RISK SHARING, MOBILE MONEY REMITTANCES, AND THE FAMILY NETWORK

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Abstract

This dissertation examines how financial inclusion facilitates risk sharing through remittances and thereby helps poor households cope with various types of shocks including extreme weather events and the COVID-19 crisis. The dissertation consists of two main chapters. In the first, we examine whether adoption of mobile money—an innovative financial inclusion technology used for remittances in developing countries—encourages maternal health investment in the event of droughts and floods. Using a rural Ugandan household panel data, we find mobile money's shock-smoothing effect on investment in maternal health. The results from our analysis of transportation mode to health facilities reveal that mobile money services help households in geographically challenging situation—in the event of floods—travel to health facilities. In the second main chapter, we explore how mobile money remittances helped migrant workers in the capital city and their original households in villages share risk and jointly cope with the COVID-19 lockdown in Bangladesh. We apply an event study approach to panel data of the migrant workers and their original households. We provide descriptive evidence of shock-coping strategies of poor households against the pandemic. While both the workers and their original households experienced decline in consumptions amid the COVID-19 lockdown, our results imply that the workers and their original households jointly utilized remittances and smoothed consumptions between them—interhousehold consumption smoothing—to cope with the large shock. Our results suggest that mobile money services play a significant role in maintaining the risk sharing mechanism through the family network during the COVID-19 lockdown. Our findings have important policy implications for promoting financial inclusion in developing countries to help poor households cope with shocks through self-insurance in the absence of public safety net.

Keywords: Risk sharing, Financial inclusion, Mobile money, Remittances, Health investment, Coronavirus, Lockdown

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1. Introduction

Poverty is persistent despite the progress made under MDG and SDGs. Poor households struggle to 1) meet their routine daily needs and 2) cope with shocks. Poor rural and urban households in developing countries face many kinds of shocks; climate risks, natural disasters, economic downturns, civil conflicts, and a large number of individual-specific negative shocks such as illness and crop loss have to be managed by poor households themselves mostly with self-insurance. As public safety net in developing countries is not well developed, poor households can only rely on insuring themselves through informal mechanisms including mutual aid within and between families.

In this dissertation, risk sharing strategies of poor rural and urban households in Uganda and Bangladesh are explored in Chapter 2 and Chapter 3, respectively. The developing countries were selected because their public safety nets such as employment insurance and health insurance are weak compared to those in developed countries. In such situations, coping with risks through informal insurance mechanisms is important—the poor are exposed to many kinds of risks on a daily basis.

How idiosyncratic shocks affect poor households' welfare and how poor households cope with many kinds of risk have received much scholarly attention (For example, Fafchamps & Lund, 2003; Townsend, 1994; Yang & Choi, 2007). Researchers have found that poor rural households are able to cope with idiosyncratic shocks such as sudden illness through utilizing informal tools such as local transfers (i.e., borrowing money from someone living nearby) and remittances sent from outside of villages (Dercon, 2002; Fafchamps & Lund, 2003). Whether rural households' consumptions and human capital investments—educational and health investment—can be smoothed against idiosyncratic shocks has been examined by a number of

empirical studies (De Weerdt & Dercon, 2006; Jacoby & Skoufias, 1997; Townsend, 1994). Many researchers have demonstrated that idiosyncratic shocks can be insured within a community or a family network.

In contrast, large adverse shocks such as economic downturn and natural disasters affecting large areas may be more difficult to cope with. This is because while idiosyncratic shocks can be fully absorbed by someone else within a community, a large shock (a common shock or an aggregate shock) cannot be absorbed. If everyone is affected, the risk cannot be fully insured (Dercon, 2002). Thereby, someone who is not affected by the large shock is necessary to insure against the shock. Thus, shock-coping tools such as international remittances or long-distance internal remittances have been shown to be effective in insuring against large shocks. Empirical studies have found that in the event of large shocks such as hurricanes, typhoons, and earthquakes, international remittances and long-distance internal remittances are utilized to absorb the shocks (Gröger & Zylberberg, 2016; Suleri & Savage, 2006; Yang, 2008).

In developing countries, a large proportion of the population lacks access to basic financial services because the financial infrastructure is not well developed (World Bank, 2018). A process that ensures the ease of access, availability and usage of financial service such as transfer of money is called “financial inclusion” and the importance of promoting financial inclusion is widely recognized by those involved in addressing poverty (Mandira & Jesim, 2011). Financial inclusion has been on the development agenda to help the poor cope with 1) meeting their routine daily needs and 2) coping with shocks. Lack of access to basic financial services makes it difficult for the poor to improve their lives through engaging in informal insurance mechanisms aimed at coping with shocks.

The reason for selecting Uganda and Bangladesh is that in those countries, the number of mobile money users—an innovative financial inclusion technology which is used frequently for sending remittances—is growing rapidly. Financial inclusion is important for facilitating informal risk sharing. Even if public safety net is not developed, poor households may be able to insure themselves if they have a tool to send or receive money across long distances. Mobile money is rapidly expanding access to financial services to the poor in developing countries. The use of mobile money has enabled people to send text messages and transfer value (remittance) through mobile phone and reduced the cost of sending money across long distances.

This dissertation studies how mobile money as a financial inclusion tool facilitates the risk sharing mechanism used by poor households and how risk sharing through the family network—remittances—helps poor households coping against various kinds of shocks. The emergence of mobile money as an innovative tool of remittances in developing countries may have changed the way poor households manage shocks. The literature has found that mobile money remittances facilitates shock-coping in consumptions against idiosyncratic shocks (Jack & Suri, 2014; Riley, 2018). This dissertation adds to the literature by exploring the role of mobile money remittances in the two situations that have been understudied: 1) for facilitating shock-smoothing of health investments in the first main chapter, and 2) for helping risk sharing amid an aggregate shock in the second main chapter.

In Chapter 2, whether mobile money remittances facilitate health investment of the rural poor in Uganda against weather shocks is examined. Climate shocks including droughts and floods in developing countries have been attracting attention of both practitioners and scholars. Moreover, for decades, health practitioners and economists have attempted to understand how rural households can avoid the disruption

of health investments in the face of adverse shocks. Using a rural Ugandan household panel data that have detailed information of maternal care-seeking behavior of 585 households, we examine whether mobile money remittances facilitate maternal health investments of rural Ugandan women in the event of extreme weather. A causal inference is conducted exploiting geographical variation of precipitation, location of sample households and mobile money agents.

In Chapter 3, amid the COVID-19 crisis, how migrant workers in the capital city of Bangladesh and their original households in rural area jointly attempted to overcome a large shock is studied. We conducted mobile phone panel surveys of seven rounds in approximately every three months since October 2018 to August 2020. In each survey, we conducted interviews with 700 pairs of migrant workers in the capital city and their original households. The surveys which observed the shock-coping strategies of both the migrant workers and the original households enables us to examine the joint shock-coping mechanism through the family network. An event study approach is conducted to show descriptive evidence of the risk sharing strategy through the family network amid the COVID-19 shock.

This dissertation consists of the following sections. In Chapter 2, study on facilitating maternal health investments through mobile money remittances against extreme weathers is documented. In Chapter 3, study on migrant workers and their original households' shock-coping strategies against the COVID-19 shock is discussed. At the end, we present a summary of the dissertation and discuss the policy implications of the studies from Chapter 2 and Chapter 3.

2. Receiving maternal care in extreme weather: evidence of mobile money use in rural Uganda

2.1. Introduction

In developing countries, a large proportion of the population lacks access to basic financial services because the financial infrastructure is not well developed. Ensuring the ease of access, availability, and usage of financial services such as transfer of money is called "financial inclusion," and the importance of promoting financial inclusion is widely recognized by those involved in addressing poverty (Mandira & Jesim, 2011). Gaining access to essential financial services will allow the poor to improve their lives through having savings, making investments, and receiving remittances.

An innovative person-to-person payment technology, mobile money is helping to rapidly expand access to financial services to the poor, thereby promoting financial inclusion in Sub-Saharan Africa. The use of mobile money has enabled people to send text messages and transfer value (remittance) through mobile phone and reduced the cost of sending money across long distances. A growing body of literature investigates the impact of mobile money on households and examines whether households become more successful in smoothing consumption in the face of shocks (Jack & Suri, 2014; Riley, 2018), increasing consumption (J. N. Lee, Morduch, Ravindran, Shonchoy, & Zaman, 2020; Munyegera & Matsumoto, 2016), or savings (Munyegera & Matsumoto, 2017). Mobile money adoption has such positive effects on households' welfare through enhancing money transfers via informal networks, such as remittances sent by distant relatives or friends.

Lack of cash is also known as a significant obstacle which hinders the rural poor in accessing healthcare. Among health issues, maternal-child care has been a

pressing issue in developing countries. The adult lifetime risk of maternal mortality in women from sub-Saharan Africa is the highest among women in developing countries. By using cash, or voucher, or goods, as demand-side financing tools, the existing literature has studied how effective those can encourage potential patients to seek maternal healthcare (Grépin, Habyarimana, & Jack, 2019; Powell-Jackson & Hanson, 2012; Schmidt, Ensor, Hossain, & Khan, 2010). Mobile money services would also help the rural poor overcome the challenge and consequently access health sites. Using the data of rural Uganda, Egami and Matsumoto (2020) suggest that access to mobile money motivates females to receive antenatal care (ANC).

Climate hazards adds to the challenge in access to maternal care. It is well known that sub-Saharan Africa experiences many climate hazards including droughts and floods. It is also understood that the rural poor in developing countries are most vulnerable to such disasters. There is rich literature arguing the way to improve the coping strategy responding to climatic hazards in sub-Saharan Africa including Uganda (Berman, Quinn, & Paavola, 2015; Helgeson, Dietz, & Hochrainer-Stigler, 2013). Also, the previous evidence suggests that the extreme weather event is harmful for early child growth (Hoddinott & Kinsey, 2001). They argue that extreme weather conditions negatively affect farmers through the drop of their income. However, little is known about how the extreme weather affects rural expectant mothers' decision on getting maternal healthcare.

The decision making on visits to health facilities could be strongly associated with extreme weather conditions. For example, in developing countries which have many unpaved roads, if an expectant mother and her household face heavy rainfall at the timing of delivery, it is reasonable to expect that the household may give up getting facility-delivery because of the bad road condition. Using the data of rural India, Vora,

Koblinsky, & Koblinsky (2015) find that having roads in good condition—all-weather road—in the neighborhood predicts the uptake of facility delivery by expectant mothers. They suggest that such a correlation is related to the fact that "Indian villages are often cut off from major services by monsoon flooding". Lee, Jin, & Lee (2016) also report that bad weather—rain and snow—discourages visits to pediatric emergency department by using the data from Korea.

Mobile money is shown to smooth the negative shocks on consumption caused by the extreme weather (Riley, 2018). Thereby, one can also conjecture that such a shock absorbing effect might also work for helping the rural poor, including expectant mothers, to access health sites. A possible causal pathway is a simple income-smoothing by the use of mobile money. The cost of health care—including the opportunity cost—might be covered by such an ability of mobile money services. On top of that, a heavy rainfall makes the road condition worse and thereby causes difficulties in accessing to a health facility. Mobile money can bring more cash in hand and provide a variety of options—for example, a taxi or an ambulance—to accessing to a health facility. In their heterogeneity analysis, Egami and Matsumoto (2020) find suggestive evidence that mobile money brings a larger benefit—in terms of access to ANC—to geographically challenged households (for example, households that live far from the main roads) by easing their liquidity constraint as they face higher cost of traveling to distant health facilities. Thus, one can conjecture that mobile money use might also help households access health sites during heavy rainfall events. However, whether mobile money services alleviate drought shocks or flood shocks on health-seeking behavior has not been investigated.

Uganda is among the worst ten countries that comprised 58% of the global maternal deaths reported in 2013. The maternal mortality ratio (maternal deaths per

100,000 live births) in Uganda is 360 and 22 times higher than that in developed regions (16). It is even higher than the average of developing regions (260) (WHO, UNICEF, UNFPA, The World Bank, & The United Nations Population Devision, 2014). A well-designed and well-implemented ANC program facilitates the detection and treatment of health problems such as anemia or infection during pregnancy; it also provides an opportunity to disseminate health messages to women and their families. ANC from a trained provider at a high-quality health care facility is vital in monitoring the pregnancy and reducing the morbidity risk for the mother and child during pregnancy and delivery (Uganda Bureau of Statistics (UBOS) and ICF International Inc., 2012).

In addition to ANC, the benefit of delivering with a skilled birth attendant[1] (SBA) or at a health care facility versus home birth has been clearly described in the literature (Halim, Bohara, & Ruan, 2011). For example, proper medical attention and hygienic conditions during delivery can reduce the risk of infections and complications that may cause death or serious illness to either the mother or the baby (or both) (WHO, 2007). As Manang and Yamauchi (2019) studied about Uganda, an increase in health facilities surrounding mothers' residential areas (supply-side change) can improve the health-seeking behavior of mothers. Evaluation studies find that maternal health service utilization is positively affected by financial inclusion, such as access to microfinance or bank accounts (Orton et al., 2016; Singh et al., 2019). The existing literature, however, has little to say whether financial inclusion helps rural women overcome weather shocks to get maternal healthcare.

[1] The World Health Organization defines skilled birth attendants as educated, trained, and accredited health professionals such as midwives, doctors, or nurses (WHO, 2004). SBAs have the skills to manage "normal (uncomplicated) pregnancies, childbirth and the immediate postnatal period, and in the identification, management and referral of complications in women and newborns."

In this study, utilizing the RePEAT data of Uganda, we attempt to fill the literature gaps. The study conducts regression analysis of community- and mother-level fixed effects models with the assumption that weather shocks are exogenous. Statistical inference is conducted in order to assess the mobile money adoption impact on maternal health-seeking behavior in the face of weather shocks. Several robustness tests including those exploit geographical variations of mobile money agents' locations are also conducted. As outcome variables, this study has chosen three dummy variables that take one if a mother achieved WHO-recommended minimum four contacts for ANC, facility delivery, and delivery assisted by an SBA, respectively.

We find evidence that mobile money use helps rural Ugandan women overcome weather shocks to get facility delivery and delivery assisted by an SBA. Such an effect is also found in two other measures of the quality of delivery care (postnatal care and baby weight measurement). On the other hand, the results have failed to reject the null-hypothesis of no mobile money's weather shock-smoothing effect on ANC. The results of heterogeneity analysis comparing droughts and floods imply two things. Firstly, the negative impact on maternal care is larger in floods than in droughts. Secondly, the mobile money effect seems to be positive for both droughts and floods. We confirm the robustness of our findings using falsification tests, a reduced-form version of the difference-in-differences analysis with measures of geographic access to mobile money agents, and instrumental variable (IV) regressions using measures of geographic proximity to mobile money agents as instruments. Moreover, we test how mobile money users' transportation modes to access health sites changes responding to the weather shocks. We find that in floods, mobile money adoption affects the choice of the transportation modes and facilitates using the transportation modes with higher costs. In contrast, in droughts, mobile money adoption has no such an effect.

This study contributes to financial inclusion literature, maternal health literature, and climate hazard literature. The results suggest that mobile money as a tool of financial inclusion positively affects women's maternal health-seeking behavior in the face of climate hazards. Maternal health literature has been searching for an effective tool to motivate women from poor households to receive proper maternal care. Climate hazard literature has been working on identifying the negative impact of such hazards on various aspects and studying coping strategies. Lack of money has been indicated as a critical problem in the two strands of literature. Adding to the existing coping strategies, we show that mobile money has the potential to become a new tool.

This chapter proceeds as follows. Section 2 gives a brief background on mobile money and the maternal health service environment in Uganda. Section 3 presents explanation on the negative impact of the extreme weather on maternal healthcare and the key potential channel conveying the impact of mobile money adoption on health-seeking behavior. Section 4 presents the study design and data. Section 5 presents identification strategy and empirical results. Section 6 gives conclusions.

2.2. **Context**

2.2.1. Mobile money services

Mobile money is an innovative, cheap, secure, and convenient medium that extends financial services even to the poor who have minimal access to formal financial institutions. At the most basic level, mobile money allows its users to make monetary transactions through mobile phones and hence, to send and receive remittances, to buy goods, and to pay fees electronically. Mobile money mechanism needs a cash-in, cash-out infrastructure, which consists of a network of "agents," who take a small commission for turning cash into electronic value (and vice versa). Mobile money agents are usually existing local business persons selling airtime cards, who chose the

mobile money business as a diversification of their services. In 2015, Uganda had 33,845 agents (Bersudskaya & McCaffrey, 2017), which was significantly larger than the number of automated teller machines (ATMs) operated by commercial banks (842) (Bank of Uganda, 2015).

Sub-Saharan African countries began seeing the entry of mobile money services in 2007 and 2008. Mobile money service was established in Uganda in March 2009; by mid-2015, Uganda had over 19.8 million mobile money users, which represent almost half of the population. The high growth rate of its penetration tells that Uganda is appropriate for analyzing the effect of mobile money adoption on social welfare.

2.2.2. Maternal health services in Uganda

In line with the WHO guidelines, the Ministry of Health (MOH) of Uganda recommends that a woman has at least four ANC visits. During these visits, health experts detect health problems associated with pregnancy. In the event of any complications, more frequent visits are advised, and admission to a higher quality health facility may be necessary. According to a study based on the Demographic and Health Surveys (DHS), 45 percent of women in rural Uganda for the period 2007-2011 made four or more ANC visits, while 55 percent delivered at health facilities (Lawn et al., 2018). Those figures are consistent with the data we use (the RePEAT study).

According to the clinical guideline of Uganda (Ministry of Health, 2016), ANC requires the following three components at all visits: addressing identified problems, checking blood pressure, and measuring the symphysis-fundal height (SFH) and fetal heart activity. In addition to those, the objective of ANC includes the following services as necessary: satisfying any insufficient nutritional, social, emotional, and physical needs of the pregnant woman, identification of high-risk pregnancy, and referral as appropriate, assessment of maternal well-being including ultrasound and vaginal

(vulval) examination. A whole package of such services is called the comprehensive ANC and can only be secured at high-quality health facilities. In fact, according to the DHS report, in 2011, only 59 percent of mothers received blood pressure measurements, which is one of the required tasks of ANC (Uganda Bureau of Statistics (UBOS) and ICF International Inc., 2012). This implies that many mothers did not visit health facilities of recommended quality. Women in rural areas are less likely to use such health facilities than those in urban areas (Uganda Bureau of Statistics (UBOS) and ICF International Inc., 2012).

According to the 2011 DHS report, 57 percent of deliveries in the five years preceding the survey took place at some health facilities while 42 percent of deliveries took place at home. Regarding delivery assistance, skilled providers assisted in the delivery of 57 percent of births, while traditional birth attendants, relatives, friends, or nobody assisted the rest. The 2016 DHS report described the improvement of those figures. Seventy-three percent of live births in the five years preceding the survey were delivered in some health facilities, and a skilled provider conducted deliveries of almost the same proportion (74 percent) (Uganda Bureau of Statistics (UBOS) and ICF., 2018). The Uganda government's guideline on the quality of health facilities, the target population size, and the geographic unit served by each facility level (Ministry of Health, 2012), is summarized in Table 2.1. Firstly, the health facility of the lowest administration level with a physical establishment is a Health Center II (HCII). An HCII is supposed to be in every parish, which is the second smallest administrative unit in Uganda. This level of the facility is neither supposed to provide any delivery care nor comprehensive ANC, although sometimes HCII may receive emergency cases and provide partial ANC, which does not require laboratory testing. Secondly, a Health Center III (HCIII) provides delivery and comprehensive ANC. This level of facility and

the facilities of higher levels can provide maternal health care of the quality recommended by WHO.

The dominant type of health facility is public-owned. There also exist relatively a small number of private or NGO health facilities, and their quality is wide-ranging from a lower level to a higher level.

The government's health inventory database indicates that there had been a significant increase in the number of health facilities in Uganda between 2002 and 2015; the number of facilities increased from about 2500 to 5000 (Manang & Yamauchi, 2019). While the increase of HCIIs mostly drove the increase in the number of health facilities, the higher-level health facilities also increased.

In this study, a lower-level health facility means HCII. A higher-level health facility includes HCIII, HCIV, government hospitals, and private or NGO health facilities. Both of the indicators are constructed based on the RePEAT survey. Map of the geographical variation of health facilities is shown in Appendix 1.6.

2.3. **Key potential channel**

2.3.1. Impact of rainfall shocks on maternal care utilization

A drought shock and a flood shock may affect maternal health seeking behavior differently. The mechanism through which both droughts and floods negatively affect maternal health seeking behavior is the loss of income of rural households by killing crops—both too little rainfall and too much rainfall can be harmful to agricultural productivity (Banerjee, 2007). The loss of income is likely to discourage women from taking maternal health seeking behavior, especially when the medical cost is expensive. On the other hand, when floods hit a village, geographical difficulty adds to the challenge in access to health facilities (Vora et al., 2015). For example, heavy rain makes the road condition worse particularly in rural areas where

roads are often not paved. Thus, the adverse shocks caused by heavy rainfall on maternal health seeking behavior could be larger than those of droughts if the magnitude of the negative income shocks are the same.

2.3.2. How mobile money use works

We examine the impact of mobile money adoption on healthcare service utilization, specifically on the use of maternal care among Ugandan women. Why would adoption of mobile money help mothers receive maternal care? To receive maternal care, an expectant mother has to bear the cost, such as payment at a health facility, transportation cost, and opportunity cost. As shown in Table 2.2, to receive ANC, mothers had to pay around 1,500 Ush in 2012 and 5,000 Ush in 2015 (to receive delivery care, 11,000 Ush in 2012 and 17,000 Ush in 2015); USD was equivalent to Uganda shilling 2,557 in financial years 2011–12 (Bank of Uganda, 2012). Considering that a typical rural household spent 3,000 Ush for a meal, one can see that the ANC cost and the delivery care cost are not cheap[2]. Besides, an expectant mother had to pay the transportation cost. According to a study which investigates modes of transport for making maternal care visits in Uganda of the period 2012-2013, 63 percent of Ugandan women used motorcycle taxi (Sacks et al., 2016). The RePEAT study also shows that an expectant mother had to spend around one hour to reach the place for ANC and wait for another one hour (Table 2.2). In this sub-section, we discuss the potential channel of the effect of mobile money adoption: effect on liquidity constraint. We also describe how past studies have attempted to overcome the financial barrier to maternity care.

2.3.2.1. Effect on liquidity constraint

[2] In 2001, by national-level health policies, user fees for maternal health services are committed to be removed in public health facilities (Lawn et al., 2018). However, in the dataset we use, mothers reported that they needed to pay money whether public facilities or private facilities. In any case, in our empirical specifications, such effects of a policy change are absorbed by district-by-time dummies (and do not bias our estimates on mobile money's shock-smoothing effects).

The 2011 Uganda Demographic Health Survey asked women what factors would be a significant problem for them in seeking medical care (Uganda Bureau of Statistics (UBOS) and ICF International Inc., 2012). Almost half of the women said that preparing money to pay for treatments was a problem in accessing health care, while almost as many said that distance to a facility was a problem. The existing literature attempts to find effective ways to motivate mothers to receive ANC by giving them cash transfer or vouchers (Bellows, Kyobutungi, Mutua, Warren, & Ezeh, 2013; Grépin et al., 2019; Jehan, Sidney, Smith, & Costa, 2012; Powell-Jackson & Hanson, 2012). Dupas (2011) also argues that liquidity constraint and lack of saving technology hinder the poor from seeking health care. While Tarozzi et al. (2014) show that microfinance is effective for encouraging poor households to take health-seeking behavior, Dupas and Robinson (2013) find that providing a safe saving tool increases health savings significantly.

Mobile money eases liquidity constraints of its users facing financial problems by giving them a means to receive immediate cash transfer from family members, relatives, or friends. It is often used as a tool for savings, which also relaxes liquidity constraints among rural residents who do not have access to other inexpensive and effective savings technologies. Indeed, mobile money users receive a larger amount of remittances more frequently from migrant workers living in cities and also save more money than non-users (Munyegera & Matsumoto, 2016, 2017).[3]

Therefore, one can see the vital potential channels of the effect of mobile money on poor households. Easing their liquidity constraint by mobile money services

[3] Specifically, our hypotheses on the mobile money effect assume that mobile money users receive a larger amount of money after rainfall shocks. In Table 10, we test whether remittances received by each household increased after rainfall shocks. The results support our argument.

may change the health-seeking behavior of pregnant women. Financial inclusion tools, including microfinance, have been found to support the take-up of health services. Thus, the adoption of mobile money as a tool of financial inclusion may also contribute to making cash more accessible to poor households and encouraging women to receive maternal care.

In addition to decrease of income, heavy rainfall makes the road condition bad and imposes people to spend a larger cost for accessing to health facilities. Mobile money can bring more cash in hand and provide a variety of options—for example, a taxi or an ambulance—to accessing to a health facility. Through such a pathway rather than a simple income-smoothing, mobile money might also help a user household access to a health facility. In their heterogeneity analysis, Egami and Matsumoto (2020) find that mobile money brings a larger benefit to geographically challenged households by easing their liquidity constraint as they face higher cost of traveling to distant health facilities. Thus, one can conjecture that mobile money use might also help households access health sites during heavy rainfall events.

2.4. **Data and study design**

We created a dataset based on household level panel surveys of rural Uganda. We utilize retrospective questions on maternal care-seeking behavior asked in the surveys. We construct an original dataset of pregnancy reports with panel-structure; mothers can report each of their pregnancy experiences in the past. Thus, pregnancy reports have a panel-structure at mother level. The mother level panel structure is a key feature of this study because it is useful for identifying the causal relationship between mobile money usage and maternal care-seeking behavior. The recall panel data allows us to use the difference-in-difference fixed effects model (at community- and mother-level in our case), which is a rigorous microeconometrics approach used in many other

mobile money studies (for example, Jack & Suri (2014); Riley (2018)). In this section, we first explain the details of the household level panel surveys that we use and then describe how we construct our original recall panel data. On top of that, we elaborate on how we constructed the rainfall measure.

2.4.1. Household level panel survey

Panel data from household surveys collected in Uganda as part of the Research on Poverty, Environment and Agricultural Technology (RePEAT) project is used in this study. The RePEAT project was jointly administered by Makerere University, Foundation for Studies on International Development (FASID), and National Graduate Institute for Policy Studies (GRIPS). Among the five survey rounds in 2003, 2005, 2009, 2012 and 2015, we use the data of 2009, 2012 and 2015. Among those three rounds, the data of 2012 and 2015 are the primary source of our study; the two rounds collected the information on maternal health-seeking behavior. The 2009 data is used as a supplement to obtain household characteristics and the GPS locations of households.

The RePEAT data consists of around 940 rural households. In the 2003 survey, 94 villages were sampled; ten households were randomly selected from each of the villages, which are scattered in three regions (Central, East, and West). In the following surveys, new households were sampled in response to attritions following the sampling method described above. At the round 2012, 911 households were surveyed; the average attrition rate between the round 2003 and 2012 was low at 8.0%. At the round 2015, 847 households were surveyed; the attrition rate from the round 2012 to 2015 was also low at 7%.

2.4.2. Retrospective reports on maternal health-seeking behavior

The RePEAT survey questionnaires include questions about maternal health-seeking behavior in 2012 and 2015 rounds; the data has 1,684 pregnancy level observations from 586 households. The locations of 585 households with GPS information from the RePEAT study is shown in Figure 2.1. Mothers aged 15-56, or females aged 15-56 at the timing of the survey who have experience of any pregnancy, were asked about their delivery history between 2001 and the survey year in each of the survey round (2012 or 2015). In round 2012, for mothers who were interviewed in 2005,[4] pregnancy experiences between 2005 and 2012 were asked. For the rest of the mothers, pregnancy experiences between 2001 and 2012 were asked. When there were more than two mothers in a household, two mothers were randomly selected and asked to answer the survey. In round 2015, the survey prioritized to interview mothers who were interviewed in 2012 (or supposed to have been interviewed in 2012). If there were fewer than two such mothers in the household, the interviewer conducted the survey with additional mother(s) in the household if any (see Appendix 1.1 for more details).

The RePEAT survey questionnaires also include questions about adoption of mobile money in 2012 and 2015 rounds. In 2012, a household head was first asked whether he/she or the spouse use mobile money or not. Next, he/she was asked about possession of a mobile money account, and then the year in which he/she opened the account. In 2015, each household head was asked about the year in which any of the household members started to use mobile money. We combined the information from 2012 and 2015 rounds and constructed a variable indicating mobile money usage by a household at the annual level.

[4] Though mothers were asked about their pregnancy experiences in the survey round 2005, the questionnaire did not include questions on ANC. That is one of the reasons that we do not use pregnancy reports from round 2005.

We use retrospective reports of both deliveries and mobile money adoption. On deliveries, a few mothers reported seven past pregnancy experiences responding to a survey round. This raises concerns that it may be prone to recall errors. However, studies on maternal health-seeking behavior using retrospective reports generally do not consider that recall errors are severe (Allendorf, 2010; Lamichhane, Sharma, & Mahal, 2017; Manang & Yamauchi, 2019; McKinnon, Harper, Kaufman, & Bergevin, 2015). Some of the studies rely on Beckett et al. (2001), which investigates the usefulness of long-term retrospective reports by using Malaysian data from the 1970s and 1980s.

Beckett et al. (2001) report two essential findings: "data quality deteriorates with the length of the recall period" and "the more salient an event is to the respondent, the more accurate its report." It argues that information on salient life events such as pregnancy experience for live-born children is less prone to recall errors. Thus, two of our primary outcome variables, facility delivery, and the presence of SBAs, are likely to be less prone to recall errors. However, we cannot rely on Beckett et al. (2001)'s findings if somebody other than the mother herself answered questions because the delivery is not a salient event for the respondent anymore. To keep the data quality better, we exclude delivery reports answered by family members other than mothers themselves. This decreases the number of observations on facility deliveries from 1650 to 1231 (1684 to 1247 for deliveries by SBAs).[5]

Detailed information such as numbers of ANC visits made in each of the three trimesters would be probably more prone to recall errors. Thus, one of our primary outcome variables—ANC visit is more likely to be prone to recall errors. The DHS is

[5] The number of observations which is shown in regression tables are less than those numbers because we cannot use samples if there are missing values in necessary control variables.

likely to avoid such a problem by restricting questions on ANC to the latest pregnancy experience within the past five years (Uganda Bureau of Statistics (UBOS) and ICF International Inc., 2012). Similarly, to create ANC related variables, in our data, we restrict the pregnancy reports to those of the past five years from the survey year. We also exclude the information on ANC answered by family members other than mothers themselves. Those decrease the number of observations on ANC from 1,634 to 844 of 399 households of 92 villages in 120 parishes. Our treatment also follows a recommendation made in Beckett et al. (2001); the study suggests varying recall periods of variables with saliency. In our case, we judge that delivery reports are more salient than ANC reports.

Table 2.2 reports summary statistics for the analysis sample of each survey round. Between 2012 and 2015, the mobile money user household rate increased from 40.7 percent to 55.2 percent. In contrast, the bank account user percentage showed no increase. The percentage of mothers who received recommended ANC at a higher-level health facility increased from 22.2 percent to 29.3 percent. The number of ANC visits (including lower-level health facilities or any other facilities providing insufficient maternal care services such as drugstores or homebirth), however, showed no increase. Those figures imply that more mothers had come to receive ANC at good quality facilities. Both the cost spent on receiving ANC and the transportation cost spent increased. In contrast, the cost spent on delivery showed a relatively moderate increase. The percentage of mothers who received delivery service by a skilled provider or at a good quality facility also increased.

2.4.3. Rainfall measure

We calculate rainfall shock measures at the household level using the GPS location of each of the households and precipitation from Goddard Earth Sciences Data

and Information Services Center. We connect the GPS location of each household and the precipitation by using GIS;[6] the data of rainfall is available at 0.1°x0.1° grid by latitude and longitude. Following the previous literature (Amare, Jensen, Shiferaw, & Cissé, 2018; Jensen, 2000; Riley, 2018), we combine drought shocks and flood shocks to construct a dummy indicating rainfall shocks; we define a drought shock as more than a 1 standard deviation in negative values from the historical mean during the rainy season[7] over the last 15 years; a flood shock is also defined as more than a 1 standard deviation in positive values from the historical mean. We follow the previous literature (Amare et al., 2018) and use precipitation of rainy seasons because extreme weather in wet seasons are likely to give a larger impact on households' income than that in dry seasons. Also, positive extreme rainfall in rainy seasons is more likely to affect road conditions than those in dry seasons. The map of the geographical variation of precipitation is shown in Appendix 1.6.

2.5. **Empirical results**

2.5.1. Estimation

2.5.1.1. Empirical specification

We follow the literature[8] and construct the basic empirical model to estimate the impact of rainfall shock on health-seeking behaviors for pregnant women with and without mobile money services:

[6] Rainfall shock measures are created at household-level instead of village-level. This is because we have the GPS location of each household. As there could be differences in the magnitude of shocks within each village, it is arguable that using household-level rainfall shock measures is better than using village-level rainfall shock measures. Although, as one can see on Figure 2.1 or the map shown in Appendix 1.6, the locations of households in each village are very close to each other.

[7] There are two rainy seasons in Uganda: from March to May and from August to November (Nkuringo Safaris, 2020).

[8] We follow Jack & Suri (2014), which also follows Gartler & Gruber (2002).

(1) $y_{jhkdt} = \gamma Shock_{hkdt} + \mu Mmoney_{hkdt} + \beta Mmoney_{hkdt} * Shock_{hkdt} + \psi X_{hkdt} + \theta X_{hkdt} * Shock_{hkdt} + \alpha_j + \eta_{dt} + v_{jhkdt}$,

(2) $y_{jhkdt} = \gamma Shock_{hkdt} + \mu Mmoney_{hkdt} + \beta Mmoney_{hkdt} * Shock_{hkdt} + \psi X_{hkdt} + \theta X_{hkdt} * Shock_{hkdt} + \gamma_k + \eta_{dt} + v_{jhkdt}$,

where y_{ijhkt} is dependent variable such as a dummy variable which indicates the take-up of a specific maternal healthcare at pregnancy completed at time period t is followed by mother j of household h living in parish k of district d. $Shock_{hkdt}$ is a dummy variable which indicates a rainfall shock at the location of household h, $Mmoney_{hkt}$ is a dummy variable which takes one if household h uses mobile money at time period t. The coefficient β is the parameter of interest. Equation (1) includes district-by-time dummies (η_{dt}) to control for the annual nation- and district-wide policy changes,[9] cultural changes, events, or shocks which might have affected the ease of maternal healthcare. The specification also includes mother fixed effects (α_j). Equation (2) is a relaxed version of the specification (1). The specification (2) uses parish fixed effects (γ_k) instead of mother fixed effects.

