributes to two main strands of the literature: farmer constraints and relational contracts. For farmer constraints, it complements the literature by providing evidence that business plan competitions in an agriculture setting can be an effective tool to mitigate credit constraints, and does not require the need for providing assets or grants. Most of the literature on credit constraints focuses on the effects of alleviating credit constraints through providing assets or grants. For instance, Bandiera et al. (2017) explore the transfers of livestock assets to women in Bangladesh, Blattman et al. (2014) study grants to young adults in Uganda, and de Mel et al. (2008) analyse the effects of capital gifts in the form of machinery or cash to micro-entrepreneurs in Sri Lanka.

Second, it adds to the literature on cash constraints and commitment devices by studying how a service (cash-in-advance), which softens a commitment device (infrequent monthly payments), may strengthen relational contracts between farmers and cooperatives. Most of the existing literature focuses on how commitment devices can either make agents worse off (John, 2020), or help agents increase savings (Thaler and Benartzi, 2004; Ashraf et al., 2006), raise labour productivity (Kaur et al., 2010), commit to fertilizer use as an enhancing technique of agricultural productivity (Duflo et al., 2011), invest more in preventive health (Dupas and Robinson, 2013b), use commitment as a signaling mechanism for a preferred behaviour (Exley and Naecker, 2017), and avoid the cost of exerting self-control (Toussaert, 2018).

Third, the thesis relates to the literature on information constraints and the use of communication technologies in agriculture. Specifically, the thesis evaluates communication interventions within the context of a supply-chain farmer development program and explores their effectiveness in conjunction with, or as substitute for, relationship managers when it comes to relational practices between farmers and coffee washing stations in Rwanda. The previous literature assessed the impact of SMS, voice messages or videos on agriculture practice take-up and production. Casaburi et al. (2020) document mixed evidence on the effect of SMSs on yields using two randomized controlled trials (RCTs) in Rwanda, whereas Fabregas et al. (2020) find that SMS-based agricultural extension programs influenced the take-up of good farming practices based on six RCTs in Rwanda and Kenya. On the same line, there is evidence on the effectiveness of voice messages (Cole and Fernando, 2020) and videos (Campenhout, 2017) on farmer behaviour.

The thesis adds to the relational contracts literature in several ways. First, it assesses the impact of a service that tackles cash constraints comprehensively and ensures that a savings commitment device achieves a balance between meeting savings targets and cash shocks on relational practices. A number of previous studies have attempted to follow the same approach, but none dealt with cash constraints in the way cash-in-advance comprehensively tackled them. For instance, Geng et al. (2017) study how mitigating one cash constraint due to health shocks affects milk deliveries. Using a sample of 120 farmers within one dairy cooperative in Kenya, they find that household medical insurance induced farmers to increase milk deliveries to their cooperative. Similarly, Casaburi and Macchiavello (2019) demonstrate that farmers are willing to pay for monthly infrequent payments due to savings considerations. Farmers tend to sacrifice the higher prices offered by informal traders as an outside-option in order to achieve monthly savings targets based on milk deliveries to cooperatives. The cash-in-advance service ensures that a savings commitment device such as monthly infrequent payments achieve a balance between meeting savings targets and cash shocks. Finally, based on a sample of 445 dairy farmers in Senegal, Bernard et al. (2019) conclude that nutrition-based incentives for women positively affects milk deliveries to their cooperative.

Second, the thesis fills the gap in the relational contracts on how successful relationships can be established, organized and deployed at scale cost-effectively. Michler and Wu (2020) and Macchiavello (2022) review the relevant literature on relational contracts. Macchiavello and Morjaria

(2021) show that relational contracting between coffee washing stations (CWSs) and farmers improves market efficiency and farmer welfare in the Rwanda coffee chain. The literature has focused on calibrating and testing the implications of dynamic incentive compatibility constraints that are key to relational contracting (see, e.g., Macchiavello and Morjaria (2015b), Blouin and Macchiavello (2019), and Casaburi and Macchiavello (2019)). Macchiavello and Miquel-Florensa (2019), for example, study the AAA Sustainable Quality Program in the Colombia Coffee chain – a supply-chain program that induced quality upgrading and farmer welfare increases. However, little is known about how successful relationships can be established, organized and deployed at scale cost-effectively.

Finally, the thesis also relies on unique datasets that I collected through collaborations with an international organization, an NGO, and a research institution. The first chapter uses an impact evaluation data set with the International Fund for Agricultural Development (IFAD). I also gathered and put together an administrative dataset on dairy farmers in Kenya with the support of Heifer International for the second chapter. The Kenyan context provides a unique setting with detailed administrative transactions between 48,000 diary farmers and 14 cooperatives. The data on coffee farmers for the third chapter results from a collaboration with a research team at the London School of Economics and Political Science (LSE).

The remainder of the thesis is organized as follows. Chapter 1 provides the first chapter on the impact of a business plan competition on selected economic outcomes for horticultural farmers in Rwanda. Chapter 2 presents the second chapter on cash constraints and relational contracts: evidence from dairy cooperatives in Kenya. Chapter 3 outlines the third chapter on building and managing relationships with farmers in the Rwanda coffee sector. The last section provides some concluding remarks and discusses both limitations and agenda for future research.

Chapter 1

The Impact of a Business Plan Competition on Economic Outcomes for Horticultural Farmers in Rwanda[1]

Abstract: Business plan competitions can play a crucial role in boosting entrepreneurship through, for example, the alleviation of credit constraints. However, the existing literature does not address the impact of these competitions on farmers. In this paper, we address this aspect by studying the impact of winning a business plan competition on selected outcomes of interest using data drawn from a sample of horticulture farmers in Rwanda. A regression discontinuity design (RDD) framework is exploited and the empirical findings reveal that the competition positively impacts certain household business outcomes and input usage. Specifically, winning the competition raises the likelihood of securing formal funding and increases the income of seasonal horticultural crops. However, the competition proved more effective when selecting proposals that expanded an existing business rather than those starting a new business.

JEL Codes: L26, L53, M13, O13, Q12, Q13, Q14

Keywords: Business plan competition, entrepreneurship, credit constraints, regression discontinuity design, horticulture, Rwanda

[1]I am grateful for comments received at the Royal Economic Society conference 2021 and a seminar at the University of Sussex. I am indebted to Nancy Qian, Anna Vitali and Emma Riley for their comments on an earlier draft of this paper. I am also grateful to the Research and Impact Assessment Division (RIA) at the International Fund for Agricultural Development (IFAD) for permission to use the PRICE impact evaluation data in this paper. Special thanks are also due to the National Agricultural Export Development Board (NAEB) staff and the Single Project Implementation Unit (SPIU) who were responsible for the PRICE project in Rwanda. Benjamin D. K. Wood, RIA team, and Andreas Kutka are also thanked for their support throughout this work. Study registry no. RIDIE-STUDY-ID-5d64ecc3e241c on Registry for International Development Impact Evaluations (RIDIE).

1.1 Introduction

Small and medium-sized enterprises (SMEs) play a vital role in the economic development process (Neumark et al., 2011; Martin et al., 2017). Yet, they still face many constraints in developing countries[2] with credit constraints one of the main impediments confronting SMEs in the agriculture sector in particular (Just et al., 2002; Guirkinger and Boucher, 2008). Policy-makers exploit various tools to mitigate these constraints, one of which is conducting business plan competitions where potential entrepreneurs develop their business plans and typically obtain feedback from an outside committee.[3] The overarching goals of these competitions include encouraging entrepreneurs to participate, supporting the entrepreneurs to develop business plans, and mitigating credit constraints through either assistance in securing funding or offering direct funding as a reward for winning these competitions (Howell, 2019).

The effectiveness of business plan competitions on business outcomes, as well as their corresponding awards, have been contentious with research findings mixed on this issue. The recent empirical evidence is summarized in Table A.1, and briefly reviewed here. Using a large-scale RCT in Nigeria, McKenzie and Sansone (2019) conclude that business plan scores are not correlated with business survival, sales, and profits. In contrast, McKenzie (2017) and Howell (2019) report that business plan scores and being a business plan competition winner are strong predictors of business plan success.[4] However, the extant literature does not examine the impact of these competitions for potential entrepreneurs in agricultural settings where credit constraints may be a more pertinent issue than in other sectors (Boucher et al., 2009). Therefore, this gap in the literature is addressed by assessing the impact of a national business plan competition on selected outcomes using data on 3,000 horticulture farmers in Rwanda over the period 2013-16.[5]

The design of the business plan competition used in this context differed from other competi-

[2]These include regulations (Djankov et al., 2002), infrastructure (Datta, 2012; Falentina and Resosudarmo, 2019), macroeconomic uncertainty (Svensson, 1998), credit access (Banerjee and Duflo, 2014; Udry and Anagol, 2006), and capital intensity (Bigsten and Gebreeyesus, 2007).

[3]Business plan competitions are typically based on scoring with respect to a set of specific selection criteria, and are associated with awards including access to microcredit through loans, grants, training, monitoring up to business implementation, or a combination of all or some of these.

[4]The role of machine learning techniques in predicting business plan success, as an alternative tool to a panel's scoring, is also controversial (Coad and Srhoj, 2019; McKenzie and Sansone, 2019).

[5]These farmers grow a wide array of crops including tamarillo, passion fruit, pineapple, tomatoes, avocado, garlic, onions, beans, carrots, hot pepper, cabbage, eggplant, and flowers.

tions along several dimensions. It included supporting farmers to develop business plans and then subsequently monitoring farmers until their actual implementation. First, the immediate award was an endorsement letter if an applicant scored above a specific threshold. Second, the award was a matching grant once a loan was secured from a Micro- Finance Institution (MFI) on condition of the repayment of 50 percent of the loan in a timely manner. The competition was implemented by the government of Rwanda (GoR) with the support of the Umurenge Savings and Credit Co-operatives (hereafter defined as SACCOs).[6] The SACCOs were the information diffusion points among farmers for this competition. Winners of this competition received an endorsement letter from the GoR indicating their business plans were feasible. Out of the 3,000 applicants, around 400 business plans were endorsed, and 177 farmers received the grant.

The setting of this competition allows us to assess the impact of winning the competition and receiving an endorsement letter (the endorsement effect) on household business outcomes and inputs. In order to do so, cross-sectional household survey data collected in 2018 comprising 1,578 horticulture farmers are used. We exploit the fact that the business plans of the participating farmers were scored externally based on predetermined selection criteria with participants assigned to the endorsement treatment group solely on the basis of a threshold score. This facilitates use of a regression discontinuity design (RDD) framework to determine the causal effect of endorsement. The main assumption is that farmers who scored just below and above the passing score have similar baseline characteristics, which provides us with a setting that is as close to that of a randomized experiment.

Our main results reveal that winning the competition with an endorsement letter increases the likelihood of securing formal loans as well as enhancing the farmer income associated with horticultural seasonal crops. Yet, the competition proved more effective when endorsing farmers with existing rather than new business lines. The results suggest that business plan competitions can be an effective tool to mitigate credit constraints among farmers even without immediate monetary awards. Approximately 70 percent of those applicants who did not win in the competition implemented their business plans. Thus, in a context of limited funding for developmental projects, the business plan competition was found to boost entrepreneurship among both successful and unsuccessful participants.

[6] Umurenge refers to the third level administrative subdivisions (or sectors) in Rwanda. According to the Rwanda Cooperative Agency (RCA), the Government of Rwanda developed a national strategy in 2008 to establish a SACCO in each of its 416 sectors. The main reason was to encourage Rwandans, especially in rural areas, to access finance through formal institutions.

This paper contributes to three linked strands of the existing literature within the agricultural sector centred around business plan competition, credit constraints, and heterogeneity between pre-existing and new entrepreneurs. The evidence on the effectiveness of business plan competitions is thin and does not assess competitions in agricultural settings. For example, based on a sample of 1,310 applicants, Klinger and Schündeln (2011) find that business training with a prize ranging from between USD 6,000 and USD 15,000 increases the likelihood of starting a business or expanding an existing business in three Central American countries. Fafchamps and Quinn (2017), using a sample of 750 applicants, report that winning USD 1,000 cash prizes in a business plan competition increases the probability of self-employment. Using a national business plan competition in Nigeria with a sample of 3,139 applicants, McKenzie (2017) concludes that winning with a prize of USD 50,000, in conjunction with training and monitoring, leads to higher firm entry and survival with increased employment and profits. Based on an RCT using a sample of 400 applicants in Ghana, Fafchamps and Woodruff (2017), however, find business training without funding has no significant impact on business growth. Unlike studies that focus on different types of potential entrepreneurs, this paper adds to the existing literature through studying a national competition within an agricultural setting, where entrepreneurship constraints are generally more severe (Boucher et al., 2009).

The paper also adds to the the larger literature on credit constraints among farmers. Most of this literature focuses on the effects of alleviating credit constraints through providing assets or grants. This is the case with Bandiera et al. (2017) which explore the transfers of livestock assets to women in Bangladesh, Blattman et al. (2014) study grants to young adults in Uganda, and de Mel et al. (2008) analyse the effects of capital gifts in the form of machinery or cash to micro-entrepreneurs in Sri Lanka. The current paper provides evidence that business plan competitions among farmers can be an effective tool to mitigate credit constraints, and does not require the need for providing assets or grants. Supporting farmers to develop business plans and negotiating with financial institutions on their behalf can also alleviate credit constraints. We show these types of competitions are cost effective and provide a signal to financial institutions that some farmers can be credit-worthy without immediate monetary awards for winners.

The paper also documents evidence on the heterogeneity between pre-existing and new entrepreneurs. Banerjee et al. (2019) provide experimental evidence from India on the long-term impact heterogeneity of access to credit on entrepreneurs with a pre-existing business and those without one. They empirically document positive effects on business outcomes of the former and almost no impact for those in the latter group. Based on a theoretical model of technology choice, they also demonstrate that entrepreneurs with pre-existing businesses can use technology with higher marginal returns if they have access to sufficient capital. The converse applies to those without sufficient capital or who are not willing to move to a more efficient productive activity with a higher fixed-cost mode of operation, thus leading to the use of technology with decreasing returns. In line with these results, using data from six RCTs in several countries, Meager (2019) finds that households with a pre-existing business experience more positive impacts compared to other households.[7]

The remainder of this paper is organized as follows. Section 1.2 presents some background on the horticulture sector in Rwanda and contains a description of the business plan competition. Detailed information about the sample, the data collected and descriptive statistics are discussed in Section 1.3. The empirical identification strategy is outlined in Section 1.4, with the results discussed in Section 1.5. A set of robustness checks are provided in Section 1.6. The conclusion and policy implications of the findings are reviewed in the final section.

1.2 Background

In this section, we present an overview of the horticulture sector in Rwanda as well as outline the context of the business plan competition implemented for horticulture farmers in Rwanda.

1.2.1 Horticulture Sector in Rwanda

Rwanda has been one of the fastest-growing economies in East Africa. Although poverty is still prevalent with more than 50 percent of the population living on less than USD 1.90 a day (representing 38 percent of households when the local poverty line is used), annual GDP growth has been estimated at 7.4 percent on average over the ten-year period between 2008 and 2018 (World Bank, 2020). Agriculture accounts for about 30 percent of GDP over the same period. The contribution of agriculture to employment is somewhat larger, with 55 percent of men and 27 percent of women in employment in this sector. According to the Agricultural Household Survey (AHS) 2017, 80 percent of households in Rwanda participate in some form of agriculture-related

[7] The current work also complements Hossain et al. (2022), who studied the same business competition, with a focus on the impact of matching grants on farmer livelihoods. We emphasize two additional points through our empirical analysis. First, the business plan competition can work without matching grants to winners. Second, the competition exhibited more effectiveness when endorsing plans for farmers related to their current business activity rather than for new activities.

activity.

Horticulture farmers mainly grow vegetables, fruits and flowers with almost all crop-producing households engaged in horticulture crop production. The cultivation of these crops assists rural households in terms of income diversification. In addition, the activity not only provides a source of increasing income through crop sales but is also an important channel for the enhanced nutrition of household members through home consumption. For instance, according to the Agricultural Household Survey (AHS) 2017, about 50 percent of crop-producing households cultivate bush beans, of which 30 percent are sold with around 40 percent used for home consumption, and the remainder allocated to other usages such as for seeds or farm rent. On the other hand, at least 80 percent of most fruits and vegetables produced are sold. Nevertheless, according to the 2013 Rwanda Horticulture Organizations Survey, around 75 percent of horticultural produce is sold within a local market in Rwanda (Clay and Turatsinze, 2014).

The horticulture sector has the potential to increase foreign trade. The Government of Rwanda has been trying to diversify exports across different sectors, one of which is the horticulture sector. The government policy is designed not only to increase the production of the horticulture crops to meet local demand but also to develop the value chain of these crops and increase horticulture exports. According to FAOSTAT, in 2019 Rwanda was a net exporter of certain horticulture crops (e.g., pineapples, avocados, and green beans). However, as the production of certain horticulture crops is restricted by seasonality (e.g., tomatoes, onions and potatoes), the country remains a net importer of horticultural crops (Van Dijk et al., 2015).

1.2.2 The PRICE Project

The business plan competition was mainly designed and financed by the International Fund for Agricultural Development (IFAD), as part of the Rural Income through Exports (PRICE) project in Rwanda. Its primary aim was to achieve sustainable increased returns to farmers through export-driven value chains for different categories of farmers, including horticulture farmers. The main objective of the business plan competition was to identify potential entrepreneurs among horticulture farmers, assist them to develop and implement business plans, and mitigate credit constraints through helping credit-constrained farmers to secure funding to implement or expand their horticulture business activities.

The business plan competition was implemented in several stages (see Figure A.1). These comprised an application stage, an evaluation stage, and a funding and business implementation stage. The National Agricultural Export Development Board (NAEB) in Rwanda first launched the application submission process over the period from October-November 2013 and during June-July 2014. Farmers were informed about the competition through SACCOs and had a month to submit their business plans using a standardized 5-page application form. Figure A.2 exhibits some selected questions from this application form. A committee consisting of professionals from NAEB, the Single Project Implementation Unit (SPIU), and the Bank of Rwanda Development Fund (BDF) participated in the evaluation process to ensure careful screening was undertaken at the evaluation stage. They were also responsible for evaluating and scoring each business plan. The screening was conducted in two stages: a pre-selection phase to exclude those who did not satisfy the basic application criteria (e.g., type of crops), and a second phase comprising a detailed evaluation where applicants were graded out of 100 points on the basis of a set of specific selection criteria.[8] All farmers were informed of the outcome at both stages by NAEB representatives.

The primary and immediate award for winning the competition was an endorsement letter delivered to those who won the competition through scoring above a specific threshold. An example of the endorsement letter is displayed in Figure A.3. The aim of the letter was to help farmers to secure funding from formal financial institutions. The ultimate goal was to encourage farmers, especially those subject to credit constraints, to engage with formal financial institutions to demonstrate their credit-worthiness. In order to motivate winners who received the endorsement letter to apply for funding, a matching grant was made available as an additional inducement for some farmers. The endorsement was also followed by a monitoring period until funds were secured and the business plans implemented for those endorsed. This follow-up process included capacity-building and business planning in the field, preparing loan applications, negotiating with financial institutions on loans, and the provision of non-financial business support.[9]

The rules governing business plan endorsement and securing matching grants are different. For a business plan to be endorsed, the evaluation committee used different pass marks (or thresholds) for different groups of crops. These threshold marks ranged between 50 to 80 percent.[10] They

[8]The selection criteria included market and export potential/differentiation opportunity/value-adding capacity (20 points), guaranteed markets (15 points), potential for export growth for Rwanda (15 points), experience and interest of the applicant, the business idea's potential impact (25 points), investment cost and financing (15 points), sustainability (5 points), and the remaining 5 points were for other factors (e.g., crop type and whether it is a primary production business plan or involves post-harvest/marketing activities).

[9]For these purposes, the PRICE management unit at NAEB partnered with BUSINESS/PARTNERS, a company that provides financial and business services, and other value-added services for formal small and medium enterprises (SMEs) in many African countries including Rwanda.

[10]The evaluation committee assigned 50 percent as a pass mark for essential oils, flowers, and all crops that

were determined in advance to prompt processing, post-harvest packaging, transportation, and marketing. The pass score for all crops involving these activities was at the minimum of 50 percent. The receipt of a matching grant was conditional on securing endorsement for a business plan, securing a loan using the endorsement letter, and repaying 50 percent of the loan as planned to the relevant financial institution. However, to avail of this matching grant, a farmer needed to receive approval from the Bank of Rwanda Development Fund (BDF) after having obtained a loan approval letter from any financial institution (e.g., SACCOs). The matching grant was approved for a small number of endorsed farmers over the period between 2014 and 2016.

The selection team received 300 submissions during the first application period (October-November 2013) and 2,700 during the second application round (June-July 2014). Out of the 3,000 applicants, only 382 business plans were endorsed and 177 farmers received matching grants. Around 70 percent of the rejected applicants implemented their proposed business concept through the use of personal savings, loans (mainly from their SACCOs), and partnerships with other farmers. As such, the competition setting features three group of farmers: endorsed farmers (winners) who implemented their business plans, rejected farmers who pursued their business plans regardless, and rejected farmers who did not take their business plans any further (see Figure A.1 again).

1.3 Data Description

We use cross-sectional household survey data collected in 2018 as part of IFAD's evaluation efforts under the auspices of the PRICE project (see Mabiso et al. (2018) for more details). Figure A.4 presents the timeline of the business plan competition and the data collection. As shown in Figure A.5, the household sample is representative of the entire country. All interviewed households include a horticulture farmer who applied to the competition. The total sample comprises 1,578 households, which covers 358 farmers with selected business plans (endorsed farmers) and 1,220 farmers with rejected business plans (rejected farmers). Table A.2 presents an overview of the number of farmers by competition outcome and crop type.[11]

The sample was randomly selected to guarantee the representativeness of all participants in the

involved processing, post-harvest, packaging, transport, and marketing. A pass score of 75 percent was set for onions, passion fruit, apple banana, and pineapple. Other business plans for vegetables and fruits needed to score 80 percent in order to receive an endorsement letter.

[11]For all crop categories, rejected farmers whose scores are within 2 standard deviations of the threshold were interviewed. This criterion was reduced to 0.5 of a standard deviation for two of the seven crop categories as they had too few endorsed and too many rejected farmers.

competition. Comparing the average investment cost of the sampled farmers (USD 11,059) with that of all applicants (USD 11,008) supports this argument. The same applies when comparing the percentages of plans that are an extension of existing businesses. About 70 percent of the business plans of the two groups involved existing business expansions.

In addition to the household sample, secondary data on all applicants linked to these households are also obtained. These data were extracted from the business plan applications of the farmers. The data comprise information on project investment costs in Rwandan francs (RWF), crop category, location, whether it is a new or existing project, whether an applicant was endorsed or rejected, and the scores assigned to each business plan by the evaluation committee. As subsequently outlined below in the empirical strategy, these scores coupled with the business plan outcome (i.e., endorsement or rejection) provide the basis for the empirical approach used in this study.

1.3.1 Data Collected

The household data were collected using a detailed questionnaire administered between March and May 2018. The questionnaire gathered information on agriculture production by plot and crop cultivated. Questions cover the three agricultural seasons within the agricultural year spanning March 2017-February 2018 (Season B: March-June 2017, Season C: July-August 2017, and Season A: September 2017-February 2018).[12] The questionnaire also solicited information on perennial crops over the period from September 2017 to August 2018, horticultural activities, demographic characteristics, food-related questions, shocks, and external financial support. In addition, some baseline variables were also retrospectively asked during interviews. Given the focus of this paper, two sections relevant to the analysis are now detailed, namely agricultural production and business plan competition activities. The outcome indicators at the household level are also constructed from the responses to the questionnaire. The indicators include crop/horticulture income, number of hired labour, and business survival.

The agricultural production section consists of four modules: agricultural production during season A, agricultural production during season B, agricultural production during season C, and perennial agricultural production. The respondent was asked to divide household land into different

[12] The agricultural year in Rwanda starts with Season A and ends with Season C. However, because of the timing of the data collection, the IFAD team decided to focus on the three most recent seasons. The justification was to avoid the difficulty farmers might encounter in recalling information about season A (September 2016-February 2017).

plots, each of which is related to a cultivated crop within a specific season. The respondent was also asked to list all perennial crops the household cultivated/harvested. Each module includes questions about production inputs (e.g., fertilizers and labour)[13] and production outputs for each crop (e.g., crop harvest and sales).

Based on these modules, harvest, sales, and the income from each crop were calculated in USD. The harvest and sales are converted to monetary values, initially to RWF and then to USD. The price of harvest and sales for each crop (per kg) is imputed based on the monetary value of the sales reported by respondents.[14] The imputed prices are then multiplied by the amount of harvest (kg) and sales (kg) to obtain the corresponding monetary values for each crop expressed in RWF. An exchange rate of 1 USD= 835 RWF, which is the average exchange rate over the agricultural year used for the household data collection period (March 2017-February 2018), is then used to convert the income into USD.

The income from each crop was also calculated as a net income measure (revenue minus input costs). The monetary value of sales represents the relevant revenue. Input costs include fertilizers, seeds, pesticides/herbicides, and labour. This is calculated in an analogous way to the harvest and sales. The prices/wages of inputs (per kg/day) are used for each crop within a specific sector based on the prices/wages of purchased/hired inputs reported by the respondents. The total monetary values of harvest, sales, and crop income are then aggregated by horticulture/non-horticulture activity, by horticulture seasonal/perennial crops, and as a total for the whole agricultural year (March 2017-February 2018).

The business plan competition module covers questions about SACCO membership and the business plan competition. The latter includes crop(s) used as part of the business plan, years of experience growing these crops, the outcome decisions at the endorsement stage, selection into implementation, funding channels, and the outcome at the matching grant stage. These questions are then compared to the secondary data to calculate business crop survival. In the current context, whether a farmer still cultivates the same crop(s) that featured in their business plan is taken to provide an indication of business crop survival. If so, this means their business is still active and has not exited the state of operation.[15]

[13] Questions about production inputs include the volume of inputs used (in kilograms or litres), the volume of inputs purchased (in kilograms or litres), the amount paid in Rwandan francs (RWF) for purchased inputs, and the type of inputs used. In the case of intercropping, production inputs are divided between crops based on the approximate percentage of each crop in a plot as reported by the respondent.

[14] We first divide the monetary value of sales (RWF) by the amount of sales (kg) to obtain a crop price, and then we calculate the median price of each crop within each sector (the third administrative level in Rwanda).

[15] One should be cautious when interpreting business crop survival given the changing nature of horticulture

1.3.2 Descriptive statistics

The nature of the business plan competition among horticultural farmers in Rwanda permits the separate identification of two groups: endorsed farmers who won the competition (T) and farmers who failed to win (C). The mean values for selected household characteristics and business outcomes/inputs across these groups are reported in Tables 1.1 and 1.2, respectively.

There appears to be a few differences across the treatment and control groups in terms of their characteristics (see Table 1.1). We find that endorsed households (winners) are more educated, possess better housing characteristics at baseline, have more years of SACCO membership, and have more ambitious business plans in terms of investment cost. Nevertheless, not-endorsed households have more household members involved in agricultural activities. No statistical differences were detected with regard to the gender of the household head, household size, owning an enterprise, land size, experience in cultivating horticulture business crops, type of projects proposed (i.e., business plans to expand existing versus new businesses), and the number of advice/training events (about agriculture, marketing, or credit) received.

Insert Table 1.1 about here

Examining differences in household business outcomes and inputs across the two groups reveals systematic differences (see Table 1.2). With respect to the outcomes, winners were more likely to implement their business ideas, realise a higher income from seasonal horticulture crops. Consistent with that, endorsed farmers were more likely to secure funding from formal financial institutions and use more hired labour and agriculture inputs, particularly for seasonal horticulture crops. It appears that there was no statistical differences between the two groups in terms of business survival, income from perennial crops, and the use of labour/agricultural inputs for perennial crops.

Insert Table 1.2 about here

An examination of the characteristics of these farmers reveals they are generally well-off. On average, they utilize around 10 hectares for cultivation purposes per year, most of which is rented. They were also able to secure an annual net income from selling crops of at least USD 1,000 in 2018, most of which was from horticultural crops. Another observation is that these farmers invest

farming. It reflects the survival of a proposed business crop rather than the survival of the business/farm activity itself. Farmers switch from one crop to another based on many factors such as changing climatic and market conditions.

more in seasonal than in perennial horticulture crops. Hence, they obtain higher income from their seasonal horticulture activities.

1.4 Empirical Strategy

The key research question of this study is whether winning the business competition exerts any impact on household business outcomes/inputs. The treatment reflects whether a farmer won the competition and obtained an endorsement letter (the endorsement effect). The unit of analysis is a household that has an endorsed farmer (the treatment group) or a rejected farmer (the control group). However, the impact of obtaining a matching grant is not analyzed for two reasons. First, the number of farmers who received the grant is few- 177 applicants of which only 132 farmers were interviewed during the data collection period. Second, the evaluation scores of 22 of these 132 farmers, are missing. There is no systematic difference in the observable baseline characteristics of farmers for whom scores are missing compared to those with grants and available scores (see Table 1.4). Thus, on this basis, we do not believe that excluding them from the analysis would materially alter the results reported in this paper.

Insert Table 1.4 about here

We now turn to the causal identification of the endorsement effect. First, a comparison of outcomes for endorsed farmers with those of the rejected farmers would not capture the endorsement effect primarily due to the role of self-selection into business implementation after the endorsement stage. The self-selection is likely to overstate the impact of winning the competition (Duflo and Saez, 2003; McKenzie, 2017). Second, there remains an additional concern since winners and those who lost might possess different motivational attributes. One group implemented their project after winning, whereas the other pursued their business plan after being rejected. In order to tackle these self-selection concerns, we use the business plan scores in a sharp RDD framework to estimate the impact of endorsement on household business outcomes and inputs.

The use of the RDD in this context is similar to its use in the seminal literature that introduced this technique (e.g., see Thistlethwaite and Campbell (1960)). The identification here relies on using the evaluation score to determine the threshold used to award farmers an endorsement treatment (i.e., through winning the competition). Farmers who failed to win in the competition but with a business plan score close to the threshold serve as a counterfactual for endorsed farmers, thus facilitating the estimation of a local average treatment effect (LATE) for endorsement.

1.4.1 Regression Discontinuity Design Assumptions

We argue the business plan competition satisfies the key assumptions for the RDD approach to provide an unbiased causal estimate of the endorsement effect in this case. The key assumptions of the RDD include the exogeneity of the forcing variable, endorsement treatment compliance, the absence of clustering around the threshold, and the discontinuity in the outcomes of interest. The validity of these features in the context of the business plan is now reviewed.

First, we examine the exogeneity of the forcing variable by exploring whether the evaluation committee followed a strict rule for endorsement and whether farmers or others were able to manipulate the scores to be endorsed. The evaluation committee determined the thresholds for each crop category before embarking on receiving any business plans, implying that the thresholds were not affected by the type of farmers and the nature of business plans presented. In addition, Figure 1.1 shows there is no evidence that scoring just above the threshold was more likely, indicating that examiners were not overly-generous at the threshold and that farmers were also not able to manipulate their score to fall just above the threshold.[16] Nevertheless, the more compelling argument about the lack of manipulation by farmers relates to the fact that participants were not aware *ex-ante* of the pass marks assigned to each category of horticulture crops.

Insert Figure 1.1 about here

The exogeneity of the forcing variable around the threshold is statistically assessed using the 'manipulation test' developed by Cattaneo (2018) and Cattaneo et al. (2019). The null for the manipulation test is that there is no evidence of discontinuity in the density of scores at the threshold. The absence of the continuity is potentially interpretable as statistical evidence of self-selection into the treatment. The robust 'manipulation test' statistic value is found to be 0.67, with a p-value of 0.50. Therefore, there is no statistical evidence suggesting any systematic manipulation of the assignment variable in the current application.

Second, the endorsement rules were followed perfectly. All farmers who scored above the threshold received an endorsement letter. Therefore, the empirical analysis undertaken does not present any compliance issues. Nonetheless, we find that the endorsement outcome of a few farmers from

[16] We standardize the scores of all crop categories, such that the threshold equals zero. The standardization of different thresholds around zero leads to a slight jump in the frequency just above the threshold.

the secondary data does not match with the outcome based on the questionnaire data collected in 2018. These farmers appeared to be confused between the first award (endorsement) and the second award (matching grant) of the competition. Consequently, they responded ”no” to the endorsement treatment question because they failed to secure a matching grant. Figure 1.2 indicates that this creates differences between the actual treatment status of certain farmers and their perceptions of the endorsement treatment. Yet, this discrepancy could be viewed as minimal involving just 82 farmers. Our results are found to be robust to the exclusion of this subset of farmers.

Insert Figure 1.2 about here

Third, we investigate the smoothness of the covariates across the threshold. We first explore the differences in observable household characteristics just above and below the threshold (i.e., the discontinuity sample) between endorsed farmers and those who were rejected.[17] We follow procedures in Calonico et al. (2020) for estimating the corresponding optimal bandwidths. Table 1.3 suggests there are no statistical differences between the two groups in the neighbourhood of the threshold using the corresponding optimal bandwidths. Figure 1.3 then presents the RD plots for selected control variables and reveals no evidence of a discontinuity in any of the variables at the threshold used for the endorsement. This provides re-assurance that the key covariates are orthogonal to the treatment. In summary, the discontinuity in outcomes, the exogeneity of the forcing variable, treatment compliance, and the smoothness of the covariates across the threshold appear satisfied in the current application confirming the internal validity of the RDD procedure for this case.

Insert Table 1.3 and Figure 1.3 about here

Finally, the discontinuity in the main outcomes of interest is investigated using regression discontinuity (RD) plots. Figures 1.4 and 1.5 reveal comparisons between the business outcomes and inputs of endorsed farmers and rejected farmers. They both reveal evidence of a jump in most business outcomes and inputs. Yet, the discontinuity is more evident in magnitude for income from horticultural seasonal crops, the likelihood of securing formal loans, horticultural inputs cost, and horticultural hired labour. Farmers ended up investing more in horticulture seasonal crops given

[17] As already noted, the household characteristics include some baseline variables, such as housing characteristics five years prior, which were retrospectively compiled during the main data collection process.

the more rapid return these crops yield, which then assisted farmers in the prompt repayment of their loans.[18] The increase in horticultural income was realized by securing formal funding to purchase horticultural inputs and hire more labour.

Insert Figures 1.4 and 1.5 about here

We also examine the heterogeneity between existing business versus *de novo* businesses given that the former represents about 70 percent of business plans submitted to the competition. Figure 1.6 shows the corresponding figures for selected business outcomes and inputs. We find that there are positive jumps when looking at indicators for existing businesses. The reverse is observed for certain new business activities. This could suggest that the competition was more effective for farmers with current business activity rather than new activities.

Insert Figure 1.6 about here

1.4.2 Econometric Modelling

We use the global parametric approach to causally estimate the endorsement effect as it affords more sample power compared to the local non-parametric approach.[19] The endorsement effects are estimated using the following model:

$$\mathrm{Y}_i = \alpha + \tau T_i + \theta_1 x_i + \theta_2 x_i^2 + \theta_3 (T_i \cdot x_i) + \theta_4 (T_i \cdot x_i^2) + \ Z_i' \gamma + \epsilon_i \tag{1.1}$$

where Y_i is the relevant outcome of interest for household i and α is a constant term. T_i is the endorsement treatment dummy that equals 1 if a farmer is endorsed, and τ is the average causal endorsement effect on Y, the estimate of which provides the primary focus of this analysis. The forcing variable is x_i, which is the business plan score of household i centered around zero

[18]Another observation is that some outcomes and inputs are declining with the score above the threshold. This may be attributed to the fact that farmers who had higher scores, while more educated, are less experienced in cultivating horticulture crops.

[19]There are two RDD conceptualizations that can be used to causally estimate the endorsement effect, one of which is a parametric approach, and the other is a non-parametric approach (see Lee and Lemieux (2010)). The parametric approach treats the RD as a discontinuity at the threshold and is known as a global approach as it exploits all available data in the sample. The non-parametric approach characterizes the RD as a local randomization around a specific threshold. Therefore, it uses only observations in the discontinuity sample within a small neighborhood (bandwidth) of the threshold. The challenge of the parametric approach is to determine the functional form of the forcing variable (scores), whereas the choice of bandwidth for the non-parametric approach is a key empirical issue. In general, the difference between these approaches involves a trade-off between precision and bias.

(i.e., the actual score minus the threshold value).[20] The inclusion of the forcing variable in the regression potentially absorbs any selection bias attributable to selection on observables. We use the quadratic form of x_i as recommended in the literature (see Gelman and Imbens (2019a)). We also interact the endorsement treatment dummy with the forcing variable in order for its effects to differ both sides of the threshold. The control variables included in the specification comprise an array of household characteristics (see again Table 1.1).

1.5 Empirical Results

The business plan competition was designed to increase horticultural crop income by mitigating credit constraints among horticulture farmers in order to create new horticultural businesses and expand existing businesses. Therefore, we first investigate its effectiveness in achieving this objective by considering the endorsement impact on certain household business outcomes (e.g., horticultural income and sales). We then focus on the mechanisms through considering the endorsement impacts on household business inputs (e.g., capital and labour). Finally, we examine the endorsement impact by the type of business (existing versus new) since 70 percent of farmers developed business plans for expanding existing businesses, with the remainder submitted *de novo* plans.

1.5.1 Household Business Outcomes

Table 1.5 reports the impact of endorsement on selected household business outcomes using the global parametric RDD specified in equation (1.1). The first three columns report the impact on overall business outcomes (business implementation, business crop survival, and crop income), while the remaining columns contain the effects on horticultural outcomes (income and sales). The results are consonant with the visual findings of the RD plots discussed earlier (see Figures 1.4 and 1.5). The results reveal positive impacts of the endorsement on business implementation and survival. Winning the competition increases the likelihoods of business implementation and survival by 27 and 9 percentage points, respectively. The endorsement is also found to have a positive impact on the horticultural business outcomes. However, the estimated effects are statistically significant only for seasonal horticultural income and sales. In this case, winning the

[20] The centring of scores around zero is undertaken for interpretational reasons. If we are exactly at the threshold, then the realization of all variables involving x_i goes to zero. The only relevant estimates under such circumstances would be α reflecting the average outcome for the rejected farmers and τ representing the difference in outcomes between the endorsed farmers and the rejected farmers after controlling for the covariates.

competition increases the annual horticulture income and sales of seasonal crops by USD 261 and USD 355 respectively. This represents at least a 42 percent increase relative to the control group mean. Farmers ended up investing more in seasonal horticulture crops because of the rapid yield and the need to repay loans as promptly as possible.

Insert Table 1.5 about here

Two observations are worth mentioning. First, the increase in seasonal horticultural income and sales is the main driver of the rise in overall horticultural sales and income. In particular, winning the competition is found to increase overall horticultural sales by USD 538, two-thirds (USD 355) of which is attributed to an increase in seasonal horticultural sales. The same applies to horticultural income. Second, there appears to be no substitution effect between seasonal and perennial horticulture crops. The endorsement effect on the latter is found to be positive but not statistically significant.

1.5.2 Household Business Inputs

Table 1.6 illustrates the endorsement effect on certain household business inputs. The results reveal that winning the competition also yields positive point estimates for all inputs other than for perennial horticultural and irrigation. The receipt of an endorsement letter increases the likelihood of receiving formal funding by approximately 29 percentage points. This is more than twice the control group mean. Thus, the endorsement letter appears to have a considerable economic impact in mitigating credit constraints among horticulture farmers. As a result of the increase in the likelihood of securing funding, the endorsement induced seasonal horticultural inputs and hired labour to increase by 41 percent compared to the control mean. The input costs and the use of hired labour for perennial horticultural corps are found to increase due to the endorsement, but only hired labour yields a statistically significant effect. These results are consistent with the endorsement effect on seasonal horticultural crops. They also support the previous argument that there was no substitution effect between seasonal and perennial horticulture crops due to success in winning the competition and implementing the proposed business plans.

It can be argued that observing a positive impact of the endorsement on securing formal funding is inevitable, given that the treatment was bundled with some support to negotiate with financial institutions. However, such negotiations were not an immediate or automatic part of the process after winning the competition. Farmers first had to have the willingness to prepare funding applications and apply to formal financial institutions. Therefore, the observed impact is mediated more through the demand side by encouraging farmers to deal with formal financial institutions. In addition to the endorsement letter, the negotiations provide a more credible signal for the supply side (i.e., financial institutions in this context) to provide farmers with formal loans.

Insert Table 1.6 about here

1.5.3 Heterogeneity between pre-existing and new businesses

Exploring whether the endorsement effect varies between existing and *de novo* businesses is relevant from both policy and research perspectives. From a policy perspective, it is crucial to understand whether the endorsement letter was sufficient to stimulate entrepreneurship among farmers with new business ideas, and support them to enable survival and realize income for their businesses. Such a conclusion is essential in order to inform whether such interventions should be tailored to provide additional support for new enterprises. As previously outlined, exploring the heterogeneous effects of endorsement also supplements the growing literature about the impacts of microfinance on pre-existing and new businesses by providing empirical evidence from an agricultural setting comprising horticulture farmers in Rwanda.

In order to evaluate the heterogeneous effects of endorsement in terms of business type, we split the sample into farmers with business plans based on existing activity and those based on new business proposals. Tables 1.7 and 1.8 respectively show the endorsement impact on household business outcomes and inputs by these two business plan types. Panel A focuses on the endorsement impact on existing businesses, while the effects on new businesses are reported in Panel B. In terms of business outcomes, the endorsement effect reported earlier seems to be mediated through existing business plans rather than new ones.[21] The endorsement promoted business implementation among both groups, with a higher increase among new (42 percentage points) rather than existing businesses (21 percentage points). However, new businesses did not exhibit persistence regarding the endorsement effect on business survival given the absence of a statistically significant effect. In contrast, the endorsement increases the business survival of existing businesses by 12.4 percentage points, on average and *ceteris paribus*. As discussed earlier, business crop survival reflects the survival of the crop activity proposed, not the survival of the business/farm activity

[21] A significant caveat in regard to the observed heterogeneity in endorsement effects is that we cannot statistically reject the hypothesis that the differences of all coefficients between the two groups are different from zero. This inference applies when pooling the two sub-samples and interacting the endorsement treatment with the project type.

itself. Most of these farmers still grow horticultural crops other than the one proposed in their business plans.

In the context of horticultural business outcomes, winning the competition assisted farmers with plans to expand existing businesses and thus increase their seasonal horticultural income (by USD 291) and sales (by USD 450). These represent at least a 47 percent increase relative to the control group mean. On the other hand, the results also reveal that winning the competition exerts no statistical impact on horticultural business outcomes for farmers who developed new business ideas for their plans. The results are consistent with previous studies in the literature regarding heterogeneity in the effects of microfinance interventions between existing and new businesses (Banerjee et al., 2019; Meager, 2019).

Insert Table 1.7 about here

The foregoing heterogeneity is also evident with respect to business inputs. In winning the competition, farmers with existing businesses overcome credit constraints by obtaining formal loans to purchase horticultural inputs and hire more labour. Success in the competition raises the likelihood of securing formal loans by 31 percentage points for those farmers with expansion plans related to existing business activity. In line with the above-reported results, the endorsement impact on existing business activity is statistically significant for seasonal horticultural crops. In particular, winning the competition raises seasonal horticultural input purchases and hired labour by USD 61 and 17 days respectively. These reflect at least a 65 percent increase relative to the control group mean.

On the other hand, the corresponding estimates for new business ideas reveal a positive endorsement impact on formal loans. However, the effect is smaller in magnitude than that for existing business activities (an increase of 21 percentage points for new businesses versus 31 percentage points for existing businesses). The results also reveal adverse effects on seasonal horticultural inputs and hired labour. This is consistent with the visual findings of the RD plots discussed earlier (see Figure 1.6) and the absence of statistical significance for the endorsement impact on business crop survival for new business activities.

Insert Table 1.8 about here

1.5.4 Endorsement effect without matching grants

We now investigate whether the estimated endorsement effects on the key outcome variables are attributable to securing matching grants. Therefore, we exclude those who received the matching grants from the analysis, reducing the sample size by 102 farmers. Tables 1.9 and 1.10 provide the corresponding estimates and these are consistent with the previous results regarding the heterogeneous endorsement effects on business outcomes. For those with existing businesses, the endorsement effect on the annual income from seasonal horticulture crops is statistically significant and similar in magnitude to that detected in the main analysis. By winning the competition, the annual seasonal horticultural income rose by 52 percent relative to the control group (compared to 47 percent for the main core analysis). The same pattern applies for business implementation and survival.

Insert Table 1.9 about here

In regard to horticultural business inputs, the endorsement without matching grants induced farmers to increase input costs and the use of hired labour for seasonal horticulture for those with pre-existing businesses. Nevertheless, only the use of hired labour yields a statistically significant effect. On the other hand, the endorsement reduces the use of inputs costs hired labour for *de novo* business activities. This is consistent with the absence of impacts on business survival for these projects.

The endorsement effect on formal funding is not invariant to this exercise and is not statistically well determined. This could be due to the fact that both endorsed and rejected farmers succeeded in obtaining loans even though they did not receive the matching grant. About 16.5 percent of endorsed farmers (32 farmers) and 17 percent of rejected farmers (147 farmers) implemented their projects through loans without obtaining the grant. This supports our finding that the competition has been effective in overcoming credit constraints among horticulture farmers by motivating them to apply for formal financial institutions without the need to award all of them grants.[22]

Insert Table 1.10 about here

[22] This is not to say it has not been effective to award grants to a few farmers. Based on some interviews conducted with relevant stakeholders, having the grant as a second award was a strong incentive to encourage farmers to develop their business plans in the first place.

1.5.5 Rate of return

The cost-effectiveness of this business plan competition is now demonstrated. We review the budget for screening all business plans and roughly estimate the cost of other aspects following the endorsement treatment (e.g., post-award mentoring and negotiation on behalf of the farmers with financial institutions). A back-of-the-envelope calculation indicates an administrative cost of USD 5 per each business plan. In addition, the average investment costs of endorsed business plans were about USD 10,000 per project, with an average grant of USD 5,000 awarded to 177 farmers (out of 400 winners).[23]

Success in the competition raised annual farmer income from horticulture by about USD 372 on average, particularly for those who expanded existing businesses. Comparing the annual farmer income from horticulture to the project investment costs yields an average rate of return of 4.7 percent for endorsed farmers.[24] Consistent with the above analysis, there also exists heterogeneity in the rate of return by type of project. The average rate of return was 4.9 percent for existing businesses, whereas *de novo* businesses realized 2.4 percent.[25] However, these suggestive rates relate to the initial phase of business activity and may increase over the long-run.

These returns reflect the promising attributes of such competitions, which do not need to award all winners with immediate cash prizes. A competition that requires only screening and supporting farmers to negotiate with financial institutions and provides grants for selected farmers should be of interest to international donors and policymakers who seek to mitigate credit constraints and enhance entrepreneurship among farmers.

1.6 Robustness Checks

Several checks to assess the robustness of the econometric estimates are now conducted. The first check assesses the previous global parametric specification using weighted regressions in conjunction with a triangular kernel density for the forcing variable rather than assigning the same weight to all observations as in the main analysis. The motivation for doing so is to assess if our

[23] This is compared to an average award of USD 1,000 in Fafchamps and Quinn (2017), USD 9,000 in Klinger and Schündeln (2011), and 50,000 in McKenzie (2017) to all winners.

[24] As the investment costs differed across farmers with and without grants, we calculated the rate of return as a weighted average between both groups. Farmers without grants incurred double the investment costs since they did not get 50 percent matching funding. Hence, farmers with grants achieved an average rate of return of 7.4 percent, which is double that of those without grants.

[25] Nevertheless, the increase in horticultural income for *de novo* businesses was not found statistically significant.

results are driven by farmers at the extremes of the forcing variable distribution. The triangular weighting adopted is justified in this case for two reasons. First, farmers with the highest and the lowest ratings on business plans might have different characteristics to those around the threshold. As such, the triangular kernel density gives higher weights to observations closer to the threshold and down-weights those further away from it, thereby capturing the importance of observations around the threshold in the estimated regressions (Calonico et al., 2019). Second, the sample does not have farmers with extreme evaluation scores (i.e., zero and 100). Therefore, we do not lose any observations as a result of assigning a zero weight to those massed at the extreme values of the forcing variable.

Tables 1.11 and 1.12 present the treatment estimates respectively for business outcomes and inputs, based on the forcing variable weights using the triangular kernel density. The estimates are congruent with the earlier results reported. This suggests that the previous estimates are robust to kernel choice, and that the estimates are not overly-influenced by farmers in the extremes of the distribution.

Insert Tables 1.11 and 1.12 about here

The second check uses 'fake' passing scores that are 7.5 points higher and 7.5 points lower than that used for the main analysis. The aim is to assess whether the observed differential effects are potentially induced by a different threshold than that predetermined by the evaluation committee threshold. The corresponding estimates are reported in Tables 1.13 through 1.16 and reveal no statistical significance for the endorsement on almost all household business outcomes and inputs using fake higher and lower thresholds. The above suggests that no meaningful effects are detected when using artificial or 'fake' pass scores above and below the actual predetermined threshold.

Insert Tables 1.13 to 1.16 about here

The third check uses the same sample but excludes farmers that exhibited confusion between the endorsement treatment and the receipt of a grant. This creates differences between the actual treatment status of certain farmers and their perceptions of the endorsement treatment. As previously stated, this involves 82 farmers. The corresponding estimates of the endorsement effect are reported in Tables 1.17 and 1.18. The results are compatible in both magnitude and statistical significance with the estimates obtained for the main analysis.

Insert Table 1.17 and Table 1.18 about here

The final check uses the local non-parametric approach as an alternative to the global parametric RDD approach adopted earlier. For the local non-parametric estimation, we use the covariate-adjusted RD estimator developed by Calonico et al. (2014) and Calonico et al. (2019). In this case, the endorsement effect ($\hat{\tau}$) is estimated by running the weighted least squares regression with only units within a specific bandwidth (h) of the threshold. This involves estimating two separate regressions using observations on both sides of the threshold. For the bandwidth selection, we employ a mean square error (MSE) optimal bandwidth as discussed in Imbens and Kalyanaraman (2012), and implement it following the approach suggested by Calonico (2014) and Calonico et al. (2017).

Tables 1.19 and 1.20 report the endorsement impact on business outcomes and inputs using the local non-parametric approach. The results are broadly comparable with those obtained using the global parametric approach for farmers with existing businesses. We find consistent but larger estimates compared to the global parametric approach. For instance, winning the competition increases the likelihood of securing a formal loan by 40 percentage points, which is nine percentage points higher than the corresponding estimate using the global parametric approach. Yet, the impact on *de novo* businesses is not statistically significant. This again confirms our previous results that the endorsement was more effective for farmers with plans based on existing rather than *de novo* business activity.

Insert Tables 1.19 through 1.20 about here

1.7 Conclusion

This paper provides empirical evidence that business plan competitions can effectively mitigate credit constraints among farmers. Results from a business plan competition involving horticultural farmers in Rwanda suggested some positive effects on household farming activity across several dimensions. Winning the competition, and thus securing an endorsement letter, increases the likelihood of both receiving formal funding and enhancing income from seasonal horticulture crops. Specifically, the receipt of funding enabled those farmers engaged in existing lines of business activity to secure higher levels of inputs that enhanced seasonal productivity and hence seasonal income.

The results are consistent with previous studies such as Fafchamps and Quinn (2017) for three African countries (Ethiopia, Tanzania, and Zambia), Klinger and Schündeln (2011) in three Central American countries (El Salvador, Guatemala, and Nicaragua), and McKenzie (2017) using data from Nigeria. The evidence provided here complements the existing literature by studying the impact of success in a business plan competition among farmers and demonstrating it can be an effective tool in mitigating credit constraints even in the absence of any direct monetary prizes. However, a key finding is that the business plan competition proved more effective when endorsing plans for farmers related to their current business activity rather than new ones. Such conclusions add to the existing literature on the heterogeneity between pre-existing and new entrepreneurs in the wake of micro-finance interventions (Banerjee et al., 2019; Meager, 2019).

