Essays on the role of risk and disaster in agricultural development

by

Arusha Ijaz

B.Sc.(Hons), Lahore University of Management Sciences, 2015

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the
requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Agricultural Economics
College of Agriculture

KANSAS STATE UNIVERSITY
Manhattan, Kansas

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Abstract

Disasters and inability to deal with risks can have far-reaching socioeconomic implications on the agricultural sector in developing countries. Agriculture plays a significant role in the economic growth of these countries, providing food security, employment, and income generation for the large rural population. However, the agricultural sector in these countries is highly vulnerable to various risks and disasters, which can have lasting effects on productivity, livelihoods, and overall development. The following essays explore the role of risk and disasters on the agricultural sector in developing countries focusing on technology adoption, credit accessibility, and trade opportunities.

In the first study, we investigate how two tools that signal the quality of a product affect willingness-to-pay (WTP) elicitation for a familiar good. Using a novel study design that combines an incentivized WTP elicitation and a randomized controlled trial, we estimate the effects of two common quality signaling tools, a reference price and a warranty contract, on WTP of the product. A reference price signals the value of the product, whereas, a warranty reduces the risk associated with product failures or defects, and provides assurance to consumers about the reliability of a product. We find a positive effect of the reference price and no effect of the warranty on WTP. We also document that previous experience using a product plays an important moderating role.

We investigate how credit responses of farmers differ to an idiosyncratic versus covariate shock, and according to the nature of the loss, in the second study. We find that households that experience idiosyncratic shocks in more than one period increase their credit uptake significantly more than households that experience negative shock in a single period using a modern difference-in-differences model. Persistent income or asset shocks damage the household's productive capacity and resourcefulness, forcing it to borrow from informal lenders.

Households increase credit from informal credit markets to overcome times of financial distress, especially when they experience productive labor loss.

The third study explores how a natural disaster and a relief effort in the form of a trade concession can impact the production and exports in the agricultural sector. Using synthetic control techniques, and data on cotton exports and production of Pakistan, we construct counterfactuals for Pakistani exports and production to find the impact of 2010 floods and the 2012 unilateral tariff waiver from EU to Pakistan. We do not find significant impacts of the tariff waiver on the production and exports of the disaster-stricken country.

Overall, this research aims to deepen our understanding of the challenges faced by farmers, the strategies they employ to manage risks, and the broader implications for agricultural development.

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Acknowledgments

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Chapter 1

Introduction

This dissertation explores the multifaceted relationship among risk, disaster, and agricultural development. Risk mitigation in agriculture is important for developing countries as they are heavily dependent on the agricultural sector for food security, employment, and foreign revenue (Binswanger et al., 1993; Dercon and Christiaensen, 2011). However, the agricultural sector in these countries is vulnerable to climate change, natural disasters, and market fluctuations (Morduch, 1995; Mobarak and Rosenzweig, 2013; Emerick et al., 2016). Increasing the adoption of resilient technologies, introducing effective post-disaster recovery policies, and leveraging social capital in communities to pool risks can integrate resilience and risk reduction measures into agricultural systems. Through a comprehensive analysis of key factors, including the role of market signals in technology adoption, the influence of informal credit markets in risk mitigation, and the impact of floods on agricultural production and exports, we shed light on the intricate dynamics that shape the agricultural sector in developing countries. We investigate how farmers can mitigate the numerous challenges they face such as product failure and negative income or asset shocks, and how such shocks at the macroeconomic level impact the aggregate performance of the agricultural sector.

In the second chapter, we investigate the impact of warranties and reference price, on the product demand by farmers and how the perception of these signals is perceived by farmers as they gain more experience. A warranty serves to mitigate the risk linked to product failures

or defects, instilling confidence in consumers regarding the quality and dependability of the product. On the other hand, a reference price acts as an indicator of the product's value. We conduct a randomized controlled experiment on Bangladeshi households, exposing them to different marketing signals when bidding for a sickle. Our findings suggest that farmers with greater experience can better perceive the value of a warranty and do not need to rely on a reference price to assess the true value of the product and determine their willingness to pay. Smallholders in developing countries have limited access to capital, lack technical knowledge, experience, and access to product support which makes technology adoption difficult (Alba and Hutchinson, 1987; Moser and Barrett, 2006; Omotilewa et al., 2019). If there is a risk of product failure, the farmers are afraid to lose not only their initial investment, but also to fall below the minimum level of sustenance (Dercon and Christiaensen, 2011). Marketing tools that address the concerns of farmers can help perpetuate the use of a particular technology.

In the third chapter, we explore how idiosyncratic and covariate shocks impact farmers' credit decisions, including the amount and share of credit taken from formal and informal sources. Using a modern difference-in-difference estimator on panel data from Bangladesh, we find that farmers rely excessively on informal credit to overcome losses from idiosyncratic shocks, while formal markets play no role in dealing with exogenous idiosyncratic or covariate shocks. Our results show evidence of strong inter-communal networks that help households in times of adversity including household emergencies. Households are equipped to deal with income shocks within a limited period, but rely on informal credit networks to smooth consumption in case of negative shocks over multiple periods that deplete their financial strength and labor productivity. Credit constraint in developing countries has been studied as a major obstacle in risk mitigation not only when it comes to technology adoption (Omotilewa et al., 2019), but also when it comes to dealing with other income or asset shocks (Mobarak and Rosenzweig, 2013). Lack of access to formal credit, due to under-developed financial markets, makes farmers rely more on informal channels of credit (Townsend, 1994; Fafchamps and Lund, 2003).

In the fourth chapter, we investigate the impact of the 2010 floods in Pakistan and the 2012 unilateral tariff waiver from the EU to Pakistan on cotton production, yield, and

exports. We do not find a positive impact of the tariff waiver on cotton exports and production. A considerable amount of revenue and foreign reserves in developing countries comes from the export of agricultural products (Heger et al., 2008). Disasters, including floods, have a significant impact on the agricultural sector in a developing country which might be unequipped in dealing with a large-scale catastrophe (Rosenzweig and Parry, 1994; Oh and Reuveny, 2010). Apart from the loss of crops, productivity, and infrastructure, there is a loss in the trade potential of the sector. While the international community comes together to help in the form of aid in such dire circumstances, trade concessions have also been advocated as a more helpful tool in dealing with disasters.

Our findings suggest that relevant risk mitigation tools including warranties, development of informal networks, and trade concessions can help the agricultural sector overcome risks and disasters in developing countries. Warranties provided by sellers can instill confidence in farmers and reduce the risk of product failure. Informal networks help farmers pool risks in rural communities via borrowing and lending. Trade concessions, such as waivers, can help stabilize agricultural markets and help in post-disaster recovery. All these risk mitigation tools contribute in overcoming risks and disasters in developing countries.

Chapter 2

Quality Signaling and Willingness-to-Pay: An Experimental Assessment

2.1 Introduction

Technology adoption enhances productivity, food security, and overall development in the agricultural sector of developing countries. However, designing policies and implementing programs that effectively market agricultural technologies and subsequently boost successful adoption is challenging for policymakers. Credit constraints (Udry and Anagol, 2006), lack of knowledge and experience (Conley and Udry, 2010), and farmer's risk and loss aversion (Tanaka et al., 2010) are some of the obstacles that impede the widespread adoption of new and productive technologies. Lack of technology adoption is also driven by the unwillingness to commit, as individuals must be patient and willing to commit to a larger return in the future by giving up immediate gains (Laibson, 1997).

Effective pricing plays a crucial role in agricultural technology adoption in developing countries (Cohen and Dupas, 2010). It directly influences farmers' decision-making pro-

cess and determines the affordability, accessibility, and perceived value of new agricultural technologies. The affordability of technology is an important determinant in the adoption decision, especially for resource-constrained farmers. At lower levels of price, there is a high price elasticity of new technology as compared to high levels of price (Cohen and Dupas, 2010). If the cost of new technology is higher than the returns, adoption becomes not feasible (Moser and Barrett, 2006; Udry and Anagol, 2006; Cohen and Dupas, 2010). For example, in Ghana pineapple cultivation is low despite higher returns because it only becomes feasible if they are cultivated on minimum plot size (Udry and Anagol, 2006). Similarly, low levels of wealth, and no other means of income discourage farmers from adopting System of Rice Intensification (SRI) technology in Madagascar (Moser and Barrett, 2006).

Hence, in the context of developing countries, appropriate marketing tools that help overcome farmers' risk and loss aversion and signal the true value of the product are crucial. Firms often use "signals" such as warranty contracts (e.g., Akdeniz et al., 2013; Dutta et al., 2022) or reference prices (e.g., Mazumdar et al., 2005; Homburg et al., 2014) designed to stimulate consumer demand. Understanding the role of signaling in enhancing consumer demand for a product has thus been an important question in business and economic literature. Furthermore, examining how signaling affects consumer demand has provided a broader implication in the context of developing countries in that development interventions often have the goal of encouraging consumer demand for products that provide either health or sanitary benefits (e.g., Berry et al., 2020; Ito and Zhang, 2020) or lead to more efficient agricultural production (e.g., Abate et al., 2018; Omotilewa et al., 2019). Despite extensive research focusing on signaling, it remains unclear whether various signaling devices or information have a causal effect on consumers' intention to purchase a product of which true quality is difficult to be assessed *ex-ante*.

This study addresses the research gap by conducting a field experiment to isolate the causal effect of signaling. To achieve our research objective, we design a randomized controlled trial (RCT) combined with a Becker-DeGroot-Marschak (BDM) auction whereby

participants are asked to report their WTP, upon receiving two types of interventions that intend to signal quality (i.e., a warranty contract and a reference price). Specifically, households are classified based on the following 2-by-2 treatment design: warranty versus no warranty and reference price versus no reference price, which allows us to quantify the extent to which signaling affects the consumers' WTP. In addition, using a piecewise linear regression approach, we identify moderating factors and boundary conditions associated with the signaling effect.

Our findings provide evidence of the signaling effect associated with the warranty contract and the reference price, suggesting that the average treatment effects of the signaling devices vary with the level of consumer experience. The warranty contract signals quality to formulate WTP only for more experienced consumers, such that they increase WTP upon receiving the contract; the reference price has an overall positive effect on WTP for both experienced and novice consumers, while the effect becomes attenuated and eventually negative as consumers accumulate experience.

Our contribution to the literature is twofold. First, we establish the causality for the signaling effects by combining an RCT and a BDM auction and achieving reliability for the measure of WTP. Unlike previous research that uses the self-explicated and non-incentive-aligned approach in which researchers directly ask each participant to state his or her WTP, our incentivized experimental design mimics a real-life setting and, thus, advances our understanding of the signaling effect associated with warranties and reference prices. With the random assignment of the treatments, we obtain the credibility for the causal estimation of the effects of the two signals. Further, this study reveals the nonlinear moderating role of consumer experience in the signaling effect, which offers a more nuanced understanding than those presented in the extant literature. While it is generally presumed that consumers utilize their prior experiences to perceive warranties and reference prices in making purchase decisions, our results indicate that such experience effects vary across the level of prior experiences at the time of purchases, providing managerial insights for effective resource

allocation when using signaling devices.

2.2 Quality Signaling and Consumer Demand

For smallholders in developing countries with imperfect knowledge, information asymmetry can create barriers to the adoption of new technology which need to be overcome. Farmers may be unaware of market prices, quality standards, gains associated with new agricultural technologies or the best farming practices. This information asymmetry can put farmers at a disadvantage whereby they miss out on profitable opportunities and gain lower returns on their produce (Smith and Tsur, 1997; Just et al., 1999; Erdem et al., 2006; Ullah et al., 2020). Smallholders may face challenges in getting credit and insurance services due to sparse information about the application process (Just et al., 1999; Udry and Anagol, 2006). Additionally, weak institutions and lack of regulations concerning natural resources only exacerbate the problems associated with asymmetric information in developing countries (Smith and Tsur, 1997).

To bridge this information gap, targeted marketing towards farmers with effective tools is necessary to disseminate information, build trust, and promote communal knowledge transfer. Hence, consumers seek more information when they are unable to observe the true product quality before making a purchase decision, which includes brand reputation (e.g., Truong et al., 2017), advertising (e.g., Nelson, 1974), prices (e.g., Gale, 1992), and warranties (e.g., Wiener, 1985; Kirmani and Rao, 2000). In response, firms use these extrinsic cues to signal product quality as they have more information than consumers (e.g., Spence, 1977; Daughety and Reinganum, 1995; Sigurdsson et al., 2020). Sellers use an assortment of signals depending on the nature of the product and consumer characteristics to convey true information to farmers.

Literature has suggested that consumers interpret these signals based on diagnosticity and scope (Purohit and Srivastava, 2001; Biswas et al., 2009; Akdeniz et al., 2013). The

diagnosticity of a signal refers to the ability to assess the true quality of the product based on how much assets, wealth, profit or credibility the firm is willing to put at stake while making promises (Biswas et al., 2009). Hence, firms often use multiple signals with different diagnosticities together (Akdeniz et al., 2013). A signal is also defined as either high- or low-scope based on the amount of time it takes for the firm to build the signal (Purohit and Srivastava, 2001). A high-scope signal is built over time and, thus, requires longer time horizons to be established (Purohit and Srivastava, 2001). Once achieved, a high-scope signal has a persistent impact on the firm's credibility and trustworthiness on behalf of the firm (Cambier and Poncin, 2020). In the context of brand extensions, e.g., a firm's brand reputation, achieved through multiple interactions with consumers, signals the (positive or negative) quality of not only the products the consumers have experienced, but also of all the other products under the brand (Rego et al., 2022). In contrast, a low-scope signal, e.g., warranties or price, is transient and instantaneous. Given that consumer perceptions of a low-scope signal are invariably linked to other high-scope signals, a high-scope signal is used to add credibility to a low-scope signal (Akdeniz et al., 2013; Truong et al., 2017).

Apart from diagnosticity and scope, signals differ inherently from each other based on their contingency to the product's functionality, i.e., default dependency. For example, a warranty is a default-dependent signal contingent on the product's functionality (Boulding and Kirmani, 1993) and is used to promote the functionality of a product, e.g., safety or durability (Spence, 1977; Price and Dawar, 2002; Guajardo et al., 2016) for individuals who want to avoid losses (Chatterjee et al., 2005). In case of default, therefore, firms can provide buyers with a free replacement warranty for low-priced products or a pro-rata warranty for a high-priced product, whereby, buyers are charged for future repairs (Akdeniz et al., 2013; Yeh and Fang, 2015). In contrast, the price a consumer faces acts as a default-independent signal that does not depend on the product's functionality (Kirmani and Rao, 2000; Schnabel and Storchmann, 2010), while it still indicates the product quality, e.g., high-quality firms benefit from increasing prices to signal high production costs (Bagwell and Riordan, 1991).

2.2.1 Warranty

Warranties can be used as an effective tool in the adoption and diffusion of agricultural technologies, especially in developing countries. By including warranties in marketing strategies, technology providers can increase the perceived value and reduce perceived risks associated with the quality and performance of the product (Sunding and Zilberman, 2001; Heiman et al., 2020). Warranties provide a sense of security to resource-constrained farmers who might be investing a lifetime of earnings into a new technology so that any potential defects or malfunctions will be addressed without additional cost. This helps mitigate the financial risks associated with investing in unfamiliar technologies (Aker et al., 2005; Zilberman et al., 2019).

A warranty not only reduces the risk of product failure, but builds a relationship of trust and confidence between the seller and buyer. It helps build communication channels through which knowledge is disseminated and ensures quicker adoption of future updates in the technology, e.g., extension services play an important role when encouraging the adoption of a new seed variety and also encourage experimentation by farmers over a longer period (Sunding and Zilberman, 2001; Shahbaz et al., 2019). By combining effective marketing strategies with warranties, agricultural technology providers can increase the adoption and diffusion of their products, driving widespread changes in farming practices across communities and perpetuating agricultural development in developing countries (Aker et al., 2005; Zilberman et al., 2019; Heiman et al., 2020).

A warranty, which is a default-contingent, low-scope signal, can affect the perceived value of the product depending on the content of the warranty contract. If there is a product failure risk, a firm can offer either a money-back guarantee (Grossman, 1981) or a free replacement (Yeh and Fang, 2015). Whereas, a replacement warranty is always considered a signal of high quality, a money-back guarantee is perceived based on brand reputation (Boulding and Kirmani, 1993; Akdeniz et al., 2013). For example, firms with a high brand reputation are motivated to offer a money-back guarantee to signal their products' high quality. In contrast,

for brands that lack familiarity and reputation, the same money-back guarantee could be considered a signal of low quality (e.g., Boulding and Kirmani, 1993; Purohit and Srivastava, 2001; Akdeniz et al., 2013). This is because consumers are likely to interpret the warranty as a sign of a desperate attempt to sell a low-quality product from whom has no credibility at stake to lose if the product fails to function. Further, these firms are likely to self-select themselves into offering a money-back guarantee as the replacement costs are greater than the refund costs (Grossman, 1981; Wiener, 1985).

The relationship between warranties and brand reputation becomes more complicated when the complexity of the product is taken into account (Spence, 1977; Mukherjee and Hoyer, 2001). For a complex product, consumers rely more on extrinsic cues to signal quality, considering their knowledge inadequate. Similarly, if the consumers are familiar with the product, they would rely less on extrinsic cues (Mukherjee and Hoyer, 2001). However, no conclusive empirical evidence in the literature supports the above theoretical implications. On the one hand, studies find that a warranty can only be perceived as a signal of high quality, when brand familiarity and reputation are high or some other external endorsement is available (e.g., Srivastava and Mitra, 1998; Dutta et al., 2022). On the other hand, others find that an exceptionally strong warranty can be used as a substitute for brand familiarity (e.g., Innis and Unnava, 1991) and more extended warranties play a more important role for unknown brands (e.g., Blair and Innis, 1996).

Given the mixed empirical evidence on how a warranty affects consumer demand for a product under an unfamiliar brand, further assessment of the role of a money-back warranty as a signaling device seems to be warranted. Based on the aforementioned theoretical foundations, we posit that in the absence of a strong brand reputation, a money-back warranty as a default-contingent and low-scope signal for a familiar product will likely decrease consumer perception of the functionality and, thus, reduce their WTP. Therefore, we hypothesize that in the absence of brand information, consumers perceive a money-back warranty for a familiar good as a signal for low quality, hence offer a low WTP.

2.2.2 Reference Prices

Reference prices have been considered an anchor for consumers to determine their WTP (e.g., Homburg et al., 2014; Gross et al., 2021; Lin et al., 2023) and purchase behavior (Feldman and Lynch, 1988; Mazumdar et al., 2005), and are categorized into two main dimensions: internal and external reference prices. An internal reference price is formed in a consumer's mind based on past prices and purchase history, while an external reference price is what consumers face from an external source, e.g., the current market price (Mazumdar et al., 2005). The external reference price often illustrates demand- or supply-related quality information (i.e., high demand or high production costs associated with high-quality; Gerstner, 1985). Upon observing the external reference price, consumers update their internal reference price (Feldman and Lynch, 1988; Mazumdar and Papatla, 2000) and WTP e.g., a higher than expected price may increase its perceived quality (Wathieu and Bertini, 2007).

Literature has suggested that consumers are likely to react more strongly to lower external reference prices, when updating the internal reference price (Biswas and Blair, 1991; Kalyanaram and Little, 1994). Consistent with the discounting theory, these studies showed that consumers perceive lower external reference prices as gains (Kalyanaram and Little, 1994) and are more willing to adjust their WTP downwards. As such, consumers often use the lowest available price as an external reference price (Rajendran and Tellis, 1994), in that the degree of price consciousness and eagerness to pay a lower price are individual traits that impact how consumers perceive external reference prices (Alford and Biswas, 2002). On the other hand, consumers react less strongly to higher reference prices and incorporate them to WTP, only after discounting them to a reasonable level (Biswas and Blair, 1991).