X_{jhkdt} is a vector of controls, including individual characteristics and household characteristics which might make ease of making health visits. The individual characteristics include maternal age at delivery, years of education, and parity. The household characteristics include mobile phone ownership, number of household members, number of migrants, log of aggregated asset value, log of the size of landholding, household head's years of education, ownership of any non-agricultural business. We also control for the household-level time-invariant geographic

[9] Uganda experienced many national-level policy changes on maternal health in 2000s and 2010s (Munabi-Babigumira, Nabudere, Asiimwe, Fretheim, & Sandberg, 2019). The effect of such policies are captured by the district-by-time dummies.

characteristics (for equation (2) only). The geographic information is likely to capture the remoteness, which could affect maternal care utilization. These include a dummy variable which takes one if the location of a household is relatively far from the closest main road. It takes one if the distance from a household to the closest road is larger than 1.3 miles, which is the mean of the sample. The controls also include a dummy variable which takes one if a household location is relatively far from the center of the village and a dummy variable which takes one if the altitude of a household location is relatively far from the center of the village. Those dummies take one if the distance is longer than the mean of the sample. We use the reference points of each village recorded in the RePEAT survey as the location of *the center of the village.* The reference points are the places used for having meetings with informants in the village by enumerators of the RePEAT study. Those are buildings such as village offices, schools, or churches. Additionally, the geographic information of a household includes a dummy variable which takes one if a household is located at an area occupied mainly by the water surface.

X_{jhkdt} also includes village characteristics that affect access to healthcare. Those include three dummies for the number of higher-level health facilities and two dummies for the number of lower-level health facilities within five miles from the reference point of each village.[10] Those dummies are time-variant variables. We also control for a dummy indicating the road condition in a dry season from each village to the closest district (for equation (2) only). It takes the value of one if the driving time

[10] For the main regression analysis, we also test using three miles as a threshold, and the results do not change qualitatively.

to the closest district is shorter than the sample average. This variable is time-invariant.[11]

Mother fixed effects capture mother-specific time-invariant characteristics such as preference towards health care, cultural background, and relationship with family members. The previous literature studies the importance of unobservable characteristics. For example, Allendorf (2010) points out that a good relationship between a woman and her family members is essential for encouraging a mother to seek maternal care. As long as a woman continues living in the same parish,[12] mother fixed effects also control for parish-specific characteristics such as the cultural background or the social norm. Meanwhile, parish fixed effects do not control for mother-specific characteristics. Thus, the mother fixed effect model is our preferred specification.

We focus on the shock-absorbing ability of mobile money which is captured by the coefficient β on $Mmoney_{hkdt} * Shock_{hkdt}$. Such an ability is ultimately tested by F-tests between the magnitude of rainfall shocks on mobile money users and non-users. There are many observable characteristics which predict self-selection into using mobile money. Such self-selection effects are absorbed into the coefficient μ on $Mmoney_{hkdt}$. Thus, the self-selection into using mobile money is not a problem for us, though we use many covariates to control it. However, we are concerned about self-selection into using mobile money which is positively correlated with a household's shock-smoothing ability conditional on parish- or mother- fixed effects and other covariates. To control for observables which could be correlated with mobile money

[11] To create this variable, we mainly use the information in the round 2015 because it covers the most significant number of villages. Three villages' information was complemented with the data of the 2012 round.

[12] We identify the parish in which a household lives by the GPS location. Households, which belong to the same village, may live in different parishes. The sample of the RePEAT surveys is composed of households of 94 villages in 128 parishes. Thus, parish fixed effects can capture some differences like remoteness, which can vary even within a village.

use and insure of an expectant mother's maternal care in the face of rainfall shocks, we include interaction of covariates with the rainfall shock in some of the specifications ($\theta X_{hkdt} * Shock_{hkdt}$).

For robustness checks, we use another specification: reduced-form analysis. The use of mobile money requires access to agents who provide cash-in and cash-out services so that mobile money users can convert stored e-money to cash, or vice versa. We use the data of agents' locations provided by Insight2Impact[13] to exploit the variation of the rapid expansion of the agent network[14] for causal analysis. We follow the literature (Jack & Suri, 2014) and use a reduced-form version of the difference-in-differences strategy with measures of access to mobile money agents:

(3) $y_{jhkdt} = \gamma Shock_{hkdt} + \nu Agent_{hkdt} + \beta Agent_{hkdt} * Shock_{hkdt} + \psi X_{hkdt} + \alpha_j + \eta_{dt} + v_{jhkdt}$,

where $Agent_{hkdt}$ is a measure of the access to a mobile money agent. This specification mirrors equation (1). We do not control for the interactions between observables and the shock in this specification because we treat the agent rollout as exogenous. The assumption that needs to hold to use this specification is that agent rollout is not systematically correlated with household-level unobservables that help females smooth the shock on maternal care-seeking behavior. The assumption is tested in the next section titled "Identification strategy".

We also use the agent rollout data to conduct IV methods to control for the endogeneity of mobile money users' shock-smoothing ability. There are two endogenous variables: mobile money adoption dummy and its interaction with the rainfall shock. As excluded instruments, we use the logged distance to the closest agent,

[13] FSPMAPS.COM
[14] Maps of the geographical variations of mobile money agents are shown in Appendix 1.7.

the number of agents within 1km from each household, and the interactions of each with the rainfall shock.

2.5.1.2. Identification strategy

There are two main sources of self-selection which could bias our results. One is self-selection by households into mobile money use. The other source is self-selection by mobile money agents into the locations where they start their business.

Firstly, we argue self-selection of households using mobile money. Our analysis is focused on the ability of mobile money to help smooth rainfall shocks. We are therefore concerned about self-selection into mobile money use being positively correlated with the shock-smoothing ability which is captured by the coefficient β on $Mmoney_{hkdt} * Shock_{hkdt}$. For obtaining unbiased estimates of the coefficient β, the rainfall shock must be exogenous. This assumption may be reasonable to hold because the shock indicator that we use is not self-reported; it is constructed based on an estimated precipitation data. We confirm the exogeneity of the rainfall shock by running separate regressions for household/village characteristics for the rainfall shock. The results are shown in Table 2.3 column (4). One can find little evidence of the correlation between the rainfall shock and household/village characteristics.

On top of that, to examine whether unobserved factors help absorbing rainfall shocks on maternal care-seeking behavior in the absence of the use of mobile money, we conduct falsification tests by using placebo mobile money dummies. In other words, we test the common trend assumption which is necessary for a difference-in-difference specification.

Moreover, we test for endogeneity in mobile money use and shock-smoothing with respect to maternal care-seeking behavior using an instrumental variables method. We use two measures that indicate the location of mobile money agents surrounding

each household as variables which should be both correlated with mobile money use and uncorrelated with each household's shock-smoothing ability. This requires the assumption that mobile money agent rollout is not correlated with maternal care-seeking smoothing ability.

Secondly, we are concerned about self-selection by mobile money agents into the location where they select to start their business. If mobile money agents select into the locations where citizens' shock-absorbing ability is improving, this would confound our results by creating a positive bias on the estimates of mobile money's shock-absorbing ability. For example, if mobile money agents like to begin their business at the location where the number of health facilities are increasing, or if mobile money agents like to stay at the location where the citizens are getting wealthier, those could create a spurious positive effect of mobile money on the health-seeking behavior. Thus, we need to have the assumption of no self-selection by mobile money agents into the location of their business correlated with factors which improve the shock-smoothing ability.

To examine whether mobile money agents' location is correlated with household/village characteristics, we run separate regressions of several measures of mobile money agents' location on household/village characteristics (Table 2.3 column (1)-(3)). The measures are number of mobile money agents within 1km/5km from each household, and log of the distance from each household to the closest agent.

For both the regressions for the rainfall shock and the measures of mobile money agents' location, rather than using the contemporaneous characteristics, we used the change of household/village characteristics (2009-2012 and 2012-2015) to calculate the correlations. This is because our concern is whether the introduction of agents was predicted by the change (or improvement) of household/village characteristics. If we

find such a correlation, it implies that an agent selects a location to conduct the business because the growth of the local economy or the improvement of the access to health facilities are expected. This violates our assumption.

Table 2.3 indicates that there is little evidence of the correlation between the rainfall shocks, the measures of mobile money agents and household or village characteristics. Although there are a few significant coefficients, we expect some to be significant just by chance. In column (3), at the significance level of five percent, the change of the number of lower-level health facilities around each village predicts the distance to the closest agent. As a result, among the four columns, only column (3)'s joint F-test p-value is significant. However, the rest two measures of agents' location (number of agents within 1km/5km) are not correlated with the number of lower-level health facilities. Moreover, the possible direction of the bias is that agents select to start their business where the access to health facilities are less improved. Thus, this would not make a positive bias on our estimates that treats health-seeking behavior. Overall, we find little evidence that the rainfall shock/the location of agents is correlated with most household/village characteristics.

2.5.1.3. Outcome variables

One of the primary outcome variables is a dummy variable, which takes one if a mother satisfies the take-up of ANC in line with the recommendation of WHO.[15] The recommendation requires at least four ANC visits in total. It also requires a mother to attend ANC at least one time in the first trimester, one time in the second trimester and two times in the third trimester. Furthermore, it requires a mother to take ANC at a particular quality health facility. In Uganda, health facilities whose quality is higher

[15] The latest guideline, created in 2016, recommends eight times of ANC contacts.

than a Health Center III satisfy the requirement. Due to the data limitation, the quality of a private health facility where women visited is not available. We included private health facilities in higher-level health facilities. Hereafter we denote making ANC in the way recommended by WHO as take-up of *recommended ANC*[16] as used in Lawn et al. (2018). A mother who seeks ANC at a low-quality facility such as a drugstore or a community health worker office is not treated as one by the dummy variable of *recommended ANC*.[17]

This study also covers two delivery related variables, a dummy variable which takes one if a mother received delivery service at a higher-level health facility and another dummy variable which takes one if a mother received delivery service from an SBA. The three variables above are chosen as outcome variables because they attracted significant attention in the previous studies of maternal health (Bellows et al., 2013; Grépin et al., 2019; Manang & Yamauchi, 2019).[18]

In the section of robustness checks, we cover some more outcome variables. We cover two more ANC related variables: a dummy indicating take-up of five times of ANC (which also needs to satisfy the requirement of recommended ANC) and the number of times for which a mother took ANC. We also show the estimates of two more delivery related variables: a dummy equal to one for receiving postnatal care (both the mother and the baby) and a dummy equal to one if baby weight was measured.

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[16] The number of observations of recommended ANC, which is shown in Table 2.2, is larger than those of other ANC related variables. This is because we calculate the recommended ANC by using four dummies: a dummy indicating at least one ANC visit in the first trimester, a dummy indicating at least one ANC visit in the second trimester, a dummy indicating at least two ANC visits in the third trimester, and a dummy indicating ANC visits to higher-level health facilities. If any of the dummies takes zero, even if the other three variables are missing, we calculate the recommended ANC as zero.

[17] The RePEAT survey does not ask mothers where they receive ANC for each trimester. The questionnaire of the survey is: "where did you typically receive antenatal care?" Thus, if a woman visited two or more types of providers, a typical provider was reported.

[18] How we constructed the outcome variables is elaborated in Appendix 1.3.

2.5.2. Mobile money impact on take-up of maternal care

Table 2.4 shows regression results of the impact of rainfall shocks on the main outcome variables—three types of maternal health seeking behavior for mobile money users and non-users. For each of the three outcome variables, we show the results of village fixed-effect models and mother fixed-effect models. Columns (2), (4), (6), (8), (10), and (12) include interaction terms of all the control variables with the rainfall shock, though the coefficients are not reported here for brevity. By having those, we consider the possibility that some observable household characteristics might be useful in alleviating the negative impact of the weather shock on maternal health seeking behavior. For example, consumption of asset-poor households is found to be less resilient to rainfall shocks (Amare et al., 2018). Likewise, shock resiliency in terms of health seeking behavior might also correlate with a household characteristic. To obtain the total effect of the rainfall shock, we take the mean value of each control variable for that household type and multiply it by the coefficient on the interaction term. These are summed to give the total effect of the rainfall shock for households with the mean characteristics of the entire sample, mobile money users, and mobile money non-users households, respectively. We also show the total effect of the rainfall shock for households of mobile money non-users evaluated at the mean characteristics of mobile money users.

We begin with looking at the estimates for facility delivery and SBA (column (5)-(12)). The estimates of the total effect of the rainfall shock (the line of "Negative shock") are negative in all 4 cases of facility delivery; the magnitude of the negative shock ranges from three percentage points to sixteen percentage points. The estimates of the total effect of the rainfall shock are negative in 3 cases out of 4 cases of SBA; the magnitude of the negative shock ranges from three percentage points to sixteen

percentage points. Hence extreme rainfall shocks have a strong negative effect on utilization of facility-delivery; the shocks also have a relatively moderate negative effect on utilization of SBA.

Turing to the interactions with the shock dummy (the line of "Mobile money use * Shock"); the estimates of the coefficient indicating shock smoothing ability of mobile money are positive (in 8 out of 8 cases) and significant (in 6 out of 8 cases) for facility delivery and SBA. When a rainfall shock occurs, mothers of the households which have access to mobile money can avoid most of the negative impact on utilization of facility delivery and SBA.[19] We confirm this by looking at the F-test in the panel below comparing A to B and C. The results of F-test indicate that the shock impact on facility delivery and SBA for mobile money users is significantly different from non-users.

Looking at the regression results of ANC, we do not find a clear pattern on the shock absorbing ability of mobile money on utilization of ANC (column (1)-(4)). The estimates of the interaction with the shock dummy are positive but not significant. In 3 out of 4 cases, the estimates of the rainfall shock (the line of "Negative shock") on utilization of recommended ANC are negative; the magnitude of the negative shock ranges from one percentage points to five percentage points. Because it is difficult to be conclusive at this point, we move to check the estimates on additional outcome variables related to ANC in the next section.

We conclude this section with the following three summary statements. Firstly, we find evidence of the existence of positive mobile money effect on alleviating the

[19] In the event of rainfall shocks, mobile money users can change the sign of the shock to positive. This might be because they have a "good" reason to ask others—distant relatives or friends—to help them by sending remittances; probably they cannot usually do so.

negative rainfall shock on utilization of facility-delivery and SBA. Secondly, we find evidence neither on existence of the shock absorbing ability of mobile money on utilization of ANC, nor absence of such an ability.

2.5.3. Robustness check

In Table 2.5, to illustrate the shock absorbing function of mobile money on utilization of maternal care from various aspects, we run regressions for four more outcome variables related to maternal care. Two outcome variables are related to ANC: a dummy indicating take-up of five times of ANC (and satisfaction of the requirement of recommended ANC) and the number of times for which a mother took ANC. The other two outcome variables are related to delivery: a dummy indicating uptake of postnatal care (both the mother and the baby) and a dummy which is equal to one if baby weight was measured. Both variables indicate the quality of the environment prepared for a delivery. We present the results of the specifications for parish- and mother- fixed effects models; all the models in the table include interaction terms of all the control variables with the rainfall shock.

The results of Table 2.4 confirm the existence of the shock absorbing function of mobile money on utilization of delivery care. The results of the regressions on the two outcome variables related to delivery (column (5)-(8))—uptake of postnatal care and whether the baby weight was measured—imply that the quality of maternal care was better for mobile money users in the event of rainfall shock. The total effects of the rainfall shock on the maternal care ("Negative shock") are negative for all 8 cases. The F stats testing (A)=(C) for the mother fixed models reject the equality of the shocks for both postnatal care and baby weight measurement. Those results indicate that the shock-smoothing effect of mobile money facilitated mothers to have a better environment for the deliveries.

On the other hand, the results of the regressions on the two ANC-related outcome variables (column (1)-(4)) are not conclusive. Firstly, it is unclear whether the extreme weather was a negative shock to uptake of ANC; in column (1) and (2), we get estimates of the "Negative shock" close to zero (.044 and -.005). Secondly, the results of the F-stats testing (A)=(C) are mixed. The results reject the equality of the shocks in 2 out of 4 cases, while in the rest 2 cases the results do not reject the equality. Altogether, the results we get for ANC is not conclusive evidence of shock absorbing effect by mobile money service on ANC.

In Figure 2.2, we graphically illustrate the estimated shock-smoothing effects of mobile money use on delivery care-related outcome variables and ANC-related outcome variables. This is essentially a summary of the estimates from mother fixed effects models shown in Table 2.4 and 2.5. One can find the shock-smoothing ability for delivery-related outcome variables, while the results for ANC-related variables failed to reject the null hypothesis of no shock-smoothing effects of mobile money. Mean values—including both mobile money users and nonusers—of each outcome variable of 2009-2015 are shown for reference.

2.5.4. Heterogeneity analysis: droughts and floods

To understand which factors—droughts or floods—might be driving the main results, we report the heterogenous effects in Table 2.6. Same as before, we use the 1 standard deviation rainfall. A drought is defined as the difference in rainfall from the mean being more than one standard deviation below the mean; a flood is defined as the difference in rainfall from the mean being more than one standard deviation above the mean. We run regressions of parish- and mother- fixed effects models for the three main outcome variables; all the models in the table include interaction terms of all the control variables with the rainfall shock.

The results indicate that the flood shock has a significant negative impact on uptake of facility-delivery and SBA (column (3)-(6)). In all the 4 cases, the estimates of the total negative effect ("Flood shock" in the table) are negative; in 2 out of 4 cases, the estimates are statistically significant and present approximately 20 percentage points decrease of uptake of facility-delivery and SBA. However, mobile money users are protected against the flood shock. The F-stats testing (D)=(E) reject the equality of the magnitude of the flood shock on mobile money users and non-users at the 10 percent significance level. In 3 out of 4 cases, the F-stats testing (D)=(F) also reject the equality of the magnitude of the flood shock at the 10 percent significance level.

The drought shock does not have a statistically significant negative impact on facility-delivery and SBA; in column (4) and (6) of the line of "(C) Drought shock, non-users |*userX's*", we see -0.06 and 0.122 for facility-delivery and SBA respectively. Meanwhile, the uptake of SBA for mobile money users are strongly encouraged in the face of the drought shock (+0.494 in column (6) of the line of "(A) Drought Shock, MM users"). The F-tests for facility delivery and SBA reject the equality of the impact of the drought shocks to mobile money users and non-users at the 10 percent significance level. In contrast, we do not find evidence of mobile money's positive effect of protecting the take-up of ANC by rural Ugandan females against the drought shock nor the flood shock.

Altogether, we find a shock-smoothing effect of mobile money for the uptake of facility delivery and SBA against both the drought shock and the flood shock. The magnitude of the negative impact on uptake of maternal care of the flood shock is larger than that of the drought shock. Those findings are graphically illustrated in Figure 2.3 where the estimates of the drought shock and the flood shock on mobile money users and non-users from mother fixed effect models are shown.

2.5.5. Transportation in droughts and floods

In floods, the difficulty of transportation adds to the challenge of the decrease of income. This is because heavy rainfall makes the road condition worse—rural Uganda has many unpaved roads. Such a deterioration of road condition does not occur in droughts. Thus, one can conjecture that mobile money adoption may change the transportation used for seeking healthcare in floods, while such change may not happen in droughts.

To understand the possible mechanism through which mobile money use facilitates the uptake of healthcare, we report the impact of mobile money adoption on the transportation used for seeking delivery-care in the event of both droughts and floods in Table 2.7. We run regressions of mother- fixed effects models for four transportation-related outcome variables: (a) log of transportation fee paid for giving birth, (b) a dummy that takes one if transportation fee was higher than the mean, (c) a dummy that takes one if females went for giving delivery by paid transportation such as taxis (mini-bus), hired cars, boda-boda motorcycle taxis, or ambulances, (d) a dummy that takes one if females went for giving delivery on foot, by bicycle, or gave delivery at home.

Our expected mechanism of mobile money adoption that supports a female to receive a better-quality delivery care by choosing a better transportation gives the following predictions. Firstly, in floods, we expect that mobile money adoption facilitate females to choose better transportations, which costs higher, to travel for giving delivery. Secondly, we expect that in droughts, mobile money adoption does not have a shock-smoothing effect (or have a smaller shock-smoothing effect compared to that in floods) on the choice of transportation because droughts do not make the road condition worse.

The results are consistent with our predictions. The F-stats testing (D)=(E) and (D)=(F) in column (1)-(4) indicate that in the events of floods, mobile money users paid higher transportation fees for travel to give delivery compared to non-users. Similarly, the results shown in column (5)-(6) indicate that in the events of floods, mobile money users preferred to choose paid transportations to travel for giving delivery compared to non-users. Moreover, the results shown in column (7)-(8) indicate that mobile money users were less likely to choose to travel for giving delivery on foot, nor by bicycle, and to give delivery at home compared to non-users in the event of floods. This also implies that mobile money users could choose a better transportation and a better-quality delivery care in floods. Meanwhile, none of those mobile money's effect on encouraging users to choose a better transportation in the event of weather shock are found for droughts. Thus, overall, the results in this section implies that mobile money adoption gives broader options of the mode of transport to a household that face a geographically challenging situation—floods.

2.5.6. Falsification tests

One may imagine that the mobile money users and non-users were systematically different and that the "mobile money adoption effect" shown above could be explained by the observed/unobserved characteristics which could have existed even in the absence of mobile money. To answer the concern of violating the common trend assumption, we run regressions for the outcome variables of facility delivery and SBA on a placebo mobile money dummy. In this estimation, we use a sub-set of observations which are from 2000 to 2008[20]. We restricted the data to this period

[20] We do not include ANC in the falsification test by two reasons. First, the results of our regressions on ANC do not indicate mobile money's shock-smoothing effects. Second, because the duration of the data for ANC is shorter than delivery-related variables, it is not possible to run the same placebo regression on ANC.

because the mobile money service began in 2009. The placebo mobile money dummy takes a value of one in 2006-2008 for the household whose members used mobile money in 2015; it takes a value of zero for the rest of the observations in the sub-set.[21] The results are shown in Table 2.8. The results of the F-tests are mostly insignificant—the only exception is the estimates from the parish fixed effects model for SBA. This indicates that the magnitude of the rainfall shocks was not significantly different between mobile money users and non-users before the penetration of the mobile money service. This is consistent with the common trend assumption which is necessary for a difference-in-difference specification. In 4 out of 8 cases, the magnitude of the rainfall shock (the line of "Negative Shock") is estimated negative at the 5 percent significance; this suggests that there's little concern of being underpowered to detect effects. The coefficients of the interaction term of the placebo dummy and the rainfall shocks are positive but small or negative and mostly insignificant.

Only cases, where the equality of placebo-mobile money users and placebo-mobile money non-users are rejected, are the regressions of parish fixed effects models on SBA. However, our preferred specification is the mother fixed effect models. On top of that, in another falsification test shown in Appendix 1.4, the F-stats from the parish fixe effects models on SBA are not significant.

2.5.7. Reduced forms using agent rollout

As another robustness check, we use the agent rollout data and estimate the reduced form difference-in-differences specification in equation (3). In tables in

[21] We also show another falsification test in Appendix 1.4. It uses a different placebo dummy which takes one if the observation is a second (and more) birth of a mother during the period of 2000-2008 for the household which used mobile money in 2015. For this falsification test, we check the possibility that the mobile money effect observed is something else such as a feeling of improvement of their life by mothers; if so, such an effect can be observed within mothers' variation even without having mobile money. The results of F-tests are shown insignificant or significant but in a wrong direction. This supports the common trend assumption.

Appendix 1.5, we report a number of estimates of mobile money adoption's shock smoothing effect on facilitating maternal care for a number of different measures of agent access: number of mobile money agents within 1km, 2km, 3km, 4km, 5km, 10km, 15km, 20km, and the logged distance to the closest agent. In Figure 2.4, we provide a graphical summary of the estimates above that take facility delivery, SBA, postnatal care, and weight measurement as dependent variables. Figure 2.4 shows that females with better access to agents are less affected by rainfall shocks. As expected, the closer a household is to an agent, the larger the coefficient implying absorbing ability against rainfall shocks. Such a relationship is more salient in postnatal care and weight measurement, rather than facility delivery and SBA. Probably due to insufficient number of samples, the magnitude of the shock-smoothing effect does not simply diminish by distance for facility delivery and SBA. Because of this, in addition to the logged distance to the closest agent, we use number of mobile money agents within 1km as the excluded instruments in the IV regressions. Overall, in Figure 2.4, one can find that the closer a household is to an agent, the better facilitated delivery care-seeking behavior again the rainfall shocks.

2.5.8. IV regressions

We instrument for mobile money adoption and its interaction with the rainfall shock using two agent access measures—the logged distance to the closest agent and the number of agents within 1km from each household—and their interactions with the rainfall shocks. In Table 2.9, we show the results of the IV regressions for facility delivery, SBA, postnatal care, and weight measurement. For all the regressions, we include our standard set of covariates as above, Year*District dummies, and mother fixed effects. For brevity, we do not show the eight first-stage regressions in Table 2.9, but Sanderson-Windmeijer first-stage F statistics are shown for checking weak

identification for each endogenous regressor (mobile money user dummy and the interaction term of mobile money user dummy and rainfall shocks). We are particularly interested in whether the interaction term of mobile money user dummy and rainfall shocks are weakly identified. Moreover, for checking weak identification for two endogenous regressors together, Kleibergen-Paap F statistics are shown. On top of that, the weak IV robust test results are listed.

The IV results are consistent with our earlier findings. The estimates of the coefficient of the interaction term indicate that mobile money users are better able to smooth rainfall shocks and facilitate the uptake of delivery care. The Sanderson-Windmeijer first-stage F statistics for weak identification of the interaction term indicate that weak identification is not a serious problem for the individual endogenous regressor of our interest.[22]

We treat the estimates in Table 2.4 and Table 2.5 preferred (OLS), rather than those in Table 2.9 (IV). With i.i.d.errors, one can perform a Hausman test to compare fixed effects models and IV regressions for testing the endogeneity of the endogenous regressors. The null hypothesis is that the specified endogenous regressors can actually be treated as exogenous. We do not report the results, but we are unable to reject the null for 3 out of 4 cases (the rejected case is baby weight measurement). Therefore, based on the Hausman tests results, the estimates in Table 2.4 and Table 2.5 are preferred because the specifications are efficient under the null.

2.5.9. Mechanism: remittances

[22] While Kleibergen-Paap F statistics show that the weak identification problem arises when two endogenous regressors are put together, the results of weak IV robust inference indicate that the null is not rejected at the 10 percent significance level in 3 out of 4 cases. In over-identified and non-homoskedastic setting like ours, there is no consensus on what weak IV robust test should be used (Andrews, Stock, & Sun, 2019). Thus, for each regression, we choose one from available weak IV robust tests (CLR test, AR test, K test, J test, and K-J test) that is efficient.

One of the proposed mechanisms of the effect of mobile money in this study is that mobile money allows remittances to be sent by friends and family in distant places in response to rainfall shocks and that this allows smoothing of maternal health-seeking behavior. Using a cross-section data, Riley (2018) shows that mobile money users in Tanzania received a larger amount of money after rainfall shocks. This supports our argument on the mechanism. On top of that, in this sub-section, we use the RePEAT data and confirm the validity of this mechanism by testing whether remittances to mobile money users increased responding to rainfall shocks.

We use the data on remittances at the survey rounds of 2009, 2012, and 2015. For running regressions, we use the following specification:

(4) $y_{hdy} = \gamma Shock_{hdy} + \mu Mmoney_{hdy} + \beta Mmoney_{hdy} * Shock_{hdy} + \psi X_{hdy} + \sigma_h + \eta_{dy} + v_{hdy}$

where y_{hdy} is whether household h in district d at the survey round of y received any remittances in the last twelve months, and the amount received by the household (we use the arcsinh transformation because remittances have many zero-valued observations). The specification includes household fixed effects (σ_h). The rest of the variables are as defined previously. The data on remittances is only available for 2009, 2012, and 2015; we do not have the data on the years in between such as 2010, 2011, 2013, or 2014. If remittances are a valid channel through which mobile money smooths rainfall shocks, then β should be larger than zero. To mitigate the influence of the potential endogeneity, we also utilize the IV regressions where instruments are the two agent access measures described previously. For brevity, we do not show the first-stage regressions, but Sanderson-Windmeijer first-stage F statistics are shown for checking weak identification for each endogenous regressor (mobile money user dummy and the

interaction term of mobile money user dummy and rainfall shocks). As before, we are particularly interested in the weakness of the identification of the interaction term.

Table 2.10 shows the results of the OLS regressions and the IV regressions. The OLS estimates of the interaction term's coefficient shown in column (1) and (3) are positive but not statistically significant. The IV estimates shown in column (2) and (4) are positive and statistically significant at the 10 percent significance level. The Sanderson-Windmeijer first-stage F statistic for the interaction term indicates that weak identification is not a concern. Overall, the results support that remittances are a valid channel through which mobile money smooths rainfall shocks.

The estimated coefficients for IVs are larger than those for OLSs. This might be because of measurement error of our mobile money adoption indicator. Though the data on remittances are sum of remittances received in the last twelve months, our mobile money adoption indicator is observed at the time of the survey. Thereby, for example, even if a household had started to use mobile money three months before the survey, our mobile money adoption indicator assumes that the household had been using mobile money since twelve months before the survey. This causes measurement error that leads to attenuation bias.

2.5.10. Potential endogeneity

In this sub-section, we summarize the potential threats that may bias our estimates and explain how we deal with them. There are three potential sources of endogeneity which could bias our estimates. The first is the mother-level correlation between mobile money use and maternal care use. If a pregnant woman with specific characteristics is more likely to facilitate shock-smoothing of maternal care-seeking behavior while her household is more likely to use mobile money, our estimates would be upwardly biased without controlling for such characteristics. The second is the

household-level correlation. A pregnant woman of a household with specific characteristics, which correlates with mobile money use, might be more likely to make health visits in the face of weather shocks. The third is the village-level correlation between mobile money agents' location and health facilities' location. If a mobile money agent is more likely to choose a place that has good access to health facilities, it would also bias our results.

To deal with the first and the second sources of endogeneity, we control for many observable characteristics. We can list a number of potential sources of endogeneity. Starting with mother-level endogeneity: a more educated woman could be more likely to overcome weather shocks to get maternal care. At the same time, she might be more likely to belong to a mobile money user household.

Similarly, we can list several potential factors that cause household-level endogeneity. For example, mobile phone use of a household, which correlates with mobile money use, may be helpful in smoothing the rainfall shock on maternal care. Further, if the number of household members is large, the probability of using mobile money could be high, while the household members could also help a pregnant woman to make health visits even in extreme weather conditions. If a household sends migrant workers to towns, the household has a higher probability of using mobile money, while remittances from the migrant workers give more abundant options of overcoming climate hazards to get maternal care to a pregnant woman. Moreover, a relatively wealthy household is more likely to use mobile money, while a woman in such a household could be more likely to take up maternal care in extreme weather. The location of a household might also correlate with mobile money use. For example, a household, which is located closer to the center of the village, might be more likely to use mobile money. Similarly, if a household is located closer to the main road, it might

also affect the take-up of mobile money in an extreme weather condition. In our regressions, we control for all the observable characteristics listed above. In addition to those, we control for any unobservable time-invariant characteristics, that might correlate with mobile money use, by mother fixed effects.

We also use several village-level characteristics to control for endogeneity. Firstly, as a time-variant variable, we control for the number of health facilities around a village. If an agent chooses a place to attract more customers, the location might correlate with the location of health facilities. That causes an upward bias in our results. Secondly, as a time-invariant variable, we control for the road condition from a village to the nearest district town. This factor could be related to the location of an agent because an agent may prefer to stay at a place that has good access to a district town. In addition to those, any unobservable time-invariant characteristics such as culture or social norm, which might affect both mobile money use and take-up of maternal care in extreme weather, are controlled by parish fixed effects.

Besides, we control for time-variant unobservables at the district level by using district-by-time dummies. However, we cannot rule out endogeneity caused by time-variant unobservables at a more granular level. There are several possible unobservables. Unfortunately, we do not have the data on household characteristics between the survey rounds. For example, between 2009 and 2012 or 2012 and 2015, a household might have extra earnings, sent migrants, or experienced change in their business. Such an event might correlate with mobile money use and shock-smoothing ability in terms of maternal care.

On top of that, to control for household-level endogeneity, we follow the previous studies and utilize the IV method. We use the location of agents as our instrumental variables. The IV method can address the household-level endogeneity,

though it cannot avoid the village-level endogeneity. To deal with the concern, in Table 2.3, we show that the agent rollout does not correlate with underlying demand of healthcare. In the previous studies, including some using the RePEAT data (Munyegera & Matsumoto, 2016, 2017; Tabetando, 2017), the IV estimates are used as well.

2.5.11. Data limitation

After being shown that mobile money adoption motivates maternal *health-seeking behavior*, one may want to know about the improvement of maternal and infant *health outcomes*. Due to the data limitation, we cannot show evidence on positive mobile money effects on such health outcomes. The RePEAT surveys have a limited number of health-related questions because the surveys were not originally designed for collecting health data—the surveys mainly focus on rural agriculture. Also, though the surveys have questionnaires on a few aspects of maternal and infant health outcomes such as pregnancy complications or birth weight, the number of missing values of the answers to those questions is large, and the sample size is likely to be too small—recall errors add to it—to find a robust and meaningful effect of mobile money use. Therefore, this study focuses on the shock-smoothing effect of mobile money adoption on maternal care utilization. However, focusing on maternity care utilization, not maternal and infant health outcomes, is found in many articles. For example, a systematic review of the effects of cash transfers and vouchers on the use of maternal care, which uses data from 51 studies, concludes that there are few studies to estimate maternal and infant health outcomes (Hunter, Harrison, Portela, & Bick, 2017).

2.6. Conclusion

It is revealed in the past studies that mobile money adoption creates a positive impact on consumption smoothing in the face of shocks including the extreme weather (Jack & Suri, 2014; Riley, 2018). This study presents evidence of mobile money's

shock-smoothing effect on maternal healthcare in the face of weather shocks. We find that uptake of several types of delivery-related maternal care—facility delivery, delivery assisted by SBAs, and postnatal care—is supported by mobile money services to cope with both droughts and floods. On the other hand, we do not find conclusive evidence of mobile money's shock-absorbing effect on getting ANC in the face of the extreme weather. The results of the heterogeneity analysis imply that a flood is more harmful than a drought for the uptake of maternal care.