The empirical results have implications for future research on business plan competitions and policymakers seeking to boost smallholder farmer entrepreneurship and formal financial transactions. First, the findings emphasize the importance of having central points (SACCOs in our context) to diffuse information about business plan competitions. Farmers are supported by these SACCOs to develop their business ideas and to secure subsequent funding for their businesses. Second, business plan competitions can effectively alleviate credit constraints among farmers, even without grant/funding as an immediate winning award. This finding is particularly important given the limited funding generally available for such developmental projects. Third, one might tend to imply that business plan judges may need to act conservatively when endorsing business plans and opt for safer proposals around existing business expertise rather than backing higher risk *de novo* business proposals. Nevertheless, this may reflect the design of the business plan and the nature of support provided to those farmers with new business line concepts that are endorsed. The support required may differ and need further enhancement to ensure greater efficacy of the endorsement process for those with new business ideas.

1.8 Tables

Table 1.1: Descriptive statistics of household characteristics by treatment status

Variables	(1) Endorsed (T)	(2) Not Endorsed (C)	(3) T-Test (T-C)	(4) *p*-value (T-C)
Panel A: Socio-economic characteristics				
Gender of household head (=1 if male)	0.89	0.88	0.01	0.66
Religion of household head (=1 if Christian)	0.97	0.97	0.00	0.80
Schooling of household head (years)	10.95	9.63	1.32	0.00
Household size (number of members)	4.95	5.02	-0.07	0.58
Number of parcels (number of parcels)[1]	2.45	2.57	-0.12	0.19
Household land (hectares)	10.59	11.73	-1.14	0.27
Agriculture household members (number)[2]	1.75	2.11	-0.36	0.00
Wage-employed household members (number)[3]	1.30	1.28	0.03	0.57
Owning an enterprise (=1 if yes)[4]	0.23	0.19	0.04	0.11
Distance from Kigali (km)	53.67	56.40	-2.73	0.17
Panel B: Housing[5]				
Wood walls (=1 if wood wall)	0.35	0.22	0.12	0.00
Concrete roof (=1 if concrete roof)	0.81	0.79	0.02	0.47
Cement floor (=1 if cement floor)	0.79	0.74	0.05	0.08
Toilet with roof (=1 if toilet with roof)	0.77	0.85	-0.08	0.00
Number of rooms (number of rooms)	3.99	4.07	-0.08	0.27
Electricity (=1 if accessing electricity)	0.72	0.58	0.14	0.00
Panel C: SACCO membership and business plan details				
SACCO membership (=1 if a SACCO member)	0.99	0.98	0.01	0.12
SACCO membership (years)	8.43	7.80	0.63	0.03
Intention to leave a SACCO (=1 if yes)	0.03	0.01	0.01	0.06
Experience of growing business plan crop (years)	6.02	5.89	0.13	0.70
Existing project (=1 if yes)	0.70	0.65	0.04	0.14

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Business investment cost (USD)	13,729	10,299	3,430	0.00
Panel D: Extensions received over Mar 2017-Feb 2018				
Number of advices received (number)	1.65	1.52	0.13	0.36
Agricultural inputs advice (=1 if yes)	0.34	0.34	0.00	0.96
Harvest techniques advice (=1 if yes)	0.24	0.21	0.03	0.27
Post-harvest techniques advice (=1 if yes)	0.20	0.18	0.03	0.21
Marketing advice (=1 if yes)	0.11	0.10	0.02	0.36
Credit access advice (=1 if yes)	0.13	0.10	0.02	0.20
Observations	**362**	**1227**		

Notes: This table shows descriptive statistics of selected household characteristics by treatment status. Columns (1) and (2) present the mean values among T and C, respectively. Columns (4) and (5) include respectively the t-test statistics and the corresponding *p*-values of the mean differences between T and C.

[1] Number of parcels cultivated over Mar 2017-Feb 2018.

[2] Number of household members who participated in agriculture activities over Mar 2017-Feb 2018.

[3] Number of household members who were wage-employed over Mar 2017-Feb 2018.

[4] It reflects whether a household owning an enterprise over Mar 2017-Feb 2018.

[5] Questions about housing were retrospectively compiled during the main data collection exercise. Respondents were asked to recall their housing characteristics five years ago- before the business plan competition was taken place.

Table 1.2: Descriptive statistics of household business outcomes and inputs by treatment status

Variables	(1) **Endorsed** **(T)**	(2) **Not Endorsed** **(C)**	(3) **T-Test** **(T-C)**	(4) ***p*-value** **(T-C)**
Panel A: Household Business Outcomes				
Business implementation (=1)	1.0	0.7	0.3	0.0
Business Survival (=1)	0.5	0.5	0.0	0.6
Crop Income (USD)	1670	1489	181	0.2
Hortic Income (USD)	1375	1088	286	0.0
Hortic Sales (USD)	1492	1077	415	0.0
Seasonal Hortic Income (USD)	831	610	220	0.0
Seasonal Hortic Sales (USD)	936	626	310	0.0
Perennial Hortic Income (USD)	646	571	75	0.3
Perennial Hortic Sales (USD)	472	386	86	0.2
Panel B: Household Business Inputs				
Formal funding (=1)	0.5	0.1	0.3	0.0
Hortic Inputs Cost (USD)	163	119	44	0.0
Hortic Hired Labour (days)	57	42	15	0.0
Seasonal Hortic Inputs Cost (USD)	119	89	30	0.1
Seasonal Hortic Hired Labour (USD)	39	26	13	0.0
Perennial Hortic Inputs Cost (USD)	44	29	15	0.1
Perennial Hortic Hired Labour (USD)	17	15	2	0.4
Irrigation(=1)	0.05	0.05	0.00	0.8
Observations	**362**	**1227**		

Notes: This table shows descriptive statistics of selected household outcomes and inputs by treatment status. Columns (1) and (2) present the mean values among T and C, respectively. Columns (4) and (5) include respectively the t-test statistics and the corresponding *p*-values of the mean differences between T and C.

Table 1.3: Descriptive statistics of discontinuity sample characteristics

Variables	(1) **Endorsed** **(T)**	(2) **Not Endorsed** **(C)**	(3) **T-Test** **(T-C)**	(4) ***p*-value** **(T-C)**
Panel A: Socio-economic characteristics				
Gender of household head (=1 if male)	0.91	0.90	0.01	0.83
Religion of household head (=1 if Christian)	0.98	0.95	0.03	0.11
Schooling of household head (years)	10.95	9.80	1.15	0.04
Household size (number of members)	5.11	4.65	0.45	0.10
Number of parcels (number of parcels)	2.67	2.45	0.22	0.29
Household land (hectares)	10.74	9.76	0.98	0.63
Agriculture household members (number)	1.95	1.95	0.00	0.97
Wage-employed household members (number)	1.34	1.30	0.04	0.67
Owning an enterprise (=1 if yes)	0.22	0.25	-0.03	0.60
Distance from Kigali (km)	57.40	61.37	-3.97	0.32
Panel B: Housing				
Wood walls (=1 if wood wall)	0.32	0.30	0.02	0.69
Concrete roof (=1 if concrete roof)	0.80	0.84	-0.04	0.36
Cement floor (=1 if cement floor)	0.78	0.77	0.01	0.80
Toilet with roof (=1 if toilet with roof)	0.78	0.82	-0.04	0.45
Number of rooms (number of rooms)	3.87	3.99	-0.12	0.45
Electricity (=1 if accessing electricity)	0.64	0.60	0.04	0.52
Panel C: SACCO membership and business plan details				
SACCO membership (=1 if a SACCO member)	0.98	0.98	0.00	0.93
SACCO membership (years)	7.82	7.94	-0.12	0.85
Intention to leave a SACCO (=1 if yes)	0.05	0.01	0.05	0.02
Experience of growing business plan crop (years)	5.69	5.24	0.45	0.49
Existing project (=1 if yes)	0.77	0.76	0.01	0.84
Business investment cost (USD)	12,476	10,913	1,563	0.19

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Panel D: Extensions received over Mar 2017-Feb 2018				
Number of advices received (number)	1.96	1.33	0.63	0.03
Agricultural inputs advice (=1 if yes)	0.40	0.33	0.07	0.22
Harvest techniques advice (=1 if yes)	0.31	0.17	0.14	0.01
Post-harvest techniques advice (=1 if yes)	0.27	0.13	0.15	0.00
Marketing advice (=1 if yes)	0.13	0.09	0.04	0.32
Credit access advice (=1 if yes)	0.14	0.11	0.03	0.44
Observations	**131**	**141**		

Notes: This table shows descriptive statistics selected household characteristics by treatment status. The statistics are based on a discontinuity sample above and below the threshold. We follow procedures in Calonico et al. (2020) for estimating the corresponding optimal bandwidths. The average bandwidth of all variables is 10 points around the threshold. Columns (1) and (2) present the mean values among T and C, respectively. Columns (4) and (5) include respectively the t-test statistics and the corresponding *p*-values of the mean differences between T and C.

[1] Number of parcels cultivated over Mar 2017-Feb 2018.

[2] Number of household members who participated in agriculture activities over Mar 2017-Feb 2018.

[3] Number of household members who were wage-employed over Mar 2017-Feb 2018.

[4] It reflects whether a household owning an enterprise over Mar 2017-Feb 2018.

[5] Questions about housing were retrospectively compiled during the main data collection exercise. Respondents were asked to recall their housing characteristics five years ago- before the business plan competition was taken place.

Table 1.4: Descriptive statistics of those with grant (with and without scores)

Variables	(1) **With scores** **(T1)**	(2) **Missing scores** **(T2)**	(3) **T-Test** **(T1-T2)**	(4) ***p*-value** **(T1-T2)**
Panel A: Socio-economic characteristics				
Gender of household head (=1 if male)	0.92	0.86	0.01	0.66
Religion of household head (=1 if Christian)	0.98	0.95	0.00	0.80
Schooling of household head (years)	9.96	9.32	1.32	0.00
Household size (number of members)	5.55	5.59	-0.07	0.58
Number of parcels (number of parcels)	2.87	2.09	-0.12	0.19
Household land (hectares)	11.51	12.76	-1.14	0.27
Agriculture household members (number)	2.02	1.45	-0.36	0.00
Wage-employed household members (number)	1.37	1.40	0.03	0.57
Owning an enterprise (=1 if yes)	0.28	0.18	0.04	0.11
Distance from Kigali (km)	66.09	54.41	-2.73	0.17
Panel B: Housing				
Wood walls (=1 if wood wall)	0.31	0.14	0.12	0.00
Concrete roof (=1 if concrete roof)	0.78	0.86	0.02	0.47
Cement floor (=1 if cement floor)	0.72	0.59	0.05	0.08
Toilet with roof (=1 if toilet with roof)	0.84	0.73	-0.08	0.00
Number of rooms (number of rooms)	4.24	5.05	-0.08	0.27
Electricity (=1 if accessing electricity)	0.69	0.48	0.14	0.00
Panel C: SACCO membership and business plan details				
SACCO membership (=1 if a SACCO member)	1.00	1.00	0.01	0.12
SACCO membership (years)	8.72	7.32	0.63	0.03
Intention to leave a SACCO (=1 if yes)	0.02	0.00	0.01	0.06
Experience of growing business plan crop (years)	7.58	10.86	0.13	0.70
Existing project (=1 if yes)	0.77	0.47	0.04	0.14
Business investment cost (USD)	11,637	11,154	3,430	0.00

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Panel D: Extensions received over Mar 2017-Feb 2018				
Number of advices received (number)	1.85	2.45	0.13	0.36
Agricultural inputs advice (=1 if yes)	0.38	0.48	0.00	0.96
Harvest techniques advice (=1 if yes)	0.25	0.29	0.03	0.27
Post-harvest techniques advice (=1 if yes)	0.24	0.19	0.03	0.21
Marketing advice (=1 if yes)	0.12	0.19	0.02	0.36
Credit access advice (=1 if yes)	0.13	0.19	0.02	0.20
Observations	**110**	**22**		

Notes: This table displays differences in farmer characteristics between those with grants and available evaluation scores (T1) and those with grants and missing scores (T2). Columns (1) and (2) present the mean values among T1 and T2, respectively. Columns (4) and (5) include respectively the t-test statistics and the corresponding *p*-value of the mean differences between T1 and T2.

[1] Number of parcels cultivated over Mar 2017-Feb 2018.

[2] Number of household members who participated in agriculture activities over Mar 2017-Feb 2018.

[3] Number of household members who were wage-employed over Mar 2017-Feb 2018.

[4] It reflects whether a household owning an enterprise over Mar 2017-Feb 2018.

[5] Questions about housing were retrospectively compiled during the main data collection exercise. Respondents were asked to recall their housing characteristics five years ago- before the business plan competition was taken place.

Table 1.5: Endorsement impact on selected business outcomes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	General			Horticultural		Seasonal Hortic.		Perennial Hortic.	
Variables	**Business implementation (=1)**	**Business survival (=1)**	**Crop income (USD)**	**Income (USD)**	**Sales (USD)**	**Income (USD)**	**Sales (USD)**	**Income (USD)**	**Sales (USD)**
Endorsement (=1)	0.272***	0.0954**	293.2	372.1**	538.1**	260.9**	355.0**	121.6	146.1
	(0.0235)	(0.0414)	(187.1)	(173.3)	(230.3)	(115.8)	(163.9)	(124.1)	(109.8)
Observations	1,567	1,567	1,567	1,567	1,567	1,567	1,567	1,567	1,567
R-squared	0.228	0.104	0.117	0.095	0.098	0.077	0.083	0.040	0.044
Control mean	0.7	0.47	1,488	1,088	1,076	610	626	570	385
	% points	% points	USD	USD	USD	USD	USD	USD	USD

Notes: This table presents results of the impact of endorsement on selected household business outcomes using equation 1.1. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 1.6: Endorsement impact on selected business inputs

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Capital	Horticultural		Seasonal Hortic.		Perennial Hortic.		Irrigation
Variables	**Formal funding (=1)**	**Inputs cost (USD)**	**Hired labour (days)**	**Inputs cost (USD)**	**Hired labour (days)**	**Inputs cost (USD)**	**Hired labour (days)**	**Irrigated land (=1)**
Endorsement (=1)	0.294***	70.55**	19.04**	36.63*	10.15*	33.91	8.664**	0.00206
	(0.0376)	(33.47)	(7.398)	(21.86)	(5.332)	(25.87)	(4.250)	(0.0113)
Observations	1,567	1,567	1,567	1,567	1,567	1,567	1,567	1,567
R-squared	0.161	0.070	0.111	0.051	0.088	0.042	0.048	0.032
Control mean	0.12	118	42	89	26	29	14	0.05
	% points	USD	days	USD	days	USD	days	% points

Notes: This table presents results of the impact of endorsement on selected household business inputs using equation 1.1. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 1.7: Endorsement impact on selected business outcomes by business type

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	General			Horticultural		Seasonal Hortic.		Perennial Hortic.	
Variables	**Business implementation (=1)**	**Business survival (=1)**	**Crop income (USD)**	**Income (USD)**	**Sales (USD)**	**Income (USD)**	**Sales (USD)**	**Income (USD)**	**Sales (USD)**
Panel A: Existing businesses									
Endorsement (=1)	0.214***	0.124**	353.6	411.9*	548.3**	291.0**	449.8**	124.5	138.7
	(0.0289)	(0.0513)	(237.4)	(210.0)	(278.6)	(147.8)	(209.8)	(149.4)	(123.8)
Observations	1,010	1,010	1,010	1,010	1,010	1,010	1,010	1,010	1,010
R-squared	0.241	0.118	0.135	0.105	0.105	0.080	0.088	0.053	0.052
Panel B: New businesses									
Endorsement (=1)	0.429***	0.0273	31.10	204.4	338.3	93.54	-5.409	127.7	156.7
	(0.0469)	(0.0787)	(351.6)	(354.6)	(474.7)	(202.8)	(268.7)	(258.5)	(255.7)
Observations	505	505	505	505	505	505	505	505	505
R-squared	0.234	0.121	0.111	0.105	0.101	0.102	0.103	0.046	0.050
Control mean	0.7	0.47	1,488	1,088	1,076	610	626	570	385
	% points	% points	USD	USD	USD	USD	USD	USD	USD

Notes: This table presents results of the impact of endorsement on selected household business outcomes by business type using equation 1.1. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 1.8: Endorsement impact on selected business inputs by business type

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Capital	**Horticultural**		**Seasonal Hortic.**		**Perennial Hortic.**		**Irrigation**
Variables	**Formal funding (=1)**	**Inputs cost (USD)**	**Hired labour (days)**	**Inputs cost (USD)**	**Hired labour (days)**	**Inputs cost (USD)**	**Hired labour (days)**	**Irrigated land (=1)**
Panel A: Existing businesses								
Endorsement (=1)	0.314***	68.23**	26.74***	61.53**	16.96**	6.702	9.167*	-0.000121
	(0.0472)	(30.28)	(9.165)	(29.08)	(6.853)	(8.300)	(4.894)	(0.0148)
Observations	1,010	1,010	1,010	1,010	1,010	1,010	1,010	1,010
R-squared	0.175	0.098	0.130	0.073	0.101	0.052	0.064	0.036
Panel B: New businesses								
Endorsement (=1)	0.209***	37.94	-7.762	-60.47**	-14.28*	98.40	7.489	-0.00588
	(0.0654)	(89.09)	(12.84)	(29.17)	(8.001)	(84.47)	(9.020)	(0.0197)
Observations	505	505	505	505	505	505	505	505
R-squared	0.173	0.070	0.112	0.052	0.116	0.116	0.062	0.045
Control mean	0.12	118	42	89	26	29	14	0.05
	% points	USD	days	USD	days	USD	days	% points

Notes: This table presents results of the impact of endorsement on selected household business inputs by business type using equation 1.1. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 1.9: Endorsement impact on business outcomes without matching grants

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	General			Horticultural		Seasonal Hortic.		Perennial Hortic.	
Variables	**Business implementation (=1)**	**Business survival (=1)**	**Crop income (USD)**	**Income (USD)**	**Sales (USD)**	**Income (USD)**	**Sales (USD)**	**Income (USD)**	**Sales (USD)**
Panel A: Existing businesses									
Endorsement (=1)	0.241***	0.115**	419.0	444.4*	505.5	320.2*	408.5*	160.3	129.1
	(0.0312)	(0.0576)	(267.4)	(233.2)	(315.9)	(166.1)	(235.2)	(174.5)	(133.7)
Observations	931	931	931	931	931	931	931	931	931
R-squared	0.235	0.132	0.143	0.110	0.105	0.082	0.086	0.058	0.064
Panel B: New businesses									
Endorsement (=1)	0.477***	0.0459	465.2	596.8	774.7	147.9	40.50	438.2	451.0
	(0.0538)	(0.0883)	(427.6)	(441.8)	(610.1)	(255.5)	(339.7)	(301.5)	(298.3)
Observations	482	482	482	482	482	482	482	482	482
R-squared	0.228	0.123	0.119	0.111	0.104	0.105	0.103	0.046	0.049
Control mean	0.7	0.47	1,488	1,088	1,076	610	626	570	385
	% points	% points	USD	USD	USD	USD	USD	USD	USD

Notes: This table presents results of the impact of endorsement on selected household business outcomes using equation 1.1, excluding those farmers who received matching grants. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 1.10: Endorsement impact on business inputs without matching grants

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Capital	**Horticultural**		**Seasonal Hortic.**		**Perennial Hortic.**		**Irrigation**
Variables	**Formal funding (=1)**	**Inputs cost (USD)**	**Hired labour (days)**	**Inputs cost (USD)**	**Hired labour (days)**	**Inputs cost (USD)**	**Hired labour (days)**	**Irrigated land (=1)**
Panel A: Existing businesses								
Endorsement (=1)	0.0307	31.76	20.75**	29.08	12.66*	2.686	7.336	0.00261
	(0.0448)	(29.28)	(10.02)	(27.61)	(7.097)	(8.748)	(5.328)	(0.0172)
Observations	931	931	931	931	931	931	931	931
R-squared	0.052	0.099	0.127	0.075	0.098	0.060	0.072	0.038
Panel B: New businesses								
Endorsement (=1)	0.0449	52.37	-4.774	-69.90**	-18.23**	122.3	13.69	-0.0120
	(0.0572)	(103.2)	(14.89)	(32.88)	(8.606)	(98.09)	(11.25)	(0.0227)
Observations	482	482	482	482	482	482	482	482
R-squared	0.090	0.082	0.118	0.053	0.116	0.145	0.073	0.051
Control mean	0.12	118	42	89	26	29	14	0.05
	% points	USD	days	USD	days	USD	days	% points

Notes: This table presents results of the impact of endorsement on selected household business inputs using equation 1.1, excluding those farmers who received matching grants. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 1.11: Endorsement impact on business outcomes using the triangular kernel density

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		General		**Horticultural**		**Seasonal Hortic.**		**Perennial Hortic.**	
Variables	**Business implementation (=1)**	**Business survival (=1)**	**Crop income (USD)**	**Income (USD)**	**Sales (USD)**	**Income (USD)**	**Sales (USD)**	**Income (USD)**	**Sales (USD)**
Panel A: Existing businesses									
Endorsement (=1)	0.210***	0.116**	306.8	356.7*	493.4*	312.7**	472.7**	48.18	77.22
	(0.0295)	(0.0532)	(241.6)	(216.5)	(292.6)	(152.6)	(215.0)	(152.9)	(126.1)
Observations	1,010	1,010	1,010	1,010	1,010	1,010	1,010	1,010	1,010
R-squared	0.242	0.106	0.139	0.113	0.111	0.084	0.092	0.058	0.057
Panel B: New businesses									
Endorsement (=1)	0.428***	0.0483	95.26	273.2	349.5	75.18	-66.05	213.2	225.7
	(0.0484)	(0.0792)	(367.5)	(364.4)	(481.3)	(207.2)	(269.4)	(257.0)	(249.1)
Observations	505	505	505	505	505	505	505	505	505
R-squared	0.250	0.124	0.114	0.112	0.107	0.111	0.113	0.048	0.052
Control mean	0.7	0.47	1,488	1,088	1,076	610	626	570	385
	% points	% points	USD	USD	USD	USD	USD	USD	USD

Notes: This table presents results of the impact of endorsement on selected household business outcomes by business type using equation 1.1. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 1.12: Endorsement impact on business inputs using the triangular kernel density

Variables	(1) Capital Formal funding (=1)	(2) Horticultural Inputs cost (USD)	(3) Hired labour (days)	(4) Seasonal Hortic. Inputs cost (USD)	(5) Hired labour (days)	(6) Perennial Hortic. Inputs cost (USD)	(7) Hired labour (days)	(8) Irrigation Irrigated land (=1)
Panel A: Existing businesses								
Endorsement (=1)	0.305***	62.87**	25.75***	58.42*	15.55**	4.444	9.599*	0.000367
	(0.0475)	(31.20)	(9.632)	(30.06)	(7.208)	(8.160)	(5.174)	(0.0156)
Observations	1,010	1,010	1,010	1,010	1,010	1,010	1,010	1,010
R-squared	0.181	0.095	0.131	0.070	0.100	0.055	0.065	0.035
Panel B: New businesses								
Endorsement (=1)	0.215***	28.52	-7.912	-61.83**	-15.37*	90.35	7.822	-0.00623
	(0.0677)	(81.23)	(12.86)	(31.00)	(8.105)	(75.11)	(9.122)	(0.0204)
Observations	505	505	505	505	505	505	505	505
R-squared	0.192	0.081	0.098	0.062	0.108	0.127	0.059	0.061
Control mean	0.12	118	42	89	26	29	14	0.05
	% points	USD	days	USD	days	USD	days	% points

Notes: This table presents results of the impact of endorsement on selected household business inputs by business type using equation 1.1. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 1.13: Endorsement impact on business outcomes using a higher fake threshold

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	General			Horticultural		Seasonal Hortic.		Perennial Hortic.	
Variables	**Business implementation (=1)**	**Business survival (=1)**	**Crop income (USD)**	**Income (USD)**	**Sales (USD)**	**Income (USD)**	**Sales (USD)**	**Income (USD)**	**Sales (USD)**
Panel A: Existing businesses									
Endorsement (=1)	0.0840	0.297	-89.07	-104.8	928.6	619.9	919.0	4.320	420.8
	(0.108)	(0.305)	(1,404)	(1,374)	(2,087)	(1,084)	(1,708)	(1,061)	(987.9)
Observations	1,010	1,010	1,010	1,010	1,010	1,010	1,010	1,010	1,010
R-squared	0.220	0.117	0.129	0.101	0.103	0.076	0.084	0.056	0.056
Panel B: New businesses									
Endorsement (=1)	0.365	-0.0737	1,733	1,460	794.9	24.70	-501.4	1,525	1,481
	(0.241)	(0.402)	(1,558)	(1,627)	(1,936)	(1,076)	(1,400)	(980.2)	(980.9)
Observations	505	505	505	505	505	505	505	505	505
R-squared	0.170	0.120	0.110	0.102	0.099	0.097	0.101	0.051	0.048
Control mean	0.7	0.47	1,488	1,088	1,076	610	626	570	385
	% points	% points	USD	USD	USD	USD	USD	USD	USD

Notes: This table presents results of the impact of endorsement on selected household business outcomes based on a higher fake threshold (i.e., 7.5 points lower than the actual threshold) using equation 1.1. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 1.14: Endorsement impact on business inputs using a higher fake threshold

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Capital	**Horticultural**		**Seasonal Hortic.**		**Perennial Hortic.**		**Irrigation**
Variables	**Formal funding (=1)**	**Inputs cost (USD)**	**Hired labour (days)**	**Inputs cost (USD)**	**Hired labour (days)**	**Inputs cost (USD)**	**Hired labour (days)**	**Irrigated land (=1)**
Panel A: Existing businesses								
Endorsement (=1)	-0.0481	46.75	-68.07	-11.62	-54.73	58.37	-8.917	0.0122
	(0.330)	(178.9)	(52.86)	(162.8)	(43.47)	(85.15)	(14.47)	(0.110)
Observations	1,010	1,010	1,010	1,010	1,010	1,010	1,010	1,010
R-squared	0.131	0.096	0.126	0.070	0.098	0.054	0.061	0.035
Panel B: New businesses								
Endorsement (=1)	0.303	-246.2*	-46.08	-139.6	-40.75	-106.5	-17.23	0.00461
	(0.325)	(142.9)	(74.39)	(111.0)	(54.23)	(71.83)	(36.94)	(0.0901)
Observations	505	505	505	505	505	505	505	505
R-squared	0.129	0.053	0.112	0.049	0.111	0.024	0.054	0.043
Control mean	0.12	118	42	89	26	29	14	0.05
	% points	USD	days	USD	days	USD	days	% points

Notes: This table presents results of the impact of endorsement on selected household business outcomes based on a lower fake threshold (i.e., 7.5 points lower than the actual threshold) using equation 1.1. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 1.15: Endorsement impact on business outcomes using a lower fake threshold

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	General			**Horticultural**		**Seasonal Hortic.**		**Perennial Hortic.**	
Variables	**Business implementation (=1)**	**Business survival (=1)**	**Crop income (USD)**	**Income (USD)**	**Sales (USD)**	**Income (USD)**	**Sales (USD)**	**Income (USD)**	**Sales (USD)**
Panel A: Existing businesses									
Endorsement (=1)	-0.0454	-0.0522	841.2**	364.2	570.3	138.4	201.4	199.8	127.6
	(0.103)	(0.115)	(411.5)	(381.4)	(478.0)	(283.9)	(387.1)	(249.2)	(220.5)
Observations	1,010	1,010	1,010	1,010	1,010	1,010	1,010	1,010	1,010
R-squared	0.221	0.121	0.130	0.102	0.104	0.076	0.083	0.054	0.055
Panel B: New businesses									
Endorsement (=1)	0.260	0.0721	254.9	325.5	211.4	-79.30	-258.0	350.3	306.7
	(0.166)	(0.175)	(681.4)	(642.8)	(876.6)	(546.5)	(818.1)	(273.9)	(259.4)
Observations	505	505	505	505	505	505	505	505	505
R-squared	0.173	0.121	0.109	0.101	0.098	0.098	0.103	0.052	0.049
Control mean	0.7	0.47	1,488	1,088	1,076	610	626	570	385
	% points	% points	USD	USD	USD	USD	USD	USD	USD

Notes: This table presents results of the impact of endorsement on selected household business outcomes based on a lower fake threshold (i.e., 7.5 points lower than the actual threshold) using equation 1.1. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 1.16: Endorsement impact on business inputs using a lower fake threshold

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Capital	**Horticultural**		**Seasonal Hortic.**		**Perennial Hortic.**		**Irrigation**
Variables	**Formal funding (=1)**	**Inputs cost (USD)**	**Hired labour (days)**	**Inputs cost (USD)**	**Hired labour (days)**	**Inputs cost (USD)**	**Hired labour (days)**	**Irrigated land (=1)**
Panel A: Existing businesses								
Endorsement (=1)	0.109	36.52	-9.284	56.35	-0.468	-19.84	-8.761	-0.0179
	(0.0864)	(50.86)	(18.04)	(48.12)	(12.86)	(19.21)	(11.15)	(0.0315)
Observations	1,010	1,010	1,010	1,010	1,010	1,010	1,010	1,010
R-squared	0.133	0.096	0.125	0.071	0.097	0.056	0.063	0.035
Panel B: New businesses								
Endorsement (=1)	-0.128	84.45	16.28	75.70	3.419	8.750	12.93	-0.00293
	(0.138)	(100.4)	(23.95)	(97.40)	(21.24)	(22.58)	(11.30)	(0.0575)
Observations	505	505	505	505	505	505	505	505
R-squared	0.124	0.052	0.118	0.049	0.114	0.024	0.057	0.044
Control mean	0.12	118	42	89	26	29	14	0.05
	% points	USD	days	USD	days	USD	days	% points

Notes: This table presents results of the impact of endorsement on selected household business outcomes based on a lower fake threshold (i.e., 7.5 points lower than the actual threshold) using equation 1.1. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 1.17: Endorsement impact on business outcomes of those with perfect treatment compliance

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		General		Horticultural		Seasonal Hortic.		Perennial Hortic.	
Variables	**Business implementation (=1)**	**Business survival (=1)**	**Crop income (USD)**	**Income (USD)**	**Sales (USD)**	**Income (USD)**	**Sales (USD)**	**Income (USD)**	**Sales (USD)**
Panel A: Existing businesses									
Endorsement (=1)	0.122**	0.113	385.4	317.1	451.9	512.6**	685.5*	-204.0	-143.9
	(0.0494)	(0.0848)	(348.4)	(344.5)	(499.0)	(259.3)	(367.2)	(240.2)	(193.5)
Observations	943	943	943	943	943	943	943	943	943
R-squared	0.242	0.117	0.131	0.105	0.107	0.085	0.093	0.055	0.056
Panel B: New businesses									
Endorsement (=1)	0.419***	0.0981	588.6	608.5	424.9	-11.69	-288.9	587.7	488.1
	(0.0918)	(0.145)	(669.5)	(656.3)	(800.0)	(354.1)	(448.4)	(468.1)	(438.2)
Observations	466	466	466	466	466	466	466	466	466
R-squared	0.227	0.129	0.118	0.113	0.106	0.110	0.116	0.052	0.047
Control mean	0.7	0.47	1,488	1,088	1,076	610	626	570	385
	% points	% points	USD	USD	USD	USD	USD	USD	USD

Notes: This table presents results of the impact of endorsement on selected household business outcomes using equation 1.1, excluding those farmers who were confused about their treatment status (i.e., whether they received an endorsement letter). Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 1.18: Endorsement impact on business inputs of those with perfect treatment compliance

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Capital	**Horticultural**		**Seasonal Hortic.**		**Perennial Hortic.**		**Irrigation**
Variables	**Formal funding (=1)**	**Inputs cost (USD)**	**Hired labour (days)**	**Inputs cost (USD)**	**Hired labour (days)**	**Inputs cost (USD)**	**Hired labour (days)**	**Irrigated land (=1)**
Panel A: Existing businesses								
Endorsement (=1)	0.166**	52.43	25.35	60.04	10.82	-7.612	13.94	0.0140
	(0.0762)	(50.12)	(16.74)	(48.93)	(12.36)	(10.82)	(8.774)	(0.0259)
Observations	943	943	943	943	943	943	943	943
R-squared	0.141	0.099	0.128	0.075	0.104	0.054	0.061	0.037
Panel B: New businesses								
Endorsement (=1)	0.0986	-104.9	-27.42	-116.6	-38.25**	11.66	8.423	-0.0106
	(0.110)	(79.89)	(23.19)	(71.38)	(16.88)	(25.63)	(14.72)	(0.0375)
Observations	466	466	466	466	466	466	466	466
R-squared	0.138	0.060	0.129	0.053	0.135	0.069	0.055	0.047
Control mean	0.12	118	42	89	26	29	14	0.05
	% points	USD	days	USD	days	USD	days	% points

Notes: This table presents results of the impact of endorsement on selected household business inputs using equation 1.1, excluding those farmers who were confused about their treatment status (i.e., whether they received an endorsement letter). Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 1.19: Endorsement impact on business outcomes using local non-parametric RDD

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		General		Horticultural		Seasonal Hortic.		Perennial Hortic.	
Variables	**Business implementation (=1)**	**Business survival (=1)**	**Crop income (USD)**	**Income (USD)**	**Sales (USD)**	**Income (USD)**	**Sales (USD)**	**Income (USD)**	**Sales (USD)**
Panel A: Existing businesses									
Endorsement (=1)	0.0675	0.151	833.0	430.9	158.6	790.2**	1,010**	-5.668	-142.2
	(0.113)	(0.133)	(1,189)	(801.4)	(985.3)	(355.2)	(486.1)	(858.7)	(490.3)
Effective observations (L)	110	138	72	90	110	90	90	72	90
Bandwidth size (L)	6.833	7.061	4.376	5.340	6.558	5.523	5.261	4.850	5.138
Effective observations (R)	131	141	102	117	131	117	117	102	117
Bandwidth size (R)	6.833	7.061	4.376	5.340	6.558	5.523	5.261	4.850	5.138
Panel B: New businesses									
Endorsement (=1)	0.0766	-0.127	1,017	1,017*	699.0	-84.31	-448.8	0.681	34.49
	(0.169)	(0.206)	(687.4)	(615.7)	(773.7)	(403.0)	(544.8)	(293.7)	(294.6)
Effective observations (L)	38	38	41	41	41	41	41	29	29
Bandwidth size (L)	6.140	6.514	7.589	7.564	7.438	7.251	7.842	5.623	5.637
Effective observations (R)	46	46	51	51	51	51	51	35	35
Bandwidth size (R)	6.140	6.514	7.589	7.564	7.438	7.251	7.842	5.623	5.637
Control mean	0.7	0.47	1,488	1,088	1,076	610	626	570	385
	% points	% points	USD	USD	USD	USD	USD	USD	USD

Notes: This table presents results of the impact of endorsement on selected household business outcomes using equation 1.1. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

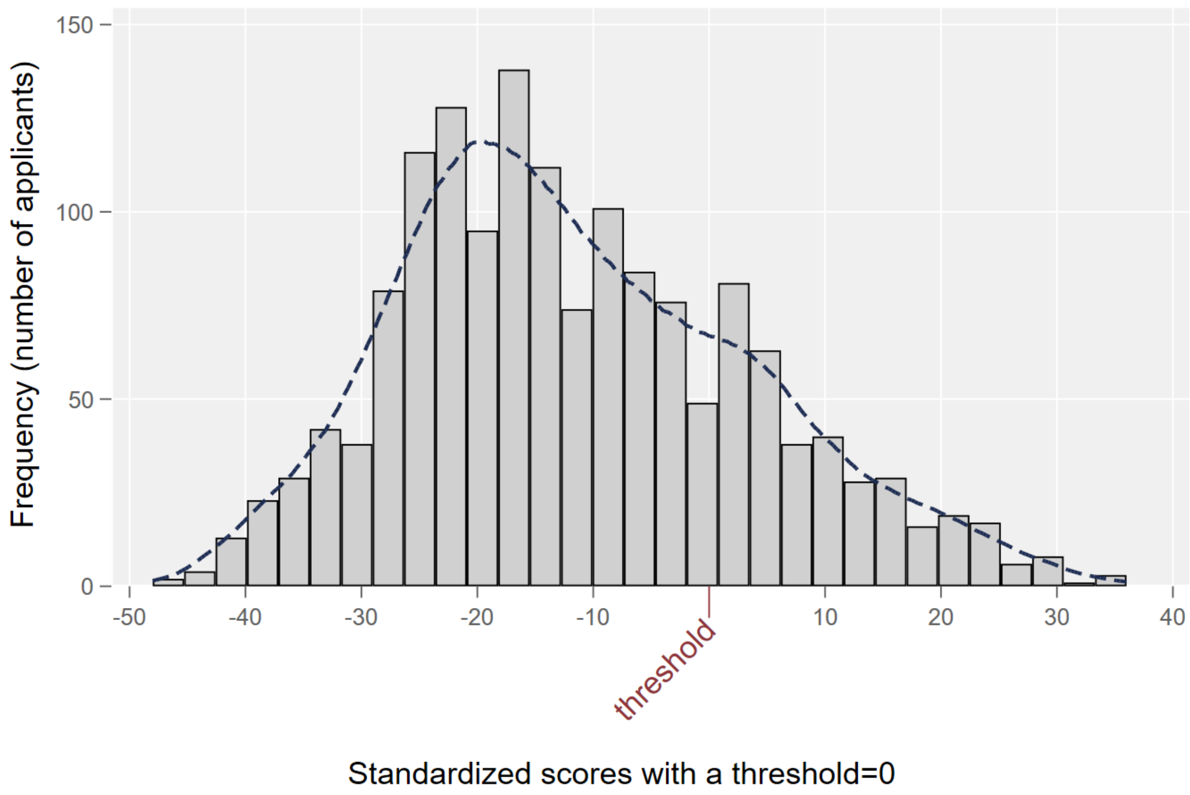
Table 1.20: Endorsement impact on business inputs using local non-parametric RDD

Variables	(1) Capital **Formal funding (=1)**	(2) Horticultural **Inputs cost (USD)**	(3) **Hired labour (days)**	(4) Seasonal Hortic. **Inputs cost (USD)**	(5) **Hired labour (days)**	(6) Perennial Hortic. **Inputs cost (USD)**	(7) **Hired labour (days)**	(8) Irrigation **Irrigated land (=1)**
Panel A: Existing businesses								
Endorsement (=1)	0.405***	182.0**	72.09***	167.0**	24.01	12.82	20.50*	0.113**
	(0.133)	(77.50)	(27.47)	(74.94)	(18.23)	(26.55)	(11.79)	(0.0464)
Effective observations (L)	72	52	72	52	90	52	90	52
Bandwidth size (L)	4.320	3.888	4.127	3.689	5.185	3.897	5.516	3.992
Effective observations (R)	102	92	102	92	117	92	117	92
Bandwidth size (R)	4.320	3.888	4.127	3.689	5.185	3.897	5.516	3.992
Panel B: New businesses								
Endorsement (=1)	0.0396	-111.4	-46.03	-171.8	-49.60*	7.817	-20.39	-0.0773
	(0.178)	(161.7)	(28.47)	(150.0)	(26.46)	(19.29)	(16.15)	(0.0589)
Effective observations (L)	29	38	29	41	29	29	22	38
Bandwidth size (L)	5.405	6.258	5.949	7.493	5.183	5.495	4.854	6.921
Effective observations (R)	35	46	35	51	35	35	26	46
Bandwidth size (R)	5.405	6.258	5.949	7.493	5.183	5.495	4.854	6.921
Control mean	0.12	118	42	89	26	29	14	0.05
	% points	USD	days	USD	days	USD	days	% points

Notes: This table presents results of the impact of endorsement on the household business inputs using equation 1.1. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

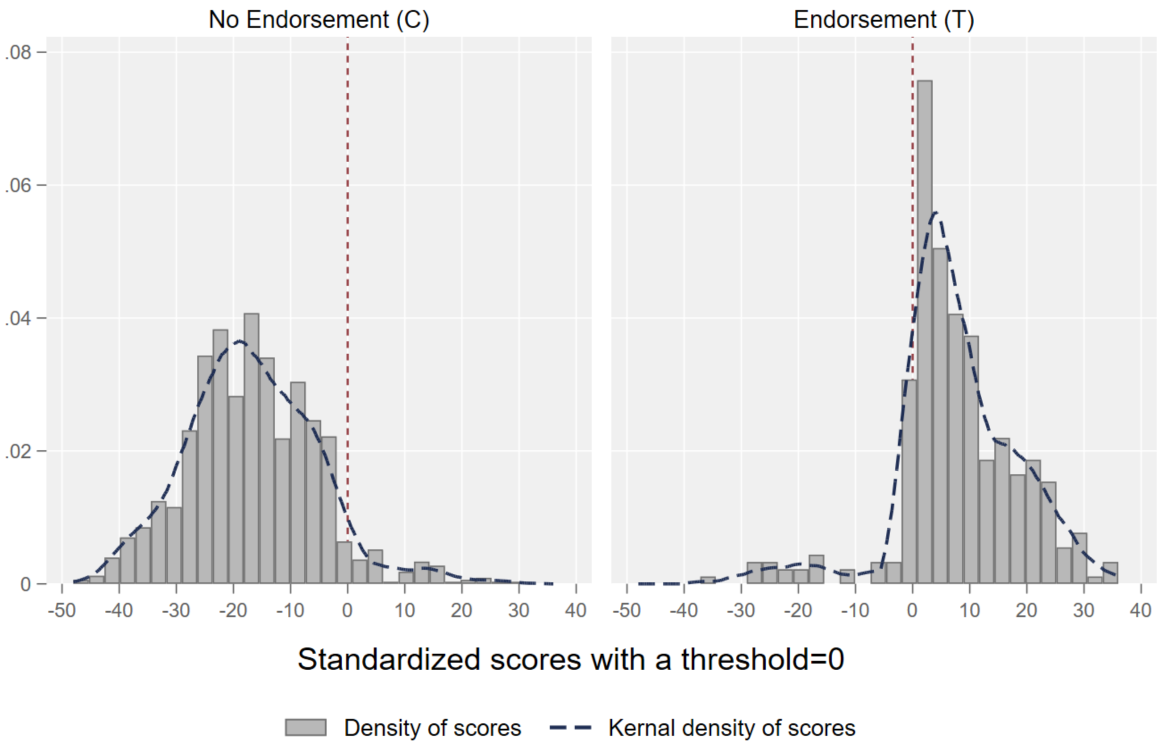
1.9 Figures

Figure 1.1: Distribution of evaluation scores



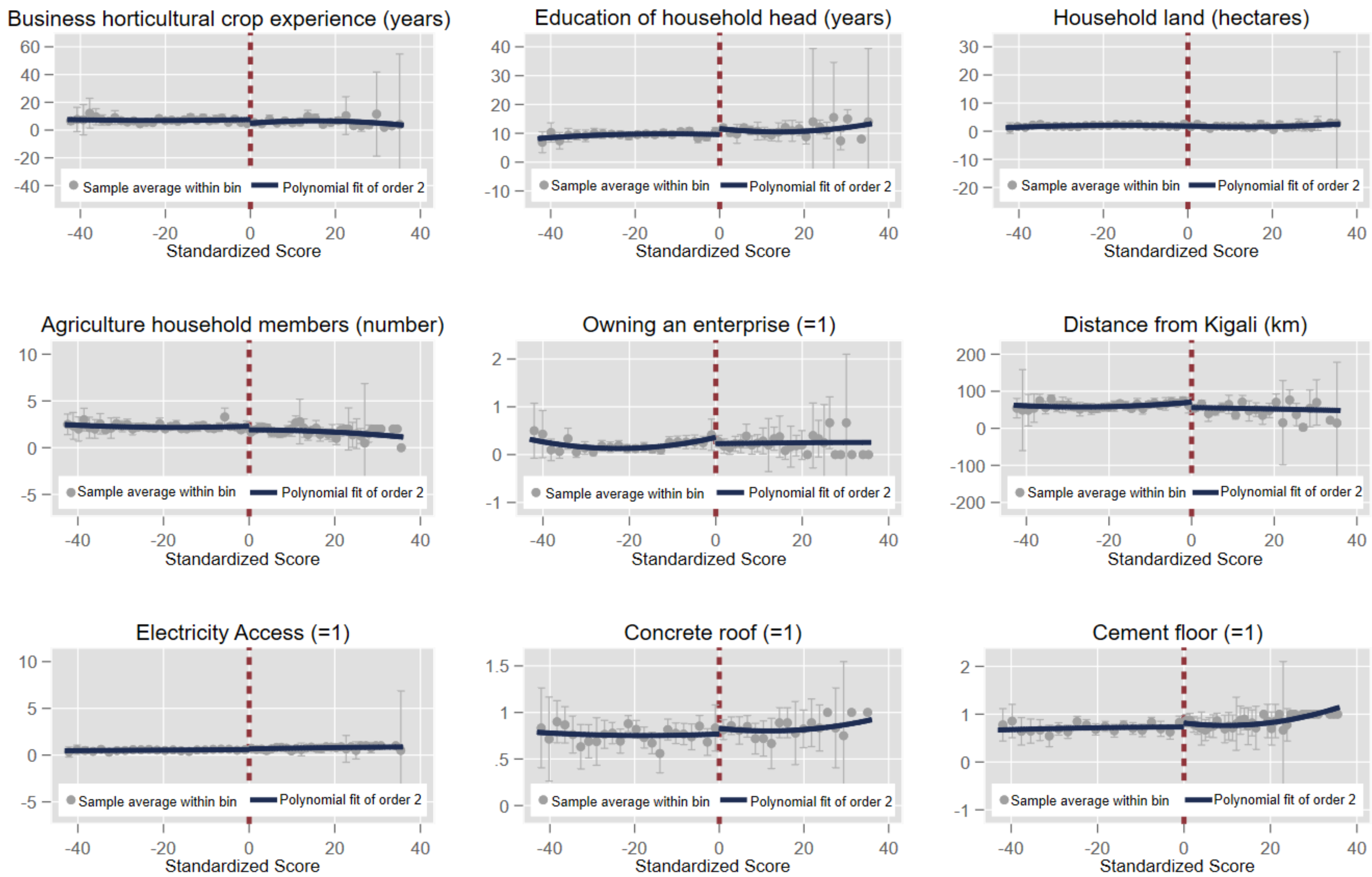
Notes: This figure displays the distribution of farmer scores in the household sample. These scores are standardized around one threshold (zero) for all crop categories. The bars reflect the frequency of farmers within each bandwidth around the zero threshold. They are overlaid with kernel density estimates (triangular kernel).

Figure 1.2: Distribution of evaluation scores by treatment status



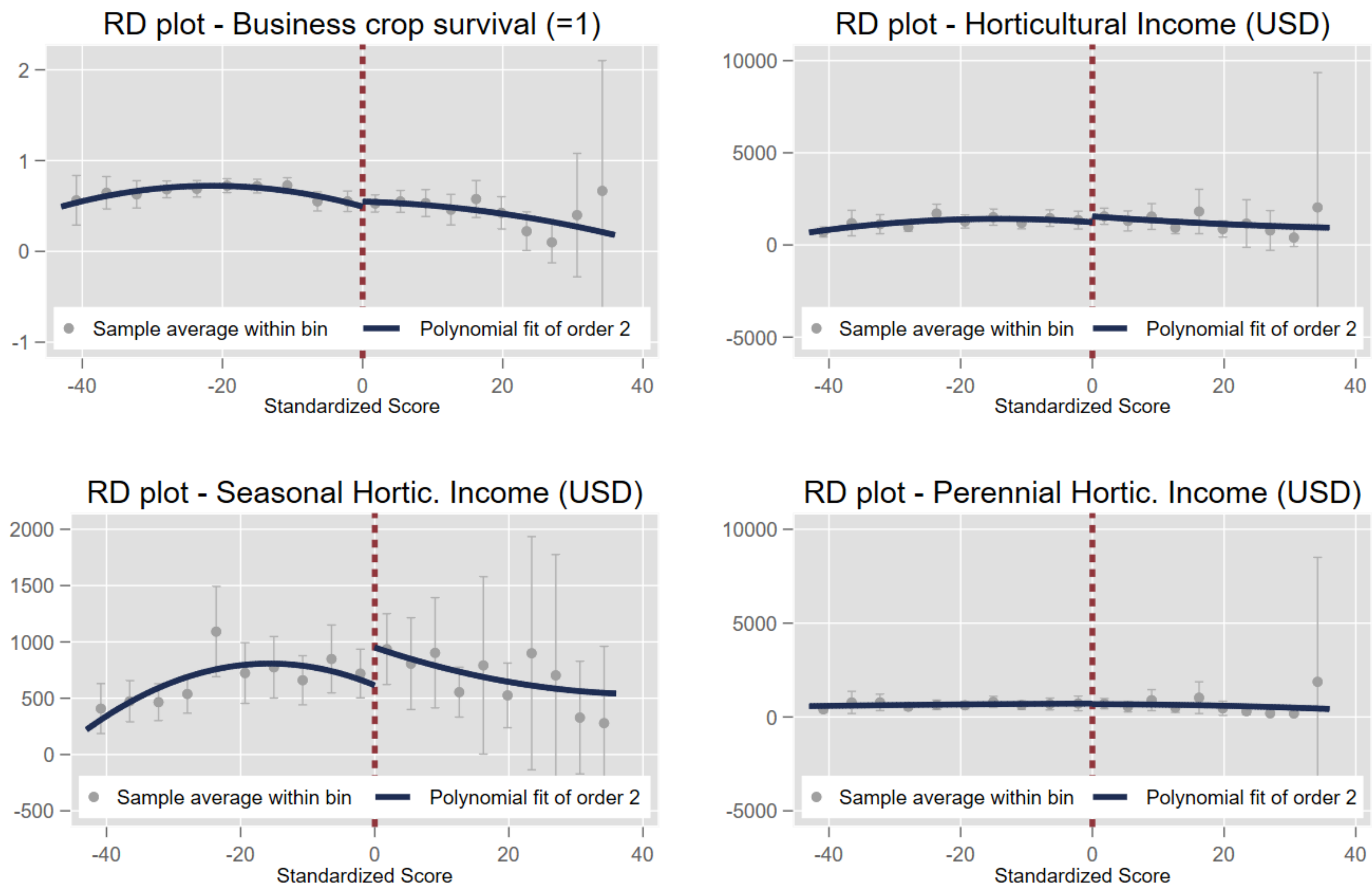
Notes: This figure shows the distribution of farmer scores in the household sample, divided into two groups: farmers who received an endorsement letter (T) on the right side and farmers who were not endorsed (C) on the left side. These scores are standardized around one threshold (zero) for all crop categories. The bars reflect the density of farmers within each bandwidth around the zero threshold. They are overlaid with kernel density estimates (triangular kernel).