Alternatively, the assimilation-contrast theory (Sherif et al., 1958; De Bruyn and Prokopec, 2017) supports the idea that consumers assimilate an external reference price when updating the internal reference price. This theory suggests that consumers adjust their WTP upwards in response to a high external reference price in that they prefer high-quality products to low-quality counterparts, and high external reference prices are likely to signal better quality

(Gerstner, 1985; Bagwell and Riordan, 1991; Chandrashekaran and Grewal, 2006; Schnabel and Storchmann, 2010). As such, it is strategically beneficial for high-quality firms to sell at high prices to signal high quality (Wolinsky, 1983). In a competitive market, high-quality firms are motivated to distinguish their product, charging higher prices (Bagwell and Riordan, 1991; Schnabel and Storchmann, 2010), while for low-quality firms a higher price would be discouraging as it would result in a reduction in sales volume (Wolinsky, 1983; Schnabel and Storchmann, 2010).

Reference prices are important for smallholders in developing countries as they enable them to make informed adoption decisions, and better assess the risks and awards associated with adoption (Feldman and Lynch, 1988; Niedrich et al., 2001; Mazumdar et al., 2005). These reference prices provide signals for farmers, who often face resource constraints and financial risks. When reference prices are set at higher levels, they create the perception of value and potential profitability of adopting the technology (Wathieu and Bertini, 2007). A potential opportunity for higher gains can encourage farmers to overcome obstacles and invest in more productive technology. Farmers also rely on these signals to assess the demand for the technology. Additionally, reference prices allow farmers to make comparative assessments of alternative technologies available in the market (Niedrich et al., 2001). Overall, reference prices of a technology have a profound impact on adoption decisions in developing countries by forming the perceived value of products, enabling cost-benefit analysis and comparisons.

Building on these theoretical foundations, we posit that providing a high reference price will signal high quality and increase WTP. This is because an effective signaling tool could ensure a (high) product quality as a gain for even price-conscious consumers, crowding out their discounting the higher external reference price. Therefore, we hypothesize that a high reference price signals high quality, hence consumers offer a high WTP.

2.2.3 Experience as a Moderator

Upon making a purchase decision, consumers take into account their prior product experience and expertise (Alba, 1983; Heilman et al., 2000; Hernández et al., 2010; Preko et al., 2020). Among other forms of experience such as self-assessments (Alba, 1983) and formal training (Hutchinson, 1983), literature has found strong evidence in favor of usage frequency impacting purchase decisions of both search and experience goods (Alba and Marmorstein, 1987; Preko et al., 2020). In the case of search goods, increased usage frequency and product experience lead to greater product knowledge and familiarity (Ackerberg, 2003; LaRiviere et al., 2014) that reduces the cognitive effort required by the consumer (Hutchinson, 1983; Alba and Hutchinson, 1987). For experience goods, greater usage frequency increases loyalty and willingness-to-pay among consumers (Preko et al., 2020). In cases where other product-related information including brand reputation is missing, consumers rely heavily on frequency information, i.e., they prefer products that are most frequently used (Alba and Marmorstein, 1987).

In the context of developing countries, experience plays a crucial role in agricultural technology adoption. Positive experiences, such as greater yields and outcomes, increased profitability, and improved resilience can serve as motivating factors for adoption (Lee, 2005; Katengeza et al., 2019). Conversely, negative experiences, such as technical difficulties or disappointing outcomes, can discourage adoption. For example, farmers' positive experiences with drought-resistant maize varieties in Malawi increased their likelihood of adoption in future (Katengeza et al., 2019). Similarly, farmers with greater experience are able to understand the value of and adopt sustainable agricultural practices (Lee, 2005). These studies emphasize the role of experience in influencing farmers' decisions to adopt agricultural technologies.

Likewise, consumers utilize their prior experiences when assessing signals, including warranties and reference prices (e.g., Srivastava and Mitra, 1998; Yadav and Seiders, 1998; Dutta et al., 2022), and, thus, the signaling effect is more pronounced from consumers who are

more informed and experienced as compared to consumers who are less experienced (Ackerberg, 2003; LaRiviere et al., 2014). When receiving a warranty, experienced consumers have greater confidence in interpreting it as a signal of high quality (Mukherjee and Hoyer, 2001). In contrast, consumers who lack product experience are uncertain about the true quality and, thus, update their quality expectations as they see additional high-scope signals such as brand reputation or third-party ratings (Akdeniz et al., 2013). With accumulating product experience through repeated interactions, these less experienced consumers lower their reliance on high-scope signals. In the context of reference prices, consumers' knowledge of market price distribution (obtained through prior experiences) (Burman and Biswas, 2004) or price fluctuation due to frequent price promotions (Erdem et al., 2008) influences their WTP and purchases (Schnabel and Storchmann, 2010), especially for non-complex products (Mukherjee and Hoyer, 2001).

Hence, we posit that product experience acquired over time is likely to increase the diagnosticity of warranties and reference prices in the eyes of consumers when other supporting high-scope signals, such as brand reputation, are missing. Specifically, consumers' prior product knowledge moderates the effect of warranties and reference prices on their WTP, such that it is more pronounced when consumers have more experience or better knowledge. Therefore, we hypothesize that consumers with more experience or better knowledge would perceive a warranty contract as more valuable, while consumers with more experience or better knowledge would consider a high reference price contract irrelevant or negative.

2.3 Data and Methodology

2.3.1 Study Design

The experiment is part of a larger study, which consists of two rounds of household surveys among rice farmers in Bangladesh. The first survey round was conducted in December 2019, during which households were asked to report the number of sickles and the value of

assets they owned. The sickle, a handheld farming tool with a semi-circular blade used for cutting, was chosen as a test bed for the present study as it is widely available and fairly easy to use with a great deal of product information and a low level of uncertainty about the technology. The second survey round was conducted in 2021, during which we conducted the following experiment. We combine a randomized controlled trial (RCT) and a Becker-DeGroot-Marschak (BDM) auction whereby participants were asked to bid for a sickle. The households were randomly divided into the following 2-by-2 treatment arms: i) warranty versus no warranty and ii) information on external reference price versus no information.

Households receiving the warranty offers were entitled to a refund if they were unsatisfied with the performance of the sickle or if the sickle got damaged. Households exposed to external reference prices were informed that the market price of the sickle was 150 Bangladeshi Takkas (BDT). Throughout the experiment, the quality of the sickles was fixed in that they were purchased from the same manufacturer. In addition, the respondents were not informed of the sickle's brand name. The experiment design, thus, disentangles the effect of warranties and reference prices from other factors relevant to consumers' familiarity with or reluctance to the product.

The study was conducted in two districts (Narail and Sherpur) where 3 upazilas (administrative sub-units in a district) per district were chosen. In each of the six upazilas chosen, we randomly selected 15 villages per upazilas. In total, 90 villages were chosen, and in each village, 10 households were sampled from a pool of eligible farms that were cultivating and harvesting Aman rice, a group of rice varieties that are planted in July and harvested in December in Bangladesh (Aman is the major rice season in Bangladesh). The treatments were randomly assigned at the household level. The total number of households in the final sample is 868 households.[1]

[1]At the beginning of the experiment, a higher quality sickle was used for some households. To have the quality of the sickle fixed, we excluded these households from the final sample.

2.3.2 WTP Elicitation: Becker-DeGroot-Marschak Auction

One of the challenges in measuring individual WTPs via survey is to provide an incentive to respondents for them to answer with their "true" WTP. Becker-DeGroot-Marschak (BDM) auction is an incentivized auction with the underlying consumer theory that presents the bid from BDM to be the true WTP of individuals (Irwin et al., 1998; Noussair et al., 2004). BDM incentivizes respondents in such a way that their dominant strategy is to bid their true WTP (Noussair et al., 2004). BDM also allows eliciting actual WTP in a field experiment and making modifications to it (Lusk et al., 2004; Berry et al., 2020). Irwin et al. (1998) establishes that BDM is a reliable elicitation method as it is easy for participants to figure out their dominant strategy and it does not unintentionally influence the participant bids.

To implement the BDM auction, we first asked the respondents to bid the maximum price that they were willing to pay for the sickle. They then drew a ball from a bowl, which had balls with different prices written on them. If the price written on the ball was less than or equal to their bid, they could pay the price on the ball and get the sickle. The minimum price drawn was 5 BDT, while the maximum price was 300 BDT. If the price written on the ball was greater than what they reported, they could not buy the sickle.

2.3.3 Summary Statistics

Table 2.1 shows WTP by treatment arms. The average WTP ranges from 53 BDT to 58 BDT, with a minimum bid of 5 BDT and a maximum of 150 BDT (the highest bid one can make under the BDM instruction). As shown, the reference price group provided a higher WTP on average as compared to the warranty group.

Table 2.1: Willingness to Pay by Treatment Arms

	Control Group					Warranty Group				
	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
Control Group	218	52.61	21.84	10	150	215	54.37	23.72	5	150
Reference Price Group	214	57.59	23.82	10	130	221	55.46	24.85	10	150

Table 2.2 shows the summary statistics and balance tests for the main variables. None of the variables are significantly different across control and treatment groups, except for the total amount of land owned across the warranty treatment groups, indicating that the treatments are randomly assigned. The average age of the respondents is about 48 years old, with about 4 years of average years educated. About 64 percent of the respondents answered that their main occupation is farming and about 18 percent of the respondents are female. Note that all of the households do farm. On average, our sample owns about 4 sickles previous to our experiment.

Our sample consists of a fairly diverse population even though our target is rural farm households in Bangladesh. For example, the education of respondents, amount of land owned, asset value, amount of land operated, and the number of sickles have coefficients of variation that are greater than unity, i.e., the standard deviation is larger than the average. This motivates us to investigate the heterogeneous and possibly moderating effects of the treatments.

Table 2.2: Summary Statistics

	Count	Mean	SD	Min	Max
Age of respondent	863	47.77	14.20	14	85
Education of respondent	860	3.824	4.029	0	16
Expenditure per capita	863	123.3	95.52	22.18	992.8
Respondent is farmer	863	0.637	0.481	0	1
Female	863	0.178	0.383	0	1
Amount of land owned	863	74.72	103.1	0	800
Asset value	863	70.57	200.4	0	5058.3
Amount of land operated	863	325.2	266.8	0	1800
Number of sickles	863	3.972	20.42	0	600
Treatment: Warranty					
	Non-treated N=429	Treated N=434	Diff.	t-stat	
Age of the respondent	48.00	47.53	0.472	0.488	
Education of the respondent	3.759	3.889	-0.130	-0.474	
Expenditure per capita	128.1	118.4	9.709	1.494	
Respondent is farmer	0.641	0.634	0.00739	0.225	
Female	0.172	0.184	-0.0118	-0.454	
Amount of land owned	81.10	68.41	12.69	1.810	
Asset value	77.49	63.72	13.77	1.009	
Amount of land operated	332.5	318.0	14.46	0.796	
Number of sickles	4.667	3.286	1.381	0.993	
Treatment: Reference Price					
	Non-treated N=430	Treated N=433	Diff.	t-stat	
Age of the respondent	47.42	48.11	-0.695	-0.718	
Education of the respondent	3.927	3.723	0.205	0.744	
Expenditure per capita	125.5	121.1	4.414	0.678	
Respondent is farmer	0.635	0.640	-0.00484	-0.148	
Female	0.191	0.166	0.0244	0.936	
Amount of land owned	72.27	77.16	-4.894	-0.697	
Asset value	65.39	75.70	-10.32	-0.756	
Amount of land operated	335.5	315.0	20.42	1.125	
Number of sickles	4.591	3.358	1.233	0.887	

2.3.4 Treatment Effect Estimations

To estimate the treatment effect of warranty and external reference price on WTP, we estimate the following equation:

$$WTP_i = \beta_0 + \beta_1 Warranty_i + \beta_2 ERP_i + \beta_3 (Warranty_i \times ERP_i) + \pi\theta_i + v_v + u_i \quad (2.1)$$

where WTP_i refers to WTP reported by household i and $Warranty_i$ and ERP_i signify if the household received a warranty or an external reference price, respectively. We also consider including a set of individual controls and village fixed effects. In the above equation, individual level controls, θ_i, consist of the number of sickles owned, education, age, and gender of respondent i, a dummy indicating if the respondent is a farmer, expenditure per capita of the household, land operated, and value of assets owned. The village fixed effects are denoted by v_v. Estimating the treatment effects via equation 2.1 allows us to test the hypotheses regarding warranty and reference price.

Furthermore, as developed in Section 2.2.3, we test the hypotheses related to experience as a moderator. To do so, we first estimate the following regression equation:

$$\begin{aligned} WTP_i = \beta_0 + \beta_1 Warranty_i + \beta_2 ERP_i + \beta_3 x_i + \beta_4 (Warranty_i \times x_i) \\ + \beta_5 (ERP_i \times x_i) + v + u_i \end{aligned} \quad (2.2)$$

where x_i is a moderator. We focus on two variables as a proxy for previous experience and knowledge of the product: i) the number of sickles that the responding household owns and ii) the size of land operated by the responding households.

As Equation 2.2 assumes a linear relationship between the moderator and the treatment effect, we further expand our analyses to incorporate possible nonlinearity in such relationships. We take insight from studies investigating the non-linear moderating effects of firm-specific characteristics (Kohtamäki et al., 2019; Peng et al., 2020; Kahn and Candi, 2021) on

the relationship between firm growth and strategy, and expand it to the consumer side. In these studies, the effect of a firm's innovation or growth strategy is nonlinearly moderated by factors such as firm size (Kahn and Candi, 2021) or institutional uncertainty (Peng et al., 2020), and polynomial regressions are used for investigating the relation. We investigate the presence of similar farm-specific non-linear moderating effects that reflect experience to see if the effect of signaling increases or decreases as farms gain more expertise.

Instead of the polynomial function to capture nonlinearity, we use the piecewise linear function for estimation because of the distributional nature of data (Gallant and Fuller, 1973). A polynomial regression estimates a non-linear relationship over a continuous independent variable, whereas the piecewise linear function assumes a different linear function in each subdomain of the independent variable. It helps identify various demographic groups based on experience and occupation for which the treatment effect differs. A piecewise linear function has the simplicity of a linear model, but the flexibility of non-parametric regressions (Liu et al., 1997). It also avoids the problem of the curse of dimensionality (i.e., having too many predictors in a model) that arises with polynomial regression. Hence, we use the piecewise linear regression to segment the population based on the two continuous moderating variables denoted by x_i. We pick a threshold t for each continuous moderator that maximizes the in-sample goodness-of-fit:

$$\begin{aligned} WTP_i = \beta_0 + \beta_1 Warranty_i + \beta_2 ERP_i + \beta_3 x_i + \beta_4 (Warranty_i \times x_i) + \beta_5 (ERP_i \times x_i) \\ + \beta_6 ((x_i - t) \times D_i \times Warranty_i) + \beta_7 ((x_i - t) \times D_i \times ERP_i) + v + u_i \end{aligned} \tag{2.3}$$

where D indicates a dummy variable which indicates if x_i is above a certain threshold, t $(D = 1 | x_i \geq t)$. If the value x_i is greater than the threshold t, i.e., $D = 1$, we interact $x_i - t$

with our treatment variables. The marginal effect of the warranty now becomes:

$$\Delta WTP_i = \beta_1 + \beta_4 x_i + \beta_6((x_i - t) \times D_i). \tag{2.4}$$

Similarly, the marginal effect of the reference price is:

$$\Delta WTP_i = \beta_2 + \beta_5 x_i + \beta_7((x_i - t) \times D_i). \tag{2.5}$$

2.4 Empirical Results

2.4.1 Effects of Quality Signaling on WTP

Table 2.3 shows the estimated results for Equation 2.1. Columns 1 through 4 in the table differ by the set of the included controls and the village-level fixed effects. The results are robust across the columns, indicating that the randomization provides well-balanced samples across the treatment arms.

Table 2.3: Treatment Effects of Warranty and External Reference Price

	(1)	(2)	(3)	(4)
VARIABLES	Dependent Variable: WTP			
Warranty	-0.246	-0.417	-1.533	-1.551
	(1.606)	(1.602)	(1.494)	(1.473)
External Reference Price	3.079*	3.337**	3.426**	3.497**
	(1.606)	(1.618)	(1.397)	(1.403)
Constant	53.47***	53.76***	53.94***	62.46***
	(1.326)	(3.905)	(1.020)	(4.101)
Controls	No	Yes	No	Yes
Village FEs	No	No	Yes	Yes
Observations	863	863	863	863

Notes: Robust standard errors are in parentheses. Significance codes are * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

As shown, offering a warranty has a negative effect on WTP, while the effect is not

statistically significant. Including controls and village-level fixed effects slightly increases the magnitude of the regression coefficient in absolute terms, but does not change the statistical significance. In sum, the results are in line with the hypothesis that a warranty is a low-scope signal and should be coupled with a high-scope signal to increase credibility when the consumers are already familiar with the product (Purohit and Srivastava, 2001; Biswas et al., 2009). The results also show a positive and significant effect of external reference price on WTP, supporting hypothesis regarding reference price. Overall, we observe that adding controls and village fixed effects makes the coefficient estimates more significant and increases the impact magnitude of external reference price on WTP. Being exposed to an external reference price of 150 BDT increases WTP in the range of 3 to 3.5 BDT. With the average WTP across our sample being about 55 BDT, the estimated effect ranges between 5.5 and 6.4%.

2.4.2 Moderating Effects of Experience

Table 2.4 shows the extent to which consumer experience moderates the effect of warranties and reference prices on WTP (Equation 2.2), whereby the number of sickles (Columns 1 and 2) and the amount of land operated (Columns 3 and 4) are used as a proxy of consumer experience. When assessing each proxy of experience, we compare our proposed model with a benchmark model with no village-level fixed effects (Columns 1 and 3). On average, we observe no statistically significant moderating effects of warranties or external reference prices on WTP, while the directions of the estimated coefficients for the interaction terms are consistent with hypotheses regarding experience. We also observe that the magnitudes of the moderating effects are larger when we control for village-level fixed effects.

Table 2.4: Heterogeneous Effects of Warranty and External Reference Price

	(1)	(2)	(3)	(4)
	Dependent Variable: WTP			
VARIABLES	Moderator: No. of Sickles		Moderator: Amount of Land Operated	
Warranty	-2.082	-4.609	0.592	-2.449
	(3.031)	(3.188)	(2.528)	(2.818)
External Reference Price	3.493	5.441*	0.187	0.560
	(3.032)	(2.778)	(2.531)	(2.477)
Moderator	0.535	0.530	0.00353	-0.00321
	(0.669)	(0.669)	(0.00512)	(0.00536)
Warranty x Moderator	0.558	0.954	-0.00214	0.00318
	(0.785)	(0.978)	(0.00602)	(0.00704)
External Reference Price x Moderator	-0.171	-0.666	0.00931	0.00898
	(0.786)	(0.657)	(0.00604)	(0.00601)
Constant	51.80***	52.29***	52.22***	54.96***
	(2.583)	(2.212)	(2.201)	(2.129)
Village FEs	No	Yes	No	Yes
Observations	862	862	863	863
R-squared	0.009	0.277	0.013	0.277

Notes: Robust standard errors are in parentheses. Significance codes are * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Despite the lack of the average (linear) moderating effects, when incorporating the potential nonlinearity, the treatment effect for warranty and reference price varies with the number of sickles and amount of land operated, which are reported in decimals or one-hundredth of an acre, respectively. When dividing the entire households into high- and low-experience groups, using 9 sickles and 1,200 decimals of the land operated as the thresholds (which maximize the in-sample goodness-of-fit), the results from the piecewise regressions show that the high-experience group perceives greater value in warranty, but adversely react to reference prices (see Figure 2.1). The marginal effects are presented in Figure 2.1. That is, for example, the WTP of an individual with 12 sickles who received the warranty treatment is expected to be greater than that of an individual with 12 sickles who received no treatment, by about 50 BDT. Similarly, we would expect that the reference price treatment would lower the WTP of an individual with 12 sickles by roughly 40 BDT. For an individual with 1,500 decimals of land operated, we would expect the reference price reduces WTP by 19 BDT.