The results of the analysis reveal that mobile money services help households in geographically challenging situation—in the event of floods—travel to health facilities. As expected, such an effect is not identified in the event of droughts. Mobile money may ease the liquidity constraint when households face higher cost of traveling to health facilities because of the bad road condition during floods. This is consistent with the finding of Egami and Matsumoto (2020) whose heterogeneity analysis illustrates that mobile money brings a larger benefit to geographically challenged households such as households living far from the main roads.

There is rich literature tackling problems caused by the climate change. Especially in developing countries, climate hazards are known to be harmful for the rural poor (Berman et al., 2015; Helgeson et al., 2013). In this study, we show that the extreme weather discourages rural Ugandan females from getting maternal care. Therefore, this study also contributes to bring a new aspect on the discussion of the negative impact of climate hazards on the rural poor.

The existing literature has studied how one can motivate the rural poor to get maternal care (Grépin et al., 2019; Powell-Jackson & Hanson, 2012; Schmidt et al., 2010). We present evidence that financial inclusion by mobile money has a shock-

absorbing effect on maternal care against weather shocks. This study highlights additional important aspect in promoting financial inclusion in developing countries.

We can compare our findings with a study on the shock-smoothing effect of mobile money adoption on health aspects. An NBER (National Bureau of Economic Research) working paper investigates the relationship between mobile money usage and health-seeking behavior responding to adverse health shocks (Ahmed & Cowan, 2019). The study utilizes a panel data of Kenya and applies the difference-in-difference fixed effects model to the data. The study shows that mobile money usage helps households increase visits to health facilities responding to health shocks. The finding of the study is in line with our finding—adoption of mobile money improves access to healthcare in the event of shocks.

3. Internal migrant workers and COVID-19 lockdown

3.1. Introduction

Human mobility has been the driving force behind economic development. Most migrants gain benefit in the form of higher incomes, better access to education and health. Higher incomes enable migrants to send remittances to original households to meet their daily needs (UNDP, 2009). Internal migrants and accompanied remittances that migrants send back home constitute an important part of the economy in developing countries (De Janvry & Sadoulet, 2016). World Bank (2020a) reports that the number of domestic migrants is about two-and-a-half times as many as that of international migrants. For the poorer families, especially from under-developed rural areas, migration to urban areas may be the path out of poverty (UNDP, 2009).

Receiving internal remittances has been demonstrated as an important instrument for rural households not only to meet daily needs but also to cope with shocks (De Weerdt & Dercon, 2006; Lucas & Stark, 1985; Rosenzweig & Stark, 1989). For example, in rural Tanzanian context, it is shown that rural households receive internal remittances in response to health shocks (De Weerdt & Dercon, 2006). Recently, there has been a profound increase in scholarly interest in mobile money[23] remittances generally as a shock-coping tool for rural households (Jack & Suri, 2014; Riley, 2018). However, researchers have paid little attention to whether rural to urban migrant workers are insured within the risk sharing network of remittances. This study attempts to address this gap by simultaneously observing the shock-coping mechanisms of both senders and recipients of remittances.

[23] Mobile money is an innovative person-to-person payment technology used for sending and receiving remittances. The technology has become widely used in developing countries in this decade.

Recently, the improvement of access to mobile phones has been seen in developing countries (UNDP, 2012). Among them, Bangladesh has seen a high growth in mobile penetration, which reached 87 percent[24] in 2017 (GSMA, 2018). Such recent proliferation of mobile phone networks has provided researchers with an innovative data collection method: mobile phone panel surveys. This low-cost method allows researchers to contact many remote and dispersed populations with a feasible logistics operation (Dabalen et al., 2016). A handbook of mobile phone survey prepared by the World Bank states that before the proliferation of mobile phone networks, it was almost impossible to conduct surveys of remote and dispersed village households and migrant workers in the city at the same time (Dabalen et al., 2016).

Bangladesh is a South Asian developing country with a large number of internal migrant workers moving from rural areas to the capital city (Dhaka). Many of them seek employment in the garment industry, whose exports account for most of the national exports. As the majority of those migrant workers do not have access to bank accounts (Bangladesh Bank, 2019), the primary mode of sending money back home had been self-carry or hand-carry by friends. After the emergence of mobile money[25] in 2011, however, many migrant workers have shifted to this quick, easy, and safe remittance tool—all it requires is access to mobile phones. Bangladesh has recently shown a dramatic increase in mobile money users, and this is true among migrant workers, too (Financial inclusion insights, 2018; Financial Inclusion insights, 2014).

To observe how migrant workers in the city and their original households back home respond to shocks, since 2018 in Bangladesh, we have collected household panel data through mobile phone surveys. Firstly, the research team conducted a baseline

[24] The figure is calculated based on the number of connected sim cards per population.
[25] In Bangladesh, mobile money is called ‘mobile banking’.

survey in person with around 700 migrant workers at garment factories in Dhaka. Then, the team contacted their home village households by mobile phone. Around 700 pairs of migrant workers and their original households have been interviewed for seven rounds in approximately every three months. The seven rounds' panel data enables me to analyze responses to shocks at both ends of remittances, and how mobile money is utilized in such transactions.

In 2020, the COVID-19 pandemic affected all countries and industries. Rural to urban migrant workers in developing countries are expected to be significantly affected by the pandemic, according to a report by the World Bank (World Bank, 2020a). Migrant workers have faced the closure of shops, offices, and factories and many of them have been fired or furloughed, according to the report. This can cause decrease of remittances to original village households and negatively affect the livelihood of the rural households.

Like other countries, Bangladesh is affected by the COVID-19 pandemic. The first cases of COVID-19 were reported on March 8th, 2020. To date, the cumulative number of confirmed cases is as many as 500,000,[26] which is the second worst in South Asia after India. Responding to the threat of the spread of COVID-19, on March 26th, the Bangladeshi government declared the national lockdown and imposed movement restrictions. This has caused major changes in the employment and livelihoods of migrant workers. On top of that, with the earlier outbreak of COVID-19 in Europe and the United States, export orders to garment factories from the western countries were suddenly cancelled or postponed. This also directly affected garment workers' employment and income.

[26] This is confirmed COVID-19 cases on December 17, 2020 from https://www.worldometers.info/coronavirus/#countries.

Unlike idiosyncratic shocks such as illness or loss of crops, the COVID-19 shock can be an aggregate shock to Bangladesh. Idiosyncratic shocks can be insured within a community or the family network. In contrast, aggregate shocks cannot be insured because if everyone is affected, the risk cannot be shared (Dercon, 2002). The pandemic as an aggregate shock is likely to affect both migrant workers and their original households at the same time. If so, workers and original households must have found it difficult to insure each other against the shock. It is less than clear how rural to urban migrant workers and their original households shared their risk amid the COVID-19 crisis. In terms of an aggregate shock in general, while how remittances sent from international migrants cushion original home against large adverse shocks such as hurricanes (Yang, 2008), and earthquakes (Suleri & Savage, 2006) has attracted scholarly attention, research activity on internal migration in this context is somewhat limited. To our knowledge, only a few studies including Gröger & Zylberberg (2016) have focused on internal migrant workers and their original households' responses to aggregate shocks. We aim to fill the gap.

The COVID-19 lockdown may have affected migrant workers in more than one way. Not only the decision on remittance behavior itself, but also the *mode* of remittances may have been affected due to the imposed movement restrictions. Under normal circumstances, by entrusting their earnings to an acquaintance who returns to their home village, migrant workers can send remittances to their original households. During the COVID-19 pandemic, physically transporting cash to the home villages proved difficult due to travel restrictions. In such a situation, to facilitate remittances, mobile money services—the technology allows one to remit money without hand-carry—may play an important role. However, to our knowledge, there is little research

exploring how mobile money services worked amid the COVID-19 lockdown. This research helps to clarify the role of mobile money during the pandemic.

By using the observations before the COVID-19 pandemic, we firstly show that to deal with idiosyncratic shocks, the migrant workers and their original village households share the risk through remittances. We find that when the other side faces idiosyncratic shocks, the workers and the original households send remittances to each other to help overcome the shocks. Further, it is revealed that for the workers, reducing remittances sent to family (remittances that would have been sent if there had been no shock to the workers) is the main shock coping strategy.

To show how the migrant workers and their original households respond to the COVID-19 shock, we proceed to use the observations before and after the COVID-19 pandemic and apply an event study approach. It is revealed that following a massive drop in income, the migrant workers attempted to smooth the effect of the shock by exploiting their main shock-coping strategy: reducing their remittances to their original households. We find that both the migrant workers and their village households reduced consumptions during the COVID-19 lockdown. In that sense, neither was successful in smoothing consumptions against the shock. However, it is implied that the workers and their original households jointly utilized the family network and smoothed the effect of the shock between the workers and their original households. Further, the mode of the remittances is shown to be affected by the lockdown. While remittances sent by hand-carry significantly decreased due to the travel restrictions, mobile money remittances remained stable. This suggests that mobile money played an important role to maintain the risk sharing network during the COVID-19 lockdown.

The main contribution of this study is to shed light on the mechanisms jointly used by migrant workers and their original households to smooth consumption

(between workers and their original households) in the context of a large aggregate shock. Though there is little empirical evidence on how the poor in developing countries use internal remittances to cope with aggregate shocks, Gröger & Zylberberg (2016) show that in the event of a strong typhoon, remittances sent from internal migrants outside the area of typhoon damage work as insurance for original households. McKenzie (2003) shows that during the Mexican peso crisis, while receipt of international remittances increased, receipt of internal remittances decreased for both rural and urban households. The study concludes that internal remittances showed a reduced role in smoothing risk during the aggregate shock, though the author admits that because of the data limitations (for example, the study lacks detailed data of internal remittances such as who sent money to whom or consumptions of senders and recipients), further study of the role of the family network in coping with aggregate shocks was prevented. In terms of the cases of international migrants, Yang & Choi (2007) and Yang (2008) find that rainfall shocks and hurricanes in Philippines, respectively, led to increase of receipt of international remittances. This study contributes to the literature by showing that, amid the COVID-19 crisis, though both migrant workers and original households failed in smoothing consumption, the workers and their original households shared the risk through remittances and smoothed the effect of the shock within the family network. This suggests that internal remittances showed a role of interhousehold risk smoothing against the aggregate shock.

Secondly, this study also contributes to the literature on migrant workers' shock-coping behavior. To our knowledge, few empirical studies have investigated whether internal migrant workers receive insurance from home households. The exceptions are De Weerdt & Hirvonen (2016) and Millán (2020). Their results are mixed; De Weerdt & Hirvonen (2016) show that original households did not bear

migrants' negative shocks in the context of Tanzania, while Millán (2020) shows that rural to urban migrants are insured in the context of Nicaragua. While the former suggests a unilateral risk sharing network, the latter proposes a bilateral risk sharing network. This study adds to the literature by providing empirical evidence that suggests bilateral risk sharing.

The third strand of related research examines how mobile money remittances facilitate shock-smoothing against several kinds of shocks. Jack & Suri (2014) show that mobile money helps smooth consumption against idiosyncratic shocks such as illness. Regarding weather shocks including droughts and floods, Riley (2018) finds that mobile money is successful in smoothing consumption against such shocks. In the last part of this chapter, we add to the literature by describing how mobile money remittances facilitated risk sharing within the family network amid the COVID-19 lockdown—a nationwide aggregate shock.

This chapter consists of the following sections. First, we cover the context of the emergence of mobile money services and the COVID-19 pandemic in Bangladesh. Second, we detail the outline of our survey and the data collected. Third, we present the empirical strategies. Then, we confirm the empirical results showing the responses to idiosyncratic shocks and the COVID-19 shock of the migrant workers and their original households. Finally, we conclude with a summary.

3.2. **Context**

3.2.1. Mobile money in Bangladesh

In Asian countries like the Philippines and Myanmar, mobile money service companies started operations in the 2010s. Nevertheless, the highest penetration rate of mobile money service has been observed in Bangladesh, where 45 percent of adults used mobile money in 2017 (Financial inclusion insights, 2018). Mobile money service

companies in Bangladesh started to operate in 2011 and the penetration rate quickly increased (GSMA, 2016). The proportion of adults accessible to mobile money was grown from 22 percent in 2013 to 45 percent in 2017 (Financial inclusion insights, 2018). Most of the adults (87 percent in 2017) in Bangladesh have access to mobile phones[27] and this probably helped the quick penetration of mobile money (GSMA, 2018). In contrast, bank accounts are owned by only 20 percent of the adults (GSMA, 2016).

Not many mobile money users in Bangladesh have their own mobile money accounts. If a person does not have a mobile money account, such a person can use mobile money with the support of mobile money agents. What one has to do is simply to contact a mobile money agent nearby requesting them to take such actions on one's behalf. The person who wants to receive the money can also just go to a mobile money agent nearby and receive the money. This is called an OTC (Over-the-counter) transaction. According to the Global Findex report 2017, less than half of the people accessible to mobile money had mobile money account (mobile money users rate: 45% vs mobile money account holders rate: 18%) (Financial inclusion insights, 2018). Regarding mobile money account ownership, the demographic group's difference between the urban and the rural population is small: 21 percent vs 17 percent. This is consistent with the existence of numerous rural to urban migrant workers; if senders use mobile money, recipients also have to use the technology. Otherwise, the recipients cannot receive money.

[27] GSMA (2014) explains the situation of mobile phone penetration in Bangladesh as follows: *"Bangladesh is a country ahead of its time in terms of mobile access. Despite being ranked as a low income country, mobile penetration levels are relatively high, even in rural areas".*

According to the data used in this study, 74.8 percent of the garment workers in the capital city who regularly send money to their home village households have at least once used mobile money in 2018 (n=7,983). Meanwhile, 46.9 percent had their own mobile money account. The figures are higher than those from the Global Findex report 2017. This can be attributed to the fact that the garment industry attracts internal migrant workers from across the nation[28]. Such migrant workers are more likely to be involved in remittances than other Bangladeshi people.

3.2.2. COVID-19 pandemic in Bangladesh[29]

In this section, we sum up the timeline of the COVID-19 pandemic in Bangladesh. The first case of COVID-19 in Bangladesh was confirmed on March 8th, 2020. Consequently, the government closed all the educational institutions on March 17th. On March 23rd, the Bangladesh government announced the closure of all public and private offices from March 26th (lockdown[30]). As planned, the nationwide lockdown was implemented on March 26th.[31] Initially, the lockdown had been planned to be in place until April 4th, but it was extended to April 11th. Further, the lockdown was extended for seven times and eventually continued until May 30th. The government had lifted the lockdown gradually by easing restrictions and reopening factories, markets, and offices with exception of educational institutes—in Nov 2020 the

[28] In Figure 3.3, the locations of migrant workers' home villages are shown. RMG workers in Dhaka are from all over the nation.

[29] The information related to the lockdown was drawn from the following websites. (i) https://tbsnews.net/coronavirus-chronicle/COVID-19-bangladesh/general-holiday-not-extend-further-state-minister-85870 (ii) https://spc.jst.go.jp/experiences/asiaplan/asiaplan_2032.html (iii) https://tbsnews.net/bangladesh/education/govt-orders-closure-all-educational-institutions-march-17-56947 (iv) https://www.business-humanrights.org/en/latest-news/bangladesh-500-garment-factories-reopen-amid-COVID-19-risks/ (v) https://www.aa.com.tr/en/asia-pacific/bangladesh-imposes-new-restrictions-on-public-movement/1828684

[30] The government called the lockdown "general holidays".

[31] People's movement were formally restricted but in fact they appeared to be able to hide and moved from the capital city to villages. As a result, the COVID-19 was quickly spread to the rural area from the capital city during the lockdown.

educational institutes are not yet allowed to reopen. In contrast, garment factories—the leading industry of Bangladesh—were reopened on April 27th.

During the lockdown, the government restricted public movement, but it seemed to be not successful. Inter-district and sub-district people's movements were formally restricted. Travel on water, rail, and air routes was banned and road-transportation was suspended. People were not allowed to go out from 8 p.m. to 6 a.m. The government declared a statement asking people to stay at home, except for the case of emergency medicine need, treatment, funeral, and else. However, some researchers argue that *"the lockdown and the social distancing strategy in a densely populated country of more than 165 million did not work"* (Shammi, Bodrud-Doza, Islam, & Rahman, 2020). *"Following the announcement of the lockdown, many people from the major cities, especially from Dhaka, started to leave the city by various means, including overcrowded public transport services" "in violation of the government instructions"* (Anwar, Nasrullah, & Hosen, 2020). Further, the researchers state that social distancing and staying at home are impractical and less effective for a country like Bangladesh that is massively populated with low-income people taking public commutes and living in the slums. In fact, though at the beginning of the lockdown most of the COVID-19 cases were found in the capital city, during the lockdown, COVID-19 had been spread all over the nation very quickly (Shammi et al., 2020). For all that, the government declared the withdrawal of the lockdown and moved to a flexible area-wise lockdown.

3.2.3. COVID-19 pandemic and garment industry in Bangladesh

The situation of the western economies strongly affects Bangladesh because more than 80 percent of Bangladeshi exports goes to Europe and the United States (The

Financial Express, 2020b)[32]. Even before the national lockdown on March 26th, 2020, Bangladeshi economy had been negatively influenced by the earlier COVID-19 outbreak in Europe and the United States (Anner, 2020). The strong relationship between the western economies and Bangladeshi economy was seen for their economic recovery as well. The western economy recovered from the COVID-19's first wave pandemic (once) in around May 2020 (German press agency, 2020). Though Bangladeshi exports showed a huge decline in April and May, the exports quickly recovered after June (a table of export values shown in Appendix 2.1).

In the western countries, the COVID-19 outbreak occurred in February 2020. The United States declared public health emergency on February 3rd, 2020 (AJMC, 2020). The first COVID-19 lockdowns in Europe were implemented in Italy on February 21st, 2020 (Metro, 2020).

As early as March 27th 2020, a report written by the Center for Global Workers' Rights of the Penn State World Campus summarized how the COVID-19 outbreak in the western countries affected Bangladesh through global garment supply chains (Anner, 2020). The demands for apparel declined drastically because clothing outlets were shut by lockdowns in the western markets. Brands and retailers moved quickly to suspend, cancel, or postpone production orders.

Responding to the quick decrease of production orders, Bangladeshi exports of garments in March 2020 fell 20.1% year-on-year, and the exports in April plunged 85.2%. The exports remained low in May and declined 62.0% (the table shown in Appendix 2.1).

[32] The garment industry contributes over 80 percent of the exports (Hossain, 2019).

The declining global orders amid the COVID-19 crisis threatened garment workers' lives and the government could not ignore their protest. Many of the workers experienced dismissal, furlough, back-pay, or partial payment of their salaries (npr, 2020; The Daily Star, 2020). On March 25, 2020, the Prime Minister of Bangladesh announced a $ 588 million stimulus package for the garment industry. She said the money would be used for providing the salaries and wages of workers (BenarNews, 2020). Nevertheless, the factory owners did not pay the full wages to the workers, nor did they pay the unpaid wages on time. Garment workers had become unable to support themselves in Dhaka without work and some of them returned to their home villages (World Economic Forum, 2020). Moreover, thousands of garment workers blocked streets or highways at a protest demanding their unpaid wages (Reuters, 2020a). In response, Bangladesh government warned that it would sue factory owners that had not completed the payments of March wages (Reuters, 2020b). In addition, it has announced that it will pay at least 60% of April salary to the workers of the temporarily closed factories (The Financial Express, 2020c). After all, on April 27th, the government accepted garment factories to resume operation and the workers returned to work (Aljazeera, 2020).[33]

Meanwhile, the western economy had gradually recovered from the chaotic situation caused by the first wave COVID-19 pandemic. Italy ended its national lockdown in May 2020 (German press agency, 2020). Britain also began easing its lockdown in May (BBC News, 2020).

After the recovery of the western economy and the resume of operation of the garment factories, Bangladeshi exports of garments recovered quickly. The fall in June

[33] Among the migrant workers of our samples, approximately ten percent of them left Dhaka (and did not come back to Dhaka within our survey period) between mid-March and August 2020.

2020 was 11.1 percent year-on-year. The magnitude of the fall became remarkably small compared to the 62.0 percent fall in May. In July, the fall was 2.1 percent year-on-year. In August, the exports showed a sharp rebound of 45.3 percent year-on-year growth (a table of Bangladesh exports' monthly values shown in Appendix 2.1).

3.3. **Data**

3.3.1. Surveys

3.3.1.1. Outline

To investigate how people responded to the spread of COVID-19 and the nationwide lockdown, during and after the COVID-19 crisis, we conducted follow-up surveys on the household panel of both the migrant workers and their original households. There are seven rounds of the panel covering two years from October 2018 to August 2020, five rounds before and two rounds during and after the COVID-19 national lockdown. Except for the initial round,[34] the surveys were conducted by phone. The mobile phone surveys allowed us to continue interviews with the respondents even during the COVID-19 national lockdown.

As outlined in Table 3.1, the surveys, which have been originally conducted for another project ("EduMatch project")[35] since 2017, were carried out according to the following procedure. Firstly, we began conducting a pre-baseline survey in December 2017. Secondly, we started conducting a baseline survey in October 2018. Subsequently, we started multiple rounds of follow-up surveys from April 2019. Until

[34] The project team contacted the Dhaka respondents in person in the pre-baseline survey and the baseline survey. The project team continued contacting them through mobile phone in the follow-up surveys. The project team contacted the village respondents by mobile phone in both the baseline survey and the follow-up surveys.

[35] With Tomoya Matsumoto and Yukichi Mano, I run the project. The main purpose of the project has been to conduct a field experiment to encourage migrant workers' educational investment. The surveys have been administrated by me. My contribution for the project has been as follows: conceptualization, methodology, investigation, project administration, and funding acquisition.

August 2020, we have conducted six rounds of follow-up surveys. In the following sections, we explain each component of the surveys in details.

An important feature of our surveys is that we conducted interviews with both the Dhaka workers and their original households in the home villages. In the literature, researchers typically interview village households when they are interested in remittances sent to the households from someone living far away such as migrant workers (for example, De Weerdt & Dercon, 2006; Jack & Suri, 2014). Thereby, migrant workers' shock-coping behaviors has been rarely reported. In contrast, our surveys can observe the migrant workers' responses against shocks in their original households or vice versa. This feature allows us to answer some important questions on the risk-coping mechanisms of the family network. Do village households support the workers in the capital city when the migrant workers face idiosyncratic shocks? What if both migrant workers and their original households face a common shock such as the COVID-19 shock?

3.3.1.2. Pre-baseline survey

To create a list of garment workers, we conducted the pre-baseline survey at 13 randomly selected factories[36] from garment factories in Dhaka,[37] the capital city of Bangladesh. Creating the list of garment workers was necessary because we aimed to conduct panel surveys to the garment workers who had migrated from outside of the

[36] We used the factory list of the BGMEA (Bangladesh Garment Manufacturers and Exporters Association) website (https://www.bgmea.com.bd/) and selected the factories randomly from those which had more than 500 workers (we did not include small factories in the pool because we wanted to secure a certain number of samples from each factory). However, one should not interpret that those randomly drawn factories represent the garment factories in Dhaka. Those factory managements that rejected our request of conducting surveys to their workers are not included in the 13 factories. Obviously, the factory managements that continue to support the project team do not represent the garment factory. Although, at least, we conducted the sampling of factories in a transparent manner.

[37] Most of the factories are located in Gazipur, which is a town next to Dhaka. For simplicity, when the word "Dhaka" is used, it may include Gazipur in this study.

capital city. To do so, we needed a list of garment workers with the information of where they were from. In the pre-baseline survey, we collected a list of basic information (i.e. household structure, age of children) on about 6,318 workers and their original village families. We used systematic sampling at each factory and interviewed the randomly selected garment workers.[38]

3.3.1.3. Baseline survey

Using the list of 6,318 garment workers obtained in the pre-baseline survey, we conducted the baseline survey to 740 families of migrant workers since October 2018. From 6,318 workers, we selected 1,154 migrant workers who regularly sent remittances to their original households and attempted to contact them by mobile phone.[39] As a result, 740 families responded and accepted to be interviewed in the coming surveys.[40]

740 samples consist of the families in which both workers and original households responded to the baseline survey, those in which only workers responded, and those in which only original households responded. Namely, while 655 pairs of the migrant workers and the original households answered the survey, for some families, only one of the two sides answered. As a result, 723 migrant workers and 672 original households responded to the survey. Thus, in total, we were successful in conducting

[38] The number of samples drawn from each factory is calculated based on the number of workers working in each factory. Namely, at a large factory we interviewed a relatively large number of workers while at a small factory we interviewed a relatively small number of workers. As a result, the minimum number of samples from each factory is 137 and the maximum is 1140.

[39] The detailed process for selection of 740 families, which was for checking eligibility for the field experiment of the EduMatch project, is shown in Appendix 2.2.

[40] The reasons why around 400 families were dropped is as follows: (i) the subject did not answer the survey phone, (ii) the phone number was no longer used, (iii) the subject refused to cooperate with the survey, (iv) the worker had already finished migrating and returned to his or her village home. (v) the subject had called his or her village family to the capital city, and lived together when the survey was conducted. (vi) there were errors in the answers from the pre-baseline survey, and subjects were not actually eligible for the EduMatch surveys (for example, the one was not from outside of the capital city).

the baseline survey to 740 families, though for some, we could only contact either the migrant workers or the village households.

From both the Dhaka workers and the village households, we collected a number of the basic socio-economic information. When we collect the information of flow of funds such as income, consumption, and remittances, for most of the variables, we asked about the information of the last 30 days from the interview dates.

3.3.1.4. Follow-up surveys

The migrant workers and their original households answered the follow-up surveys for up to six times. The timings of the follow-up surveys are displayed in Table 3.1.

The migrant workers of our sample occasionally go back to their home villages and stay there for a while. Some of them decided to leave the capital city and moved to their home villages during the survey period. All of those may create missing observations and affect our regression results. Thereby, we discuss how we treat the issue.

As for round 1-5, if a migrant worker answered that he/she is not in the capital city, the surveys for the migrant workers (hereafter, 'Dhaka survey') were not conducted to that person. Thus, when the Dhaka workers went back to their home village, attritions of the data from the Dhaka surveys occur.

In contrast, whether the Dhaka workers left Dhaka or not does not matter for conducting the surveys to the village households (hereafter, 'village survey'). Thus, village surveys' attritions only include missing values due to no-response to our mobile phone surveys. In the regressions, we attempt to treat those attrition problems by the inverse probability weighting model.

To know how the COVID-19 shock influenced the migrant workers' decision on where to work, at round 6 (July-August of 2020), we collected information on where the migrant workers live. At that time, we conducted the survey including those who returned to their original village. When we contacted the migrant workers and found that they are not in Dhaka anymore, we asked when they had left Dhaka. Thus, for the migrant workers who answered the survey of round 6, we have the information whether the migrant workers left Dhaka or not and when they left Dhaka.

There is another type of information that was supplementarily collected. At round 2 and round 6, in addition to the last 30 days, we collected the information of the last 31-60 days. This is to make up for the information when the surveys interval was too long. The information collected as such is money inflow, money outflow (i.e. remittances), and income.[41]

3.3.1.5. Definitions of migrant workers and original households

To observe remittance behavior between migrant workers and their original households, in the surveys from the baseline surveys, we contacted the garment workers who satisfied following two conditions. Firstly, one must be a person who regularly sends remittances to a household outside of Dhaka. Secondly, because of the nature of the project, one must be a person who send remittances for supporting students[42] in the household outside of Dhaka. Thus, the garment workers who met those conditions are defined as 'migrant workers' in this study.

[41] Figure 3.1 shows the interview dates for those variables (money inflow, money outflow, and income). As for the observations for those asked about last 31-60 days, the interview dates are defined as 31 days before the actual interview date. Meanwhile, as for the variables with no supplementarily collected data such as consumptions, the interview dates are shown in Appendix 2.3. Those variables' number of observations are smaller than those shown in Figure 3.1.

[42] More detailed information is found in Appendix 2.2.

‘Original households’ (or village households) in this study is defined by the definition of migrant workers. Thus, households (outside of Dhaka) to which the migrant workers regularly send remittances for supporting students are defined as original households. Recall that we first contacted migrant workers and then contacted their original households (to which the migrant workers send remittances regularly). It is worth noting that approximately 20 percent of the original households’ household heads are mothers, fathers, brothers, or sisters *in law* of the migrant workers (shown in Table 3.2). Meanwhile, approximately 70 percent of the original households’ household heads are mothers, fathers, brothers, or sisters of the migrant workers. This indicates that some of the migrant workers regularly send remittances to support someone in the households whose heads are their relatives in law. This occurs because our definition of original households does not always mean a household that migrant workers were born in. Because we aim to explore risk sharing mechanism through remittances, we defined migrant workers based on their remittance behavior.

Naturally, the definition of migrant workers and original households are slightly different from those in previous studies. The previous studies firstly conducted sampling of “original households” in rural areas and subsequently searched “migrant workers” from the pool of their sample households that researchers have the information such as consumptions (for example, De Weerdt & Hirvonen, 2016; Millán, 2020). Thereby, it is expected that the migrant workers in the previous studies send less-amount or less-frequent remittances than those in our study. The differences of the definitions of migrant workers and original households may affect results and implications. In conclusion, we argue this in more detail.

3.3.2. Dataset, summary statistics, and attritions

The dataset used in this study consists of 723 pairs of Dhaka households and village households.[43] Those are the households that answered the surveys at least once in round 0-4 (the baseline survey and the follow-up surveys of round 1-4). The data collected from round 0 to round 4 is the information before the COVID-19 pandemic. Thereby, the data includes at least one observation before the COVID-19 pandemic for all the 723 pairs of households, respectively. During the period of the fifth-round survey (March 20, 2020 to May 16), the COVID-19 lockdown was implemented on March 26th, 2020. After the end of the lockdown on May 30th, the sixth-round survey was conducted from July 20th to August 30th. The overview of our sampling process is shown in Figure 3.2.

While a typical survey data has characteristics of only one side, the unique data used in this study has the information of both sides: the migrant workers and their original village households. This approach of the surveys has become feasible with the spread of mobile phones and the emergence of mobile phone survey. It would be expensive and logistically difficult if we conduct surveys in person to both migrant workers and their original households because the project team needs to visit both people in the capital city and those in the rural area. In Figure 3.3, locations of the original households and those of the garment factories that the migrant workers worked for are shown.

Interview dates for the surveys for the migrant workers (hereafter, 'Dhaka survey') and those for the original households (hereafter, 'Village survey') are displayed in Figure 3.1. The bins used in our event study approach are also displayed.

[43] This is decreased from 740 families that answered the baseline survey. For 17 families, we could only contact either the migrant workers or the original households during the surveys of round 0 to 4. As we are interested in pairs of migrant workers and original households, the families of which we could obtain responses only from one side were dropped.

One can see that the project team conducted a survey approximately every three months. This feature of our surveys made it possible for us to use an event study approach in this study.

Having the information of both the migrant workers and the original household every three months is an advantage that enables us to gain the deeper understanding of the risk sharing mechanisms through the family network. However, there is a drawback. Because we attempt to contact both the workers and the village households over the phone simultaneously, it becomes more difficult to construct the complete panel data of the pairs of the workers and their original households. Moreover, to conduct interviews every three months, we need to contact the respondents within a short period. If a respondent does not answer the phone in a timely manner, the next survey would come soon. Indeed, some households did not respond in the baseline survey, though they answered the phone in the following surveys. This drawback created some missing observations in the baseline survey.

We design the questionnaires of the follow-up surveys so that we can recover some of the missing information due to the failure of conducting interviews in the previous surveys. For instance, as we mentioned earlier, some households did not respond in the baseline survey. In such cases, to form the baseline characteristics, we replaced missing values with those reported at the closest survey (for example, if a household did not answer the baseline survey and answered round 1 follow-up survey then we replace missing values with those reported at round 1). We applied this

approach only to time-invariant characteristics such as age, gender, and educational attainment of household members.[44]

3.3.2.1.Attrition of migrant workers during and after COVID-19 crisis

Because of the nature of the dataset, there are some types of attritions. Since attritions could affect our regression results, we discuss their handlings. We define four groups of the sample migrant workers shown in Table 3.2. Firstly, we consider a group of workers (called Group 1) with whom we had at least one interview between March and August 2020 (round 5-6 survey, meaning during and after the COVID-19 pandemic). The workers of Group 1 gave us the complete information required for our regression analyses (meaning at least one observation before the COVID-19 shock and after the COVID-19 shock). Secondly, Group 2 is the workers to whom we failed to conduct interviews in the surveys between March and August 2020, accounting for 8.1 percent of the samples. Thirdly, the Group 3 samples are the migrant workers who had left the capital city before February 2020 (meaning before the COVID-19 pandemic).[45] Lastly, Group 4 represents the migrant workers who left the capital city after the arrival of COVID-19. Namely, Group 3 and 4 consists of the migrant workers who left Dhaka. Group 3 and 4 account for 7.3 percent of the samples. In total, the attrition rate for Dhaka household surveys is 15.4 percent.

Conditioning on the attrition status of the migrant workers, we divide the 723 families into four groups in Table 3.2, which illustrates their baseline characteristics.

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[44] To form the most accurate baseline characteristics, we also applied this approach to some baseline characteristics such as values of asset holdings and land holdings. For example, if a household in the 732 households did not answer the baseline survey and answered the first follow-up survey, the baseline characteristics such as the value of asset holdings is recovered with the information obtained at the first follow-up survey.

[45] This means that they had left Dhaka between October 2018 and February 2020. If a migrant worker left Dhaka and went back to his/her home village, naturally we cannot conduct an interview with him/her as a migrant worker. Thus, this creates a missing observation.

For brevity, Table 3.2 illustrates only a part of 49 characteristics used in this study. The full list of the baseline characteristics is shown in Appendix 2.4. Though Table 3.2 displays only a part of the baseline characteristics, the F-stat of the joint significance is calculated with all the variables shown in Appendix 2.4.

The attributes of Group 1 (complete cases) are different from Group 2 and 4. The results of F-tests of the joint significance indicate that there are statistically significant differences. However, it is worth noting that the comparison between Group 2, 3 and 4 reveals that those groups are not different (results of t-tests and F-tests are not shown for brevity). We therefore move to treat Group 2, 3, and 4 as a single group of attrition.

Table 3.3 is the simplified comparison table constructed based on the response of the Dhaka respondents. Like the previous table, only a part of the baseline characteristics is displayed (the full list is shown in Appendix 2.5). The baseline characteristics of the complete cases and the attrition cases (Group 2 to 4 are integrated) are compared. As expected, the result of F-test of the joint significance indicates that there are statistically significant differences. Again, like the previous table, the F-stat is calculated with all the variables shown in Appendix 2.5.