Figure 1.3: Regression discontinuity plots of selected household characteristics



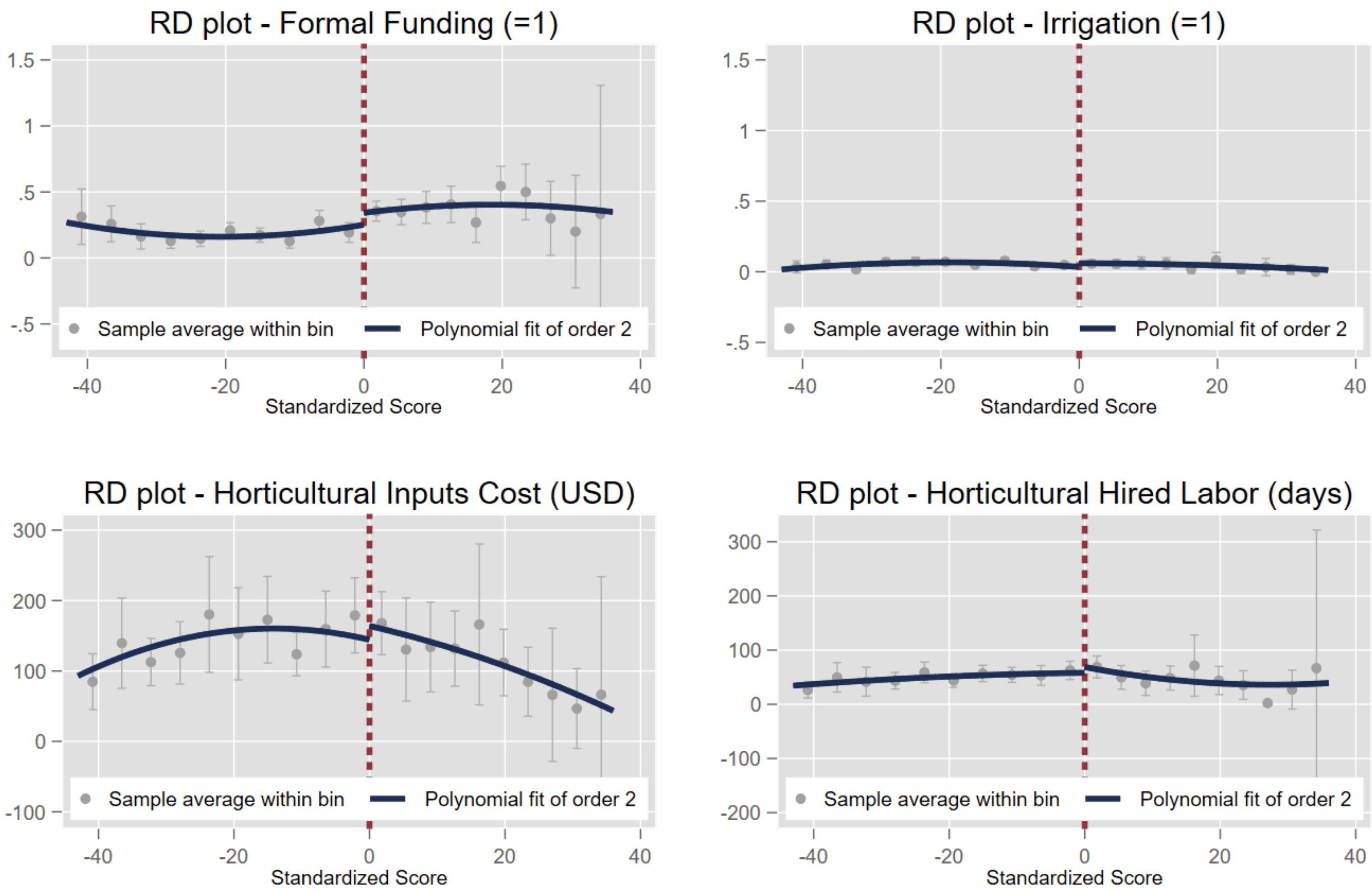
Notes: This figure depicts the regression discontinuity plots for selected household characteristics. Within each sub-figure, the dots reflect the sample average within each bin of scores, assigned with a 95 percent confidence interval. We use ten evenly-distributed bins for this purpose. The lines indicate the polynomial fit of order 2. The line and dots on the right side is related to the endorsed farmer outcomes, and the ones on the left side belong to the rejected farmers who implemented their business.

Figure 1.4: Regression discontinuity plots of household business outcomes



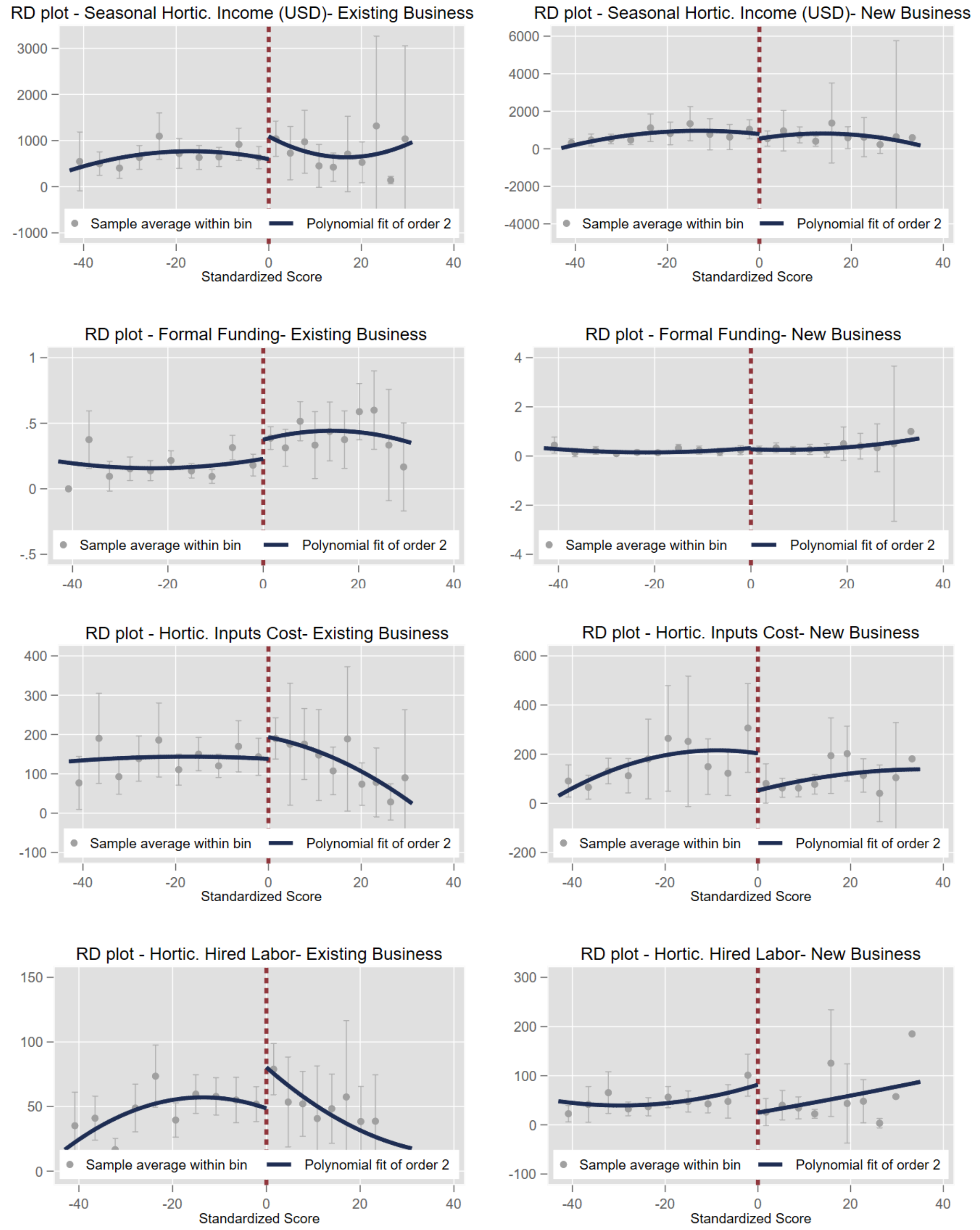
Notes: This figure depicts the regression discontinuity plots for the household business outcomes used in the analysis. Within each sub-figure, the dots reflect the sample average within each bin of scores, assigned with a 95 percent confidence interval. We use ten evenly-distributed bins for this purpose. The lines indicate the polynomial fit of order 2. The line and dots on the right side is related to the endorsed farmer outcomes, and the ones on the left side belong to the rejected farmers who implemented their business.

Figure 1.5: Regression discontinuity plots of household business inputs



Notes: This figure depicts the regression discontinuity plots for some household business inputs used in the analysis. Within each sub-figure, the dots reflect the sample average within each bin of scores, assigned with a 95 percent confidence interval. We use ten evenly-distributed bins for this purpose. The lines indicate the polynomial fit of order 2. The line and dots on the right side is related to the endorsed farmer outcomes, and the ones on the left side belong to the rejected farmers who implemented their business.

Figure 1.6: Regression discontinuity plots of selected indicators by type of business



Notes: This figure depicts the regression discontinuity plots for selected outcomes/inputs by type of business. Sub-figures on the left column are for existing businesses, whereas the new businesses' sub-figures are on the right. Within each sub-figure, the dots reflect the sample average within each bin of scores, assigned with a 95 percent confidence interval. We use ten evenly-distributed bins for this purpose. The lines indicate the polynomial fit of order 2. The line and dots on the right side is related to the endorsed farmer outcomes, and the ones on the left side belong to the rejected farmers who implemented their business.

Chapter 2

Cash Constraints and Relational Contracts: Evidence from Dairy Cooperatives in Kenya[1]

Abstract: Deferred payments are prevalent in agricultural value chains in developing countries. In some settings, trading parties interpret such payments as a commitment savings device. However, the challenge arises when trading parties encounter cash shocks without the capacity to absorb them. Such cash constraints can threaten contractual agreements between parties, especially in weak institutionalized settings. In this paper, we study whether softening deferred payments as a commitment device by providing a cash-in-advance service strengthens contractual agreements between dairy farmers and cooperatives in the Kenyan dairy sector. We address this research question using administrative data on milk deliveries of 48,000 farmers using a difference-in-differences framework. We find evidence that the cash-in-advance service is associated with increases in milk deliveries to cooperatives through two main complementary mechanisms: monthly milk income target and farmer loyalty. We also provide suggestive evidence that the treatment effects are heterogeneous across certain dimensions.

JEL Codes: K12, L14, Q12, Q13

Keywords: Cash constraints, relational contracts, dairy farmers, dairy cooperatives, cash-in-advance, Kenya

[1]The author is grateful for Heifer International's permission to use the Kenya EADD impact evaluation data in this paper. I am thankful to Benjamin Wood for his support and encouragement to obtain and use these data.

2.1 Introduction

Lack of adequate financial intermediation can hinder the welfare of rural populations in developing countries (Stephens and Barrett, 2011; Karlan et al., 2014; Banerjee et al., 2015). Saving constraints, as a consequence, can impede business growth (Dupas and Robinson, 2013a), the use of agricultural inputs (Brune et al., 2016), agricultural investments and crop income (Flory, 2018), and the ability to exploit inter-temporal arbitrage opportunities (Burke et al., 2018). Commitment savings devices, where individuals voluntarily save either with some fees imposed for early withdrawal or no withdrawal for a pre-specified period, provide channels to mitigate saving constraints (Ashraf et al., 2006; Bryan et al., 2010).[2]

Individuals consider infrequent payments (e.g., monthly) as a natural commitment savings device, compared to obtaining frequent payments (e.g., daily) that might be spent more frivolously (Casaburi and Macchiavello, 2019).[3] Infrequent payments are not, however, necessarily a welfare-enhancing tool. They can preclude individuals from accessing cash when needed before the scheduled date of payment. Cash constraints typically encourage individuals to deal with other organizations to obtain immediate cash (Geng et al., 2017). Such a situation might weaken the contractual agreements between members and their organization. Against this backdrop, organizations offer services such as cash in advance or loans to their members to meet their cash constraints as well as strengthen their members' loyalty.

Contractual agreements in agricultural value chains are assessed to enhance farmer welfare through mitigating coordination problems between farmers and processors/ buyers as well as market imperfections (Casaburi et al., 2014; Minot and Sawyer, 2016). Yet, Deb and Suri (2013) conclude that contracts are more likely to succeed in the absence of an outside option for farmers (e.g. informal traders); otherwise markets would be characterized by weak contract enforcement. This leads to a setting where relational contracts[4] are crucial to realize the benefits of contract farming.

Whether mitigating cash constraints helps strengthen relational contracts in agriculture is an empirical question. In the context of dairy farming in Kenya, we assess the impact of a cash-in-

[2]These savings devices are considered to be effective for individuals with hyperbolic preferences (O'Donoghue and Rabin, 1999) or self-control problems (Gul and Pesendorfer, 2001).

[3]Infrequent payments represent a commitment from individuals to deliver goods or services to their organization, and secure their payments on a deferred basis (e.g., monthly payments).

[4]Relational contracts are informal agreements that depend on trust and long-term relationships (Baker et al., 1994; Levin, 2003; Halac, 2012).

advance service as a method to tackle farmer cash shocks within an infrequent payments scheme using farmer milk delivery to dairy cooperatives as an indicator for relational contract strength. Dairy cooperatives in Kenya provide a good example of the prominence of infrequent payments as a saving commitment device, cash constraints, and relational contracts.

Farmers deliver milk daily to their cooperatives and obtain monthly payments based on the amount of milk delivered. Casaburi and Macchiavello (2019) conclude that dairy farmers in Kenya prefer monthly milk payments from their cooperative despite the fact they can obtain immediate daily payments from informal milk traders. The authors note that farmers trust cooperatives more than informal traders, and are willing to pay for infrequent monthly payments for savings purposes. Kramer and Kunst (2019) also confirm these farmers defer regular milk payments due to lump-sum expenditures, habit formation and income visibility from family members.

Though farmers appreciate infrequent payments due to savings constraints, they are prone to cash constraints (Burke et al., 2018). Cash-constrained farmers have an incentive to side-sell milk to informal traders, who offer immediate cash payments and sometimes higher milk prices rather than to their cooperatives offering monthly payments (Geng et al., 2017).[5] This hidden action (adverse selection) issue can negatively affect the enforcement of relational contracts between farmers and cooperatives to deliver a regular amount of milk. Geng et al. (2017) also claim that using financial instruments, such as household health insurance reduces the likelihood that farmers deliver milk outside their cooperative. Cooperatives offer a cash-in-advance service in order to reduce the interactions between informal traders and farmers.

Leveraging administrative data on milk transactions between 48,000 Kenyan dairy farmers and 14 cooperatives, I study how members respond in terms of milk delivery after receiving a cash-in-advance service. Based on a difference-in-differences (DiD) specification, I find three main results: 1) the cash-in-advance treatment led to an increase in milk delivery on both the extensive and intensive margins; 2) two complementary channels through which the treatment affects milk delivery are documented, namely a monthly milk payments target[6] and farmer loyalty towards cooperatives;[7] 3) the treatment effects are heterogeneous across certain dimensions.

[5]Farmers do not have any incentive to deliver low quality milk as cooperatives have quality assurance measures in place to reject such milk without payments. In economic terms, this means that the relational contracts between farmers and cooperatives are not prone to any hidden information (moral hazard) issue.

[6]Farmers target a monthly income based on their milk delivery to cooperatives. This means that they will increase milk delivery if they use the cash-in-advance facility from cooperatives before their scheduled monthly milk payments.

[7]Farmers will presumably see this as an illustration that their cooperative is taking an interest in the welfare of their households to mitigate unexpected cash constraints. This in return can increase loyalty and hence milk delivery (Bernard et al., 2019).

The remainder of the paper is organized as follows. The related literature is outlined in section 2.2. Section 2.3 provides an overview about the dairy sector in Kenya as well as explaining the EADD project from which the data are drawn. Section 2.4 discusses the data used in the analysis, while Section 2.5 outlines the identification strategy. Section 2.6 presents results and some conclusions are presented in Section 2.7.

2.2 Related Literature

Studying the impact of the cash-in-advance service as a contractual agreement between farmers and cooperatives on milk delivery contributes to three strands of the existing literature, namely successful contract farming, farmer loyalty towards cooperatives, and commitment devices.

Various contractual agreements have been studied in the contract farming literature by addressing their impacts on farmer decisions to deliver their agricultural products to cooperatives. Using a framed field experiment with a sample of 205 farmers from 4 milk collection centers in Vietnam, Saenger et al. (2013) conclude that a price bonus/penalty based on quality led to higher input use and milk quality. Similarly, using a quasi-experimental econometric technique, Casaburi and Macchiavello (2015) find mixed impacts of sanction threats for cheating on milk delivery among Kenyan dairy farmers using a sample of 1,754 farmers from one cooperative.[8] Unlike the 'stick' approaches that buyers used to motivate farmers to increase deliveries, the cash-in-advance service represents more of a 'carrot' approach. While penalty or sanctions do not tackle directly the reasons why farmers side-sell milk to an outside option, the cash-in-advance service with monthly infrequent payments balances savings considerations and cash constraints. The latter represents one of the main reasons why farmers side-sell milk to an outside option. A number of previous studies have attempted to implement the 'carrot' approach, but none dealt with cash constraints in the way cash-in-advance addressed them. Unlike the cash-in-advance that covers all cash shocks that farmers might encounter, Geng et al. (2017) study how mitigating one cash constraint due to health shocks affects milk deliveries. Using a sample of 120 farmers within a single dairy cooperative in Kenya, they find that household medical insurance induced farmers to increase milk deliveries to their cooperative. Similarly, Casaburi and Macchiavello (2019) demonstrate that farmers are willing to pay for monthly infrequent payments due to savings considerations. Farmers tend to sacrifice the higher prices offered by informal traders as an outside-option in order to achieve

[8]Some farmers decided to cancel membership with the cooperative (exit strategy) as a result of the threats of sanctions, while others actually increased their milk deliveries.

monthly savings targets based on milk deliveries to cooperatives. The cash-in-advance service ensures that a savings commitment device such as monthly infrequent payments achieve a balance between meeting savings targets and cash shocks. Finally, based on a sample of 445 dairy farmers in Senegal, Bernard et al. (2019) conclude that nutrition-based incentives for women positively affect milk deliveries to their cooperative.

A related literature to contract farming is based on farmer loyalty towards cooperatives. Member loyalty is essential to most successful organizations. Hirschman (1970) demonstrates that loyalty represents a barrier to exit from relationships and associations between members and their organization. Brooks (2019) argues that Hirschman's notion of loyalty ascribes member commitment and compliance towards their organization to three distinct but connected modalities: rewards and sanctions (structural loyalty), member preferences and tastes (characterological loyalty), and social identity (behavioral loyalty). Rey and Tirole (2000) suggest that cooperatives need barriers or constraints to member exit in order to strengthen their loyalty. The rationale is that cooperatives are fragile institutions due to the outside financing options and the potential for member exit. Although, member exit has an efficiency rational, it involves negative externalities on remaining members which can threaten cooperative viability through triggering the exit of more members. The current paper contributes to this thin literature by quantifying farmer loyalty as a potential mechanism through which the cash-in-advance service affects milk delivery.

The third strand of literature relates to commitment devices. Most of the existing literature focuses on how commitment devices can either make agents worse off (John, 2020),[9] or help agents to increase savings (Thaler and Benartzi, 2004; Ashraf et al., 2006), raise labour productivity (Kaur et al., 2010), commit to fertilizer use as an enhancing technique for agricultural productivity (Duflo et al., 2011), invest more in preventive health (Dupas and Robinson, 2013b), use commitment as a signaling mechanism for a preferred behavior (Exley and Naecker, 2017), and avoid the cost of exerting self-control (Toussaert, 2018). Nevertheless, none of the above addresses how a service (cash-in-advance) that softens a commitment device (infrequent monthly payments) strengthens relational contracts between farmers and cooperatives, which is the primary focus of this paper.

The current paper exploits a transactions dateset comprising a sample of 48,000 farmers and 14 dairy cooperatives. These cover the main areas of milk production in Kenya. In contrast to the previous studies which depend on a sample of farmers within a single or just a few cooperatives, the

[9]Commitment devices can reduce agent welfare as some may select into the wrong commitment device due to imperfect knowledge about their preferences.

sample of farmers studied in this paper covers dairy cooperatives that represent about 10 percent of milk production in Kenya.

2.3 Background

This section includes a brief history of the dairy sector in Kenya. We then provide an overview of the industry's current situation, and finally outline the study context.

2.3.1 Brief history of the dairy sector in Kenya

The emergence of formalized and institutional dairy farming in Kenya dates back to the colonial period where large-scale dairy settlers dominated the sector. The Swynnerton Plan in 1954 was a turning point as it allowed indigenous Kenyans to venture into dairy farming. This was followed by the Dairy Industries Act in 1958, which led to the establishment of the Kenya Dairy Board (KDB) to regulate the industry and the appointment of Kenya Cooperative Creameries (KCC) to be solely responsible for milk marketing.

Post-independence, the involvement of smallholder farmers in dairy farming was one of the main development policy pillars in Kenya. With government support, KCC monopolized the dairy industry by offering a stable marketing system for dairy farmers. However, during the 1970s and 1980s, KCC experienced losses due to high operating costs and internal mismanagement. This was reflected in KCC's inability to cover all milk collection in Kenya. This paved the way to liberalize the milk market in 1992.

Following milk price liberalization, private processors/cooperatives as well as informal traders emerged and became key players in the dairy sector. Due to the increasing competition as well as its internal mismanagement, KCC faced increasing issues, including delayed payments to dairy farmers. This led to its collapse in 1999. As KCC was a main actor in the dairy market for more than 70 years, the government intervened and attempted to revitalize KCC in 2003. Though this resulted in a resurgence of the dairy sector, this reform did not solve all challenges in the sector, such as the high costs of production that precludes farmers from engaging in the regional market and expanding their value chains (Atieno and Kanyinga, 2008).

2.3.2 Current situation of the dairy sector in Kenya

The dairy sector is the largest agricultural industry in Kenya, contributing approximately 14 percent of agricultural GDP and 3.5-4.5 percent of overall GDP (Nassiuma and Nyoike, 2014). About 85 percent of dairy cattle (approximately 3.4 million head) in East Africa are handled by Kenyan smallholders who typically own 1-3 cows. About 70-80% of milk production in Kenya comes from smallholders, which represent 35% of rural households and 26% of all households (TechnoServe, 2008). Milk consumption per capita is one of the highest in Kenya compared to other East Africa countries (Burke et al., 2015). Kenya has recently become a net importer of milk and other dairy products due to the high domestic demand for these products relative to domestic production (FAOSTAT, 2018).

Dairy cooperatives play a crucial role in the dairy sector in Kenya. The FAO estimates that cooperatives and farmer groups handle about 40 percent of the marketed milk in Kenya (FAO, 2011).[10] Dairy cooperatives typically own milk chilling plants, where they collect and bulk milk from farmers and then sell on to processors. They exploit economies of scale in collecting a large amount of milk and negotiate higher prices for their farmers. Nevertheless, there are many constraints inherent in this approach. These comprise the competition from a vibrant informal milk market, high operating costs, unenforced contractual agreements with farmers, and limited incentives for farmers to consistently deliver milk to cooperatives (Feed the Future, 2018). Seasonality of milk production, high overhead investment costs, and a lack of information about market participation represent barriers for farmers to participate in the dairy market (Burke et al., 2015).

2.3.3 Study context

The East Africa Dairy Development (EADD) project is one of the developmental interventions implemented in Kenya with an ultimate objective to resolve constraints facing dairy cooperatives and farmers, thus enhancing dairy production and market access for smallholder farmers. The EADD was mainly funded by the Bill & Melinda Gates Foundation and implemented in Kenya by Heifer International over the period 2008-2018. The project mobilized nearly 140,000 farmers to form 24 dairy cooperatives, eight of which were established as new cooperatives by the EADD. They are located in the Rift Valley and Central regions of Kenya, which are the major commercial milk producing regions of Kenya (Nassiuma and Nyoike, 2014).

[10] The remainder of the marketed milk is sold through traders, hotels, restaurants etc.

The project employed the hub approach, which comprises chilling plant(s), agro-vet store(s), and microfinance institution(s) owned by each dairy cooperative. The hub approach aimed at facilitating milk collection from farmers, bulking milk in chilling plants, passing the milk to processors, negotiating over milk prices and contractual agreements with processors, and providing dairy services (e.g., milk transportation, artificial insemination, silage, and other agrovet products) as well as non-dairy services (e.g., cash in advance, savings, and medical insurance) to farmers. The ultimate goal was to achieve sustainable and profitable cooperatives as well as to yield sustainable income for smallholder dairy farmers.

The EADD hub model depends on a checkoff system, where farmers deliver milk to their cooperative and access services against the delivered milk in the absence of immediate payments. Farmers receive a net income at the end of each month, depending on their milk delivery, after deducting the value of services received. This system was designed to mitigate cash constraints for dairy farmers as well as facilitate access to goods and services needed for dairy farming or households. In order to alleviate any potential cash constraints that farmers might encounter before receiving their monthly payments, the checkoff system was also combined with a cash-in-advance service. Through this service, cooperatives aimed for less interaction between farmers and informal traders, which can help maintain farmer loyalty to deliver milk (TechnoServe, 2008).

Similar to other settings,[11] the contractual agreements between farmers and cooperatives do not depend on a written contract; instead, it hinges on long-term relationships and trust between them (i.e., relational contracts). Farmers produce milk twice a day (morning and afternoon). On the basis of cooperative by-laws, farmers are supposed to sell their milk, after deducting home milk consumption, to their cooperatives. Casaburi and Macchiavello (2015) note that dairy farmers in Kenya tend to sell their morning milk to cooperatives and the reminder to informal traders. The literature documents two main reasons why farmers choose to deliver to informal traders, namely higher milk prices (Casaburi and Macchiavello, 2019) and unexpected health shocks to household members (Geng et al., 2017). In this paper, I generalize the latter by studying how mitigating cash constraints, regardless of the reason behind them, can strengthen the relational contracts between dairy farmers and cooperatives.

[11]See for example (Bernard et al., 2019)

2.4 Data

We exploit administrative data on 48,893 farmers, distributed unevenly across 14 dairy cooperatives in Kenya as shown in Figure 2.2.[12] These cooperatives originally supported by the EADD project. Figure 2.1 shows the number of farmers joining cooperatives over time. Female membership stands at 44 percent. We focus on farmers who joined before 2015 to avoid any confounded impacts associated with new members. We also exclude those who were registered as members, but never delivered any milk to their cooperatives.

Insert Figures 2.1 and 2.2 about here

The data cover daily milk transactions between dairy farmers and cooperatives over the period January-June 2015. The data include daily milk delivery (the amount of milk delivered in mornings and evenings, milk price, and transportation costs), daily services (the type of service, amount of money to be deducted), monthly income (gross milk income, net income, value of services deducted), transporters (whether a farmer transports milk through a transporter, when a transporter was assigned to a farmer, whether it is still active, previous transporters, transport cost). The data also contain farmer characteristics (registration date, gender, location, and whether a farmer uses cash or bank/cooperatives when dealing with their cooperative).

The two main outcome variables of interest are related to milk delivery to cooperatives. Specifically, whether a farmer delivers milk or not (extensive margin) and the amount of milk delivered (intensive margin). Both variables are consistent with the goal of the cash-in-advance service to strengthen the relational contracts between farmers and cooperatives through increasing milk delivery. Figure 2.3 depicts the amount of milk collected over the 2015-2018 period by the 14 cooperatives included in the sample as well as the amount of milk production in Kenya. These cooperatives handle about 10 percent of the milk production in Kenya. Both milk collection and milk intakes closely follow the same seasonal pattern. The high rainy season in Kenya extends from October to December/January. Consequently, farmers end up delivering more milk to cooperatives during these months as their production of milk increases. The opposite happens during the dry season, which extends into April.

Insert Figure 2.3 about here

[12]The data were obtained with the help and support of Heifer International.

We present summary statistics on farmer characteristics in Table 2.1. About 44 percent of the sample are women. As the sample includes only those who joined before 2015, the average membership with a cooperative is 2.5 years. About 33 percent of farmers deal in cash with their cooperatives. The rest use a bank account (29%), Savings and Credit Cooperatives (SACCOs) (26%), or M-PESA (12%),[13] through which they receive their milk payments from cooperatives. About 50 percent of farmers had a mobile phone when joining cooperatives. Only a few farmers received a loan from cooperatives. When it comes to milk transportation, nearly 17% of farmers used a regular transporter to deliver milk to cooperatives on their behalf. This facility entailed a cost of 0.013 USD per litre of milk, representing about 4% of the milk price received for each litre.

Insert Table 2.1 about here

Summary statistics on monthly milk transactions with cooperatives are presented in Table 2.2. Farmers deliver milk over 8 days per month on average. This reflects a likelihood of 25 percent that a farmer delivers milk to cooperatives on a specific day. Most of those who deliver milk do so once per day. Based on the fact that farmers milk their cows twice a day, storing milk at home is risky and costly. This provides suggestive evidence that these farmers deliver evening milk to informal traders. This is consistent with what was claimed in Casaburi and Macchiavello (2015). On average, the monthly amount of milk delivered is 49 litres. Conditional on milk delivery, the number of days of deliveries increases to 21 days per month, with an average of 130 monthly litres. This again supports the argument that these farmers deal with informal traders. There is a heterogeneity in milk delivery, which might reflect the fact there is a wide range of different herd sizes.[14]

Insert Table 2.2 about here

Net milk payments are based on the amount of milk delivered multiplied by the milk price within a specific month. The services deductions represent the amount of money paid for services received during a month. These include agrovet products, artificial insemination, and milk transportation. Net milk payments are gross payments after deductions for services. On average, farmers obtain

[13]M-Pesa is a mobile banking service that permits users to save and transfer money through their mobile phones.

[14]Secondary data from this project on 14,522 dairy farmers, who are currently members with our sample cooperatives, reveal that herd size ranges between 1-13 cows with a mean of 5. However, the average lactating herd size is more modest at 2.5 cows ranging between 0 to 8 cows.

14.6 USD as gross milk payments, pay 3.6 USD for services, and obtain 10.9 USD as net milk payments.

2.5 Empirical Strategy

This section introduces the cash-in-advance treatment. We then outline the econometric modelling to assess the impact of the cash-in-advance treatment on milk delivery. We then highlight self-selection concerns in the current study and how our identification strategy addresses these.

2.5.1 Cash-in-advance treatment

The treatment is whether a farmer obtained cash-in-advance. Nine out of fourteen cooperatives introduced this service in April 2015. The treatment group includes 701 farmers who availed of the cash-in-advance facility over April-June 2015 (**T**). Not all farmers received the treatment at the same time. Instead, they received the cash-in-advance when needed. The number of farmers who received the treatment was 182 farmers in April (**T1**), 257 in May (**T2**), and 262 in June (**T3**). The average of the cash-in-advance amount was between 5 to 10 percent of farmers' net milk income. There is no information about the reason behind the cash-in-advance treatment for each farmer. Some of the reasons emerging during the fieldwork include health expenses, funeral expenses, marriage expenses and school fees.

We define the control group in three different ways:

C1: The "not-yet-treated" farmers have not received the treatment at a specific time. This entails using only T2 and T3 as control when evaluating the impact of T1, and using only T3 as control when assessing the effect of T2. However, using the not-yet-treated farmers as a control group doesn't allow for measuring the effect of T3 as there are no other not-yet-treated farmers.

C2: The "never-treated" farmers from within cooperatives that offered the cash-in-advance service. There are 27,814 farmers belonging to this group. This group serves as a second control group for the 701 treated farmers together.

C3: The "never-treated" farmers from within cooperatives that did not introduce the cash-in-advance (placebo control group). There are 20,378 farmers under this category. This group serves as a third control group for the 701 treated farmers together.

Our preferred control group is the not-yet-treated group. The latter provides a more comparable group in terms of baseline characteristics compared to the never-treated control groups.[15] Table 2.3 reveals statistical differences between T, C2, and C3. It is evident that the treatment group is different when compared with C2 and C3 with respect to farmer characteristics and monthly milk transactions with cooperatives during baseline. For instance, about 13 percent of the treatment farmers previously received loans from cooperatives, where it is at most 3 percent among C2 and C3. Nevertheless, the percentage of treated farmers using banks when dealing with cooperatives is less. Instead, most of the treatment group uses mobile money (M-Pesa). The treatment group farmers also delivered a higher amount of milk and hence realized higher milk payments during the baseline period over January-March 2015. Milk prices offered to all farmers are generally uniform.

Insert Table 2.3 about here

Table 2.4 presents statistical differences between T1, T2, and T3. It appears that these three groups are largely comparable in terms of farmer characteristics and milk transactions at baseline. For instance, there are no differences between them regarding the payment method used for transactions with cooperatives. The same applies to the percentage of farmers who received loans within each group. There are no statistical differences in terms of the average litres of milk delivered by each group and the prices received from cooperatives per litre. However, there are some minor differences between these groups. For example, T1 farmers were more likely to be female compared to other groups. Although T3 were more likely to use transporters to deliver milk, the average amount of milk delivered is 20 litres lower compared to the rest. Nevertheless, the difference is not statistically significant. T3 also realised less gross and net milk income compared to the rest and the differences are statically significant. These differences in milk transactions are not statistically different when comparing T1 and T2.

Insert Table 2.4 about here

We acknowledge that the reason behind seeking cash-in-advance might have made farmers react differently regarding their milk delivery. For instance, if a farmer obtains the cash-in-advance to cover unexpected medical expenditures, they might react differently compared to a farmer who secures the cash-in-advance to pay for schooling fees for their children. Farmers might have been planning for the latter by delivering more milk even before receiving the cash-in-advance.

[15]We present results using the not-yet-treated group, along with results from the never-treated control groups as robustness checks.

2.5.2 Econometric Modelling

The unit of analysis is comprised of dairy farmers who are cooperative members. The goal is to assess the extent to which receiving the cash-in-advance treatment affects subsequent milk delivery to cooperatives. The treatment group includes those who received cash-in-advance. We acknowledge that the cash-in-advance treatment might be endogenous given that those who receive the treatment have different observable characteristics and potentially unobservables. In order to mitigate the bias that might arise in this context, we exploit the fact that the milk delivery data are available both before and after treatment for both the treatment and control groups. This enables estimation of the causal impact of the cash-in-advance treatment on milk delivery in a difference-in-differences (DiD) framework.

Our setting deviates from the canonical DiD set-up, where there are two time periods, treated units in the second period (treatment) and never treated units (control group). Instead, our framework includes different groups of farmers experiencing the treatment at various periods. A popular way to estimate an average treatment effect on the treated (ATET) in this case is to use a two-way fixed effects (TWFE) regression. The notion of the TWFE is to control for both group and time fixed effects to estimate a weighted average treatment effect of all 2x2 comparisons at different periods. Weights are determined by the size of the groups and the variance in the treatment dummy across each pair.

The TWFE requires two assumptions for an unbiased treatment effect, namely the common trend and the constant treatment effects assumptions. The common trend assumption is the weighted average of all 2x2 pairwise common trends in untreated potential outcomes. The TWFE regression entails an additional assumption which is the constant effects assumption. The latter implies that the treatment effect should be homogeneous over time, an unreasonable assumption in many settings that can lead to a biased estimate of the ATET.

Recent literature has developed alternative approaches to relax these assumptions. de Chaisemartin and D'Haultfoeuille (2022) provide a detailed discussion about recent literature on treatment effects in DiD with variation in treatment timing. For instance, Callaway and Sant'Anna (2021) present an alternative estimator that is robust to treatment effect heterogeneity and also allows for the parallel trends assumption after conditioning on observed covariates.

We first analyze the data using the traditional TWFE to provide an overview of the relationship between the cash-in-advance service and milk delivery. For robustness checks, we deploy the

Callaway and Sant'Anna (2021)'s approach (CS approach hereafter), which permits for more realistic identification assumptions, including conditional parallel trend and heterogeneous treatment effects over time. First, a unique feature of this approach is the flexibility to incorporate covariates into a staggered DiD approach to fulfill the conditional parallel trends assumption. Second, it does not require a fully randomized treatment adoption date, which is a stronger assumption than the conditional parallel trends assumption. Third, one of the main compelling features of this approach is the possibility to use the "not-yet-treated" farmers and/or the "never treated" farmers as a control group. We check the sensitivity of our results under these two scenarios, but we prefer using the "not-yet-treated" group as it affords a more comparable group for the treated group. This is particularly crucial for our context given the potential presence of self-selection in receiving the cash-in-advance treatment.[16] We now explain both approaches in turn.

TWFE Approach

In order to compute the impact of the cash-in-advance treatment using the traditional TWFE, we use the following specification:

$$\mathrm{Y}_{it} = \alpha_i + \gamma_t + \tau T_j \times Post_t + \; Z_{it}'\theta + \epsilon_{it} \tag{2.1}$$

Y_{it} is the milk delivery outcome for a farmer i in month t. α_i is farmer fixed effect. The use of farmer FE should mitigate potential time-invariant self-selection. γ_t time (year*month) fixed effect. $T_j = 1$ if a farmer i received cash-in-advance. $Post_t = 1$ if month t is in the post-treatment period. τ is the parameter of interest corresponding to the ATET of the cash-in-advance treatment on milk delivery. Z is a vector of control variables (e.g., gender and membership years).

CS Approach (Callaway and Sant'Anna, 2021)

We now explain the procedures of estimating group-time ATET of the cash-in-advance treatment using the CS approach. First, we deploy the inverse probability weighting (IPW) framework for the conditional common trends assumption.[17] We use the following assignment equation to

[16] One drawback of using the "not-yet-treated" farmers as a comparison group is that one can not estimate the group-time treatment effect for the last treated group in the analysis.

[17] We show results with and without the conditional trends assumptions for robustness. Roth et al. (2022) recommend using the conditional parallel trends assumption to increase the credibility of the corresponding treatment

estimate farmer propensity scores for receiving the treatment using a logistic regression model:

$$p_i(T_j = 1|X) = \alpha + X_i'\beta$$

$p_i(T_j = 1|X)$ is the propensity score of receiving the cash-in-advance treatment conditional on observables X_i. The observables include gender, days of membership with cooperatives, payment method used for transactions with cooperatives (e.g., cash, bank, SACCO, or M-PESA), whether the farmer received a loan from their cooperative, whether a farmer had a phone number when registering with cooperatives, and a set of cooperative fixed effects.

Second, the CS approach identifies the group-time ATET non-parametrically.[18] Following the inverse probability weighting (IPW) framework for the conditional common trend assumption,[19] we adapt the following CS specification to estimate the group-time ATET:

$$ATET(T_j, t) = \mathbb{E}\left[\left(\frac{G_{T_j}}{\mathbb{E}[G_{T_j}]} - \frac{\frac{p_{T_j}(X)C}{1-p_{T_j}(X)}}{\mathbb{E}[\frac{p_{T_j}(X)C}{1-p_{T_j}(X)}]}\right)(Y_t - Y_{T_j-1})\right] \tag{2.2}$$

$p_{T_j}(X) = P(G_{T_j} = 1|X_i, G_{T_j} + C = 1)$ is farmer i's propensity score (probability) to receive the cash-in-advance treatment conditional on observables X_i and being part of a not-yet-treated control group or never-treated groups. G_{T_j} is a binary variable that takes a value of one if a unit is first treated in period T_j. C is a binary variable that takes the value of one for never-treated or not-yet-treated units. The ATET expression is a weighted average of the difference in the outcome variable between the T_j group and the control group used.

Two observations are worth-mentioning. First, there are no restrictions on ATE heterogeneity across group or time. One can fix the a group T_j and vary time t to assess how ATEs change

effects. One reason is that the validity of the parallel trends assumption can be questionable in the presence of time-varying confounding factors. Another reason is the sensitivity of the parallel trends assumption to the functional form of the outcome of interest (e.g., the mean of outcome or the mean of its logarithmic transformation.).

[18]The CS approach relies on three main identification assumptions: limited treatment anticipation, conditional parallel trends, and matching overlap for all T_j and t. The first allows for treatment anticipation behaviours as long as we understand the anticipation horizon well. The second generalizes the traditional 2x2 DiD common trends assumption to include multiple treatment groups over different periods, allowing for conditioning on observables. The third ensures that for all T_j and t, the generalized propensity score is uniformally bounded by the value of one. The CS approach imposes two additional assumptions on the setting and data structure. The first states that once units become treated in period t, they do not forget the treatment in the following periods (i.e., the irreversibility of treatment). The second requires access to panel data. However, the CS approach generalizes the results to the case of repeated cross sections data.

[19]The results are comparable when using the doubly robust difference-in-differences approach proposed in Sant'Anna and Zhao (2020). This approach provides consistent estimates even if either (not both) the propensity score or outcome regression models are not correctly specified.

over time for that specific group. Alternatively, one can fix time and change a group to highlight the ATE heterogeneity across groups. Second, weights depends on the propensity scores and are normalized to sum to one. The notion is to up-weight those who are similar to the farmers in group T_j, and under-weight those who are not similar based on observables.

The final step of the CS approach is to summarize the group-treatment effects as follows:[20]

1) **Group-specific effect**: This summarizes the heterogeneity effects (if any) of whether farmers who availed of the cash-in-advance facility experienced different treatment effects than those treated later over their corresponding post-treatment periods. This includes the effects of following:

   - T1 over April through June,
   - T2 over May-June,
   - and T3 over June.

   The effect of T3 is not included in the case of using the not-yet-treated control group as there are no other not-yet-treated farmers to use a control group.

   The overall group-specific impact is an average of all group-treatment effects, weighted by the number of treated farmers within each group.

2) **Calendar time effect**: This relates to the heterogeneity in terms of the cumulative effect of participating in the treatment up to a time period t across groups that have obtained the treatment by time t. This covers the effect of the following:

   - April (i.e., the 1st period for T1),
   - May (i.e., the 2nd period for T1 and the 1st period for T2),
   - and June (i.e., the 3rd period for T1, the 2nd period for T2, and the 1st period for T3). The T3-related impacts are dropped when using the not-yet-treated group.

   The overall calendar time impact is an unweighted average of all calendar time effects.

3) **Event study effect**: This highlights how the effects vary with the length of exposure to the treatment. It provides a dynamic-effect of participating in the treatment for e post-treatment periods as well as e' pre-treatment periods.

[20]Robust standard errors are estimated for all group-treatment effects, but our results are the same when clustering at the cooperative level or using bootstrapped standard errors.

- The CS approach balances the treatment and control groups with respect to the *e* and *e'* periods, estimating $ATET(T_j, t)$ for only a fixed set of groups that share the same number of *e* and *e'* periods.
- In the case of using the not-yet-treated group, T1 has three pre-treatment periods and three post-treatment periods; T2 has four pre-treatment periods and two post-treatment periods; T3 is dropped because of no other not-yet-treated groups. This means that $ATET(T_j, t)$ captures the impacts of only T1 and T2 with three pre-treatment periods and two post-treatment periods.

  The overall event study impact is an unweighted average of all the dynamic effects.

2.5.3 Self-selection concerns

The combination of the TWFE and the CS approach mitigates potential self-selection concerns. First, fixed effects eliminate time-invariant unobserved farmer heterogeneity that might be correlated with the cash-in-advance treatment. Second, the DiD approach helps in removing any bias steaming from time-trend or permanent average differences in outcomes between the treatment and control groups. Finally, the most compelling argument is the flexibility of the CS to assess the robustness of the TWFE with DiD, to allow for conditional parallel trends assumption based on observables, and to estimate the ATET using either the ”never-treated” or ”not-yet-treated” control groups. As shown in Tables 2.3 and 2.4, using the ”not-yet-treated” control group provides a more comparable control group than the ”never-treated” groups.

The notion of using the ”not-yet-treated” group does not imply that the self-selection is absent. Instead, the assumption is that the self-selection is the same across these groups (T1, T2 and T3), and it is swept out when comparing differences. This assumption is plausible within the short time span of our study, which implies that the unobservables related to the treatment are less likely to change over time.

2.6 Results

Figure 2.4 presents the estimated impacts of the cash-in-advance treatment, along with the corresponding 95% confidence intervals, on milk delivery at the extensive and intensive margins using the CS event study framework. The estimates are based on the three types of control groups and the unconditional parallel trends assumption. The figure includes both the pre- and post-treatment periods. The impacts reveal how the average treatment effects vary by the length of exposure to the treatment. The post-treatment impacts suggest that milk delivery increased with the cash-in-advance treatment. In particular, the cash-in-advance treatment induced the monthly frequency of milk delivery to rise by at least six days. The same applies to the litres of milk delivered per month. It increased by at least 50 litres per month.

Insert Figure 2.4 about here

There are two things to notice about using the not-yet-treated group compared to the never-treated and placebo control groups. First, it gives us more conservative treatment effects. It reduces the dynamic treatment effects from 80-100 litres of monthly milk delivery (10-15 delivery days) to 50 litres (6 days). This suggest that using other control groups might upward-bias the treatment effects. Second, the results provide suggestive evidence against the parallel trends assumption. We cannot reject the null hypothesis that the pre-treatment estimates are jointly zero when only using the not-yet-treated control. These support the argument that the not-yet-treated control group provides a more comparable group and hence mitigates potential self-selection bias stemming from the use of other less comparable control groups.[21]

Fortunately, the CS approach permits assessing the sensitivity of results in the absence of the parallel trends assumption by allowing for a conditional parallel trends assumption. We use the following convariates for this purpose: gender, days of membership with cooperatives, payment method used for transactions with cooperatives (cash, bank, SACCO, or M-PESA), whether the farmer got a loan from their cooperative, whether a farmer had a phone number when registering themselves with cooperatives, and cooperative fixed effects.

Table 2.5 presents results based on the unconditional (Panel A) and conditional (Panel B) parallel trend assumptions. Columns 1 to 3 show the impacts on the number of delivery days, whereas columns 4 to 6 present the effects on the amount of milk delivered in litres. Results are based on using the three different control groups. There are two observations worthy of note about the results. First, the conditional parallel trends results broadly provide lower impacts. Second, and most importantly, the not-yet-treated group yields more conservative estimates when

[21] One should bear in mind that T3 (the treatment group that received the treatment in June) is dropped when using the not-yet-treated group as there are no other not-yet-treated farmers to use as a control group. As explained later, the exclusion of T3 in the case of using the not-yet-treated is not the reason behind their conservative estimates.

comparing absolute magnitudes, and relative to the corresponding control group averages.

Insert Table 2.5 about here

Our preferred specification is with the not-yet-treated control group conditional on the parallel trends assumption. The results reveal that the cash-in-advance treatment induces milk delivery to increase by about 5 litres per months, an increase of 40 percent compared to the control group mean. Similar effects were found on the intensive margin for milk delivery where the amount of milk delivered increased by 49 litres per month.

One concern regarding the comparability between the results using the not-yet-treated control group and those based on other control groups is that we drop T3 from the analysis when using the former. We re-run the analysis based on other control groups using only T1 and T2 to check whether the conservative results of the not-yet-treated control group are due to the drop of T3. Tables B.1 and B.2 present the corresponding treatment impacts. The results reveal that the impact gap between using the not-yet-treated control groups and other control groups is even bigger when dropping T3 from the analysis for the latter. This eliminates the concern that the conservative impacts obtained when using the not-yet-treated control groups are not driven by excluding T3 from the analysis.

Figures 2.5 and 2.6 reveal the group-time ATET and cumulative periods ATET on the frequency of milk delivery and litres of milk deliverers per month, respectively. It is evident there are heterogeneous treatment effects on milk delivery on the extensive and intensive margins across groups. The group-time treatment effects range between 3 and 7 days of milk deliveries and between 45 to 55 litres per month. When looking at how the cumulative impact evolves, we find that the impact on the number of days to deliver milk per month declines over time. The effect on the amount of monthly milk delivery exhibits an upward trend and then eventually drops.

Insert Figures 2.5 and 2.6 about here

2.6.1 Mechanisms

The increase in milk delivery caused by the cash-in-advance facility can be attributed to two complementary mechanisms: a monthly milk payment target and farmer loyalty. The first mechanism is that farmers have a monthly milk payment target based on their milk delivery to co-operatives. This implies that they adjust their milk delivery accordingly to reach this target.

This mechanism is concordant with Casaburi and Macchiavello (2019) who demonstrate that dairy farmers in Kenya target monthly savings based on milk deliveries to cooperatives to cover lumpy expenses. In addition, it also speaks to the work of Geng et al. (2017) which demonstrates that farmers balance their savings and cash needs through diversifying across different buyers to whom they are selling milk.

The second mechanism is related to farmer loyalty. The ultimate goal of the cash-in-advance is that farmers would presumably perceive having cash-in-advance when needed reflecting their cooperative taking an interest in their welfare and that of their households to mitigate unexpected cash constraints. This mechanism is consistent with the study of Casaburi and Macchiavello (2015), which present farmer loyalty as a paramount element in agricultural value chains where there is imperfect contract enforcement. It also aligns with Kramer and Kunst (2019) who recommend that aligning farmer preference on when to pay them can help improve contract enforcement through increasing farmer loyalty towards cooperatives. We now examine both mechanisms in turn.[22]

Monthly milk payments target

The notion is that farmers target specific monthly milk payments based on their milk delivery to cooperatives. Farmers obtain cash-in-advance amounts against their milk delivery. This amount is deducted from their gross milk payments at the end of each month. Through this mechanism, farmers would increase their milk delivery to compensate for the amount of the cash-in-advance, thereby reaching their initial targeted payments. If farmers follow this logic, their gross milk payments from cooperatives will rise due to increased milk delivery. However, their net milk payments should not change or vary slightly given their increase in milk delivery offsets the drop due to the cash-in-advance amount.

Table 2.6 contains estimates for the impact of the cash-in-advance treatment on gross and net monthly milk payments. Columns 1 through 3 report the effects on gross milk payments, whereas columns 4 to 6 present results on net milk payments. Again, the results suggest that the not-yet-treated group provides the most conservative treatment impacts. Focusing on results using this group, we find a significant increase in gross milk payments by at least USD 17 (about 56 percent compared to the control mean) and a slight increase in the net milk payments (about USD 3). Nevertheless, the increase in net milk payments is not statistically different from zero. This

[22] Our setting provides suggestive evidence regarding the complementary impacts of the two mechanisms but does not allow for distinguishing between them.

finding is consistent with the suggested mechanism for monthly milk payments. Once farmers claim the cash-in-advance facility, they increase milk delivery afterwards to reach their monthly target of milk income. However, the increase in gross milk payment goes beyond the amount of cash-in-advance, motivating a discussion of the farmer loyalty mechanism as an alternative explanation.

Insert Table 2.6 about here

Farmer loyalty towards cooperatives

Farmers will presumably interpret having the cash-in-advance when needed as their cooperative enhancing the welfare of their households to mitigate against unexpected cash constraints. This in turn will increase farmer loyalty towards cooperatives and hence milk delivery. If this is the case, we should expect the impact of the cash-in-advance to go beyond the month when a farmer obtained a cash-in-advance amount from their cooperative. Figure 2.7 presents the treatment effects by the length of exposure to the treatment using the CS event study and various control groups. Based on the results using the not-yet-treated group, it is evident that the treatment effect extends beyond the month of the treatment, with a a lower effect in the following month. The average treatment effect in the first month is an increase of USD 13 in gross milk payments, and USD 11 in the following month. This suggests that farmers might be becoming more loyal towards their cooperative, which explains why the impacts last beyond the month when they receive the treatment.

Insert Figure 2.7 about here

2.6.2 Heterogeneity

We now explore two dimensions of treatment effect heterogeneity, namely gender and payment methods for milk transactions with their dairy cooperatives. About 44 percent of members are women and nearly 33 percent of members deal with cooperatives in cash. As discussed in the following subsections, there are differences between farmers by gender and payment method, thus motivating an interest in exploring the differences in potential treatment effects across these groups of farmers.

Gender heterogeneity

Women represent about 44 percent of our sample frame. Descriptive statistics on baseline gender differences among the treated farmers are presented in Table 2.7. Women appear to have fewer membership years compared to men, but the difference is trivial (about 0.2 years). Gender differences are noticed in using SACCOs and M-Pesa when dealing with cooperatives. The percentage of women using M-Pesa is higher, while the opposite is the case for transactions through SACCOs. No differences are detected regarding transactions in cash and through banks. Both deliver on average the same number of days when it comes to milk delivery. However, women's monthly milk delivery is less (80 litres) than men's (97 litres). This yields lower gross milk payments- USD 27 compared to USD 32.5 for men. However, men tend to purchase more cooperative services (USD 3) than women (USD 0.85). This leads to a statically insignificant difference in net milk payments. Finally, although the cash-in-advance received by women is lower than men, women obtained the same cash-in-advance as a percent of milk payments (7 percent). These gender differences raise the question whether women react differently to the cash-in-advance treatment compared to men.

Insert Table 2.7 about here

We divide the sample by gender to assess the difference in treatment effects. This leaves us with almost an equal sub-sample of the not-yet-treated sample- 342 women and 358 men used the cash-in-advance facility. Table 2.8 presents the corresponding results using the not-yet-treated control group. The treatment impacts are still positive and statically significant using both sub-samples. Nevertheless, the effects on women are higher than for men. This finding is the case for both the absolute magnitude and as a percentage of the corresponding control groups. The treatment increased milk deliveries for women by nearly six days per month (57.8 litres), while only 3.7 days (39.8 litres) for men. However, these differences are not found to be statistically different.

Insert Table 2.8 about here

The increase in milk delivery was manifested in higher gross milk payments for both gender groups. Women experience larger impacts, as shown in Table 2.9. The gross income increased by at least USD 19.6 for women and USD 15.6 for men. However, the differential impacts on net milk income is not statistically distinguishable from zero, reinforcing the mechanism of monthly milk income target across gender.

Insert Table 2.9 about here

Payments method heterogeneity

As previously noted, nearly 33 percent of farmers deal in cash with their cooperatives. The remainder use bank accounts (29%), Savings and Credit Cooperatives (SACCOs) (26%), or M-PESA (12%) for transactions with their dairy cooperatives. Descriptive statistics on baseline characteristics of the treated farmers by payment method are presented in Table 2.10. We split our treated farmers into 201 farmers who use cash and the other 500 farmers who deal with cooperatives through a bank, SACCO, or M-PESA.