These results are consistent with the hypothesis that users who use the product more

frequently value warranties higher than infrequent users. That may arise because warranties provide more direct value to more intensive users or because such users are familiar with the lack of guarantees for a similar product and perceive a higher quality signal associated with the warranty. We also investigate other moderators, such as the age and education of respondents and the wealth level of the household, and find significant heterogeneity with respect to age (see figures 2.2 and 2.3).

Figure 2.1: Moderating Effects of Experience: Piecewise Linear

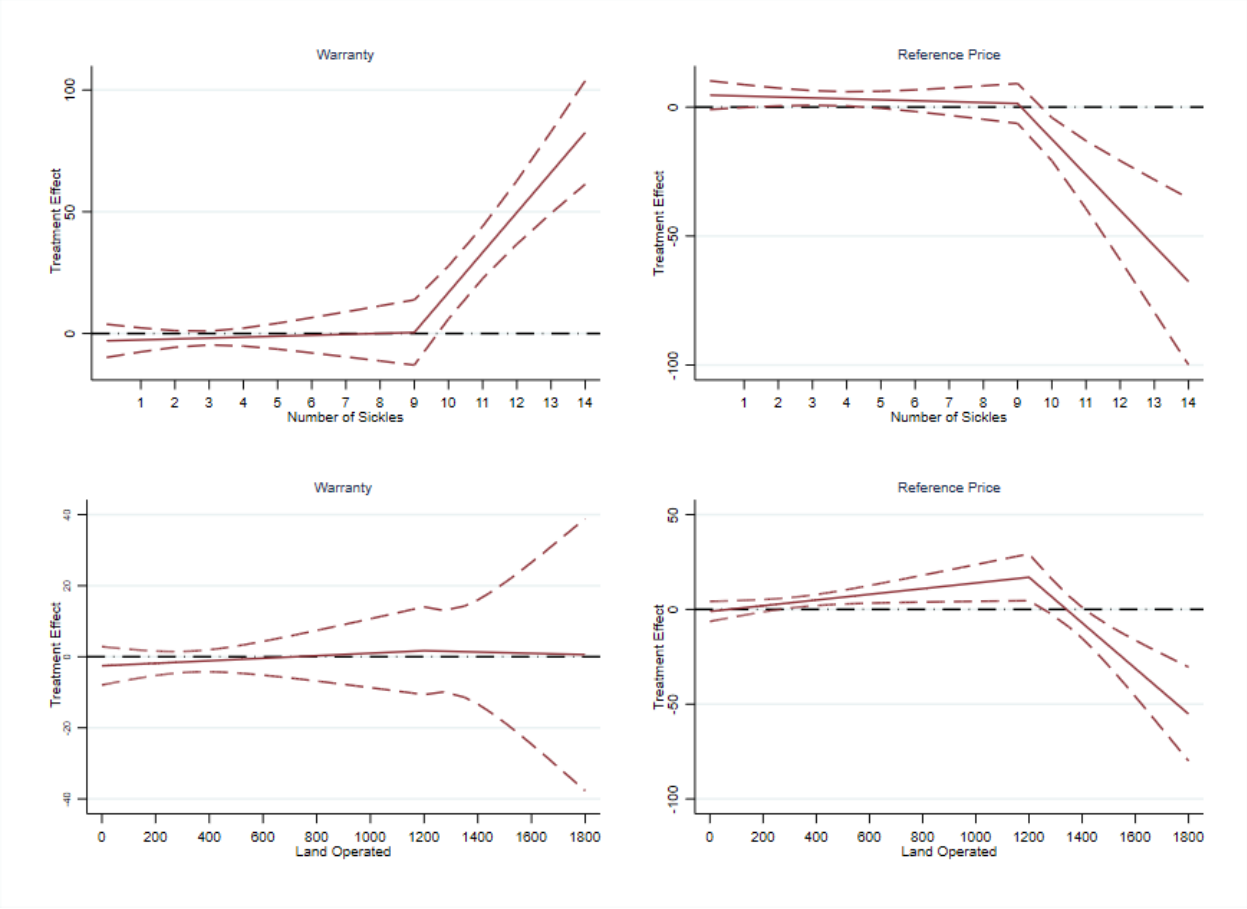


Figure 2.2: Moderating Effects of Age and Education of the Respondents: Piecewise Linear

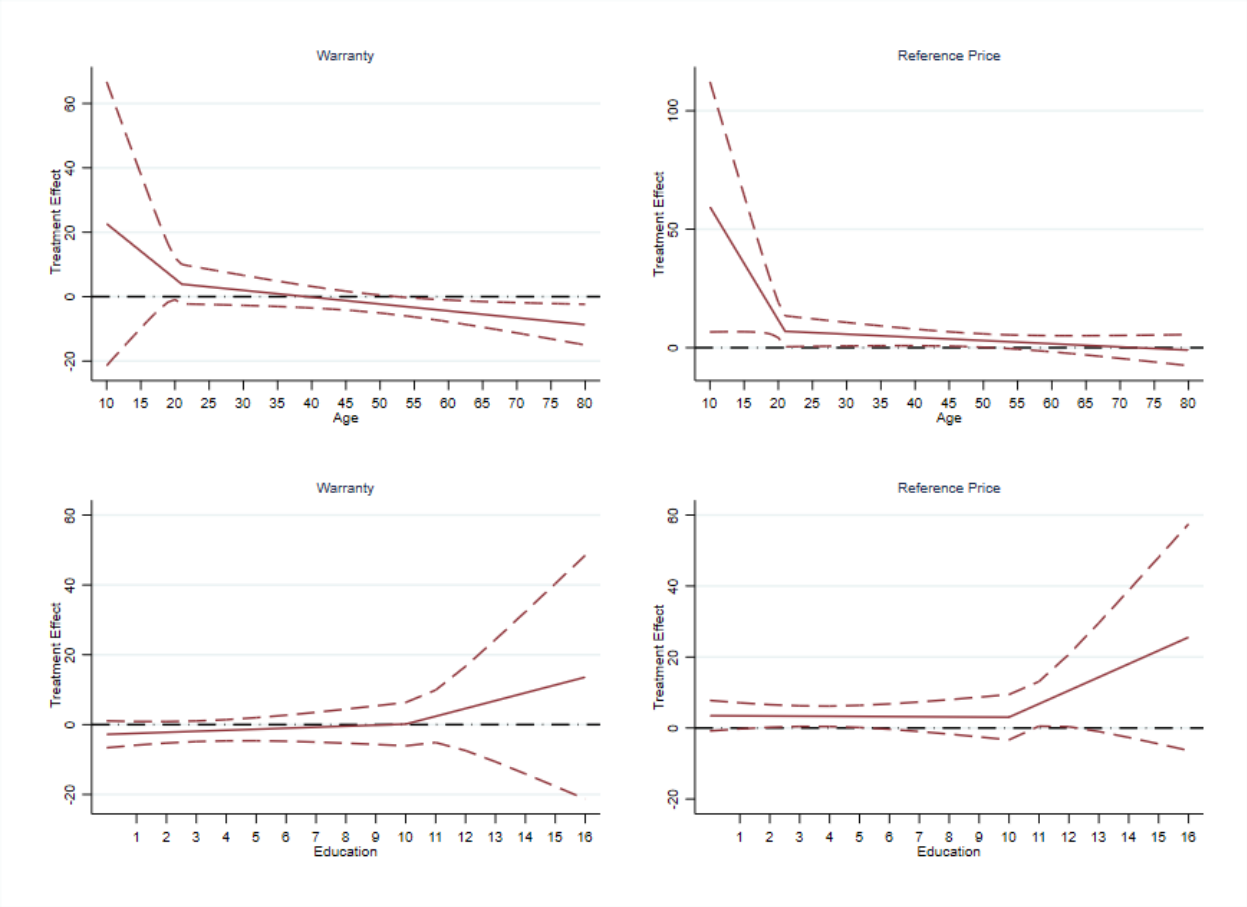
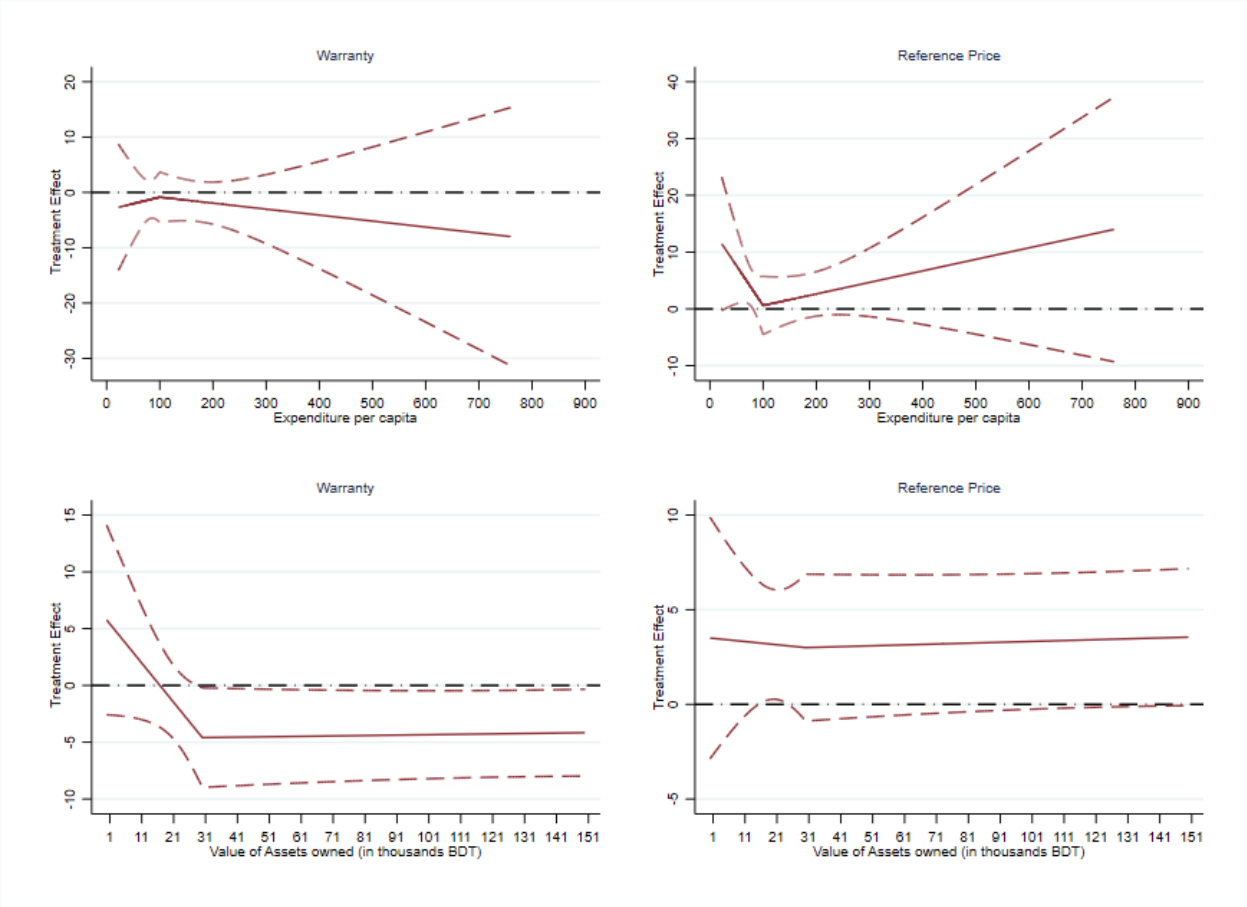


Figure 2.3: Moderating Effects of Household Wealth: Piecewise Linear



2.5 Conclusion

This study has made an effort to advance our understanding of the signaling effect on WTP, associated with two commonly used quality signaling devices: warranty and reference price. Our findings suggest that an unknown firm offering a warranty with no brand reputation provides zero credibility to the warranty (Boulding and Kirmani, 1993; Purohit and Srivastava, 2001) and, thus, a warranty offered by an unknown firm is perceived negatively. In addition, when consumers are familiar with the product, they think they have sufficient knowledge to assess the product quality and do not feel any need to rely on extrinsic cues (Mukherjee and Hoyer, 2001). Meanwhile, consistent with the assimilation-contrast theory, higher reference

prices signal high quality and are assimilated in consumers' WTP (Sherif et al., 1958).

By combining an RCT and a BDM auction, we establish the causality for the effects of interest and also achieve reliability for the measure of WTP. Previous studies on warranty contracts or reference prices focused on the effect of brand reputation/credibility on consumers' self-explicated, non-incentive-aligned preferences. These approaches, however, provide limited insights on the causal effects of such signaling devices in the absence of brand information, eliciting a hypothetical WTP that deviates significantly from the actual WTP (Hofstetter et al., 2021). Our findings, thus, contribute to the marketing and economics literature, with which experiment design mimics real-life decisions and provides reliable estimates of WTP. The results also support the idea that new firms and unknown brands benefit from having higher prices at the start. Higher prices indicate higher costs which signal better quality for consumers and drive WTP upwards (Schnabel and Storchmann, 2010).

Furthermore, we demonstrate the nonlinear moderating role of consumer experience in the signaling effect, which offers a more nuanced understanding than what is presented in the extant literature. The nonlinear approach via piecewise regressions allows us to identify consumer segments that could have been ignored under traditional linear approaches. Given that the treatment effect of warranty and reference price differs across different demographic and behavioral consumer segments, our results provide managerial insights for effective resource allocations on signaling devices. For example, firms with an established loyal consumer base should be able to engage in offering warranty contracts or external reference prices, while firms with no brand reputation could allocate their marketing resources to promotional activities to increase customer experience with their products before offering warranty contracts or external reference prices.

Some further considerations can advance the study. While we have enough samples to estimate the main treatment effects, the estimations of moderating effects may be underpowered given that we need large samples within each interval for each moderator. While our key findings are based on fairly precise estimates, further studies with stratified randomization

and larger samples may provide more precise estimates of the moderating effects. Second, the product in our context is standardized, while there may be other settings in which the firm provides more customized products, leading to a potential interaction between product and consumer characteristics. One could also construct extended experiments with multiple products and variations. Lastly, our experiment design focuses on a single firm. While such an approach is intended to control for the potential impact of the brand reputation/credibility, the availability of competitive data may allow us to develop boundary conditions for the signaling effect associated with warranty contracts and reference prices. We hope that future research can address these limitations.

Chapter 3

Asymmetric Credit Response to Idiosyncratic and Covariate Shocks: Evidence from Rural Bangladesh

3.1 Introduction

Risk management is important for farmers in developing countries, who face various risks, including adverse weather conditions, pests, diseases, price variations, and health issues. These risks can reduce agricultural productivity, cause food insecurity, and aggravate poverty (Binswanger et al., 1993; Dercon, 2005; Dercon and Christiaensen, 2011). Persistent income shocks can prevent chronically poor households from investing in human capital and escaping poverty, and also, slide wealthier households into transient poverty (Binswanger et al., 1993; Dercon and Christiaensen, 2011).

Access to credit provides smallholders the opportunity to smooth consumption in case of various negative shocks that reduce income or assets (Rosenzweig and Wolpin, 1993; Morduch, 1995). They can also invest in new and risky technologies, if they can smooth consumption over time (Morduch, 1995). As formal credit markets are limited in developing

countries, farmers rely more on informal credit markets to mitigate these risks (Udry, 1990; Fafchamps and Lund, 2003).

In this paper, we explore how informal and formal credit markets are used to mitigate risks by farmers in a developing country, Bangladesh. We investigate how the total credit uptake and the amount and share of credit from informal or formal sources change after an idiosyncratic or covariate shock. We explore asymmetry in the credit response for farmers who switch in the treatment, e.g., households who do not face a negative shock in the first round, but face a negative shock in the second round versus those who switch out, e.g., households who face a negative shock in the first round, but do not face a negative shock in the second round. The credit response of farmers who are treated in the second round, is compared to that of households who remain untreated in both rounds. Likewise, the credit response of farmers who are treated in only the first round, is compared to that of households who remain treated in both rounds. As part of our secondary analysis, we differentiate income or asset shocks according to the nature of the shock, e.g., crop shock, livestock shock or labor shock to understand the driving mechanism behind credit decisions.

Informal credit markets are an important source of credit for small-scale farmers in developing countries, whereby lending and borrowing occur between individuals, groups, and institutions that are not regulated by formal financial institutions and are willing to lend to farmers in times of need (Eswaran and Kotwal, 1989; Fafchamps and Lund, 2003; Mobarak and Rosenzweig, 2013). Informal credit markets make borrowing easy for small-scale farmers as they are flexible, accessible, and often based on social relationships and trust (Dercon, 2002; Fafchamps and Lund, 2003).

Another advantage of informal credit markets is their ability to provide credit to farmers to mitigate idiosyncratic risks (Dercon, 2002; Townsend, 1994). Idiosyncratic risks are risks that are unique to a particular farmer, such as a loss of assets due to theft, death of an earner or crop failure due to a disease. Informal credit markets can provide farmers with access to credit that can be used to purchase inputs or to cover other expenses, such as medical bills,

etc., during times of low income or crop failure (Eswaran and Kotwal, 1989; Fafchamps and Lund, 2003).

However, informal credit markets are often ineffective in dealing with covariate risks, which are risks that affect a large number of farmers at the same time, such as a drought or a flood (Townsend, 1994). This makes it impossible to pool risks within a community or village. Covariate risks can lead to a decrease in income for farmers, which can make it more difficult for them to repay their loans, causing lenders to be more cautious in lending (Karlan and Morduch, 2010).

Formal credit markets can better mitigate covariate risks, but are difficult to access (Morduch, 1995; Dercon, 2002). Formal credit markets are better equipped to deal with covariate risks, as they are often backed by governments, international organizations or other large institutions that can provide reinsurance or other risk-sharing mechanisms (Karlan and Morduch, 2010). However, they are difficult to access for small-scale farmers in developing countries, who often lack the collateral, credit history or documentation required by formal lenders (Morduch, 1995; Dercon, 2002; Dercon and Christiaensen, 2011).

Our study contributes to the existent literature on credit markets and household risk management in several ways. It explores a crucial aspect of household financial behavior by investigating the effects of negative income or asset shocks on households' credit uptake, particularly examining the amount and share of loans. Our study is distinct, because we examine the transition of farm households in and out of rounds of financial distress, using the advanced difference-in-difference technique by De Chaisemartin and d'Haultfoeuille (2020) and household-level panel data to estimate the impact of the treatment. If there is a heterogeneity in treatment effect and the treatment timing varies, then the weights for the weighted sum in a traditional two-way fixed effects (TWFE) estimation can lead to misleading estimates of the average treatment effect, as the weights can be negative (De Chaisemartin and d'Haultfoeuille, 2020; Goodman-Bacon, 2021). By accounting for the dynamic nature of financial vulnerability and looking at the nature of shocks, particularly idiosyncratic versus

covariate shocks, we find insights into how different shocks have different impact on credit utilization from formal and informal sources. This research sheds light on the nuanced relationship between income shocks and credit decisions, and how availability of credit can help households pool the risk of income and asset shocks in rural communities. This can help policymakers and financial institutions in designing effective credit policies for households facing financial adversities.

3.2 Literature Review

Smallholders in developing countries have limited access to formal credit and insurance, and rely more on informal risk-sharing mechanisms to smooth consumption and income (Dercon, 2002; Fafchamps and Lund, 2003), but the efficacy of informal credit in managing risks associated with covariate shocks is subject to debate. In this section, we examine several studies that have explored the effectiveness of informal and formal credit in reducing the risk of idiosyncratic and covariate shocks.