3.3.2.2.Attrition of village households during and after COVID-19 crisis

Next, we compare the baseline characteristics of the complete cases and the attrition cases of village respondents. Table 3.4 is the comparison table (like the previous tables, only a part of the baseline characteristics is displayed; the full list is shown in Appendix 2.6). Analogically, when a village household answered surveys at least once between March 2020 and August 2020, the household is counted as a

complete case. The attrition rate of the village household surveys is 7.7 percent.[46] Between the complete cases and the attrition cases of the village households, a significant difference is found by the joint F-test. Again, like the previous tables, the F-stat shown in Table 3.4 is calculated with all the variables shown in Appendix 2.6.

3.3.2.3. Inverse probability weighting approach

As seen in Table 3.3 and 3.4, for both the Dhaka respondents and the village respondents, statistically significant differences between the complete cases and the attrition cases are found. To treat the possible attrition bias, we utilize the inverse probability weighting approach for the regressions through which we attempt to estimate the responses to the COVID-19 pandemic. 49 variables listed in Appendix 2.4 (which are the same set of variables shown in Appendix 2.5 and 2.6) are used for calculating weights. The weights calculated based on the attrition of the Dhaka respondents are used for the regressions that take the variables of the Dhaka households as the outcome variables. Similarly, the weight calculated based on the attrition of the village respondents are used for the regressions that take the variables of the village households as the outcome variables.[47]

3.4. **Study design**

3.4.1. Empirical strategy

3.4.1.1. Risk sharing through family network before COVID-19 pandemic

[46] One can see that the rate is close to that of the pure attritions in Dhaka household surveys. As seen in Table 3.2, Group 2's attrition rate is 8.1 percent.

[47] In the regressions for the Dhaka households, attritions including those due to the workers who went back to villages are adjusted by the inverse probability weighting approach. Greater weights are given to the workers whose characteristics are similar with those who went back to the villages. Thereby, the regressions give estimates of economic activities that the workers would have taken if they had not returned to the villages. In contrast, in the regressions for the village households, the weights given by the inverse probability weighting approach only address attritions due to no response. The return to the villages by the migrant workers does not create attritions in the village surveys. Thus, the regressions give estimates of economic activities by taking into account the return of the migrant workers.

The first goal of this study is to test whether the Dhaka households and the village households helped each other through remittances when they faced idiosyncratic income and health shocks before the COVID-19 pandemic. We test this by using the observations before December 2019 so that we can avoid using the data possibly affected by the COVID-19 shock. Later, we compare the results with those obtained from the similar analysis using the data after the COVID-19 shock.

The first empirical model to estimate responses of the Dhaka households and the original households to shocks in the Dhaka households is described as the following equation:

(1) $y_{tbih} = \beta_1 Shock_{1_{tbih}} + \beta_2 Shock_{2_{tbih}} + \omega_t + \gamma_b + \mu_h + \epsilon_{tbih}$

where y represents outcome variables of Dhaka household h of family h[48] in the last 30 days, such as remittances received from their original households, remittances sent to their original households, and consumption per capita of Dhaka household. The subscripts t, b, and i correspond to the interview year t, two-month season b, and interview date i. To control for time effect, we consider the year effects, ω_t, [49] and the two-month season effects, γ_b. The six bi-monthly seasonal dummy variables respectively represent January and February, March and April, May and June, July and August, September and October, and November and December. μ_h capture household fixed effects—or it could be expressed as family (that consists of a Dhaka household and an original household) fixed effects. $Shock_{1_{tbih}}$ is a dummy variable that takes one if due to health problems, any of Dhaka household members (of family h) could not work for more than seven days in the last 30 days since the interview date i

[48] Letter h represents a family that includes a Dhaka household and a village household.
[49] The year dummy takes one for October 2019 to September 2020. It takes zero for October 2018 to September 2019. we define the year dummy in this way because the baseline survey started in October 2018.

(hereafter, 'type 1 shock dummy'). $Shock_2$ is a dummy variable that takes one if Dhaka household (of family h) experienced any shocks, which may cause a financial burden, of the following in the last 30 days since the interview date i: back pay, loss of job / employment, loss due to long term strikes and other political programs, death of earning members, and loss due to arrest/ detention of household members (hereafter, 'type 2 shock dummy').

The second empirical model, which is analogous to the first one, to estimate responses of the original households and the Dhaka households to shocks in the village households is described as the following equation with the mild abuse of notation:

(2) $y_{tbih} = \beta_1 Shock_{1_{tbih}} + \beta_2 Shock_{2_{tbih}} + \omega_t + \gamma_b + \mu_h + \epsilon_{tbih}$

where y represents outcome variables of village household h in the last 30 days, such as remittances sent from migrant workers and consumption per capita. Again, the subscripts t, b, and i correspond to the interview year t, two-month season b, and interview date i for the village interviews. The date of the village interviews can be different from that of the Dhaka interviews.[50] The definitions of γ_b, ω_t, μ_h are analogous to those used in the equation (1). $Shock_{1_{tbih}}$ is a dummy variable that takes one if due to health problems, any village household members (of family h) could not work for more than seven days in the last 30 days. While the definition of the type 1 shock dummy of equation (2) is the same to that of equation (1), the definition of the type 2 shock dummy is slightly different. This is because the shocks that bear financial burdens are different between urban households and rural households. For example, there is no back-pay in rural areas, meanwhile, there is no crop loss in urban areas. Thus, $Shock_{2_{tbih}}$ is a dummy variable that takes one if village household experienced any

[50] The mean difference of the dates of the Dhaka interviews and the village interviews is as small as approximately six days.

shocks, which may cause a financial burden, of the following: loss of crop / domestic animals / any goods due to unexpected shocks, loss from family's business failure, death of earning members, loss due to arrest / detention of household members.

In equation (2), note that there is a mild abuse of notation; the definitions of the variables are different between equation (1) and (2). While all the variables in equation (1) are constructed from the interviews with the Dhaka households, all the variables in equation (2) are constructed from the interviews with the original households.

3.4.1.2. Risk sharing through family network amid COVID-19 aggregate shock

The main goal of this study is to analyze the response of our sample families—both Dhaka and village households—to the COVID-19 shock by using an event study approach. The empirical model for our event study is described with equation (3) for the Dhaka households and equation (4) for the village households, respectively. The equation for the Dhaka households is described as the following equation:

(3) $y_{tbih} = \sum_{k=-3}^{k=3} \beta_k E_k + \omega_t + \gamma_b + \mu_h + \epsilon_{tbih}$

where y represents outcome variables of interest of Dhaka household h. Again, the subscripts t, b, and i correspond to the interview year t, two-month season b, and interview date i for the Dhaka interviews. The definitions of γ_b, ω_t, μ_h are analogous to those used in the equation (1). E_k are event dummy variables that takes one if the dates of Dhaka interviews are within the specific periods surrounding the lockdown implementation (March 26th, 2020). The window of the analysis is October 2018 to August 2020, which is equivalent to [-542,158] days around the lockdown implementation date. E_{-3}~E_3 respectively represent the periods of the following: [-

542, -211], [-150, -91], [-90, -31], [-30, +30], [+31, +90], [+91, +150], [+151, +158][51]. Thus, the reference period is the [-210, -151] days before the lockdown implementation date (October 27, 2019 to December 26, 2019). The estimated coefficients on the E_k dummies should be interpreted as the effect of being in (for example) the [+31, +90] days after the lockdown implementation (E_1) as compared to the [-210, -151] days before the lockdown.[52]

Notice that E_0 takes one for the period of [-30, +30] instead of [0, +60]. We defined the event dummies in this way because even before the lockdown implementation, Bangladeshi economy had been strongly affected by COVID-19. The garment industry in Bangladesh is sensitive to any changes in the western countries. As seen in Section 3.2.3, right after the occurrence of the COVID-19 crisis in the western countries in February, Bangladeshi garment factories had faced the adverse shock due to numerous order cancels and postpones from major apparel brands of Europe and the United States. Thus, the garment factory workers' employment status and income are likely to be negatively affected already before the lockdown implementation. If so, by defining [0, +60] as the event period zero, one would include such negative shocks occurred in the early stage of the COVID-19 crisis in the pre-trend (E_{-1}). To avoid such contaminations as much as possible, E_{-1} and E_o are defined as [-90, -31] and [-30, +30] respectively.

Our event study should not be interpreted as a causal inference because our sample households' observations do not have counterfactual comparisons observed at the same period. This is because the COVID-19 shock affected all the sample

[51] The estimates of E_3 is not shown in the results of event study because the period is too short. The number of observations of this period is too small for having a meaningful estimate.

[52] Note that most of the outcome variables capture activities of the last 30 days from the interview dates. Thereby, for example, a figure reported at an interview conducted on March 26th, 2020 is equal to the activity of [-30, 0] days relative to the lockdown implementation.

households. That said, at least the comparisons are conducted within each household. Moreover, we can test the validity of our event study by checking the pre-trend. Namely, if there is an estimate that is significantly different from the reference level in the periods before the COVID-19 shock, then it is arguable that removing confounding factors by controlling ω_t, γ_b and μ_h is insufficient to discuss what we obtained is descriptive evidence. In the next section, when we interpret the results of the event study, we consider whether a pre-trend is found or not in each regression.

To use an event study approach for analyzing the responses of the village households to the COVID-19 shock, the fourth empirical model is described as the following equation with the mild abuse of notation:

(4) $y_{tbih} = \sum_{k=-3}^{k=3} \beta_k E_k + \omega_t + \gamma_b + \mu_h + \epsilon_{tbih}$

where y represents outcome variables of interest of village household h. Again, the subscripts t, b, and i correspond to the interview year t, two-month season b, and interview date i for the village interviews. The definitions of γ_b, ω_t, μ_t, and E_k are analogous to those used in the equation (3). E_k are event dummy variables that takes one if the dates of village interviews are within the specific periods surrounding the lockdown implementation. The window of the analysis and the reference period are the same to that in equation (3).

Again, in equation (4), there is a mild abuse of notation; the definitions of the variables are different between equation (3) and (4). While all the variables in equation (3) are constructed from the interviews with the Dhaka households, all the variables in equation (4) are constructed from the interviews with the original households.

3.5. **Empirical results**

3.5.1. Risk sharing through family network before COVID-19 pandemic

The first aim of this study is to answer the following question: do migrant workers and their original households in Bangladesh share the risk against idiosyncratic health and income shocks? We examine this question by observing behaviors of both sides of rural to urban migration: migrant workers and original households. The results are shown in Table 3.5. All the regressions include household fixed effects and a year dummy. Bi-monthly seasonal dummy variables, which takes the value of one in their respective bi-month, control for seasonality. In the regressions for the Dhaka households, standard errors are clustered at combinations of factory, year and bi-month. The regressions have 97 factory-by-year-by-month clusters. In the regressions for the village households, standard errors are clustered at upazila-level.[53] The regressions have 230 upazila clusters.

We begin with interpreting the results for the regressions using the information observed by the Dhaka households. By looking at Column (1)-(2), one can find suggestive evidence that the Dhaka workers received remittances from their home village household when they faced health shocks. The estimates of the coefficients for both the amount of remittances in column (1) and the likelihood of remittances in column (2) imply increase, though those are marginally significant (p-values are 0.127 and 0.162, respectively). Further, it is suggested that when the Dhaka workers face income shocks (type2 shocks which include shocks other than health shocks, such as job loss), the amount and the likelihood of receiving remittances from original households increase (shown in column (1) and (2)). Those are also marginally significant; p-values of the estimates for the amount and the likelihood are 0.138 and

[53] Upazila is a unit of administrative area in Bangladesh. There are 544 upazilas in the GIS data that is provided by OCHA (United Nations Office for the Coordination of Humanitarian Affairs). The reference year of the data is 2015. We use the GIS data for adding the location information to the Bangladeshi households in our data.

0.139, respectively. Notice that the mean values are low for those measures of receiving remittances by the Dhaka workers. This suggests that only when they faced shocks, they received remittances from their original households. Otherwise, they rarely received remittances from their original households. Further, from Column (3)-(4), one can see that the Dhaka workers received remittances from someone other than the original households when they faced unexpected shocks other than health problems.

We move to interpret the results for the regressions of the village households. Column (5)-(6) indicate that the village households received remittances from the migrant workers when they faced income shocks (shocks other than health problems). The village households regularly received remittances[54] (the mean probability is 0.769) of around 3,000 Taka[55]. Thereby, the estimates indicate that when they faced income shocks, both the amount and the probability of received remittances from the Dhaka workers increased by approximately ten percent. However, no significant increase on neither the amount nor the likelihood of received remittances from the Dhaka workers was found for health shocks. Meanwhile, the village households received a larger amount of remittances from someone other than the Dhaka workers when they faced health shocks. The estimated amount of the increase of remittances (278) is close to the mean value (432); this implies that only when the village households faced health shocks, they received remittances from someone other than the Dhaka workers. Otherwise, they rarely received remittances from someone other than the Dhaka workers.

[54] This is expected because in the sampling process, we selected the garment workers who answered that they regularly sent remittances to their original households as explained in Section 3.3.
[55] Taka is the currency of Bangladesh. As of December 21st,2020, 1 USD is 85 Taka.

Our aim in this section is to examine whether the Dhaka workers and their original households share the risk against idiosyncratic shocks. In particular, we are interested in whether the migrant workers' risk is shared with the original households. From the results of Table 3.5, we conclude that the Dhaka workers received remittances from their original households when they faced health shocks and income shocks. Further, it is shown that when the original village households faced health shocks, they did not receive extra remittances from the migrant workers. Meanwhile, in the event of income shocks, the original village households received extra remittances.

Next, we go one step further by examining remittance behaviors by senders' side, which is understudied in the literature—researchers have focused attention on remittances received by rural households. In table 3.5, column (9)-(10) and (13)-(14) illustrate how remittance behaviors of the Dhaka workers and the village households respond to idiosyncratic shocks. Column (9)-(10) indicate that when the Dhaka workers faced their own shocks, they reduced remittances that they would have sent if there had been no shocks. Both regression results for the amount and the dummy of the Dhaka workers' remittances strongly indicate that the Dhaka workers used reduction of remittances to cope with their own shocks. It is revealed that the magnitudes of the reduction of remittances from the Dhaka workers are larger than those of additional remittances sent to the Dhaka workers from their original households. Analogically, column (13) indicates that the village households reduced the amount of their remittances sent to the Dhaka households in the event of their own health shocks, though column (14) does not show any significant estimates of the responses for their own shocks.

To conclude our analysis on examining the risk sharing mechanism against idiosyncratic shocks, whether the Bangladeshi households could smooth their

consumption is tested in column (11)-(12) and (15)-(16). While column (11) and (15) show results for the regressions taking food consumptions as their outcome variables, column (12) and (16) display the results for the regressions taking total consumptions as their outcome variables.[56] In column (11) and (15), both for the Dhaka households and the village households, it is shown that food consumptions were successfully smoothed against idiosyncratic shocks. This is consistent with findings in the empirical literature (De Weerdt & Dercon, 2006; Townsend, 1994). Column (12) and (16) show that with respect to the total consumptions of both the Dhaka households and the village households, no statistically significant decrease of consumptions is observed in the event of idiosyncratic shocks. In particular, in the event of health shocks, the total consumptions significantly increased. This is because of increase of the health expenditure. In column (15), though a decrease of the food consumptions of the village household in the event of income shocks was observed at the 10 percent significance level, the magnitude is economically small (only 4 percent of the mean).

In summary, from column (9)-(16), firstly it is revealed that decreasing remittances that would have been sent if it were not for idiosyncratic shocks is an important tool for coping with idiosyncratic shocks. The instrument is mainly exploited by Dhaka workers, while village households are also likely to use it. Secondly, both Dhaka workers and village households are found to be successful in smoothing consumptions against idiosyncratic shocks.

3.5.2. Risk sharing through family network amid COVID-19 aggregate shock

[56] All the consumption measures listed in this table are nominal values.

From the previous analysis, we conclude that to cope with idiosyncratic shocks, the Bangladeshi migrant workers and their village households form the mutual insurance networks through remittances. In what follows, my aim is to answer the following question: how did the COVID-19 shock—an aggregate shock—affect the poor in Bangladesh and how did they respond to the shock? We display descriptive evidence of the COVID-19 lockdown shock to various aspects of economic activities of the migrant workers and those of their home village households. In particular, we are interested in their decisions on remittances and whether they could smooth their consumption successfully. We begin with looking at the shock to income of the garment workers, who experienced suspensions of factories for a month during the lockdown. We then examine the changes in remittances and consumptions. We conclude this section with studying how the COVID-19 lockdown affected the mode of remittances.

The figures shown in this section provide descriptive evidence from our event study. We rely on the empirical strategy described in Section 3.4. Equation (3) and (4) are used for the event study. Again, in the regressions for the Dhaka households, standard errors are clustered at combinations of factory, year and bi-month. The regressions have 97 factory-by-year-by-month clusters. In the regressions for the village households, standard errors are clustered at upazila-level. The regressions have 230 upazila clusters. We explore the change in the behavior of the workers and the village households around the date of the implementation of lockdown, which was March 26th 2020.

While the figures graphically display the estimates of the COVID-19 shock, at the same time, the figures provide visual tests of validity of our empirical strategy. Our empirical strategy is not for identification of causal relationships in a strict manner. However, like what researchers do in a difference-in-difference approach, one can

check whether significant pre-trends are observed or not. If one observes statistically significant pre-trend point estimates, one should not interpret the point estimates for the coefficients after the COVID-19 outbreak as solely representing the COVID-19 shock. Basically, when we interpret the estimates for coefficients of our event study, we rely on the graphs where we do not find any pre-trends.

3.5.2.1. COVID-19 Shock to income

The point estimates of the COVID-19 shock to the Dhaka households' income are graphically illustrated in Figure 3.4. It is revealed that the Dhaka households experienced a large decrease in their income at the period of [+31, +90]. The magnitude of the shock is around 3,000 taka which is roughly 20 percent point decrease considering the mean income. It is found that at the period of [+91, +150], income recovered to the pre-shock level. This is consistent with the fact that the lockdown was implemented for two months and garment factories had been closed for at shortest 30 days. The graph indicates that there is no statistically significant pre-trend.

3.5.2.2. COVID-19 Shock to remittances[57]

To study how the migrant workers respond to the drop of income, in Figure 3.5, we display the estimates of COVID-19 shock to remittances sent from the Dhaka households and received by the village households. Two measures of remittances are shown: amount of remittances and whether a village household received remittances from a Dhaka household within last 30 days from an interview date. Both variables are constructed from interviews answered by the village households.

[57] One may want to know whether sample households receive international remittances as during the lockdown, they might have received additional international remittances. In the surveys, we ask whether respondents receive international remittances for both the Dhaka workers and the original households, but very few reported receipt of internal remittances.

It is estimated that the amount of remittances from the Dhaka households significantly decreased at the period of [+31, +90]. Further, the estimates from the event study that takes the dummy of remittances sent from a Dhaka household suggest that likelihood of receiving remittances by village household decreased at the period of [+31, +90], though the estimate is not statistically significant. The estimates from the two measures of remittances imply that at the period of [+91, +150], the amount and the likelihood of remittances recovered to the pre-shock level. The point estimate of the decrease of remittances at the period [+31, +150] is around 2000 Taka. This is close to the estimated decline of the Dhaka households' income.

Next, to explore how the migrant workers coped with the COVID-19 shock, whether remittances sent to the Dhaka workers from the original households increased or not in the event of COVID-19 shock is tested. Figure 3.6 displays the results of our event study taking measures of remittances sent to the Dhaka workers from the original households as its outcome variables. One should notice that in the graph of the left-hand side, there is a significant pre-trend. Thus, the point estimates are not reliable. Although, both graphs—those show the results for the amount and the likelihood of receiving remittances from original households—make apparent that there was no increase of remittances from the original households in response to the COVID-19 shock.

Taking the results shown in Figure 3.5 and 3.6 together, it is suggested that cutting remittances was the main shock-coping tool for the migrant workers amid the COVID-19 shock. This is analogous to the results of our previous analysis on the shock-coping tools against idiosyncratic shock that occurs on the side of migrant workers. Moreover, the results from Figure 3.5 and 3.6 suggest that the adverse shock caused by the COVID-19 pandemic was larger for the migrant workers. Otherwise, it is expected

that transfer from the migrant workers to the original households, which is seen in the previous analysis of the responses to the original households' idiosyncratic shocks, would be observed. It is worth noting that the World bank also reports that the COVID-19 economic shock was, at least in a short-term, larger in the urban area compared to the rural area (World Bank, 2020b).

3.5.2.3. COVID-19 Shock to asset sales

To further examine whether the migrant workers used shock-coping tools other than cut of remittances, following the literature such as Fafchamps & Lund (2003), we test whether asset sales were the tool to cope with the COVID-19 shock. The results of our event study are shown in Appendix 2.7.[58] The total asset price of both the Dhaka households and the village households remained stable, though the pre-trends were not removed well. This suggests that there were no asset sales in response to the COVID-19 shock. We also test whether there are significant changes in other kinds of money inflow and outflow including borrowing and loaning shown later (not shown all the figures on money inflow or outflow for brevity). We find that cutting remittances is the largest in its magnitude as a tool to keep money in the migrant workers' possession.

3.5.2.4. COVID-19 Shock to consumption

We proceed to examine how consumptions of the Dhaka households and original households were affected by the COVID-19 shock. Figure 3.7 displays the results of the event study taking consumptions of the Dhaka households and the original

[58] The list of the items of assets are displayed in Appendix 2.9. Asset values are calculated based on self-reports. The questions are: i) Does your household have these assets now? ii) Report current value (=if the asset is sold today, how much will you receive?) in Taka.

households as the outcome variable, respectively.[59] Both results for the Dhaka households and the village households indicate that their consumptions decreased at the period of [-30, +30] and [+31, +90]. The Dhaka households' consumptions show a larger decrease at the period of [+31, +90]. This is consistent with the estimated decrease of their income at the period of [+31, +90].[60]

The results of the event study imply that both the Dhaka households and the village households were not successful in consumption smoothing against the COVID-19 shock.[61] In contrast, in our previous analysis, it is revealed that the Bangladeshi households in our sample could successfully smooth their consumption against idiosyncratic shocks. Such a contrast is reasonable because the COVID-19 shock was an aggregate shock, which affected both the Dhaka households and their original households almost at the same time—though the intensity of the shock in the urban area was likely to be larger than that in the rural area.

But was the risk sharing mechanism through the family network completely useless in the face of the COVID-19 shock? Though it was not successful in (intertemporal) consumption smoothing (nor providing full insurance) against the shock, our results imply that the risk sharing mechanism through the family network

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[59] We use consumptions which is not divided by the number of household members because this is useful to compare with remittances and other kinds of money inflows and outflows. In the Appendix 2.8, as a robustness check, we use consumptions per capita and test the decrease in consumptions. The implication of the graphs is basically the same to those of the total consumptions reported in the main text. The pre-trend of the consumption per capita for Dhaka households is slightly negatively biased. This can be partly attributed to the existence of the pre-trend in the number of children of Dhaka households. The graph providing the results of the event study of the number of children is reported.

[60] One may notice that at the pre-COVID-19 periods, the point estimates are already negative, though those are not statistically significant. This implies that the magnitude of the decrease of the consumption after the COVID-19 shock might be overestimated.

[61] While total consumptions were not smoothed, food consumptions were fully smoothed against the COVID-19 shock in both the Dhaka households and their original households. This is consistent with the literature such as McKenzie (2006) that shows reducing consumptions other than food consumption in order to smooth food consumptions is a major tool to cope with aggregate shocks. The figures of the event study of food consumptions are not shown for brevity.

was effective in smoothing consumptions between the migrant workers and their original households. The point estimates of consumption declines for the migrant workers and the village households are approximately -4000 and -4500 Taka, respectively. Recall that the point estimate of remittances cut by the migrant workers is approximately -2000 Taka. Thereby, roughly speaking, if there were no remittance cuts, the workers' consumptions would have been even lower; the consumption declines for the workers and the village households would have been approximately -6000 and -2500 Taka, respectively.[62] This allocation of consumptions between the workers and the village households is much more unbalanced than it really is. Thereby, it is suggested that the Dhaka workers and the village households jointly attempted to smooth consumptions against the COVID-19 shock.

There is a question remaining: why did the Dhaka households decrease their consumption in such a large magnitude? The magnitude of the decrease of the Dhaka households' remittances is roughly -2000 taka, while the magnitude of the decrease of their income is roughly -3000 Taka. This implies that most of the decrease of the income was covered by reducing the remittances. If so, the decrease of the Dhaka households' consumption seems unreasonably large. There may be another factor that made the Dhaka households reduce their consumptions. We proceed to analyze other kinds of money flows of Dhaka households that might have decreased.

3.5.2.5. COVID-19 Shock to borrowing and loaning behavior

To explore how the COVID-19 pandemic affected other kinds of money flows of the Dhaka households, we examine the change in borrowing and loaning behavior of

[62] We can consider the mean consumption at the baseline survey (10228 Taka for the Dhaka households and 12465 Taka for the original households) and express the declines of consumptions as percentages. Then, (-4000, -4500) becomes (-39%, -36%), while (-6000, -2500) becomes (-59%, -20%). The implication is unchanged. The results suggest that interhousehold consumption smoothing may be occurring through the interhousehold transfers.

the migrant workers. Figure 3.8 displays the results of the event study that takes measures of borrowing and loaning behavior as outcome variables. Borrowing behavior represents the money inflow that occurs when the Dhaka workers borrow money from someone who lives nearby.[63] When Dhaka workers borrow money from entities such as shops and microfinance institutions, it is included in loaning behavior.[64]

It is found that the COVID-19 shock made it difficult for the Dhaka households to borrow money in the local informal risk sharing network. Both the amount and the likelihood of borrowing money shows a sharp decline. Although we should note that the pre-trend for the event study of borrowing behavior is not removed well, the graphs make apparent that there was a sudden change in the local informal risk sharing network. On the contrary, the graphs of loaning behavior indicate that the environment of loaning market remained stable. Thereby, it is suggested that the decrease of consumptions of the Dhaka households is partly attributable to the shrink of the local informal borrowing market.

3.5.3. Mode of remittances amid COVID-19 lockdown

Last but not least, we proceed to answer an important question: how did mobile money services work amid the COVID-19 lockdown? In peacetime, for sending remittances, it is usual for Dhaka workers to travel with money and bring money by hand by themselves or ask friends or relatives to bring money. Based on our data collected before the COVID-19 outbreak (round 0-4), 21 percent of remittances were sent by travelling, while 77 percent of remittances (calculated by frequencies) were sent through mobile money. However, during the lockdown, moving between Dhaka and

[63] This can include money borrowed with interest. Also, when money lent to someone has come back, the money inflow is included in "borrowing".
[64] Pawning, using rent arrears, and other informal lending schemes such as ROSCA are also included.

their home villages were restricted. The restrictions of movement made it difficult for Dhaka workers to send remittances by travelling. In such a situation, mobile money could be the most reliable mean of remittances with a reasonable cost. Thereby, it is expected that during the lockdown, less remittances had been sent by travelling. To examine how important mobile money was for the migrant workers and their original households during the lockdown, we show descriptive evidence from our event study.

Figure 3.9 provides the point estimates of the COVID-19 shock to remittances sent from the migrant workers to the village households by modes. The upper half graphs show the estimates of the COVID-19 shock to the amount and the likelihood of mobile money remittances. The lower half graphs show the estimate of the amount and the likelihood of remittances by means of travelling and bringing by hand (in short, 'hand-carry remittance').[65]

From the lower half graphs, we find that the COVID-19 shock negatively affected remittances by means of travelling and bringing by hand. This is reasonable because the COVID-19 lockdown accompanied movement restrictions. From the upper half graphs, surprisingly, it is revealed that even under the conditions of the COVID-19 shock, remittances through mobile money remained stable in both the amount and the likelihood. Given that the COVID-19 shock decreased the Dhaka households' income, it would have been possible to reduce their remittances. The stability of their remittances will imply that mobile money services made it possible for the migrant workers to continue sending remittances even during the COVID-19 shock, though we

[65] Though the proportion (in frequency) is less than 1 percent, there are a few reports of remittances that used bank transfer, post office, and else. Those are included in the estimates of the graphs of the lower half".

cannot be conclusive on this point because we do not conduct a causal inference (of mobile money effect) in this study.

Nevertheless, because the travel restrictions were imposed during the COVID-19 lockdown, it is arguable that mobile money remittances facilitated consumption smoothing between the migrant workers and the original households. If mobile money services did not exist in Bangladesh, remittances sent from the migrant workers to the original households might have been even lower. The mean of the amount of hand-carry remittances is approximately 700 Taka and the estimated decline of hand-carry remittances is around -1000 Taka. This implies that hand-carry remittances almost disappeared during the COVID-19 lockdown (the same thing is suggested by the estimates on the likelihood of hand-carry remittances). Considering that the mean amount of remittances is approximately 3000 Taka, the decline in remittances amid the COVID-19 lockdown could have been even larger than the current estimate of -2000 Taka and could have been around -3000 Taka. This would have led to further decline in the village households' consumptions. Roughly speaking, if mobile money services were not available and the migrant could not send money, the consumption declines for the workers and the village households would have been approximately -3000 and -5500 Taka (recall that the current estimates are -4000 and -4500 Taka).[66] This allocation of consumptions between the workers and the village households is unbalanced than it really is.[67]

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[66] By considering the mean consumption at the baseline survey (10228 Taka for the Dhaka households and 12465 Taka for the original households), we can express the declines of consumptions as percentages. Then, (-4000, -4500) becomes (-39%, -36%), while (-3000, -5500) becomes (-29%, -44%). The implication is unchanged. The results suggest that interhousehold consumption smoothing may be facilitated by mobile money remittances as a tool of interhousehold transfers during the lockdown.

[67] As this is not a causal inference, those are likely to be overestimated. For example, if mobile money did not exist, the migrant workers might have returned to the villages to help the original households. As a result, consumption decline of the village households could have become smaller.

As this is not a causal inference, those estimates should not be understood as causal. The estimates can be overestimated or underestimated. For example, if mobile money did not exist, the migrant workers might have returned to the villages to help the original households. If this happened, without receiving mobile money remittances, consumption decline of the village households could have become smaller (thanks to supports from the migrant workers). Whether access to mobile money had a causal impact on the amount of remittances sent during the lockdown, and thereby the relationship between access to mobile money and interhousehold consumption smoothing is causal, have to be tested through a causal inference.

3.6. **Limitations**

There are some limitations in this study. Firstly, the event study analysis that we conduct should not be understood as a causal inference. Rather, we aim to interpret the results as descriptive evidence. If we attempt to understand the results as causal evidence, our empirical strategies of the event study have to satisfy the following assumption: by controlling ω_t, γ_b, and μ_h in equation (3) and (4), there is no more confounding factors. This is difficult to assume because our empirical strategy does not follow standard causal identification strategies such as a difference-in-difference approach. Although we make comparisons within each household by including household fixed effects, because the COVID-19 shock affected all the sample households of this study, we cannot compare a household with the COVID-19 shock and another household without the shock. Lacking such an effective comparison makes it difficult for us to call our event study as a causal inference. However, as seen in section 3.5, at least we can test whether a pre-trend is found before the COVID19 pandemic. Thus, we avoid using regression estimates that have a problem in the pre-trend. On top of that, the analysis on idiosyncratic shocks using equation (1) and (2) is

not suffered from this limitation. When a sample household faced an idiosyncratic shock, other households do not face the shock. The comparisons that we use include not only within households, but also between households. Thereby, it is arguable that the results obtained in section 3.5.1 (analysis for the period of before the COVID-19 pandemic) can be understood as causal.

Secondly, there is no discussion of how returning to home villages as a shock-coping strategy is utilized by migrant workers during the COVID-19 pandemic. A number of migrant workers selected to go back to home villages in response to deterioration of employment situation in Dhaka (World Economic Forum, 2020). Thus, going back home is apparently one of the common shock-coping strategy against the COVID-19 shock. However, in this study, we focus on shock-coping through remittances and the family network.

Thirdly, though our data has the information of both migrant workers and village households, there are some drawbacks. In particular, our surveys of the village side have a relatively small number of questions, partly because we have conducted all the interviews with the village households through mobile phone. It is more difficult to conduct long interviews through mobile phone compared to in-person interviews. Thereby, we made our village surveys as short as possible. As a result, there is some data limitations. For example, on the village side, we do not have income and detailed information of money inflows and outflows (other than remittances) such as borrowing and lending within the local community. If we have the information, we could have examined how the COVID-19 shock affected their shock-coping behavior within the local community and the results could have been integrated with the analysis of the family network.

3.7. **Conclusion**

In this study, we examined how migrant workers and their original households coped with the COVID-19 shock through the family network. To compare the risk coping strategy against the COVID-19 shock and that against idiosyncratic shocks (before the COVID-19 pandemic), we began our analysis with examining how the migrant workers and the original households shared the risk in the event of idiosyncratic health and income shocks. To analyze the risk sharing mechanisms, the previous literature has focused on received remittances by rural households (for example, De Weerdt & Dercon, 2006). A few recent studies examine whether migrants are insured against the shocks (De Weerdt & Hirvonen, 2016; Millán, 2020). The results are mixed; while one study (De Weerdt & Hirvonen, 2016) finds that migrants are not insured within the network, another study (Millán, 2020) finds that migrants are insured within the network. We add to the literature[68] and find that the migrant workers receive remittances from their original households when they faced health and income shocks.

The reason why those studies (including this study) obtain mixed results might be attributable to the differences of the definition of migrants, as suggested in Millán (2020). It is reasonable to expect that whether a migrant is insured within the family network depends on how close the relationship of the migrant and the home household is. In that sense, the definitions of migrants used in De Weerdt & Hirvonen (2016), Millán (2020), and this study use different definitions of migrants. In De Weerdt & Hirvonen (2016), anyone who has moved out of the baseline village are defined as

[68] An advantage of this study compared to the previous studies (De Weerdt & Hirvonen, 2016; Millán, 2020) in this context is the frequency of the surveys. While the two studies used annual remittances (which were obtained by asking respondents about their remittance behavior of the last 12 months), our surveys were conducted in approximately every three months (and asked about remittance behavior of last one month). By doing so, one can reduce recall errors of remittance behaviors and thus obtain estimates with smaller standard errors. On top of that, one can match timings of shocks with timings of remittances more accurately.

migrants.[69] Millán (2020) defines migrants as those absent for more than 9 months in the last 12 months, or people who have left more recently but have no plans to return in the short run, and who at the time of the follow-up were members of a new household. In this study, garment workers (in Dhaka) who answered our pre-baseline survey (December 2017) and told us that they regularly sent remittances to their original household[70] (among the garment industry workers) are defined as migrant workers. According to our record, the migrant workers sometimes go back to their home village and seem to stay there for some time. Thereby, the migrants (or the migrant workers) and their original households of Millán (2020) and this study seem to have a closer relationship than those of De Weerdt & Hirvonen (2016). This difference might affect the results of the tests conducted by each study.