Insert Table 2.10 about here

Both groups are different along all baseline characteristics and transactions with the exception of gender and the amount of services both groups of farmers receive from cooperatives. The cash farmers have fewer years of membership than other farmers- an average of 1.7 for the former compared to 2.3 years for the latter. The likelihood that cash farmers have a phone when registering with cooperatives is lower than that of other farmers. The probability of cash farmers obtaining a loan from their cooperative or using the milk transport service is almost zero, whereas 18 percent of the other farmers received a loan, and 29 percent used a milk transporter to deliver milk to cooperatives on their behalf. Similarly, cash farmers deliver monthly on average 11 days more than the other farmers. This also applies to the monthly amount of milk delivered and milk payments made. Overall, this suggests that the cash farmers have a less established relationship with cooperatives or are more constrained than others. The differences above motivate looking at the heterogeneity impacts by payment method.

Results reveal treatment heterogeneity across payment groups. Table 2.11 presents the corresponding impacts on milk delivery using the not-yet-treated control group. The cash farmers react with higher milk delivery than others, in terms of magnitude and as a percentage of the corresponding control groups. This conclusion covers all specifications. Our preferred specification with conditional parallel trends indicates that the cash farmers increase their milk delivery on average by 72.6 litres (13.2 days), whereas from others it went up by 42.4 litres (2.8 days). These differences are statically different from zero. These differences, not surprisingly, extend to milk payments, as shown in Table 2.12. The monthly gross income of the cash farmers increased by USD 28, which is double the increase for the other farmers. The same applies to the net income of both groups. The foregoing suggests that being more constrained or having a less established relationship with cooperatives might have pushed farmers to use the cash-in-advance service more.

Insert Tables 2.11 and 2.12 about here

We finally explore heterogeneity in treatment effects when interacting gender and payment methods. Tables 2.13 and 2.14 present results based on these interactions. Women using cash show the highest treatment effects on milk delivery and payment outcomes. Nevertheless, the differences are not statistically significant compared with men in most cases where using cash for milk transactions with cooperatives.

Insert Tables 2.13 and 2.14 about here

2.7 Conclusion

The paper provides natural experimental evidence on the importance of the cash-in-advance service as a way of contract enforcement between farmers and cooperatives in the Kenya dairy sector. The analysis utilizes daily and monthly transactions between around 48,000 farmers and 14 cooperatives over the period covering January-June 2015. We document suggestive evidence that the cash-in-advance treatment increases milk delivery to cooperatives. There are two mechanisms through which this works, namely monthly milk payments target and farmer loyalty. The former indicates that farmers have a target of monthly income payments from cooperatives, and this provides a motive for why they increase their milk delivery in the event of obtaining cash-in-advance. Farmer loyalty is another complementary reason. Farmers presumably see the cash-in-advance service as a way of cooperatives softening the commitment device of monthly payments in order to help farmers meet their cash needs. We also provide evidence on the heterogeneous effects of the cash-in-advance in terms of gender and the payment method used for transactions between farmers and cooperatives.

This paper provides some additional insights on the existing literature. It complements the work of Casaburi and Macchiavello (2019) to provide evidence about how to optimally structure infrequent payments through providing a cash-in-advance service to meet lumpy expenses as well as cash constraints. It also answers a question raised in Ashraf et al. (2006) and John (2020) that commitment devices for savings may cause harm to individuals through liquidity/cash constraints.

By providing cash-in-advance, such commitment devices can be welfare-enhancing tools to increase savings as well as cover the adverse consequences of cash shocks. As the cash-in-advance service softens the infrequent payment scheme as a commitment device, our results inform recent empirical evidence that demonstrates soft savings commitment devices have greater impacts compared to hard commitment devices (Dupas and Robinson, 2013b).

An issue is the extent to which one can generalize these results to the whole dairy sector in Kenya as well as to other agricultural sectors. The analysis here is based on thousands of farmers and several cooperatives that collect about 10 percent of the overall milk production in Kenya. The locations of these farmers also cover the Rift Valley and Central regions of Kenya, which are the major commercial milk producing regions in Kenya. Most dairy cooperatives in Kenya work similarly to the cooperatives featured here in the sample. Such a setting suggests that generalising the results to the whole dairy sector in Kenya is plausible. This has not been possible in previous studies that typically depend on a smaller sample of farmers usually within just one cooperative.

The infrequent payments are also a common tool in other agricultural value chains and in labour market settings (Casaburi and Macchiavello, 2019). Softening infrequent payments as a commitment device by offering services similar to cash-in-advance might help farmers to realize the benefits of contract farming with balancing savings targets and cash considerations at the same time. The same applies for labour market settings. The combination of infrequent payments (monthly or semi-monthly) with a cash-in-advance service may help workers to balance between lumpy expenses and cash shocks, which may have an impact not only on their loyalty towards employers but also on their productivity.

2.8 Tables

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Table 2.1: Summary statistics of farmer characteristics

	(1) Observations	(2) Mean	(3) SD	(4) Min	(5) Max
Membership gender (=1 if female)	48,893	0.44	0.49	0	1
Cooperative membership (years)	48,893	2.58	1.68	0.04	6.46
Transactions method (=1 if in cash)	48,893	0.33	0.47	0	1
Transactions method (=1 if bank)	48,893	0.29	0.45	0	1
Transactions method (=1 if SACCO)	48,893	0.26	0.44	0	1
Transactions method (=1 if M-Pesa)	48,893	0.12	0.32	0	1
Phone (=1 if registered)	48,893	0.52	0.49	0	1
Loan (=1 if received from cooperatives)	48,893	0.025	0.16	0	1
Milk transport (=1 if by transporters)	48,893	0.17	0.37	0	1

Notes: This table shows descriptive statistics of farmer characteristics of 48,893 farmers from 14 cooperatives included in the analysis.

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Table 2.2: Summary statistics of monthly milk transactions

	(1) Observations	(2) Mean	(3) SD	(4) Min	(5) Max
Number of milk deliveries (days)	293,358	7.9	11.74	0	31
Amount of milk Delivery (litres)	293,358	49.1	122.5	0	1330
conditional on milk delivery					
Number of milk deliveries (days)	110,433	20.9	9.7	1	31
Amount of milk delivery (litres)	110,433	130.5	170.9	1	1330
Milk price per litre (USD)	110,433	0.33	0.02	0.28	0.39
Net milk payments (USD)	293,358	16.3	39.7	0	335.6
Services deductions (USD)	293,358	2.1	6.1	0	30.9
Net Milk Payments (USD)	293,358	14.4	37.0	0	335.6
conditional on milk delivery					
Gross milk payments (USD)	110,433	43.4	54.9	0.46	335.6
Services Deductions (USD)	110,433	5.1	8.8	0	30.9
Net milk payments (USD)	110,433	38.4	52.2	0	335.6

Notes: This table shows descriptive statistics of monthly transactions between 48,893 farmers and 14 cooperatives over January-June 2015.

Table 2.3: Summary statistics by treatment status

	(1)	(2)	(3)	(4)	(5)
	T	**C2**	**C3**	*P*-value	
				(T)-(C2)	(T)-(C3)
Panel A: Farmer Characteristics					
Membership gender (=1 if female)	0.49	0.45	0.42	0.05	0.00
Cooperative membership (years)	2.13	2.80	2.29	0.00	0.00
Transactions method (=1 if in cash)	0.29	0.37	0.28	0.00	0.54
Transactions method (=1 if bank)	0.04	0.12	0.12	0.00	0.00
Transactions method (=1 if SACCO)	0.20	0.20	0.41	0.97	0.00
Transactions method (=1 if M-Pesa)	0.47	0.31	0.19	0.00	0.00
Phone (=1 if registered)	0.62	0.52	0.53	0.00	0.00
Loan (=1 if received from cooperatives)	0.13	0.03	0.01	0.00	0.00
Milk transport (=1 if by transporters)	0.21	0.25	0.05	0.01	0.00
Panel B: Monthly Milk Transactions (average over the baseline period)					
Number of milk deliveries (days)	16.20	9.66	12.40	0.00	0.00
Amount of milk delivery (litres)	89.01	40.46	63.96	0.00	0.00
Milk price per litre (USD)	0.33	0.32	0.33	0.00	0.00
Gross milk payments (USD)	29.89	13.09	20.88	0.00	0.00
Services deductions (USD)	1.37	2.48	1.37	0.00	0.98
Net milk payments (USD)	28.66	10.88	19.67	0.00	0.00
Observations	701	27,814	20,378		

Notes: This table shows descriptive statistics of baseline farmer characteristics and milk transactions by treatment status. T represents the treatment group and includes 701 farmers who availed of the cash-in-advance facility over April-June 2015. C2 is the "never-treated" control group of farmers from within cooperatives offered the cash-in-advance service. C3 is the "never-treated" control group of farmers from within cooperatives that did not provide the cash-in-advance service. Panel A presents the corresponding statistics of farmer characteristics, and Panel B focuses on monthly milk transactions during the baseline period between January-March 2015.

Table 2.4: Summary statistics by not-yet-treatment status

	(1)	(2)	(3)	(4)	(5)
	T1	**T2**	**T3**	*P*-value	
				(T1)-(T2)	(T1)-(T3)
Panel A: Farmer Characteristics					
Membership gender (=1 if female)	0.58	0.42	0.49	0.00	0.07
Cooperative membership (years)	1.99	2.08	2.29	0.58	0.05
Transactions method (=1 if in cash)	0.34	0.27	0.27	0.10	0.10
Transactions method (=1 if bank)	0.04	0.03	0.05	0.68	0.71
Transactions method (=1 if SACCO)	0.16	0.22	0.21	0.10	0.18
Transactions method (=1 if M-Pesa)	0.46	0.48	0.48	0.72	0.75
Phone (=1 if registered)	0.66	0.63	0.58	0.53	0.09
Loan (=1 if received from cooperatives)	0.13	0.14	0.13	0.77	0.99
Milk transport (=1 if by transporters)	0.14	0.18	0.30	0.31	0.00
Panel B: Monthly Milk Transactions (average over the baseline period)					
Number of milk deliveries (days)	15.40	17.83	15.16	0.05	0.85
Amount of milk delivery (litres)	94.45	99.69	74.76	0.67	0.12
Milk price per litre (USD)	0.33	0.33	0.33	0.33	0.38
Gross milk payments (USD)	31.71	33.88	24.70	0.61	0.09
Services deductions (USD)	1.29	1.16	1.62	0.73	0.44
Cash-in-advance (USD)	1.51	1.91	2.40	0.08	0.00
Net milk payments (USD)	30.53	32.78	23.33	0.59	0.07
Observations	182	257	262		

Notes: This table shows descriptive statistics of baseline farmer characteristics and milk transactions by treatment groups. T1, T2, and T3 are farmers who used the cash-in-advance facility in April, May, and June, respectively. C2 is the "never-treated" control group of farmers from within cooperatives offered the cash-in-advance service. C3 is the "never-treated" control group of farmers from within cooperatives that did not provide the cash-in-advance service. Panel A presents the corresponding statistics of farmer characteristics, and Panel B focuses on monthly milk transactions during the baseline period between January-March 2015.

Table 2.5: Impact of cash-in-advance on milk delivery

Var	(1) Monthly milk delivery (days)	(2)	(3)	(4) Monthly milk delivery (litres)	(5)	(6)
Control group	Not-yet-treated	Never-treated	Placebo	Not-yet-treated	Never-treated	Placebo
Panel A: Unconditional parallel trends						
TWFE	5.86***	9.56***	11.05***	48.58***	85.15***	93.81***
	(0.73)	(0.49)	(0.49)	(8.79)	(6.6)	(6.62)
Group-specific effects (CS)	6.89***	8.49***	9.60***	49.10***	80.26***	85.27***
	(0.74)	(0.43)	(0.44)	(8.47)	(5.85)	(5.88)
Calendar time effects (CS)	6.08***	10.88***	12.42***	47.10***	81.36***	91.72***
	(0.81)	(0.53)	(0.53)	(8.51)	(6.87)	(6.85)
Event study (CS)	6.08***	10.08***	11.95***	49.32***	89.8***	100.73***
	(0.81)	(0.57)	(0.53)	(10.51)	(8.44)	(8.42)
Panel B: Conditional parallel trends						
TWFE	5.10***	8.44***	11.04***	49.20***	78.97***	93.70***
	(0.70)	(0.43)	(0.50)	(7.05)	(6.54)	(6.66)
Group-specific effects (CS)	5.10***	7.77***	9.59***	49.20***	75.88***	84.69***
	(0.70)	(0.41)	(0.45)	(7.05)	(5.80)	(5.93)
Calendar time effects (CS)	5.55***	9.35***	12.41***	48.54***	73.98***	91.82***
	(0.68)	(0.46)	(0.54)	(6.91)	(6.76)	(6.88)
Event study (CS)	5.10***	8.55***	11.94***	49.20***	81.69***	100.73***
	(0.70)	(0.51)	(0.58)	(7.05)	(8.35)	(8.42)
Control group mean	12.4	7.3	10.3	89	40.5	63.9
Number of treated farmers	700	700	700	700	700	700
Number of total farmers	700	28,514	21,079	700	28,514	21,079
Observations	4,200	171,084	126,474	4,200	171,084	126,474

Note: This table presents treatment effects on milk delivery. Results are based on the TWFE and the CS approaches. Panel A shows results using the unconditional parallel trends, whereas Panel B's results are based on the conditional parallel trends assumption. The "TWFE" row reports the coefficient on a post-treatment dummy variable from a TWFE regression (see Section 2.5.2 for more details). The "Group-Specific Effects" row summarizes average treatment effects by the timing of treatment. The "Calendar Time Effects" row reports the cumulative monthly treatment effects average. The "Event Study" row depicts average treatment effects by the length of exposure to the treatment. See Section 2.5.2 for more details about how to aggregate group-time effects into these effects. The Control group mean reflects the three months before treatment over January-March 2015. The last month is dropped from the analysis when using the not-yet-treated farmers as a control group. Robust standard errors in parentheses. $***$ p <0.01, $**$ p<0.05, $*$ p<0.1.

Table 2.6: Impact of cash-in-advance on milk payments

	(1)	(2)	(3)	(4)	(5)	(6)
Var	**Gross payments (USD)**			**Net payments (USD)**		
Control group	Not-yet-treated	Never-treated	Placebo	Not-yet-treated	Never-treated	Placebo
Panel A: Unconditional parallel trends						
TWFE	17.46***	29.43***	32.16***	3.52	14.76***	17.19***
	(3.00)	(2.21)	(2.21)	(2.77)	(2.04)	(2.04)
Group-specific effects (CS)	17.83***	27.99***	29.48***	4.05	13.34***	14.52***
	(3.01)	(2.03)	(2.04)	(2.82)	(1.88)	(1.89)
Calendar time effects (CS)	17.26***	28.43***	31.79***	3.1	12.75***	15.98***
	(2.86)	(2.28)	(2.28)	(2.62)	(2.08)	(2.08)
Event study (CS)	17.13***	30.27***	33.74***	3.18	15.63***	18.78***
	(3.47)	(2.68)	(2.67)	(3.22)	(2.48)	(2.47)
Panel B: Conditional parallel trends						
TWFE	18.40***	27.37***	31.95***	4.44	12.98***	17.15***
	(2.58)	(2.19)	(2.06)	(2.40)	(2.03)	(2.05)
Group-specific effects (CS)	18.40***	26.51***	29.13***	4.05	12.03***	14.25***
	(2.58)	(2.02)	(2.06)	(2.29)	(1.88)	(1.91)
Calendar time effects (CS)	18.19***	25.90***	31.70***	4.44	10.64***	16.07***
	(2.48)	(2.25)	(2.29)	(2.40)	(2.06)	(2.09)
Event study (CS)	18.40***	27.64***	33.63***	4.44	13.36***	18.86***
	(2.58)	(2.65)	(2.69)	(2.4)	(2.46)	(2.48)
Control group mean	29.9	13.09	20.88	28.7	10.9	19.7
Number of treated farmers	700	700	700	700	700	700
Number of total farmers	700	28,514	21,079	700	28,514	21,079
Observations	4,200	171,084	126,474	4,200	171,084	126,474

Note: This table presents treatment effects on milk payments. Results are based on the TWFE and the CS approaches. Panel A shows results using the unconditional parallel trends, whereas Panel B's results are based on the conditional parallel trends assumption. The "TWFE" row reports the coefficient on a post-treatment dummy variable from a TWFE regression (see Section 2.5.2 for more details). The "Group-Specific Effects" row summarizes average treatment effects by the timing of treatment. The "Calendar Time Effects" row reports the cumulative monthly treatment effects average. The "Event Study" row depicts average treatment effects by the length of exposure to the treatment. See Section 2.5.2 for more details about how to aggregate group-time effects into these effects. The Control group mean reflects the three months before treatment over January-March 2015. The last month is dropped from the analysis when using the not-yet-treated farmers as a control group. Robust standard errors in parentheses. $***$ p <0.01, $**$ p<0.05, $*$ p<0.1.

Table 2.7: Summary statistics by gender

	(1) Women	(2) Men	(3) t-test	(4) *P*-value (Women)-(Men)
Panel A: Farmer Characteristics				
Cooperative membership (years)	2.03	2.23	-0.20	0.09
Transactions method (=1 if in cash)	0.29	0.28	0.01	0.88
Transactions method (=1 if bank)	0.04	0.03	0.01	0.47
Transactions method (=1 if SACCO)	0.15	0.25	-0.09	0.00
Transactions method (=1 if M-Pesa)	0.51	0.44	0.07	0.05
Phone (=1 if registered)	0.60	0.64	-0.04	0.30
Loan (=1 if received from cooperatives)	0.13	0.13	-0.01	0.75
Milk transport (=1 if by transporters)	0.22	0.21	0.01	0.74
Panel B: Monthly Milk Transactions (average over the baseline period)				
Number of milk deliveries (days)	15.94	16.44	-0.50	0.61
Amount of milk delivery (litres)	80.33	97.28	-16.95	0.08
Milk price per litre (USD)	0.33	0.33	0.00	0.12
Gross milk payments (USD)	27.09	32.55	-5.46	0.09
Services deductions (USD)	0.85	3.02	-2.17	0.00
Services deductions (USD)	0.76	1.95	-1.18	0.00
Net milk payments (USD)	26.38	30.84	-4.45	0.16
Observations	342	359		

Notes: This table shows descriptive statistics of baseline farmer characteristics and milk transactions by gender. Panel A presents the corresponding statistics of farmer characteristics, and Panel B focuses on monthly milk transactions during the baseline period between January-March 2015.

Table 2.8: Impact of cash-in-advance on milk delivery by gender

	(1)	(2)	(3)	(4)
Var	**Monthly milk delivery (days)**		**Monthly milk delivery (litres)**	
Not-yet-treated control group	Women	Men	Women	Men
Panel A: Unconditional parallel trends				
TWFE	7.03***	4.58***	63.74***	33.39***
	(0.99)	(1.09)	(12.80)	(11.72)
Group-specific effects (CS)	6.08***	3.89***	61.47***	36.83***
	(0.96)	(1.05)	(11.45)	(12.42)
Calendar time effects (CS)	7.81***	5.83***	62.10***	31.39***
	(0.99)	(1.13)	(12.9)	(9.97)
Event study (CS)	7.21***	4.68***	67.72***	28.68***
	(1.06)	(1.28)	(14.91)	(13.86)
Panel B: Conditional parallel trends				
TWFE	5.93***	3.72***	57.84***	39.82***
	(0.97)	(1.02)	(9.76)	(10.19)
Group-specific effects (CS)	5.93***	3.72***	57.84***	39.82***
	(0.97)	(1.02)	(9.76)	(10.19)
Calendar time effects (CS)	5.98***	4.56***	57.82***	36.80***
	(0.959)	(1.01)	(9.78)	(8.9)
Event study (CS)	5.93***	3.72***	57.84***	39.82***
	(0.98)	(1.02)	(9.76)	(10.19)
Control group mean	12.3	12.7	80.3	97.4
Number of treated farmers	358	342	358	342
Number of total farmers	358	342	358	342
Observations	2,148	2,052	2,148	2,052

Note: This table presents treatment effects on milk delivery by gender. Results are based on the TWFE and the CS approaches. Panel A shows results using the unconditional parallel trends, whereas Panel B's results are based on the conditional parallel trends assumption. The "TWFE" row reports the coefficient on a post-treatment dummy variable from a TWFE regression (see Section 2.5.2 for more details). The "Group-Specific Effects" row summarizes average treatment effects by the timing of treatment. The "Calendar Time Effects" row reports the cumulative monthly treatment effects average. The "Event Study" row depicts average treatment effects by the length of exposure to the treatment. See Section 2.5.2 for more details about how to aggregate group-time effects into these effects. The Control group mean reflects the three months before treatment over January-March 2015. The last month is dropped from the analysis when using the not-yet-treated farmers as a control group. Robust standard errors in parentheses. $***$ p <0.01, $**$ p<0.05, $*$ p<0.1.

Table 2.9: Impact of cash-in-advance on milk payments by gender

	(1)	(2)	(3)	(4)
Var	**Gross milk payments (USD)**		**Net milk payments (USD)**	
Not-yet-treated control group	Women	Men	Women	Men
Panel A: Unconditional parallel trends				
TWFE	20.79***	14.17***	5.64	1.5
	(4.10)	(4.32)	(3.79)	(3.99)
Group-specific effects (CS)	19.97***	15.60***	5.13	2.88
	(3.69)	(4.72)	(3.42)	(4.43)
Calendar time effects (CS)	20.73***	13.54***	5.4	0.63
	(4.17)	(3.60)	(3.86)	(3.19)
Event study (CS)	21.70***	12.00***	6.4	-0.32
	(4.71)	(4.91)	(4.37)	(4.49)
Panel B: Conditional parallel trends				
TWFE	19.68***	16.80***	4.48	4.01
	(3.22)	(4.02)	(2.96)	(3.83)
Group-specific effects (CS)	19.68***	16.80***	4.1	4.02
	(3.22)	(4.02)	(4.59)	(3.83)
Calendar time effects (CS)	19.70***	15.61***	4.48	2.77
	(3.23)	(4.42)	(2.96)	(3.17)
Event study (CS)	19.68***	16.8***	4.48	4.02
	(3.22)	(4.02)	(2.95)	(3.83)
Control group mean	27	32.5	26.4	30.8
Number of treated farmers	358	342	358	342
Number of total farmers	358	342	358	342
Observations	2,148	2,052	2,148	2,052

Note: This table presents treatment effects on milk payment by gender. Results are based on the TWFE and the CS approaches. Panel A shows results using the unconditional parallel trends, whereas Panel B's results are based on the conditional parallel trends assumption. The "TWFE" row reports the coefficient on a post-treatment dummy variable from a TWFE regression (see Section 2.5.2 for more details). The "Group-Specific Effects" row summarizes average treatment effects by the timing of treatment. The "Calendar Time Effects" row reports the cumulative monthly treatment effects average. The "Event Study" row depicts average treatment effects by the length of exposure to the treatment. See Section 2.5.2 for more details about how to aggregate group-time effects into these effects. The Control group mean reflects the three months before treatment over January-March 2015. The last month is dropped from the analysis when using the not-yet-treated farmers as a control group. Robust standard errors in parentheses. $***$ p <0.01, $**$ p<0.05, $*$ p<0.1.

Table 2.10: Summary statistics by payment method

	(1) Cash (C)	(2) Bank, SACCO, M-Pesa (N)	(3) t-test (C)-(N)	(4) *P*-value
Panel A: Farmer Characteristics				
Membership gender (=1 if female)	0.49	0.49	0.01	0.88
Cooperative membership (years)	1.66	2.32	-0.66	0.00
Phone (=1 if registered)	0.42	0.70	-0.28	0.00
Loan (=1 if received from cooperatives)	0.01	0.18	-0.17	0.00
Milk transport (=1 if by transporters)	0.01	0.29	-0.28	0.00
Panel B: Monthly Milk Transactions (average over the baseline period)				
Number of milk deliveries (days)	7.69	19.62	-11.93	0.00
Amount of milk delivery (litres)	24.82	114.81	-89.99	0.00
Milk price per litre (USD)	0.32	0.34	-0.02	0.00
Gross milk payments (USD)	7.87	38.73	-30.86	0.00
Services deductions (USD)	1.40	1.36	0.04	0.91
Net milk payments (USD)	6.82	37.44	-30.62	0.00
Observations	201	500		

Notes: This table shows descriptive statistics of baseline farmer characteristics and milk transactions by payment method. Panel A presents the corresponding statistics of farmer characteristics, and Panel B focuses on monthly milk transactions during the baseline period between January-March 2015.

Table 2.11: Impact of cash-in-advance on milk delivery by payment method

	(1)	(2)	(3)	(4)
Var	**Monthly milk delivery (days)**		**Monthly milk delivery (litres)**	
Not-yet-treated control group	Cash	Bank, SACCO, M-Pesa	Cash	Bank, SACCO, M-Pesa
Panel A: Unconditional parallel trends				
TWFE	11.7***	3.4***	67.4***	40.8***
	(1.4)	(0.8)	(17.3)	(10.1)
Group-specific effects (CS)	10.8***	5.4***	68.7***	41.2***
	(1.3)	(1.1)	(17.9)	(9.4)
Calendar time effects (CS)	12.7***	4.4***	68.8***	37.4***
	(1.4)	(0.8)	(15.7)	(10.2)
Event study (CS)	11.7***	3.7***	64.4***	43.5***
	(1.5)	(0.9)	(19.5)	(12.5)
Panel B: Conditional parallel trends				
TWFE	13.2***	2.8***	72.6***	42.4***
	(2.0)	(0.7)	(15.2)	(10.0)
Group-specific effects (CS)	13.2***	2.2***	72.6***	42.4***
	(2.0)	(0.8)	(15.2)	(9.3)
Calendar time effects (CS)	13.2***	3.5***	72.6***	38.5***
	(2.0)	(0.73)	(15.2)	(10.1)
Event study (CS)	13.2***	3.0***	72.6***	46.4***
	(2.0)	(0.82)	(15.2)	(12.4)
Control group mean	7.7	19.6	24.8	114.8
Number of treated farmers	201	500	201	500
Number of total farmers	201	500	201	500
Observations	1,206	3,000	1,206	3,000

Note: This table presents treatment effects on milk delivery by payment method farmers use to deal with their cooperatives. Results are based on the TWFE and the CS approaches. Panel A shows results using the unconditional parallel trends, whereas Panel B's results are based on the conditional parallel trends assumption. The "TWFE" row reports the coefficient on a post-treatment dummy variable from a TWFE regression (see Section 2.5.2 for more details). The "Group-Specific Effects" row summarizes average treatment effects by the timing of treatment. The "Calendar Time Effects" row reports the cumulative monthly treatment effects average. The "Event Study" row depicts average treatment effects by the length of exposure to the treatment. See Section 2.5.2 for more details about how to aggregate group-time effects into these effects. The Control group mean reflects the three months before treatment over January-March 2015. The last month is dropped from the analysis when using the not-yet-treated farmers as a control group. Robust standard errors in parentheses. $***$ p <0.01, $**$ p<0.05, $*$ p<0.1.

Table 2.12: Impact of cash-in-advance on milk payments by payment method

	(1)	(2)	(3)	(4)
Var	**Gross milk payments (USD)**		**Net milk payments (USD)**	
Not-yet-treated control group	Cash	Bank, SACCO, M-Pesa	Cash	Bank, SACCO, M-Pesa
Panel A: Unconditional parallel trends				
TWFE	25.7***	13.9***	8.2	1.4
	(6.3)	(3.3)	(5.9)	(3.0)
Group-specific effects (CS)	26.8***	14.2***	9.7	1.6
	(6.8)	(3.2)	(6.4)	(2.9)
Calendar time effects (CS)	26.4***	13.1***	8.6	0.4
	(5.8)	(3.2)	(5.3)	(2.9)
Event study (CS)	23.8***	14.4***	6.1	2.1
	(6.8)	(4.0)	(6.4)	(3.7)
Panel B: Conditional parallel trends				
TWFE	28.4***	14.2***	9.4	2.0
	(5.8)	(3.3)	(5.2)	(3.0)
Group-specific effects (CS)	28.4***	14.3***	9.4	2.1
	(5.8)	(3.1)	(5.2)	(2.9)
Calendar time effects (CS)	28.4***	13.2***	9.4	0.7
	(5.8)	(3.2)	(5.2)	(2.9)
Event study (CS)	28.4***	15.1***	9.4	3.2
	(5.8)	(3.9)	(5.2)	(3.6)
Control group mean	7.9	38.7	6.8	37.4
Number of treated farmers	201	500	201	500
Number of total farmers	201	500	201	500
Observations	1,206	3,000	1,206	3,000

Note: This table presents treatment effects on milk payments by payment method farmers use to deal with their cooperatives. Results are based on the TWFE and the CS approaches. Panel A shows results using the unconditional parallel trends, whereas Panel B's results are based on the conditional parallel trends assumption. The "TWFE" row reports the coefficient on a post-treatment dummy variable from a TWFE regression (see Section 2.5.2 for more details). The "Group-Specific Effects" row summarizes average treatment effects by the timing of treatment. The "Calendar Time Effects" row reports the cumulative monthly treatment effects average. The "Event Study" row depicts average treatment effects by the length of exposure to the treatment. See Section 2.5.2 for more details about how to aggregate group-time effects into these effects. The Control group mean reflects the three months before treatment over January-March 2015. The last month is dropped from the analysis when using the not-yet-treated farmers as a control group. Robust standard errors in parentheses. $***$ p <0.01, $**$ p<0.05, $*$ p<0.1.

Table 2.13: Impact of cash-in-advance on milk delivery by gender and payment method

Var	**Monthly milk delivery (days)**				**Monthly milk delivery (litres)**			
	Men		Women		Men		Women	
Not-yet-treated control group	Cash	Bank, SACCO, M-Pesa	Cash	Bank, SACCO, M-Pesa	Cash	Bank, SACCO, M-Pesa	Cash	Bank, SACCO, M-Pesa
Panel A: Unconditional parallel trends								
TWFE	10.04***	2.47*	12.78***	4.39***	52.93*	25.79	90.19***	54.25***
	(2.22)	(1.23)	(1.84)	(1.13)	(23.27)	(13.39)	(21.67)	(15.70)
Group-specific effects (CS)	9.89***	1.66	11.39***	3.73***	64.75*	26.62*	85.24***	54.11***
	(1.99)	(1.20)	(1.85)	(1.09)	(27.92)	(13.41)	(19.97)	(13.79)
Calendar time effects (CS)	11.15***	3.75***	13.64***	5.02***	52.40***	23.08	88.74***	50.95***
	(2.40)	(1.25)	(1.75)	(1.15)	(18.13)	(11.91)	(21.09)	(16.20)
Event study (CS)	9.18***	2.89*	13.14***	4.49***	35.2	26.75	95.96***	57.71***
	(2.63)	(1.45)	(1.95)	(1.21)	(22.51)	(17.06)	(24.77)	(18.47)
Panel B: Conditional parallel trends								
TWFE	10.19***	2.22	12.78***	4.34***	56.56*	21.46	94.63***	55.11***
	(2.29)	(1.18)	(1.84)	(1.09)	(22.64)	(13.44)	(21.36)	(15.71)
Group-specific effects (CS)	10.04***	1.44	11.39***	3.64***	67.68*	22.26	88.71***	55.11***
	(2.03)	(1.18)	(1.85)	(1.08)	(26.97)	(13.50)	(19.41)	(13.78)
Calendar time effects (CS)	11.12***	3.49***	13.64***	5.01***	55.15***	19.78	92.81***	51.56***
	(2.56)	(1.18)	(1.75)	(1.09)	(18.12)	(11.85)	(21.00)	(16.23)
Event study (CS)	9.47***	2.59	13.14***	4.48***	40.78	21.46	101.63***	58.68***
	(2.70)	(1.39)	(1.95)	(1.16)	(22.10)	(17.09)	(24.42)	(18.51)
Control group mean	12.1	18.3	12.5	18.3	76.2	148.5	65.4	122.5
Number of treated farmers	102	256	99	243	102	256	99	243
Number of total farmers	102	256	99	243	102	256	99	243
Observations	612	1,536	594	1,458	612	1,536	594	1,458

Note: This table presents treatment effects on milk delivery by gender and payment method farmers use to deal with their cooperatives. Results are based on the TWFE and the CS approaches. Panel A shows results using the unconditional parallel trends, whereas Panel B's results are based on the conditional parallel trends assumption. The "TWFE" row reports the coefficient on a post-treatment dummy variable from a TWFE regression (see Section 2.5.2 for more details). The "Group-Specific Effects" row summarizes average treatment effects by the timing of treatment. The "Calendar Time Effects" row reports the cumulative monthly treatment effects average. The "Event Study" row depicts average treatment effects by the length of exposure to the treatment. See Section 2.5.2 for more details about how to aggregate group-time effects into these effects. The Control group mean reflects the three months before treatment over January-March 2015. The last month is dropped from the analysis when using the not-yet-treated farmers as a control group. Robust standard errors in parentheses. $***$ p <0.01, $**$ p<0.05, $*$ p<0.1.

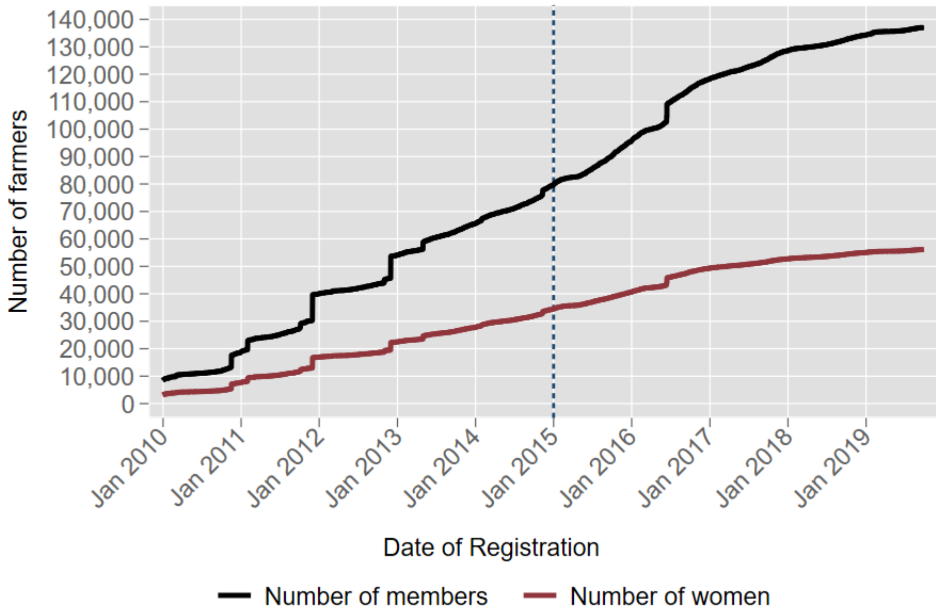
Table 2.14: Impact of cash-in-advance on milk payments by gender and payment method

Var	**Gross payments (USD)**				**Net payments (USD)**			
	Men		Women		Men		Women	
Not-yet-treated control group	Cash	Bank, SACCO, M-Pesa	Cash	Bank, SACCO, M-Pesa	Cash	Bank, SACCO, M-Pesa	Cash	Bank, SACCO, M-Pesa
Panel A: Unconditional parallel trends								
TWFE	23.6*	10.69*	31.79***	16.51***	6.86	-0.44	13.72*	2.64
	(9.54)	(4.69)	(7.39)	(4.78)	(8.88)	(4.33)	(6.85)	(4.44)
Group-specific effects (CS)	29.36*	10.81*	29.65***	16.67***	12.49	-0.41	12.43*	2.86
	(11.84)	(4.75)	(6.71)	(4.30)	(11.11)	(4.48)	(6.15)	(4.01)
Calendar time effects (CS)	22.45***	10.19*	32.05***	15.66***	5.74	-1.26	13.67*	1.69
	(7.24)	(4.15)	(7.43)	(4.89)	(6.58)	(3.65)	(6.89)	(4.54)
Event study (CS)	15.85	10.92	33.39***	17.17***	-0.72	0.32	14.9	3.33
	(8.57)	(5.92)	(8.24)	(5.60)	(7.86)	(5.42)	(7.71)	(5.18)
Panel B: Conditional parallel trends								
TWFE	24.88***	10.69*	33.23***	16.51***	8.18	-1.71	15.17*	2.84
	(9.31)	(4.69)	(7.30)	(4.78)	(8.63)	(4.44)	(6.71)	(4.43)
Group-specific effects (CS)	30.38***	10.81*	30.76***	16.67***	13.47	-1.77	13.64*	3.12
	(11.51)	(4.75)	(6.54)	(4.30)	(10.77)	(4.58)	(5.93)	(3.99)
Calendar time effects (CS)	23.42***	10.19*	33.39***	15.66***	6.82	-2.11	14.95*	1.81
	(7.21)	(4.15)	(7.41)	(4.89)	(6.52)	(3.72)	(6.82)	(4.54)
Event study (CS)	17.85*	10.92	35.25***	17.17***	1.37	-1.18	16.74*	3.55
	(8.38)	(5.92)	(8.14)	(5.60)	(7.65)	(5.57)	(7.55)	(5.18)
Control group mean	12.1	18.3	12.5	18.3	76.2	148.5	65.4	122.5
Number of treated farmers	102	256	99	243	102	256	99	243
Number of total farmers	102	256	99	243	102	256	99	243
Observations	612	1,536	594	1,458	612	1,536	594	1,458

Note: This table presents treatment effects on milk payments by gender and payment method farmers use to deal with their cooperatives. Results are based on the TWFE and the CS approaches. Panel A shows results using the unconditional parallel trends, whereas Panel B's results are based on the conditional parallel trends assumption. The "TWFE" row reports the coefficient on a post-treatment dummy variable from a TWFE regression (see Section 2.5.2 for more details). The "Group-Specific Effects" row summarizes average treatment effects by the timing of treatment. The "Calendar Time Effects" row reports the cumulative monthly treatment effects average. The "Event Study" row depicts average treatment effects by the length of exposure to the treatment. See Section 2.5.2 for more details about how to aggregate group-time effects into these effects. The Control group mean reflects the three months before treatment over January-March 2015. The last month is dropped from the analysis when using the not-yet-treated farmers as a control group. Robust standard errors in parentheses. $***$ p <0.01, $**$ p<0.05, $*$ p<0.1.

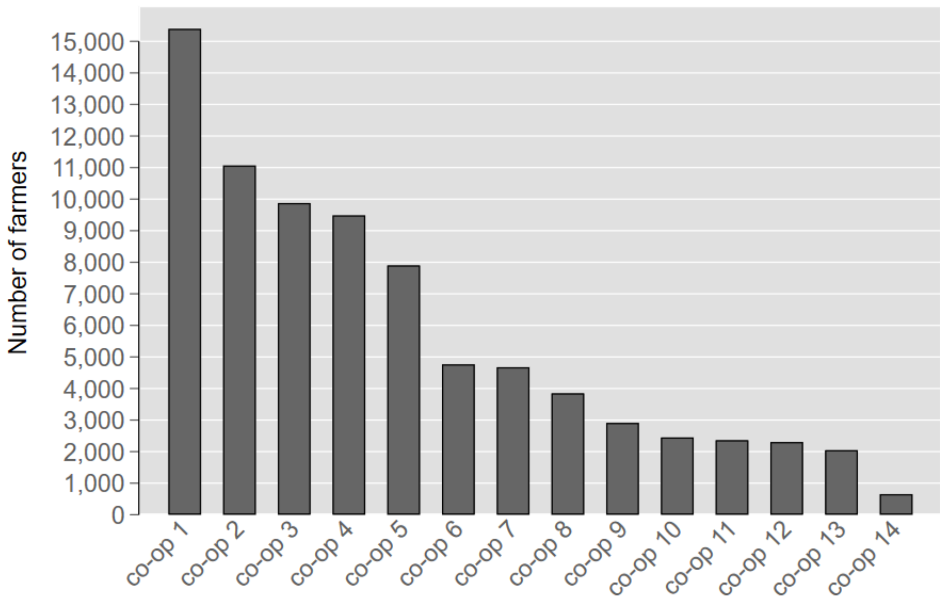
2.9 Figures

Figure 2.1: Number of farmers over time



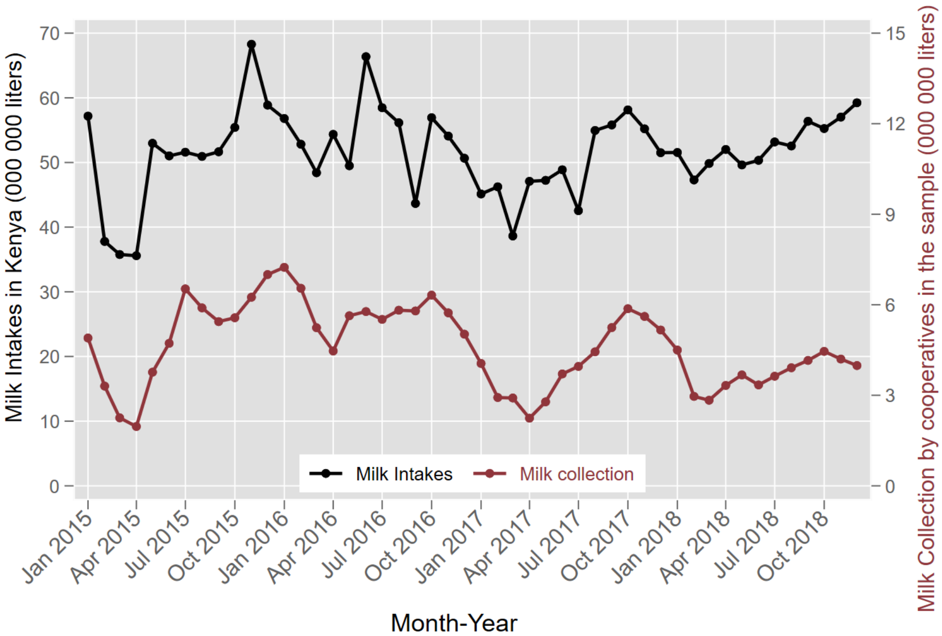
Note: This figure exhibits the number of farmers joining the 15 cooperatives in our sample over time.

Figure 2.2: Number of farmers per coop in the final sample



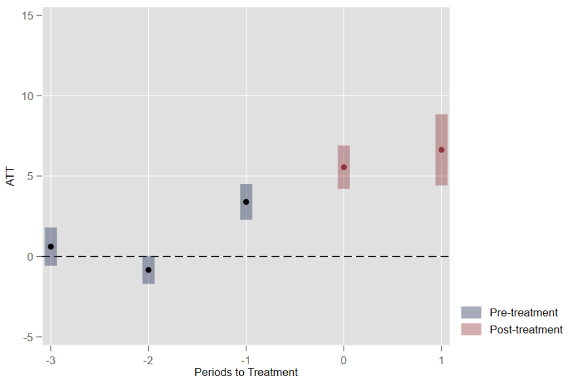
Note: This figure shows the number of farmers by cooperative as of end of 2018.

Figure 2.3: Milk intakes in Kenya and milk collection by cooperatives in the sample

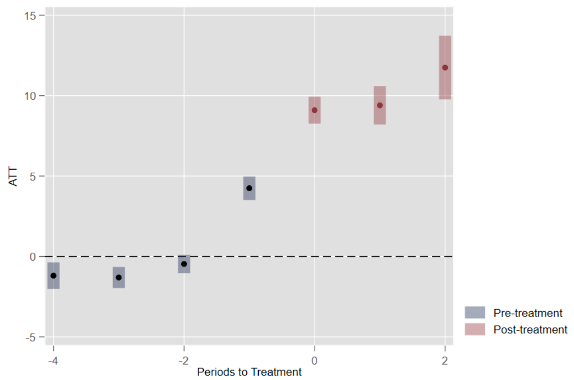


Note: This figure displays the amount of milk production in Kenya (represented by the black line and left y-axis) and the amount of milk collected by the 15 cooperatives in our sample (represented by the red line and right y-axis) over January 2015-December 2018.

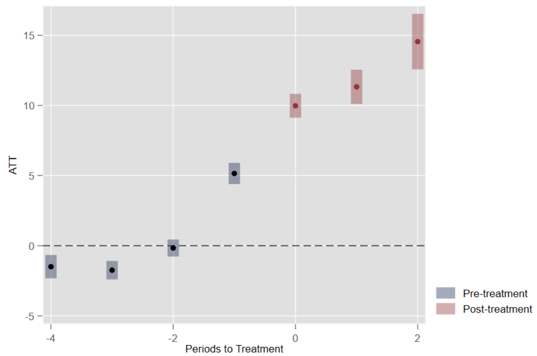
Figure 2.4: ATT on milk delivery by periods before and after treatment using an event study



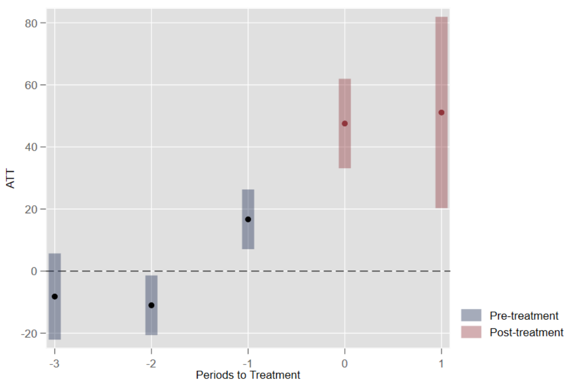
a) Using not-yet-treated control (days)



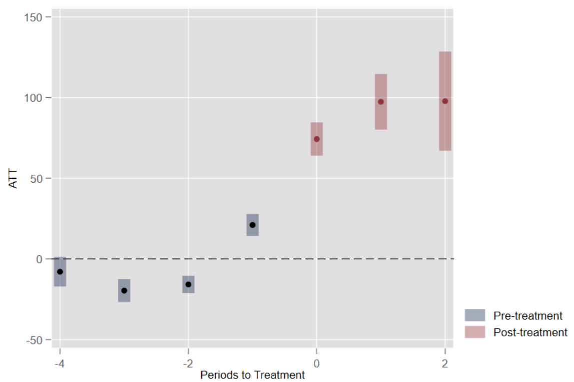
b) Using never-treated control (days)



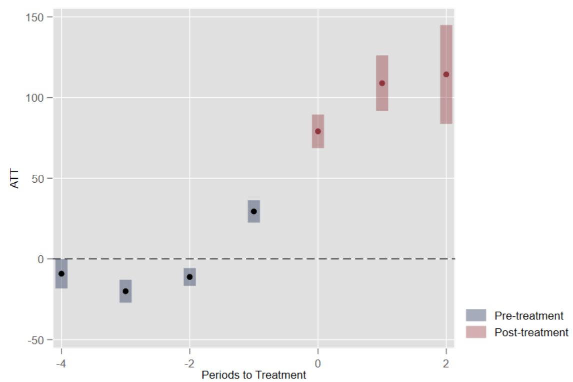
c) Using placebo control (days)



d) Using not-yet-treated control (litres)



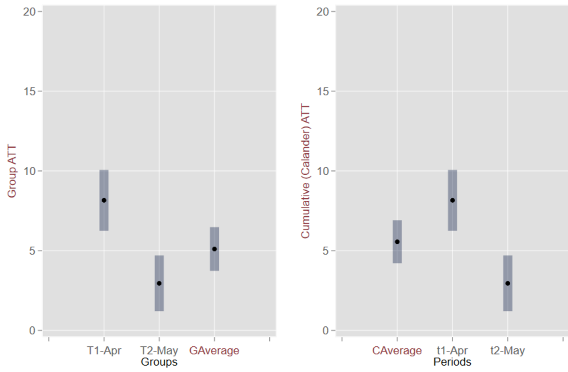
e) Using never-treated control (litres)



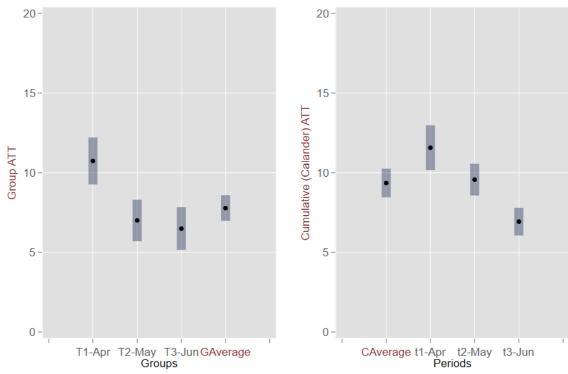
f) Using placebo control (litres)

This figure shows impacts on milk delivery using the CS event study approach. Results are based on three control groups: not-yet-treated, never-treated group from within cooperatives offered the cash-in-advance service, and never-treated group from cooperatives that did not provide the service (placebo control). Sub-figures a, b, c show impacts on days of milk delivery, and Sub-figures d, e, and f display effects on the amount of milk delivery in litres. The CS approach balances the treatment and control groups with respect to the *e* and *e'* periods, estimating group-time effects for only a fixed set of groups that share the same number of *e* and *e'* periods. In the case of using the not-yet-treated group, T1 has three pre-treatment periods and three post-treatment periods; T2 has four pre-treatment periods and two post-treatment periods; T3 is dropped because of no other not-yet-treated groups. This means that the group-time effect captures the impacts of only T1 and T2 with three pre-treatment periods and two post-treatment periods. See Section 2.5.2 for more details. Figures include ATT's point estimates along with the corresponding 95% confidence intervals.

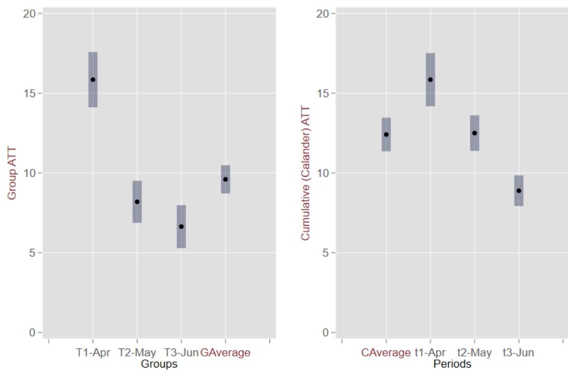
Figure 2.5: Group-time ATT and dynamic ATT on frequency of milk delivery



a) Using not-yet-treated control (days)



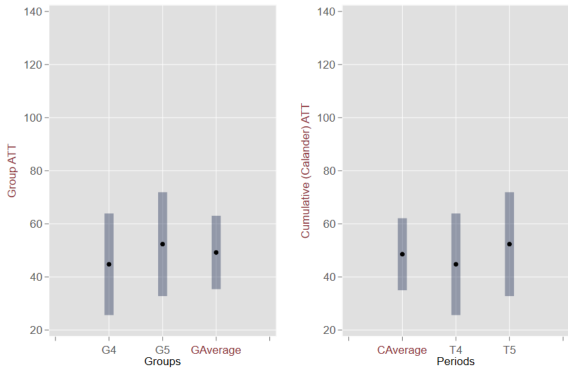
b) Using never-treated control (days)



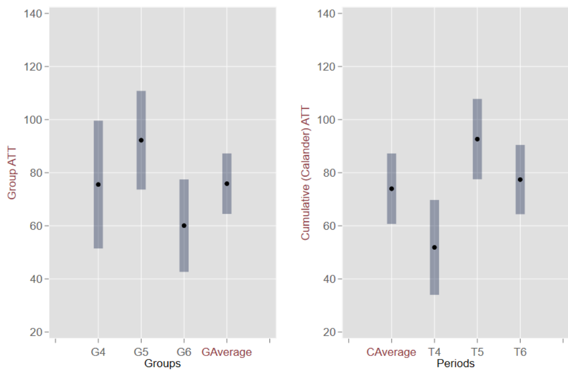
c) Using placebo control (days)

This figure shows heterogeneity impacts on days of milk delivery based on the CS by group and calendar time. The group ATTs reflect heterogeneity effects (if any) of whether farmers who participated in the cash-in-advance facility experienced different treatment effects than those treated later over their corresponding post-treatment periods. The calendar ATTs relate to the heterogeneity in terms of the cumulative effect of participating in the treatment till a time period t across groups that have obtained the treatment by time t. See Section 2.5.2 for more details. Results are based on using three control groups: the not-yet-treated group (Sub-figure a), the never-treated group from cooperatives that offered the cash-in-advance service (Sub-figure b), and the never-treated group from cooperatives that did not provide the service (Sub-figure c). Figures include ATT's point estimates along with the corresponding 95% confidence intervals.