Different risk-mitigating mechanisms are developed within a community to smooth consumption in case of an idiosyncratic shock, including the use of credit markets to pool risks (Eswaran and Kotwal, 1989; Morduch, 1995). Different examples of networks that enable risk-sharing, lending, borrowing or exchange of gifts are caste-based networks in India (Mobarak and Rosenzweig, 2013), relatives, friends, and employers (Fafchamps and Lund, 2003). Joint liability lending (Ghatak and Guinnane, 1999), tenant-landlord arrangements such as share contracts (Eswaran and Kotwal, 1989), savings groups, and rotating savings and credit associations (Conning and Udry, 2007), also provide a way for households to cope with idiosyncratic shocks and invest in income-generating activities. Households pooling risks within a community are able to reduce the risk of loss of income or assets at individual-level, but are unable to reduce the residual village-level risk (Townsend, 1994).

Previous research presents contrasting evidence regarding the extent to which informal

credit can be used to mitigate covariate risks (Kurosaki and Fafchamps, 2002; Holden et al., 2004; Dercon, 2005; Karlan and Zinman, 2008). On one hand, managing covariate risks through informal credit markets is difficult because pooling risks is not possible and lenders become more cautious in times of distress (Townsend, 1994; Karlan and Morduch, 2010). The risk of covariate shocks cannot be pooled as the entire community or village gets affected and inter-village borrowing becomes difficult, as a result of which household consumption varies with the average consumption in a community or village (Townsend, 1994). Informal means of insuring risks is also imperfect as risk is normally spread across households with similar income levels, leaving out those in the lowest income strata (Banerjee and Duflo, 2007). Covariate shocks make it difficult for farmers to repay their loans as the financial condition aggravates, causing lenders to be more cautious in lending and raising interest rates (Heltberg and Lund, 2009; Karlan and Morduch, 2010).

Given the imperfection of the informal credit market, covariate shocks can be better mitigated through formal credit which is difficult to access by smallholders (Eswaran and Kotwal, 1989; Dercon and Christiaensen, 2011). For example, in Ethipia formal credit accounts for only 7.5 percent of farm credit, as information asymmetry in case of income or asset shocks makes it difficult for farmers to get formal credit (Udry, 1990). In the absence of credit markets, farmers engage in various consumption or income smoothing activities including selling off assets, off-farm employment, and planting safer crops (Binswanger et al., 1993; Morduch, 1995; Dercon, 2002) to deal with covariate shocks. This comes at the cost of lower agricultural productivity or financial aggravation of farmers.

However, informal credit markets are based on mutual trust, social capital, and relationships which allow informal credit markets to be more flexible and viable in some instances (Coleman, 1988; Udry, 1994; Fafchamps and Lund, 2003). They also reflect empowerment, feelings of obligation, mutual trust, and reciprocity within communities which prevents any default (Coleman, 1988). In the absence of formal financial institutions, social capital allows farmers to borrow from each other without any formal collateral requirement and the need

to establish creditworthiness. Social capital allows borrowers to build reputations over time which makes any future borrowing in times of need easier and allows for arrangements to be made for late payments as well, while social repercussions and penalties ensure that the repayment rate remains high (Geertz, 1962; Coleman, 1988; Besley and Coate, 1995).

Hence, informal credit, when used effectively, can mitigate the repercussions of negative shocks. Access to informal credit allows households to rebuild assets which increases their resilience to both covariate and idiosyncratic shocks (Holden et al., 2004; Dercon, 2005; Karlan and Zinman, 2008). Furthermore, farmers who are part of these groups smooth consumption better (Fafchamps and Lund, 2003) and show signs of improved income, consumption, asset ownership, and other social indicators (Udry, 1994; Deininger and Liu, 2013) as compared to farmers who are not part of such informal networks. In such situations, informal credit markets can help households cope with income volatility and reduce poverty, but it is not an effective coping mechanism for the poorest households who are excluded from such social networks (Kurosaki and Fafchamps, 2002).

Different types of informal credit may be more effective in dealing with different types of shocks. For example, microfinance may be more effective in dealing with idiosyncratic shocks, while community-based organizations and insurance schemes may be more effective in dealing with covariate shocks (Karlan and Morduch, 2010). Rotating credit associations are a prime example of how an informal credit arrangement, based on trust, can enforce obligations and payments (Geertz, 1962; Coleman, 1988). Under joint liability groups that are formed because of social capital, households have the incentive to make repayments on behalf of other households in case of default (Besley and Coate, 1995).

Access to credit is crucial for promoting risk management amongst smallholders in developing countries. Based on the literature, informal credit markets can provide a risk mitigation tool for poor households against idiosyncratic shocks and to a certain extent against covariate shocks. Formal credit can potentially better mitigate covariate shocks, but access to it is limited. Therefore, we investigate the impact of idiosyncratic and covariate shocks

on the credit decisions of households that switch in and out of a treatment over time.

3.3 Data

Our sample consists of a balanced panel of 2,305 households from the rounds 2011/12, 2015, and 2018/19 of the IFPRI's Bangladesh Integrated Household Survey (BIHS)[1]. The BIHS is representative of all seven administrative districts and gathers data on income, consumption, production, and other demographic variables.

The outcome variables are constructed using credit information in the survey data. BIHS has information on the credit used by farmers, including the amount of loan taken (in Bangladeshi Takkas) and the source of credit. We classify the sources of credit into formal or informal sources. Credit sources such as a moneylender, friend, relative or employer are considered informal, while credit sources such as a bank or an NGO are considered formal. We compute the share of credit from each credit source relative to the total amount of credit taken.

Treatment variables are developed using data on negative income and asset shocks. For each round of the survey, we have negative income or asset shock data for the past five years or since the last time survey was administered. A household reports if it lost crops, livestock or productive assets due to a natural calamity, disease or theft, etc., in the period surveyed. It also reports any labor-related loss such as death or illness of a household member. We use the cause of loss to classify the negative shocks into covariate or idiosyncratic shocks. A covariate shock is experienced by multiple households in the same geographical region (e.g. flood, drought, etc.), while an idiosyncratic shock is experienced by a sole household and is unrelated to the experience of other households in the same geographic location. For example, livestock loss due to a flood would be classified as a covariate shock, while livestock loss from theft would be classified as an idiosyncratic shock. While examining the effect

[1]The surveys are conducted across multiple months. The first round of the survey started in October 2011 and ended in March 2012, the second round of the survey started in January 2015 to May 2015, and the third round of the survey started in November 2018 and ended in May 2019.

of idiosyncratic shocks, we remove households that faced covariate shocks across the three survey rounds, to ensure that we have a clean design. Similarly, while examining the effect of covariate shocks, we remove households that faced idiosyncratic shocks across the three survey rounds.

BIHS also provides information on income, assets, and education for the household members and plot-level details. We use a set of relevant control variables including the number of plots, the total value of assets owned, the number of household members who attended school, and the number of working members in the household.

Table 3.1 shows summary statistics for the full sample across the three rounds. Table 3.1 shows that on average amount of credit taken from informal sources is greater than the amount of loan taken from formal sources. On average, the amount of loan taken from formal sources is 23,853 BDT and the amount of loan taken from informal sources is 35,640 BDT. This shows that households get a larger amount of loans from informal sources. However, the relative share of credit taken from formal sources and informal sources is roughly one-third as a ratio of total credit across the population. Table 3.1 also shows that labor shock is the most common type of shock faced by households, as compared to crop shock, livestock shock and productive asset shock. Around 40 percent of the sample experienced loss of labor due to either injury, illness, unemployment or death. On average, one household in our sample has 3.176 plots, 1.493 working members, 65,525 BDT worth of assets, and a monthly income of 8,100 BDT. These statistics confirm that our sample consists mainly of smallholders with a small number of plots, one or two working members, and income levels on the lower side.

We conduct balance tests across the treated versus untreated groups in Tables 3.2 and 3.3. The balance tests help us determine the comparability of treatment and control groups and to determine if there are any significant differences in the observed variables between the treatment and control groups, which could potentially bias the estimated treatment effects. By ensuring that there is no difference between the treated and control group, we can attribute any differences observed in the credit variables, after the treatment to

the treatment itself, which ultimately helps establish causal inference between the negative shocks and the credit variables.

Table 3.2 compares variables across households with different treatment statuses concerning idiosyncratic shocks across the three rounds. It restricts the sample to 1,709 households, by omitting households that faced a covariate shock in any one of the three rounds. Households that face idiosyncratic shocks have a higher number of members who went to school as compared to households that did not face idiosyncratic shocks in rounds 2 and 3. As most of the idiosyncratic shocks are labor related in our sample, households treated with idiosyncratic labor shocks might have more household members going to school as they may have more family members, to begin with. In round 2, households treated with idiosyncratic shocks have less monthly income as compared to non-treated households, which can be a result of the income or asset shock.

Table 3.3 compares variables across households with different treatment statuses concerning covariate shocks across the three rounds. It restricts the sample to 140 households by omitting any household that faced an idiosyncratic shock in any one of the three rounds. Households that face covariate shocks in round 1 have higher monthly incomes, but lower value of assets as compared to households that did not face covariate shocks. In round 2, treated household have more working members and greater number of plots as compared to untreated households.

To account for the above pre-existing differences between the treated and control variables, we control for these variables in our estimations.

Table 3.1: Summary Statistics (Full Sample)

	Mean (N=6915)	Std. Dev	Min	Max
Amount of loan taken (BDT)	59,493.6	191,051.8	0	8,905,000
Amount of loan taken from formal sources (BDT)	23,853.0	103,083.8	0	5,000,000
Amount of loan taken from informal sources (BDT)	35,640.6	150,963.4	0	8,740,000
Share of loan taken from formal sources	0.354	0.437	0	1
Share of loan taken from informal sources	0.370	0.442	0	1
Idiosyncratic Shock (1= Shock, 0= No Shock)	0.570	0.495	0	1
Covariate Shock (1=Shock, 0= No Shock)	0.105	0.306	0	1
Crop Shock (1=Shock, 0= No Shock)	0.0768	0.266	0	1
Livestock Shock (1=Shock, 0= No Shock)	0.0697	0.255	0	1
Productive Asset Shock (1=Shock, 0= No Shock)	0.0430	0.203	0	1
Labor Shock (1=Shock, 0= No Shock)	0.400	0.490	0	1
No. of plots	3.176	4.090	0	38
No. of working members	1.493	0.922	0	6
Value of assets (BDT)	65,525.6	114,448.8	0	3,763,040
No. of HH members who went to school	3.252	1.810	0	15
Monthly HH income (BDT)	8,100.7	8,823.1	0	129,000

Table 3.2: Summary Statistics by Treatment (Idiosyncratic Shock)

	Round 1			
	Non-treated (N=145)	Treated (N=1564)	Difference	t-stat
No. of plots	1.062	2.313	-1.251	-4.333
No. of working members	1.138	1.691	-0.553	-6.932
Value of assets (BDT)	25,872.0	35,952.0	-10,080.0	-1.075
No. of HH members who went to school	2.255	2.439	-0.184	-1.406
Monthly HH income (BDT)	3,827.6	5,599.6	-1772.0	-3.362
	Round 2			
	Non-treated (N=1063)	Treated (N=646)	Difference	t-stat
No. of plots	2.634	2.478	0.156	0.847
No. of working members	1.516	1.466	0.0496	1.098
Value of assets (BDT)	60,469.1	57,245.5	3,223.6	0.822
No. of HH members who went to school	3.218	3.432	-0.214	-2.587
Monthly HH income (BDT)	7,959.2	6,980.0	979.2	2.572
	Round 3			
	Non-treated (N=834)	Treated (N=875)	Difference	t-stat
No. of plots	3.112	2.968	0.144	0.715
No. of working members	1.155	1.246	-0.0910	-2.215
Value of assets (BDT)	103,985.0	87,726.7	16,258.3	2.509
No. of HH members who went to school	3.751	4.029	-0.278	-3.137
Monthly HH income (BDT)	10,299.2	10,939.4	-640.2	-1.224

Table 3.3: Summary Statistics by Treatment (Covariate Shock)

	Round 1			
	Non-treated (N=58)	Treated (N=82)	Difference	t-stat
No. of plots	1.534	4.366	-2.831	-5.753
No. of working members	1.086	1.866	-0.780	-5.563
Value of assets (BDT)	32,687.8	25,363.8	7,324.0	0.981
No. of HH members who went to school	2.052	2.439	-0.387	-1.508
Monthly HH income (BDT)	3,889.3	5,511.3	-1622.0	-2.106
	Round 2			
	Non-treated (N=128)	Treated (N=12)	Difference	t-stat
No. of plots	3.680	6.500	-2.820	-2.606
No. of working members	1.336	1.917	-0.581	-2.001
Value of assets (BDT)	69,209.7	62,520	6,689.7	0.280
No. of HH members who went to school	3.164	3.417	-0.253	-0.477
Monthly HH income (BDT)	7,471.9	11,240.3	-3,768.4	-1.517
	Round 3			
	Non-treated (N=118)	Treated (N=22)	Difference	t-stat
No. of plots	4.305	4.864	-0.559	-0.571
No. of working members	1.110	1.045	0.0647	0.291
Value of assets (BDT)	126,776.1	85,895.7	40,880.4	1.188
No. of HH members who went to school	3.788	3.682	0.106	0.235
Monthly HH income (BDT)	10,870.9	8,911.8	1,959.1	0.575

Figures 3.1 and 3.2 compare the severity and frequency of idiosyncratic and covariate shocks across the three rounds of the survey. Figure 3.1 compares the severity of the idiosyncratic and covariate shocks. In the first and second rounds, households were asked to rank the worst three shocks that they faced in the last five years. In the third round, the households were asked to tell how severe was the impact of the income or asset shock on their economic condition and consumption, if they faced the income or asset shock in the past one year. The households were asked to select their response on a scale of "not severe" to "extremely severe". While rounds 1 and 2 show the relative severity of the shocks as compared to other shocks they faced, round 3 shows a more objective measure of severity as households are not asked to rank shocks against each other.

Figure 3.1 shows that the severity of income shocks as reported by households is not

drastically different for idiosyncratic and covariate shocks. In round 1, 80 percent of the idiosyncratic shocks and 90 percent of the covariate shocks were reported as " the worst shocks" in the last five years[1]. Less than 20 percent of the idiosyncratic and covariate shocks were reported as "the second worst shocks". None of the covariate shocks was reported as the "third worst shock" in relation to other shocks. In round 2, all the covariate shocks were reported as "the worst shocks" the households faced in the last five years. On the other hand, the relative severity of the idiosyncratic shocks was more diverse in the same round.

In the round 3, 40 percent of the idiosyncratic shocks and around 70 percent of the covariate shocks, faced in the last one year, had a severe impact on households' economic condition [2]. Approximately, 35 percent of the idiosyncratic shocks and ten percent of the covariate shocks had an extremely severe impact on households' economic condition. Similarly, 45 percent of the idiosyncratic shocks and around 35 percent of the covariate shocks had a severe impact on household consumption in the last one year. Overall, the severity of the covariate and idiosyncratic shocks follows the same pattern across the three rounds of the survey, with more covariate shocks being reported as extremely severe in the last year.

Figure 3.2 reports the frequencies of idiosyncratic and covariate shocks the households faced in the past five years as reported in the rounds 1 and 2. In round 1, the frequency of idiosyncratic shocks in the last five years varied from 1 to 7, whereas the maximum number of covariate shocks reported by the households was 2. All of the households that faced covariate shocks reported that they experienced only one covariate shock in the last five years in round 2. Around 80 percent of the households who experienced idiosyncratic shock reported one idiosyncratic shock for the rounds 1 and 2 in the previous five years.

We also compare the average frequency of shocks for households that faced shocks in both rounds versus those that faced shocks in a single round. Households that faced idiosyn-

[1]In the round 1 and 2, households were asked to rank the worst three shocks they faced in the past five years, as "the worst shock", " the second worst shock" or the " third worst shock".

[2]In the round 3, households were asked to report the severity of the shocks they faced in the last year on household's economic condition and consumption on a scale. The households could report that the impact was "not severe", " somewhat severe", " severe", or "extremely severe".

cratic shocks in both rounds reported an average frequency of 1.24 while households that faced idiosyncratic shocks in one round reported an average frequency of 1.21. Similarly, households that faced covariate shocks in both rounds reported an average frequency of 1.04 while households that faced idiosyncratic shocks in one round reported an average frequency of 1.13. Hence, in terms of frequency, the treatment received by the households remained consistent regardless if they were treated in one round or multiple rounds.

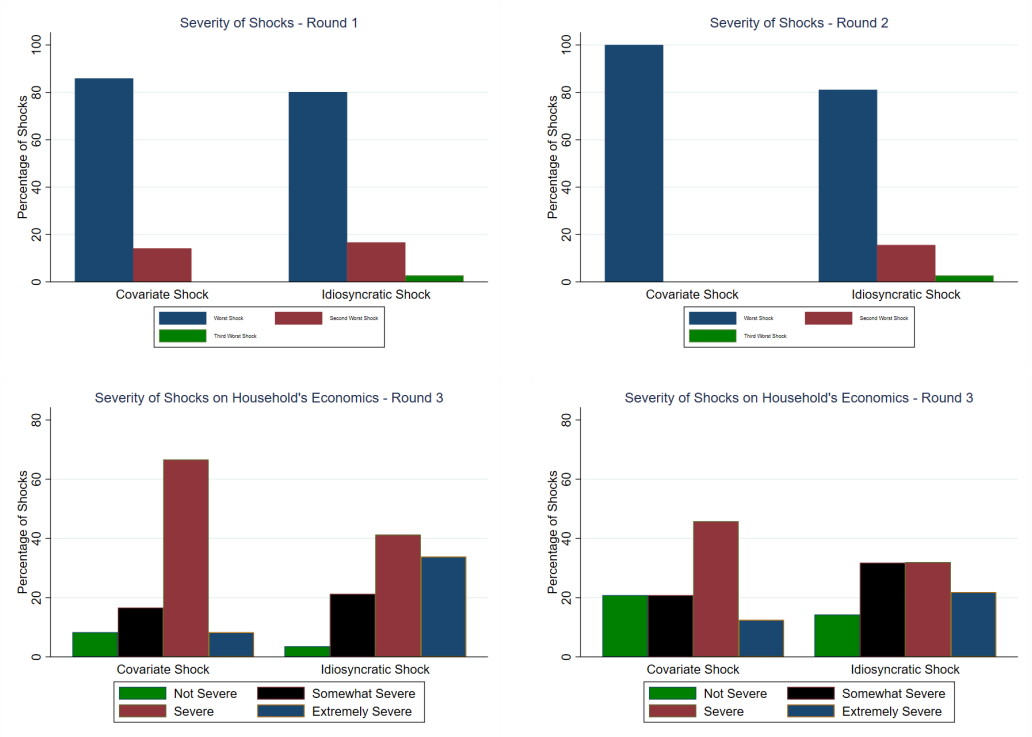


Figure 3.1: Severity of Shocks

Note: In rounds 1 and 2, households were asked to rank the worst three shocks they faced in the past five years. In round 3, households were asked to report the severity of the shocks they faced in the last year on household's economic condition and consumption. Households are reported as a percentage of households that face either idiosyncratic or covariate shocks. In round 1, the total number of covariate shocks are 100 and total number of idiosyncratic shocks are 1,925. In round 2, the total number of covariate shocks are 12 and total number of idiosyncratic shocks are 784. In round 3, the total number of covariate shocks are 24 and total number of idiosyncratic shocks are 1,119.