On top of that, we find that cutting remittances to home is the main shock-coping strategy for the migrant workers against idiosyncratic shocks. To our knowledge, researchers have paid little attention to reducing remittances sent to family as a tool to cope with shocks. Interestingly, the magnitude of such reduction (in both the amount and the likelihood) was revealed to be larger than that of received remittances from their original households to offset one's additional financial burden caused by idiosyncratic shocks.

In our main analysis, using an event study approach, we proceeded to examine how migrant workers and their original households responded to the COVID-19 pandemic and jointly attempted to insure against the shock. Firstly, we confirmed that the migrant workers' income decreased amid the COVID-19 pandemic. It is revealed

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[69] The definition of "moving out" is not clear in the paper.

[70] Strictly speaking, to be included in our surveys, the workers also need to satisfy a few more things: 1) one needed to answer our baseline survey conducted in Dhaka in October 2018, 2) a student of a particular grade who was scheduled to take the exam was in the subject's village home (students who will be in the grade 4, 5, 7, 8, 10 in 2019).

that in response to the shock, the workers cut remittances that would have been sent if there was no COVID-19 shock. We do not find descriptive evidence that the workers received remittances from their original households in response to the shock. Because we do not observe significant changes in other kinds of money outflow, it is arguable that cutting remittances was the main tool to cope with the COVID-19 shock for the workers. This is analogous to the findings from our previous analysis about the idiosyncratic health and income shocks (of Bangladesh). The magnitude of cutting remittances in response to the COVID-19 shock is approximately four to five times that of remittances received in response to their own idiosyncratic health and income shocks.

We then examine how consumptions of the migrant households and the village households changed amid the COVID-19 shock. We find that neither was successful in smoothing consumptions against the shock. This is reasonable because the COVID-19 pandemic was likely to affect both almost at the same time. However, by taking into account the fact that money transfer from the workers to the village households was cut rather than increased, it is arguable that the shock to the workers might have been larger in magnitude than that to the village households. This is consistent with the argument that the COVID-19 economic shock was, at least in a short-term, larger in the urban area compared to the rural area (World Bank, 2020b). If the opposite is true, additional money transfer from the workers to the village households is expected to be observed (which was not observed in our analysis).

Taking the estimates on changes in remittances and consumptions together, it is suggested that the Dhaka workers and their original households jointly attempted to smooth consumptions against the shock. The point estimates of the event study indicate that there was about the same level of consumption reduction for the workers and the

village households. If the workers had not cut remittances to the village households, the workers' consumption would have been even lower. Thereby, it is implied that our sample families were successful in *smoothing* consumption between the workers and their original households—interhousehold risk smoothing—in response to the COVID-19 shock, though they were not able to intertemporally smooth consumptions. In contrast, McKenzie (2003) argues that internal remittances can only show a reduced role for coping with aggregate shocks. However, McKenzie (2003) could only show that in the event of the large aggregate shock (Mexican Peso crisis), the sample households received additional international remittances while they received reduced internal remittances. McKenzie (2003) admits that because of some data limitations (for example, no information of senders of remittances and no information of senders' consumptions), the study could not explore the role of internal remittances during the crisis more deeply. This study contributes to moving further towards a more comprehensive understanding of the roles of family networks in coping with aggregate shocks.

It is worth noting that our event study should not be understood as a causal inference. Because the COVID-19 shock affected all the sample households of this study, we cannot compare a household with the COVID-19 shock and another household without the shock. Lacking such an effective comparison makes it difficult for us to treat our findings of the event study as causal. This is one of the limitations of this study.

From the results of the event study, we can also see what happened after the COVID-19 lockdown in a short-term (up to three months after the end of the lockdown). We find that income and consumptions recovered quickly after the COVID-19 pandemic. Income of the Dhaka workers and consumptions of both the workers and the

village households showed recovery after the end of the lockdown, though one cannot necessarily attribute the recovery to the end of the lockdown.[71] In contrast, it is revealed that borrowing transactions by the migrant workers within the local network had not recovered, exhibiting a sharp decline. This implies that there was disruption in the local informal borrowing network due to the COVID-19 shock.

Finally, we proceeded to examine changes in the mode of remittances used by the migrant workers amid the COVID-19 crisis. As expected, due to the travel restriction imposed during the COVID-19 lockdown, we find that hand-carry remittances from the migrant workers significantly decreased. In contrast, mobile money remittances (both the amount and the likelihood) remained stable. This implies that even during the COVID-19 lockdown, the workers were sending mobile money remittances to the village if they decided it was necessary. Such risk sharing through the family network amid the COVID-19 crisis would not have been possible without mobile money due to the movement restrictions. Thereby, the results imply that if mobile money services did not exist in Bangladesh, the amount of money sent from the migrant workers to the original households amid the COVID-19 pandemic would have decreased further. That may have led to a further decline in the village consumption, though this hypothesis has to be formally tested by a causal inference.[72] This study shed light on such an important role that mobile money has played amid the COVID-19 pandemic.

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[71] As seen in Appendix 2.1, the national exports have also shown a quick recovery.

[72] For example, if migrant workers had no access to mobile money services, more workers could have decided to go back to their home villages (with violating the imposed travel restrictions) and physically brought money to their original households.

4. Conclusion & policy implication

This dissertation studies how risk sharing through the family network—remittances—can facilitate coping against shocks and how mobile money as a financial inclusion tool facilitates the risk sharing mechanism. Though risk sharing through the family network has attracted much scholarly attention (Fafchamps & Lund, 2003; Jack & Suri, 2014), the emergence of mobile money as an innovative tool of remittances in developing countries may have changed the way poor households manage shocks.

In the first main chapter, we examine whether mobile money services encourage investing in maternal health in the event of weather shocks including droughts and floods (idiosyncratic shocks). Using a rural Ugandan household panel data, we identify that use of mobile money have a shock-smoothing effect on investment in maternal health against weather shocks. In particular, we find that uptake of several types of delivery-related maternal care—facility delivery, delivery assisted by SBAs, and postnatal care—is supported by mobile money services to cope with droughts and floods. While the results of the heterogeneity analysis imply that floods are more harmful than droughts for the uptake of maternal care, the results indicate that mobile money is useful in coping against both droughts and floods. Moreover, our analysis about transportation mode to health facilities reveals that mobile money services help households in geographically challenging situation—in the event of floods—travel to health facilities. As expected, such an effect is not identified in the event of droughts. Thus, this study suggests one path through which mobile money facilitates maternal health investment; mobile money may ease the liquidity constraint when households face higher cost of traveling to health facilities because of the bad road condition during floods.

In the second main chapter, we examine how migrant workers in the capital city and their original households jointly coped with the COVID-19 pandemic—an aggregate shock—by exploiting the family network. Applying an event study approach to Bangladeshi household panel data, we show descriptive evidence on how the pairs of migrant workers and their original households responded to the aggregate shock. Firstly, we find that responding to the decline in income during the COVID-19 lockdown, the migrant workers cut remittances to their original households, which they would not have done if there had been no COVID-19 shock. As a result, both the migrant workers and the village households could not smooth consumptions against the COVID-19 shock and experienced similar amount of decline in consumptions. However, the results imply that the migrant workers and their original households jointly decided to smooth consumptions between each migrant worker and original household—interhousehold risk sharing through remittances. In this way, the migrant workers and their original households attempted to smooth consumptions against the COVID-19 shock within the family network. This implies that the family network showed a role of coping with the aggregate shock through interhousehold consumption smoothing. Further, we find descriptive evidence that if poor households in Bangladesh had no access to mobile money and thereby were not able to make any remittances, consumptions in the village households would have been even lower. While hand-carry remittances showed a decline during the COVID-19 lockdown, mobile money remittances remained stable. This implies that even during the COVID-19 lockdown, risk sharing through the family network was facilitated by mobile money.

Our findings offer several policy implications for financial inclusion, health care utilization, and the COVID-19 pandemic. Firstly, the findings of the first main chapter provide practical policy implications on financial inclusion and health care

utilization. This study provides evidence to governments, international bodies, and donors for supporting the spread of mobile money services that extend financial services to the world's poor. Health agencies are aware of the issue of the financial resource constraint in encouraging the poor to invest more in their health. This study provides evidence that mobile money adoption is effective in making households cope against sudden shocks such as climate hazards and seek a better healthcare.

The findings from the second main chapter might help policy makers better understand how the COVID-19 pandemic affect migrant workers in large cities and their original households in villages and how mobile money services help self-insuring against the shock. In particular, it is suggested that the economic downturn in urban area (or a lockdown in urban area) and subsequent decline in consumptions in urban area quickly leads to decline in consumptions in rural area through the risk sharing mechanisms within the family network—remittances. This can be beneficial in a sense that the adverse shock can be smoothed within the family network. Such a risk sharing behavior was possible because mobile money services are available in Bangladesh. We find that while hand-carry remittances decreased during the COVID-19 lockdown, mobile money remittances remained stable. This sheds light on the importance of mobile money as a tool of financial inclusion that helps poor households' self-insurance against the COVID-19 pandemic. Access to financial services is shown to enhance informal risk sharing against the COVID-19 pandemic. Having efficient informal risk sharing mechanisms is important for poor households in the absence of formal insurance system including public safety net. Thereby, financial inclusion should be further promoted in developing countries by governments and international bodies before emergence of the next large shock.

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Tables

Table 2.1. Public health facilities in Uganda

2. Types of health center (HC)	Area to cover	Target population	Definition in this paper	Notes
HCI	A village (or *Local Council I*)	1,000	Lower-level health facilities	HCIs comprise of village health teams which provide community-based preventive and promotive services.
HCII	A parish	5,000		HCIIs provide preventive and curative health services, outreach care, and emergency deliveries.
HCIII	A subcounty	20,000	Higher-level health facilities	This level of facilities can provide maternal health care of the quality recommended by WHO, which includes inpatient and laboratory services.
HCIV	A county	100,000		
HCV (general hospital)	A district	500,000		
Regional hospital	A region	2,000,000		
National hospital	Located in the capital city	-		

Sources: Ministry of Health.

Table 2.2. Summary statistics

Panel A

	2012 ROUND			2015 ROUND		
	# of observations	Mean	SD	# of observations	Mean	SD
Mother level characteristics						
Age	455	32.2	8.28	148	36.4	7.32
Education	455	5.05	3.53	148	5.26	3.4
1 if household head	455	.101	.302	148	.0743	.263
Number of pregnancies	455	2.69	1.56	148	3.33	1.8
Household (HH) level characteristics						
Head Education	406	5.95	3.57	143	5.57	3.8
Total value of assets (Ush)	415	1,046,906	1,777,093	143	1,586,759	6,617,767
Land holding size (acre)	416	5.52	11.7	145	6.35	13.4
1 if having non-agriculture business	416	.548	.498	146	.548	.499
Number of HH members	416	11.3	4.49	146	13.6	7.15
Number of migrants sent from HH	416	.409	1.16	146	.452	1.08
1 if mobile phone owned	415	.79	.408	143	.839	.369
1 if hold mobile money account	391	.407	.492	143	.552	.499
1 if hold bank account	415	.222	.416	143	.217	.414
Village level characteristics						
Number of higher-level health facilities around village (<=5 miles)	90	1.36	1.04	69	1.57	1.08
Number of higher-level health facilities* around village (<=5 miles)	90	1.4	1.09	69	1.61	1.14
Number of lower-level health facilities around village (<=5 miles)	90	.478	.622	69	.551	.631

Table 2.2. (continued)

	2012 ROUND			2015 ROUND		
	# of observations	Mean	SD	# of observations	Mean	SD
Pregnancy level information						
Year of pregnancy termination	1,080	2,008	2.88	167	2,013	2.45
Antenatal care (ANC) related information						
Number of ANC visits	1,029	4.91	2.65	164	4.73	2.94
Number of ANC visits at a higher-level health facility	1,066	3.88	3.15	164	4	3.27
1 if received recommended ANC (4times,1-1-2, at a higher-level health facility)	1,075	.222	.416	164	.293	.456
1 if received ANC within first trimester at a higher-level health facility	1,071	.361	.481	164	.512	.501
1 if received ANC within second trimester at a higher-level health facility	1,071	.692	.462	164	.72	.451
1 if received ANC 2 times within third trimester at a higher-level health facility	1,071	.562	.496	164	.524	.501
Cost of making an ANC visit (Ush)	1,065	1,540	6,948	165	5,130	11,768
Transportation cost of making an ANC visit (Ush)	978	914	1,994	164	1,559	2,969
Travel time for ANC	1,025	49.4	45.2	161	41.8	38.5
Waiting time for ANC	1,028	70.7	73.5	159	68.8	80.8
Delivery related information						
Cost of delivery (Ush)	1,051	11,143	25,307	165	17,258	31,658
Transportation cost for delivery (Ush)	1,017	2,123	6,502	165	2,955	5,175
1 if delivered by a skilled provider	1,080	.603	.49	167	.725	.448
1 if delivered at a higher-level health facility	1,066	.371	.483	165	.509	.501
1 if baby weight was measured	1,035	.559	.497	160	.613	.489
1 indicates receiving postnatal care	1,032	.294	.456	146	.384	.488

Table 2.2. (continued)

Panel B

Village level time invariant characteristics	(1) N	(2) mean	(3) sd
Time for driving to nearest district town in dry season (min)	117	36.2	30.1
1 if road condition in a dry season is better than an average village	117	.615	.489

Panel C

Household (HH) level time invariant characteristics	(1) N	(2) mean	(3) sd
Distance(mile) from HH location to the closest road	585	1.32	2.25
1 if HH is more than 1.3 mile (mean) away from the closest road	585	.347	.476
Distance(mile) between village reference point and HH	585	0.43	.635
1 if village reference point is more than 0.4 mile (mean) away from HH location	585	.362	.481
Altitude of HH location (m)	585	1,306	272
Difference of altitude between HH and village reference point	585	14.6	34.1
1 if altitude difference from HH to village reference point is over 14.6 m (mean)	585	.26	.439
1 indicating that HH is located at an area largely occupied by water	585	.00684	.0825

Sources: The RePEAT study 2009 / 2012 / 2015, Uganda Bureau of Statistics, DIVA-GIS

Notes: 1) According to the Bank of Uganda's Annual Report 2012, USD was equivalent to Uganda shilling 2557 in financial years 2011–12.

2) Age is calculated at the year of pregnancy terminated. We exclude the pregnancy reports answered by family members other than mothers themselves.

3) Panel B shows the summary statistics of all the 117 villages covered by the RePEAT study 2009 / 2012 / 2015. Most of the time for driving to the nearest district town in the dry season was brought from the 2015 round. Three villages' information was complemented with the data of the 2012 round.

4) Panel C shows summary statistics of all the 585 households with GPS information of the round 2012 and 2015, which reported at least one pregnancy information.

5) The source of the data of the location of the closest road from households and areas largely occupied by water is the Uganda Bureau of Statistics. The source of the data of altitude is DIVA-GIS. The source of the rest of the data is the RePEAT study.

6) The information on the household characteristics is only available for the survey years. The values of the survey year are copied and assigned to the non-survey years for the regressions (details can be found in Appendix 1.2). The information on the adoption of mobile money by a household is the exception; it is available at the annual level. Regarding village characteristics, the numbers of health facilities are available at the annual level. However, the numbers of lower-level health facilities of 2013~2015 are available for only 59 villages in the RePEAT study. Those of the rest of the villages are missing. To preserve observations in 2013~2015, we conducted interpolation by copying the numbers of 2012 to 2013~2015 for those villages.

8) Higher-level health facilities with asterisk provide delivery care. Higher-level health facilities without asterisk provide comprehensive ANC. The RePEAT surveys collected the information in villages from informants. We use each of the variables to control for the regressions on corresponding outcome variables.

9) Main outcome variables used in our regressions are shown in bold.

Table 2.3. Correlations of mobile money agent rollout and rainfall shocks

	Agents w/in 1km	Agents w/in 5km	Distance to agent	Rainfall shock (1sd)
	(1)	(2)	(3)	(4)
ΔHousehold size	.0499	.0399	.00465	.00351
	(.0727)	(.231)	(.005)	(.00267)
ΔNumber of migrants sent from HH	-.114	-.421	.00636	.000627
	(.115)	(.675)	(.0178)	(.0084)
ΔTotal value of assets (log)	-.0646	-.7	.0126	-.0099
	(.114)	(.464)	(.0126)	(.0129)
ΔLand holding size (log)	.0809	.533	.00847**	.00478
	(.0759)	(.362)	(.00367)	(.00409)
ΔMobile phone ownership	.619	1.45	.0284	-.0121
	(.613)	(1.69)	(.0348)	(.0313)
ΔHH works for a non-agricultural business	-.0841	-.609	.00147	-.0168
	(.103)	(.557)	(.0354)	(.0168)
ΔHH has a bank account	.141	-.0731	-.0591	.024
	(.268)	(.508)	(.0498)	(.0175)
ΔNumber of higher-level health facilities around village (<=5 miles)	.137	-.545	.0537	-.0225
	(.313)	(3.09)	(.183)	(.0915)
ΔNumber of lower-level health facilities around village (<=5 miles)	-2.01	-6.99	.332**	-.227**
	(1.92)	(4.58)	(.161)	(.093)
Rainfall shock	1.32	6.23	-.0175	
	(1.18)	(6.4)	(.112)	
Joint F-test P-value	.216	.256	.002	.37

Notes: 1) Dependent variable: measures of agent access and the rainfall shock. Distance to the closest agent is measured in log kilometers. 2) Independent variables: changes in the characteristics of households/villages and the rainfall shock. 3) Each row is a separate regression. 4) Each regression controls for Year × District and parish FE. 5) Joint F-test P-values are calculated based on independent variables except the bank account indicator. 6) The data of the access to bank account is only available for 2012 and 2015. The rest of the data is available for 2009, 2012 and 2015. 7) Standard errors are clustered at the district level. Significance level: * p<0.1, ** p<0.05, *** p<0.01.

Table 2.4. Impact of rainfall shocks on utilization of maternal care for mobile money users and non-users

Dependent variable:	Recommended ANC				Facility delivery				Skilled birth attendance			
	Parish FE		Mother FE		Parish FE		Mother FE		Parish FE		Mother FE	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1 if HH used mobile money	.0773	.0747	.0953	.0675	-.119	-.105	-.21*	-.186*	-.088	-.079	-.183*	-.174*
	(.0632)	(.0631)	(.103)	(.119)	(.101)	(.103)	(.105)	(.108)	(.102)	(.101)	(.0946)	(.0998)
Mobile money use * Shock	.13	.184	.0321	.0262	.357***	.344***	.285**	.268**	.286***	.29***	.35***	.389***
	(.129)	(.135)	(.189)	(.22)	(.0923)	(.092)	(.117)	(.123)	(.077)	(.0735)	(.115)	(.136)
Rainfall Shock	-.0398	.143	-.0509	.146	-.126**	-.429**	-.193***	-.391	-.0829	-.515***	-.151**	-.465*
	(.0625)	(.189)	(.0752)	(.287)	(.0575)	(.154)	(.0543)	(.237)	(.05)	(.171)	(.0641)	(.227)
Observations	696	696	479	479	994	994	785	785	1,012	1,012	802	802
R-squared	.484	.509	.851	.871	.5	.515	.819	.828	.509	.53	.822	.832
Year*District	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parish FE	Yes	Yes	-	-	Yes	Yes	-	-	Yes	Yes	-	-
Mother FE	-	-	Yes	Yes	-	-	Yes	Yes	-	-	Yes	Yes
Interactions with shock	-	Yes	-	Yes	-	Yes	-	Yes	-	Yes	-	Yes
Negative shock	-.019	.065	-.046	-.054	-.087	-.036	-.161***	-.126**	-.051	.044	-.112*	-.033
	[.061]	[.065]	[.083]	[.09]	[.052]	[.063]	[.049]	[.049]	[.046]	[.054]	[.058]	[.06]
(A) Shock, MM users	.09	.196	-.019	-.06	.23***	.296***	.092	.129	.203***	.366***	.199**	.32**
	[.129]	[.131]	[.209]	[.228]	[.074]	[.104]	[.102]	[.125]	[.067]	[.086]	[.095]	[.123]
(B) Shock, non-users	-.04	.041	-.051	-.053	-.126**	-.078	-.193***	-.158***	-.083	.004	-.151**	-.077
	[.063]	[.067]	[.075]	[.087]	[.058]	[.067]	[.054]	[.053]	[.05]	[.057]	[.064]	[.065]
(C) Shock, non-users |*userX's*	-	.011	-	-.086	-	-.048	-	-.139**	-	.076	-	-.069
	-	[.073]	-	[.104]	-	[.078]	-	[.066]	-	[.082]	-	[.07]
F stat (A)=(B)	1.011	1.442	.029	.001	14.91***	11.083***	5.932**	4.33**	13.776***	17.181***	9.192***	8.404***
F stat (A)=(C)	-	1.858	-	.014	-	13.981***	-	4.73**	-	15.551***	-	8.166***
Mean	.253	.253	.253	.253	.632	.632	.632	.632	.679	.679	.679	.679

Notes: 1) Regressions include control variables: years of mother's education, mother's age, parity, a dummy taking one if the household had mobile phone, number of household members, number of migrants in household, household's asset value in log, household's land size in log, years of household head's education, a dummy taking one if household had non-agricultural business, a dummy taking one if household was far from the closest road, a dummy taking one if household was far in altitude from village reference point, a dummy indicating an area largely occupied by water surface, a dummy

indicating that the distance from the household location to the reference point of the village was larger than the mean, a dummy indicating that the driving time to the nearest district town from the village was less than the mean, three dummies for the number of higher-level health facilities, and two dummies for the number of lower-level health facilities.

2) When there are interactions with the shock this set of control variables is interacted with the shock but not shown here for brevity.

3) Standard errors are clustered at district level. Significance level: * p<0.1, ** p<0.05, *** p<0.01.

Table 2.5. Robustness checks

	Measures of ANC access				Measures of delivery care access			
Dependent variable:	1 indicates receiving antenatal care of five times		Number of times that mother received antenatal care		1 indicates receiving postnatal care		1 if baby weight was measured	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1 if HH used mobile money	.0468	-.0546	-.0659	-.443	-.0859	-.0317	-.0175	-.0747
	(.0539)	(.0806)	(.358)	(.757)	(.0787)	(.0846)	(.0935)	(.0851)
Mobile money use * Shock	.246**	.235**	1.02	1.28	.189*	.179**	.201**	.299**
	(.0995)	(.109)	(1.01)	(1.02)	(.0944)	(.0662)	(.0763)	(.13)
Rainfall Shock	-.104	-.00792	-3.25	.0687	.0357	-.162	-.558***	-.398
	(.174)	(.248)	(2.16)	(2.6)	(.278)	(.168)	(.192)	(.25)
Observations	696	479	691	473	941	732	957	745
R-squared	.507	.867	.498	.852	.492	.896	.535	.848
Year*District	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parish FE	Yes	-	Yes	-	Yes	-	Yes	-
Mother FE	-	Yes	-	Yes	-	Yes	-	Yes
Interactions with shock	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Negative shock	.044	-.005	-.63	-.238	-.133	-.049*	-.053	-.111
	[.077]	[.093]	[.558]	[.895]	[.126]	[.029]	[.096]	[.077]
(A) Shock, MM users	.255*	.192	.499	.624	.04	.101	.167*	.106
	[.134]	[.146]	[.846]	[1.104]	[.09]	[.06]	[.094]	[.122]
(B) Shock, non-users	.005	-.042	-.837	-.396	-.153	-.067*	-.08	-.138
	[.071]	[.09]	[.57]	[.94]	[.132]	[.032]	[.099]	[.086]
(C) Shock, non-users |*userX's*	.009	-.043	-.521	-.652	-.149	-.077	-.034	-.193**
	[.081]	[.103]	[.746]	[.956]	[.123]	[.051]	[.098]	[.084]
F stat (A)=(B)	7.185**	4.409**	3.141*	0.946	5.809**	5.352**	11.455***	2.595
F stat (A)=(C)	8.396***	4.644**	1.03	1.563	3.987*	7.292**	6.938**	5.341**
Mean	.22	.22	3.985	3.985	.317	.317	.588	.588

Notes: 1) Regressions include control variables: years of mother's education, mother's age, parity, a dummy taking one if the household had mobile phone, number of household members, number of migrants in household, household's asset value in log, household's land size in log, years of household head's education, a dummy taking one if household had non-agricultural business, a dummy taking one if household was far from the closest road, a dummy taking one if household was far in altitude from village reference point, a dummy indicating an area largely occupied by water surface, a dummy indicating that the distance from the household location to the reference point of the village was larger than the mean, a dummy indicating that the driving time to the nearest district town from the village was less than the mean, three dummies for the number of higher-level health facilities, and two dummies for the number of lower-level health facilities.

2) When there are interactions with the shock this set of control variables is interacted with the shock but not shown here for brevity.

3) To mitigate the influence of outliers, the numbers of the times that a mother received ANC are replaced with ten if the numbers exceed ten.

4) Standard errors are clustered at district level. Significance level: * p<0.1, ** p<0.05, *** p<0.01.

Table 2.6. Heterogenous effects: droughts and floods

Dependent variable:	Recommended ANC		Facility delivery		Skilled birth attendance	
	(1)	(2)	(3)	(4)	(5)	(6)
1 if HH used mobile money	.0769	.0798	-.105	-.203	-.0756	-.175
	(.0694)	(.136)	(.104)	(.128)	(.104)	(.125)
Mobile money use * Drought Shock	.278	-.0363	.311***	.305*	.292***	.526***
	(.222)	(.238)	(.0863)	(.159)	(.0916)	(.159)
Drought Shock	.196	-.0962	-.237	-.0156	-.0187	.155
	(.259)	(.264)	(.261)	(.418)	(.248)	(.432)
Mobile money use * Flood Shock	-.0287	-.0398	.39**	.244	.34*	.287*
	(.191)	(.215)	(.16)	(.186)	(.169)	(.162)
Flood Shock	.246	1.34*	-.636**	-.976***	-1.16***	-1.22***
	(.508)	(.779)	(.252)	(.257)	(.245)	(.227)
Observations	696	479	994	785	1,012	802
R-squared	.541	.884	.523	.836	.541	.842
Year*District	Yes	Yes	Yes	Yes	Yes	Yes
Parish FE	Yes	-	Yes	-	Yes	-
Mother FE	-	Yes	-	Yes	-	Yes
Interactions with shock	Yes	Yes	Yes	Yes	Yes	Yes
Drought shock	.154	.012	.025	-.06	.155	.122
	[.103]	[.195]	[.128]	[.098]	[.105]	[.077]
(A) Drought Shock, MM users	.392**	-.011	.29*	.139	.404***	.494***
	[.15]	[.222]	[.142]	[.148]	[.129]	[.162]
(B) Drought Shock, non-users	.11	.017	-.008	-.084	.124	.076
	[.124]	[.151]	[.134]	[.106]	[.109]	[.094]
(C) Drought Shock, non-users |*userX's*	.114	.025	-.02	-.166	.112	-.031
	[.143]	[.16]	[.125]	[.115]	[.116]	[.099]
F stat (A)=(B)	1.737	.012	4.759**	1.79	5.626**	7.564**
F stat (A)=(C)	1.567	.023	12.95***	3.707*	10.146***	10.874***
Flood shock	-.06	.01	-.057	-.205**	-.041	-.158*
	[.135]	[.136]	[.084]	[.075]	[.093]	[.092]
(D) Flood Shock, MM users	-.157	-.172	.328*	.164	.396**	.252
	[.157]	[.216]	[.167]	[.196]	[.173]	[.172]
(E) Flood Shock, non-users	-.042	.044	-.104	-.251***	-.095	-.208**
	[.154]	[.208]	[.086]	[.08]	[.096]	[.085]
(F) Flood Shock, non-users |*userX's*	-.128	-.132	-.062	-.08	.056	-.035
	[.115]	[.173]	[.089]	[.093]	[.101]	[.086]
F stat (D)=(E)	.316	1.092	7.214**	3.949*	8.40***	5.534**
F stat (D)=(F)	.022	.034	5.95**	1.711	4.052*	3.137*
Mean	.253	.253	.632	.632	.679	.679

Notes: 1) Regressions include control variables: years of mother's education, mother's age, parity, a dummy taking one if the household had mobile phone, number of household members, number of migrants in household, household's asset value in log, household's land size in log, years of household head's education, a dummy taking one if household had non-agricultural business, a dummy taking one if household was far from the closest road, a dummy taking one if household was far in altitude from village reference point, a dummy indicating an area largely occupied by water surface, a dummy indicating that the distance from the household location to the reference point of the village was larger than the mean, a dummy indicating that the driving time to the nearest district town from the village was less than the mean, three dummies for the number of higher-level health facilities, and two dummies for the number of lower-level health facilities.

2) When there are interactions with the shock this set of control variables is interacted with the shock but not shown here for brevity.

3) Standard errors are clustered at district level. Significance level: * p<0.1, ** p<0.05, *** p<0.01.

Table 2.7. Transportation in the extreme weather

Dependent variable:	Transportation fee for delivery		1 if transportation fee for delivery is high		1 if went for delivery by paid transportation		1 if went for delivery on foot/by bike/at home	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1 if HH used mobile money	-1.67*	-1.56	-.159	-.165	-.209*	-.205	.274**	.269*
	(.894)	(1.01)	(.102)	(.104)	(.116)	(.134)	(.12)	(.135)
Mobile money use * Drought Shock	.684	.966	-.0215	-.0625	.0439	.105	-.0651	-.146
	(.945)	(1.32)	(.133)	(.106)	(.13)	(.189)	(.199)	(.218)
Drought Shock	-1.19	-6.2**	.0339	-.37*	-.175*	-.657*	.267**	.645*
	(.697)	(2.87)	(.0929)	(.193)	(.097)	(.372)	(.0994)	(.358)
Mobile money use * Flood Shock	2.64*	3.28**	.217	.351**	.497**	.524**	-.669***	-.791***
	(1.41)	(1.57)	(.131)	(.163)	(.206)	(.203)	(.188)	(.23)
Flood Shock	-1.31	-1.43	-.0663	.107	-.193	-.315	.341**	.407
	(1.16)	(3.41)	(.114)	(.256)	(.156)	(.372)	(.137)	(.365)
Observations	799	799	799	799	802	802	779	779
R-squared	.801	.816	.776	.794	.808	.823	.81	.824
Year*District	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mother FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Interactions with shock	-	Yes	-	Yes	-	Yes	-	Yes
Drought shock	-1.119*	-.931	.032	.009	-.17*	-.116	.26**	.275*
-	[.647]	[1.38]	[.088]	[.099]	[.159]	[.127]	[.139]	[.146]
(A) Drought Shock, MM users	-.51	.911	.012	.044	-.131	.063	.202	.063
se of (A)	[.818]	[1.051]	[.13]	[.129]	[.131]	[.167]	[.224]	[.261]
(B) Drought Shock, non-users	-1.194	-1.157	.034	.005	-.175*	-.138	.267**	.301*
se of (B)	[.697]	[.892]	[.093]	[.1]	[.097]	[.131]	[.099]	[.146]
(C) Drought Shock, non-users |*userX's*	-	-.055	-	.107	-	-.042	-	.21
se of (C)	-	[1.043]	-	[.108]	-	[.157]	-	[.146]
F stat (A)=(B)	.524	3.424*	.026	.138	.114	1.719	.107	1.072
F stat (A)=(C)	-	.536	-	.348	-	.311	-	.451
Flood shock	-1.026	-.293	-.043	.023	-.139	-.089	.269*	.196
-	[1.119]	[.841]	[.108]	[.12]	[.093]	[.18]	[.102]	[.161]
(D) Flood Shock, MM users	1.323	2.71*	.151	.371**	.304	.401*	-.328	-.577***
se of (D)	[1.537]	[1.376]	[.132]	[.145]	[.264]	[.199]	[.233]	[.186]
(E) Flood Shock, non-users	-1.315	-.662	-.066	-.019	-.193	-.15	.341**	.29
se of (E)	[1.156]	[1.484]	[.114]	[.127]	[.156]	[.191]	[.137]	[.172]
(F) Flood Shock, non-users |*userX's*	-	-0.572	-	.019	-	-.123	-	.214
se of (F)	-	[1.476]	-	[.141]	-	[.191]	-	[.194]
F stat (D)=(E)	3.485*	4.208*	2.769	6.034**	5.844**	6.73**	12.674***	18.072***
F stat (D)=(F)	-	4.378**	-	4.626**	-	6.663**	-	11.869***
Mean	3.623	3.623	.278	.278	.455	.455	.472	.472

Notes: 1) Regressions include control variables: mother's age, parity, a dummy taking one if the household had mobile phone, number of household members, number of migrants in household, household's asset value in log, household's land size in log, a dummy taking one if household had non-agricultural business, three dummies for the number of higher-level health facilities, and two dummies for the number of lower-level health facilities.

2) When there are interactions with the shock this set of control variables is interacted with the shock but not shown here for brevity.

3) Standard errors are clustered at district level. Significance level: * p<0.1, ** p<0.05, *** p<0.01.