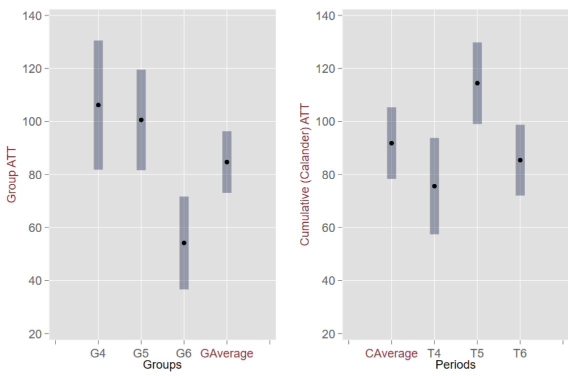
Figure 2.6: Group-time ATT and dynamic ATT on amount of milk delivery



a) Using not-yet-treated control (litres)



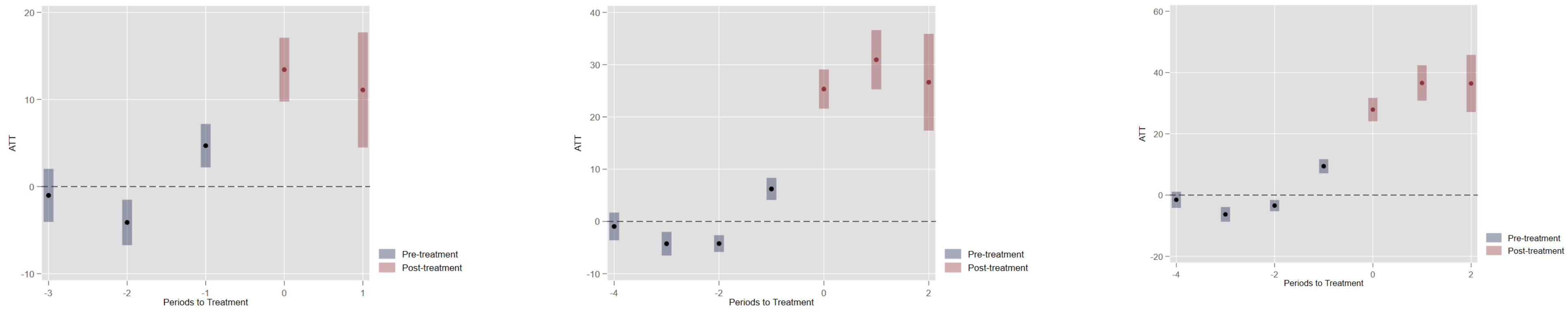
b) Using never-treated control (litres)



c) Using placebo control (litres)

This figure displays heterogeneity impacts on the amount of milk delivery in litres based on the CS by group and calendar time. The group ATTs reflect heterogeneity effects (if any) of whether farmers who participated in the cash-in-advance facility experienced different treatment effects than those treated later over their corresponding post-treatment periods. The calendar ATTs relate to the heterogeneity in terms of the cumulative effect of participating in the treatment till a time period t across groups that have obtained the treatment by time t. See Section 2.5.2 for more details. Results are based on using three control groups: the not-yet-treated group (Sub-figure a), the never-treated group from cooperatives that offered the cash-in-advance service (Sub-figure b), and the never-treated group from cooperatives that did not provide the service (Sub-figure c). Figures include ATT's point estimates along with the corresponding 95% confidence intervals.

Figure 2.7: ATT on milk payments by periods before and after treatment using an event study



a) Using not-yet-treated control (gross)

b) Using never-treated control (gross)

d) Using placebo control (gross)

This figure shows impacts on gross milk payments using the CS event study approach. Results are based on three control groups: not-yet-treated, never-treated group from within cooperatives offered the cash-in-advance service, and never-treated group from cooperatives that did not provide the service (placebo control). The CS approach balances the treatment and control groups with respect to the e and e' periods, estimating group-time effects for only a fixed set of groups that share the same number of e and e' periods. In the case of using the not-yet-treated group, T1 has three pre-treatment periods and three post-treatment periods; T2 has four pre-treatment periods and two post-treatment periods; T3 is dropped because of no other not-yet-treated groups. This means that the group-time effect captures the impacts of only T1 and T2 with three pre-treatment periods and two post-treatment periods. See Section 2.5.2 for more details. Figures include ATT's point estimates along with the corresponding 95% confidence intervals.

Chapter 3

Building and Managing Relationships with Farmers: Evidence from The Rwanda Coffee Sector

Abstract: Agricultural chains are often characterized by imperfect markets and poor contract enforcement. Under those circumstances, buyers and sellers benefit from long-term relationships based on mutual trust. We explore how to build and manage relationships with farmers in the context of the Rwandan coffee chain. Specifically, we co-design and evaluate a *Farmer Development Program* (FDP) in close partnership with one of the world's leading coffee multinationals (Partner). Based on a combination of experimental and RDD designs, we explore two questions: (1) What is the impact of the FDP on farmers? (2) Are relationship managers and communication strategies effective in establishing relationships with farmers? Results reveal that the FDP successfully affected relational practices, including the awareness and take-up of agricultural practices, training session attendance, trust towards the Partner, and coffee delivery.

JEL Codes: D22, L14,O12, Q13

Keywords: Relational Contracts, Farmer Development Program, Organizational Capabilities, Agricultural Upgrading, Rwanda

3.1 Introduction

Contract-enforcing institutions are essential to market development (Greif, 2008). Yet, in developing countries, markets are often characterized by imperfect contract enforcement. Imperfect contract enforcement might pose particularly severe challenges for agricultural value chains. Due to widespread failures in input and financial markets, farmers often tend to bundle the sale of agricultural products with access to services – such as inputs and loans – from their buyers (Bardhan, 1991). Many large buyers – particularly those in export-oriented agricultural chains – are seeking closer relationships with supply farmers, to foster quality upgrading, reliability of supply and compliance with certifications and sustainability standards (World Bank, 2019).

Relational contracts – defined as long-term informal arrangements sustained by the value of future relationships (Baker et al., 2002) – allow parties to alleviate contracting problems and often underpin transactions in these contexts. A relational contract is sustainable if the associated dynamic incentive compatibility constraints are satisfied – i.e., if the future value of the relationship is sufficiently high to deter short-term incentives to deviate. Recent research has calibrated and tested the implications of dynamic incentive compatibility constraints, thereby expanding our understanding of the conditions that sustain relational contracting in practice (see, e.g., Macchiavello and Morjaria (2015b), Blouin and Macchiavello (2019), Casaburi and Macchiavello (2019), Macchiavello and Miquel-Florensa (2019) and, for reviews focusing on agricultural chains and development, Michler and Wu (2020) and Macchiavello (2022)).

Although necessary, dynamic incentive compatibility constraints are not sufficient to establish successful relational contracts in practice. Indeed, a large management literature has emphasized the central role played by organizational capabilities to successfully deploy relational contracts both within and across organizational boundaries. For instance, parties need to coordinate on the cooperative equilibrium and build "clarity" about the sources of future value and expectations in the relationship (Gibbons and Henderson, 2012). Successfully deploying relational contracts along supply chains also critically hinges on developing adequate organizational capabilities (see, e.g., Sako and Helper (1998) and Helper and Henderson (2014)).[1] Little is known, however, about how successful relationships can be established, organized and deployed at scale to benefit farmers in a cost effective way. In a recently published paper, Macchiavello and Morjaria (2021) show that relational contracts between coffee washing stations (hereafter CWSs) and farmers are essential for

[1] Cajal-Grossi et al. (2022) provide a formal test of the importance of organizational capabilities in driving sourcing strategies in the context of the global apparel value chain.

market efficiency – benefiting both mills and farmers alike.[2]

Several challenges – including very small landholdings, low education, literacy and trust levels among farmers, and intense competition – make it very difficult to organize and sustain relational contracts with farmers in this – and similar – contexts. Against this backdrop, we borrow ideas from the supply-chain and marketing literature to co-develop, roll-out and evaluate an innovative Farmer Development Program (FDP) aimed at building, organizing, and managing relationships with farmers in the supply chain of our Partner.[3]

This paper evaluates the short-term impact of the roll-out of the FDP among 4,902 coffee farmers in the government's assigned catchment areas of four CWSs. The FDP aims to build long-term relationships with farmers and support them to upgrade their coffee farms, adopt better agriculture practices, and increase deliveries to the Partners' CWS. Eligible farmers were invited to attend three training sessions (two sessions on agricultural practices and one relationship-building session that outlined the benefits from, and the Partner's expectations of, the FDP). In addition, eligible farmers were given access to a call centre that would answer questions about coffee cultivation, harvest and sales, and services provided by the Partner. We also investigate how to maintain and organize relationships by implementing two organizational interventions: 1) a relationship manager experiment and 2) two communication experiments.[4]

The outcomes of interest cover relational practices between farmers and CWSs. Key indicators of these practices include coffee delivery, attendance of FDP sessions, call centre usage, and the take-up of good agricultural practices. Additionally, we measure the impact on farmer trust towards CWSs and farmer knowledge of the expectations and benefits associated with the FDP. We do not expect short-term impacts on coffee business investment. Given the perennial nature of coffee, a longer period is needed to detect the impact of good agricultural practices on replanting and on yields.

[2]On the one hand, CWSs rely on farmers to ensure reliable supply of large volumes of coffee and, increasingly so, to differentiate their offering to downstream coffee roasters in terms of traceability and sustainability requirements. On the other hand, farmers rely on the CWSs to sell their coffee cherries as the home-processing coffee entails additional costs and produces lower quality coffee that attracts significantly lower prices. Due to weak input markets and extension services – farmers also rely on CWSs for accessing inputs, training, and loans.

[3]We partner with one of the world's leading coffee sourcing companies (Partner) to understand the role of organizational capabilities in supporting relational contracts with farmers in the Rwanda coffee chain. Our Partner is the largest exporter of coffee from Rwanda, operating 26 mills (coffee washing stations (CWSs)) and directly sourcing from almost 30,000 coffee farmers across the country.

[4]The design of the FDP was informed by the success of the AAA Sustainable Quality Program in the Colombia Coffee chain – a supply-chain program that induced quality upgrading and farmer welfare increases (Macchiavello and Miquel-Florensa, 2019). However, the different nature of the Rwanda context requires a significant degree of adaptation to the local context.

Results reveal that the FDP successfully affected relational practices, including the awareness and take-up of agricultural practices, training session attendance, trust towards the Partner, and coffee delivery. Specifically, the FDP induces the awareness of good agriculture practices to increase by double relative to the control mean. This was manifested in an increase in the uptake of seedlings by eight percentage points. The FDP also increased the attendance at training sessions by 30 percentage points. It also enhanced trust in the CWS, on a scale between 1 (no trust) and 10 (trust fully), along several dimensions such as the provision of loans and agriculture training by at least 3 percent compared to the control mean. Finally, we provide suggestive evidence that the program effectively increased coffee delivery.

The remainder of this paper proceeds as follows. Section 3.2 provides the related literature and Section 3.3 presents the context and research design. Section 3.4 gives detailed information about the sample and data collection. The empirical identification strategy is outlined in Section 3.5, and results are presented in Section 3.6. Section 3.7 investigates the results using robustness checks and Section 3.8 provides conclusions.

3.2 Related Literature

Our paper contributes to four strands of literature: relational contracts, the evaluation of extension services programs, the role of technology in agricultural value chains, and the relational marketing literature.

Michler and Wu (2020) and Macchiavello (2022) review the relevant literature on relational contracts. Macchiavello and Morjaria (2021) show that relational contracting between coffee washing stations (CWSs) and farmers improves market efficiency and farmer welfare by facilitating trade in the Rwanda coffee chain.[5] The literature has focused on calibrating and testing the implications of dynamic incentive compatibility constraints that are key to relational contracting (see, e.g., Macchiavello and Morjaria (2015b), Blouin and Macchiavello (2019), and Casaburi and Macchiavello (2019)). Macchiavello and Miquel-Florensa (2019), for example, study the AAA Sustainable Quality Program in the Colombia Coffee chain – a supply-chain program that induced quality upgrading and farmer welfare increases. However, little is known about how successful relationships can be established, organized and deployed at scale cost-effectively - which is the key contribution of this paper.

[5]The authors conclude that the adaption of relational practices is positively correlated with firm efficiency and output quality.

Our paper also relates to the literature on the evaluations of extension services programs (see, e.g., Carter et al. (2013), Kondylis et al. (2017), Jones et al. (2022) and, for a review about technology adoption in developing countries, Magruder (2018)). Recent literature focuses on evaluating multi-faceted extension services programs (e.g., see Behaghel et al. (2020)). Corral et al. (2020), for instance, evaluate the impact of programs combining localized soil analyses, tailored input recommendations, extension services and an in-kind grant for agricultural technology adoption. Gignoux et al. (2022) complement an agricultural inputs subsidy program with an information intervention to set future expectations with farmers. Similar to these interventions, we bundle several components under the program and clarify the expectations and benefits of the FDP in the future. Our contribution, however, differs in both focus and context. We are interested in understanding organizational capabilities that foster relationships with farmers and develop relational contracts to support the delivery of such programs at scale. For example, our design hinges on the assumption that increased trust between farmers and CWSs could impact farmers' take-up of good agricultural practices and deliveries. In terms of context, we work in partnership with a large private company that sources from farmers to evaluate a buyer-driven FDP program. Most of the literature, instead, focuses on public or NGO driven extension services unrelated to sourcing decisions (Bandiera et al., 2021).

The FDP includes a call centre that enhances the Partner's ability to communicate with farmers. The project thus relates to studies on the impact of SMS, voice messages and videos on agriculture practices and yields. Previous literature assessed the impact of SMS, voice messages or videos on agriculture practices take-up and production. Casaburi et al. (2020) document mixed evidence on the effect of SMSs on yields using two RCTs in Rwanda, whereas Fabregas et al. (2020) find that SMS-based agricultural extension programs influenced the take-up of good farming practices based on six RCTs in Rwanda and Kenya. Along the same lines, there is evidence on the effectiveness of voice messages (Cole and Fernando, 2020) and videos (Campenhout, 2017) on farmer behaviour. We evaluate similar interventions within the context of a supply-chain farmer development program and explore their effectiveness in conjunction with, or as a substitute for, relationship managers. Our outcomes of interest also include relational practices as a proxy for the relationship strength between farmers and CWS.

Finally, we borrow ideas from different strands of marketing and supply-chain studies in designing and evaluating the FDP. The latter takes its inspiration from a large literature on supplier development programs in supply chain management (see, e.g., Hahn et al. (1990), Watts and Hahn

(1993), and Modi and Mabert (2007)). The organizational interventions, instead, are inspired by the literature in "relationship marketing" – marketing activities directed towards establishing, developing, and maintaining relational exchanges ((Dwyer et al., 1987; Morgan and Hunt, 1994)).[6] Early work by (Crosby et al., 1990) acknowledges the role of relationship managers as integral to building and maintaining relationships between buyers and sellers.[7] We build on this literature by examining the effect of a relational program, known as the FDP, on buyer-seller relational practices and provide experimental evidence on the relative effectiveness of organizational capabilities interventions, namely relationship managers and communication, on managing buyer-seller relationships. To the best of our knowledge, our intervention is the first to evaluate this mix of organizational strategies to manage relationships with farmers in a developing country.

3.3 Context and Research Design

The coffee sector plays a vital role in the Rwandan economy. It accounts for nearly 12%-15% of Rwanda's GDP and approximately 20% of the country export revenue (Macchiavello and Morjaria, 2021). Given the importance of the sector, the Government of Rwanda (GoR) developed extensive policies promoting coffee production. Starting in the 1990s the GoR increasingly liberalized their coffee markets by reducing barriers to trade, incentivizing private sector investments, and encouraging sales of higher quality coffee beans (Boudreaux, 2010). The number of coffee washing stations (CWSs), a tool used to clean coffee beans before processing and sale, and thus improving bean value, has also increased from 187 in 2009 to nearly 245 in 2015. The volume of fully washed coffee has almost doubled over the same period, reaching approximately 40 percent of total production (NAEB, 2016).

In regulating the coffee sector, the GoR has introduced two important policies, namely the zoning policy and farm gate price (Gerard et al., 2021). The zoning policy was introduced in 2016 with the aim of improving relationships between CWSs and farmers.[8] It created a monopsony

[6] Relationship marketing refers to all marketing activities directed towards establishing, developing, and maintaining successful relational exchanges. Common strategies include relationship managers, communication activities, and relationship programs.

[7] Relationship managers can directly influence the other parties' response to relationship-building activities by improving trust and commitment (Mullins et al., 2014). Relationship managers often are the face of the company. Replacing them can result in the need to reestablish relationships with customers and/or suppliers (Shi et al., 2017). Relationship programs act as an effective managerial strategy to increase trust in the relationship manager (Palmatier et al., 2006). Communication (particularly its frequency and the accuracy and relevance of the information transmitted) is also essential to the long-term success of relationships (Jap and Ganesan, 2000).

[8] The zoning policy also aimed at improving coffee traceability, limiting informal traders, and protecting CWSs from competition.

system that requires farmers to sell their coffee cherries to specific CWSs and oblige CWSs to buy from these farmers. With the farm gate price policy, the National Agricultural Export Development Board (NAEB) set a price per kilo of coffee cherry purchased by CWSs, taking into account production costs. The aim of the policy is to ensure a fair share is allocated to coffee farmers.

Despite the progress in the coffee sector in Rwanda, there are still several factors restricting both farmers and CWSs. Farmer challenges include small land sizes, unfair coffee price, information constraints, and poor land suitability. For instance, the average land sizes in Rwanda hover around 0.75 hectares, reducing the ability of Rwandan coffee farmers to exploit economies of scale in production (Dawson et al., 2016). Gerard et al. (2021) also posit that the gate farm price does not reflect the real production cost, pushing farmers away from coffee farming to other profitable crops. Farmers also lack information about good agricultural practices and the financial means to adapt them, hence the low productivity (Boudreaux, 2011). CWSs also encounter several challenges, leading to underutilized coffee washing stations. Macchiavello and Morjaria (2015a) attribute the latter to the lack of contract enforcement, inadequate access to working capital, poor managerial practices, and few external coffee buyers.

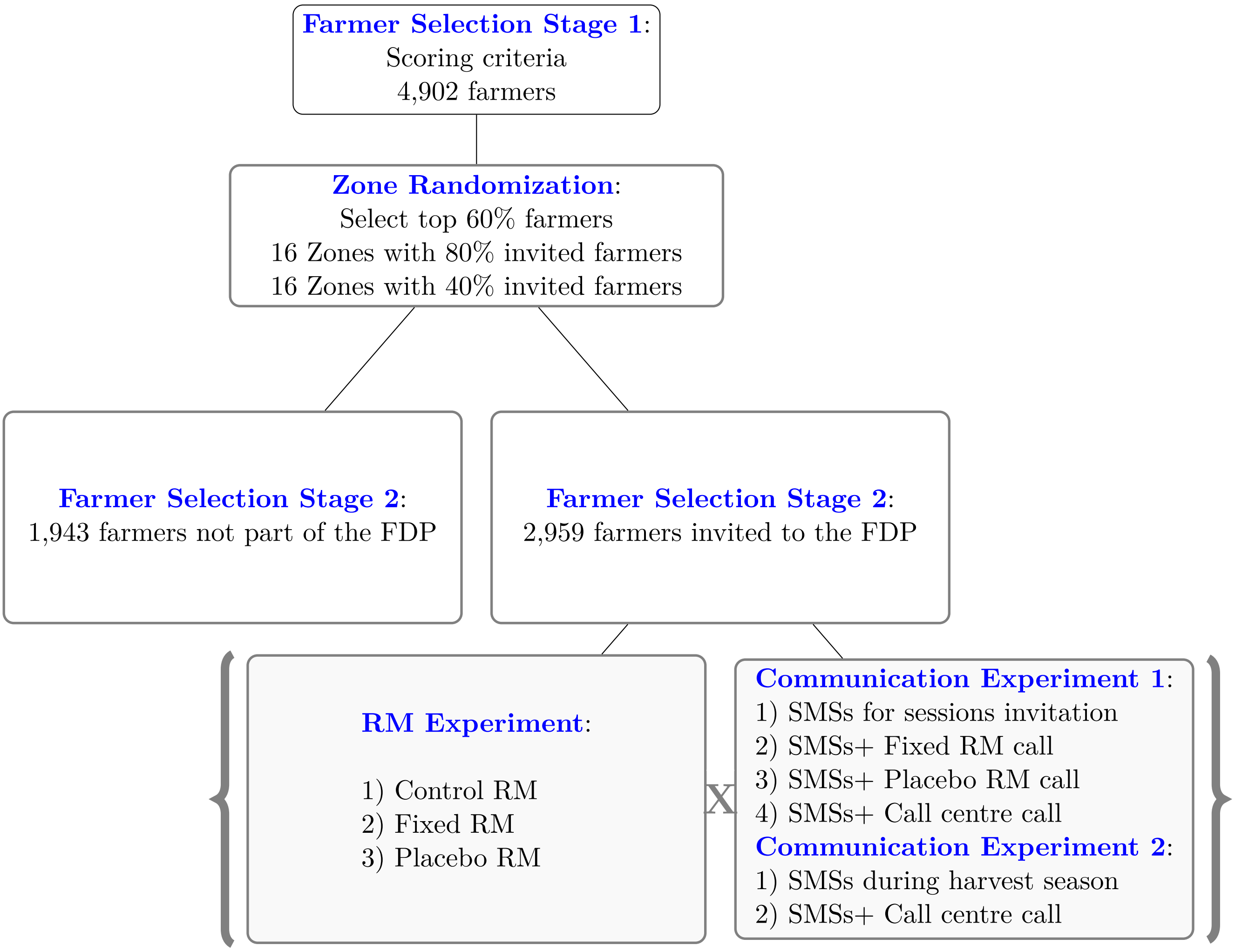
In order to address some of these constraints, especially those related to information constraints and the lack of contract enforcement mechanisms, we design and evaluate a *Farmer Development Program* (FDP) in the Rwanda coffee chain in close partnership with a leading coffee multinational (Partner). The Partner -as noted earlier the largest coffee exporter in Rwanda - directly sources coffee from nearly 30,000 farmers and operates 22 coffee washing stations (CWSs). The FDP became a critical component of the Partner's engagement with farmers in the Rwanda coffee chain as it transitions towards a fully traceable and digitized supply chain.

We co-designed, rolled-out and evaluated the FDP in four pilot CWSs.[9] Figure 3.1 presents the FDP as introduced to farmers. We initially conducted a comprehensive baseline survey of all farmers in the government-assigned catchment areas of the four CWSs. During the first stage, the baseline survey data was matched with comprehensive administrative data on deliveries to create a score for all farmers. The resulting score was used to select 60% of farmers for participation in the FDP. We describe below how the 60% of farmers was selected to conduct the evaluation. In the second stage, selected farmers were invited to the FDP. In the build up towards the 2022 harvest season (December 2021 to March 2022), the selected farmers were invited to three FDP training

[9]We acknowledge that selecting these four CWSs might have some implications for our results. If the selection was based on choosing the best (worst) performing CWSs, this might upward (downward) bias our results.

sessions (see details below) and given access to a call centre. Three cross-randomized organizational experiments were also implemented on the invited farmers to gain a deeper understanding of the organizational practices and capabilities required to build relationships with farmers: a relationship manager (henceforth, RM) intervention and two communication interventions. We now provide a detailed discussion on the FDP farmer selection, which is followed by the RM and communication experiments.

Figure 3.1: Farmer Development Program Design



Notes: This figure depicts the design of the Farmer Development Program (FDP).

3.3.1 FDP Farmers Selection

The selection of farmers eligible to participate in the FDP was implemented in two stages. First, we computed farmer scores using predetermined selection criteria (see Table C.1). The score is based on four categories, each contributing with a specific weight. All variables under each category are compiled from the baseline survey and administrative data of previous years' coffee delivery. The selection criteria - the variables to be included and the weights assigned to the score - were agreed in close collaboration with Partner. The first category includes variables on farmer identification which carries 30% of the score. These variables cover farmer information such as age, phone ownership, and information on farmer plot details and coffee delivery, if available. The relationship with CWS at baseline represents the second category contributing 25% to a farmer's score. Coffee delivery volume in previous years carries most of the weight within this category. The third scoring category relates to agriculture practices, with 25% of the scoring weight. Variables under this category include the number of coffee trees owned by farmers and whether they are implemented or willing to implement good agricultural practices. Finally, the scoring mechanism assigns 20% to education, numeracy, and personality traits.

Based on these scoring criteria, each farmer was assigned a normalized score between 0 and 1. Farmers were scored relative to each other within their corresponding CWS. Top farmers within each CWS received the highest score, while other farmers got a score relative to the highest. To determine the top scores for each scoring variable, we used the 95^{th} percentile instead of the maximum values to avoid outlier sensitivity. Lastly, we applied the corresponding scoring weights to assign each farmer a value between 0 and 1. Figure 3.2 displays the score distribution of 4,902 farmers in our sample frame.

Insert Figure 3.2 about here

Second, we selected 60% of farmers (2,959 out of 4,902) to participate in the FDP. Our approach to select the top 60% of farmers for the intervention is similar to Carter et al. (2021) who also targeted farmers who have a high potential to gain from being part of an input subsidy intervention in Mozambique. The FDP is also designed by taking inspiration from similar flagship programs in the industry (typically implemented in Latin and Central America) but applied to the more challenging context of Rwanda. For example, Macchiavello and Miquel-Florensa (2019) provides a quasi-experimental evaluation of the AAA Sustainable Quality Program in the Colombia Coffee Chain and finds that farmers with better plantations were more likely to join and benefit from the Program.[10]

In order to select the 60% of farmers, we randomized the percentage of farmers invited to the

[10]The choice of which farmers to invite on to the program was driven by a number of considerations. We agreed with the partner that, at least in this initial phase of the FDP roll-out, we would target farmers who were relatively more likely to engage with, and benefit from, the program. This was a natural choice given the long-term aims of the FDP, which are, inter alia, to facilitate farmers upgrading and achieve full traceability in the Partner's supply chain.

FDP within each zone.[11] Zones were allocated to either a low-intensity treatment arm, in which the 40% of farmers with the highest scores in the zone were invited (low-intensity zones), or a high-intensity treatment arm, in which the 80% of farmers with the highest scores were invited (high-intensity zones).[12] This procedure leads to a balanced allocation of farmers (i.e., 2,451 in each high-intensity and low-intensity zones).[13]

Conditional on selection, 2,960 farmers received a number of services and benefits from the Partner as part of the FDP program, including access to a call centre, and invitations to in-person training sessions. The call centre was installed to assist farmers with agricultural practices, answer questions, or discuss complaints. The training sessions included two sessions on good agricultural practices and one ”relationship-building” session to create clarity around the expectations and benefits of the FDP.

3.3.2 Organizational Capabilities Interventions

We are interested in understanding the role of organizational practices and capabilities in supporting the relationships with farmers. Specifically, We design and assess the effectiveness of two interventions: a relationship manager (RM) experiment and two communication experiments. These interventions were cross-randomized and conducted on the sample of farmers invited into the FDP. We describe both in turn.

RM Experiment

We examine the effectiveness of relationship managers (RM), as an organizational intervention, in building and organizing relationships with farmers. The RM was responsible for managing and delivering the in-person FDP training sessions. CWS staff (i.e., the managers and accountants) were hired and trained to become RMs. Farmers were randomly assigned to one of three treatment arms: Fixed RM, Control RM, and Placebo RM.

[11]Zones are not an administrative unit in Rwanda. Instead, we designed them to guarantee at least 100 farmers living at most 2 kilometers apart within each zone. The zones include either one or several adjoining villages. Villages represent the fifth administrative level in Rwanda after provinces, districts, sectors, and cells.

[12]We conducted the zone randomization as follows. First, we rank zones within each CWS by the number of farmers (see Figure C.1) and then pair zones within each CWS to minimize the differences in the distributions of farmer scores. We use the Kolmogorov-Smirnov equality-of-distributions test to pair zones conditional on minimizing the differences in farmer score distributions. This pairing procedure leaves us with 16-paired zones. Finally, we randomly assigned zones to either high-intensity or low-intensity categories within each pair.

[13]Table C.3 shows the balance table for baseline variables at zone-level. Individual t-tests and the joint overall significance F-test indicate balance on selected baseline variables between the two groups.

Farmers assigned to the (*Fixed RM*) category were invited to attend one RM introduction session, two agricultural sessions, and one relationship-building session with the same designated relationship manager.[14] Farmers in the (*Control RM*) condition were invited to attend the same two agricultural sessions and one relationship-building session. However, their sessions were led by rotating RM. They were also not invited to attend the RM introduction session. To disentangle the impact of meeting a designated *fixed RM* from the impact of attending an additional session, we included a *Placebo RM* category. Farmers were invited to attend the introduction session, and the same two agricultural sessions and one relationship building session. Similar, to the Control RM category, farmers meet with a different RM in each session. As such, the comparison between the Fixed RM and Placebo RM groups captures the impact of having a designated RM on relationship-building. By comparing Placebo RM and Control RM groups, we can infer the effect of the additional RM introduction session.[15]

The *agricultural sessions* were co-organized by agronomists with the objective to teach farmers agricultural techniques to improve productivity in coffee cultivation. The first session involved a training plot visit to demonstrate good agricultural practices concerning organic fertilizers, seedlings, and soil management. The second session was conducted in classrooms and covered topics such as regenerative agriculture, cropping, tiling, and lime application.

The *relationship-building session*'s objective was to train farmers about the importance of building sustainable relations between farmers and CWS, and increase clarity regarding expectations and potential benefits for both trading parties from such relationships (Macchiavello and Miquel-Florensa, 2019; Macchiavello and Morjaria, 2021). The session also introduced farmers to a supplier-tier system that will be launched after the end of the 2022 harvest season.[16] According to this system, farmers will be divided into "*gold*", "*silver*", and "*bronze*" tiers. Coffee delivery, traceability, engagement with the call centre, and take-up of best agriculture practices will represent the main criteria according to which farmers will be assigned to tiers. In turn, each tier gives farmers eligibility to a different services and support (e.g., top tier farmers include loans and labour support for stumping and replanting). The session offered a detailed explanation of the

[14]The objective of the *introduction session* is to introduce farmers to their assigned RM as a first step in order to initiate a relationship between farmers and CWSs.

[15]We do not use the Placebo group in the conventional sense, where they would receive a fake treatment with no potential impacts. However, in our context, placebo farmers attended four sessions; hence, there might be potentially additional effects.

[16]The supplier tier system is inspired by a large literature in supply chain management in manufacturing on supplier development programs (see, e.g., Hahn et al. (1990), Watts and Hahn (1993), and Modi and Mabert (2007)) and marketing literature (Lewis, 2004; Rust and Chung, 2006; Kivetz et al., 2006). We are planning to evaluate these aspects of the FDP in a follow-up project.

expectations and benefits of each tier category. The session also explained the expected behaviours (i.e., delivery of coffee and engagement with call centre) to move upwards in the tier system.

Table 3.2 reveals balance on the observable baseline characteristics between the three groups. The balance is achieved when testing for individual variable differences and jointly testing for overall differences across different treatment arms.

Insert Table 3.2 about here

Communication Experiments

Our second organizational intervention evaluates how to organize relationships with farmers using different communication strategies. We implement two sequential communication experiments. Before harvest season, we randomly assigned farmers to one of four communication methods when inviting them to the FDP training sessions: 1) SMS, 2) SMS and calls from the FDP call centre, 3) SMS and calls from a Fixed RM, and 4) SMS and calls from a Placebo (Rotating) RM. The SMS group serves as a control and includes 724 farmers who only received SMSs as an invitation (*SMSs*). Farmers assigned to the other three groups received the same SMS and a phone call before every FDP session. In total, 741 farmers received a call from RMs (*Fixed RM Call*), 743 farmers from placebo RMs (*Placebo RM Call*), and 751 farmers from the FDP call centre (*Call Centre*). This intervention covered invitations to two agricultural practices sessions and the relational-building session.[17] Random assignment to these groups was stratified within zones and RM treatment arms. The communication treatment arms were kept constant across sessions. Table 3.3 presents the balance across the four groups in terms of observable baseline characteristics.

Insert Table 3.3 about here

Next, we implemented a follow-up communication experiment during the harvest season. The experiment was conducted between April and July 2022. We randomly assigned the FDP farmers to receive: either 1) SMS or 2) SMS and calls from the FDP call centre. The "SMS" group serves as a control in which farmers (1,475) received a weekly SMS reminding them of delivering coffee to the Partner CWSs and associated benefits. The remaining farmers (1,484) received the same weekly SMS and a monthly call about the message. Appendix C include all the messages used for this experiment. We stratified the assignment to this intervention within zones and RM treatment

[17]We used both SMSs and calls to invite farmers to the initial RM introduction session.

arms. Table 3.4 shows balance across the two communication groups based on observable baseline characteristics.

Insert Table 3.4 about here

3.4 Data

We use three types of data in our analysis: 1) farmer survey data, 2) administrative data, and 3) FDP session data. We collected baseline data for the 4,902 farmers in our sample frame using a household questionnaire and plot visits. The questionnaire covered household characteristics, coffee and non-coffee farming, financial background, household assets, psychometric questions, and measures of relationship with CWS. Data collected during the agricultural plot visits included the size of plots and the number of coffee trees. We also collected midline data. It covers the same 4,902 farmers who participated in the baseline survey. We collect data on farmer perceptions of relationship with their CWS, agricultural practices adoption, and the knowledge of the FDP.[18]

Data on farmer coffee delivery to CWSs is recorded automatically in the Partner's data system at the time of delivery. The data include the amount of coffee delivered to CWS by farmers, a binary measure on the quality of coffee delivered, the price paid, the number and frequency of transactions, and whether a farmer received a transport premium. The data cover three recent harvest seasons, over the period from 2020 to 2022. The data are available for 18 CWSs, including the 4 CWSs where the FDP was rolled out (i.e., 14 non-FDP CWSs and 4 FDP CWSs).

We also collected data during the FDP training sessions. The sessions data cover session attendance, farmer engagement during the session (recorded by enumerators), RM performance, and a short farmer questionnaire. Attendance is an intermediate outcome, partly reflecting the willingness to engage in a relationship with CWS. Furthermore, we collect data on farmer engagement during all sessions, covering the topics and number of questions, comments, answers, and feedback a farmer makes. In addition, we ask farmers about their prior familiarity with the RM and knowledge of good agriculture practices before the corresponding training.

3.4.1 Outcomes

We focus on the following outcomes as relational practices between CWSs and farmers.

[18]The response rate during the baseline survey was 95%.

1) Knowledge of the FDP expectations/benefits: These are binary variables that take the value of one if a farmer is aware of the expectations and benefits from their relationship with CWSs, and 0 otherwise. These cover knowledge of FDP, the tier system, good agricultural practices, and Partner's expectations (e.g., the use of farmer card and coffee delivery).

2) Session attendance: These are binary variables that take the value of one if a farmer attended an FDP session, and 0 otherwise.

3) Call centre usage: This is a binary variable that takes value one if a farmer contacted the FDP call centre, and 0 otherwise. We also use the number of calls from a farmer as an outcome.

4) Trust towards CWSs: These are based on self-reported questions. The latter includes trusting CWS about providing loans, bonus payments, field visits, agricultural training, agricultural inputs, and trust towards the CWS manager. They all take a value between 1 (no trust) and 10 (complete trust).

5) Agriculture practices: These are binary variables that take the value of one if a farmer implemented one of the agriculture practices covered during the FDP sessions, and 0 otherwise. The practices include application of seedlings, organic fertilizers, pruning, shading trees, lime application, and tiling.

6) Coffee Delivery: This is a continuous variable indicating the amount of coffee delivered by farmers to CWSs during the 2022 harvest season between February and July. It is based on the administrative data on coffee delivery. In order to ensure results that are not sensitive to extreme values or data entry errors, the coffee delivery in kg is winsorized at the 99th percentile. We also exclude coffee delivery by collectors from the analysis.[19] We also measure coffee delivery on the extensive margin. The corresponding variable takes the value of zero if a farmer does not deliver coffee.

We consider the first four outcomes as short-run indicators, whereas the last two are more medium- and long-term. Therefore, the impacts on agricultural practices and coffee delivery might be realised later given the perennial nature of coffee farming. This is why we plan to conduct an endline survey and look into the FDP impacts on coffee delivery during the 2023 harvest season.

[19] Collectors are typically farmers that deliver coffee both from their plots and from other farmers as well.

Our outcomes differ from the relational practices between CWSs and farmers studied in (Macchiavello and Morjaria, 2021). The authors differentiate between relational practices during and after harvest based on existing relationships between CWSs and farmers.[20] Our focus instead is on relational practices when establishing those relationships in the first place. We are similar, however, with respect to the coffee delivery outcome.

3.5 Empirical strategy

The focus of this paper is threefold. First, we examine whether the FDP impacts the aforementioned outcomes. Second, we evaluate whether attending with a Fixed RM and attending an additional relationship-building session impacts relationship-building practices (RM experiment). Third, we assess whether calls, as opposed to SMSs, have an impact on farmers (Communication experiment). For the empirical analysis, we use a combination of quasi-experimental and experimental econometric methods. Next, we outline the research hypotheses, followed by the econometric modelling for the FDP selection, RM and communication experiments.

3.5.1 Hypotheses

We aim to test the following three research hypotheses:

Hypothesis 1 (FDP Selection): Selection into the FDP strengthens relational practices between farmers and CWSs. The comparison here will be between farmers invited to the FDP (FDP treatment group) and those who were not invited (FDP control group).

Hypothesis 2 (RM Experiment): Assignment to a Fixed RM session exerts additional effects. The comparison here will be between the Fixed RM versus Placebo RM groups. This experiment will also allow us to assess whether the introductory RM session has an additional effect by comparing the placebo RM and control RM groups.

Hypothesis 3 (Communication Experiments): Calls improves engagement with FDP compared to SMSs. The comparison will be between FDP farmers assigned to different communication categories.

[20]Their during-harvest practices cover access to inputs, extension services, and loans. The after-harvest practices include delivering coffee on credit to CWSs with first payment and the likelihood of receiving a second payment.

3.5.2 Impact of FDP

We begin by discussing the causal identification of the effect of the FDP on the relationship between farmers and CWSs. As mentioned above, our sample is split into two groups: the 60% of farmers who were above the corresponding thresholds within their zones (FDP treatment), and the remaining 40% farmers who scored below the thresholds (FDP control). This entails about 2,960 representing the FDP treatment groups and 1,940 farmers as the FDP control group.

Comparing outcomes between FDP and non-FDP farmers would not capture the causal impact of the FDP as the farmers are systematically different on the basis of the farmer scoring system design. We exploit the fact that all farmers were scored with respect to predetermined criteria and were not able to ex-ante manipulate their farmer scores to participate in the FDP. The notion is that those just above and below the threshold should not reveal any systematic differences of observable characteristics. This allows for the use of a sharp regression discontinuity design (RDD) framework to causally identify the impact of the FDP.

RDD Validity: We review the validity of the key assumptions of the RDD design in the context of the FDP. One main assumption is the exogeneity of the forcing/scoring variable used to allocate the farmers into the FDP treatment. First, in coordination with the Partner, the selection criteria used for farmer scores were chosen to prioritize the participation of farmers who were more likely to be amenable and respond positively to the FDP. Second, the percentage of invited farmers from each zone was randomly assigned (i.e., either 40% or 80% of farmers were invited). Third, the most compelling argument supporting the exogeneity assumption of scores relates to the fact that farmers were not aware *ex-ante* of the thresholds assigned to each zone, nor the existence of farmer scores.[21]

Furthermore, the exogeneity of the forcing scoring variable is statistically assessed using the McCrary test for manipulation of the assignment variable (Cattaneo et al., 2020). The null hypothesis is that there is no evidence of a discontinuity in the density of scores at the threshold. The absence of a continuity is potentially interpretable as statistical evidence of self-selection into the FDP treatment. The robust 'manipulation test' statistic value is found to be 1.24, with a p-value of 0.21. Therefore, there is no statistical evidence suggesting any systematic manipulation in the assignment variable in the FDP application. The same conclusion follows when splitting zones into two categories, either with 40% or 80% of invited farmers. The corresponding manipulation test

[21] The Partner has not assigned farmer scores in the past. Hence, the roll-out of a scoring exercise was new and unknown to the farmers as well as to staff members of the CWS.

plots are presented in Figure C.3.

Another key identifying assumption for the RD design refers to the absence of clustering around the scoring threshold used to determine the FDP farmers. There should be no systematic differences in observables for farmers near the thresholds. To test this, we investigate the smoothness of selected baseline covariates across the discontinuity threshold used for FDP in two ways. First, Table C.2 suggests there are no statistical differences between the two groups in the neighbourhood of the threshold. Second, Figure C.4 presents the RD plots for selected baseline variables and reveals no evidence of a discontinuity in any of them at the discontinuity threshold. In summary, the exogeneity of the forcing variable and the smoothness of the covariates across the threshold are satisfied in the FDP application and confirms the internal validity of the RDD procedure.

FDP Effect: There are two RDD approaches to causally estimate the FDP effect: parametric and non-parametric (Lee and Lemieux, 2010). The parametric approach treats the RD as a discontinuity at the threshold and it is known as a global approach as it exploits all data in the sample. The non-parametric approach characterizes the RD as a local randomization around a specific threshold. Thus, it uses only observations (the discontinuity sample) within a small neighborhood (bandwidth) to this threshold. The challenge of the parametric approach is to determine the functional form of the forcing variable (farmer scores), whereas the choice of bandwidth for the non-parametric approach is an empirical issue. The differences between these approaches involve the standard trade-off between precision and bias.

We plan to utilize the global parametric approach as it affords more sample power and use the following specification:

$$\mathrm{Y}_i = \alpha + \tau FDP_i + \theta_1 x_i + \theta_2 x_i^2 + \theta_3 (FDP_i \cdot x_i) + \theta_4 (FDP_i \cdot x_i^2) + \ X_i'\gamma + \sum_{s=1}^{S} \lambda_s + \epsilon_i \qquad (3.1)$$

where Y_i is an outcome of farmer i and α is a constant term. FDP_i is the FDP treatment dummy variable that equals 1 if a farmer i was assigned to the FDP, and τ is the average causal effect of the FDP on Y. x_i is the evaluation score of farmer i, centered around zero (i.e., the actual score minus the corresponding zone-specific threshold). The inclusion of the evaluation score in the regression helps correct for any selection bias attributable to selection on observables. We use the quadratic form of x_i as recommended in the literature (Gelman and Imbens, 2019b). We interact the FDP treatment dummy with the evaluation score in order to allow the forcing variable effects to differ across both sides of the threshold. The effects of the re-centered forcing variable and its quadratic form are represented by θ_1 and θ_2, while the differences in these effects between FDP and non-FDP farmers are captured by θ_3 and θ_4. X_i' is a vector of covariates, and γ is its corresponding unknown parameter vector. The control variables include whether a farmer previously received a loan , bonus payment, or farmer card from their CWS. We also control for strata fixed effects λ_s as recommended by Bruhn and McKenzie (2009).[22] ϵ_i is a random error term. We use the Huber-White standard errors for the ϵ_i.[23]

We assess the sensitivity of our results to using the non-parametric local polynomial least squares estimators with different optimal bandwidth choices (Calonico et al., 2019; Carter et al., 2021).

3.5.3 Impact of FDP on coffee delivery

Besides evaluating the impact of the FDP on coffee delivery using the RDD framework, the data allows assessing the FDP effect within a difference-in-differences (DiD) framework using data on coffee delivery from other non-FDP CWSs. This assists in evaluating the FDP impact on the CWS level. The administrative data on coffee delivery is available for farmers from our pilot CWSs and other Partner CWSs over three harvest seasons between 2020 and 2022. This leaves us with more than 14,000 farmers from 18 CWSs, comprising the 4092 farmers from our four FDP CWSs. As the delivery data are available before and after the intervention, we evaluate the impact on coffee delivery in a DiD framework. The treatment is whether a farmer was assigned to the FDP. This means that 2,959 farmers from our four pilot CWSs act as a treatment group. We define the control group in three ways: 1) non-FDP farmers from the four CWSs where the FDP was rolled-out, 2) non-FDP farmers from all 18 CWSs, and 3) top 60% farmers from the non-FDP CWSs. The latter represents farmers who would have been invited to the FDP had the program been implemented in the remaining CWSs.[24]

We use the following specification to quantify the impact of the FDP on coffee delivery in a DiD framework:

$$\mathrm{Y}_{it} = \alpha_i + \gamma_t + \tau FDP_i \times Post_t + \sum_{s=1}^{S} \lambda_s + \epsilon_{it} \tag{3.2}$$

where Y_{it} is a coffee delivery outcome for farmer i in year t. α_i are farmer fixed effects, γ_t are year fixed effects, and ϵ_{it} is an error term. FDP_i is a dummy variable that takes the value of 1 if

[22] We have 32 strata covering 16 zones.

[23] The results are similar when clustering on the zone level (see Section 3.7).

[24] For this purpose, we use baseline data to assign evaluation scores to farmers from non-FDP CWSs almost the same way as those from the FDP CWSs studied in this paper.

a farmer was assigned to the FDP. $Post_t$ is a dummy variable taking a value of 1 if the year was 2022, when the FDP was rolled out. The coefficient τ captures the average change in coffee delivery in farmer's outcomes Y associated with the assignment to the FDP. When assessing the impacts using the non-FDP farmers from the four FDP CWSs, we control for strata (Zone$X$Gender) fixed effects (λ_s). In the other two cases, we control for CWS fixed effects.

3.5.4 Impact of organizational interventions

We now turn to the causal identification of the two organizational interventions: relationship manager and communication. In the RM intervention, FDP farmers were randomly allocated to one of three RM groups, namely Control RM, Fixed RM, and Placebo RM.

We use the following econometric specification to obtain two effects: 1) the causal effects of attending with a Fixed RM, and 2) the causal impact of attending an additional session. We compare the Fixed RM and Placebo RM groups to estimate the *Fixed RM effect*, and the Placebo RM and control RM groups to evaluate the *additional session effect.* We use the following specification to estimate both effects:

$$\mathrm{Y}_i = \alpha + \tau \mathit{Fixed\ RM}_i + \delta \mathit{Placebo\ RM}_i + \sum_{c=1}^{n} \beta_c \mathit{Communication}_c + \theta_1 x_i + X_i'\gamma + \sum_{s=1}^{S} \lambda_s + \epsilon_i \quad (3.3)$$

where Y_i is an outcome of farmer i and α is a constant term. $\mathit{Fixed\ RM}_i$ is a dummy variable that equals 1 if a farmer i invited to attend with a Fixed RM, and 0 if farmer was assigned a Control RM. Similarly, $\mathit{Placebo\ RM}_i$ equals 1 if a farmer i was assigned to attend sessions with a Placebo RM, 0 if with Control RM. The difference between τ and δ captures the average causal effect of Fixed RM on the outcome Y. δ is the average causal effect of attending an additional relationship-building session on the outcome Y.

$\mathit{Communication}_c$ indicates the communication categories used in the two communication experiments. When checking the RM impacts on the FDP sessions attendance, we use the categories of the first communication experiment (i.e., before harvest). In this case, SMS is the base category, where we control for four dummy variables for the communication methods used to invite farmers to attend the FDP sessions. For other outcomes such as agricultural practice adoption, we use the categories of the second communication experiment. The SMS group that received a weekly

SMS about coffee delivery serves as a base category. In both cases, β_c indicate the corresponding impact of each category compared to the base category.

In order to control for potential selection on observables, we include the evaluation score x_i of farmer i, centered around zero (i.e., the actual score minus the corresponding zone threshold). X_i' is a vector of covariates, and γ is its corresponding unknown parameter vector. The control variables include whether a farmer previously received a loan , bonus payment, or farmer card from their CWS. ϵ_i is a random error term. We also use Huber-White standard errors and control for the 32 strata fixed effects in our analysis.[25]

3.6 Results

We explore our results initially with descriptive statistics on the baseline characteristics and balance tables related to our experiments. We then demonstrate the FDP components' discontinuity. However, during our intervention, the Partner distributed farmer cards, bonus payments, and loans for the FDP and non-FDP farmers. Therefore, we demonstrate no discontinuity in these measures. We then discuss empirical results of the FDP impact and the organizational experiment effect on our outcomes of interest. The latter covers the awareness and expectations of the FDP, sessions attendance, call centre usage, the take-up of good agricultural practices, coffee delivery, and farmer trust towards CWSs. We use specification (3.1) to quantify the impact of the FDP and specification (3.3) to assess the effect of the organizational capabilities experiments.

3.6.1 Descriptive and Balance Statistics

Table 3.1 displays the descriptive statistics for selected baseline variables from the baseline household questionnaire, plot visits data, and the administrative data on coffee delivery. Looking at household characteristics, we find that the average age of the farmer responsible for coffee production is 51 years, with 40% of farmers being women. Regarding housing, only 40% of these farmers have electricity in their houses. Most of them grow other crops besides coffee and own livestock. Very few of the farmers hold regular waged jobs or run their own enterprise. In terms of dealing with financial institutions, they save more with SACCOs (50%) and informal groups (30%) than with formal institutions such as banks (20%). Finally, on average, the farmers have relatively low levels of numeracy and abstract reasoning.

[25]The results are similar when clustering on the zone level.

In terms of coffee farming characteristics, the average estimated number of trees is 208, with an average of 27 trees at most three years old. Only 10% of farmers reported an expansion of their coffee cultivation in 2021. Regarding their relationship with CWSs, farmers deliver, on average, about 302 KG of coffee in 2021, which is higher than the average delivery volume in 2020 (220 kg). Although 60% of farmers reported they attended meetings at CWS in the past, only 20% know their local CWS managers well.

Insert Table 3.1 about here

3.6.2 FDP delivery and placebo components

We now show evidence of the discontinuity in the FDP components. These include the invitations to the two FDP agricultural sessions and the relationship-building session. The components also cover the number of calls, and SMSs received by farmers through the FDP call centre.[26] We also demonstrate no discontinuity in other factors that the Partner implemented during our intervention between the FDP and non-FDP farmers (hereafter Placebo elements). These elements include farmer card distribution, bonus payments, and loans. Figures 3.3 and 3.4 show RD plots for the FDP components and Placebo FDP components. It is evident that there are jumps in all FDP components but not for the Placebo.

Insert Figures 3.3 and 3.4 about here

To quantify the discontinuity in the FDP components and the absence of it in the the Placebo FDP elements, we run specification (3.1) on all FDP components and Placebo elements. The corresponding results are shown in Tables 3.5 and 3.6. As expected, the assignment to the FDP increases receiving session invitations by at least 85 percentage points.[27] The FDP induces the receipt of at least 3.6 more calls from the FDP call centre. The FDP impacts on the Placebo elements is trivial in magnitude and statistically insignificant. These results show evidence that the implementation of the FDP was largely undertaken as planned. They also show that one should not be concerned about other initiatives that the Partner implemented during the intervention.[28]

[26]These include the calls and SMSs related to the first and second communication experiments, which include the invitations to the FDP sessions and the harvest- and delivery-related SMSs/calls. They also cover the SMS about the FDP call centre launch.

[27]The rest of the farmers assigned to the FDP did not have a phone or could not be reached by calling. They were invited instead by lead farmers in their villages.

[28]We control for the Placebo components when analyzing the FDP impact and the organizational capabilities experiments' effect.

Insert Tables 3.5 and 3.6 about here

3.6.3 Awareness and expectations of FDP

We now present the impacts of FDP and the organizational capabilities experiments on awareness of the FDP components and FDP expectations. First, the outcomes cover whether a farmer knows the FDP and the Tier system. They also include the number of agricultural practices taught during the FDP agricultural sessions that a farmer can recognize. Finally, the outcomes also contain the awareness of the Partner's expectations. The latter consists of coffee delivery, using farmer cards when dealing with CWSs for tractability purposes, call centre engagement, training sessions attendance, and ultimately the adoption of good agricultural practices. Figure 3.5 presents evidence of a jump in all the awareness and expectations outcomes.

Insert Figure 3.5 about here

Table 3.7 reveals the FDP impacts on the awareness and expectations outcomes. The FDP assignment induces awareness of the FDP and the Tier system to increase by at least 29 percentage points. The same applies to the number of good agricultural practices that farmers recognize. The FDP causes an increase of 2.2 agricultural practices. The impact on the Partner's expectations is positive but not statically significant. These expectations were made aware to farmers during the building-relationship session, which coincided with the start of the coffee harvest season. This might have disrupted the farmer's attention during that session, leading to less understating of the Partner's expectations.

Insert Table 3.7 about here

As show in Table 3.8, we find evidence on heterogeneity between low-intensity and high-intensity zones when it comes to the awareness of the FDP and Tier system. The likelihood of farmers from low-intensity zones being aware of the FDP is higher by about 10 percentage points, which is twice the control mean. The same applies to the awareness of the Tier system. The probability of farmers from low-intensity zones to be aware of the Tier system is higher by about 6 percentage points.