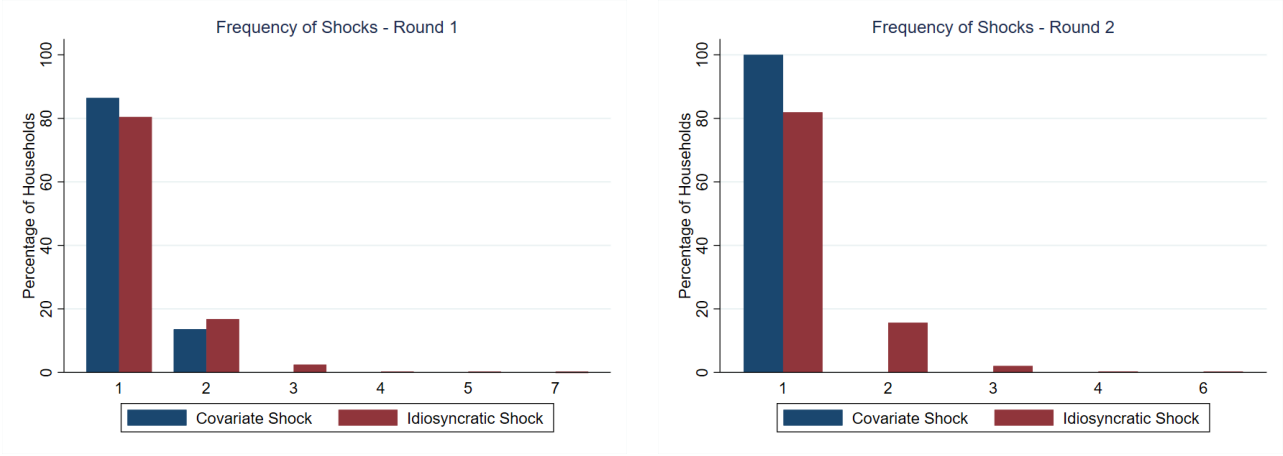


Figure 3.2: Frequency of Shocks

Note: In rounds 1 and 2, households were asked to report the number of idisosyncratic or covariate shocks they faced in the past five years. In round 1 there are 82 households exposed to idiosyncratic shocks and 1564 households exposed to covariate shocks. In round 2 there are 12 households exposed to idiosyncratic shocks and 646 households exposed to covariate shocks.

3.4 Empirical Approach

The objective of our empirical analysis is to estimate the impact of income or asset shocks on the amount and share of loans taken by households from formal and informal sources. We want to estimate the average treatment effect on the treated, which is represented as follows:

$$ATT = E(Y_{ig}(1) - Y_{ig}(0)|D_g = 1, X_i). \tag{3.1}$$

In the above equation, $Y_{ig}(1)$ represents the outcome with treatment for household i in group g, and $Y_{ig}(0)$ represents the outcome without treatment. In the above eqyation, $D_g = 1$ represents that the group is treated and $D_g = 0$ would indicate that the group is untreated. X_i is the vector of controls for the household. ATT measures the difference between potential outcomes with and without treatment for treated households. In our case, ATT measures the impact of income and asset shocks on the credit decisions of the treated households.

TWFE is a common method employed by studies that aim to find causal effects from panel data (De Chaisemartin and d'Haultfoeuille, 2022). In TWFE, group and time-fixed effects are included in a linear model to isolate the effect of treatment on the outcome variables:

$$Y_{igt} = \hat{\alpha}_g + \hat{\gamma}_t + \hat{\beta}_{fe} D_{g,t} + u_{it}. \tag{3.2}$$

De Chaisemartin and d'Haultfoeuille (2020) shows that β_{fe}, is represented as the weighted sum of treatment effects of all groups g at period t:

$$\beta_{fe} = \sum_{D_{g,t}=1} W_{g,t} \Delta_{g,t}. \tag{3.3}$$

In equation 3.3, $\Delta_{g,t}$ is the treatment effect for all groups g and time t. The sum of all weights, $W_{g,t}$, equals to 1. The weight assigned to each treatment effect depends on the amount of time it is exposed to the treatment. For our purpose, we have three periods (t=2012, 2015, and 2018), and the treatment effects need to be estimated for each group across two consecutive periods. Mordern difference-in-difference literature shows that TWFE estimations provide misleading β_{fe} when treatment timing varies and effects are heterogeneous (De Chaisemartin and d'Haultfoeuille, 2020; Goodman-Bacon, 2021).

Hence, we utilize De Chaisemartin and d'Haultfoeuille (2020)'s difference-in-differences method that enables us to properly average the heterogeneous treatment effects across all groups g and periods t, solve the problem of negative weights and allows households to switch out of treatment. For our purpose, we have three time periods (t=2012, 2015 and 2018), and four groups (g=$N_{0,0}$, $N_{1,1}$, $N_{1,0}$, and $N_{0,1}$). $N_{1,0}$ represents the number of households that are untreated in the first period and treated in the second period, $N_{0,0}$ represents the number of households that are untreated in both times, $N_{0,1}$ is the number of households that are treated in the first period and untreated in the second period, and $N_{1,1}$ is the number of households that are untreated in both times. As we have data across three rounds of survey,

households treatment status is observed over rounds 1 and 2, and then across rounds 2 and 3.

The causal effect identified by the estimator is:

$$\delta^s = E\Big[\frac{1}{N_S}\sum_{(i,g,t):t\geq 1, D_{g,t}\neq D_{g,t-1}} [(Y_{i,g,t}(1) - Y_{i,g,t-1}(0)) - (X_{i,g,t} - X_{i,g,t-1})'\hat{\pi}]\Big] \tag{3.4}$$

where δ^s represents the average treatment effect across all groups g that switch treatment from t-1 to t. N_s is the number of switchers that switch treatment across the two time periods. $Y_{i,g,t}(1)$ is the outcome for household i that is treated in period t, while $Y_{i,g,t-1}(0)$ is the outcome for the same household that is untreated in $t-1$. The g is restricted to N_s, that is inclusive of $N_{0,1}$ and $N_{1,0}$. $X_{i,g,t}$ is the vector of controls for household i in period t. We let $\hat{\pi}$ denote the coefficient of the regression of $Y_{i,g,t} - Y_{i,g,t-1}$ on $X_{i,g,t} - X_{i,g,t-1}$. Given that we have sharp designs with non-stochastic treatments, the existence of stable groups that do not switch over times, and common trends for groups with the same treatment in $t-1$, we can estimate δ^s by estimating DID_M. Given our assumptions hold, equation 3.4 equals equation 3.5:

$$DID_M = \sum_{t=1}^{T}\Big(\frac{N_{1,0,t}}{N_s}DID_{+,t} + \frac{N_{0,1,t}}{N_s}DID_{-,t}\Big). \tag{3.5}$$

We estimate DID_M by estimating $DID_{+,t}$ and $DID_{-,t}$. $DID_{+,t}$ is the difference-in-differences estimator for households that switch into the treatment as shown in equation 3.6. $DID_{-,t}$ is the difference-in-differences estimator for households that switch out of the treatment as shown in equation 3.7.

$$DID_{+,t} = \sum_{g:D_{g,t}=1,D_{g,t-1}=0} \frac{N_{g,t}}{N_{1,0,t}}((Y_{g,t} - Y_{g,t-1}) - (X_{i,g,t} - X_{i,g,t-1})'\hat{\pi}) - \sum_{g:D_{g,t}=D_{g,t-1}=0} \frac{N_{g,t}}{N_{0,0,t}}((Y_{g,t} - Y_{g,t-1}) - (X_{i,g,t} - X_{i,g,t-1})'\hat{\pi}), \tag{3.6}$$

$$DID_{-,t} = \sum_{g:D_{g,t}=D_{g,t-1}=1} \frac{N_{g,t}}{N_{1,1,t}}((Y_{g,t} - Y_{g,t-1}) - (X_{i,g,t} - X_{i,g,t-1})'\hat{\pi}) - \sum_{g:D_{g,t}=0,D_{g,t-1}=1} \frac{N_{g,t}}{N_{0,1,t}}((Y_{g,t} - Y_{g,t-1}) - (X_{i,g,t} - X_{i,g,t-1})'\hat{\pi}). \tag{3.7}$$

This method is useful in estimating instantaneous treatment effects when treated individuals switch out over time.

To compare the results with the results from De Chaisemartin and d'Haultfoeuille (2020)'s estimator, we estimate equation 3.8 using TWFE approach:

$$Y_{it} = \beta x_{it} + \alpha_i + \gamma_t + \pi\theta_{it} + u_{it}. \tag{3.8}$$

In the above equation, Y_{it} is a measure of credit uptake for household i in period t, x_{it} is the vector of treatment variables as reported by household i in period t, α_i represents household fixed effect, γ_t is the time fixed effects, and θ_{it} is the vector of other covariates.

We consider the following measures of credit uptake as our dependent variables: the total amount of credit taken, the amount of loan taken from formal sources, the amount of loan taken from informal sources, the share of credit taken from formal sources, and the share of loan taken from informal sources. We use the inverse hyperbolic sine (IHS) transformation for the amount of credit taken, as the variables include a large number of zero values.

Our explanatory variables are dummy variables to indicate if the household faced any idiosyncratic shock, covariate shock, crop shock, livestock shock or productive asset shock in

the last five years or since the previous survey. We use the number of plots, the number of working members, and the total value of assets owned by the household as control variables. We control for the number of plots and the number of working members in the household, as these variables are significantly different for treated and untreated households. The number of plots is a signal of vulnerability to covariate shocks and is also linked to a household's ability to take credit. Similarly, the number of working members is linked to a household's vulnerability to labor-related shocks, earning ability, and subsequently credit decisions.

3.5 Results

Tables 3.4 and 3.5 show results from difference-in-differences estimation using the De Chaisemartin and d'Haultfoeuille (2020)'s difference-in-differences estimator. Table 3.4 shows the treatment effect of idiosyncratic shocks on the total amount of loan taken, amount of loan taken from formal sources and informal sources, and share of loan from formal sources and informal sources. We include the number of plots, number of working members, and value of assets as covariates for the household to control for wealth, creditworthiness, and earning abilities of the household. Out of 3,418 observations in our sample, 1,893 observations either switched in (602 observations) or out (1,291 observations) of the treatment at some point.

Table 3.4: Estimation of Results Using Difference-in-Differences of De Chaisemartin and d'Haultfoeuille (2020): Idiosyncratic Shocks

Dependent Variable: Total Credit Taken (IHS Transformed)						
	Treatment Effect	Std. Dev	N	No. of Switchers	t-stat	p-val
Idiosyncratic Shock (Overall ATT)	0.549	0.212	3418	1893	2.587	0.00968
Idiosyncratic Shock (Switchers in)	0.413	0.291	1208	602	1.417	0.156
Idiosyncratic Shock (Switchers out)	0.588	0.250	2210	1291	2.353	0.0186
Dependent Variable: Credit Taken from Formal Sources (IHS Transformed)						
	Treatment Effect	Std. Dev	N	No. of Switchers	t-stat	p-val
Idiosyncratic Shock (Overall ATT)	0.190	0.215	3418	1893	0.883	0.377
Idiosyncratic Shock (Switchers in)	-0.0476	0.322	1208	602	-0.148	0.883
Idiosyncratic Shock (Switchers out)	0.300	0.231	2210	1291	1.301	0.193
Dependent Variable: Credit Taken from Informal Sources (IHS Transformed)						
	Treatment Effect	Std. Dev	N	No. of Switchers	t-stat	p-val
Idiosyncratic Shock (Overall ATT)	0.689	0.220	3418	1893	3.133	0.00173
Idiosyncratic Shock (Switchers in)	0.493	0.397	1208	602	1.241	0.215
Idiosyncratic Shock (Switchers out)	0.780	0.264	2210	1291	2.952	0.00316
Dependent Variable: Share of Credit Taken from Formal Sources						
	Treatment Effect	Std. Dev	N	No. of Switchers	t-stat	p-vall
Idiosyncratic Shock (Overall ATT)	-0.00288	0.0169	3418	1893	-0.170	0.865
Idiosyncratic Shock (Switchers in)	-0.00573	0.0259	1208	602	-0.221	0.825
Idiosyncratic Shock (Switchers out)	-0.00155	0.0224	2210	1291	-0.0693	0.945
Dependent Variable: Share of Credit Taken from Informal Sources						
	Treatment Effect	Std. Dev	N	No. of Switchers	t-stat	p-val
Idiosyncratic Shock (Overall ATT)	0.0474	0.0177	3418	1893	2.679	0.00739
Idiosyncratic Shock (Switchers in)	0.0459	0.0284	1208	602	1.616	0.106
Idiosyncratic Shock (Switchers out)	0.0481	0.0245	2210	1291	1.965	0.0494

Note: Control variables included are number of plots, number of working members, and value of assets.

Table 3.4 shows that an idiosyncratic shock has an overall positive impact on the total amount of loans taken by a household. An idiosyncratic shock increases the total credit uptake of a household by 55 percent. Our results show that households that face negative shocks in the second period do not increase their credit uptake drastically relative to the control group. However, we find a different response to negative shocks for households that face a negative shock in the first period, but no negative shock in the second period. We find that households that face an idiosyncratic shock in consecutive two rounds have 58.8 percent more amount of credit than households that switched out of idiosyncratic shock in the second period. This shows that households that face income or asset shocks in consecutive periods either have to take more loans to cope or fail to repay existing loans.

Our finding implies that farmers tend to increase credit uptake after experiencing negative

income or asset shocks over multiple periods, but not after experiencing negative shocks in a single period. Negative shocks in multiple periods can deplete farmers' financial resources and productive abilities and accessing more credit becomes necessary to continue agricultural operations or to repair and replace productive assets. Another implication is that once farmers recover from a negative income or asset shock they prioritize repayment to informal lenders, to fulfill their financial and social obligation. This reduces their financial burden in the aftermath of a negative shock and helps them regain financial independence.

The impact of idiosyncratic shocks on the amount of credit can be further decomposed into the credit taken from formal and informal sources. A major portion of this increase in credit comes from informal lending. Idiosyncratic shocks do not have a significant impact on the amount of credit taken from formal sources. Idiosyncratic shocks can impact the creditworthiness of farmers, because of which they cannot gain credit from the formal sector and resort to the informal sector. There is an overall treatment effect of 68.9 percent on the credit uptake from the informal sector by households that face idiosyncratic shock. Households that face income or asset shocks in two rounds have an increased credit uptake by 78 percent relative to the households that switched out of the treatment in the second round. The results show that a negative shock does not impact creditworthiness in an informal setting, allowing households to either borrow more or make flexible repayment arrangements despite facing negative shocks in consecutive rounds. Households that faced negative shocks in consecutive rounds would not be able to borrow from the formal sector, but informal lenders trust the borrower, understand the circumstances, and are willing to lend.

We also look at the impact of idiosyncratic shocks on the share of loans from formal and informal sources. We do not see a significant impact of idiosyncratic shocks on the share of loans from formal sources even though there is an increase in total credit uptake. The increase in credit uptake translates into an increase in the overall share of credit taken from informal sources by 4.74 percentage points as a result of an idiosyncratic shock. Households

that face negative shocks in two rounds increase the share of credit uptake informal sources by 4.81 percentage points as compared to households that faced idiosyncratic shocks in a single round and switched out later. Our results highlight the importance of informal credit markets in dealing with negative shocks, especially when the income shocks are persistent. It is reflective of the flexible nature of the informal credit markets whereby the requirements of creditworthiness and repayment are more relaxed as compared to the formal sector.

Table 3.5: Estimation of Results Using Difference-in-Differences of De Chaisemartin and d'Haultfoeuille (2020): Covariate Shocks

Dependent Variable: Total Credit taken (IHS Transformed)						
	Treatment Effect	Std. Dev	N	No. of Switchers	t-stat	p-val
Covariate Shock (Overall ATT)	1.305	1.319	280	100	0.990	0.322
Covariate Shock (Switchers in)	1.716	1.398	186	20	1.228	0.220
Covariate Shock (Switchers out)	1.343	1.729	94	80	0.777	0.437
Dependent Variable: Credit Taken from Formal sources (IHS Transformed)						
	Treatment Effect	Std. Dev	N	No. of Switchers	t-stat	p-val
Covariate Shock (Overall ATT)	-0.120	1.987	280	100	-0.0604	0.952
Covariate Shock (Switchers in)	0.478	0.854	186	20	0.559	0.576
Covariate Shock (Switchers out)	-0.269	2.844	94	80	-0.0947	0.925
Dependent Variable: Credit Taken from Informal sources (IHS Transformed)						
	Treatment Effect	Std. Dev	N	No. of Switchers	t-stat	p-val
Covariate Shock (Overall ATT)	1.759	44.99	280	100	0.0391	0.969
Covariate Shock (Switchers in)	1.133	1.767	186	20	0.641	0.521
Covariate Shock (Switchers out)	1.915	9.489	94	80	0.202	0.840
Dependent Variable: Share of Credit Taken from Formal Sources						
	Treatment Effect	Std. Dev	N	No. of Switchers	t-stat	p-val
Covariate Shock (Overall ATT)	-0.0192	0.170	280	100	-0.113	0.910
Covariate Shock (Switchers in)	0.0436	0.0955	186	20	0.456	0.648
Covariate Shock (Switchers out)	-0.0348	0.194	94	80	-0.179	0.858
Dependent Variable: Share of Credit Taken from Informal Sources						
	Treatment Effect	Std. Dev	N	No. of Switchers	t-stat	p-val
Covariate Shock (Overall ATT)	0.149	0.274	280	100	0.545	0.586
Covariate Shock (Switchers in)	0.0936	0.124	186	20	0.752	0.452
Covariate Shock (Switchers out)	0.163	0.259	94	80	0.629	0.530

Note: Control variables included are number of plots, number of working members, and value of assets.

Table 3.5 shows the treatment effect of covariate shocks on the total amount of loan taken, amount of loan taken from formal sources and informal sources, and share of loan from formal sources and informal sources. We include same covariates as table 3.4. Our sample consists of 280 observations, 20 of which switched into the treatment and 80 of which switched out

of the treatment. We do not observe any significant impact of covariate shocks on the total amount of loans taken or the number of loans taken from formal or informal sources. There is no impact of treatment on the share of loans from formal and informal sources as well. We have observed earlier that the covariate shocks do not differ from idiosyncratic shocks when it comes to the severity and the frequency. Therefore, we can attribute the lack of any observed treatment effect of covariate shocks on the inherent widespread nature of the losses.

Lastly, Tables 3.6 and 3.7 show results from the estimation of TWFE using idiosyncratic shocks and covariate shocks as treatment variables respectively. The results are used for comparison and also show that idiosyncratic shocks increase the amount and share of credit taken from informal sources, but do not impact the amount and share of credit from formal sources. Covariate shocks also do not impact credit decisions.

Table 3.6: Estimation of Results Using TWFE - Idiosyncratic Shocks

VARIABLES	(1) Credit taken from formal sources (IHS transformed)	(2) Cedit taken from formal sources (Share of total)	(3) Credit taken from informal sources (IHS transformed)	(4) Credit taken from informal sources (Share of total)
Idiosyncratic Shock	0.258	0.00279	0.888***	0.0551***
	(0.160)	(0.0138)	(0.196)	(0.0157)
Number of plots	0.106***	0.00583*	0.000567	-0.00423
	(0.0352)	(0.00302)	(0.0430)	(0.00346)
Number of working members	0.165	0.0108	0.181	0.00954
	(0.105)	(0.00905)	(0.129)	(0.0104)
Value of assets	2.15e-06***	1.66e-07**	-8.63e-07	-7.22e-08
	(7.71e-07)	(6.63e-08)	(9.43e-07)	(7.58e-08)
Round 2	0.461***	0.0108	0.737***	0.0274*
	(0.164)	(0.0141)	(0.201)	(0.0161)
Round 3	1.146***	0.0393***	1.058***	0.0211
	(0.168)	(0.0145)	(0.206)	(0.0165)
Constant	3.653***	0.304***	3.539***	0.301***
	(0.255)	(0.0219)	(0.312)	(0.0251)
Observations	5,127	5,127	5,127	5,127
R-squared	0.029	0.009	0.010	0.005
Number of households	1,709	1,709	1,709	1,709

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.7: Estimation of Results Using TWFE - Covariate Shocks

VARIABLES	(1) Credit taken from formal sources (IHS transformed)	(2) Cedit taken from formal sources (Share of total)	(3) Credit taken from informal sources (IHS transformed)	(4) Credit taken from informal sources (Share of total)
Covariate Shock	-0.364	-0.00444	0.330	0.0103
	(0.650)	(0.0552)	(0.815)	(0.0684)
Number of plots	0.295**	0.0161	0.124	-0.00584
	(0.118)	(0.00999)	(0.147)	(0.0124)
Number of working members	-0.0133	-0.00900	-0.120	0.00243
	(0.382)	(0.0325)	(0.479)	(0.0402)
Value of assets	-2.78e-06	-3.01e-07	1.01e-06	-1.87e-08
	(3.05e-06)	(2.59e-07)	(3.82e-06)	(3.20e-07)
Round 2	0.872	0.0557	0.732	0.00157
	(0.581)	(0.0493)	(0.728)	(0.0611)
Round 3	1.823***	0.127**	0.982	0.00370
	(0.634)	(0.0538)	(0.794)	(0.0666)
Constant	2.181***	0.186***	3.774***	0.376***
	(0.744)	(0.0632)	(0.933)	(0.0782)
Observations	420	420	420	420
R-squared	0.090	0.047	0.018	0.001
Number of households	140	140	140	140

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The results show the inability of formal and informal markets to deal with covariate shocks. Households are not able to mitigate community-wide risks. However, number of households that reported income or asset loss as a result of a covariate shock is much smaller as compared to number of households who reported income or asset loss as a result of an idiosyncratic shock. The number of observations is also small, because we remove households that faced both idiosyncratic and covariate shocks. The inclusion of controls solves the problem of endogeneity arising from household characteristics to some extent.