Table 2.8. Falsification test: placebo mobile money dummy

Dependent variable:	Facility delivery				Skilled birth attendance			
	Parish FE		Mother FE		Parish FE		Mother FE	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Placebo mobile money dummy	-.0373	-.0559	-.0619	-.0759	-.138	-.147	.0274	-.00122
	(.102)	(.106)	(.158)	(.168)	(.0978)	(.104)	(.173)	(.178)
Placebo dummy * Shock	.0502	-.0676	.0221	.134	.295**	.257**	-.0362	.0902
	(.124)	(.121)	(.117)	(.14)	(.109)	(.115)	(.0779)	(.128)
Rainfall Shock	-.168	-.602**	-.239**	-.922*	-.274**	-.837***	-.14**	-1.11**
	(.143)	(.259)	(.0833)	(.518)	(.132)	(.262)	(.059)	(.488)
Observations	507	507	278	278	518	518	286	286
R-squared	.53	.565	.872	.883	.562	.598	.882	.898
Year*District	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parish FE	Yes	Yes	-	-	Yes	Yes	-	-
Mother FE	-	-	Yes	Yes	-	-	Yes	Yes
Interactions with shock	-	Yes	-	Yes	-	Yes	-	Yes
Negative shock	-.15	.145	-.231***	-.267***	-.172	.034	-.152***	-.201**
	[.109]	[.122]	[.058]	[.083]	[.107]	[.096]	[.045]	[.085]
(A) Shock, MM users	-.118	.076	-.217**	-.165	.021	.184**	-.176***	-.167
	[.078]	[.11]	[.076]	[.105]	[.087]	[.087]	[.057]	[.135]
(B) Shock, non-users	-.168	.156	-.239**	-.306**	-.274**	-.065	-.14**	-.285**
	[.143]	[.136]	[.083]	[.121]	[.132]	[.126]	[.059]	[.103]
(C) Shock, non-users |*userX's*	-	.143	-	-.299**	-	-.073	-	-.257**
	-	[.138]	-	[.114]	-	[.131]	-	[.091]
F stat (A)=(B)	.163	.489	.036	.853	7.34**	6.254**	.216	.659
F stat (A)=(C)	-	.312	-	.916	-	5.011**	-	.494

Notes: 1) Regressions include control variables: years of mother's education, mother's age, parity, a dummy taking one if the household had mobile phone, number of household members, number of migrants in household, household's asset value in log, household's land size in log, years of household head's education, a dummy taking one if household had non-agricultural business, a dummy taking one if household was far from the closest road, a dummy taking one if household was far in altitude from village reference point, a dummy indicating an area largely occupied by water surface, a dummy indicating that the distance from the household location to the reference point of the village was larger than the mean, a dummy indicating that the driving time to the nearest district town from the village was less than the mean, three dummies for the number of higher-level health facilities, and two dummies for the number of lower-level health facilities.

2) When there are interactions with the shock this set of control variables is interacted with the shock but not shown here for brevity.

3) Standard errors are clustered at district level. Significance level: * p<0.1, ** p<0.05, *** p<0.01.

4) The regressions use the data of 2000-2008 (mobile money services in Uganda began in 2009). The placebo mobile money dummy takes one in 2006-2008 for the household which used mobile money in 2015. It takes a value of zero for the rest of the observations in the sub-set.

Table 2.9. IV results

Dependent variables:	Facility delivery	Skilled birth attendance	1 indicates receiving postnatal care	1 if baby weight was measured
	Mother FE	Mother FE	Mother FE	Mother FE
	1	2	3	4
1 if HH used mobile money	.214	-.00299	-.197	.587
	(.302)	(.234)	(.473)	(.377)
Mobile money use * Shock	.535*	.431**	.367	.725**
	(.285)	(.187)	(.258)	(.332)
Rainfall Shock	-.227**	-.16**	-.111**	-.289**
	(.0896)	(.069)	(.051)	(.136)
Observations	785	802	732	745
Year*District	Yes	Yes	Yes	Yes
Mother FE	Yes	Yes	Yes	Yes
Negative shock	-.167**	-.113*	-.073**	-.21*
-	[.069]	[.062]	[.032]	[.112]
(A) Shock, MM users	.309	.271	.256	.436*
se of (A)	[.226]	[.168]	[.218]	[.25]
(B) Shock, non-users	-.227**	-.16**	-.111**	-.289**
se of (B)	[.09]	[.069]	[.051]	[.136]
Test (A)=(B) p-value	.06	.021	.155	.029
Mean	.632	.679	.317	.588
SW F test for weak identification of endogenous regressor 1 (mobile money user dummy)	6.18***	5.59***	7.21***	7.78***
SW F test for weak identification of endogenous regressor 2 (interaction term)	3.44**	2.64*	6.78***	8.43***
Kleibergen-Paap F stat	1.704	1.575	1.528	1.905
Weak IV robust test p-value	0.0419	0.0344	0.1660	0.0864

Notes: 1) Instruments are distance to closest mobile money agent and number of mobile money agent within 1km from each household, and their interactions with the shock variable. 2) Regressions include control variables: years of mother's education, mother's age, parity, a dummy taking one if the household had mobile phone, number of household members, number of migrants in household, household's asset value in log, household's land size in log, years of household head's education, a dummy taking one if household had non-agricultural business, a dummy taking one if household was far from the

closest road, a dummy taking one if household was far in altitude from village reference point, a dummy indicating an area largely occupied by water surface, a dummy indicating that the distance from the household location to the reference point of the village was larger than the mean, a dummy indicating that the driving time to the nearest district town from the village was less than the mean, three dummies for the number of higher-level health facilities, and two dummies for the number of lower-level health facilities.

3) Standard errors are clustered at district level. Significance level: * p<0.1, ** p<0.05, *** p<0.01.

Table 2.10. Remittances received in the event of rainfall shocks

Dependent variable:	1 if any remittances received		Amount of remittances received (arcsinh)	
	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)
1 if HH used mobile money	.142***	.0465	1.73***	.857
	[.0408]	[.318]	[.51]	[4.23]
Mobile money use * Shock	.0434	.243*	.607	3.52*
	[.0756]	[.141]	[.909]	[2.08]
Rainfall shock	-.0116	-.0958*	-.24	-1.45**
	[.0437]	[.0518]	[.567]	[.685]
Observations	1,463	1,463	1,463	1,463
Year*District	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes
Mean	.23	.23	2.9	2.9
Semi-elasticity	-	-	.214	2.851
-	-	-	[1.103]	[8.027]
SW F test for weak identification of endogenous regressor 1 (mobile money user dummy)		3.2**		3.2**
SW F test for weak identification of endogenous regressor 2 (interaction term)		7.13***		7.13***
Kleibergen-Paap F stat		1.484		1.484

Notes: 1) All regressions control for a standard set of our covariates: a dummy taking one if the household had mobile phone, number of household members, number of migrants in household, household's asset value in log, household's land size in log, years of household head's education, a dummy taking one if household had non-agricultural business. 2) Data of remittances for 2009, 2012, and 2015 that was collected at the survey rounds of 2009, 2012, and 2015 is used. 3) Standard errors are clustered at the district level. Significance level: * p<0.1, ** p<0.05, *** p<0.01. 4) Estimated equation is: $y_{hdy} = \gamma Shock_{hdy} + \mu Mmoney_{hdy} + \beta Mmoney_{hdy} * Shock_{hdy} + \psi X_{hdy} + \sigma_h + \eta_{dy} + v_{hdy}$ 5) Following Bellemare and Wichman (2020), we calculated the semi-elasticities with the following statistic: $\exp\left(\hat{\beta} - 0.5\widehat{Var}(\hat{\beta})\right) - 1$. 6) Instruments are distance to closest mobile money agent and number of mobile money agent within 1km from each household, and their interactions with the shock variable.

Table 3.1. Outline of EduMatch surveys[73]

		Pre-baseline survey	Baseline survey (round 0)	Follow-up round 1	Follow-up round 2	Follow-up round 3	Follow-up round 4	Follow-up round 5	Follow-up round 6
Dhaka surveys	Interview Periods	12/12/2017~8/10/2018	10/21/2018~11/30	4/19/2019~6/28	7/7/2019~8/20	9/13/2019~10/26	12/5/2019~1/1/2020	3/20/2020~5/16	7/20/2020~8/30
	Notes on households interviewed at different dates		40 samples were interviewed at different dates: 1/5/2019 ~ 4/17		A sample was interviewed at a different date: 9/19/2019		10 samples were interviewed at different dates: 1/22/2020~1/30		
	# of samples in Dhaka	6318	723	545	686	661	622	595	546
	# of HHs returned to village that answered to survey								111
Village surveys	Interview Periods	12/12/2017~8/10/2018	10/21/2018~11/30	4/19/2019~6/28	7/7/2019~8/20	9/13/2019~10/26	12/5/2019~1/1/2020	3/20/2020~5/16	7/20/2020~8/30
	Notes on households interviewed at different dates		40 samples were interviewed at different dates: 1/3/2019~6/24		4 samples were interviewed at different dates: 9/22/2019~9/30	4 samples were interviewed at different dates: 11/9/2019~11/20	33 samples were interviewed at different dates: 1/22/2020~1/30		
	# of samples in villages		672	533	692	632	660	628	643

[73] The attrition rate for the follow-up round 1 survey is relatively high because it was the first follow-up mobile phone survey conducted by the research company collaborated with us. We had problems in the administration of the survey and could not effectively contact respondents. We could find a better way to administrate the survey in the follow-up round 2 survey.

Table 3.2. Descriptive table (characteristics of Dhaka households and village households) of four groups

Variable	N	(1) Dhaka HH complete cases Mean/SE	N	(2) Pure Attrition in Mar-Aug2020 Mean/SE	N	(3) Attrition b/c left Dhaka ~Feb2020 Mean/SE	N	(4) Attrition b/c left Dhaka Mar~Aug2020 Mean/SE	t-test Difference (1)-(2)	t-test Difference (1)-(3)	t-test Difference (1)-(4)
Dhaka households											
age of Dhaka respondent	611	28.856	59	27.542	33	25.970	20	25.150	1.314	2.886**	3.706**
		[0.271]		[0.886]		[1.048]		[1.148]			
1 if Dhaka respondent is male	611	0.565	59	0.424	33	0.424	20	0.450	0.141**	0.140	0.115
		[0.020]		[0.065]		[0.087]		[0.114]			
1 if Dhaka respondent is married	611	0.768	59	0.576	33	0.606	20	0.850	0.191***	0.162**	-0.082
		[0.017]		[0.065]		[0.086]		[0.082]			
1 if respondent is household head	611	0.655	59	0.627	33	0.545	20	0.500	0.028	0.109	0.155
		[0.019]		[0.063]		[0.088]		[0.115]			
# of household members in Dhaka	611	2.013	59	1.797	33	1.818	20	1.950	0.216*	0.195	0.063
		[0.039]		[0.099]		[0.160]		[0.185]			
1 if using mobile money through agent account	611	0.311	59	0.356	33	0.364	20	0.300	-0.045	-0.053	0.011
		[0.019]		[0.063]		[0.085]		[0.105]			
1 if using mobile money through own account	611	0.453	59	0.424	33	0.364	20	0.400	0.030	0.090	0.053
		[0.020]		[0.065]		[0.085]		[0.112]			
Household income of last 30 days (Taka)	611	15484.710	59	15822.153	33	15325.091	20	15021.000	-337.442	159.619	463.710
		[232.548]		[835.301]		[1323.507]		[1110.035]			
Consumption of last 30 days alltypes per capita (Taka)	611	5598.645	59	5599.949	33	5509.683	20	5923.665	-1.303	88.962	-325.020
		[71.368]		[198.994]		[244.950]		[489.705]			
Amount of sent remittances to original HH (Taka)	611	3064.746	59	3296.610	33	3424.242	20	2575.000	-231.864	-359.496	489.746
		[109.534]		[338.266]		[520.472]		[389.458]			

Village households											
(village) age of HH head	611	54.227	59	54.339	33	53.909	20	56.200	-0.111	0.318	-1.973
		[0.538]		[1.643]		[1.684]		[2.545]			
(village) 1 if HH head is male	611	0.728	59	0.695	33	0.727	20	0.800	0.033	0.001	-0.072
		[0.018]		[0.060]		[0.079]		[0.092]			
(village) 1 if HH head is married	611	0.828	59	0.780	33	0.818	20	0.900	0.048	0.010	-0.072
		[0.015]		[0.054]		[0.068]		[0.069]			
(village)HH head: wife/husband/son/daughter of Dhaka respondent	611	0.074	59	0.034	33	0.061	20	0.050	0.040	0.013	0.024
		[0.011]		[0.024]		[0.042]		[0.050]			
(village)HH head: father/mother/brother/sister/grandfa/grandmo of Dhaka respondent	611	0.710	59	0.746	33	0.667	20	0.750	-0.035	0.044	-0.040
		[0.018]		[0.057]		[0.083]		[0.099]			
(village)HH head: (In law) father/mother/brother/sister of Dhaka respondent	611	0.187	59	0.203	33	0.242	20	0.200	-0.017	-0.056	-0.013
		[0.016]		[0.053]		[0.076]		[0.092]			
(village) # of household members	611	4.597	59	4.627	33	4.364	20	4.700	-0.030	0.234	-0.103
		[0.065]		[0.213]		[0.307]		[0.309]			
(village) Has anyone of household ever used mobile money	611	0.399	59	0.356	33	0.364	20	0.300	0.043	0.036	0.099
		[0.020]		[0.063]		[0.085]		[0.105]			
(village) Total value of assets (Taka) per HH member	611	3857.787	59	3284.187	33	4258.086	20	5059.345	573.600	-400.299	-1201.559
		[201.107]		[445.041]		[954.470]		[1282.645]			
(village) Total value of productive assets (Taka)	611	4921.773	59	3564.338	33	5544.535	20	5478.976	1357.435	-622.762	-557.203
		[332.246]		[730.122]		[1162.860]		[1389.736]			
(village) Consumption of last 30 days alltypes per capita (Taka)	611	2851.187	59	2642.342	33	2754.905	20	2993.482	208.845	96.282	-142.294
		[53.279]		[110.625]		[115.007]		[309.807]			
F-test of joint significance (F-stat)									1.503**	0.742	1.410**
F-test, number of observations									670	644	631

Notes: 1) Total number of the variables of the baseline characteristics used for the inverses probability weighting model is 49. Only a part of them is shown in this table for brevity. The complete set of the variables are shown in Appendix 2.4. 2) The value displayed for t-tests are the differences in the means across the groups. The value displayed for F-tests are the F-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level. 3) Taka is the currency of Bangladesh. As of December 21st,2020, 1 USD is 85 Taka.

Table 3.3. Comparison between complete cases and attrition cases of migrant workers

	(1)		(2)	t-test
	Dhaka HH complete cases		Attrition in Mar-Aug2020	Difference
Variable	N	Mean/SE	N	Mean/SE	(1)-(2)
Dhaka households					
age of Dhaka respondent	611	28.856	112	26.652	2.204***
		[0.271]		[0.599]	
1 if Dhaka respondent is male	611	0.565	112	0.429	0.136***
		[0.020]		[0.047]	
1 if Dhaka respondent is married	611	0.768	112	0.634	0.134***
		[0.017]		[0.046]	
1 if respondent is spouse of the household head	611	0.314	112	0.366	-0.052
		[0.019]		[0.046]	
# of household members in Dhaka	611	2.013	112	1.830	0.183*
		[0.039]		[0.077]	
1 if using mobile money through agent account	611	0.311	112	0.348	-0.037
		[0.019]		[0.045]	
1 if using mobile money through own account	611	0.453	112	0.402	0.052
		[0.020]		[0.047]	
Household income of last 30 days (Taka)	611	15484.710	112	15532.634	-47.924
		[232.548]		[615.988]	
Consumption of last 30 days alltypes per capita (Taka)	611	5598.645	112	5631.159	-32.514
		[71.368]		[153.323]	
Amount of sent remittances to original HH (Taka)	611	3064.746	112	3205.357	-140.611
		[109.534]		[244.843]	

Village households					
(village) age of HH head	611	54.227	112	54.545	-0.317
		[0.538]		[1.090]	
(village) 1 if HH head is male	611	0.728	112	0.723	0.005
		[0.018]		[0.042]	
(village) 1 if HH head is married	611	0.828	112	0.813	0.016
		[0.015]		[0.037]	
(village)HH head: wife/husband/son/daughter of Dhaka respondent	611	0.074	112	0.045	0.029
		[0.011]		[0.020]	
(village)HH head: father/mother/brother/sister/grandfa/grandmo of Dhaka respondent	611	0.710	112	0.723	-0.013
		[0.018]		[0.042]	
(village)HH head: (In law) father/mother/brother/sister of Dhaka respondent	611	0.187	112	0.214	-0.028
		[0.016]		[0.039]	
(village) # of household members	611	4.597	112	4.563	0.035
		[0.065]		[0.154]	
(village) Has anyone of household ever used mobile money	611	0.399	112	0.348	0.051
		[0.020]		[0.045]	
(village) Total value of assets (Taka) per HH member	611	3857.787	112	3888.132	-30.345
		[201.107]		[431.844]	
(village) Total value of productive assets (Taka)	611	4921.773	112	4489.689	432.084
		[332.246]		[573.779]	
(village) Consumption of last 30 days alltypes per capita (Taka)	611	2851.187	112	2738.212	112.976
		[53.279]		[87.035]	
F-test of joint significance (F-stat)					1.517**
F-test, number of observations					723

Notes: 1) Total number of the variables of the baseline characteristics used for the inverses probability weighting model is 49. Only a part of them is shown in this table for brevity. The complete set of the variables are shown in Appendix 2.5. 2) The value displayed for t-tests are the differences in the means across the groups. The value displayed for F-tests are the F-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level. 3) Taka is the currency of Bangladesh. As of December 21st,2020, 1 USD is 85 Taka.

Table 3.4. Comparison between complete cases and attrition cases of village households

	(1)		(2)		t-test
	Village HH complete cases		Village HH Attrition in Mar-Aug2020		Difference
Variable	N	Mean/SE	N	Mean/SE	(1)-(2)
Dhaka households					
age of Dhaka respondent	667	28.573	56	27.821	0.751
		[0.257]		[0.947]	
1 if Dhaka respondent is male	667	0.549	56	0.482	0.067
		[0.019]		[0.067]	
1 if Dhaka respondent is married	667	0.760	56	0.589	0.171***
		[0.017]		[0.066]	
1 if respondent is spouse of the household head	667	0.327	56	0.268	0.059
		[0.018]		[0.060]	
# of household members in Dhaka	667	1.994	56	1.875	0.119
		[0.037]		[0.111]	
1 if using mobile money through agent account	667	0.310	56	0.393	-0.083
		[0.018]		[0.066]	
1 if using mobile money through own account	667	0.453	56	0.357	0.096
		[0.019]		[0.065]	
Household income of last 30 days (Taka)	667	15469.334	56	15763.696	-294.362
		[225.251]		[869.700]	
Consumption of last 30 days alltypes per capita (Taka)	667	5609.905	56	5529.568	80.337
		[67.920]		[214.030]	
Amount of sent remittances to original HH (Taka)	667	3078.051	56	3187.500	-109.449
		[104.993]		[322.974]	

Village households					
(village) age of HH head	667	54.436	56	52.375	2.061
		[0.506]		[1.693]	
(village) 1 if HH head is male	667	0.729	56	0.714	0.014
		[0.017]		[0.061]	
(village) 1 if HH head is married	667	0.823	56	0.857	-0.034
		[0.015]		[0.047]	
(village)HH head: wife/husband/son/daughter of Dhaka respondent	667	0.070	56	0.054	0.017
		[0.010]		[0.030]	
(village)HH head: father/mother/brother/sister/grandfa/grandmo of Dhaka respondent	667	0.708	56	0.768	-0.060
		[0.018]		[0.057]	
(village)HH head: (In law) father/mother/brother/sister of Dhaka respondent	667	0.196	56	0.125	0.071
		[0.015]		[0.045]	
(village) # of household members	667	4.586	56	4.661	-0.075
		[0.063]		[0.171]	
(village) Has anyone of household ever used mobile money	667	0.388	56	0.429	-0.040
		[0.019]		[0.067]	
(village) Total value of assets (Taka) per HH member	667	3884.350	56	3602.090	282.260
		[189.895]		[666.869]	
(village) Total value of productive assets (Taka)	667	4903.956	56	4269.820	634.135
		[312.124]		[796.783]	
(village) Consumption of last 30 days alltypes per capita (Taka)	667	2848.842	56	2653.175	195.667
		[49.620]		[136.848]	
F-test of joint significance (F-stat)					1.580***
F-test, number of observations					723

Notes: 1) Total number of the variables of the baseline characteristics used for the inverses probability weighting model is 49. Only a part of them is shown in this table for brevity. The complete set of the variables are shown in Appendix 2.6. 2) The value displayed for t-tests are the differences in the means across the groups. The value displayed for F-tests are the F-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level. 3) Taka is the currency of Bangladesh. As of December 21st,2020, 1 USD is 85 Taka.

Table 3.5. Responses to migrant workers' and their original households' idiosyncratic shocks

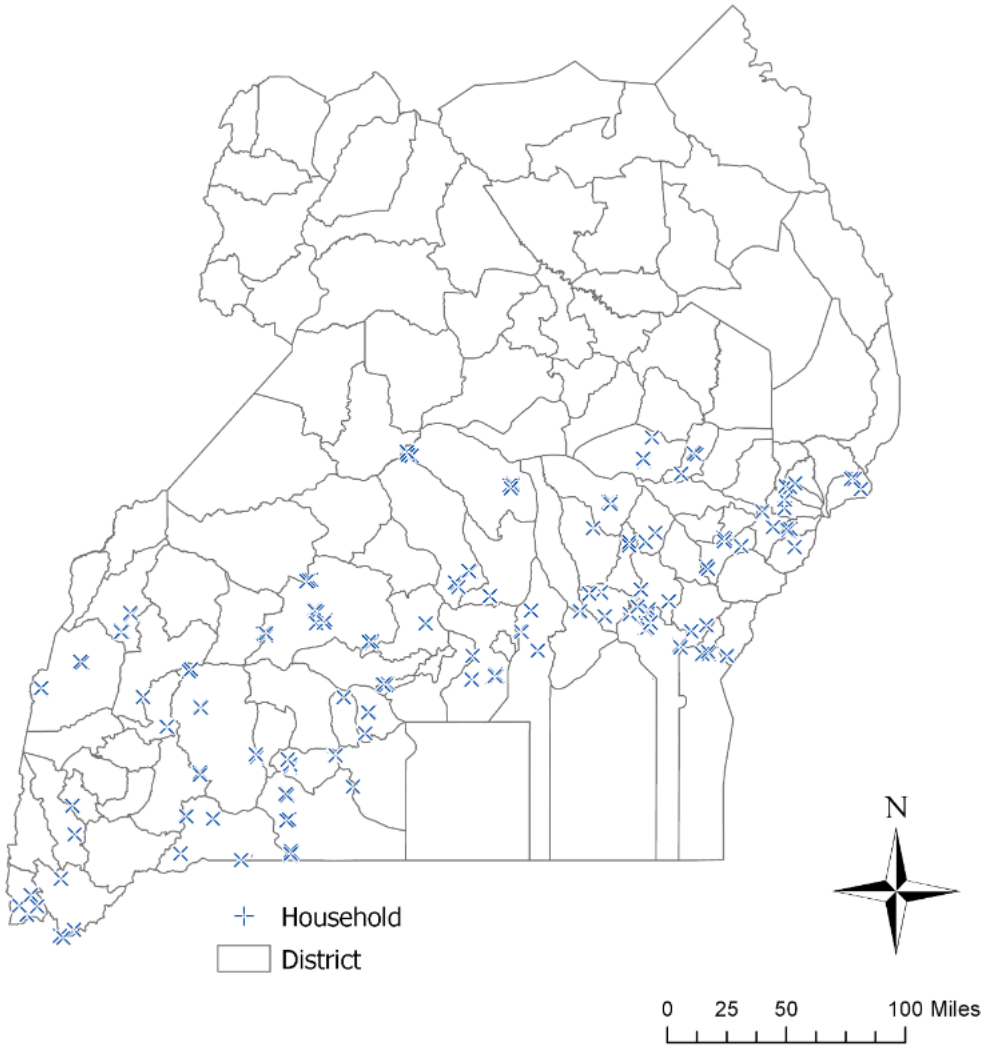
Households that answered interviews:	(1) Dhaka	(2) Dhaka	(3) Dhaka	(4) Dhaka	(5) Village	(6) Village	(7) Village	(8) Village
VARIABLES	Amount of received remittances from original HH (Taka)	Dummy of received remittances from original HH	Amount of received remittances from o/than original HH (Taka)	Dummy of received remittances from o/than original HH	(village) Amount of remittances from Dhaka worker (Taka)	(village) Dummy of remittances from Dhaka worker	(village) Amount of remittances from other than Dhaka worker (Taka)	(village) Dummy of remittances from other than Dhaka worker
(Dhaka) Shock type1: 1 if >=7 days, hh member could not work due to health reason	128	.0167	113	.0112				
	(83.2)	(.0119)	(113)	(.0121)				
(Dhaka) Shock type2: 1 if hh member faced unexpected shocks	88.8	.0158	376**	.0291***				
	(59.3)	(.0106)	(167)	(.00901)				
(village) Shock type1: 1 if >=7 days, hh member could not work due to health rea					66.5	.00129	278*	.0181
					(115)	(.0209)	(166)	(.018)
(village) Shock type2: 1 if hh member faced unexpected shocks					332*	.0744**	-142	-.0312
					(193)	(.0293)	(302)	(.0226)
Observations	3,898	3,898	3,898	3,898	3,840	3,840	3,840	3,840
R-squared	.171	.182	.279	.176	.46	.335	.253	.305
Bimonth dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean	70.992	.016	107.086	.018	3030.641	.769	432.714	.084

Households that answered interviews:	(9) Dhaka	(10) Dhaka	(11) Dhaka	(12) Dhaka	(13) Village (village)	(14) Village (village)	(15) Village (village)	(16) Village (village)
VARIABLES	Amount of sent remittances to original HH (Taka)	Dummy of sent remittances to original HH	Food consumption per capita of last 30 days (Taka)	Consumption of last 30 days all types per capita (Taka)	Amount of remittances sent to Dhaka worker (Taka)	Dummy of remittances sent to worker	Food consumption per capita of last 30 days (Taka)	Consumption of last 30 days all types per capita (Taka)
(Dhaka) Shock type1: 1 if >=7 days, hh member could not work due to health reason	-542***	-.0559**	22.2*	1,464***				
	(152)	(.0281)	(12.5)	(388)				
(Dhaka) Shock type2: 1 if hh member faced unexpected shocks	-427***	-.0895***	17.7	308				
	(145)	(.0245)	(12.8)	(505)				
(village) Shock type1: 1 if >=7 days, hh member could not work due to health rea					-48.1**	-.00663	4.9	264***
					(22.4)	(.00522)	(6.92)	(75.6)
(village) Shock type2: 1 if hh member faced unexpected shocks					-16.3	.0041	-17.4*	53.6
					(27.7)	(.0121)	(9.09)	(96.6)
Observations	3,898	3,898	3,212	3,212	3,860	3,860	3,190	3,190
R-squared	.398	.334	.561	.285	.219	.238	.5	.267
Bimonth dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean	2976.549	.738	717.711	5923.769	40.657	.014	412.074	2951.269

Notes: 1) In the regressions for the Dhaka households, standard errors are clustered at combinations of factory, year and bi-month. In the regressions for the village households, standard errors are clustered at upazila-level. 2) Significance level: * p<0.1, ** p<0.05, *** p<0.01.

Figures

Figure 2.1. Location of households and the 2010 district boundaries in Uganda



Sources: Uganda Bureau of Statistics, the RePEAT study 2009 / 2012 / 2015

Figure 2.2. Rainfall shock on maternal care utilization

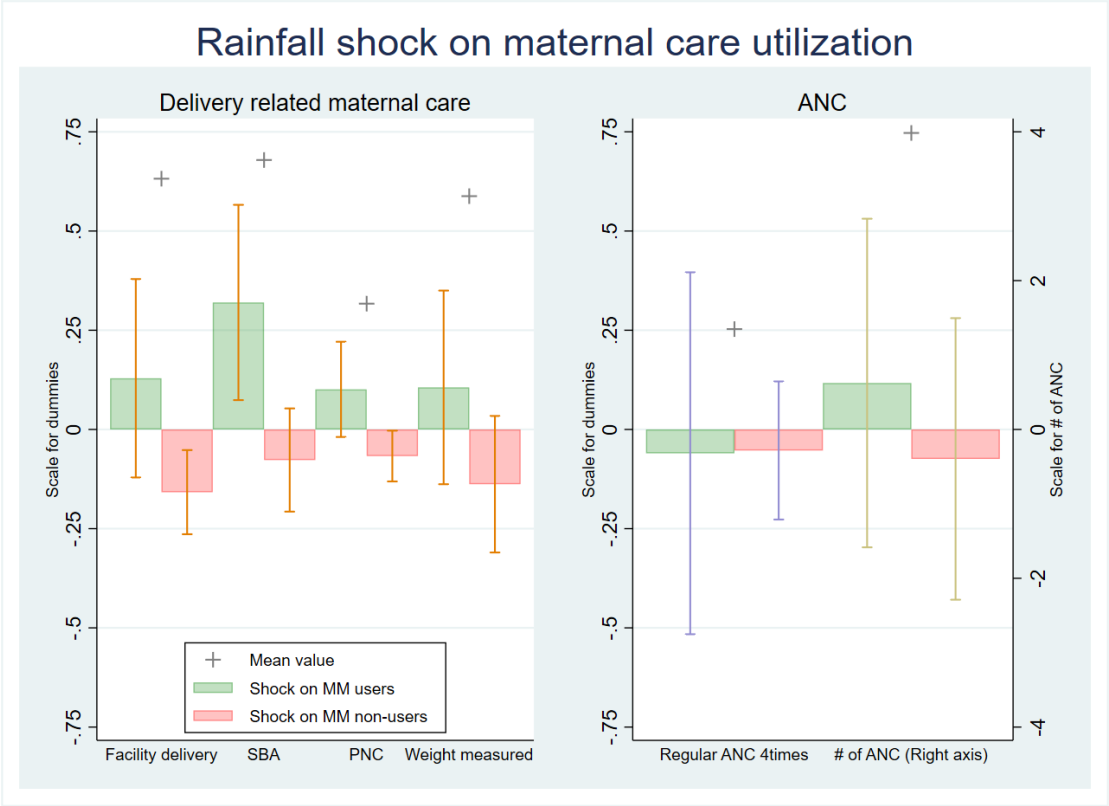


Figure 2.3. Mobile money's ability against droughts and floods

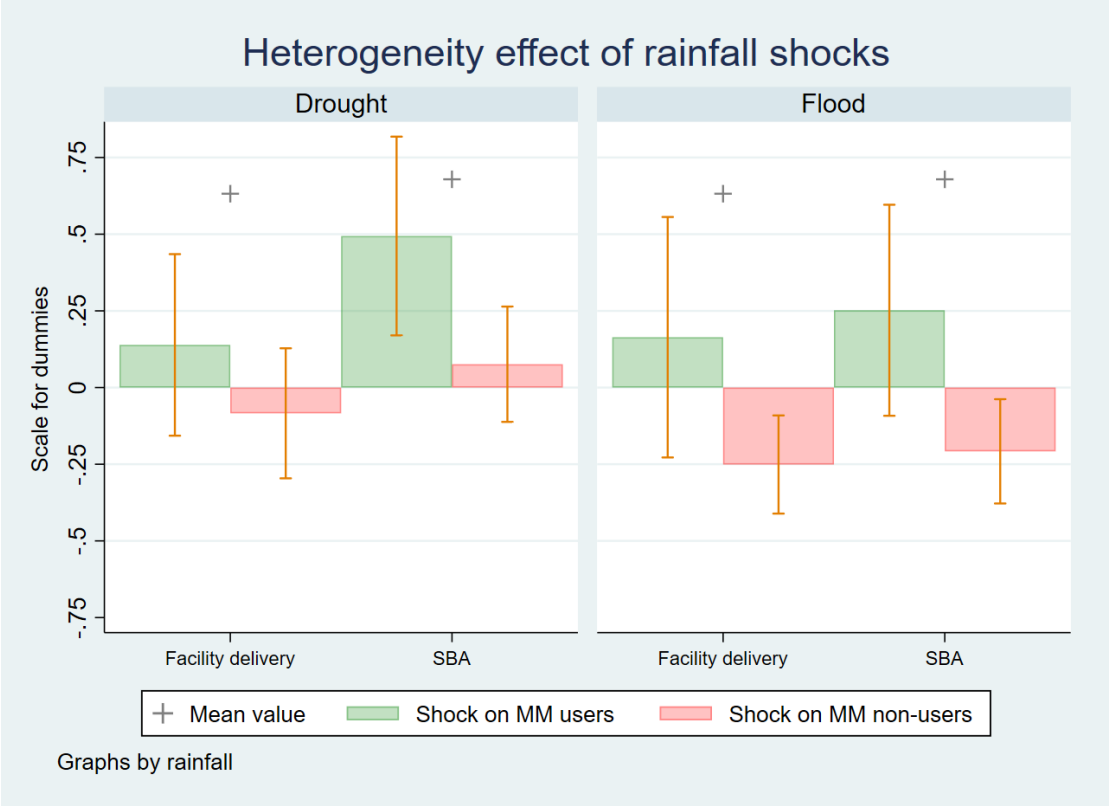
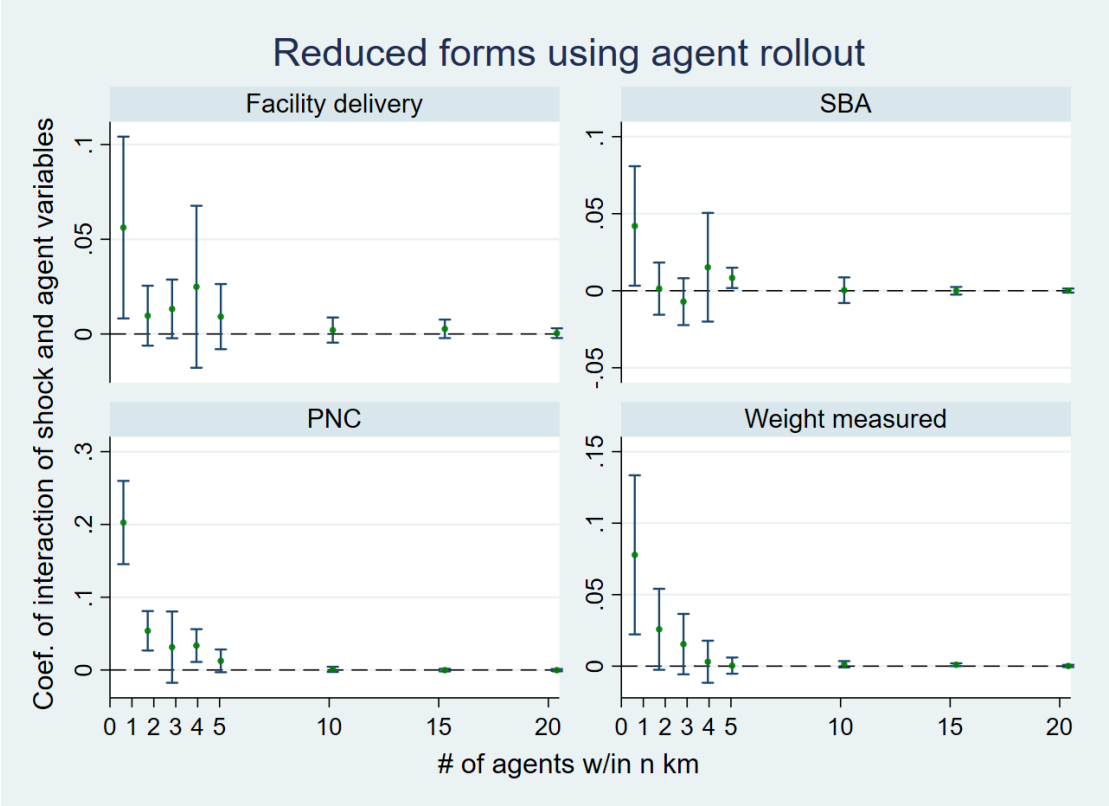
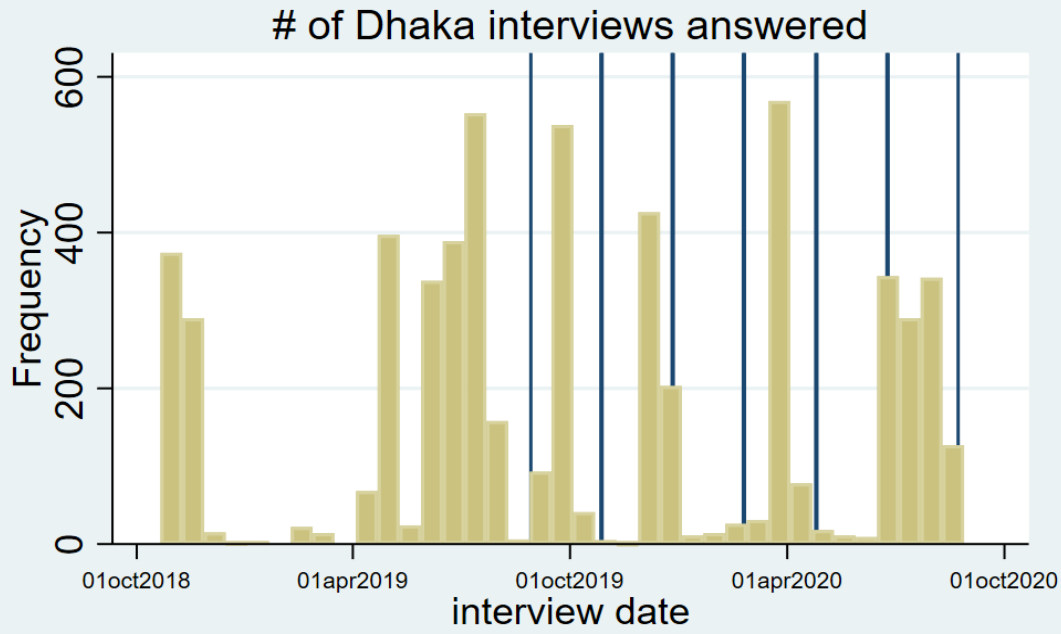


Figure 2.4. Reduced forms (of four outcome variables) using agent rollout

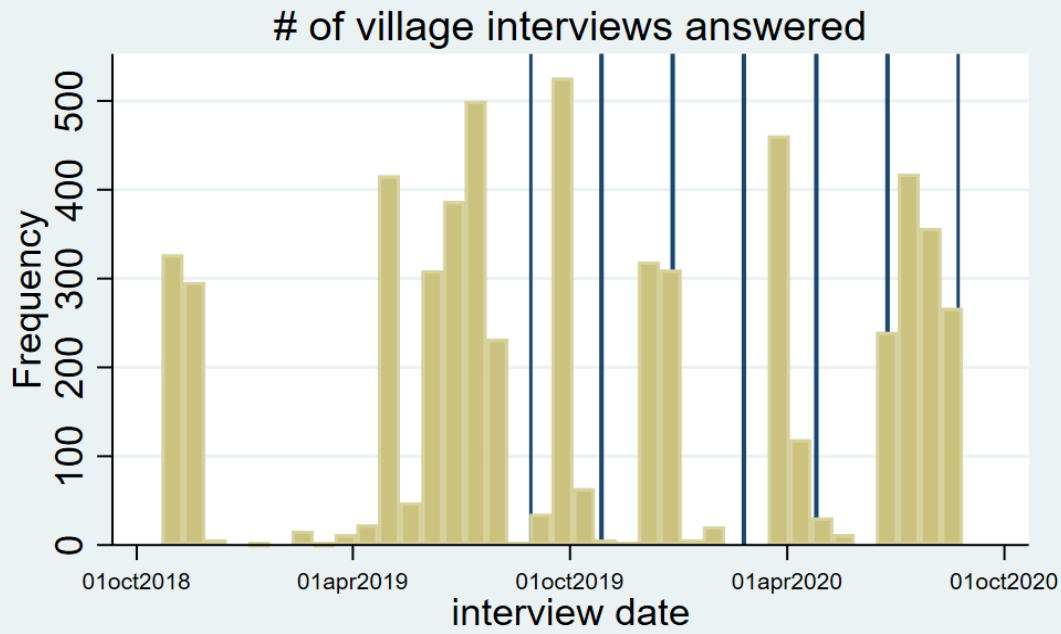


Notes: 1) The coefficients are calculated in separate regressions and the point estimates are shown with 95% confidence intervals. 2) The estimated coefficients of interactions of shock and number of agents within 1, 2, 3, 4, 5, 10, 15, 20 km, respectively, are shown.