Insert Table 3.8 about here

Table 3.9 presents the impacts of the RM and communication experiments. We find impacts for being assigned to an RM and receiving a call from the partner. Compared to the control group, the assignment to a Fixed RM increases the likelihood of being aware of the FDP and Tier system by at least 10 percentage points. It also slightly increases the number of agricultural practices and Partner expectations that farmers recognize. There is no statistical difference between the impact of Fixed and Placebo RM, suggesting no impact of being assigned to a Fixed RM. Farmers awareness and expectations seem to be the same regardless of whether they were assigned to a Fixed or rotating RM. However, the positive impacts of the Placebo RM demonstrate the impact of the additional introductory RM session. During this session, the Placebo farmers obtained a brief introduction about the RM sessions and the FDP/Tier system.

Using calls in addition to SMSs appears to be more effective at increasing awareness about the FDP and good agricultural practices compared to using only SMSs regardless of the source of the call (see Table 3.9). The impacts are higher regarding the awareness of the FDP. However, this conclusion doesn't apply to the understanding of the Partner's expectations. This is not surprising given that the emphasis of calls was to invite farmers to the FDP sessions but not to explain the Partner's expectations.

Insert Table 3.9 about here

3.6.4 Session attendance

The attendance at FDP sessions is one of the immediate outcomes of farmer engagement with the Partner. Figure 3.6 shows a discontinuity in the attendance of the FDP sessions around the FDP selection threshold. As presented in Table 3.10, the FDP assignment induces an increase in attendance by 35.4 percentage points. The attendance of the agricultural sessions was ten percentage points higher than that of the relationship-building session. As already mentioned, the latter coincided with the harvest season start. Farmers might also have been curious about the first sessions. Regarding heterogeneity, it appears that the farmer attendance from the low-intensity zones was slightly higher than that from the high-intensity zones, especially for the first agricultural session (see Table 3.11). Farmers from low-intensity zones might have felt privileged to be invited to the FDP, hence the higher attendance.

Insert Figure 3.6 and Tables 3.10 and 3.11 about here

Table 3.12 reveals the impacts of the organizational capabilities experiments on attendance. Regarding the RM experiment, the assignment to a Fixed RM increases attendance by about 4 percentage points. This applies to all FDP sessions. The additional RM introduction, however, appears to have no impact on attendance as shown by the Placebo RM' coefficients. The impacts of communication on attendance is higher in magnitude compared to those of the RM experiment. Calls prove effective in increasing attendance, especially through the FDP call centre. For instance, being invited through a call from the FDP call centre increases attendance by 18.9 percentage points. The corresponding effects of calls from a Fixed or a Placebo RM are at least 15 percentage points.

Insert Table 3.12 about here

3.6.5 Call centre usage

Engagement with the FDP call centre is considered one of the main objectives of the FDP. The Partner would like to reduce information frictions through the call centre. Specifically, the aim is to facilitate information dissemination, allowing farmers to clarify information and ask for support. There is a discontinuity in the likelihood of using the FDP call centre on the extensive and intensive margins around the FDP selection's threshold, as depicted in Figure 3.7. Nevertheless, the jumps around the FDP selection cutoff appear not statistically significant, as shown in Table 3.13. Only farmers assigned to the FDP from the low-intensity zones reveal a slight increase in the probability of using the call centre (see Table 3.14).

Insert Figure 3.7 and Tables 3.13 and 3.14 about here

Both the RM and communication experiments did not show any impacts on using the FDP call centre, as presented in Table 3.15. Nevertheless, receiving an SMS about the call centre launch seems effective. It increases the likelihood of using the call centre by 14.6 percentage points and the number of calls by 0.37.

Insert Table 3.15 about here

3.6.6 Trust towards CWS

Building trust between farmers and the Partner is one of the main short-term outcomes observed here. Figure 3.8 shows small jumps in farmer trust towards CWSs. Table 3.16 corroborates this observation. The FDP led to a small increase in farmer trust towards CWS in providing loans and agricultural training. Nevertheless, it seems that there was no improvement regarding the trust towards bonus payments and field visits. The latter might have been due to delays from the Partner side in paying bonus payments and conducting field visits during the current harvest season. The same result applies to farmer trust in obtaining agricultural inputs and towards CWS managers.

Insert Figure 3.8 and Table 3.16 about here

It seems there is no heterogeneity in terms of zone-intensity, as presented in Table 3.17. In the same vein, the organizational experiments did not exert any impacts across the FDP farmers (see Table 3.18).

Insert Tables 3.17 and 3.18 about here

3.6.7 Agricultural practices

The take-up of good agricultural practices is one of the long-term objectives of the FDP. The Partner is interested in motivating farmers to adopt such practices to increase their coffee harvest, leading to a rise in coffee delivery to CWSs. We focus on agricultural practices that were taught during the two FDP agricultural sessions. Figure 3.9 reveals a jump in all agricultural practices, but the discontinuity is more apparent regarding seedlings, organic fertilizers and shading trees. Table 3.19 quantifies the graphical discontinuity representation. The FDP enhanced the take-up of all agricultural practices. Nevertheless, the FDP impact is statistically significant regarding only seedlings and tiling. Specifically, the FDP induced the take up of seedlings (tiling) by eight (two) percentage points, double (20 percent more than) the control mean. The heterogeneity between zones is also evident when it comes to seedlings (see Table 3.20). FDP farmers from low-intensity zones showed a higher likelihood of receiving seedlings than those from high-intensity zones. Specifically, the FDP increased the chance of seedlings receipt by 7 percentage points for farmers from high-intensity zones and 10.5 percentage points for those from low-intensity zones.

Insert Figure 3.9 and Tables 3.19 and 3.20 about here

The RM assignment exerts a statically significant impact on organic fertilisers and shading trees (See Table 3.21). On the one hand, the Fixed RM caused the take-up of organic fertilizers and shading trees to increase by about four percentage points. On the other hand, the Placebo RM induced an increase of 3 percentage points in the take-up of seedlings. Regarding the communication experiments, calls did not change the take-up of good agricultural practices, except for seedlings.

Insert Table 3.21 about here

3.6.8 Coffee delivery

Increased coffee delivery is one of the long-term objectives for the Partner. Our intervention focuses on building sustained long-term relationships with farmers, leading to a higher take-up of good agricultural practices, increased coffee productivity, and delivery. We focus on the coffee delivery on the extensive and intensive margins. The coffee delivery on the intensive margins covers standard quality and floater (less) quality.

The FDP led to an increase in coffee delivery using the DiD framework. As previously mentioned, the coffee delivery data are available for 14 non-FDP CWSs and the 4 FDP CWSs studied in this paper. Table 3.22 presents FDP impacts on coffee delivery using three control groups: 1) non-FDP farmers from the four CWSs where the FDP was rolled-out (Panel A), 2) non-FDP farmers from all 18 CWSs (Panel B), and 3) farmers with similar evaluation scores from the 14 non-FDP CWSs (Panel C). Results reveal that the FDP increases coffee delivery by at least double the control mean on the extensive and intensive margins. All estimates are statistically significant.

Insert Table 3.22 about here

When looking at the margin with farmers around the threshold using an RDD, Figure 3.10 reveals no discontinuities in all coffee delivery outcomes. The corresponding FDP impacts are not statistically significant (Table 3.23). However, the low-intensity zones' interaction with FDP shows some positive impacts on coffee delivery. It is statistically different from the high-intensity zones only when looking at the amount of self-reported coffee delivery (Columns 2 in Table 3.24).

Insert Tables 3.23 and 3.24 about here

With respect to the organizational capabilities experiments, they do not exert any effect on coffee delivery outcomes. This applies to the RM experiment and the two communication interventions (see Table 3.25).

Insert Table 3.25 about here

3.7 Robustness Checks

We conduct several robustness checks to evaluate the robustness of the RDD estimates. Our focus is placed mainly on outcomes that yielded statistical significance as a result of the FDP. The first check uses the previous global parametric RDD approach but with dummy variables about the number of invited sessions instead of the FDP assignment treatment variable. About 15% of the farmers assigned to the FDP did not have a phone or could not be reached through calling. They were invited instead by lead farmers in their villages. This check also helps evaluate the effects of the FDP treatment intensity in terms of the number of invitations received. Results are presented in Table 3.26 and are consistent with the previous ones. Furthermore, they indicate that the intensity of the FDP matters. The invitation to three sessions shows the highest effect in magnitude.

Insert Table 3.26 about here

The second check deploys the previous global parametric specification using farmers with no prior knowledge about the CWS manager. As shown in table 3.1, about 60% of farmers in our sample previously know the CWS manager. We exclude those farmers from the analysis. Table 3.27 reports the corresponding FDP treatment effects. The results are robust to the exclusion of farmers who knew the CWS manager before the FDP.

Insert Table 3.27 about here

The third check uses the previous global parametric specification but with a 'fake' selection score. We use the 90^{th} percentile of the score as a fake selection score. Table 3.28 outlines the corresponding estimates. The impacts on all outcomes are not statistically significant. This supports that no meaningful effects are detected when using 'fake' pass scores above the actual predetermined threshold.[29]

[29] Results are also similar when using the 75^{th} percentile.

Insert Table 3.28 about here

The fourth check assesses the previous global parametric specification using weighted regressions in conjunction with a triangular kernel density for the forcing variable rather than assigning the same weight to all observations as in the main analysis. The motivation for doing so is to assess if our results are driven by farmers at the extremes of the forcing variable distribution. The triangular weighting adopted is justified in this case for two reasons. First, farmers with the highest and the lowest ratings on business plans might have different characteristics to those around the threshold. As such, the triangular kernel density gives higher weights to observations closer to the threshold and down-weights those further away from it, thereby capturing the importance of observations around the threshold in the estimated regressions (Calonico et al., 2019). Second, the sample does not have farmers with extreme evaluation scores (i.e., zero and 1). Therefore, we do not lose any observations as a result of assigning a zero weight to those massed at the extreme values of the forcing variable. The corresponding treatment estimates are reported in Table 3.29. The results are congruent with the earlier results reported. This again supports the robustness of the results reported in the main analysis.

Insert Table 3.29 about here

The fifth check uses the previous global parametric specification with clustered standard errors on the zone level instead of the Huber-White standard errors. As previously mentioned, there are 32 zone covering the 4 pilot CWSs. The corresponding results are similar in magnitude and statistical significance to those discussed in the main analysis (see Table 3.30).

Insert Table 3.30 about here

The final check uses a local non-parametric framework as an alternative to the global parametric RDD approach adopted earlier.[30] For this purpose, we use the covariate-adjusted RD estimator developed by Calonico et al. (2014) and Calonico et al. (2019). In this case, the FDP effect ($\hat{\tau}$) is estimated by running a weighted least squares regression with only units within a specific bandwidth (h) of the threshold. This involves estimating two separate regressions using observations on both sides of the threshold. For the bandwidth selection, we employ a mean square error (MSE) optimal bandwidth as discussed in Imbens and Kalyanaraman (2012), and implement it following

[30] As previously explained, the preference to use the parametric RDD in our analysis is due to sample power considerations.

the approach suggested by Calonico (2014) and Calonico et al. (2017). Table 3.31 presents the FDP treatment estimates using a local non-parametric RDD. The results are consistent with the earlier results obtained above. The FDP impacts on farmer trust outcomes are positive, but not statistically significant. These findings confirm our main results and are robust to the choice of the econometric specification in the main analysis.

Insert Table 3.31 about here

3.8 Conclusion

This paper aims to evaluate the short-term impact of the roll-out of an FDP among coffee farmers in Rwanda. The FDP was designed closely with a leading coffee multinational (Partner). The Partner - the largest coffee exporter in Rwanda - directly sources coffee from nearly 30,000 farmers and operates 22 coffee washing stations (CWSs). We focus on 4,902 farmers from four pilot CWSs. Farmers assigned to the FDP were invited to attend three training sessions (two sessions on agricultural practices and one relationship-building session explaining the benefits and the Partner's expectations for the FDP). In addition, the FDP farmers were introduced and given access to a call centre that would answer questions about coffee cultivation, harvest and sales, and services provided by the Partner.

We are interested in two separate sets of questions. First, we assess the impact of the FDP on eligible farmers. Second, we evaluate the effectiveness of several organizational interventions aimed at improving relationships with the farmers. These interventions include sessions with relational managers (RMs) and communication experiments.

The results reveal that the FDP and the organizational interventions improved the relationship between the Partner and farmers for several short-run outcomes. The FDP assignment increased awareness about the FDP and good agricultural practices. It caused seedlings take up to increase, especially among farmers who were invited from zones with a lower proportion of farmers assigned to the FDP. The same result was observed regarding the call centre usage and coffee delivery. Regarding the organizational experiments, the assignment to a Fixed RM seems to have an additional impact on the awareness of the FDP and good agricultural practices, session attendance, and the take up of some agricultural practices. Compared to the use of SMSs, calls create an additional- and bigger in magnitude than the RM- impact along several dimensions.

Our results are consistent with previous literature (e.g., see Fabregas et al. (2020)). Nevertheless, we provide empirical evidence on how successful relationships can be established, organized and deployed at scale cost-effectively. To the best of our knowledge, our intervention is also the first to evaluate this mix of organizational strategies to manage relationships with farmers in a developing country. We work in partnership with a large private company that sources from farmers to evaluate a buyer-driven FDP program. Most of the literature, instead, focuses on public or NGO-driven extension services unrelated to sourcing decisions (Bandiera et al., 2021).

3.9 Tables

Descriptive and Balance Statistics

Table 3.1: Descriptive statistics of selected baseline characteristics

	(1) N	(2) Mean	(3) SD	(4) Min	(5) P25	(6) P50	(7) P75	(8) Max
Scoring Index $(0-1)$	4902.0	0.5	0.1	0.1	0.4	0.5	0.6	0.9
Panel A: Household Characteristics								
HH size (number)	4902.0	4.3	1.9	1.0	3.0	4.0	5.0	14.0
Coffee person age (years)	4902.0	51.0	15.3	13.0	39.0	50.0	63.0	100.0
Coffee person female (=1)	4902.0	0.4	0.5	0.0	0.0	0.0	1.0	1.0
Coffee person attended school (=1)	4902.0	0.7	0.5	0.0	0.0	1.0	1.0	1.0
Panel B: Housing & other income								
Verified phone (=1)	4902.0	0.6	0.5	0.0	0.0	1.0	1.0	1.0
Electricity(=1)	4902.0	0.4	0.5	0.0	0.0	0.0	1.0	1.0
House rooms (number)	4902.0	3.7	1.4	0.0	3.0	4.0	5.0	12.0
Grow other crops (=1)	4902.0	0.9	0.3	0.0	1.0	1.0	1.0	1.0
Own livestock (=1)	4902.0	0.8	0.4	0.0	1.0	1.0	1.0	1.0
Own enterprise (=1)	4902.0	0.1	0.3	0.0	0.0	0.0	0.0	1.0
Regular job (=1)	4902.0	0.0	0.2	0.0	0.0	0.0	0.0	1.0
Casual job (=1)	4902.0	0.4	0.5	0.0	0.0	0.0	1.0	1.0
Panel C: Coffee Farming								
Estimated trees (trees)	4902.0	208.7	313.5	0.0	30.0	105.0	257.0	2008.0
Self-reported 3-year (trees)	4902.0	27.8	78.5	0.0	0.0	0.0	0.0	500.0
Calculated yield (KG per tree)	4902.0	1.3	1.1	0.0	0.5	1.0	1.7	6.0
Propagation rate (%)	4902.0	0.9	0.2	0.0	0.9	1.0	1.0	1.0
Coffee farming expanded (=1)	4902.0	0.1	0.3	0.0	0.0	0.0	0.0	1.0
Panel D: Rwacof relationship								
Coffee delivery 2020 (KG)	4902.0	220.0	458.3	0.0	0.0	19.0	229.0	2794.0
Coffee delivery 2021 (KG)	4902.0	302.6	595.7	0.0	0.0	75.5	325.0	3792.0
CWS membership (years)	4902.0	7.7	5.4	0.0	4.0	7.0	10.0	30.0
CWS manager name (know=1)	4902.0	0.2	0.4	0.0	0.0	0.0	0.0	1.0
CWS manager (never met=1)	4902.0	0.4	0.5	0.0	0.0	0.0	1.0	1.0
CWS manager (know little=1)	4902.0	0.2	0.4	0.0	0.0	0.0	0.0	1.0
CWS manager (know somewhat=1)	4902.0	0.2	0.4	0.0	0.0	0.0	0.0	1.0
CWS manager (know well=1)	4902.0	0.2	0.4	0.0	0.0	0.0	0.0	1.0
Attended meeting (=1)	4902.0	0.6	0.5	0.0	0.0	1.0	1.0	1.0
Panel E: Savings & Loans								
Saving with SACCO (=1)	4902.0	0.5	0.5	0.0	0.0	1.0	1.0	1.0
Saving with Bank (=1)	4902.0	0.2	0.4	0.0	0.0	0.0	0.0	1.0
Mobile money savings (=1)	4902.0	0.3	0.5	0.0	0.0	0.0	1.0	1.0
Home savings (=1)	4902.0	0.4	0.5	0.0	0.0	0.0	1.0	1.0
Informal group savings (=1)	4902.0	0.7	0.5	0.0	0.0	1.0	1.0	1.0
Outstanding loan (=1)	4902.0	0.1	0.3	0.0	0.0	0.0	0.0	1.0
Panel F: Raven & Numeracy								
Raven (correct Qs out of 6 Qs)	4902.0	1.6	1.4	0.0	0.0	1.0	2.0	6.0
Numeracy (correct Qs out of 3 Qs)	4902.0	0.9	0.8	0.0	0.0	1.0	1.0	3.0

Note: This table shows descriptive statistics of baseline characteristics, including household characteristics (Panel A), housing and other income sources (Panel B), coffee farming (Panel C), relationship with partner (Panel D), financial-related variables (Panel E), and Raven and numeracy results (Panel F). Observations include all farmers from the four coffee washing stations included in our sample. The baseline characteristics comprise of variables from a detailed questionnaire, plot visits and administrative data on coffee delivery. The estimated trees variable was compiled from the plot visits data, whereas coffee delivery 2020 and 2021 are based on the administrative datasets.

Table 3.2: Balance of RM experiment

	(1) Fixed RM	(2) Placebo RM	(3) Control RM	(4) (1)-(3)	(5) *P*-value (2)-(3)	(6) F-test
Scoring Index $(0-1)$	0.54	0.53	0.53	0.09	0.88	0.16
Panel A: Household Characteristics						
HH size (number)	4.53	4.55	4.53	0.93	0.94	0.97
Coffee person age (years)	48.63	48.35	48.20	0.51	0.77	0.79
Coffee person female (=1)	0.30	0.31	0.28			
Coffee person attended school (=1)	0.81	0.81	0.82	0.29	0.47	0.55
Panel B: Housing & other income						
Verified phone (=1)	0.84	0.81	0.82	0.64	0.13	0.11
Electricity(=1)	0.47	0.45	0.42	0.13	1.00	0.21
House rooms (number)	3.83	3.85	3.80	0.53	0.57	0.78
Grow other crops (=1)	0.93	0.92	0.93	0.94	0.42	0.55
Own livestock (=1)	0.78	0.78	0.77	0.99	0.61	0.89
Own enterprise (=1)	0.11	0.12	0.10	0.34	0.26	0.47
Regular job (=1)	0.06	0.07	0.06	0.72	0.76	0.78
Casual job (=1)	0.38	0.40	0.40	0.31	0.87	0.45
Panel C: Coffee Farming						
Estimated trees (trees)	274.92	264.88	248.88	0.09	0.35	0.23
Self-reported 3-year (trees)	36.00	34.70	39.37	0.40	0.23	0.50
Calculated yield (KG per tree)	1.36	1.40	1.35	0.98	0.53	0.82
Propagation rate (%)	0.89	0.90	0.90	0.42	0.93	0.68
Coffee farming expanded (=1)	0.20	0.16	0.17	0.15	0.24	0.03
Panel D: Rwacof relationship						
Coffee delivery 2020 (KG)	292.56	328.67	303.07	0.54	0.42	0.32
Coffee delivery 2021 (KG)	426.81	427.99	396.01	0.31	0.30	0.49
CWS membership (years)	7.78	7.90	7.70	0.84	0.56	0.84
CWS manager name (know=1)	0.29	0.30	0.28	0.61	0.21	0.46
CWS manager (never met=1)	0.30	0.29	0.29	0.51	0.79	0.79
CWS manager (know little=1)	0.24	0.24	0.26	0.51	0.38	0.65
CWS manager (know somewhat=1)	0.25	0.26	0.25	0.99	0.76	0.92
CWS manager (know well=1)	0.20	0.21	0.21	0.99	0.75	0.93
Attended meeting (=1)	0.63	0.61	0.65	0.58	0.13	0.23
Panel E: Savings & Loans						
Saving with SACCO (=1)	0.58	0.59	0.59	0.93	0.98	0.98
Saving with Bank (=1)	0.22	0.23	0.20	0.39	0.23	0.45
Mobile money savings (=1)	0.44	0.43	0.43	0.68	0.76	0.70
Home savings (=1)	0.39	0.37	0.40	0.38	0.06	0.17
Informal group savings (=1)	0.73	0.73	0.69	0.06	0.12	0.13
Outstanding loan (=1)	0.19	0.18	0.16	0.07	0.27	0.19
Panel F: Raven & Numeracy						
Raven (correct Qs out of 6 Qs)	1.91	1.93	1.86	0.57	0.46	0.76
Numeracy (correct Qs out of 3 Qs)	1.07	1.06	1.07	1.00	0.62	0.87
Joint significance (Prob > F)				0.55	0.78	
Observations	986	993	980			

Note: This table displays the balance across the RM treatment arms (i.e., Fixed RM, Placebo RM, and Control RM) on baseline characteristics on the farmer level. These cover household characteristics (Panel A), housing and other income sources (Panel B), coffee farming (Panel C), relationship with Partner (Panel D), financial-related variables (Panel E), and Raven and numeracy results (Panel F). Observations include only the 60% invited farmers to the FDP. The baseline characteristics comprise of variables from a detailed questionnaire, plot visits and administrative data on coffee delivery.

Table 3.3: Balance of communication experiment before harvest

	(1) Call Center Call	(2) Fixed RM Call	(3) Placebo RM Call	(4) SMSs	(5) (1)-(4)	(6) *P*-value (2)-(4)	(7) (3)-(4)	(8) F-test
Scoring Index $(0-1)$	0.53	0.53	0.53	0.53	0.86	0.21	0.91	0.49
Panel A: Household Characteristics								
HH size (number)	4.42	4.53	4.62	4.58	0.21	0.50	0.50	0.27
Coffee person age (years)	48.54	48.37	48.18	48.48	0.69	0.79	0.66	0.95
Coffee person female (=1)	0.31	0.29	0.28	0.30	0.85	0.75	0.25	0.63
Coffee person attended school (=1)	0.83	0.80	0.81	0.81	0.14	0.56	0.75	0.28
Panel B: Housing & other income								
Verified phone (%)	0.80	0.83	0.81	0.84	0.07	0.47	0.12	0.29
Electricity(=1)	0.44	0.46	0.45	0.44	0.47	0.67	0.51	0.52
House rooms (number)	3.82	3.76	3.98	3.74	0.07	0.37	0.76	0.34
Grow other crops (=1)	0.93	0.94	0.93	0.92	0.87	0.28	0.87	0.67
Own livestock (=1)	0.78	0.77	0.78	0.78	0.47	0.54	0.69	0.83
Own enterprise (=1)	0.11	0.10	0.11	0.13	0.49	0.27	0.67	0.74
Regular job (=1)	0.06	0.06	0.06	0.07	0.96	0.26	0.78	0.74
Casual job (=1)	0.40	0.39	0.39	0.39	0.34	0.93	0.68	0.73
Panel C: Coffee Farming								
Estimated trees (trees)	259.76	258.79	263.97	269.37	0.59	0.59	0.39	0.54
Self-reported 3-year (trees)	35.98	40.54	35.68	34.48	0.30	0.19	0.41	0.59
Calculated yield (KG per tree)	1.37	1.41	1.36	1.34	0.61	0.46	0.45	0.37
Propagation rate (%)	0.89	0.90	0.89	0.90	0.63	0.97	0.74	0.95
Coffee farming expanded (=1)	0.17	0.19	0.16	0.18	0.52	0.37	0.40	0.41
Panel D: Rwacof relationship								
Transactions 2020 (KG)	303.05	276.55	316.14	337.63	0.16	0.01	0.49	0.03
Transactions 2021 (KG)	408.09	393.76	403.33	464.08	0.44	0.02	0.45	0.09
CWS membership (years)	8.02	7.98	7.55	7.61	0.33	0.98	0.52	0.38
CWS manager name (know=1)	0.28	0.30	0.33	0.27	0.49	0.48	0.22	0.26
CWS manager (never met=1)	0.30	0.30	0.27	0.30	0.68	0.71	0.74	0.83
CWS manager (know little=1)	0.22	0.23	0.28	0.25	0.14	0.44	0.21	0.04
CWS manager (know somewhat=1)	0.28	0.26	0.22	0.25	0.44	0.72	0.06	0.05
CWS manager (know well=1)	0.20	0.20	0.22	0.20	0.80	0.97	0.33	0.75
Attended meeting (=1)	0.61	0.65	0.64	0.62	0.72	0.19	0.36	0.33
Panel E: Savings & Loans								
Saving with SACCO (=1)	0.57	0.59	0.61	0.58	0.83	0.70	0.21	0.31
Saving with Bank (=1)	0.22	0.21	0.22	0.22	0.96	0.49	0.75	0.79
Mobile money savings (=1)	0.44	0.44	0.42	0.42	0.44	0.83	0.73	0.76
Home savings (=1)	0.39	0.38	0.39	0.40	0.72	0.36	0.33	0.76
Informal group savings (=1)	0.70	0.72	0.71	0.74	0.33	0.40	0.56	0.70
Outstanding loan (=1)	0.15	0.18	0.18	0.19	0.03	0.84	0.51	0.08
Panel F: Raven & Numeracy								
Raven (correct Qs out of 6 Qs)	1.99	1.80	1.89	1.92	0.28	0.19	0.61	0.14
Numeracy (correct Qs out of 3 Qs)	1.07	1.09	1.06	1.05	0.17	0.20	0.52	0.55
Joint significance (Prob > F)					0.31	0.22	0.91	
Observations	751	741	743	724				

Note: This table displays the balance across four communication methods used to invite farmers to the FDP sessions. Farmers were divided into four groups. "Call centre" covers 751 farmers who received an SMS and a call from the call centre. "CWS staff" contains 741 farmers who got an SMS and a call from CWS staff. "RM" covers 743 farmers invited by an SMS and a call from their assigned RM. "No Call" serves as a control group and includes 724 farmers who were invited by SMSs. The balance is on baseline characteristics at the farmer level, including household characteristics (Panel A), housing and other income sources (Panel B), coffee farming (Panel C), relationship with Partner (Panel D), financial-related variables (Panel E), and raven and numeracy results (Panel F). Observations include only the 60% invited farmers to the FDP. The baseline characteristics comprise of variables from a detailed questionnaire, plot visits and administrative data on coffee delivery.

Table 3.4: Balance of communication experiment during harvest season

	(1) SMSs	(2) SMSs and Calls	(3) T-test (1)-(2)	(4) *P*-value (1)-(2)
Scoring Index $(0-1)$	0.53	0.53	0.00	0.17
Panel A: Household Characteristics				
HH size (number)	4.49	4.58	0.08	0.22
Coffee person age (years)	48.18	48.60	0.37	0.47
Coffee person female (=1)	0.31	0.29	-0.02	0.26
Coffee attended school (=1)	0.81	0.82	0.01	0.42
Panel B: Housing & other income				
Verified phone (=1)	0.82	0.82	0.01	0.69
Electricity(=1)	0.44	0.45	0.01	0.62
House rooms (number)	3.76	3.89	0.06	0.12
Grow other crops (=1)	0.92	0.94	0.01	0.22
Own livestock (=1)	0.77	0.79	0.01	0.53
Own enterprise (=1)	0.12	0.10	-0.01	0.32
Regular job (=1)	0.07	0.06	-0.01	0.19
Casual job (=1)	0.40	0.38	-0.02	0.33
Panel D: Coffee Farming				
Estimated trees (trees)	252.01	273.78	26.93	0.03
Self-reported 3-year (trees)	36.93	36.43	0.06	0.99
Calculated yield (KG per tree)	1.36	1.39	0.00	0.95
Propagation rate (%)	0.90	0.90	-0.00	0.70
Coffee farming expanded (=1)	0.18	0.17	-0.01	0.43
Panel C: Rwacof relationship				
Transactions 2020 (KG)	292.92	323.30	31.19	0.10
Transactions 2021 (KG)	414.40	419.60	17.65	0.47
CWS membership (years)	7.77	7.81	0.03	0.85
CWS manager name (know=1)	0.29	0.30	0.00	0.79
CWS manager (never met=1)	0.30	0.29	0.00	0.75
CWS manager (know little=1)	0.25	0.24	-0.01	0.41
CWS manager (know somewhat=1)	0.26	0.25	-0.01	0.40
CWS manager (know well=1)	0.20	0.22	0.02	0.14
Attended meeting (=1)	0.62	0.64	0.01	0.60
Panel E: Savings & Loans				
Saving with SACCO (=1)	0.56	0.61	0.04	0.03
Saving with Bank (=1)	0.21	0.22	0.01	0.32
Mobile money savings (=1)	0.41	0.45	0.04	0.04
Home savings (=1)	0.39	0.39	0.01	0.75
Informal group savings (=1)	0.71	0.73	0.03	0.08
Outstanding loan (=1)	0.17	0.18	0.00	0.78
Panel F: Raven & Numeracy				
Raven (correct Qs out of 6 Qs)	1.87	1.93	0.04	0.47
Numeracy (correct Qs out of 3 Qs)	1.06	1.07	0.01	0.63
Joint significance (Prob > F)			0.90	0.63
Observations	1475	1484		

Note: This table displays the balance across four communication methods used during harvest season. Farmers were divided into two groups. The "SMSs" group serves as a control group and includes 1,475 farmers who received a weekly SMS about the benefits of delivering coffee. The second group covers 1,484 farmers who received the same weekly SMS and a monthly call about the same message. The balance is on baseline characteristics at the farmer level, including household characteristics (Panel A), housing and other income sources (Panel B), coffee farming (Panel C), relationship with Partner (Panel D), financial-related variables (Panel E), and Raven and numeracy results (Panel F). Observations include only the 60% invited farmers to the FDP. Baseline characteristics comprise of variables from a detailed questionnaire, plot visits and administrative data on coffee delivery.

FDP delivery and placebo components

Table 3.5: Impact of FDP on FDP delivery components

	(1) Agri session invitation (=1)	(2) Agri session invitation (=1)	(3) Relationship-building invitation (=1)	(4) Number of calls/SMSs
FDP (=1)	0.984***	0.855***	1.000***	3.657***
	(0.01)	(0.01)	(0.00)	(0.10)
Farmer score ([0-1])	-0.022	0.023	0.000***	5.622***
	(0.03)	(0.10)	(0.00)	(0.64)
Farmer score^2	-0.069	-0.232	0.000***	2.339
	(0.07)	(0.35)	(0.00)	(2.35)
FDP X Farmer score	-0.039	-0.185	-0.000***	10.009***
	(0.07)	(0.22)	(0.00)	(1.36)
FDP X Farmer score^2	0.334	0.562	-0.000	-22.821***
	(0.18)	(0.67)	(0.00)	(3.98)
Control Mean	0.00	0.00	0.00	0.54
Strata FE	Y	Y	Y	Y
R2	0.96	0.71	1.00	0.71
Observations	4902	4902	4902	4902

Notes: This table presents the discontinuity in FDP delivery components. Observations include FDP and non-FDP farmers. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3.6: Impact of FDP on FDP placebo components

	(1) Farmer card (=1)	(2) Bonus payments (=1)	(3) Loan (=1)
FDP (=1)	0.049	0.021	0.011
	(0.03)	(0.03)	(0.01)
Farmer score ([0-1])	0.217	0.776	-0.034
	(0.45)	(0.46)	(0.12)
Farmer score^2	-0.474	-1.297	-0.498
	(1.78)	(1.76)	(0.43)
FDP X Farmer score	0.587	0.828	-0.118
	(0.52)	(0.52)	(0.21)
FDP X Farmer score^2	-0.560	0.897	3.541***
	(1.96)	(1.91)	(0.76)
Control Mean	0.46	0.41	0.02
Strata FE	Y	Y	Y
R2	0.21	0.22	0.14
Observations	4902	4902	4902

Notes: This table presents the discontinuity in FDP placebo components that the Partner implemented not as a part of the FDP. Observations include FDP and non-FDP farmers. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Awareness and expectations of FDP

Table 3.7: Impact of FDP on awareness and expectations

	(1) Aware of FDP (=1)	(2) Aware of Tier system (=1)	(3) Aware of Agri practices (number)	(4) Aware of Partner's expectations (number)
FDP (=1)	0.312***	0.293***	2.230***	0.091
	(0.03)	(0.03)	(0.18)	(0.07)
Farmer score ([0-1])	0.422	0.380	1.981	2.471*
	(0.26)	(0.31)	(2.41)	(0.98)
Farmer score^2	0.379	0.930	-0.462	3.595
	(0.90)	(1.21)	(9.41)	(3.85)
FDP X Farmer score	0.930*	1.063*	7.402*	0.432
	(0.38)	(0.42)	(3.03)	(1.18)
FDP X Farmer score^2	-1.343	-2.629	-13.053	-7.585
	(1.22)	(1.48)	(10.89)	(4.34)
Control Mean	0.06	0.08	1.43	1.46
Strata FE	Y	Y	Y	Y
R2	0.27	0.22	0.27	0.21
Observations	4655	4655	4902	4902

Notes: This table presents impacts of the FDP on awareness and expectations. Observations include FDP and non-FDP farmers. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3.8: Heterogeneous impact of FDP on awareness and expectations

	(1) Aware of FDP (=1)	(2) Aware of Tier system (=1)	(3) Aware of Agri practices (number)	(4) Aware of Partner's expectations (number)
FDP (=1)	0.253***	0.254***	2.218***	0.132
	(0.03)	(0.03)	(0.21)	(0.08)
FDP X Low intensity zone (=1)	0.100***	0.066*	0.022	-0.071
	(0.03)	(0.03)	(0.19)	(0.07)
Farmer score ([0-1])	0.294	0.296	1.951	2.567**
	(0.26)	(0.31)	(2.41)	(0.99)
Farmer score^2	0.230	0.832	-0.498	3.713
	(0.90)	(1.20)	(9.41)	(3.86)
FDP X Farmer score	1.141**	1.202**	7.450*	0.276
	(0.39)	(0.43)	(3.06)	(1.19)
FDP X Farmer score^2	-1.298	-2.599	-13.039	-7.631
	(1.21)	(1.48)	(10.89)	(4.34)
Control Mean	0.06	0.08	1.43	1.46
Strata FE	Y	Y	Y	Y
R2	0.27	0.22	0.27	0.21
Observations	4655	4655	4902	4902

Notes: This table presents impacts of the FDP on awareness and expectations by zone type. Observations include FDP and non-FDP farmers. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3.9: Impact of organizational capabilities interventions on awareness and expectations

	(1) Aware of FDP (=1)	(2) Aware of Tier system (=1)	(3) Aware of Agri practices (number)	(4) Aware of Partner's expectations (number)
RM Experiment				
Fixed RM (=1)	0.128***	0.105***	0.543***	0.044
	(0.02)	(0.02)	(0.14)	(0.05)
Placebo RM (=1)	0.111***	0.087***	0.618***	0.103*
	(0.02)	(0.02)	(0.14)	(0.05)
Communication Experiment				
Call centre call (=1)	0.125***	0.078**	0.698***	0.028
	(0.03)	(0.03)	(0.16)	(0.06)
Fixed RM call (=1)	0.131***	0.037	0.797***	0.091
	(0.03)	(0.03)	(0.16)	(0.06)
Placebo RM call (=1)	0.119***	0.097***	0.677***	0.020
	(0.03)	(0.03)	(0.16)	(0.06)
Farmer score ([0-1])	0.875***	0.717***	2.848***	1.025***
	(0.12)	(0.13)	(0.77)	(0.28)
Call centre launch SMS (=1)	0.112***	0.125***	0.645***	0.213***
	(0.03)	(0.03)	(0.17)	(0.06)
Control Mean (RM)	0.43	0.44	4.21	1.85
Control Mean (Communication)	0.42	0.45	4.00	1.82
R2	0.11	0.08	0.10	0.23
Observations	2846	2846	2959	2959

Notes: This table shows impacts of the RM and communication experiments on awareness and expectations. Observations include only FDP farmers who were invited to attend with Fixed RM, Control RM, or Placebo RM. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Session attendance

Table 3.10: Impact of FDP on sessions attendance

	(1) FDP sessions attendance (=1)	(2) Agri 1 attendance (=1)	(3) Agri 2 attendance (=1)	(4) Relationship-building attendance (=1)
FDP (=1)	0.354***	0.396***	0.387***	0.278***
	(0.01)	(0.02)	(0.02)	(0.02)
Farmer score ([0-1])	0.201**	0.235*	0.208*	0.162
	(0.07)	(0.10)	(0.10)	(0.09)
Farmer score^2	0.313	0.231	0.382	0.327
	(0.27)	(0.39)	(0.36)	(0.35)
FDP X Farmer score	0.992***	1.146***	0.920**	0.911**
	(0.21)	(0.30)	(0.30)	(0.29)
FDP X Farmer score^2	-2.038**	-2.385*	-1.837*	-1.891*
	(0.65)	(0.93)	(0.94)	(0.92)
Control Mean	0.002	0.002	0.002	0.002
Strata FE	Y	Y	Y	Y
Session FE	Y	N	N	N
Farmers	4902			
Sessions	3			
R2		0.33	0.33	0.23
Observations	14706	4902	4902	4902

Notes: This table presents impacts of the FDP on sessions attendance. Observations include FDP and non-FDP farmers. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3.11: Heterogeneous impact of FDP on sessions attendance

	(1) FDP sessions attendance (=1)	(2) Agri 1 attendance (=1)	(3) Agri 2 attendance (=1)	(4) Relationship-building attendance (=1)
FDP (=1)	0.329***	0.332***	0.378***	0.277***
	(0.02)	(0.02)	(0.02)	(0.02)
FDP X Low intensity zone (=1)	0.042**	0.110***	0.015	0.002
	(0.02)	(0.02)	(0.02)	(0.02)
Farmer score ([0-1])	0.144*	0.086	0.188	0.158
	(0.07)	(0.09)	(0.10)	(0.09)
Farmer score^2	0.243	0.048	0.358	0.323
	(0.27)	(0.37)	(0.36)	(0.35)
FDP X Farmer score	1.085***	1.387***	0.952**	0.916**
	(0.21)	(0.30)	(0.31)	(0.30)
FDP X Farmer score^2	-2.010**	-2.313*	-1.828	-1.889*
	(0.65)	(0.92)	(0.93)	(0.92)
Control Mean	0.002	0.002	0.002	0.002
Strata FE	Y	Y	Y	Y
Session FE	Y	N	N	N
Farmers	4902			
Sessions	3			
R2		0.34	0.33	0.23
Observations	14706	4902	4902	4902

Notes: This table presents impacts of the FDP on sessions attendance by zone type. Observations include FDP and non-FDP farmers. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3.12: Impact of organizational capabilities interventions on sessions attendance

	(1) FDP sessions attendance (=1)	(2) Agri 1 attendance (=1)	(3) Agri 2 attendance (=1)	(4) Relationship-building attendance (=1)
RM Experiment				
Fixed RM (=1)	0.047***	0.046*	0.050*	0.045*
	(0.01)	(0.02)	(0.02)	(0.02)
Placebo RM (=1)	0.007	-0.023	0.023	0.021
	(0.01)	(0.02)	(0.02)	(0.02)
Communication Experiment				
Call centre call (=1)	0.189***	0.186***	0.181***	0.201***
	(0.02)	(0.02)	(0.02)	(0.02)
Fixed RM call (=1)	0.157***	0.140***	0.179***	0.153***
	(0.02)	(0.02)	(0.02)	(0.02)
Placebo RM call (=1)	0.149***	0.121***	0.153***	0.173***
	(0.02)	(0.02)	(0.02)	(0.02)
Farmer score ([0-1])	0.343***	0.455***	0.314**	0.260*
	(0.08)	(0.12)	(0.12)	(0.12)
Call centre launch SMS (=1)	0.111***	0.133***	0.096***	0.104***
	(0.02)	(0.03)	(0.02)	(0.02)
Control Mean (RM)	0.44	0.49	0.47	0.35
Control Mean (Communication)	0.32	0.37	0.35	0.24
Strata FE	Y	Y	Y	Y
Session FE	Y	N	N	N
Farmers	2959			
Sessions	3			
R2		0.14	0.17	0.11
Observations	8877	2959	2959	2959

Notes: This table shows impacts of the RM and communication experiments on sessions attendance. Observations include only FDP farmers who were invited to attend with Fixed RM, Control RM, or Placebo RM. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Call centre usage

Table 3.13: Impact of FDP on call centre engagement

	(1) Call centre usage (=1)	(2) Number of calls (calls)
FDP (=1)	0.010	0.048
	(0.02)	(0.07)
Farmer score ([0-1])	1.374***	3.025***
	(0.31)	(0.64)
Farmer score^2	2.835**	6.825**
	(1.08)	(2.15)
FDP X Farmer score	-0.116	-0.487
	(0.40)	(1.02)
FDP X Farmer score^2	-3.832**	-7.310*
	(1.34)	(3.23)
Control Mean	0.09	0.15
Strata FE	Y	Y
R2	0.11	0.08
Observations	4902	4902

Notes: Notes: This table presents impacts of the FDP on call centre engagement. Observations include FDP and non-FDP farmers. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3.14: Heterogeneous impact of FDP on call centre engagement

	(1) Call centre usage (=1)	(2) Number of calls (calls)
FDP (=1)	-0.016	-0.031
	(0.03)	(0.07)
FDP X Low intensity zone (=1)	0.045	0.136*
	(0.02)	(0.06)
Farmer score ([0-1])	1.313***	2.839***
	(0.31)	(0.65)
Farmer score^2	2.761*	6.599**
	(1.08)	(2.17)
FDP X Farmer score	-0.018	-0.187
	(0.40)	(1.05)
FDP X Farmer score^2	-3.803**	-7.221*
	(1.35)	(3.23)
Control Mean	0.09	0.15
Strata FE	Y	Y
R2	0.11	0.08
Observations	4902	4902

Notes: Notes: This table presents impacts of the FDP on call centre engagement by zone type. Observations include FDP and non-FDP farmers. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3.15: Impact of organizational capabilities interventions on call centre engagement

	(1) Call centre usage (=1)	(2) Number of calls (calls)
RM Experiment		
Fixed RM (=1)	0.001	0.022
	(0.02)	(0.06)
Placebo RM (=1)	0.016	0.029
	(0.02)	(0.06)
Communication Experiment		
Call centre call (=1)	0.014	0.053
	(0.02)	(0.07)
Fixed RM call (=1)	-0.016	0.084
	(0.02)	(0.08)
Placebo RM call (=1)	0.004	0.065
	(0.02)	(0.07)
Farmer score ([0-1])	0.706***	1.721***
	(0.11)	(0.37)
Call centre launch SMS (=1)	0.146***	0.374***
	(0.02)	(0.06)
Control Mean (RM)	0.26	0.56
Control Mean (Communication)	0.27	0.52
R2	0.10	0.07
Observations	2959	2959

Notes: This table shows impacts of the RM and communication experiments on call centre engagement. Observations include only FDP farmers who were invited to attend with Fixed RM, Control RM, or Placebo RM. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Trust towards CWS

Table 3.16: Impact of FDP on trust towards CWS

	(1) Trust CWS about loans [1-10]	(2) Trust CWS about bonus payments [1-10]	(3) Trust CWS about field visits $[1-10]$	(4) Trust CWS about Agri training $[1-10]$	(5) Trust CWS about Agri inputs $[1-10]$	(6) Trust CWS manager $[1-10]$
FDP (=1)	0.298**	0.060	0.129	0.338***	-0.045	0.141
	(0.11)	(0.10)	(0.12)	(0.10)	(0.10)	(0.08)
Farmer score ($[0-1]$)	-3.812*	0.421	-3.361	-0.255	0.085	-1.002
	(1.77)	(1.55)	(1.90)	(1.61)	(1.55)	(1.35)
Farmer score^2	-11.583	-0.262	-8.743	1.399	1.627	-2.134
	(6.85)	(6.11)	(7.48)	(6.19)	(6.03)	(5.28)
FDP X Farmer score	2.439	-1.291	3.024	0.742	-0.362	1.008
	(2.02)	(1.80)	(2.18)	(1.78)	(1.80)	(1.52)
FDP X Farmer score^2	18.560*	5.796	11.035	-0.503	0.895	3.318
	(7.45)	(6.68)	(8.12)	(6.54)	(6.56)	(5.71)
Control Mean	8.14	8.59	7.95	8.60	8.50	9.02
Strata FE	Y	Y	Y	Y	Y	Y
R2	0.06	0.07	0.08	0.10	0.09	0.07
Observations	4655	4655	4655	4655	4655	4655

Notes: This table presents impacts of the FDP on farmer trust towards CWS. Observations include FDP and non-FDP farmers. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3.17: Heterogeneous impact of FDP on trust towards CWS

	(1) Trust CWS about loans [1-10]	(2) Trust CWS about bonus payments [1-10]	(3) Trust CWS about field visits $[1-10]$	(4) Trust CWS about Agri training $[1-10]$	(5) Trust CWS about Agri inputs $[1-10]$	(6) Trust CWS manager $[1-10]$
FDP (=1)	0.292*	0.038	0.078	0.290*	0.000	0.185
	(0.13)	(0.12)	(0.15)	(0.12)	(0.12)	(0.10)
FDP X Low intensity zone (=1)	0.010	0.037	0.087	0.082	-0.077	-0.076
	(0.12)	(0.11)	(0.13)	(0.10)	(0.11)	(0.09)
Farmer score ($[0-1]$)	-3.824*	0.374	-3.473	-0.360	0.184	-0.904
	(1.78)	(1.55)	(1.90)	(1.62)	(1.56)	(1.36)
Farmer score^2	-11.597	-0.317	-8.872	1.277	1.742	-2.020
	(6.86)	(6.10)	(7.47)	(6.19)	(6.03)	(5.28)
FDP X Farmer score	2.459	-1.213	3.208	0.915	-0.526	0.846
	(2.04)	(1.80)	(2.18)	(1.79)	(1.81)	(1.53)
FDP X Farmer score^2	18.565*	5.812	11.074	-0.467	0.860	3.284
	(7.46)	(6.68)	(8.12)	(6.54)	(6.57)	(5.71)
Control Mean	8.14	8.59	7.95	8.60	8.50	9.02
Strata FE	Y	Y	Y	Y	Y	Y
R2	0.06	0.07	0.08	0.10	0.09	0.07
Observations	4655	4655	4655	4655	4655	4655

Notes: This table presents impacts of the FDP on farmer trust towards CWS by zone type. Observations include FDP and non-FDP farmers. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3.18: Impact of organizational capabilities interventions on trust towards CWS

	(1) Trust CWS about loans [1-10]	(2) Trust CWS about bonus payments [1-10]	(3) Trust CWS about field visits $[1-10]$	(4) Trust CWS about Agri training $[1-10]$	(5) Trust CWS about Agri inputs $[1-10]$	(6) Trust CWS manager $[1-10]$
RM Experiment						
Fixed RM (=1)	-0.034	-0.113	-0.068	0.068	-0.038	-0.046
	(0.07)	(0.07)	(0.08)	(0.06)	(0.07)	(0.05)
Placebo RM (=1)	0.112	-0.038	0.015	0.103	0.022	-0.072
	(0.07)	(0.07)	(0.08)	(0.06)	(0.07)	(0.05)
Communication Experiment						
Call centre call (=1)	-0.034	0.054	0.100	0.001	0.038	0.023
	(0.09)	(0.08)	(0.10)	(0.07)	(0.08)	(0.06)
Fixed RM call (=1)	-0.023	0.043	0.015	0.124	0.077	0.072
	(0.09)	(0.08)	(0.10)	(0.07)	(0.08)	(0.06)
Placebo RM call (=1)	0.002	0.103	0.103	0.105	0.111	0.119
	(0.09)	(0.08)	(0.10)	(0.07)	(0.08)	(0.06)
Farmer score ([0-1])	0.037	0.331	-0.112	0.226	-0.030	0.060
	(0.42)	(0.38)	(0.46)	(0.32)	(0.40)	(0.29)
Call centre launch SMS (=1)	-0.077	0.024	-0.045	0.098	0.069	-0.177**
	(0.09)	(0.09)	(0.10)	(0.08)	(0.09)	(0.06)
Control Mean (RM)	8.16	8.71	7.93	8.88	8.45	9.15
Control Mean (Communication)	8.24	8.65	7.91	8.92	8.41	9.08
R2	0.07	0.08	0.09	0.09	0.09	0.08
Observations	2846	2846	2846	2846	2846	2846

Notes: This table shows impacts of the RM and communication experiments on on farmer trust towards CWS. Observations include only FDP farmers who were invited to attend with Fixed RM, Control RM, or Placebo RM. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Agricultural practices

Table 3.19: Impact of FDP on agricultural practices take up

	(1) Received seedlings (=1)	(2) Applied organic fertilizers (=1)	(3) Did pruning (=1)	(4) Planted shading trees (=1)	(5) Applied lime (=1)	(6) Did tiling (=1)
FDP (=1)	0.091***	0.023	0.007	0.026	0.012	0.023**
	(0.01)	(0.03)	(0.02)	(0.03)	(0.01)	(0.01)
Farmer score ([0-1])	0.077	-0.196	0.173	0.168	-0.045	-0.234
	(0.06)	(0.44)	(0.35)	(0.51)	(0.11)	(0.14)
Farmer score^2	0.065	-1.681	0.688	-2.751	-0.395	-0.771
	(0.23)	(1.75)	(1.37)	(2.07)	(0.37)	(0.53)
FDP X Farmer score	-0.034	0.376	-0.190	0.126	-0.021	0.244
	(0.20)	(0.49)	(0.40)	(0.56)	(0.15)	(0.15)
FDP X Farmer score^2	0.234	1.437	-0.998	3.118	0.563	0.744
	(0.65)	(1.85)	(1.48)	(2.18)	(0.49)	(0.54)
Control Mean	0.00	0.76	0.83	0.59	0.02	0.98
Strata FE	Y	Y	Y	Y	Y	Y
R2	0.08	0.11	0.25	0.15	0.03	0.03
Observations	4655	4655	4655	4655	4655	4655

Notes: This table presents impacts of the FDP on the take up of selected good agricultural practices. Observations include FDP and non-FDP farmers. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3.20: Heterogeneous impact of FDP on agricultural practices take up

	(1) Received seedlings (=1)	(2) Applied organic fertilizers (=1)	(3) Did pruning (=1)	(4) Planted shading trees (=1)	(5) Applied lime (=1)	(6) Did tiling (=1)
FDP (=1)	0.070***	0.025	0.008	0.031	0.009	0.024*
	(0.01)	(0.03)	(0.03)	(0.04)	(0.01)	(0.01)
FDP X Low intensity zone (=1)	0.035**	-0.003	-0.001	-0.008	0.006	-0.001
	(0.01)	(0.03)	(0.02)	(0.03)	(0.01)	(0.01)
Farmer score ([0-1])	0.032	-0.192	0.174	0.178	-0.053	-0.232
	(0.06)	(0.44)	(0.35)	(0.51)	(0.11)	(0.14)
Farmer score^2	0.012	-1.676	0.689	-2.739	-0.404	-0.769
	(0.23)	(1.75)	(1.37)	(2.07)	(0.37)	(0.54)
FDP X Farmer score	0.041	0.368	-0.192	0.109	-0.008	0.241
	(0.20)	(0.49)	(0.40)	(0.57)	(0.15)	(0.15)
FDP X Farmer score^2	0.249	1.435	-0.998	3.115	0.566	0.743
	(0.65)	(1.85)	(1.48)	(2.18)	(0.49)	(0.54)
Control Mean	0.00	0.76	0.83	0.59	0.02	0.98
Strata FE	Y	Y	Y	Y	Y	Y
R2	0.08	0.11	0.25	0.15	0.03	0.03
Observations	4655	4655	4655	4655	4655	4655