The results show that farmers have different credit responses to covariate versus idiosyncratic shocks. Covariate shocks, such as natural disasters or widespread macroeconomic shocks, affect a large number of farmers simultaneously, resulting in a widespread reduction in agricultural productivity and income. As a result, farmers are unable to borrow from both formal and informal credit markets. They may face difficulties in accessing credit due to the overall financial strain on the agricultural sector and the community. On the other

hand, in instances of idiosyncratic shocks farmers may benefit from their relationships with informal lenders who are willing to provide credit based on personal trust and familiarity.

Informal lenders provide more flexibility in terms of repayment and loan sizes, making them more viable. Farmers can leverage their relationships and social capital in the informal credit market, which is reflected in the asymmetric response of households that switch in versus those that switch out. Informal credit decreases once farmers switch out of an income shock. They can borrow when they face persistent shocks or delay their repayments on the loans in times of need and make their payments later. However, such facilities are not provided by the formal credit markets due to which farmers may be unwilling to borrow from the formal credit market. This is in line with the studies that have found evidence of strong informal ties that help empower a community in times of distress and improve welfare (Udry, 1994; Fafchamps and Lund, 2003; Karlan and Morduch, 2010; Deininger and Liu, 2013).

3.6 Mechanism

To understand the mechanism through which income or asset shocks impact the credit uptake of smallholders, we investigate how the nature of shocks influences credit decisions. Tables 3.8 and 3.9 show results from De Chaisemartin and d'Haultfoeuille (2020)'s difference-in-difference estimation of the impact of the nature of shocks on the credit decisions. In Table 3.8, we use the entire sample including households that experienced both covariate and idiosyncratic shocks. In Table 3.9, we exclude households that experienced covariate shocks.

In Table 3.8, we categorize the negative shocks according as a crop shock, livestock shock or a labor shock. We do not observe an overall treatment effect of any of the three shocks on the total amount of credit, the amount, and share of credit taken from formal sources. Only labor shock has a significant and positive impact on the amount and share of credit taken from informal sources. Households experiencing labor shocks face loss of labor due to illness, injury or death, etc. Most of these labor shocks are idiosyncratic, and when households face

these shocks, they lose their extra earning capacity and resort to informal credit. A labor shock increases the amount of credit taken from informal sources by 69.5 percent and the share of loans taken from informal sources by 5.72 percentage points.

Table 3.9 validates the findings of Table 3.8. We exclude households that experienced covariate shocks and separate the effect of labor shocks into the treatment effect from those who switch in and those who switch out. Households that switch out have 93.6 percent less credit from the informal credit market as compared to households that are treated in both rounds. Similarly, these households have 7.16 percentage points smaller share of loans as compared to the control group. This implies that farmers can use their social relationships and borrow when they are facing a continuous loss in earning ability. When the household recovers from labor loss, the earning members immediately enter the labor market to repay the debts. This gives them financial autonomy and freedom of decision-making.

Table 3.8: Estimation of Results Using Difference-in-Differences of De Chaisemartin and d'Haultfoeuille (2020): Nature of Shocks

Dependent Variable: Total Credit Taken (IHS Transformed)						
	Treatment Effect	Std. Dev	N	No. of Switchers	t-stat	p-vall
Crop Shock (Overall ATT)	0.453	0.429	4610	536	1.056	0.291
Livestock Shock (Overall ATT)	1.034	0.690	4610	488	1.498	0.134
Labor Shock (Overall ATT)	0.412	0.208	4610	2133	1.983	0.0473
Dependent Variable: Credit Taken from Formal Sources (IHS Transformed)						
	Treatment Effect	Std. Dev	N	No. of Switchers	t-stat	p-val
Crop Shock (Overall ATT)	0.185	0.470	4610	536	0.392	0.695
Livestock Shock (Overall ATT)	0.827	0.708	4610	488	1.167	0.243
Labor Shock (Overall ATT)	0.0171	0.188	4610	2133	0.0908	0.928
Dependent Variable: Credit Taken from Informal Sources (IHS Transformed)						
	Treatment Effect	Std. Dev	N	No. of Switchers	t-stat	p-vall
Crop Shock (Overall ATT)	0.0975	0.514	4610	536	0.190	0.850
Livestock Shock (Overall ATT)	0.927	0.898	4610	488	1.032	0.302
Labor Shock (Overall ATT)	0.695	0.281	4610	2133	2.476	0.0133
Dependent Variable: Share of Credit Taken from Formal sources						
	Treatment Effect	Std. Dev	N	No. of Switchers	t-stat	p-val
Crop Shock (Overall ATT)	0.0285	0.0310	4610	536	0.921	0.357
Livestock Shock (Overall ATT)	0.0384	0.0513	4610	488	0.748	0.454
Labor Shock (Overall ATT)	-0.0226	0.0163	4610	2133	-1.382	0.167
Dependent Variable: Share of Credit Taken from Informal Sources						
	Treatment Effect	Std. Dev	N	No. of Switchers	t-stat	p-val
Crop Shock (Overall ATT)	0.00373	0.0417	4610	536	0.0896	0.929
Livestock Shock (Overall ATT)	0.0550	0.0666	4610	488	0.827	0.409
Labor Shock (Overall ATT)	0.0572	0.0189	4610	2133	3.020	0.00252

Note: Control variables included are number of plots, number of working members, and value of assets.

Table 3.9: Estimation of Results Using Difference-in-Differences of De Chaisemartin and d'Haultfoeuille (2020): Labor Shocks by Treatment Status

Dependent variable: Total Credit Taken (IHS Transformed)						
	Treatment Effect	Std. Dev	N	No. of Switchers	t-stat	p-val
Labor Shock (Overall ATT)	0.448	0.264	3418	1653	1.698	0.0895
Labor Shock (switchers in)	0.227	0.263	1900	640	0.861	0.389
Labor Shock (switchers out)	0.588	0.326	1518	1013	1.802	0.0715
Dependent Variable: Credit Taken from Formal Sources (IHS Transformed)						
	Treatment Effect	Std. Dev	N	No. of Switchers	t-stat	p-val
Labor Shock (Overall ATT)	0.0328	0.221	3418	1653	0.148	0.882
Labor Shock (switchers in)	0.0336	0.261	1900	640	0.129	0.898
Labor Shock (switchers out)	0.0323	0.302	1518	1013	0.107	0.915
Dependent Variable: Credit Taken from Inormal Sources (IHS Transformed)						
	Treatment Effect	Std. Dev	N	No. of Switchers	t-stat	p-val
Labor Shock (Overall ATT)	0.633	0.305	3418	1653	2.072	0.0382
Labor Shock (switchers in)	0.154	0.323	1900	640	0.476	0.634
Labor Shock (switchers out)	0.936	0.400	1518	1013	2.339	0.0193
Dependent Variable: Share of Credit Taken from Formal Sources						
	Treatment Effect	Std. Dev	N	No. of Switchers	t-stat	p-val
Labor Shock (Overall ATT)	-0.0143	0.0170	3418	1653	-0.841	0.400
Labor Shock (switchers in)	0.00509	0.0246	1900	640	0.207	0.836
Labor Shock (switchers out)	-0.0266	0.0274	1518	1013	-0.971	0.332
Dependent variable: Share of Credit Taken from Informal Sources						
	Treatment Effect	Std. Dev	N	No. of Switchers	t-stat	p-val
Labor Shock (Overall ATT)	0.0501	0.0200	3418	1653	2.510	0.0121
Labor Shock (switchers in)	0.0162	0.0268	1900	640	0.606	0.544
Labor Shock (switchers out)	0.0716	0.0350	1518	1013	2.045	0.0409

Note: Control variables included are number of plots, number of working members, and value of assets.

Our findings suggest that in times of financial need farmers rely on labor markets, rather than credit markets, to either fulfill immediate labor requirements in recovery efforts or provide off-farm labor to deal with income shocks. In such situations, farmers may be reluctant to take on additional loans, as it could worsen their financial risks. Off-farm labor markets provide a more readily available and flexible source of income than credit markets, allowing farmers to quickly access the workforce they need to cope with the immediate challenges. It is only in times when there is a loss of labor that farmers resort to informal credit markets, which is in line with previous literature that advocates that in the absence of formal insurance and credit markets, farmers rely heavily on labor markets to smooth their consumption (Zimmerman and Carter, 2003). When the households recover from the labor

loss, the earning members immediately pay off the debts. However, we need to look at the impact of other income shocks on off-farm income or labor hours worked immediately after the negative shock to validate our findings.

3.7 Conclusion

This study sheds light on the dynamics of credit access in rural areas, including the role of the formal and informal sectors. Formal and informal sectors exist simultaneously in rural sectors, whereby both sectors either cater to different needs of the borrowers, or the informal sector addresses the inadequacies in the formal sector (Adams and Vogel, 1986; Udry, 1990). The formal sector offers subsidized loans for productive purposes and does not assist with consumption needs arising from income volatility (Miracle et al., 1980; Bui and Bui, 2021). The informal sector fills in this gap by enabling borrowing and lending within communities in dire times, as obtaining credit for consumption purposes is much easier from the informal sector (Bui and Bui, 2021). An increase in capital in the formal sector increases the amount of credit floating in the informal sector. Hence, farmers who are unable to borrow directly from the formal sector can indirectly access the same credit from creditworthy households borrowing from the same sector (Adams and Vogel, 1986).

We find that rural informal credit markets help farmers cope with idiosyncratic shocks, while formal credit markets fall short of meeting the needs of farmers who face any type of income or asset shock. Households are unable to mitigate widespread risks that impact the entire community, but can rely on each other to smooth consumption in times of individual-level shocks (Townsend, 1994). Households that face income or asset shocks in consecutive rounds have greater credit uptake from informal sources as compared to households that face income or asset shocks in a single round. This highlights the reliance of farmers on informal networks to cope in the face of continuous challenges, as households that rely on informal credit are less vulnerable to both idiosyncratic and covariate shocks, as they have reduced

expected poverty and food insecurity (Imai et al., 2010; Bui and Bui, 2021).

Households' reliance on the informal sector can be attributed to the presence of social trust and relationships within these markets (Coleman, 1988), which facilitate access to credit during times of financial distress. The informal credit market can mobilize savings through social trust that makes credit access easier (Miracle et al., 1980) and makes repayment options more flexible (Pham and Lensink, 2007). Informal credit markets provide the facility of state-contingent loans, where the repayment terms of the loan are linked to the borrower's future income or other contingencies (Udry, 1994). If the borrower's income falls below a certain threshold, the repayment of the loan may be reduced or even temporarily suspended to accommodate the borrower.

Constraints in the formal credit sector also hinder credit uptake in times of need as it is difficult to establish creditworthiness in difficult times (Udry, 1990; Dercon, 2002). The formal sector is unable to encourage households to save money and channel those savings into the financial system (Miracle et al., 1980). Lack of saving mobilization results in a limited stream of capital in the formal credit market leading to stringent credit requirements (Fafchamps and Lund, 2003). Farmers exposed to covariate shocks reported that such losses had severe impact on their economic condition and consumption. Despite the severity of the shocks, constraints in the formal sector prevent farmers from leveraging formal credit to smooth consumption when impacted by a flood or a drought.

Interestingly, once farmers recover from a negative income or asset shock, they prioritize credit repayment. This underscores the importance of honoring financial obligations and maintaining creditworthiness within the agricultural community (Geertz, 1962; Coleman, 1988). Farmers rely on credit markets primarily when they experience a loss of earning ability due to labor loss (Zimmerman and Carter, 2003). This suggests that credit is used as a means to bridge the gap between lost income and essential expenses during times of reduced productivity.

This study highlights the ability of informal credit markets to overcome idiosyncratic

shocks within a community. Rural communities have a strong sense of social obligation which can be capitalized on to form a more accessible and structured mechanism of risk management in developing countries. However, the formal sector is unable to mitigate losses in times of idiosyncratic or covariate shocks. Formal credit can provide financial support during times of need, reducing the vulnerability of households to covariate shocks. Further research and policy interventions are necessary to strengthen the resilience of farmers by taking advantage of the social capital and trust to strengthen both informal and formal credit mechanisms.

Chapter 4

Recovering from Natural Disaster through Exports: The Case of 2010 Pakistan Flood and EU Tariff Waiver on Pakistan Cotton Industry

4.1 Introduction

The agricultural sector plays a vital role in the economy of developing countries, by generating employment for agricultural producers and export revenues (Heger et al., 2008; Freund et al., 2022). Disasters, including floods, have a significant impact on the agricultural sector of developing countries, which might be unequipped in dealing with a large-scale catastrophe (Rosenzweig and Parry, 1994; Oh and Reuveny, 2010). As the international community comes together to help in the form of aid in such dire circumstances (Heger et al., 2008), trade concessions have been advocated as a helpful tool in dealing with disasters (Cheong et al., 2017).

In 2010, Pakistan faced one of the worst floods in its history, resulting from heavy pre-

monsoon and monsoon rains, and glacial outbursts. Apart from displacing 6 million people, destroying 1.8 million houses, and causing damage worth $10 billion (USD), the flood impacted the textile industry significantly (NDMA, 2011). The flood resulted in significant crop loss, destroying 2.1 million hectares of standing Kharif crops (NDMA, 2011) and 2 million cotton bales (Ahmed, 2010).

To overcome the aftermath of the flood, the Pakistani textile industry started demanding greater access to international markets particularly the EU and US as part of the relief efforts. Textile exports amounted to 60 percent of Pakistan's exports to the EU before 2010 and faced a high tariff of 12 percent (Ahmed, 2010). Hence, the EU requested WTO to grant a waiver to 75 products imported from Pakistan in November 2010, which was finally approved in February 2012. The tariff waiver was implemented from November 2012 to December 2013, whereby the tariff was removed for 75 export products from Pakistan to the EU, comprising mainly of textile products (Rana, 2012).

The objective of this study is to estimate the impact of a unilateral tariff waiver to Pakistan from the EU, intended as a relief package after the 2010 floods, on the textile exports and cotton production in the country. As lower trade barriers encourage exports of the subject country and expect positive economic effects, it is a potential tool for disaster relief in developing countries. We aim to investigate if a tariff waiver can help overcome a natural disaster by stimulating the growth of export thereafter. Furthermore, we explore whether better foreign market access for the downstream industry, e.g., textile, can affect the upstream, e.g., cotton production.

Hence, we investigate if the tariff waiver helped a) increase the export of cotton-related products, yarn and fabric, and b) revive the cotton production in the country or even increase cotton production further. Before the 2010 flood, Pakistan produced 12 million cotton bales and there were plans to increase cotton production in the country (Ahmed, 2010). We address the question of whether the effect of the tariff waiver on exports and production is sustained beyond the concession period.

As our research question is a policy matter investigating a single country, we follow the spirit of the synthetic control method, pioneered by Abadie and Gardeazabal (2003) and later developed by Abadie et al. (2010), to evaluate how the tariff waiver impacted cotton exports, and cotton production in the country. The synthetic control approach allows us to build a counterfactual control for comparison, particularly useful when there is a single treated unit.

While the synthetic control method of Abadie et al. (2010) is one of the most important developments in the empirical policy evaluation literature (Abadie et al., 2015; Athey and Imbens, 2017; Abadie, 2021), recent developments in the synthetic control methods literature discuss the challenges in handling uncertainty in weights to construct the synthetic control and providing natural ways to conduct statistical inferences (Doudchenko and Imbens, 2016; Carvalho et al., 2018; Li, 2020).

One promising way to handle the aforementioned issues in implementing the synthetic control method is to construct counterfactuals using a model-based approach (e.g., Xu, 2017; Liu et al., 2022) (see Cepeda-Francese and Ramírez-Álvarez (2023) for a recent example of the application in the context of development studies). Xu (2017) and Liu et al. (2022) propose to build a synthetic control by specifying the underlying data-generating process with an interactive fixed effects specification. Counterfactuals are imputed from the estimated model. Hence, we utilize both the synthetic control method of Abadie et al. (2010) and the interactive fixed effect counterfactual estimator of Liu et al. (2022) as the results complement each other. Using country-level production and export data from Food and Agricultural Organization (FAO) and Eurostat, we construct a counterfactual Pakistan ranging from 2000 to 2021.

Our findings provide an insightful explanation of the effectiveness of a tariff waiver as a relief tool in times of natural disasters. Given that the desired relief outcomes can be achieved with a tariff waiver, it can be compared with other mediums of aid. This can solve the problem of relief aid not reaching desired recipients in times of natural disasters, because of weak institutions in developing countries (Svensson, 2003). If temporary flood

relief can be translated into longer-term outcomes with new firms entering cotton and textile production by incurring fixed costs, the benefits of a tariff waiver can last longer than any other form of foreign aid as well.

With increasing climate change, natural disasters like floods, storms, and droughts are becoming more frequent, which will have an inevitable impact on international trade (Reilly and Hohmann, 1993; Oh and Reuveny, 2010). Natural disasters can impact the trade of agricultural products by disrupting the transportation of raw materials and final goods (Freund et al., 2022), damaging machinery (Heger et al., 2008), and impacting global value chains (Freund et al., 2022). Trade in developing countries is at a greater risk of being impacted by natural disasters as the political risks, such as corruption, government instability, and weak institutional quality, are high in developing countries and exacerbate the negative effects of natural disasters on trade (Oh and Reuveny, 2010). Crop production in developing countries is also likely to decline more relative to the developed world due to the inability to adapt to changing weather patterns, increasing carbon emissions (Rosenzweig and Parry, 1994), and lack of diversification (Heger et al., 2008).

Previous studies have looked at the impact of natural disasters on exports and imports separately. There is evidence that exports in developing countries can reduce by a conservative estimate of 3 percent (Gassebner et al., 2010) to a more liberal estimate of 22 percent (Da Silva and Cernat, 2012) as a result of a natural disaster. Exports from a smaller country are also more likely to be impacted by a disaster than a larger country, because of the geographical limitations (Felbermayr and Gröschl, 2013). Moreover, climate shocks have a more pronounced impact on the exports of agricultural products than compared to the trade of manufactured goods (Jones and Olken, 2010; Freund et al., 2022). However, the final impact of natural disasters can be mitigated, if the disaster-stricken is more open towards trade (Gassebner et al., 2010; Felbermayr and Gröschl, 2013). Hence, given all the extraneous characteristics of a country that might impact trade, including but not limited to size (Gassebner et al., 2010), political risks (Oh and Reuveny, 2010), and trade openness

(Felbermayr and Gröschl, 2013), it is important to compare the impact of a natural disaster in a country with a counterfactual as close to reality as possible.