Figure 3.1. Histogram of number of interviews (with Dhaka respondents and village respondents) by interview dates



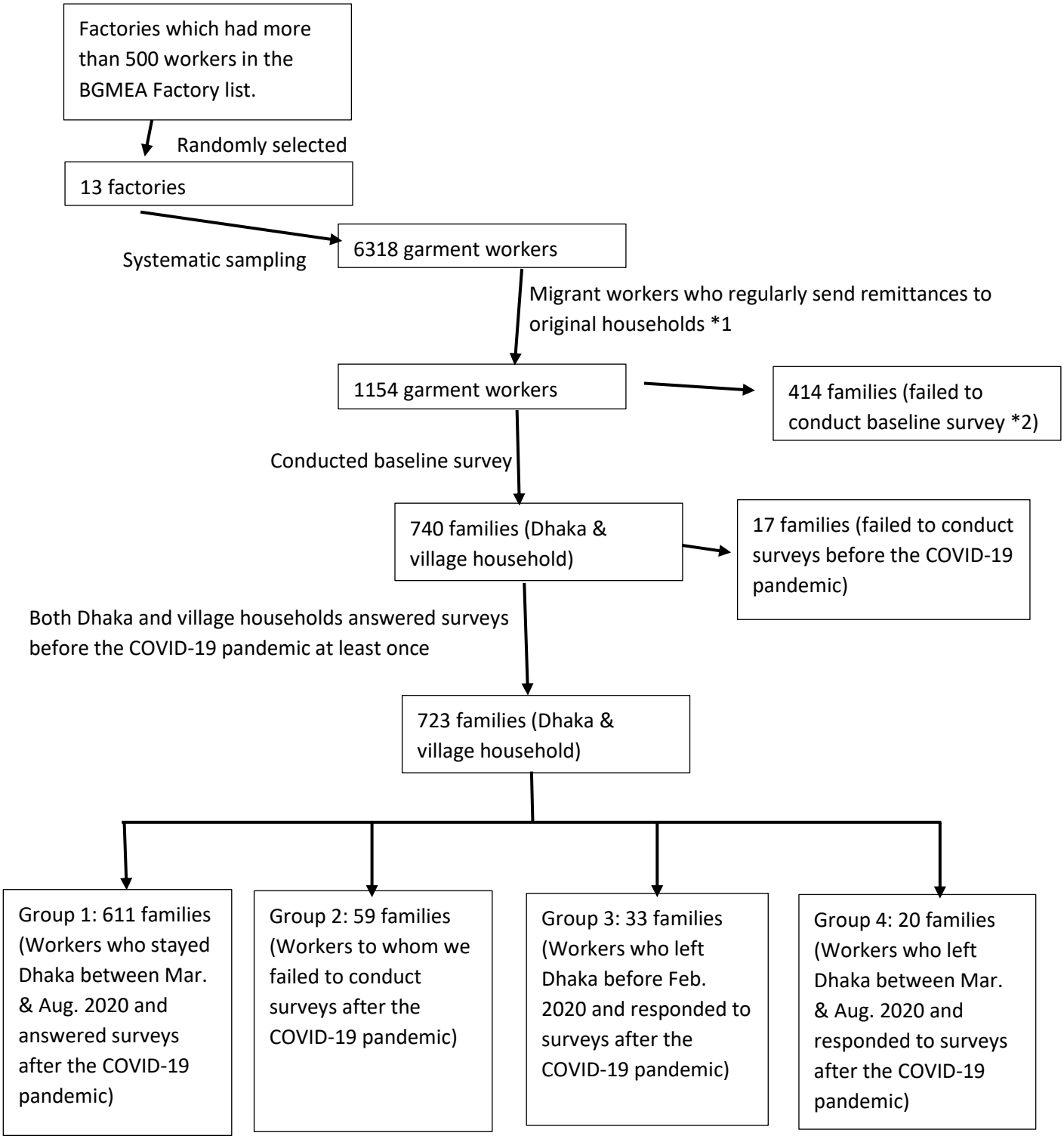
Information collected: money inflow/outflow, income, shocks
Note: The bins used for event study is shown.



Information collected: remittances, shocks
Note: The bins used for event study is shown.

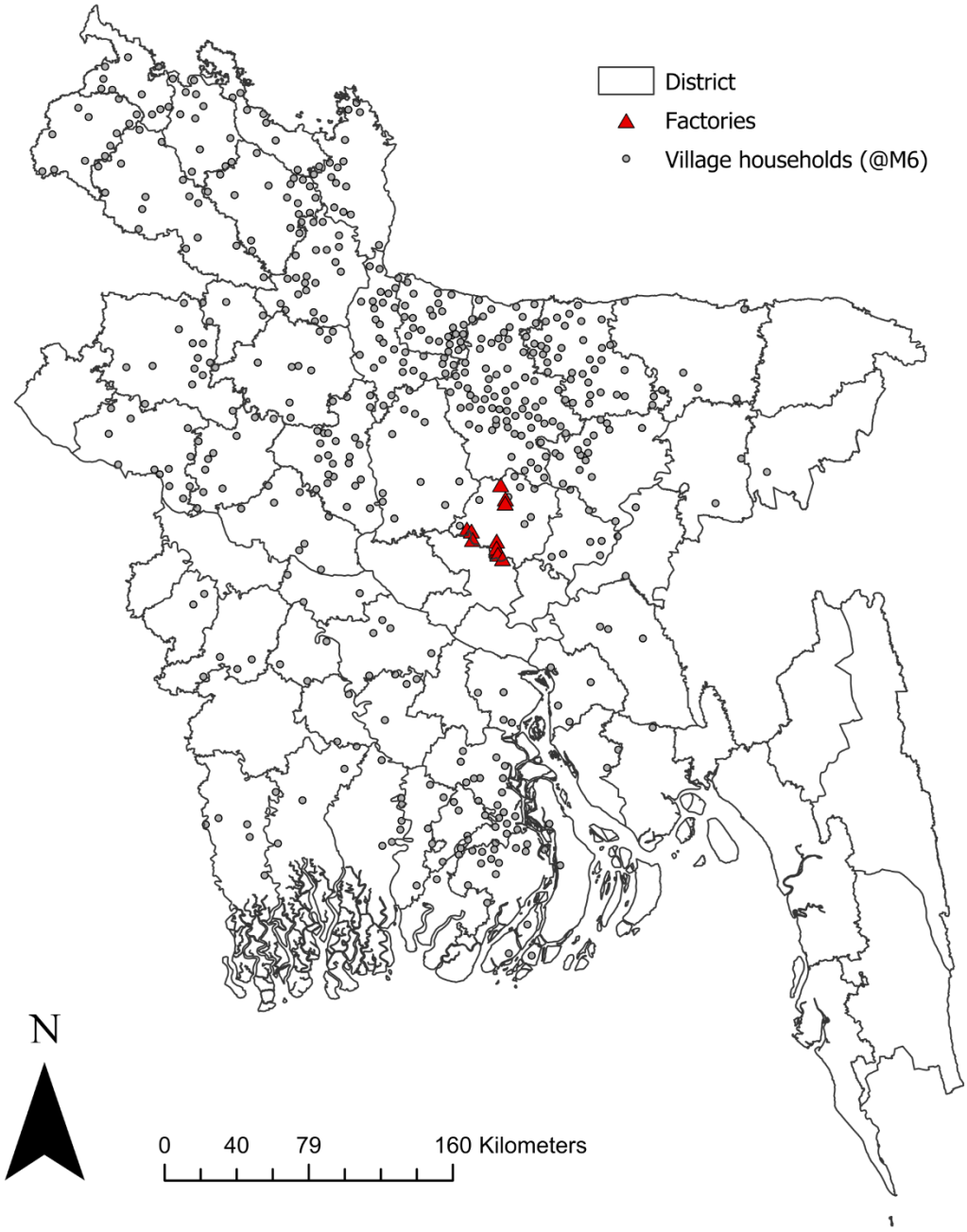
Note: 1) March 26th, 2020 was the date of implementation of the lockdown in Bangladesh. 2) The bins for the event studies are shown.

Figure 3.2. Sample selection and contacting respondents before and after COVID-19 pandemic



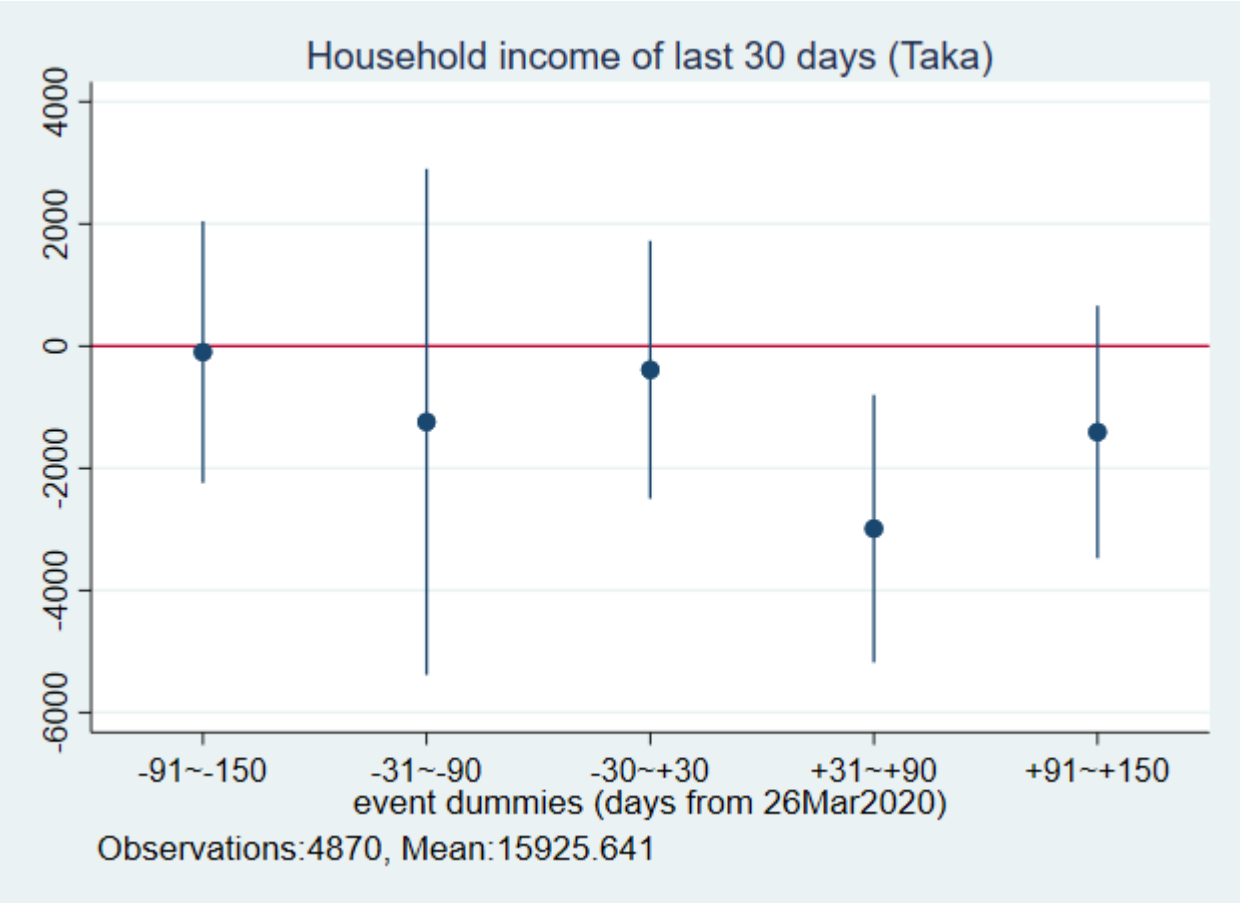
*1. Those workers also satisfy the required criteria of the EduMatch program shown in Appendix 2.2.
*2. Or not eligible for the EduMatch program.

Figure 3.3. Location of village households and factories



Notes: The village households' locations at round six follow-up survey are shown.

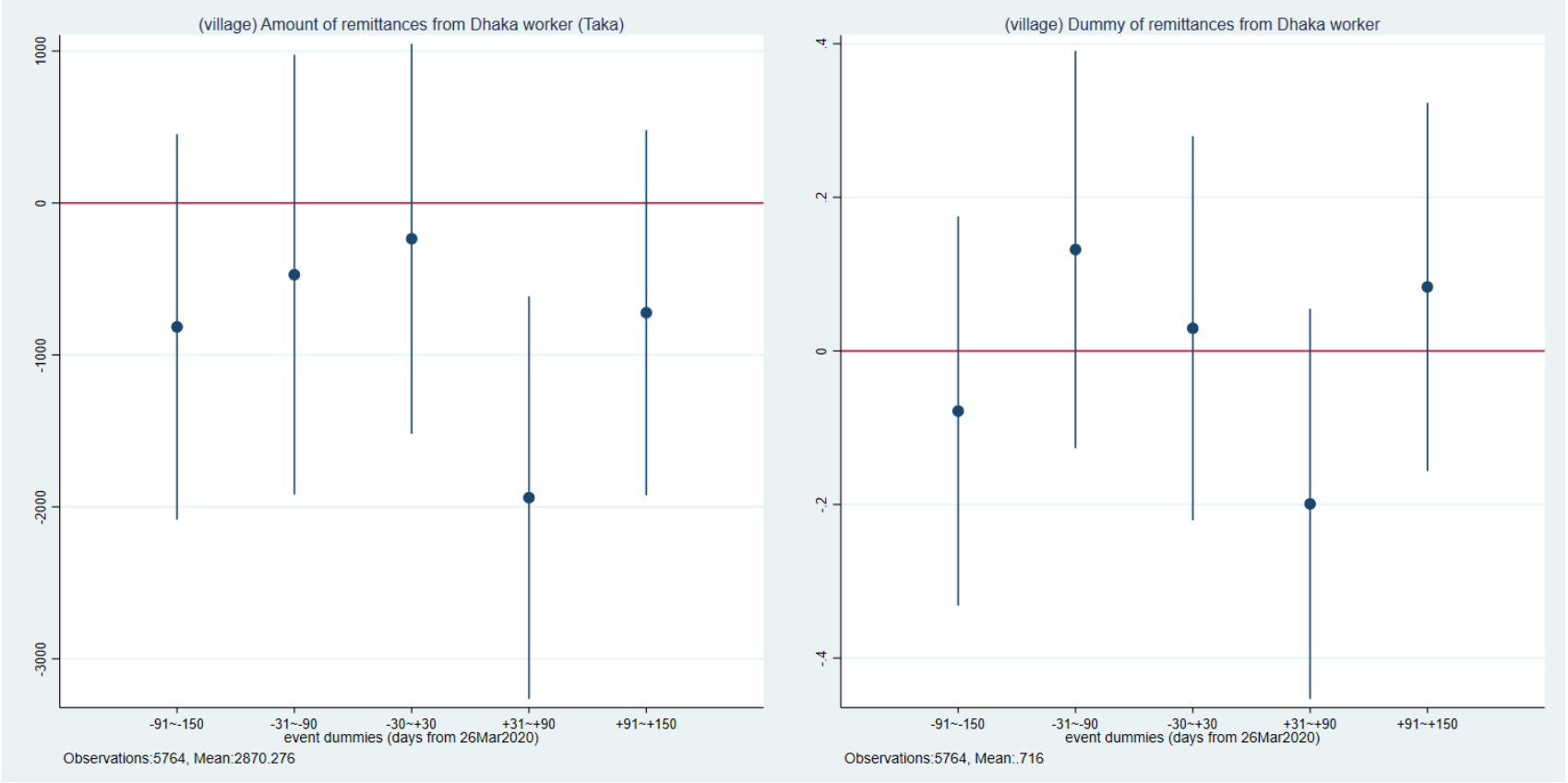
Figure 3.4. COVID-19 shock to Dhaka households' income



Notes: 1) Standard errors are clustered at combinations of factory, year and bi-month. 2) Together with 95% confidence intervals, the figure reports the dynamic coefficients obtained from the specification of equation (3) in the main text.

Figure 3.5. Cut of remittances sent from Dhaka workers to village households in response to COVID-19 lockdown

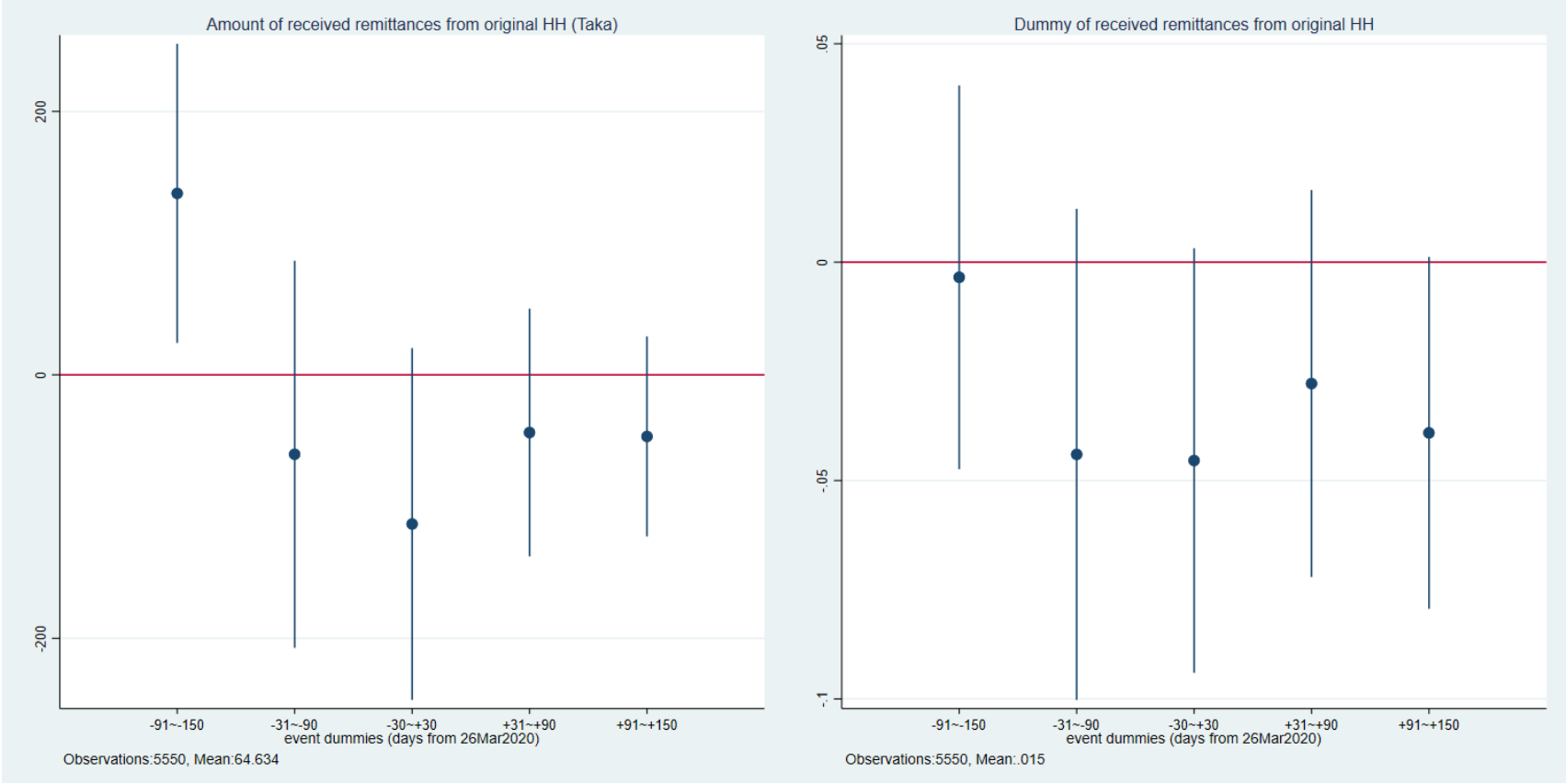
(a) Amount of remittances (Taka) (b) Dummy of remittances



Notes: 1) Standard errors are clustered at upazila-level. 2) Together with 95% confidence intervals, the figures report the dynamic coefficients obtained from the specification of equation (4) in the main text. 3) The measures of remittances in the figures are those answered by the village households.

Figure 3.6. No additional remittances sent from village households to Dhaka workers in response to COVID-19 shock

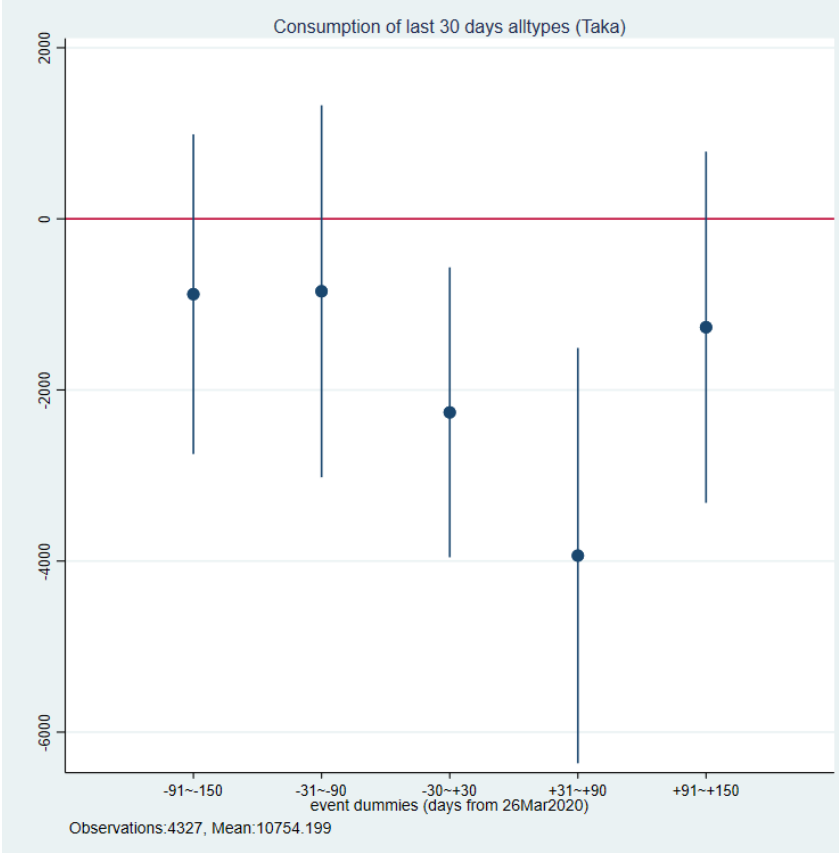
(a) Amount of remittances (Taka) (b) Dummy of remittances



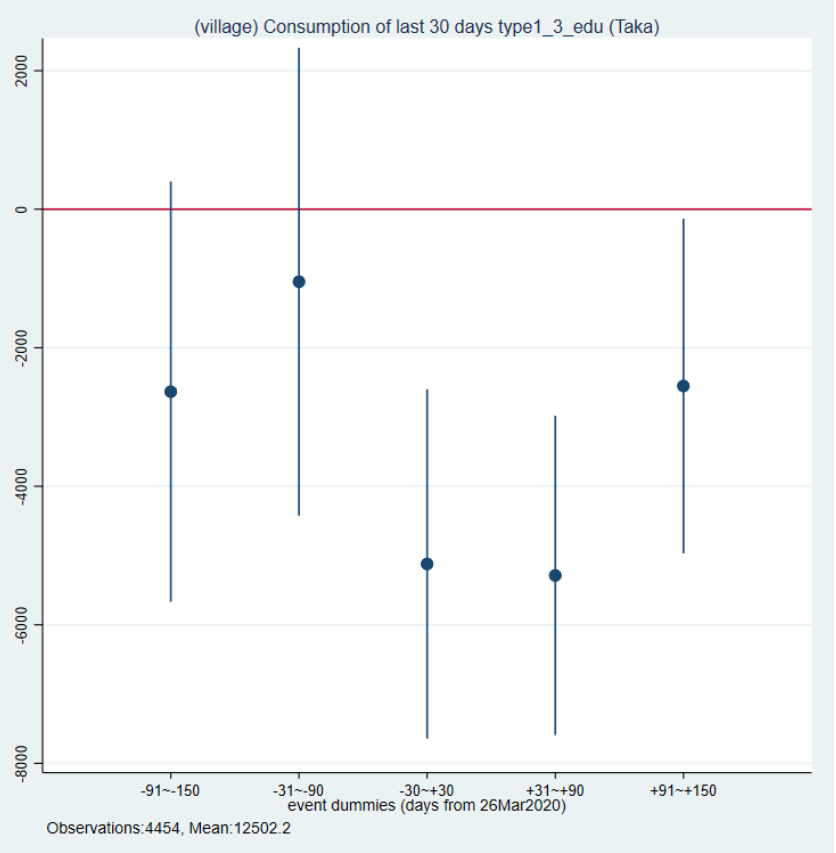
Notes: 1) Standard errors are clustered at combinations of factory, year and bi-month. 2) Together with 95% confidence intervals, the figures report the dynamic coefficients obtained from the specification of equation (3) in the main text. 3) The measures of remittances in the figures are those answered by the Dhaka households.

Figure 3.7. COVID-19 shock to consumption of Dhaka households and village households

(a) Dhaka household consumption of last 30 days (Taka)



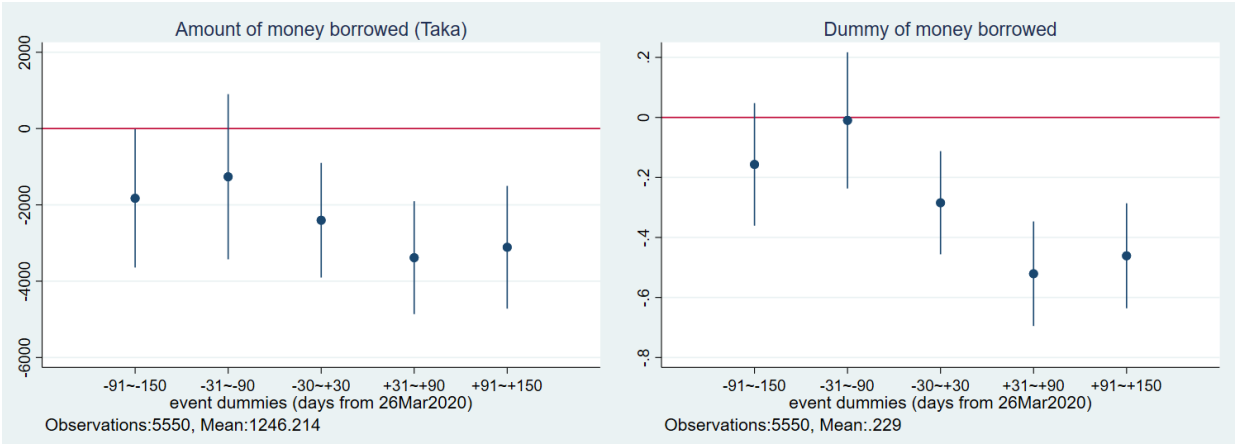
(b) Village household consumption of last 30 days(Taka)



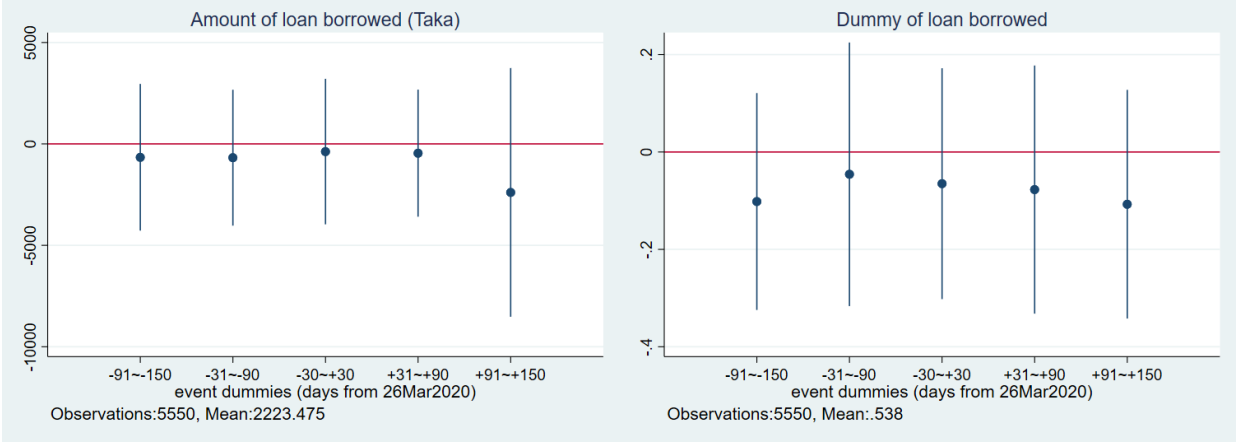
Notes: 1) For figure (a), standard errors are clustered at combinations of factory, year and bi-month. For figure (b), standard errors are clustered at upazila-level. 1) Together with 95% confidence intervals, the figures report the dynamic coefficients obtained from the specification of equation (3) for figure (a) and equation (4) for figure (b), respectively, in the main text.