Notes: This table presents impacts of the FDP on the take up of selected good agricultural practices by zone type. Observations include FDP and non-FDP farmers. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3.21: Impact of organizational capabilities interventions on agricultural practices take up

	(1) Received seedlings (=1)	(2) Applied organic fertilizers (=1)	(3) Did pruning (=1)	(4) Planted shading trees (=1)	(5) Applied lime (=1)	(6) Did tiling (=1)
RM Experiment						
Fixed RM (=1)	-0.013	0.042*	-0.025	0.044*	0.010	-0.001
	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.00)
Placebo RM (=1)	0.030*	-0.014	-0.003	0.027	0.002	0.003
	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.00)
Communication Experiment						
Call centre call (=1)	0.040**	0.015	-0.005	0.024	0.007	-0.005
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.00)
Fixed RM call (=1)	0.037*	0.005	-0.021	-0.024	0.007	-0.003
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.00)
Placebo RM call (=1)	0.030	0.010	0.007	0.021	0.004	-0.002
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.00)
Farmer score ([0-1])	0.049	0.120	-0.016	0.271*	-0.019	0.014
	(0.08)	(0.10)	(0.08)	(0.11)	(0.04)	(0.02)
Call centre launch SMS (=1)	0.040**	-0.005	-0.028	0.038	0.003	-0.008*
	(0.01)	(0.02)	(0.02)	(0.02)	(0.01)	(0.00)
Control Mean (RM)	0.10	0.79	0.85	0.67	0.02	0.99
Control Mean (Communication)	0.08	0.77	0.85	0.67	0.02	1.00
R2	0.08	0.12	0.26	0.16	0.04	0.03
Observations	2846	2846	2846	2846	2846	2846

Notes: This table shows impacts of the RM and communication experiments on the take up of selected good agricultural practices. Observations include only FDP farmers who were invited to attend with Fixed RM, Control RM, or Placebo RM. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Coffee delivery

Table 3.22: Impact of FDP on coffee delivery using DiD

	(1)	(2)	(3)
Panel A: FDP CWSs			
	Coffee delivery (=1)	Coffee delivery - standard (kg)	Coffee delivery - floater (kg)
FDP x Post (=1)	0.108***	306.817***	8.618***
	(0.01)	(44.15)	(1.53)
Control Mean	0.55	143.58	4.70
Farmer FE	Y	Y	Y
Strata x Year FE	Y	Y	Y
Farmers	4902	4902	4902
Years	3	3	3
Observations	14706	14706	14706
Panel B: All CWSs			
	Coffee delivery (=1)	Coffee delivery - standard (kg)	Coffee delivery - floater (kg)
FDP x Post (=1)	0.118***	287.713***	7.060***
	(0.01)	(24.92)	(1.22)
Control Mean	0.17	53.89	2.61
Farmer FE	Y	Y	Y
CWS x Year FE	Y	Y	Y
Farmers	14754	14754	14754
Years	3	3	3
Observations	44262	44262	44262
Panel C: All CWSs and farmers with similar scores			
	Coffee delivery (=1)	Coffee delivery - standard (kg)	Coffee delivery - floater (kg)
FDP x Post (=1)	0.110***	144.383*	-10.876*
	(0.03)	(68.33)	(4.67)
Control Mean	0.12	49.42	3.01
Farmer FE	Y	Y	Y
CWS x Year FE	Y	Y	Y
Farmers	10032	10032	10032
Years	3	3	3
Observations	30096	30096	30096

Notes: This table presents the impacts of the FDP on administrative coffee delivery outcomes using DiD. The treatment is on the farmer level. Panel A focuses on farmers from the four pilot CWSs and Panel B uses farmers from 18 CWSs. Panel C is the same as Panel B but uses on the top 60% farmers from the non-FDP CWSs as a control group. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3.23: Impact of FDP on coffee delivery using RDD

	(1) Admin coffee delivery (kg)	(2) Self-reported coffee delivery (kg)	(3) Admin coffee delivery – certified A grade (kg)	(4) Number of transactions
FDP (=1)	-24.894	29.282	-19.258	-0.277
	(24.10)	(22.83)	(18.98)	(0.69)
Farmer score ([0-1])	1008.815***	694.324*	798.027***	21.801*
	(281.34)	(287.60)	(229.77)	(8.60)
Farmer score^2	1105.075	-248.904	646.928	2.981
	(962.87)	(1093.37)	(802.74)	(32.07)
FDP X Farmer score	-195.534	-425.289	-227.933	0.271
	(464.59)	(436.98)	(362.00)	(13.35)
FDP X Farmer score^2	4761.658**	8043.660***	4704.431***	107.461*
	(1682.77)	(1634.74)	(1322.37)	(50.49)
Control Mean	160.97	215.85	128.47	7.66
Strata FE	Y	Y	Y	Y
R2	0.26	0.31	0.28	0.23
Observations	4902	4655	4902	4902

Notes: This table presents the impacts of the FDP on coffee delivery using RDD. Observations include FDP and non-FDP farmers. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3.24: Heterogeneous impact of FDP on coffee delivery using RDD

	(1) Admin coffee delivery (kg)	(2) Self-reported coffee delivery (kg)	(3) Admin coffee delivery – certified A grade (kg)	(4) Number of transactions
FDP (=1)	-120.748***	-84.196**	-107.168***	-2.427**
	(27.17)	(26.04)	(21.74)	(0.80)
FDP X Low intensity zone (=1)	165.179***	192.908***	151.488***	3.705***
	(25.66)	(25.90)	(20.67)	(0.73)
Farmer score ([0-1])	784.241**	447.606	592.066*	16.764
	(283.22)	(287.33)	(230.96)	(8.55)
Farmer score^2	830.930	-536.122	395.505	-3.169
	(959.11)	(1086.42)	(799.32)	(31.89)
FDP X Farmer score	166.799	-16.490	104.368	8.399
	(476.96)	(447.39)	(372.82)	(13.49)
FDP X Farmer score^2	4869.450**	8130.128***	4803.290***	109.879*
	(1677.12)	(1627.02)	(1317.16)	(50.37)
Control Mean	160.97	215.85	128.47	7.66
Strata FE	Y	Y	Y	Y
R2	0.26	0.31	0.28	0.23
Observations	4902	4655	4902	4902

Notes: This table presents the impacts of the FDP on coffee delivery by zone type using RDD. Observations include FDP and non-FDP farmers. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3.25: Impact of organizational capabilities interventions on coffee delivery

	(1) Admin coffee delivery (kg)	(2) Self-reported coffee delivery (kg)	(3) Admin coffee delivery – certified A grade (kg)	(4) Number of transactions
RM Experiment				
Fixed RM (=1)	12.243	-2.566	6.193	0.740
	(20.62)	(19.95)	(16.42)	(0.53)
Placebo RM (=1)	5.793	-1.653	13.164	0.657
	(19.70)	(19.76)	(16.09)	(0.53)
Communication Experiment				
Call centre call (=1)	-34.857	-16.059	-25.602	-0.026
	(24.17)	(24.94)	(19.41)	(0.65)
Fixed RM call (=1)	-37.957	-30.133	-27.063	-0.350
	(23.47)	(23.76)	(18.71)	(0.61)
Placebo RM call (=1)	-11.956	-43.382	-7.055	0.253
	(25.92)	(23.80)	(20.59)	(0.67)
Farmer score ([0-1])	2249.963***	2502.503***	1946.591***	45.395***
	(152.68)	(154.23)	(122.08)	(4.43)
Call centre launch SMS (=1)	-100.857***	-137.959***	-94.762***	-3.345***
	(22.68)	(20.32)	(17.81)	(0.75)
Harvest experiment call (=1)	-19.278	11.270	-10.697	-0.448
	(17.74)	(16.55)	(13.90)	(0.47)
Control Mean (RM)	352.19	425.12	282.33	12.10
Control Mean (Communication)	404.64	466.60	316.02	12.99
R2	0.31	0.35	0.33	0.29
Observations	2959	2846	2959	2959

Notes: This table shows impacts of the RM and communication experiments on coffee delivery. Observations include only FDP farmers who were invited to attend with Fixed RM, Control RM, or Placebo RM. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Robustness Checks

Table 3.26: Impact of FDP using number of invited sessions

	(1) Agri 1 attendance (=1)	(2) Agri 2 attendance (=1)	(3) Relationship-building attendance (=1)	(4) Trust CWS about loans [1 − 10]	(5) Trust CWS about Agri training [1 − 10]	(6) Aware of Agri practices (number)	(7) Received seedlings (=1)	(8) Self-reported coffee delivery (kg)
Invited to 1 session (=1)	0.150*	0.170*	0.066	0.309	0.113	1.642**	0.005	30.345
	(0.06)	(0.08)	(0.06)	(0.26)	(0.24)	(0.52)	(0.03)	(60.77)
Invited to 2 sessions (=1)	0.344***	0.229***	0.229***	0.195	0.297*	1.925***	0.110***	31.866
	(0.04)	(0.04)	(0.03)	(0.13)	(0.13)	(0.33)	(0.02)	(30.83)
Invited to 3 sessions (=1)	0.402***	0.408***	0.287***	0.273**	0.352***	2.228***	0.088***	24.277
	(0.03)	(0.02)	(0.02)	(0.09)	(0.09)	(0.24)	(0.02)	(28.89)
Farmer score ([0-1])	0.284*	0.280	0.174	-3.438*	-0.295	2.566	0.082	735.154
	(0.11)	(0.14)	(0.11)	(1.43)	(1.55)	(2.60)	(0.06)	(396.99)
Farmer score^2	0.408	0.672	0.383	-10.352	1.288	1.579	0.075	-118.924
	(0.38)	(0.41)	(0.39)	(5.51)	(6.59)	(8.28)	(0.23)	(1476.77)
FDP X Farmer score	1.144*	0.910*	0.927**	2.244	0.788	7.147*	-0.032	-448.526
	(0.44)	(0.39)	(0.34)	(1.84)	(1.58)	(3.26)	(0.25)	(604.69)
FDP X Farmer score^2	-2.679*	-2.285*	-2.019*	16.903**	-0.414	-15.899	0.207	7872.759**
	(1.14)	(0.94)	(0.87)	(6.18)	(7.13)	(9.53)	(0.84)	(2441.18)
Strata FE	Y	Y	Y	Y	Y	Y	Y	Y
R2	0.34	0.34	0.23	0.06	0.10	0.27	0.08	0.31
Observations	4902	4902	4902	4655	4655	4902	4655	4655

Notes: This table presents the impacts of the FDP using the number of invited sessions instead of the FDP assignment. Observations include FDP and non-FDP farmers. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3.27: Impact of FDP on those with no prior knowledge with the CWS manager

	(1) Agri 1 attendance (=1)	(2) Agri 2 attendance (=1)	(3) Relationship-building attendance (=1)	(4) Trust CWS about loans $[1-10]$	(5) Trust CWS about Agri training $[1-10]$	(6) Aware of Agri practices (number)	(7) Received seedlings (=1)	(8) Self-reported coffee delivery (kg)
FDP (=1)	0.374***	0.383***	0.302***	0.492*	0.454**	2.044***	0.062**	-51.180
	(0.04)	(0.04)	(0.04)	(0.19)	(0.17)	(0.33)	(0.02)	(31.02)
Farmer score ([0-1])	0.330*	0.470*	0.139	-4.096	-2.656	1.597	0.133	702.342
	(0.16)	(0.20)	(0.17)	(2.67)	(2.36)	(3.59)	(0.10)	(388.59)
Farmer score^2	0.736	1.261*	0.442	-8.080	-5.152	-1.126	0.327	467.229
	(0.55)	(0.64)	(0.57)	(9.98)	(8.84)	(13.84)	(0.32)	(1442.55)
FDP X Farmer score	1.204	0.233	0.532	1.649	4.390	8.252	0.042	820.169
	(0.73)	(0.72)	(0.71)	(3.46)	(2.96)	(5.77)	(0.39)	(631.76)
FDP X Farmer score^2	-3.822	-1.548	-1.281	16.827	0.408	-18.336	-0.621	-1851.307
	(2.79)	(2.78)	(2.70)	(12.89)	(10.87)	(21.16)	(1.45)	(2570.76)
Strata FE	Y	Y	Y	Y	Y	Y	Y	Y
R2	0.34	0.35	0.26	0.10	0.15	0.28	0.09	0.17
Observations	1731	1731	1731	1625	1625	1731	1625	1625

Notes: This table presents the impacts of the FDP using only farmers with no prior knowledge with the CWS manager. Observations include FDP and non-FDP farmers. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3.28: Impact of FDP using a fake threshold

	(1) Agri 1 attendance (=1)	(2) Agri 2 attendance (=1)	(3) Relationship-building attendance (=1)	(4) Trust CWS about loans $[1-10]$	(5) Trust CWS about Agri training $[1-10]$	(6) Aware of Agri practices (number)	(7) Received seedlings (=1)	(8) Self-reported coffee delivery (kg)
FDP (=1)	0.699	0.477	0.619	-0.575	-0.951	3.261	0.174	-188.008
	(0.43)	(0.44)	(0.44)	(1.33)	(1.03)	(2.43)	(0.31)	(619.29)
Farmer score ([0-1])	2.225***	2.037***	1.590***	0.094	1.596***	13.831***	0.407***	1181.737***
	(0.06)	(0.06)	(0.06)	(0.28)	(0.24)	(0.47)	(0.04)	(70.48)
Farmer score^2	2.347***	1.978***	2.029***	2.292	4.446**	15.410***	-0.123	2050.941***
	(0.41)	(0.40)	(0.38)	(1.89)	(1.61)	(3.18)	(0.21)	(406.98)
FDP X Farmer score	-4.385	-2.435	-3.527	2.534	4.283	-19.999	-1.140	214.256
	(2.93)	(2.98)	(2.95)	(9.03)	(6.78)	(16.47)	(2.19)	(4356.91)
FDP X Farmer score^2	1.194	-1.726	0.670	-1.000	-9.126	-4.238	1.583	4315.589
	(4.79)	(4.86)	(4.79)	(14.83)	(10.83)	(27.00)	(3.68)	(7340.15)
Strata FE	Y	Y	Y	Y	Y	Y	Y	Y
R2	0.27	0.27	0.20	0.06	0.10	0.23	0.07	0.28
Observations	4902	4902	4902	4655	4655	4902	4655	4655

Notes: This table presents the impacts of the FDP using a fake threshold- the 90th percentile of the evaluation score. Observations include FDP and non-FDP farmers. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3.29: Impact of FDP using a triangular kernel density

	(1) Agri 1 atendance (=1)	(2) Agri 2 attendance (=1)	(3) Relationship- building attendance (=1)	(4) Trust CWS about loans $[1-10]$	(5) Trust CWS about Agri training $[1-10]$	(6) Aware of Agri practices (number)	(7) Received seedlings (=1)	(8) Self-reported coffee delivery (kg)
FDP (=1)	0.395***	0.389***	0.279***	0.295*	0.327**	2.237***	0.090***	26.706
	(0.02)	(0.02)	(0.02)	(0.11)	(0.10)	(0.18)	(0.01)	(22.04)
Farmer score ([0-1])	0.227*	0.211*	0.171	-3.794*	-0.297	1.684	0.071	640.309*
	(0.10)	(0.10)	(0.09)	(1.80)	(1.64)	(2.41)	(0.06)	(295.49)
Farmer score^2	0.183	0.406	0.350	-11.463	1.233	-1.839	0.043	-436.361
	(0.40)	(0.38)	(0.36)	(6.98)	(6.30)	(9.44)	(0.23)	(1131.95)
FDP X Farmer score	1.189***	0.865**	0.881**	2.423	1.037	7.794*	0.009	-333.093
	(0.30)	(0.31)	(0.30)	(2.05)	(1.82)	(3.06)	(0.19)	(423.21)
FDP X Farmer score^2	-2.436**	-1.686	-1.829	18.381*	-1.164	-11.923	0.137	8022.081***
	(0.95)	(0.95)	(0.94)	(7.59)	(6.67)	(11.00)	(0.63)	(1608.88)
Strata FE	Y	Y	Y	Y	Y	Y	Y	Y
R2	0.33	0.33	0.23	0.06	0.10	0.27	0.08	0.28
Observations	4902	4902	4902	4655	4655	4902	4655	4655

Notes: This table presents the impacts of the FDP using a the triangular kernel density. Observations include FDP and non-FDP farmers. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3.30: Impact of FDP using clustered standard errors

	(1) Agri 1 attendance (=1)	(2) Agri 2 attendance (=1)	(3) Relationship-building attendance (=1)	(4) Trust CWS about loans $[1-10]$	(5) Trust CWS about Agri training $[1-10]$	(6) Aware of Agri practices (number)	(7) Received seedlings (=1)	(8) Self-reported coffee delivery (kg)
FDP (=1)	0.396***	0.387***	0.278***	0.298**	0.338***	2.230***	0.091***	29.282
	(0.03)	(0.02)	(0.02)	(0.10)	(0.09)	(0.25)	(0.02)	(27.98)
Farmer score ([0-1])	0.235*	0.208	0.162	-3.812*	-0.255	1.981	0.077	694.324
	(0.11)	(0.13)	(0.11)	(1.48)	(1.56)	(2.70)	(0.06)	(397.08)
Farmer score^2	0.231	0.382	0.327	-11.583*	1.399	-0.462	0.065	-248.904
	(0.37)	(0.38)	(0.40)	(5.68)	(6.63)	(8.66)	(0.22)	(1470.32)
FDP X Farmer score	1.146*	0.920*	0.911**	2.439	0.742	7.402*	-0.034	-425.289
	(0.43)	(0.37)	(0.33)	(1.86)	(1.58)	(3.32)	(0.25)	(607.42)
FDP X Farmer score^2	-2.385	-1.837	-1.891*	18.560**	-0.503	-13.053	0.234	8043.660**
	(1.19)	(0.96)	(0.90)	(6.34)	(7.19)	(9.95)	(0.84)	(2432.64)
Strata FE	Y	Y	Y	Y	Y	Y	Y	Y
R2	0.33	0.33	0.23	0.06	0.10	0.27	0.08	0.31
Observations	4902	4902	4902	4655	4655	4902	4655	4655

Notes: This table presents the impacts of the FDP using clustered standard errors on the zone level. Observations include FDP and non-FDP farmers. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

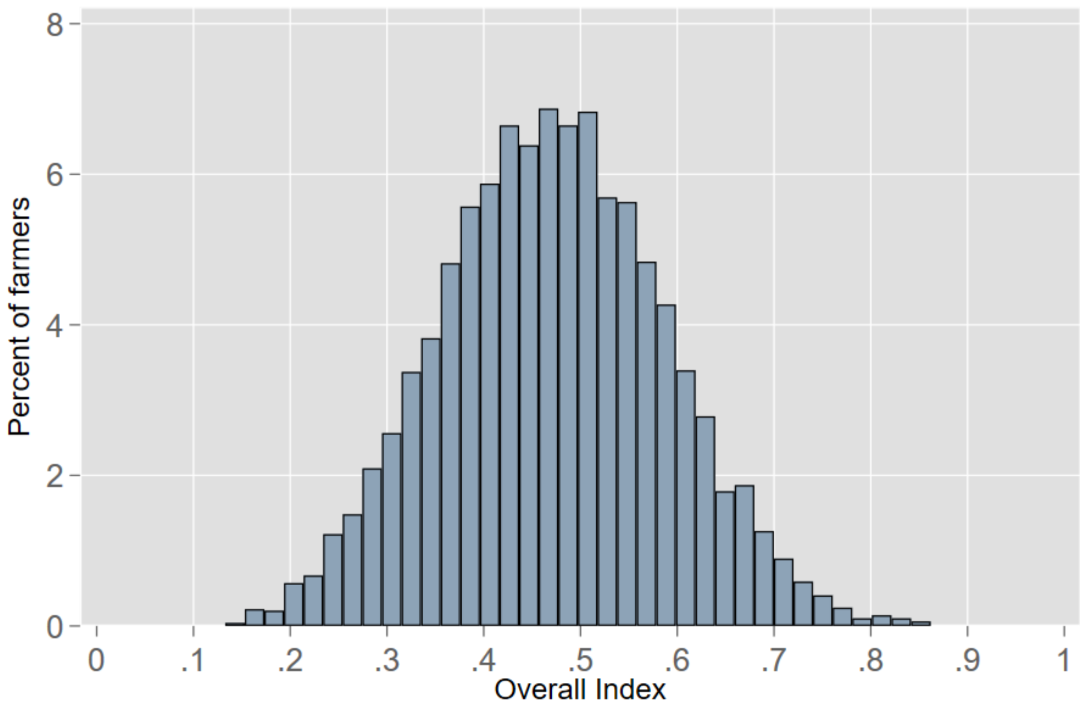
Table 3.31: Impact of FDP using a non-parametric RDD framework

	(1) Agri 1 attendance (=1)	(2) Agri 2 attendance (=1)	(3) Relationship-building attendance (=1)	(4) Trust CWS about loans $[1-10]$	(5) Trust CWS about Agri training $[1-10]$	(6) Aware of Agri practices (number)	(7) Received seedlings (=1)	(8) Self-reported coffee delivery (kg)
FDP (=1)	0.411***	0.401***	0.331***	0.059	0.275	2.558***	0.057**	-8.502
	(0.03)	(0.03)	(0.03)	(0.21)	(0.17)	(0.31)	(0.02)	(38.93)
N	4902	4902	4902	4655	4655	4902	4655	4655
Left-thershold N	1774	1804	1445	1160	1334	1466	1445	1239
Right-thershold N	2416	2501	1801	1422	1680	1836	1883	1539
Effective left-thershold N	947	996	672	502	557	653	632	542
Effective right-thershold N	1070	1142	773	577	646	748	718	630

Notes: This table presents the impacts of the FDP using a non-parametric RDD framework. Observations include FDP and non-FDP farmers. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

3.10 Figures

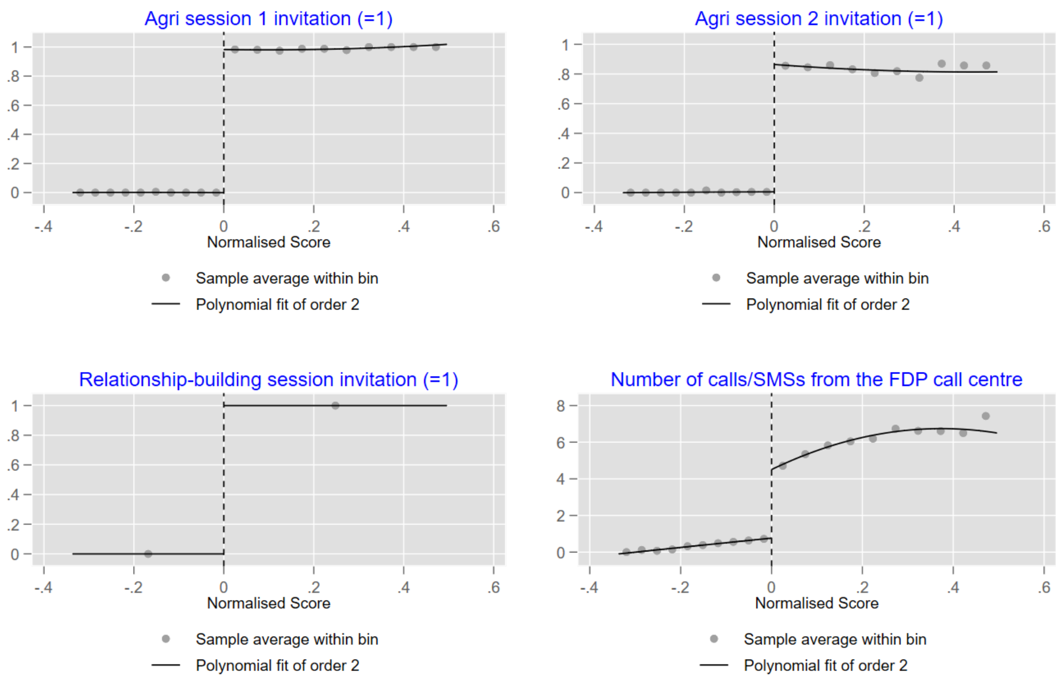
Figure 3.2: Distribution of farmer scores



Note: This figure exhibits the distribution of the overall farmer score. We used the categories and weights outlined in Table C.1 to calculate farmer scores.

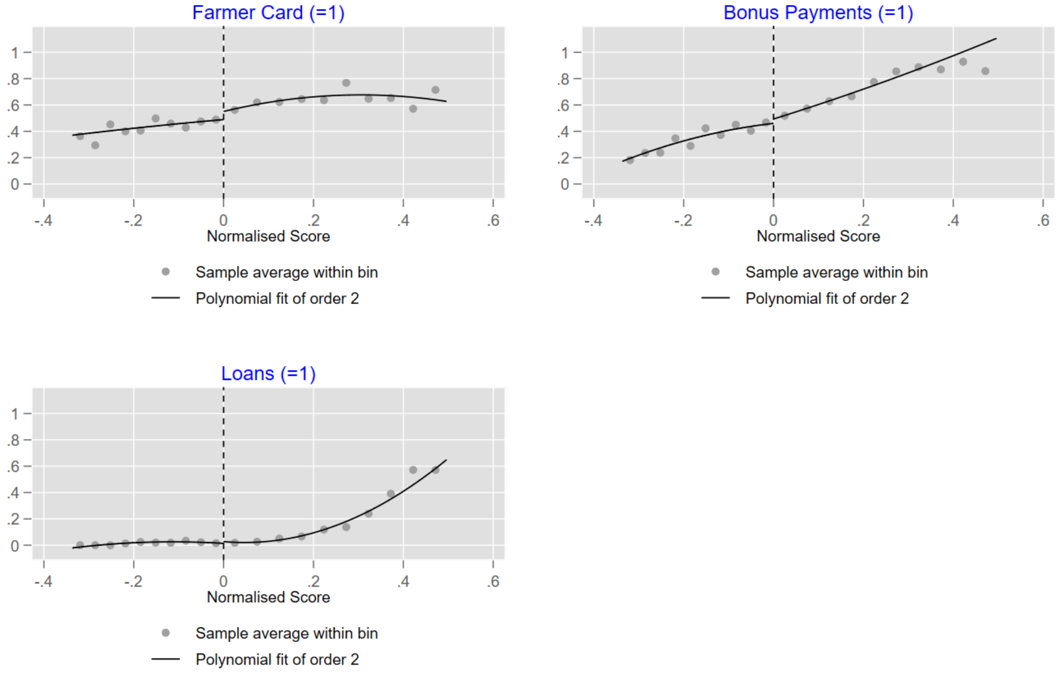
FDP delivery and placebo components

Figure 3.3: Discontinuity plots of FDP components



Note: This figure displays regression discontinuity plots of the FDP elements between the FDP and non-FDP farmers. They are based on evenly spaced partitioning using the ”rdplot” Stata command. It shows both binned sample means and polynomial point estimates.

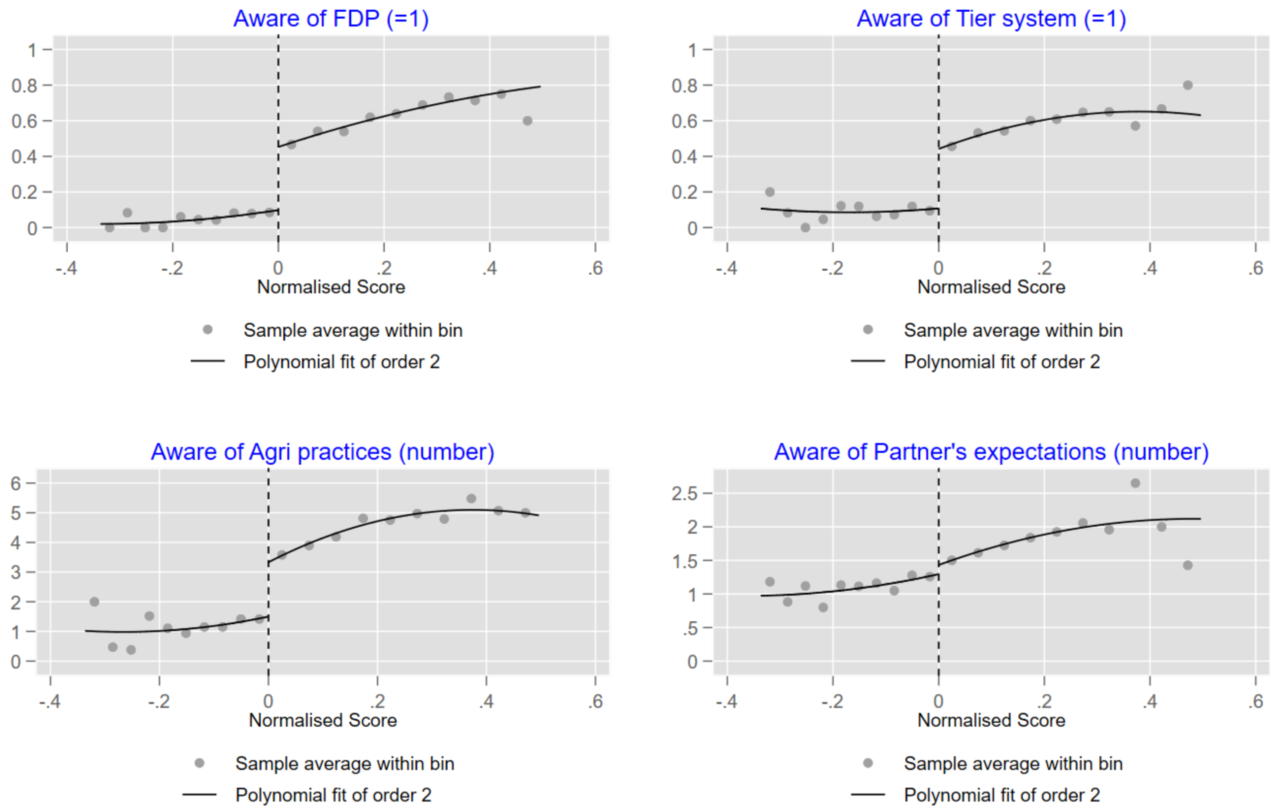
Figure 3.4: Discontinuity plots of FDP placebo components



Note: This figure displays regression discontinuity plots of the placebo elements that the Partner implemented not as a part of the FDP. They are based on evenly spaced partitioning using the "rdplot" Stata command. It shows both binned sample means and polynomial point estimates.

Awareness and expectations of FDP

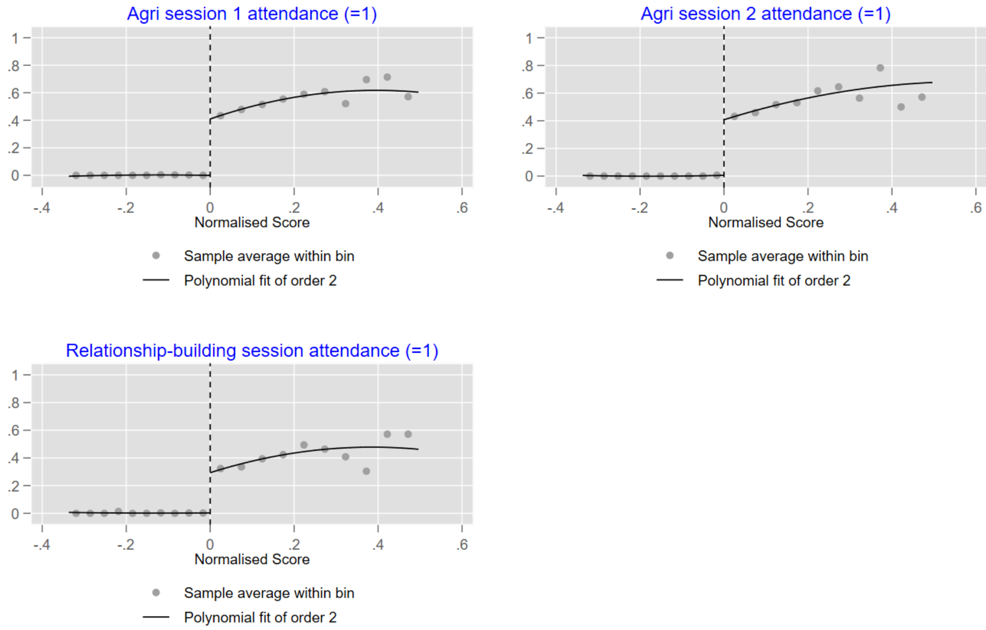
Figure 3.5: Discontinuity plots of awareness and expectations of FDP



Note: This figure displays regression discontinuity plots of awareness and expectations between the FDP and non-FDP farmers. They are based on evenly spaced partitioning using the "rdplot" Stata command. It shows both binned sample means and polynomial point estimates.

Session attendance

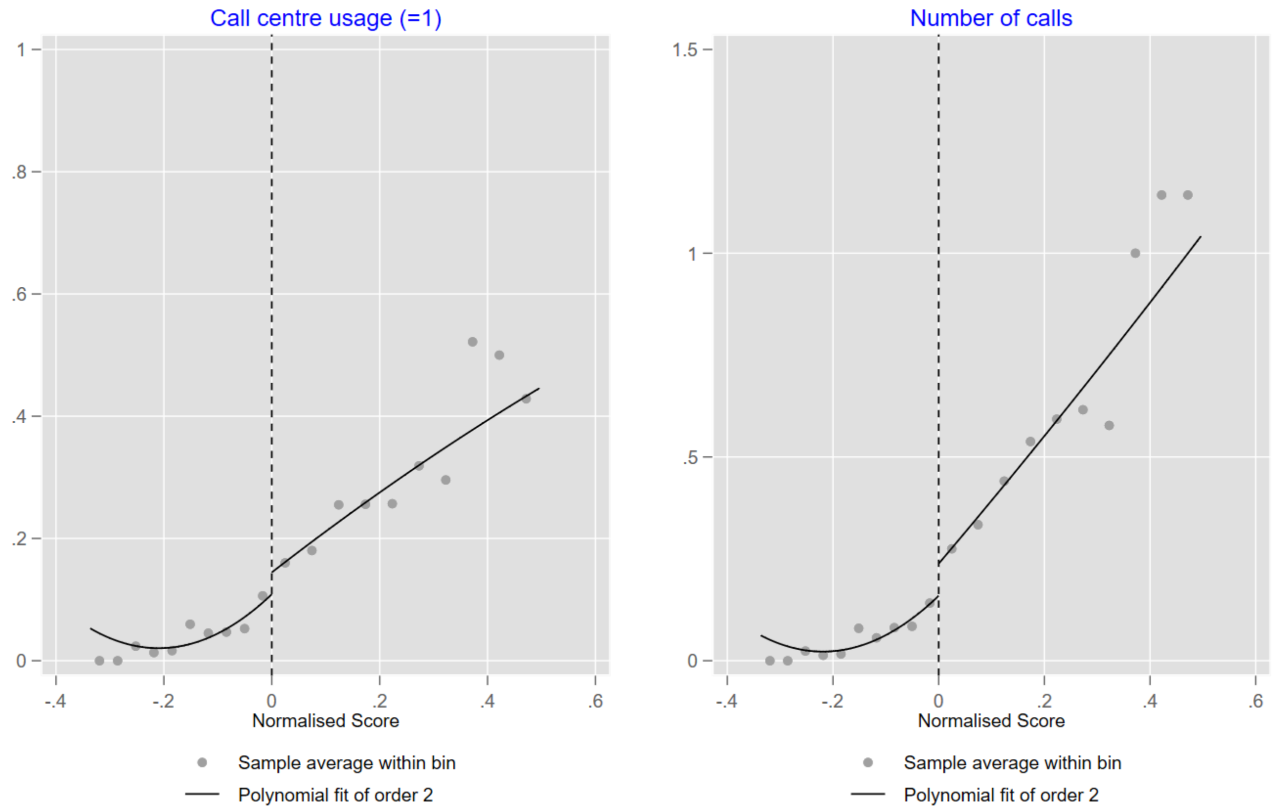
Figure 3.6: Discontinuity plots of sessions attendance



Note: This figure displays regression discontinuity plots of session attendance between the FDP and non-FDP farmers. They are based on evenly spaced partitioning using the "rdplot" Stata command. It shows both binned sample means and polynomial point estimates.

Call centre usage

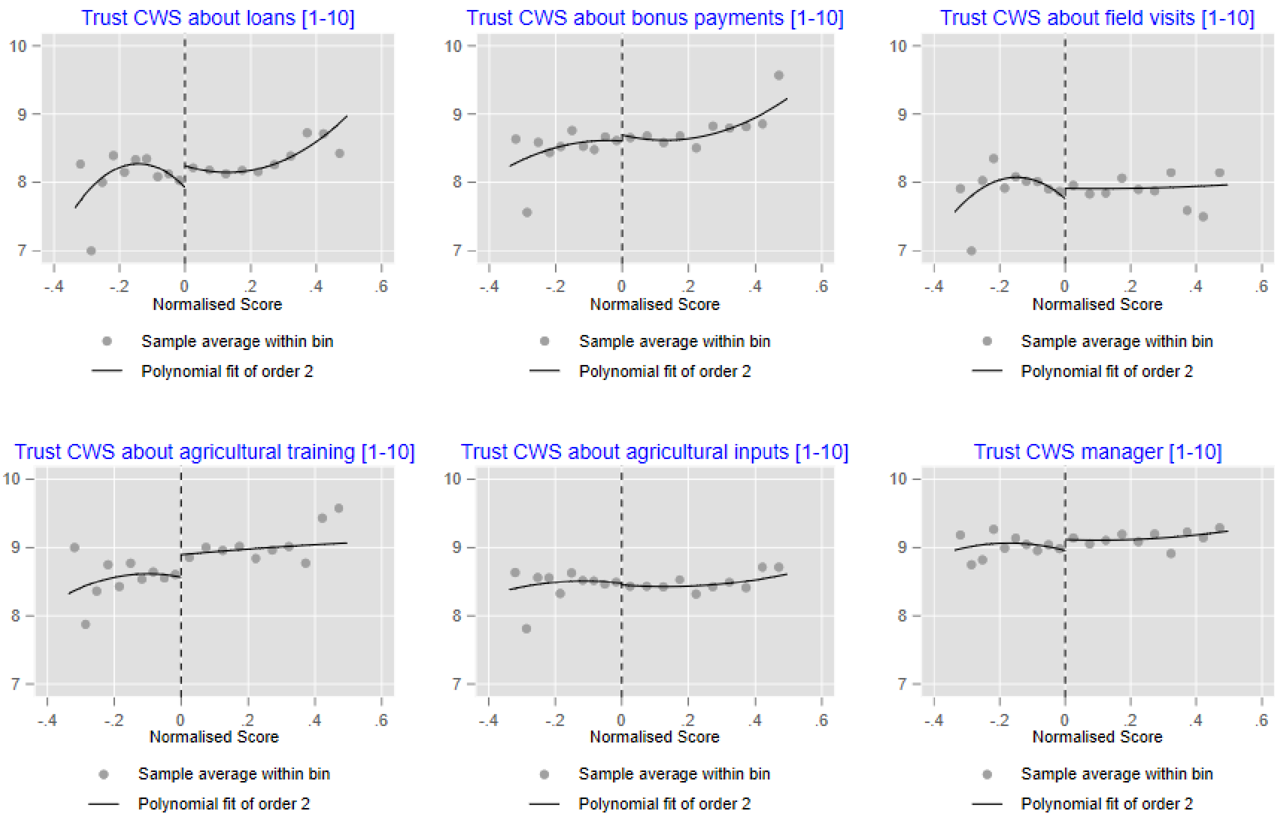
Figure 3.7: Discontinuity plots of call centre engagement



Note: This figure displays regression discontinuity plots of call centre engagement between the FDP and non-FDP farmers. They are based on evenly spaced partitioning using the "rdplot" Stata command. It shows both binned sample means and polynomial point estimates.

Trust towards CWS

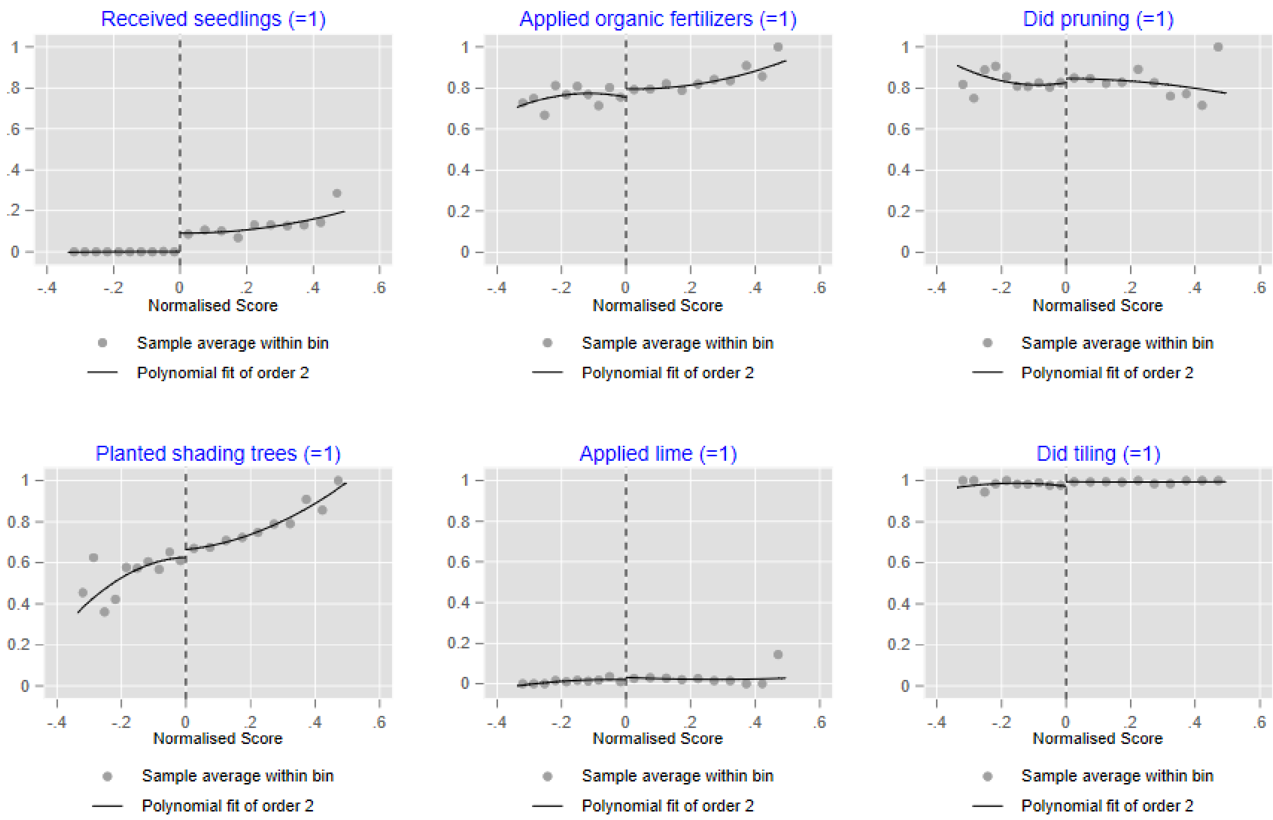
Figure 3.8: Discontinuity plots of trust towards CWS



Note: This figure displays regression discontinuity plots of farmer trust towards CWS between the FDP and non-FDP farmers. They are based on evenly spaced partitioning using the "rdplot" Stata command. It shows both binned sample means and polynomial point estimates.

Agricultural practices

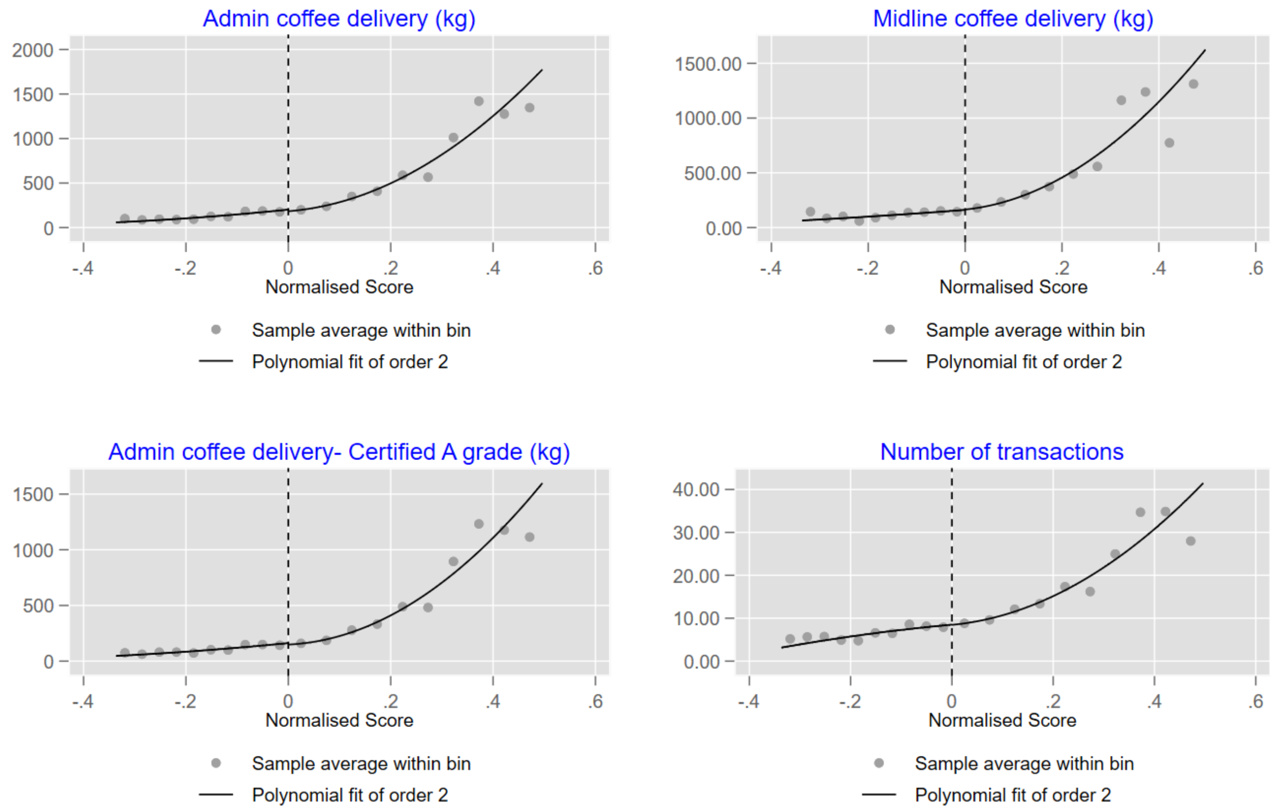
Figure 3.9: Discontinuity plots of agricultural practices take up



Note: This figure displays regression discontinuity plots of the take up of selected good agricultural practices, over 6 months after the FDP was launched, between the FDP and non-FDP farmers. They are based on evenly spaced partitioning using the "rdplot" Stata command. It shows both binned sample means and polynomial point estimates.

Coffee delivery

Figure 3.10: Discontinuity plots of coffee delivery



Note: This figure displays regression discontinuity plots of coffee delivery outcomes. They are based on evenly spaced partitioning using the ”rdplot” Stata command. It shows both binned sample means and polynomial point estimates.

Conclusion

The thesis explored empirically farmer constraints and relational contracts in three agricultural value chains in East Africa. It first provides evidence on the impact of a business plan competition on selected economic outcomes for horticultural farmers in Rwanda. It then assesses the the relationship between cash constraints and relational contracts using administrative data from dairy cooperatives in Kenya. Finally, it addresses research questions relating how to build and maintain relationships with farmers in the Rwanda coffee sector.

The first chapter provides empirical evidence that business plan competitions can effectively mitigate credit constraints among farmers. Results from a business plan competition involving horticultural farmers in Rwanda suggested some positive effects on household farming activity across several dimensions. Nevertheless, a key finding is that the business plan competition proved more effective when endorsing plans for farmers related to their current business activity rather than new ones. Such conclusions add to the existing literature on the heterogeneity between pre-existing and new entrepreneurs in the wake of micro-finance interventions (Banerjee et al., 2019; Meager, 2019).

The second chapter provides natural experimental evidence on the importance of the cash-in-advance service as a mode of contract enforcement between farmers and cooperatives in the Kenya dairy sector. The analysis utilizes daily and monthly transactions for around 48,000 farmers and 14 cooperatives over the period covering January-June 2015. We povide suggestive evidence that the cash-in-advance treatment increases milk delivery to cooperatives. There are two mechanisms through which this operates, namely monthly milk payments target and farmer loyalty. The former indicates that farmers have a target of monthly income payments from cooperatives, and that provides a reason why they increase their milk delivery in the event of obtaining cash-in-advance. Farmer loyalty is another complementary reason. Farmers presumably see the cash-in-advance service as a way of cooperatives softening the commitment device of monthly payments in order to help farmers meet their cash needs. We also provide evidence on the heterogeneous effects of cash-in-advance in terms of gender and the payment method used for transactions between farmers and cooperatives. Specifically, women and cash farmers experience larger impacts. These results inform recent empirical evidence that demonstrate soft savings commitment devices have greater impacts compared to hard commitment devices (Dupas and Robinson, 2013b). It also complements the work of Casaburi and Macchiavello (2019) to provide evidence about how to optimally structure infrequent payments through providing a cash-in-advance service to meet lumpy expenses as well as cash constraints.

The third chapter provides evidence on the short-term impact of the roll-out of a Farmer Development Program (FDP) with the focus of understanding the effectiveness of several organizational interventions aimed at improving relationships with coffee farmers in Rwanda. Results reveal that the FDP and the organizational interventions improved the relationship between coffee washing stations and farmers along several short-run outcomes. The FDP assignment increased awareness about the FDP and good agricultural practices. It caused seedling take up to increase, especially among farmers who were invited from zones with a lower proportion of farmers assigned to the FDP. The same result was observed regarding the call centre usage and coffee delivery. Regarding the organizational experiments, the assignment to a Fixed RM seems to have an additional impact on the awareness of the FDP and good agricultural practices, session attendance, and the take up of some agricultural practices. Compared to the use of SMSs, calls create an additional- and bigger in magnitude than the RMs- impact.

Overall, the three chapters highlight the value of alleviating farmer constraints on farmer outcomes and relational practices. They also provide some implications. First, business plan competitions can effectively ease credit constraints among farmers, even without grant/funding as an immediate winning award. The thesis also emphasizes differentiating between existing and new projects when conducting such competitions. Second, the results stress balancing savings and cash considerations when offering deferred payments to farmers. Finally, the thesis highlights the importance of organizational interventions in building and maintaining long-term relationships with farmers.

Several limitations have arisen. The data used in the first chapter is cross-sectional and do not permit assessing the long-term impacts of the business plan competition on farmers. We also recognize that there may be a sample power issue regarding the number of new businesses included in the analysis. Although the second chapter covers 48,000 dairy farmers in Kenya, it does not capture detailed data on all dairy business inputs (e.g., herd size) and outputs (e.g., milk home consumption) over time. This precluded, for instance, an analysis of the impact of the cash-in-advance service on farmer transactions with informal traders. The data used for the third chapter was on farmers from four CWSs out of 22 CWSs from which our research Partner sources coffee. This weakens our position in terms of the external validity of our results. Finally, despite the similarity of the agricultural value chains studied in this thesis with others in East Africa and other countries, the relevance of my findings might still be an empirical question given the context differences.

My future research agenda will address these limitations in several ways. First, I aim to raise funding for another round of data collection on a larger pool of farmers who participated in the business plan competition studied in this thesis. This will assist in providing empirical evidence on the long-term of such interventions and enhancing statistical power. Second, I plan to complement the quasi-experimental evidence of the second paper with a randomized control trial. The idea is to exogenously deliver cash-in-advance to a subset of farmers (treatment group) and use another group with similar characteristics as a control group. The proposed experiment will include data collection that captures all farmer characteristics and dairy business information. Third, I plan to expand the analysis of the third chapter to include endline data. This will give us more insights into the impacts of the FDP and its organizational experiments on the medium- and long-term outcomes such as agricultural practices and coffee delivery. I am also in the process of scaling up the intervention studied in the third chapter with a research team at LSE. Such a scale-up will help provide results from more CWSs and areas in Rwanda and hence improve the representatives of our sample to the coffee sector in Rwanda.