A unilateral tariff waiver on exports is an example of rebuilding efforts that can help revive the economy in the aftermath of a flood. A tariff waiver promotes exports (Looi Kee et al., 2009), which can help regain the economic stability of a flood-stricken country. Tariff reductions stabilize consumer prices, stimulate demand, and enhance market efficiencies (Evenett and Keller, 2002). Tariff reductions and waivers promote efficient allocation of resources, leading to higher productivity and economic efficiency (Rodriguez and Rodrik, 2000). For example, the African Growth and Opportunity Act in 2000 increased export levels from African countries to the United States (Frazer and Van Biesebroeck, 2010). After the 2001 US-Vietnam bilateral trade agreement, there was a more pronounced poverty-reducing effect of U.S. market access in provinces with initially higher poverty rates, suggesting that trade openness can contribute to reducing regional inequality (McCaig, 2011). Yet, the impact of unilateral tariff waivers on resilience also depends on the specific industries or sectors targeted and how much of the waiver trickles down the value chain (Freund et al., 2022). For example, the increase in exports might not translate into higher wages and incomes for workers (Cheong et al., 2017).

Therefore, we assess the effect of natural disasters on the agricultural sector and exports and the role of trade in post-disaster recovery to identify opportunities for economic revival and resilience. We investigate the impacts of the 2010 floods in Pakistan and the 2012 tariff waiver (which was effective till 2013) on cotton production and cotton exports in Pakistan. We find limited evidence that the tariff waiver increased cotton exports or production. Our contribution lies in providing credible evidence on the limited impacts of the tariff waiver using a novel empirical approach including the use of state-of-art counterfactual estimators.

To our knowledge, Cheong et al. (2017) is the only study that examines the impact of this particular waiver. Cheong et al. (2017) uses the triple-difference estimator and the synthetic control method to examine the impact of the particular waiver. For its empirical results

from the synthetic control method, the study uses non-waived Pakistani exports to the EU to build a synthetic control for textile exports and finds a positive effect of the tariff waiver on the number of textile exports.

Several important distinctions in our study make it different from Cheong et al. (2017). First, unlike Cheong et al. (2017), our synthetic control is constructed using data from different countries and not using data from non-tariff waived exports. We argue this approach provides important additional insights as the interactions across industries differ from the interactions across countries competing in exports. A tariff waiver in one sector influences the relative supply of resources in the other sector, influencing the production capacity of non-tariff-waived products. Cheong et al. (2017) also faces relatively poor pre-treatment fit and does not provide the inference. With the placebo tests of Abadie et al. (2010) and the interactive fixed effects counterfactual estimator of Liu et al. (2022), we provide evidence from improved pre-treatment fits and reliable statistical inferences.

Secondly, we expand our analysis beyond the textile industry to cotton production as well. This gives additional insights into the effect of the waiver on upstream industries. By looking at the impact of the waiver on similar products and upstream industries, we can assess the extent to which a tariff waiver plays a role in stimulating the economy after a disaster. We also look at the longer-term impact of the waiver using data till the year 2022.

4.2 Synthetic Control Method and Interactive Fixed Effects Counterfactual Estimator

The synthetic control method is a statistical technique used in estimating the causal effect of a treatment or intervention. It was introduced by Abadie and Gardeazabal (2003) and further developed by Abadie et al. (2010). It is particularly useful when examining a single treated unit. The method constructs a "synthetic control" group that closely resembles the treated unit or group, serving as a counterfactual for comparison.

The synthetic control method is based on the idea that the treated unit can be represented as a weighted sum of the outcomes of control units. These control units are selected from a pool of potential donors based on their similarity to the treated unit in terms of observed pre-treatment characteristics. The weights assigned to each control unit reflect their contribution to constructing a synthetic control group that closely matches the treated unit's pre-treatment outcomes. Furthermore, we do not need a parallel trend assumption in order to construct a synthetic control.

We observe outcome y for unit i in period t. We can use synthetic control to estimate treatment effect τ in period t on the treated unit (i=1). The treatment effect τ in the following equation is the difference in the outcome for the treated unit in different treatment states:

$$\tau_t = y_{1t}(1) - y_{1t}(0). \tag{4.1}$$

However, we do not observe the treated unit in both the treatment status in the same period. Assuming that the treatment begins for i=1 in period t*, we observe the following:

$$\begin{aligned} y_{1t} &= y_{1t}(0) \quad \textit{if } t < t^* \\ y_{1t} &= y_{1t}(1) \quad \textit{if } t \geq t^* \\ y_{it} &= y_{it}(0) \quad \textit{for } i \neq 1, \end{aligned}$$

Suppose the underlying model of the outcome without the treatment is:

$$y_{it}(0) = \delta_t + \theta_t Z_i + \lambda_t \mu_i + \epsilon_{it}, \tag{4.2}$$

Then, we can construct a "synthetic" control as long as there is a set of weights w^* that satisfy

$$\begin{aligned} \textstyle\sum_{j=2} w_j^* y_{js} &= y_{1s} \quad \forall \quad s < t^* \\ \textstyle\sum_{j=2} w_j^* Z_j &= Z_1 \quad \forall \quad s < t^*. \end{aligned}$$

The weights assigned to control units are determined through an optimization process that minimizes the difference between the pre-treatment outcomes of the treated unit and the synthetic control group (see Abadie et al. (2010) for the details). Given that the synthetic control unit predicts the pre-treatment outcome of the treated unit, we can estimate the treatment effect with the followings:

$$\sum_{j=2} w_j^* y_{jt} = y_{1t}(0) \tag{4.3}$$

$$\hat{\tau}_t = y_{1t} - \sum_{2} w_j^* y_{jt} \tag{4.4}$$

subject to

$$w_j \geq 0$$

$$\textstyle\sum_{j=2} w_j = 1.$$

Naturally, with a single treated unit, the inference is challenging. A common approach is to conduct placebo tests. In a placebo test, we apply the synthetic control method to a placebo unit instead of the actual treated group. In our case, each of the control unit included in the donor pool is considered a placebo group. By comparing the outcomes of the treated group with those of the placebo group, we can explore if the synthetic control method produces a "surprising" trend, which can be interpreted as a statistical significance.

Recent developments in causal inference propose an alternative approach, the Interactive Fixed Effects Counterfactual Estimator (Xu, 2017; Liu et al., 2022). This approach is based on the interactive fixed effects model addressing the problem of unobserved heterogeneity in panel data models (Bai, 2009; Xu, 2017). The traditional panel data models assume time-invariant unit fixed effects, failing to account for interactive effects between individual and time-specific characteristics. To overcome this limitation, Bai (2009) proposes an interactive fixed effects framework that incorporates interactions between individual-specific and time-specific factors.

Imputing counterfactuals based on the interactive fixed effects model addresses the limitations of the synthetic control method and traditional two-way fixed effects (Xu, 2017). The details are described in Xu (2017) and Liu et al. (2022) and the key idea is to estimate the parameters of the interactive fixed effects model using control units. These parameters are then used in imputing counterfactuals and then further used to estimate the treatment effects on the treated, as indicated by δ_{it} in equation 4.5:

$$Y_{it} = \delta_{it} D_{it} + X_{it}^{'} \beta + \lambda_i^{'} f_t + \alpha_i + \xi_t + \epsilon_{it} \tag{4.5}$$

Here, Y_{it} is the main outcome variable for unit i in period t. D_{it} is the treatment indicator that equals 1 if the household is treated and $t > T_0$, whereby T_0 is the period in which treatment occurs, and δ_{it} is the treatment effect of unit i in time t. X_{it} is a vector of covariates and β is a vector of unknown parameters. For any $i = 1, 2, ..., N$ and $t = 1, 2, ..., T$, $f_t = [f_{1t}, ..., f_{rt}]$ is a $(r \times 1)$ vector of unobserved common factors that influence our observed variables, and $\lambda_i = [\lambda_{i1}, ..., \lambda_{ir}^{'}]$ is a $(r \times 1)$ vector of unknown factor loadings that help estimate the relationship between the unobserved factors and the observed variables.

One of the challenges in estimating the parameters in equation 4.5 is specifying the number of loading factors, r. We follow Liu et al. (2022) that uses a cross-validation procedure to find the optimal r. We use a cross-validation procedure that finds the number of factors between 0 and 4 and the optimal r is defined as the value that gives us parameters with the minimal mean squared prediction error.

Liu et al. (2022) explains the advantages of considering data from the treated unit as missing, while using the control group data to estimate β, $\lambda_i^{'}$, f_t, α_i and ξ_t in the above equation to control for time-varying heterogeneity. By excluding the treated observations during the modeling stage, it avoids the problem of negative weights being assigned to treatment effects and prevents biases arising from treatment effect heterogeneity, which is a common problem with two-way fixed effects model documented by the recent causal inference literature (e.g., Goodman-Bacon, 2021).

4.3 Data

We obtain data on cotton exports from Eurostat, the official website of the European Union ranging from 2000 to 2022, and data on cotton production from the Food and Agricultural database ranging from 2000 to 2020. We use 4-digit HS codes to extract quarterly data on the value of exports for which tariff waiver was granted by EU to Pakistan. The tariff waiver is granted to the following product groups- 5205, 5208, and 5209. The HS code 5205 represents cotton yarn, while 5208 and 5209 represent cotton fabric. All three cotton groups contain 85 percent or more weight of cotton, while 5208 is cotton fabric weighing not more than 200 grams per meter square, and 5209 is cotton fabric weighing more than 200 grams per meter square. For cotton production, we use data on area harvested in hectares, production quantity in tonnes, and cotton yield in hectograms per hectare.

Our interest is to analyze the impact of the 2010 flood and the 2012 tariff waiver by comparing the observed trend of Pakistan and the trend of "synthetic Pakistan". For each of the variables of interest, we construct a synthetic control using the set of 22 donor countries for cotton exports and 92 donor countries for cotton production. We construct "synthetic Pakistan" using the weights estimated from pre-treatment outcomes till 2009. Similarly, for the interactive fixed effects counterfactual estimator, we use the same set of countries to estimate the parameters to impute the counterfactual outcomes for Pakistan. Again, the treatment period is 2010 to investigate the impacts of the flood and the tariff waiver.

4.4 Results

Figures 4.1 to 4.5 show the results using the synthetic control method of Abadie et al. (2010) (ADH synthetic control), and all the variables of interest are in logarithmic form. Trends of the outcomes from observed and synthetic control, average treatment effects, the weights for donors that construct synthetic control, and the placebo plots are reported.

Figure 4.1 shows the impact of the flood and the waiver on the exports of yarn from

Pakistan to EU. The weights are chosen by minimizing the mean squared errors in prediction over the pre-treatment period for the set of donor countries. The trend for yarn exports before and after treatments, i.e., 2010 floods and the 2012 tariff waiver, is shown in panel (a), figure 4.1. The ADH synthetic control is a close fit to the actual pre-treatment yarn exports in Pakistan. Panel (b) of figure 4.1 plots the treatment effect before and after 2010. We observe a decline in yarn exports in the year 2012 by 30 percent, after which the amount of yarn exports starts to increase. However, the impact remains negative throughout, and we do not observe the positive impact of the tariff waiver on yarn exports till the eleventh quarter after the tariff waiver or the year 2014, when the yarn exports increase by 50 percent. The weight given to each control unit is shown in panel (c) of figure 4.1 showing that India and Peru have been used to create the synthetic control.

The placebo test is reported in panel (d), whereby we treat the rest of the countries as "placebos" and plot their treatment effects. For the placebo test, we assign the "treatment" for each country exporting yarn to EU and estimate the gap between predicted and actual exports to find the treatment effect. The observed treatment effect for Pakistan is visibly different from the estimated treatment effect of other countries, highlighting the positive effect of the tariff waiver on yarn exports. There is no visible impact of the waiver for our placebo groups, which validates our finding that the tariff waiver increased the value of yarn exports. However, we acknowledge that some of the placebo plots face poor pre-treatment fit, which raises concerns about the validity of the inference. Hence, we complement the finding with the results from the interactive fixed effects counterfactual estimator.

In figures 4.2 and 4.3, we observe the impact of the floods and tariff waiver on the exports of fabric from Pakistan to EU. Panel (a) of figures 4.2 and 4.3 show the pre and post-treatment trend of the fabric exports for Pakistan and the ADH synthetic control. We observe a good pre-treatment fit for the synthetic control and an upward trend for fabric exports from Pakistan till 2012. After 2012, we see that the fabric exports from Pakistan to EU sustained an upward trend, but the exports from synthetic Pakistan declined. Hence, we

see positive average treatment effects of the tariff waiver on the fabric exports from Pakistan as shown in panel (b) of figures 4.2 and 4.3.

In panel (b) of figure 4.2, we observe a sharp increase in exports after 2012. Immediately after the waiver, we observe a 60 percent increase in exports as compared to the counterfactual for HS code 5208. By the year 2022, we observe an increase of 100 percent in the value of exports. In panel (b) of figure 4.3, we observe a similar positive average treatment effect of the tariff waiver. The placebo tests compare the treatment effect of Pakistan against that of other countries that were given placebo treatment. The placebo effect for Pakistan is greater than zero, but does not show the maximum effect of the treatment and is not visibly different from the placebo effects of other control units. The estimated placebo effects for control units have a better pre-treatment fit compared to the case of yarn exports and we do not have statistical significance in these positive effects.

Our results show an overall boost for the aggregate exports, in yarn and fabric exports but the effects are not statistically significant. Also, there is no sustained negative impact of the flood on the value of exports, indicating that effective rebuilding strategies may have helped overcome the negative consequences of a disaster in the longer term (Mohan et al., 2018).

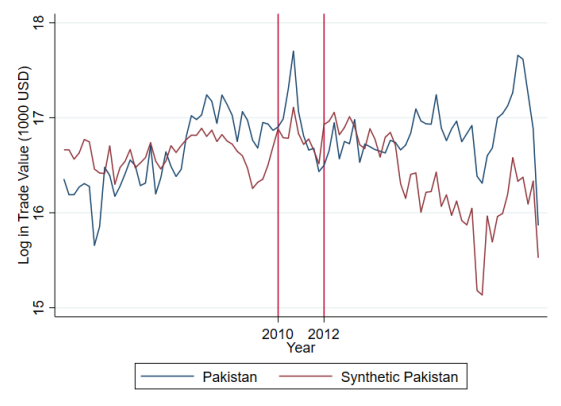
Lastly, we look at the impact of the flood and the tariff waiver on the area harvested and the cotton yield in figures 4.4 and 4.5. In figure 4.4, we observe a good pre-treatment fit for area harvested prior to the 2010 flood as seen in panel (a), after which there is a 25 percent decline in area harvested as observed in panel (b). In 2012, there is a further decrease in area harvested of 30 percent. The tariff waiver did not help in reviving production. In 2015, we observe a 15 percent decrease in area harvested as seen in panel (b) of figure 4.4.

Likewise, we observe the impact of the flood and the tariff waiver on the cotton yield of Pakistan. Panel (a) of figure 4.5 shows that cotton yield has been fluctuating over the years for Pakistan, but the ADH counterfactual provides a good fit for the pre-treatment yield data in Pakistan. After the 2010 floods, we observe that the treatment effect on yield

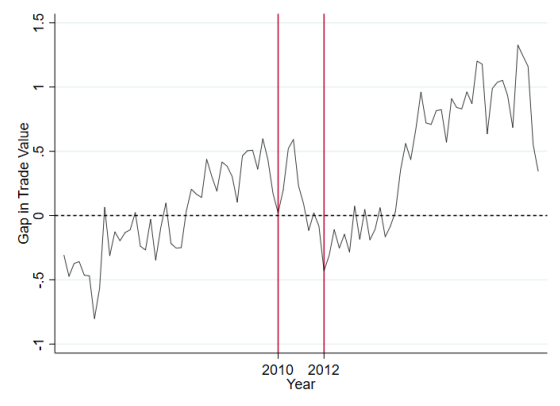
fluctuates over time.

The results obtained from figures 4.4 and 4.5 indicate that we do not find statistical evidence that the tariff waiver was able to boost cotton production. This suggests that factors other than the tariff waiver may have had a more dominant influence on cotton production, especially since the amount of area harvested under cotton did not increase post the 2010 flood. Other constraints such as weather conditions or market dynamics, apart from the waiver, may have a more substantial impact on production levels.

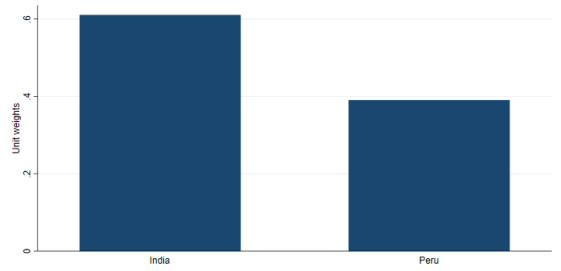
We do not see an impact of the tariff waiver on upstream industries, which is similar to the results presented in Cheong et al. (2017), whereby the impact of the tariff waiver on employment opportunities in the areas and industries impacted by floods is examined. Even though it finds evidence of an increase in employment, the increased labor demand from trade was not beneficial for the regions most affected by the floods.



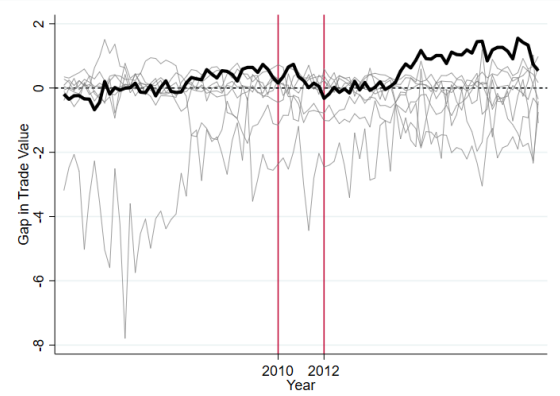
(a) Trend



(b) Average Treatment Effects



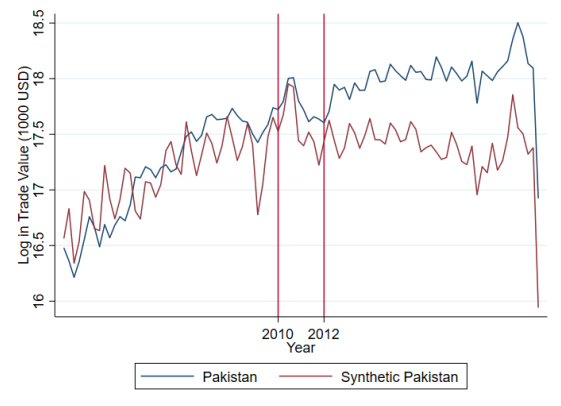
(c) Control Weights



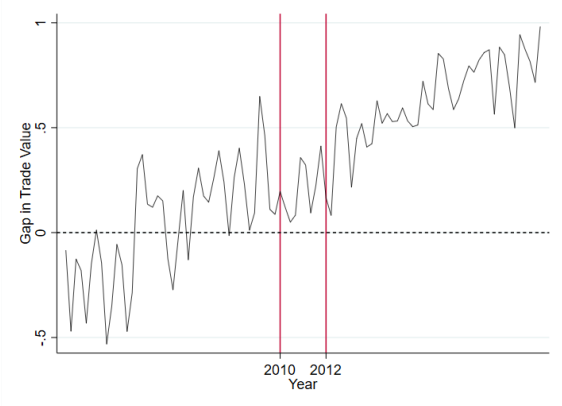
(d) Placebo Test

Figure 4.1: Yarn Exports (HS code 5205)

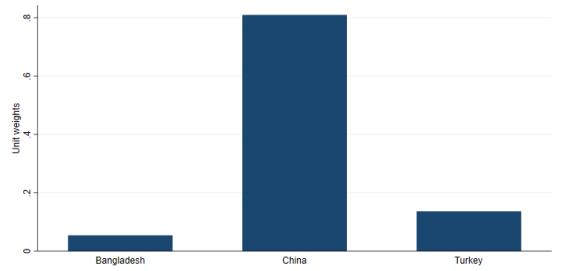
Note: Synthetic Pakistan is constructed using period 2002 – 2009 using the amount of yarn exports as covariates.



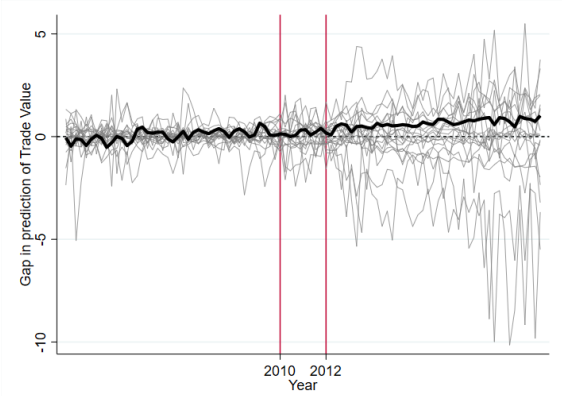
(a) Trend



(b) Average Treatment Effects



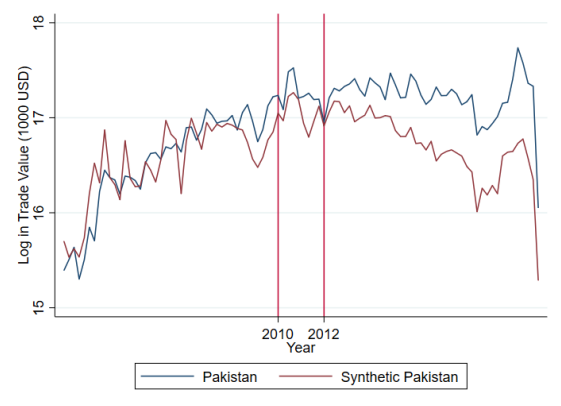
(c) Control Weights



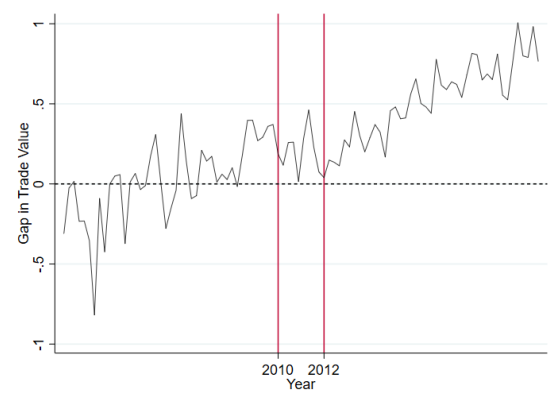
(d) Placebo Test

Figure 4.2: Fabric Exports (HS code 5208)

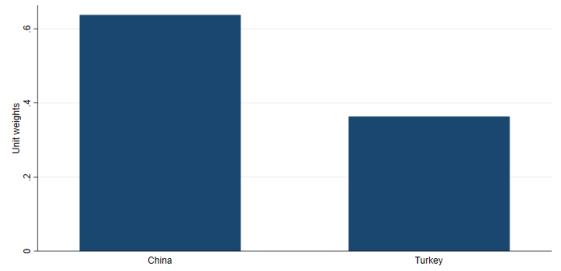
Note: Synthetic Pakistan is constructed using period 2002 – 2009 using the amount of cotton fabric exports as covariates.



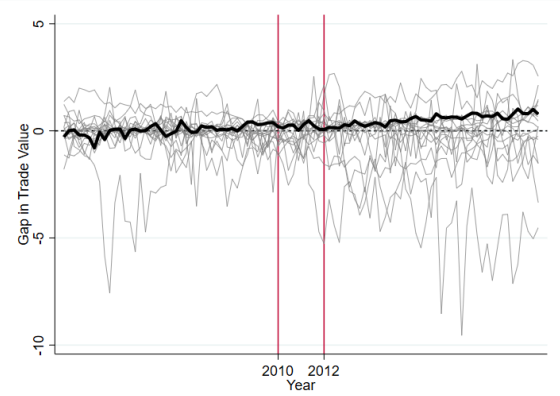
(a) Trend



(b) Average Treatment Effects



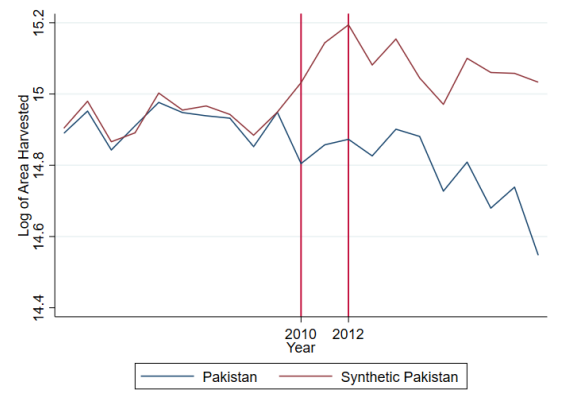
(c) Control Weights



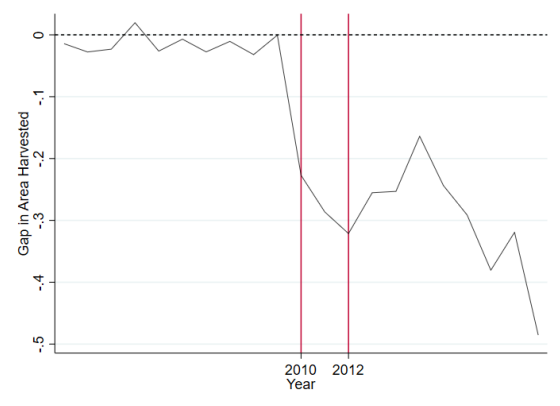
(d) Placebo Test

Figure 4.3: Fabric Exports (HS code 5209)

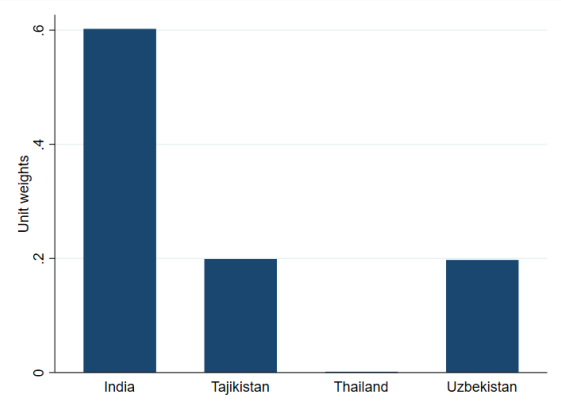
Note: Synthetic Pakistan is constructed using period 2002 – 2009 using the amount of cotton fabric exports as covariates.



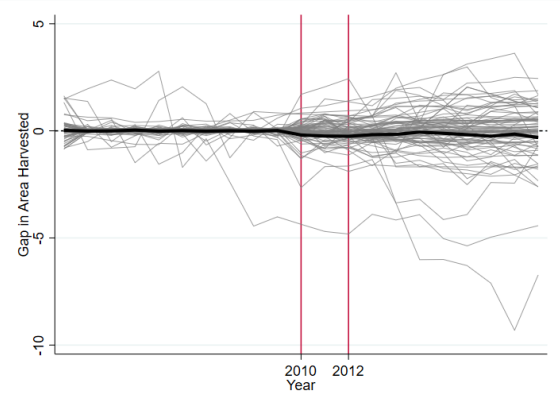
(a) Trend



(b) Average Treatment Effects



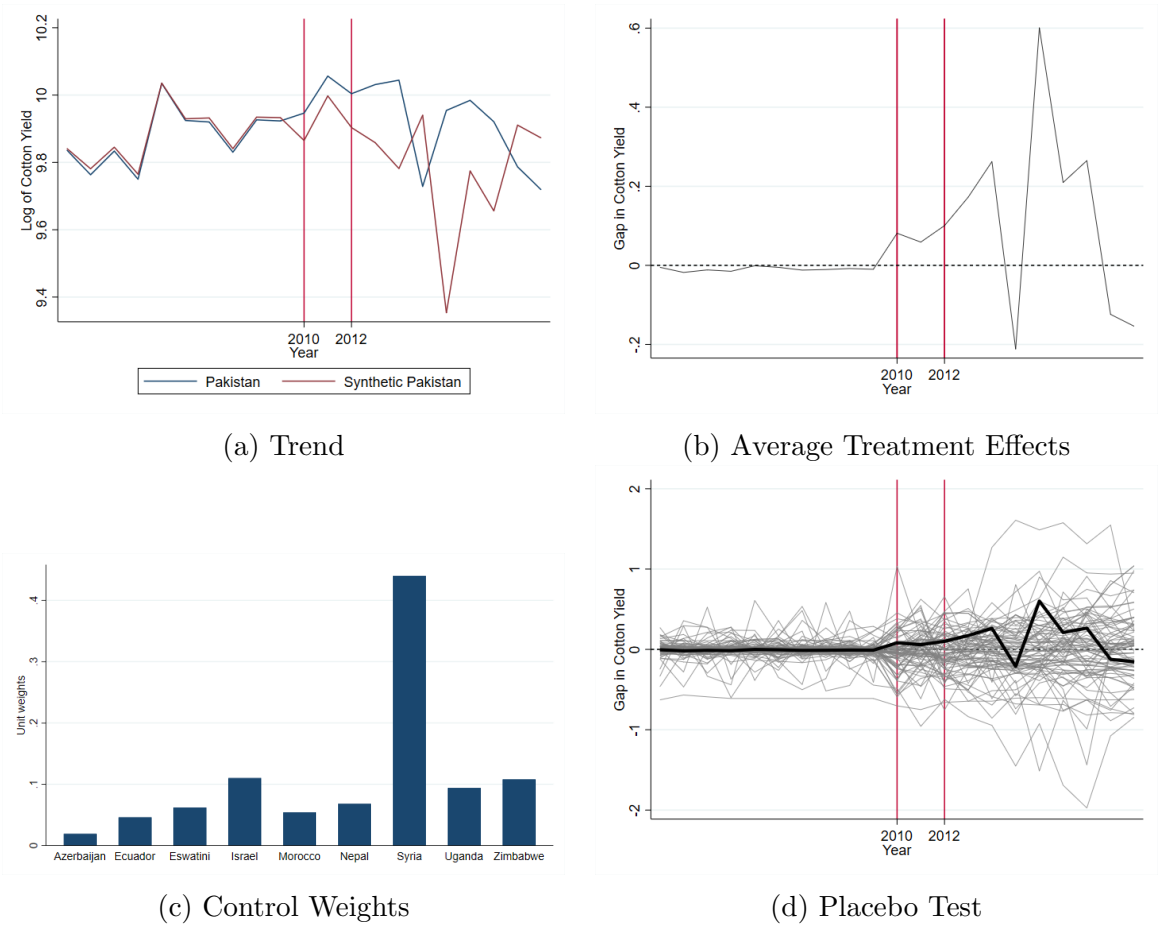
(c) Control Weights



(d) Placebo Test

Figure 4.4: Area Harvested

Note: Synthetic Pakistan is constructed using period 2000 – 2009 using the area harvested under cotton as covariates.



(a) Trend

(b) Average Treatment Effects

(c) Control Weights

(d) Placebo Test

Figure 4.5: Yield

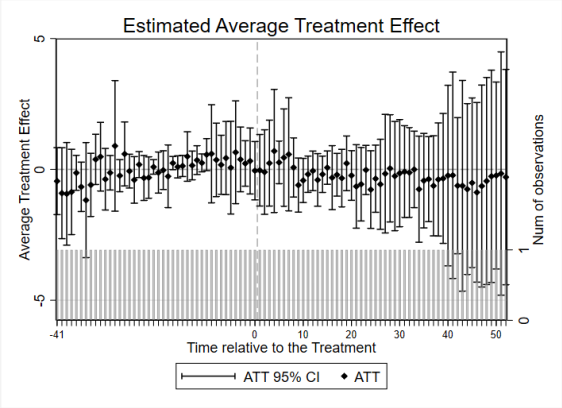
Note: Synthetic Pakistan is constructed using period 2000 – 2009 using the cotton yield in these years as covariates.

Figure 4.6 shows the results from the Interactive Fixed Effects Counterfactual Estimator revealing the impact of the tariff waiver on the cotton sector. The analysis does not show a positive effect of the tariff waiver on the value of cotton exports or on cotton production. Our finding shows that while the tariff waiver may have increased fabric exports, the impact is not significant. Despite the widespread destruction and crop loss, the flood did not lead to a substantial decline in cotton exports or production over the coming years. Likewise, the tariff waiver aimed to boost Pakistan's cotton exports post-disaster did not increase cotton exports.

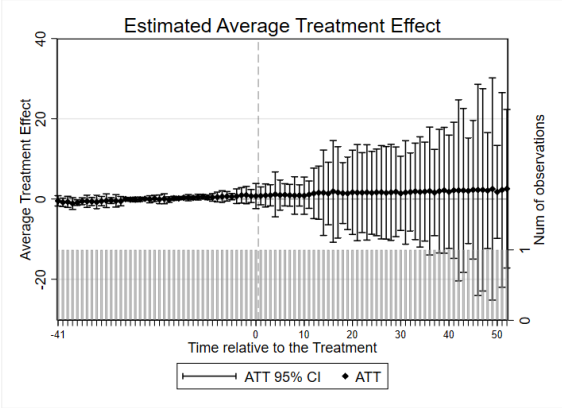
The insignificant treatment effects from the Interactive Fixed Effects Counterfactual Estimator combined with the findings from the ADH synthetic control further validate that we

do not have statistically significant evidence on the positive impacts of the tariff waiver on cotton exports and production.

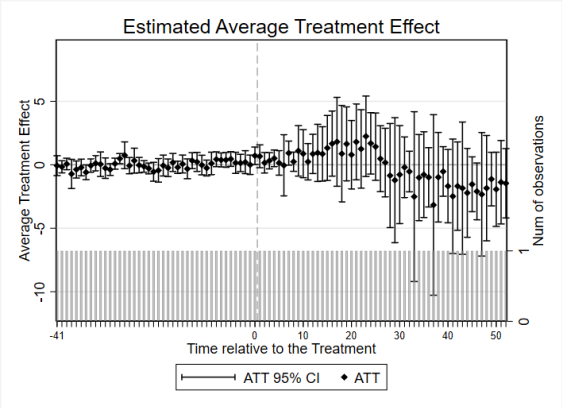
Spillover effects to other competing countries, which serve as donors in the ADH synthetic control and are used to estimate the parameters for the interactive fixed effects counterfactual estimator, can be a concern in interpreting the results. Yet, as the expected direction of the spillover effects is the overestimation of the treatment effects since controls may have been negatively affected by the tariff waiver, considering the possible spillover effect further validate our findings of the lack of significant positive impacts of the waiver on the exports.



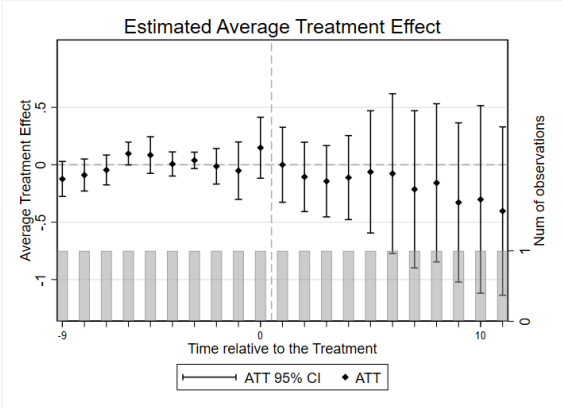
(a) Yarn Exports (HS code 5205) ($r = 1$)



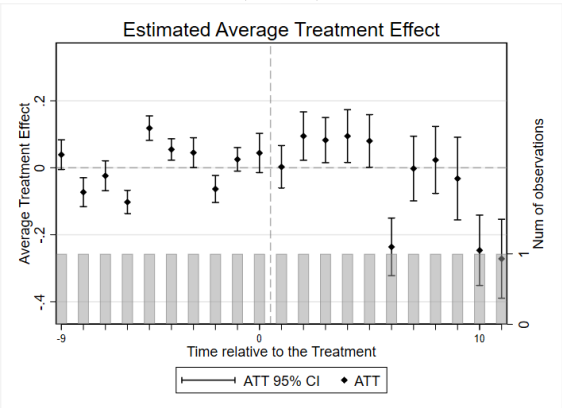
(b) Fabric Exports (HS code 5208) ($r = 1$)



(c) Fabric Exports (HS code 5209) ($r = 2$)



(d) Area Harvested under Cotton ($r = 1$)



(e) Cotton Yield ($r = 1$)

Figure 4.6: Interactive Fixed Effects Counterfactual Estimator

4.5 Conclusion

Our study shows that the 2010 flood in Pakistan and the subsequent 2012 tariff had no impact on either cotton exports or cotton production in Pakistan. We rely on not only the synthetic control method, but also on the interactive fixed effects counterfactual estimator to obtain our results. The robustness of the findings further supports the null effects we find. Overall, these results highlight the limited role of tariff waivers in promoting export growth and facilitating international trade in the post-disaster recovery phase while acknowledging that the null effects may have been due to compensation of the negative effects of flood, i.e., we would have seen negative effects of the flood, if the waiver has not been in place.

Furthermore, it seems to be the case that the impact of the waiver does not translate to the cotton industry upstream, particularly to the cotton farmers who were directly impacted by the flood. Of course, similar to the observations on the exports, one needs to be cautious in interpreting the results as the effects can be the sum of the negative effect of the flood and the positive effect of the waiver.

While we acknowledge that the null effects can be due to the fact that the effects of the flood and the tariff waiver can be opposite, one possible driver behind the limited impact is that developing countries have weak institutions or limited capacity which could hinder one's ability to benefit from the tax waiver (Svensson, 2003). Also, a one-time or a one-year waiver may have not been enough to create significant impacts.

Complementing the approach of Cheong et al. (2017), we provide a novel empirical approach to evaluate macro-level shocks in the context of international trade and development. Further methodological work on a comprehensive discussion of different empirical approaches on causal inference of country- or region-specific interventions would improve our understanding of important policy questions regarding the role of international trade in economic development.

Chapter 5

Conclusion

Managing risks is an essential part of production decisions that agricultural households make. Farmers producing crops or livestock for either consumption or selling purposes, aim to achieve basic sustenance levels while increasing their revenue. In such a case, the failure of a new technology adopted, loss of assets to a natural disaster or labor loss can cause consumption volatility and loss of livelihood opportunities for farmers. Hence, risk mitigation tools such as warranties, credit access, and relevant trade measures can help households overcome these hindrances and increase the adoption of new technology.

As observed in Chapter 2, experience plays an important role in the effective adoption of new technology and the way consumers perceive marketing signals. Warranties can help reduce uncertainty and apprehension concerning new technologies, and reference price signals the true value of the product. Consumers with experience or knowledge can correctly interpret marketing signals such as a warranty and a reference price, and do not rely on other extrinsic cues. Effectively combining marketing signals can enable technology adoption and increase the spread of knowledge and technical expertise.

Apart from the risk of product failure, farmers deal with the risk of various idiosyncratic and covariate shocks that can be mitigated, if credit markets are present. Chapter 3 highlights the role of informal credit markets in dealing with income or asset shocks, par-

ticularly idiosyncratic shocks. Informal credit markets provide flexible borrowing options for farmers in desperate times, without having to prove creditworthiness. They also provide a mechanism for farmers to pool risks at household level, but not at communal or village level. Agricultural households can overcome one-off income or asset shocks by increasing labor hours, but rely on informal credit markets to deal with persistent labor-related shocks. However, formal credit markets that can mitigate losses from covariate shocks are unable to serve this purpose in rural communities.

Therefore, macroeconomic policies should also be developed that help the agricultural sector recover efficiently from any negative shocks arising from covariate shocks such as floods and droughts. After a natural disaster, a tariff waiver can stimulate trade and economic activity in the agricultural sector by encouraging agricultural exports and generating income opportunities for farmers, which helps in long-term recovery and growth. However, while tariff waivers can help increase exports, the benefits of trade are not transferred to upstream industries as evident in Chapter 4. Effective trade policies should trigger spillover benefits across the supply chain and any constraint that prevents so should be addressed.

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