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Appendix A

Appendix to Chapter 1

A.1 Additional tables

Table A.1: Previous studies on business plan competitions

Context	Award	Data	Sample	Approach	Outcomes	Results
Nigeria	USD 50,000 + Training/ Monitoring	5 years later	3,139	RCT	Business survival Sales Employment Profits	Positive impact of winning McKenzie (2017)
El Salvador **Guatemala** **Nicaragua**	USD 6,000-15,000 + Training	1 year later	1,310	RDD	Start a business Expand a business	Positive impact of training Klinger and Schündeln (2011)
Ethiopia **Tanzania** **Zambia**	USD 1,000	6-months later	750	RCT	Start a business Sales Profits Wealth	Positive impact of winning Fafchamps and Quinn (2017)
USA	USD 73,000 for 64% of winners		4,328	RDD	Funding Survival Employment	Positive impact of winning & Smaller impact of cash prizes Howell (2019)
Nigeria	USD 50,000 + Training/ Monitoring	3 years later	2,506	RCT	Business survival Sales Employment Profits	No impact of scores McKenzie and Sansone (2019)
Ghana	Training	2 years later	400	RCT	Firm performance	No impact of scores & training Fafchamps and Woodruff (2017)

Table A.2: Sample distribution within crop categories

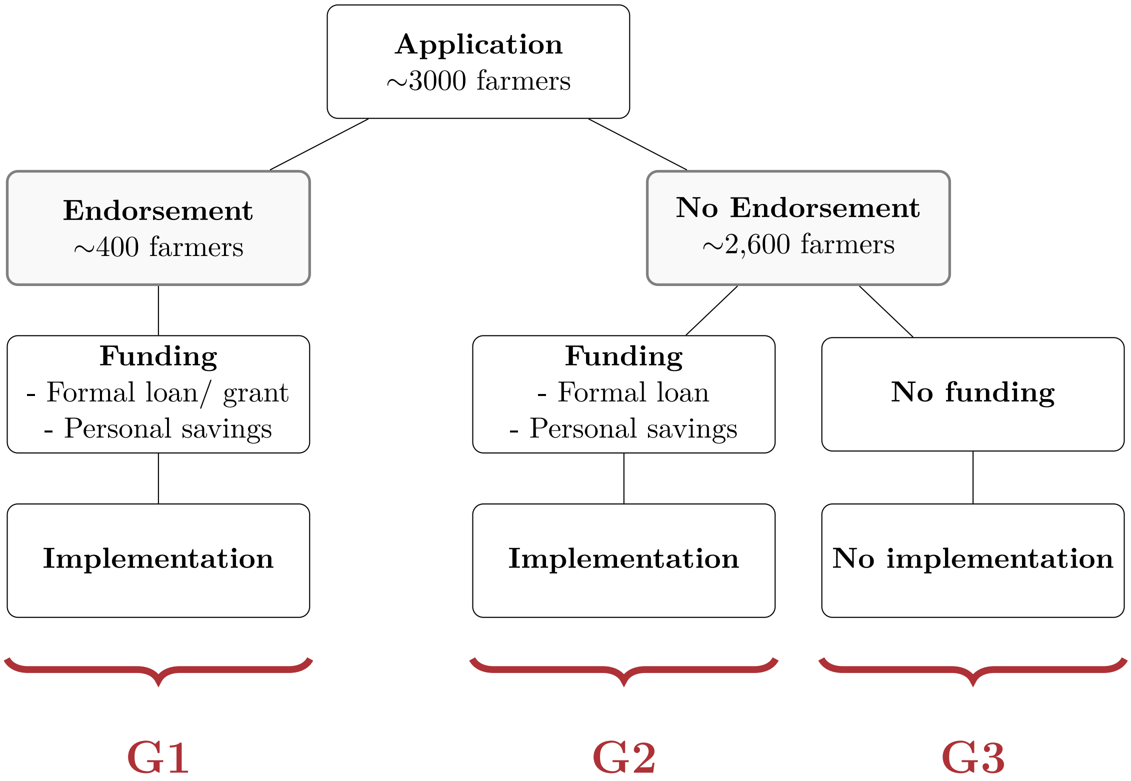
Crop Category	**Total number of farmers**	**Passing score (out of 100)**	**Percentage of endorsed farmers (treatment group)**
1. All horticultural crops (post-harvest value-adding)	110	50	60.9
2. Essential oils & flowers (primary production)	58		70.7
3. Onion (primary production)	199	75	19.6
4. Passion fruit (Primary Production)	133		19.5
5. Apple banana (Primary Production)	159		10.1
6. Pineapple (Primary Production)	134		12.7
7. Other Vegetables & Fruits (Primary Production)	785	80	19.4
Total	1578		

Notes: This table presents a summary of the number of households included in the sample, the passing scores, and the percentage of endorsed farmers within each crop category. The sample was designed to cover all the endorsed farmers and some rejected farmers whose scores are near to the passing scores. Within all crop categories, rejected farmers whose scores are within at least 2 standard deviations from the threshold were interviewed. This criterion was modified to 0.5 standard deviation for the last two crop categories as very few endorsed farmers and too many rejected farmers applied for the competition.

[1] The sample was designed according to these crop categories as the passing scores to win the competition were different across them. It was 50 percent for categories 1-2, 75 percent for categories 3-6, and 80 percent for category 7. These different passing marks were determined in advance to prompt processing, post-harvest, packaging, transport, marketing, essential oil and flowers. That is why the passing score for all crops involving these activities was at the minimum.

A.2 Additional figures

Figure A.1: Stages of the business plan competition



Notes: This figure depicts the stages of the business plan competition as follows: 1) the development and submission of business plans (Application), 2) the evaluation and endorsement (Endorsement), 3) funding applications (Funding), and 4) the implementation with monitoring for farmers who were endorsed and implementation without monitoring for farmers who were rejected (Implementation).

Figure A.2: Some questions asked in the business plan application form

NAEB

PRICE/NATIONAL AGRICULTURAL EXPORT DEVELOPMENT BOARD

Republic of Rwanda

Project for Rural Income through Exports (PRICE)

APPLICATION FORM (URUPAPURO RWO KUZUZA)

1. Briefly explain your business idea?

....

2. What crop(s) will you deal with?

....

3. What status of project?

New project

Existing project

4. How long have you been in business?

....

5. What is the focus of your business idea?

Primary production

Processing

Marketing

6. What are your target markets?

....

7. How much initial investment do you plan for the business?

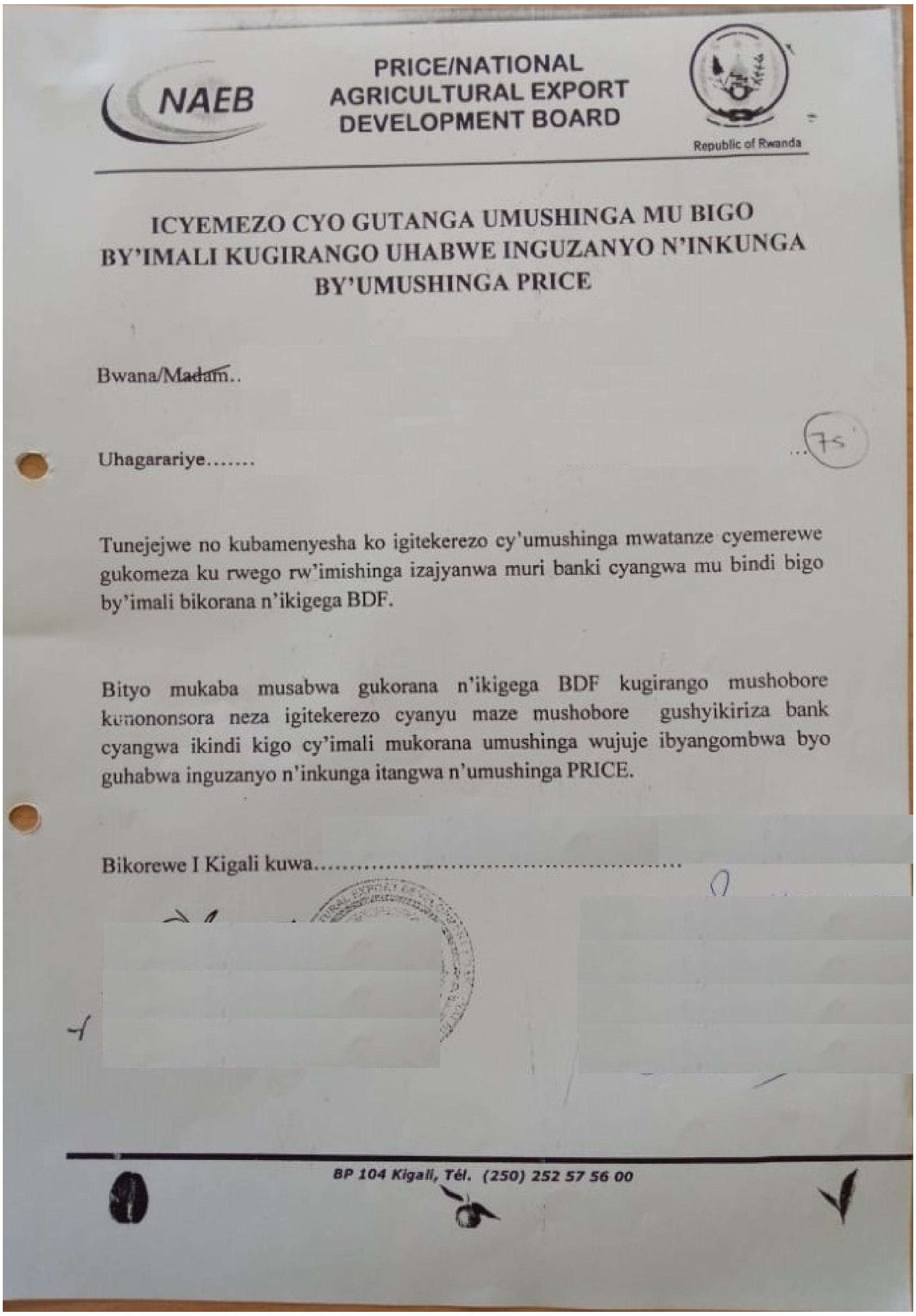
....

8. Why are you interested in that business?

....

Notes: This figure shows some questions asked in the in the standardized business plan application form that horticulture farmers used to apply for the competition. The original application was 5-page long contained questions about the applicants (location, experience, age, etc.), and their business idea (investment cost, horticulture crop, existing/new project, etc.), and farmer's motivation. Questions were asked in English and official language of Rwanda (Kinyarwanda).

Figure A.3: Endorsement letter example



NAEB

PRICE/NATIONAL AGRICULTURAL EXPORT DEVELOPMENT BOARD

Republic of Rwanda

ICYEMEZO CYO GUTANGA UMUSHINGA MU BIGO BY'IMALI KUGIRANGO UHABWE INGUZANYO N'INKUNGA BY'UMUSHINGA PRICE

Bwana/~~Madam~~..

Uhagarariye.......

75

Tunejejwe no kubamenyesha ko igitekerezo cy'umushinga mwatanze cyemerewe gukomeza ku rwego rw'imishinga izajyanwa muri banki cyangwa mu bindi bigo by'imali bikorana n'ikigega BDF.

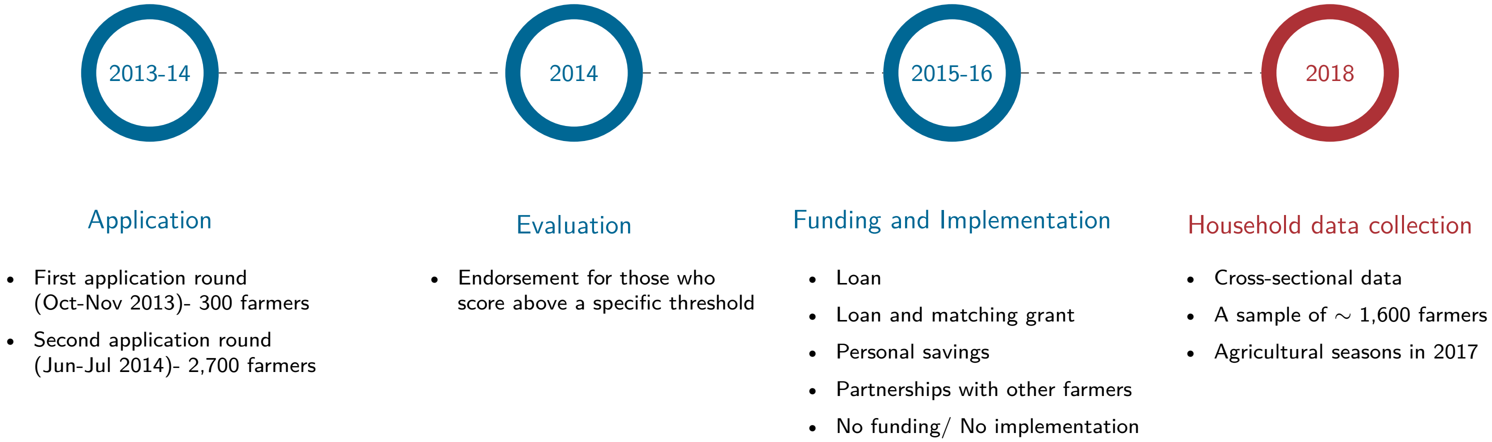
Bityo mukaba musabwa gukorana n'ikigega BDF kugirango mushobore kunononsora neza igitekerezo cyanyu maze mushobore gushyikiriza bank cyangwa ikindi kigo cy'imali mukorana umushinga wujuje ibyangombwa byo guhabwa inguzanyo n'inkunga itangwa n'umushinga PRICE.

Bikorewe I Kigali kuwa...

BP 104 Kigali, Tél. (250) 252 57 56 00

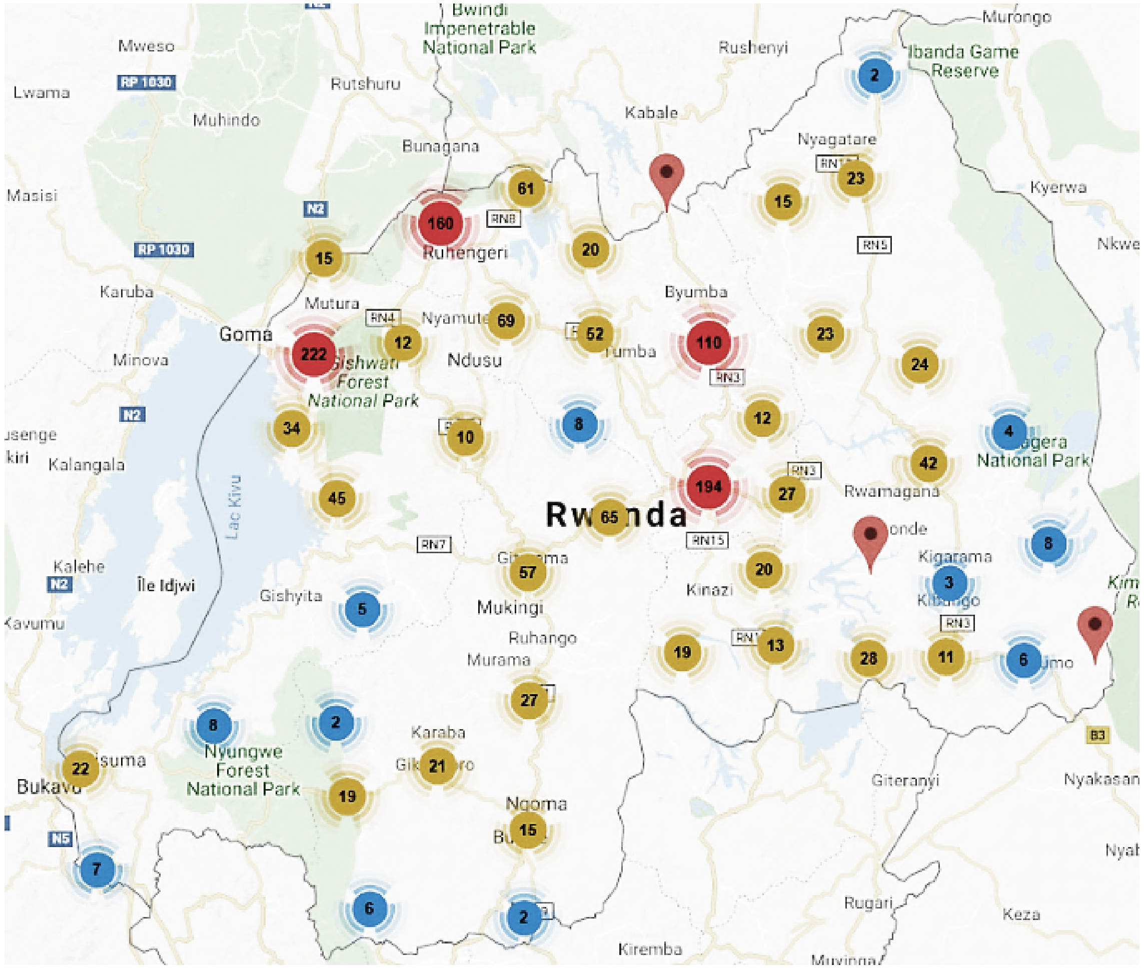
Notes: This figure displays an example of the endorsement letter that was delivered to the competition's winners. It is written in the official language of Rwanda (Kinyarwanda). It indicates that a farmer win the competition (referring to a score out of 100) and encourages farmers to start preparing funding applications to submit to financial institutions. It also confirms that a business plan is endorsed by the National Agricultural Export Development Board (NAEB) and the Bank of Rwanda Development Fund (BDF).

Figure A.4: Timeline of the business plan competition and data collection



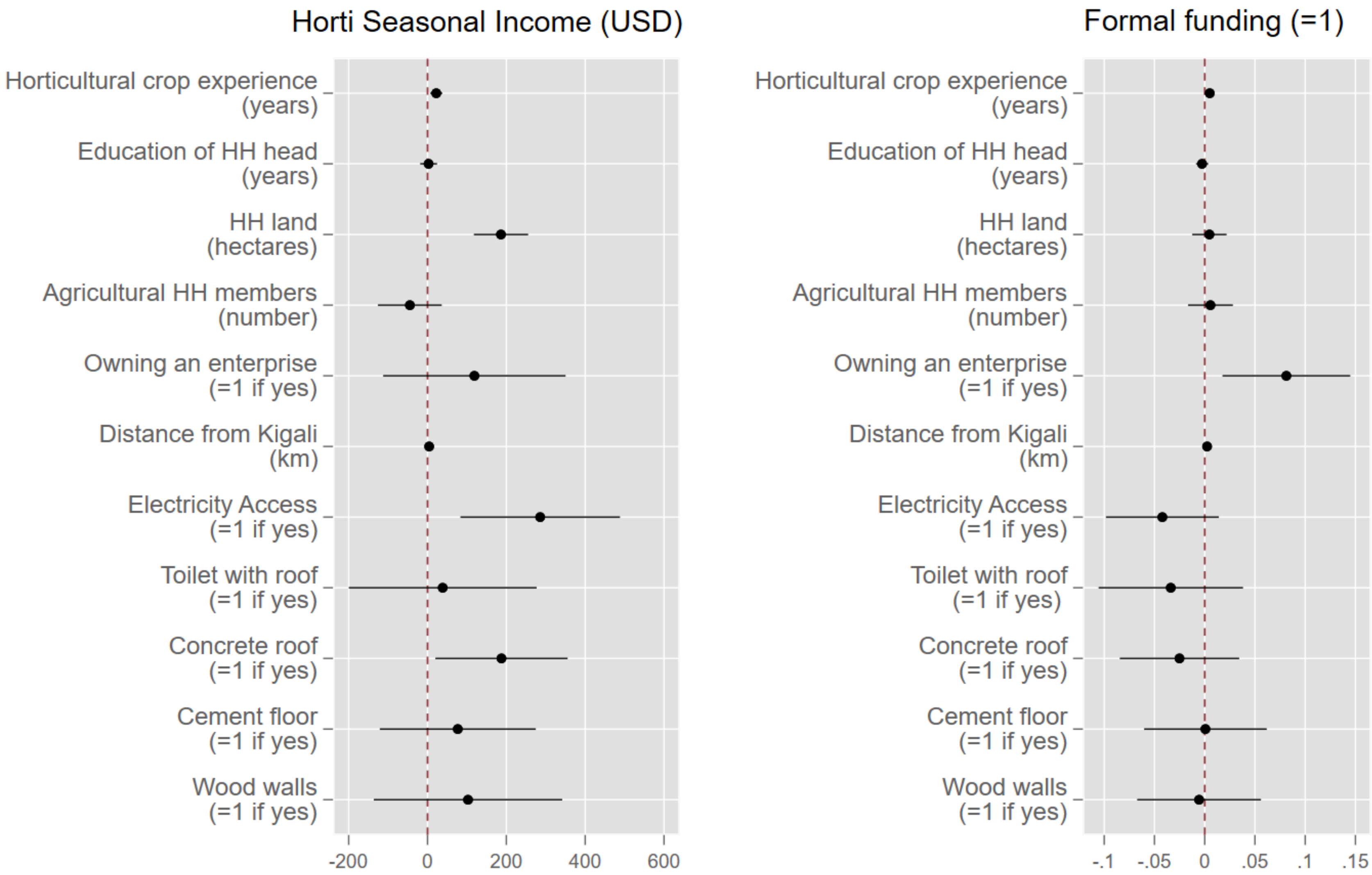
Notes: This figure portrays the stages of the business plan competition and household data collection. The navy circles show the timing of the business plan competition stages (application, endorsement, funding, and implementation). The maroon circle shows the timing of the household data collection.

Figure A.5: Geographic distribution of household data



Note: This figure shows the geographical distribution of the household sample. The numbers in each circle reflect how many households in each area were interviewed. The yellow, blue and red circles respectively refer to a group of fewer than 10 farmers, a group between 10-99 farmers, and a group of more than 100 farmers.

Figure A.6: The association of control variables with selected household outcomes



This graph depicts the estimates related to the control variables used in the analysis for two household outcomes. It provides both point estimates as well as 95% confidence intervals of all control variables.

Appendix B

Appendix to Chapter 2

B.1 Additional Tables

Table B.1: Impact of cash-in-advance on milk delivery using only T1 and T2

	(1)	(2)	(3)	(4)	(5)	(6)
Var	**Monthly milk delivery (days)**			**Monthly milk delivery (litres)**		
Control group	Not-yet-treated	Never-treated	Placebo	Not-yet-treated	Never-treated	Placebo
Panel A: Unconditional parallel trends						
TWFE	5.86***	10.29***	12.13***	48.58***	91.13***	103.18***
	(0.73)	(0.57)	(0.58)	(8.79)	(7.93)	(7.92)
Group-specific effects (CS)	6.89***	9.62***	11.36***	49.10***	91.7***	102.81***
	(0.74)	(0.55)	(0.56)	(8.47)	(7.6)	(7.63)
Calendar time effects (CS)	6.08***	11.09***	12.86***	47.10***	85.59***	97.76***
	(0.81)	(0.59)	(0.59)	(8.51)	(7.80)	(7.79)
Event study (CS)	6.08***	10.57***	12.61***	49.32***	92.43***	105.36***
	(0.81)	(0.62)	(0.62)	(10.51)	(8.99)	(8.96)
Panel B: Conditional parallel trends						
TWFE	5.10***	8.92***	12.13***	49.20***	83.6***	103.47***
	(0.70)	(0.51)	(0.59)	(7.05)	(7.84)	(7.96)
Group-specific effects (CS)	5.10***	8.54***	11.36***	49.20***	85.34***	102.91***
	(0.70)	(0.50)	(0.56)	(7.05)	(7.56)	(7.68)
Calendar time effects (CS)	5.55***	9.44***	12.86***	48.54***	77.44***	98.03***
	(0.68)	(0.51)	(0.59)	(6.91)	(7.69)	(7.83)
Event study (CS)	5.10***	8.93***	12.60***	49.20***	83.76***	105.89***
	(0.70)	(0.55)	(0.63)	(7.05)	(8.88)	(9.01)

Note: This table presents treatment effects on milk delivery- similar to Table 2.5- using only T1 and T2. Results are based on the TWFE and the CS approaches. Panel A shows results using the unconditional parallel trends, whereas Panel B's results are based on the conditional parallel trends assumption. The "TWFE" row reports the coefficient on a post-treatment dummy variable from a TWFE regression (see Section 2.5.2 for more details). The "Group-Specific Effects" row summarizes average treatment effects by the timing of treatment. The "Calendar Time Effects" row reports the cumulative monthly treatment effects average. The "Event Study" row depicts average treatment effects by the length of exposure to the treatment. See Section 2.5.2 for more details about how to aggregate group-time effects into these effects. The Control group mean reflects the three months before treatment over January-March 2015. The last month is dropped from the analysis when using the not-yet-treated farmers as a control group. Robust standard errors in parentheses. $***$ p <0.01, $**$ p<0.05, $*$ p<0.1.

Table B.2: Impact of cash-in-advance on milk payments using only T1 and T2

	(1)	(2)	(3)	(4)	(5)	(6)
Var	**Gross payments (USD)**			**Net payments (USD)**		
Control group	Not-yet-treated	Never-treated	Placebo	Not-yet-treated	Never-treated	Placebo
Panel A: Unconditional parallel trends						
TWFE	17.46***	31.34***	35.21***	3.52	17.03***	20.58***
	(3.00)	(2.64)	(2.63)	(2.77)	(2.43)	(2.42)
Group-specific effects (CS)	17.83***	31.75***	35.26***	4.05	17.97***	21.11***
	(3.01)	(2.62)	(2.61)	(2.82)	(2.42)	(2.41)
Calendar time effects (CS)	17.26***	29.68***	33.63***	3.1	14.52***	18.30***
	(2.86)	(2.58)	(2.58)	(2.62)	(2.36)	(2.35)
Event study (CS)	17.13***	31.26***	35.41***	3.18	16.66***	20.49***
	(3.47)	(2.88)	(2.87)	(3.22)	(2.66)	(2.65)
Panel B: Conditional parallel trends						
TWFE	18.40***	28.89***	35.13***	4.44	14.92***	20.73***
	(2.58)	(2.61)	(2.65)	(2.40)	(2.42)	(2.44)
Group-specific effects (CS)	18.40***	29.66***	35.11***	4.05	16.15***	21.16***
	(2.58)	(2.59)	(2.63)	(2.29)	(2.40)	(2.42)
Calendar time effects (CS)	18.19***	26.93***	33.59***	4.44	12.22***	18.46***
	(2.48)	(2.54)	(2.59)	(2.40)	(2.34)	(2.36)
Event study (CS)	18.40***	28.45***	35.38***	4.44	14.25***	20.69***
	(2.58)	(2.85)	(2.89)	(2.4)	(2.64)	(2.66)

Note: This table presents treatment effects on milk payments- similar to Table 2.6- using only T1 and T2. Results are based on the TWFE and the CS approaches. Panel A shows results using the unconditional parallel trends, whereas Panel B's results are based on the conditional parallel trends assumption. The "TWFE" row reports the coefficient on a post-treatment dummy variable from a TWFE regression (see Section 2.5.2 for more details). The "Group-Specific Effects" row summarizes average treatment effects by the timing of treatment. The "Calendar Time Effects" row reports the cumulative monthly treatment effects average. The "Event Study" row depicts average treatment effects by the length of exposure to the treatment. See Section 2.5.2 for more details about how to aggregate group-time effects into these effects. The Control group mean reflects the three months before treatment over January-March 2015. The last month is dropped from the analysis when using the not-yet-treated farmers as a control group. Robust standard errors in parentheses. $***$ p <0.01, $**$ p<0.05, $*$ p<0.1.

Appendix C

Appendix to Chapter 3

C.1 Additional tables

Table C.1: Farmer scoring categories

Scoring categories	Weight
Panel A: Farmer Identification	30
Verified phone	10
Age	5
Transactions data availability	7
Plot details data availability	4
Quality of baseline surveys	4
Panel B: Relationship with RAWCOF CWS	25
Coffee delivery	22
Loans	1
Meeting attendance	1
Technology uptake	1
Panel C: Agricultural practices	25
Coffee trees/seedlings	17
Soil improvement/organic fertilizer	2
Weeding/mulching/pruning	2
Rejuvenating/ replacing old trees	2
Use of shading trees	2
Panel D: Education and personality	20
Raven/Numeracy	10
Education	5
Future orientation	5
Total	100

Note: This table shows the scoring categories and sub-categories with the corresponding weights. Variables under each sub-category are based on the baseline data and administrative data on coffee delivery.

Table C.2: Balance around discontinuity threshold on observable baseline characteristics

	(1) Above threshold	(2) Below threshold	(3) T-test (1)-(2)	(4) *P*-value (1)-(2)
Panel A: Household Characteristics				
HH size (number)	4.15	4.15	0.03	0.85
Coffee person age (years)	50.79	51.08	-0.10	0.94
Coffee person female (=1)	0.42	0.37	0.05	0.23
Coffee person attended school (=1)	0.74	0.72	0.02	0.58
Panel B: Housing & other income				
Verified phone (=1)	0.62	0.60	0.00	0.97
Electricity(=1)	0.43	0.40	0.01	0.69
House rooms (number)	3.70	3.56	0.03	0.74
Grow other crops (=1)	0.94	0.95	-0.02	0.35
Own livestock (=1)	0.77	0.77	-0.00	0.90
Own enterprise (=1)	0.07	0.09	-0.01	0.52
Regular job (=1)	0.06	0.04	0.03	0.15
Casual job (=1)	0.40	0.40	0.01	0.86
Panel D: Coffee Farming				
Estimated trees (trees)	151.07	136.51	18.04	0.26
Self-reported 3-year (trees)	22.57	20.18	2.53	0.63
Calculated yield (KG per tree)	1.20	1.12	0.03	0.68
Propagation rate (%)	0.88	0.86	0.02	0.33
Coffee farming expanded (=1)	0.13	0.11	0.02	0.51
Panel C: Rwacof relationship				
Transactions 2020 (KG)	139.17	119.14	7.48	0.70
Transactions 2021 (KG)	178.84	211.24	-42.31	0.13
CWS membership (years)	7.84	7.69	-0.22	0.53
CWS manager name (know=1)	0.26	0.17	0.07	0.02
CWS manager (never met=1)	0.32	0.40	-0.05	0.19
CWS manager (know little=1)	0.26	0.19	0.06	0.09
CWS manager (know somewhat=1)	0.26	0.28	-0.04	0.32
CWS manager (know well=1)	0.16	0.13	0.03	0.33
Attended meeting (=1)	0.62	0.55	0.04	0.35
Panel E: Savings & Loans				
Saving with SACCO (=1)	0.55	0.53	0.04	0.34
Saving with Bank (=1)	0.15	0.11	0.03	0.34
Mobile money savings (=1)	0.32	0.30	0.01	0.84
Home savings (=1)	0.42	0.38	0.02	0.55
Informal group savings (=1)	0.71	0.71	-0.00	1.00
Outstanding loan (=1)	0.12	0.10	0.03	0.29
Panel F: Raven & Numeracy				
Raven (correct Qs out of 6 Qs)	1.51	1.33	0.15	0.14
Numeracy (correct Qs out of 3 Qs)	0.84	0.81	0.03	0.60
Joint significance (Prob > F)			1.01	0.45
Observations	336	278		

Note: This table shows the balance between farmers above and below the discontinuity threshold. Variables comprise of baseline characteristics on the farmer level, including household characteristics (Panel A), housing and other income sources (Panel B), coffee farming (Panel C), relationship with Partner (Panel D), financial-related variables (Panel E), and raven and numeracy results (Panel F). The statistics are based on a discontinuity sample (bandwidth=0.02). Columns (1) and (2) present the mean values of farmers just above and below the discontinuity threshold, respectively. Columns (4) and (5) presents the t-test statistics and the corresponding *p*-values of the mean differences between the two groups.

Table C.3: Balance of zone randomization

	(1) Zones with 40% Invited	(2) Zones with 80% Invited	(3) T-test (1)-(2)	(4) P-value (1)-(2)
Scoring Index $(0-1)$	0.47	0.47	-0.00	0.68
Panel A: Household Characteristics				
HH size (number)	4.32	4.24	-0.08	0.24
Coffee person age (years)	50.90	51.30	0.40	0.59
Coffee person female (%)	0.39	0.36	-0.03	0.24
Coffee person attended school (%)	0.70	0.69	-0.01	0.59
Panel B: Housing & other income				
Verified phone (%)	0.64	0.64	-0.01	0.73
Electricity(%)	0.43	0.40	-0.03	0.70
House rooms (number)	3.83	3.83	0.00	0.99
Grow other crops (%)	0.94	0.93	-0.00	0.82
Own livestock (%)	0.77	0.75	-0.02	0.32
Own enterprise (%)	0.08	0.09	0.01	0.51
Regular job (%)	0.05	0.04	-0.01	0.24
Casual job (%)	0.37	0.39	0.02	0.34
Panel C: Coffee Farming				
Estimated trees (trees)	199.30	200.67	1.37	0.94
Self-reported 3-year (trees)	26.02	27.21	1.18	0.67
Calculated yield (KG per tree)	1.27	1.31	0.04	0.64
Propagation rate (%)	0.88	0.89	0.01	0.58
Coffee farming expanded (%)	0.14	0.14	0.00	0.88
Coffee delivery 2020 (KG)	210.67	235.09	24.43	0.19
Coffee delivery 2021 (KG)	277.41	287.63	10.22	0.73
CWS membership (years)	7.75	7.67	-0.08	0.78
CWS manager name (% know)	0.24	0.27	0.03	0.55
CWS manager (never met)	0.35	0.35	0.00	0.98
CWS manager (% know little)	0.23	0.24	0.00	0.86
CWS manager (% know somewhat)	0.25	0.24	-0.01	0.50
CWS manager (% know well=1)	0.16	0.17	0.01	0.83
Attended meeting (%)	0.57	0.58	0.00	0.91
Panel E: Savings & Loans				
Saving with SACCO (%)	0.51	0.52	0.01	0.80
Saving with Bank (%)	0.18	0.16	-0.02	0.53
Mobile money savings (%)	0.37	0.34	-0.04	0.22
Home savings (%)	0.42	0.38	-0.04	0.53
Informal group savings (%)	0.71	0.68	-0.03	0.31
Outstanding loan (%)	0.15	0.13	-0.02	0.27
Panel F: Raven & Numeracy				
Raven (correct Qs out of 6 Qs)	1.61	1.58	-0.03	0.74
Numeracy (correct Qs out of 3 Qs)	0.88	0.86	-0.02	0.51
Joint significance (Prob > F)			0.47	0.86
Observations	16	16		

Note: This table display the balance between zones (i.e., zones with 40% and with 80% farmers invited to the FDP) along baseline characteristics on the zone level, including household characteristics (Panel A), housing and other income sources (Panel B), coffee farming (Panel C), relationship with Partner (Panel D), financial-related variables (Panel E), and raven and numeracy results (Panel F). The statistics reflect the averages of farmer characteristics within each zone. Observations include farmers from four coffee washing stations representing our sample frame, encompassing invited and non-invited farmers to the FDP. The baseline characteristics comprise variables from a detailed questionnaire, plot visits and administrative data on coffee delivery. The estimated trees variable was compiled from the plot visits data, whereas coffee delivery 2020 and 2021 are based on the administrative datasets.

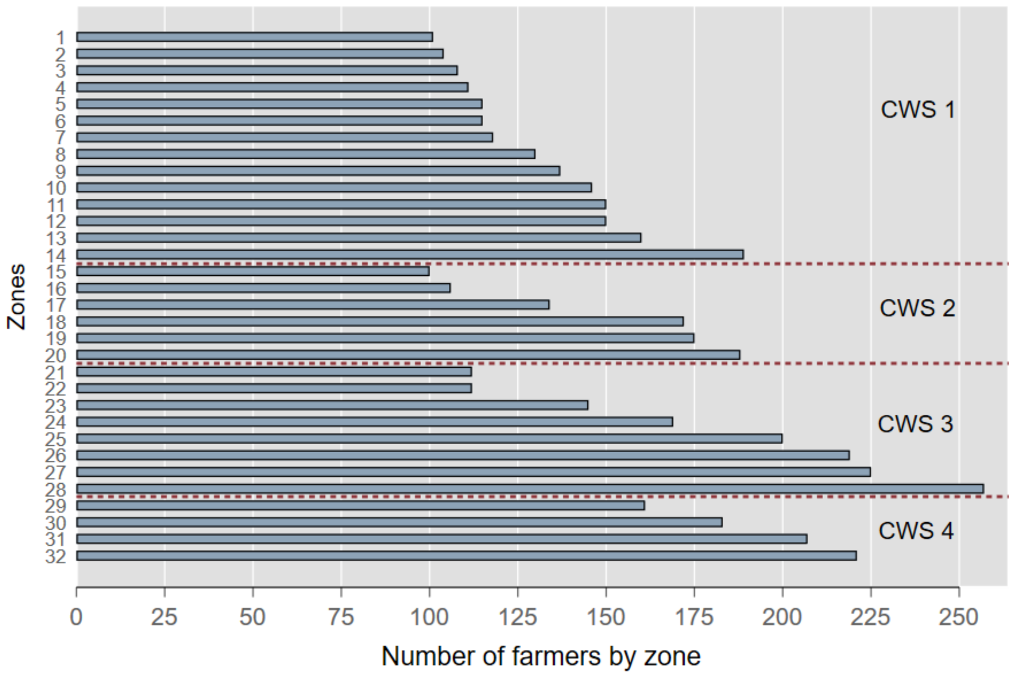
Table C.4: Descriptive statistics of selected baseline characteristics by gender

	(1) Women	(2) Men	(3) T-test (1)-(2)	(4) *P*-value (1)-(2)
Scoring Index $(0-1)$	0.43	0.49	-0.06	0.00
Panel A: Household Characteristics				
HH size (number)	3.83	4.55	-0.72	0.00
Coffee person age (years)	53.44	49.62	3.79	0.00
Coffee attended school (=1)	0.60	0.76	-0.17	0.00
Panel B: Housing & other income				
Verified phone (=1)	0.57	0.68	-0.11	0.00
Electricity(=1)	0.38	0.41	-0.04	0.00
House rooms (number)	3.55	3.81	-0.25	0.00
Grow other crops (=1)	0.93	0.93	-0.00	0.71
Own livestock (=1)	0.70	0.78	-0.08	0.00
Own enterprise (=1)	0.07	0.10	-0.03	0.00
Regular job (=1)	0.04	0.05	-0.01	0.26
Casual job (=1)	0.40	0.38	0.02	0.25
Panel D: Coffee Farming				
Estimated trees (trees)	148.56	244.03	-90.45	0.00
Self-reported 3-year (trees)	14.37	35.66	-20.40	0.00
Calculated yield (KG per tree)	1.17	1.33	-0.15	0.00
Propagation rate (%)	0.88	0.89	-0.00	0.42
Coffee farming expanded (=1)	0.11	0.16	-0.04	0.00
Panel C: Rwacof relationship				
Transactions 2020 (KG)	160.28	255.17	-85.88	0.00
Transactions 2021 (KG)	230.59	345.01	-96.57	0.00
CWS membership (years)	7.73	7.70	0.26	0.04
CWS manager name (know=1)	0.21	0.26	-0.05	0.00
CWS manager (never met=1)	0.44	0.30	0.13	0.00
CWS manager (know little=1)	0.21	0.24	-0.03	0.01
CWS manager (know somewhat=1)	0.21	0.26	-0.04	0.00
CWS manager (know well=1)	0.13	0.20	-0.06	0.00
Attended meeting (=1)	0.51	0.62	-0.10	0.00
Panel E: Savings & Loans				
Saving with SACCO (=1)	0.44	0.57	-0.13	0.00
Saving with Bank (=1)	0.12	0.20	-0.07	0.00
Mobile money savings (=1)	0.26	0.40	-0.13	0.00
Home savings (=1)	0.38	0.39	-0.01	0.54
Informal group savings (=1)	0.70	0.70	-0.00	0.95
Outstanding loan (=1)	0.13	0.15	-0.02	0.02
Panel F: Raven & Numeracy				
Raven (correct Qs out of 6 Qs)	1.39	1.66	-0.29	0.00
Numeracy (correct Qs out of 3 Qs)	0.75	0.95	-0.21	0.00
Joint significance (Prob > F)			27.79	0.00
Observations	1815	3087		

Note: This table shows descriptive statistics of baseline characteristics by gender of the household member responsible for the coffee business. The baseline characteristics include household characteristics (Panel A), housing and other income sources (Panel B), coffee farming (Panel C), relationship with Partner (Panel D), financial-related variables (Panel E), and raven and numeracy results (Panel F). Observations include farmers from four coffee washing stations representing our sample frame, encompassing invited and non-invited farmers to the FDP. The baseline characteristics comprise variables from a detailed questionnaire, plot visits and administrative data on coffee delivery. The estimated trees variable was compiled from the plot visits data, whereas coffee delivery 2020 and 2021 are based on the administrative datasets.

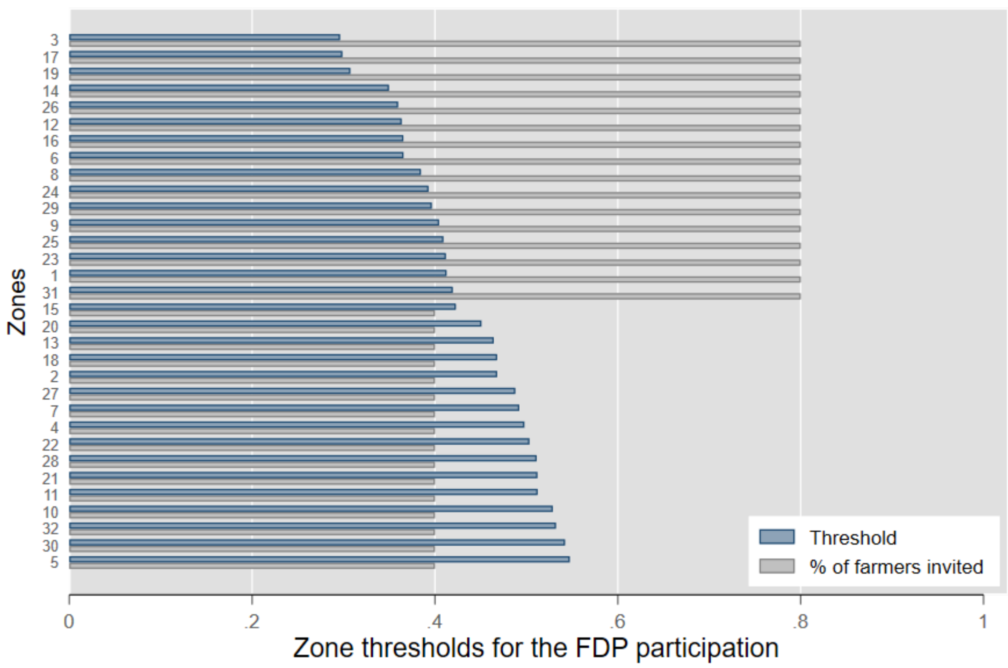
C.2 Additional figures

Figure C.1: Number of farmers by zone



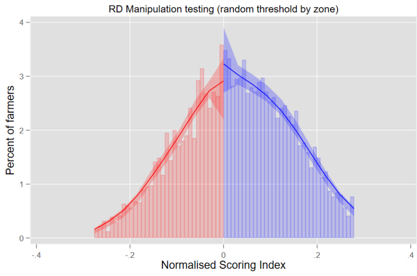
Note: This figure displays the rank of zones by farmers' number in the four CWS. Zones include either one village or a group of villages that are 2 kilometres apart. Villages were grouped to guarantee having at least 100 farmers each.

Figure C.2: Zone thresholds for the FDP participation

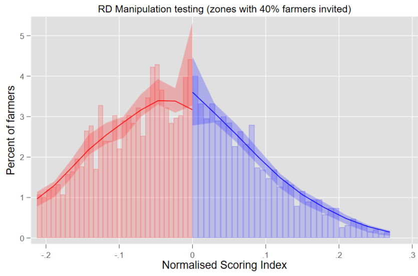


Note: This figure shows two groups of zones, either with 40% or 80% of farmers included in the FDP, with the corresponding thresholds for the FDP assignment.

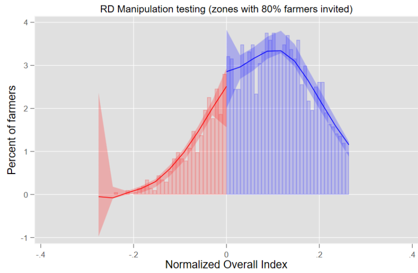
Figure C.3: McCrary test plots for manipulation of the FDP assignment



(a) All zones



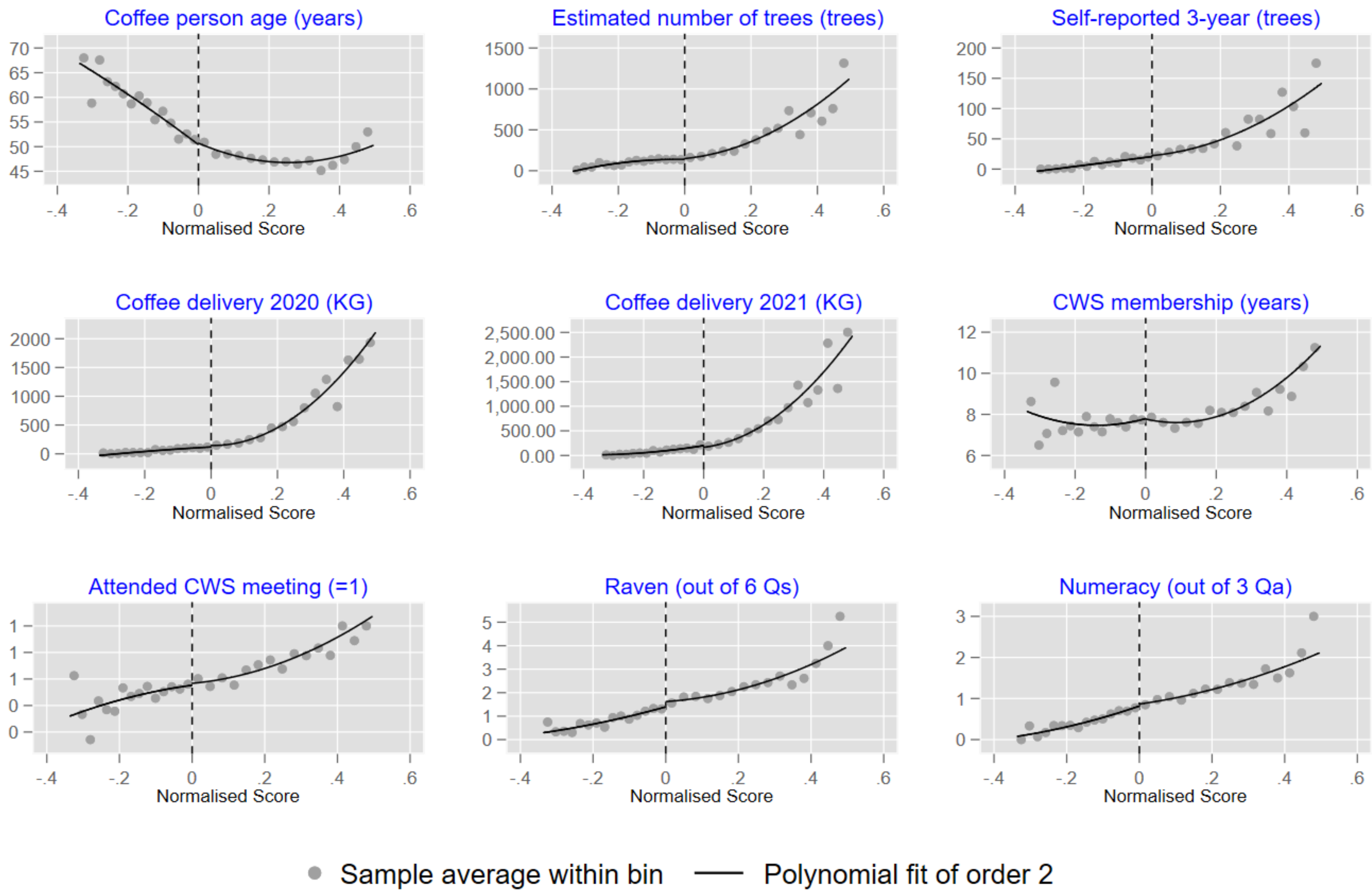
(b) Zones with 40% invited farmers



(c) Zones with 80% invited farmers

Note: This figure displays the manipulation test plots for all zones together (sub-figure a), zones with 40% farmers invited to the FDP (sub-figure b), and with 80% farmers invited to the FDP (sub-figure c). Farmer scores are normalized around the threshold of each zone, leading to having zero as a common threshold.

Figure C.4: Discontinuity in selected observable characteristics around threshold



Note: This figure exhibits regression discontinuity plots on selected observable characteristics. Observations include all farmers in our sample frame. They are based on evenly spaced partitioning using the ”rdplot” Stata command. It shows both binned sample means and polynomial point estimates. Farmer scores are normalized around the threshold of each zone, leading to having zero as a common threshold.

C.3 Sample and Power Calculations

The sample frame covers the population of farmers registered with (i.e., in the government assigned catchment areas of) four CWSs (4,902 farmers). The selection of CWSs included in our study was made by the Partner. The choice was mainly driven by a desire to ensure representatives to the rest of the Partner CWSs. We plan to use other surveys and administrative datasets to compare the included CWSs to other CWSs of the Partner.

Since our research design consists of multiple interventions, this requires various sample size estimates. For the main sample power calculations, we use administrative coffee delivery from 2020 and 2021 harvest seasons. We also evaluate the sensitivity of our sample power calculations in several ways. First, we assess the MDE for self-reported coffee delivery when collected in the survey. Second, we also redo the calculations using other baseline relational outcomes, namely the willingness to take-up good agricultural practices and the attendance of CWS meetings.

The first part of the sample power calculations focuses on the impact of the FDP. As mentioned before, this will be assessed through a RD design around the eligibility cutoff in each zone (see details for the results of the standard RDD validity checks below). In order to calculate the power of this design, we use a baseline specification which controls for the scoring variable in a flexible quadratic functional form around the threshold, as well as controlling for some key background covariates (zone fixed effects, gender, education, and land size). Our sample size for the FDP treatment has 80% statistical power to detect an effect of size 0.14 SD in coffee delivery based on 2020 and 2021 harvest season data (or a 9% increase in delivery compared to the control mean) at 5% level of significance. Our results using self-reported coffee harvest and delivery give us a similar level of power. Other relational practices variables afford similar power to detect an effect of size between 2 to 5 percentage points effect of the FDP treatment.

Since our sample frame covers the population of farmers within four CWS, this implies that the only source of variation in the estimation comes from random treatment assignment (Abadie et al., 2020). Correcting for this usually gives more conservative standard errors, and hence more power. Currently, we have not corrected our standard errors and have, therefore, strong reasons to believe we are conservative with our power calculations.

The second part of the sample power calculations is related to the organizational experiments on relationship managers and communication methods. Out of the 4,902 farmers involved in the FDP design, only 2,959 farmers are covered in these experiments. The relevant strata is "CWS x

Zone x Gender". The randomization was done at the cluster level, with a group of about 10 farmers forming a cluster. We have at least 80% sample power per experimental arm for an effect size of 0.08 SD in coffee delivery (or a 6.5% increase in delivery compared to the control mean) at 5% level of significance and after accounting for clustering at the group level. We also have high power when using self-reported coffee harvest and delivery. The same applies to the relational practices variables, which afford us to detect an effect of size 10 percentage points.

C.4 Communication experiment during harvest

Below are the messages used for the communication experiment during the harvest season. The messages were sent every week and in chronological order. Once we reach the final message, we start again from the beginning.

1) Dear [FARMER NAME], as part of IKAWA HAMWE program of Rwacof, we will send you weekly messages with information and reminders during harvest season. Additionally, you can always reach us by calling the Rwacof call center (6016).

2) This is a reminder to deliver your coffee to Rwacof [LOCATION] CWS. The volume of cherries you deliver to [NAME CWS] decides what tier you will be assigned to as part of the IKAWA HAMWE program. The higher the volume of coffee cherries you deliver, the higher your tier, and more benefits you'll receive from Rwacof.

3) Based on your coffee cherry delivery volume, you can access various benefits such as loans, agricultural input and invites to more training sessions. Questions? Please call the Rwacof Call Centre (6016).

4) A reminder to deliver your coffee to Rwacof [LOCATION] CWS. We recommend you deliver your cherries at a high frequency as you receive a higher price per kg for fresh and high-quality cherries.

5) Based on your coffee cherry delivery volume, you can access various benefits such as loans, agricultural input and invites to more training sessions. Questions? Please call the Rwacof Call Centre (6016).