Figure 3.8. COVID-19 shock to borrowing and loaning behavior

(a) Amount of money borrowed by Dhaka HHs (b) Dummy of money borrowed by Dhaka HHs



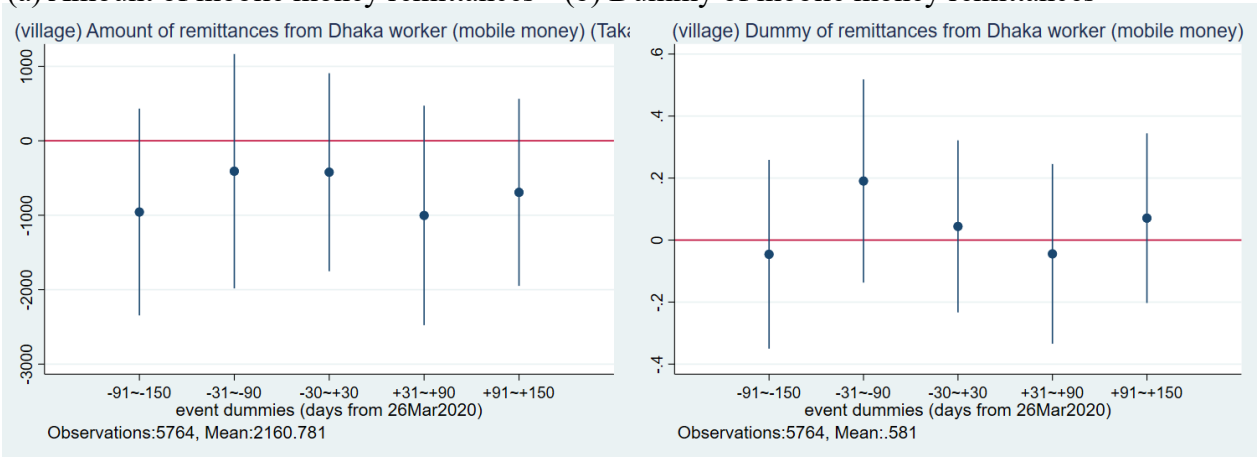
(c) Amount of hand-carry remittances (Taka) (d) Dummy of hand-carry remittances



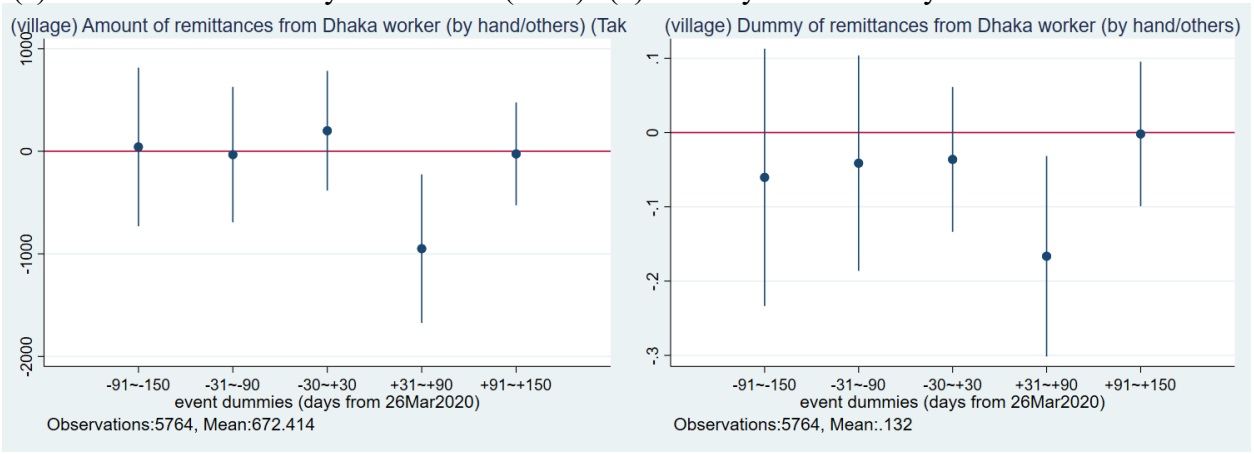
Notes: 1) Standard errors are clustered at combinations of factory, year and bi-month. 2) Together with 95% confidence intervals, the figures report the dynamic coefficients obtained from the specification of equation (3) in the main text. 3) The measures of remittances in the figures are those answered by the Dhaka households.

Figure 3.9. Stable mobile money remittances and no hand-carry remittances amid COVID-19 lockdown

(a) Amount of mobile money remittances (b) Dummy of mobile money remittances



(c) Amount of hand-carry remittances (Taka) (d) Dummy of hand-carry remittances



Notes: 1) Standard errors are clustered at upazila-level. 2) Together with 95% confidence intervals, the figures report the dynamic coefficients obtained from the specification of equation (4) in the main text. 3) The measures of remittances are those answered by the village households.

Appendix

Appendix 1. Appendix for Chapter 2

Appendix 1.1. Details on surveys and data construction

In this Appendix, we elaborate on the surveys that we use.

Appendix 1.1.1. Household level panel survey

- The RePEAT data of 2003-2012 consists of around 940 rural households.
- At the round 2015, additional households were surveyed; 1732 households were surveyed in total. Among the households, 847 households were the households that were surveyed in 2012. The rest of the households were new samples. One hundred seventeen villages were sampled at the round 2015 (meaning that 23 new villages were sampled); fifteen households were surveyed from each of the villages (meaning that five additional households were sampled from the 94 villages which were surveyed at the round 2012; fifteen households were sampled from the 23 newly sampled villages). However, the questions on the maternal health-seeking behavior were not asked to the newly sampled 846 households. Thus, we do not include those additional households.

Appendix 1.1.2. Retrospective reports on maternity care

- The survey round 2012 and 2015 asked retrospective questions on maternal care that we use.
- In the survey round 2005, though mothers were asked about their pregnancy experiences, the questionnaire did not include questions on ANC. That is one of the reasons that we do not use pregnancy reports from round 2005.

Appendix 1.1.3. Retrospective reports on mobile money use

- The survey round 2012 and 2015 asked retrospective questions on mobile money use.
- The 2012 survey asked the following questions:
    - Do you/your spouse use mobile money services?
    - If yes, do you/your spouse own a mobile money account?
    - If yes, when did you open the account (year)?
- The 2015 survey asked the following questions:
    - Has any member of this household ever used mobile money?
    - If yes, which year did the first person start to use mobile money in this household?
- A drawback of using those questions to define mobile money use is measurement errors. The questions asked in which year a household opened a mobile money account (2012) or started to use mobile money (2015). Thus, we cannot know whether the household continued using mobile money frequently since then. A household might have stopped using mobile money. This causes measurement errors of the indicator of mobile money use. As a result, our estimate may have a downward bias and be more conservative.

Appendix 1.2. Interpolation methodology

We implement interpolation of household-level data in the following manner. The values of the three survey rounds (2009, 2012, and 2015) are copied to the years of pregnancy surrounding each survey round.

Table A1.1 Details of interpolation

Years of pregnancy	Survey years of the data used for interpolation	Interpolation	Number of observations	Percent	Cum.
2000	2009	Copied	4	0.32	0.32
2001	2009	Copied	28	2.25	2.57
2002	2009	Copied	36	2.89	5.45
2003	2009	Copied	27	2.17	7.62
2004	2009	Copied	39	3.13	10.75
2005	2009	Copied	131	10.51	21.25
2006	2009	Copied	129	10.34	31.6
2007	2009	Copied	124	9.94	41.54
2008	2009	Copied	136	10.91	52.45
2009	2009	Survey year	114	9.14	61.59
2010	2009	Copied	118	9.46	71.05
2011	2012	Copied	119	9.54	80.59
2012	2012	Survey year	105	8.42	89.01
2013	2012	Copied	52	4.17	93.18
2014	2015	Copied	41	3.29	96.47
2015	2015	Survey year	44	3.53	100

Appendix 1.3. Notes on constructing variables

Appendix 1.3.1. Questionnaire that are used for constructing outcome variables

1. Recommended ANC

The questionnaire of the survey is: “where did you typically receive antenatal care?” The RePEAT survey does not ask mothers where they receive ANC for each trimester. Thus, if a woman visited two or more types of providers, a typical provider was reported.

2. Facility delivery

The questionnaire of the survey is: “where did you go for delivery, or treatment for miscarriage?”

3. Skilled birth attendance

The questionnaire of the survey is: “who attended the delivery?”

Appendix 1.3.2. How we construct dummy indicating the road condition

- The dummy indicating the road condition is time invariant. To create this variable, we mainly use the information in the round 2015 because it covers the most significant number of villages. Three villages’ information was complemented with the data of the 2012 round.

Appendix 1.4. Falsification test

Table A1.2 Falsification test: placebo mobile money dummy

Dependent variable:	Facility delivery				Skilled birth attendance			
	Parish FE		Mother FE		Parish FE		Mother FE	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Placebo mobile money dummy	-.0944	-.0821	-.0716	-.104	-.0582	-.0581	-.0524	-.0747
	(.0862)	(.101)	(.101)	(.116)	(.0727)	(.0737)	(.111)	(.11)
Placebo dummy * Shock	-.101	-.265	.188	.349**	-.0797	-.212*	.00178	.136
	(.137)	(.178)	(.122)	(.162)	(.135)	(.114)	(.115)	(.127)
Rainfall Shock	-.0783	-.628**	-.336***	-.976*	-.0231	-.737***	-.153**	-1.07**
	(.108)	(.26)	(.086)	(.519)	(.117)	(.236)	(.0671)	(.483)
Observations	507	507	278	278	518	518	286	286
R-squared	.534	.57	.873	.885	.556	.596	.882	.898
Year*District	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parish FE	Yes	Yes	-	-	Yes	Yes	-	-
Mother FE	-	-	Yes	Yes	-	-	Yes	Yes
Interactions with shock	-	Yes	-	Yes	-	Yes	-	Yes
Negative shock	-.1	.164	-.295***	-.332***	-.041	.174*	-.153***	-.254**
	[.089]	[.099]	[.07]	[.104]	[.105]	[.1]	[.048]	[.091]
(A) Shock, MM users	-.179*	-.006	-.149	-.106	-.103	.036	-.151**	-.097
	[.094]	[.141]	[.087]	[.09]	[.126]	[.073]	[.069]	[.122]
(B) Shock, non-users	-.078	.211*	-.336***	-.396***	-.023	.213*	-.153**	-.298***
	[.108]	[.106]	[.086]	[.126]	[.117]	[.116]	[.067]	[.101]
(C) Shock, non-users |*userX's*	-	.259	-	-.455***	-	.248*	-	-.233**
	-	[.173]	-	[.155]	-	[.131]	-	[.094]
F stat (A)=(B)	.54	2.477	2.378	4.256*	.349	2.987*	0	2.306
F stat (A)=(C)	-	2.22	-	4.63**	-	3.492*	-	1.152

1) Regressions include control variables: years of mother's education, mother's age, parity, a dummy taking one if the household had mobile phone, number of household members, number of migrants in household, household's asset value in log, household's land size in log, years of household head's education, a dummy taking one if household had non-agricultural business, a dummy taking one if household was far from the closest road, a dummy taking one if household was far in altitude from village reference point, a dummy indicating an area largely occupied by water surface, a dummy indicating that the distance from the household location to the reference point of the village was larger than the mean, a dummy indicating that the driving time to the nearest district town from the village was less than the mean, three dummies for the number of higher-level health facilities, and two dummies for the number of lower-level health facilities.
2) When there are interactions with the shock this set of control variables is interacted with the shock but not shown here for brevity.
3) Standard errors are clustered at district level. Significance level: * p<0.1, ** p<0.05, *** p<0.01.
4) The regressions use the data of 2000-2008 (mobile money services in Uganda began in 2009). The placebo mobile money dummy takes one if the observation is a second (and more) birth of a mother during the period of 2000-2008 for the household which used mobile money in 2015. It takes a value of zero for the rest of the observations in the sub-set.

Appendix 1.5. Reduced forms

Table A1.3 Reduced forms using agent rollout

Dependent variable:	Facility delivery						Skilled birth attendance					
Agent variables:	Agents w/in 1km	Agents w/in 2km	Agents w/in 3km	Agents w/in 5km	Agents w/in 20km	Distance to closest agent	Agents w/in 1km	Agents w/in 2km	Agents w/in 3km	Agents w/in 5km	Agents w/in 20km	Distance to closest agent
	1	2	3	4	5	6	7	8	9	10	11	12
Agent	-.0821**	-.00568	-.0044	-.00742	-.000273	-.033	-.0684**	-.00877**	-.00661*	-.00955**	-.000107	.0135
	(.0352)	(.00607)	(.00429)	(.00688)	(.00133)	(.0625)	(.0328)	(.00337)	(.00371)	(.00347)	(.000644)	(.039)
Agent*shock	.0562**	.00966	.0132*	.00917	.000425	-.0409	.042**	.00136	-.00709	.00832**	.00011	-.0427*
	(.0231)	(.00762)	(.00747)	(.00828)	(.00123)	(.0315)	(.0187)	(.00817)	(.00734)	(.00318)	(.000637)	(.0227)
Rainfall Shock	-.156***	-.153***	-.158***	-.168***	-.163***	-.0135	-.101*	-.0982*	-.0927*	-.111*	-.0993	.0542
	(.0482)	(.048)	(.05)	(.0534)	(.055)	(.124)	(.0565)	(.0547)	(.0539)	(.0588)	(.0649)	(.111)
Observations	785	785	785	785	785	785	802	802	802	802	802	802
R-squared	.817	.817	.817	.817	.817	.818	.819	.819	.819	.82	.819	.82
Year*District	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mother FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Negative shock	-.154***	-.15***	-.151***	-.156***	-.152***	-.175**	-.1*	-.098*	-.096*	-.099*	-.097	-.115*
-	[.048]	[.048]	[.049]	[.051]	[.051]	[.063]	[.056]	[.056]	[.054]	[.057]	[.059]	[.055]
Mean of agents	.031	.311	.528	1.405	25.877	3.949	.03	.307	.52	1.386	25.604	3.956
Mean of outcome variables [2009~]	.632	.632	.632	.632	.632	.632	.679	.679	.679	.679	.679	.679

1) Regressions include control variables. 2) Standard errors are clustered at district level. Significance level: * p<0.1, ** p<0.05, *** p<0.01. 3) The negative shocks are evaluated at the mean values of the agent variables.

Table A1.3 (continued)

Dependent variable:	1 indicates receiving postnatal care						1 if baby weight was measured					
Agent variables:	Agents w/in 1km	Agents w/in 2km	Agents w/in 3km	Agents w/in 5km	Agents w/in 20km	Distance to closest agent	Agents w/in 1km	Agents w/in 2km	Agents w/in 3km	Agents w/in 5km	Agents w/in 20km	Distance to closest agent
	13	14	15	16	17	18	19	20	21	22	23	24
Agent	.0285	-.0169*	-.000142	-.00722	.000487	-.0664	-.0663**	-.00855	.0143***	-.000406	-.000131	-.0922**
	(.0438)	(.00918)	(.00944)	(.00822)	(.00081)	(.0625)	(.0244)	(.00948)	(.00476)	(.00331)	(.00034)	(.037)
Agent * shock	.203***	.0538***	.0314	.0125	-.0003	-.00606	.0778***	.0258*	.0154	.000357	.000135	-.0414**
	(.0276)	(.0131)	(.0236)	(.00755)	(.000737)	(.0248)	(.0268)	(.0137)	(.0102)	(.00272)	(.000363)	(.019)
Rainfall Shock	-.0712*	-.0715**	-.0663**	-.0804*	-.0447	-.0428	-.202***	-.203***	-.2***	-.193***	-.197***	-.0689
	(.0362)	(.0309)	(.0288)	(.039)	(.0408)	(.106)	(.0591)	(.0639)	(.0688)	(.0626)	(.0676)	(.0976)
Observations	732	732	732	732	732	732	745	745	745	745	745	745
R-squared	.897	.893	.891	.892	.891	.892	.831	.831	.832	.831	.831	.834
Year*District	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mother FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Negative shock	-.065*	-.056*	-.051	-.064*	-.052*	-.067**	-.2***	-.196***	-.192***	-.193***	-.193***	-.233***
-	[.036]	[.031]	[.031]	[.032]	[.029]	[.031]	[.059]	[.062]	[.067]	[.062]	[.061]	[.073]
Mean of agents	.03	.294	.497	1.298	24.914	3.982	.031	.29	.512	1.396	25.909	3.959
Mean of outcome variables [2009~]	.317	.317	.317	.317	.317	.317	.588	.588	.588	.588	.588	.588

Table A1.3 (continued)

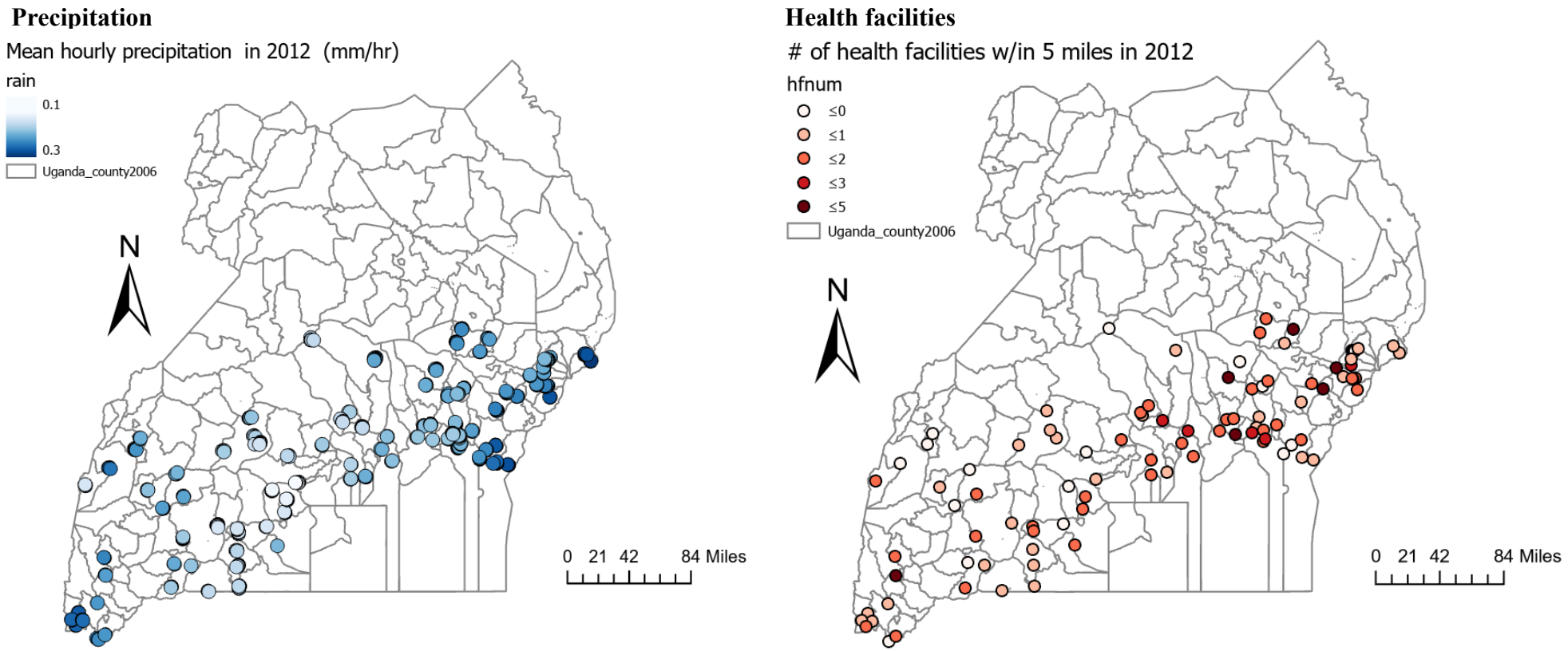
Dependent variable:	Recommended ANC						1 indicates receiving antenatal care of five times					
Agent variables:	Agents w/in 1km	Agents w/in 2km	Agents w/in 3km	Agents w/in 5km	Agents w/in 20km	Distance to closest agent	Agents w/in 1km	Agents w/in 2km	Agents w/in 3km	Agents w/in 5km	Agents w/in 20km	Distance to closest agent
	1	2	3	4	5	6	7	8	9	10	11	12
agent	.0186	-.00685	-.0158***	-.0137**	-.00174	-.0845	-.00683	-.00739	-.0157***	-.0152***	-.00166	-.095
	(.0657)	(.00967)	(.00435)	(.00522)	(.00118)	(.0589)	(.0627)	(.00907)	(.00457)	(.00502)	(.00119)	(.0572)
Agent * shock	.139***	.0349**	.0416**	.00909	.00119	.0315	.168***	.0404**	.044*	.0104	.00104	.0104
	(.0395)	(.0144)	(.0196)	(.00838)	(.00113)	(.0456)	(.0392)	(.0153)	(.0212)	(.00761)	(.00115)	(.042)
Rainfall Shock	-.0633	-.0558	-.0803	-.0573	-.0756	-.163	.0272	.0355	.0106	.0332	.0228	-.00633
	(.0722)	(.0776)	(.0758)	(.0864)	(.0729)	(.204)	(.0664)	(.0704)	(.071)	(.0822)	(.0798)	(.174)
Observations	479	479	479	479	479	479	479	479	479	479	479	479
R-squared	.854	.852	.854	.853	.856	.852	.86	.858	.86	.859	.862	.858
Year*District	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mother FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Negative shock	-.057	-.04	-.049	-.039	-.032	-.063	.035	.054	.044	.054	.061	.027
-	[.071]	[.079]	[.079]	[.085]	[.086]	[.081]	[.066]	[.073]	[.075]	[.078]	[.067]	[.073]
Mean of agents	.044	.446	.756	2.007	36.94	3.178	.044	.446	.756	2.007	36.94	3.178
Mean of outcome variables [2009~]	.253	.253	.253	.253	.253	.253	.22	.22	.22	.22	.22	.22

Table A1.3 (continued)

Dependent variable:	Number of times that mother received antenatal care					
Agent variables:	Agents w/in 1km	Agents w/in 2km	Agents w/in 3km	Agents w/in 5km	Agents w/in 20km	Distance to closest agent
	1	2	3	4	5	6
agent	.11	.0456	-.0849	-.0409	-.00063	-1.11**
	(.497)	(.081)	(.172)	(.0838)	(.00376)	(.448)
Agent * shock	.23	.0724	.0963	-.00248	-.00178	.55*
	(.275)	(.151)	(.151)	(.0688)	(.00377)	(.304)
Rainfall Shock	.756*	.801*	.681	.831*	.882*	-1.18
	(.397)	(.427)	(.411)	(.465)	(.432)	(1.22)
Observations	473	473	473	473	473	473
R-squared	.823	.824	.824	.824	.824	.828
Year*District	Yes	Yes	Yes	Yes	Yes	Yes
Mother FE	Yes	Yes	Yes	Yes	Yes	Yes
Negative shock	.766*	.83*	.75*	.826*	.817**	0.568
-	[.39]	[.411]	[.422]	[.411]	[.386]	[.485]
Mean of agents	.043	.408	.719	1.976	36.894	3.181
Mean of outcome variables [2009~]	3.985	3.985	3.985	3.985	3.985	3.985

Appendix 1.6. Geographical variations of precipitation and health facilities

Figure A1.1 Precipitation and health facilities

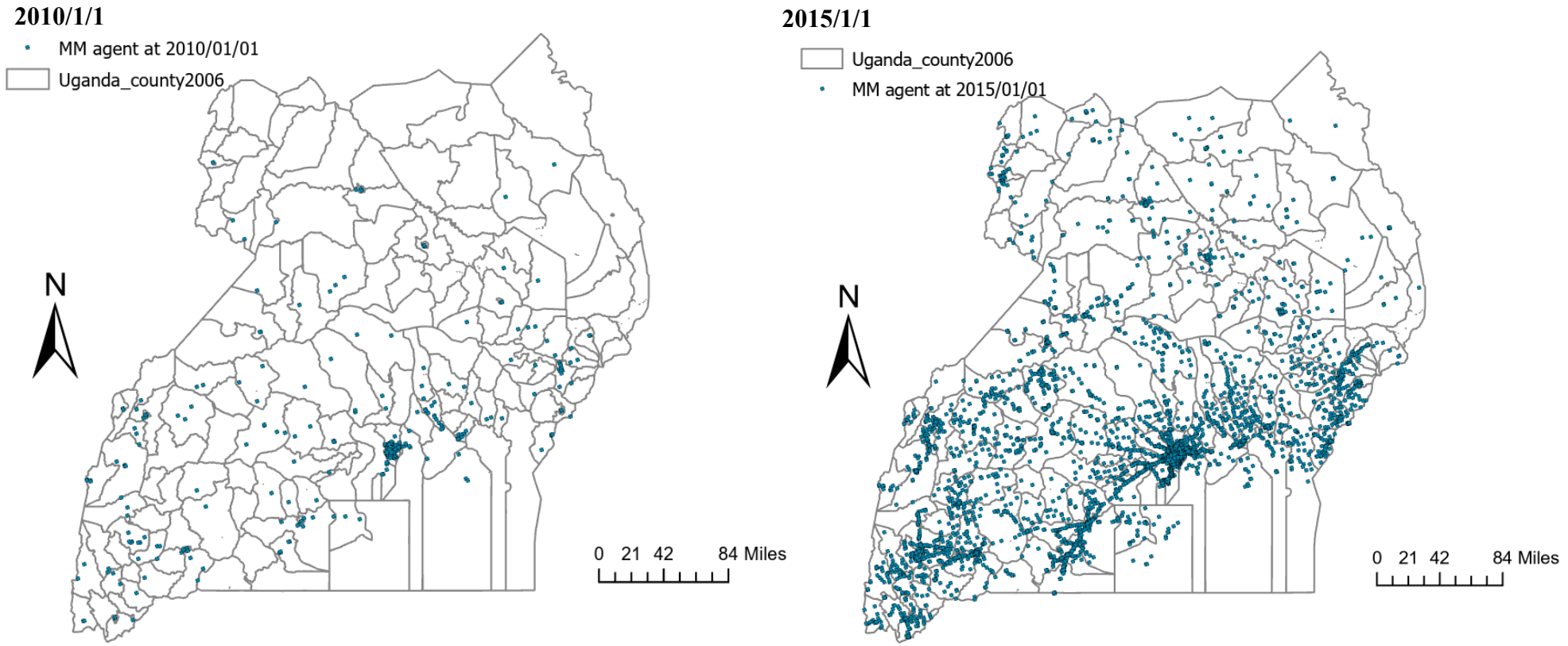


Notes: Mean hourly precipitation is calculated based on household-level GPS information. Number of health facilities are drawn from the village-level information of the RePEAT data.

Source: Goddard Earth Sciences Data and Information Services Center, RePEAT 2012 and 2015.

Appendix 1.7. Geographical variations of mobile money agents

Figure A1.2 Mobile money agents' locations



Source: FSPMaps.com

Appendix 2. Appendix for Chapter 3

Appendix 2.1. Bangladesh RMG (Ready-Made-Garments) Export Value per month

Table A2.1 RMG export value per month

Calendar Month, Year	RMG export nominal value (Million US$)	Year to year growth
Jan-2020	3,039	-3.0%
Feb-2020	2,784	-4.3%
Mar-2020	2,256	-20.1%
Apr-2020	375	-85.2%
May-2020	1,231	-62.0%
Jun-2020	2,240	-6.6%
Jul-2020	3,240	-2.1%
Aug-2020	3,240	45.3%

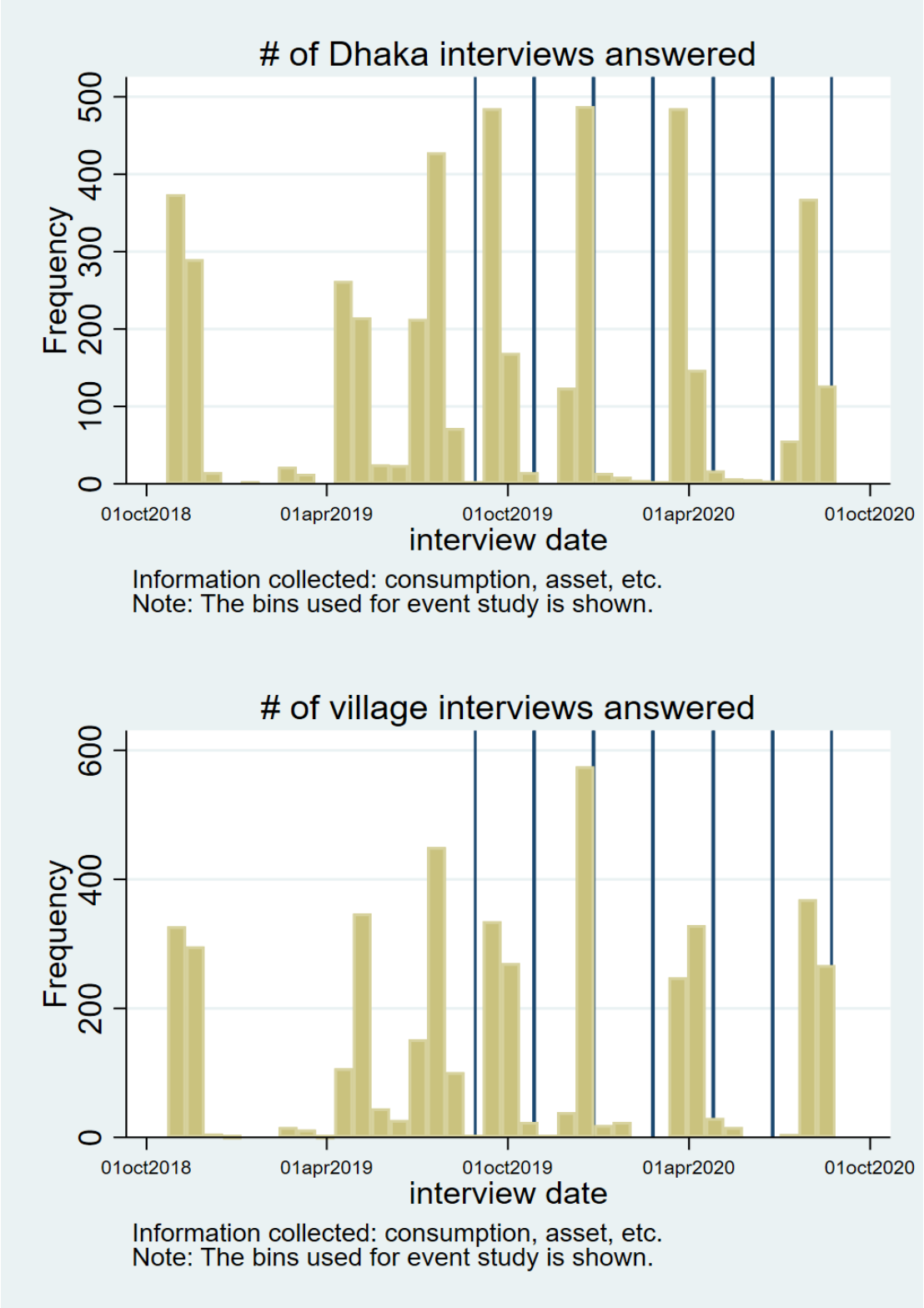
Source: The Financial Express (2020a), which brought the data from BGMEA.

Appendix 2.2. Process of selecting samples from list of 6,318 workers

In this section, we outline the process of selecting 740 migrant families used in the EduMatch project. From 6,318 workers, 1,154 workers eligible for the field experiment of the EduMatch project were extracted. Because the field experiment was related to educational investment, we set the eligibility conditions to the following two points. That is, a student of a particular grade who was scheduled to take the exam was in the subject's village home (students who will be in the grade 4, 5, 7, 8, 10 in 2019), and in addition, the subject remitted money to his or her village home on a regular basis.

Appendix 2.3. Histogram of interviews by interview date

Figure A2.1 Interview dates of outcome variables other than money flows



Notes: 1) March 26th, 2020 was the date of implementation of the lockdown in Bangladesh. 2) The bins for the event studies are shown. 3) In the main texts, the interview dates of asking questions about money flows are shown. This figure shows the interview dates of asking about consumption, asset, and other kinds of questions are shown.

Appendix 2.4. Descriptive table of four groups (full table)

Table A2.2 Full list of baseline characteristics of Dhaka households and village households of four groups

Variable	N	(1) Dhaka HH complete cases Mean/SE	N	(2) Pure Attrition in Mar-Aug2020 Mean/SE	N	(3) Attrition b/c left Dhaka ~Feb2020 Mean/SE	N	(4) Attrition b/c left Dhaka Mar~Aug2020 Mean/SE	t-test Difference (1)-(2)	t-test Difference (1)-(3)	t-test Difference (1)-(4)
age of Dhaka respondent	611	28.856	59	27.542	33	25.970	20	25.150	1.314	2.886**	3.706**
		[0.271]		[0.886]		[1.048]		[1.148]			
1 if Dhaka respondent is male	611	0.565	59	0.424	33	0.424	20	0.450	0.141**	0.140	0.115
		[0.020]		[0.065]		[0.087]		[0.114]			
1 if Dhaka respondent is married	611	0.768	59	0.576	33	0.606	20	0.850	0.191***	0.162**	-0.082
		[0.017]		[0.065]		[0.086]		[0.082]			
1 if Dhaka respondent is widow/widower/divorced/separated	611	0.049	59	0.153	33	0.030	20	0.000	-0.103***	0.019	0.049
		[0.009]		[0.047]		[0.030]		[0.000]			
1 if respondent is household head	611	0.655	59	0.627	33	0.545	20	0.500	0.028	0.109	0.155
		[0.019]		[0.063]		[0.088]		[0.115]			
1 if respondent is spouse of the household head	611	0.314	59	0.305	33	0.394	20	0.500	0.009	-0.080	-0.186*
		[0.019]		[0.060]		[0.086]		[0.115]			
# of household members in Dhaka	611	2.013	59	1.797	33	1.818	20	1.950	0.216*	0.195	0.063
		[0.039]		[0.099]		[0.160]		[0.185]			
Dhaka respondent did not get PSC or did not attend school	611	0.133	59	0.237	33	0.091	20	0.250	-0.105**	0.042	-0.117
		[0.014]		[0.056]		[0.051]		[0.099]			
Dhaka respondent completed PSC	611	0.188	59	0.203	33	0.182	20	0.150	-0.015	0.006	0.038
		[0.016]		[0.053]		[0.068]		[0.082]			
Dhaka respondent completed grade 6 ~ grade 9	611	0.401	59	0.407	33	0.424	20	0.350	-0.006	-0.023	0.051

		[0.020]		[0.065]		[0.087]		[0.109]			
Dhaka respondent graduated from SSC or above SSC	611	0.272	59	0.153	33	0.303	20	0.250	0.119**	-0.031	0.022
		[0.018]		[0.047]		[0.081]		[0.099]			
1 if Dhaka respondent's job: RMG worker	611	0.992	59	0.983	33	1.000	20	0.950	0.009	-0.008	0.042*
		[0.004]		[0.017]		[0.000]		[0.050]			
1 if Dhaka respondent's job: Housewifery	611	0.002	59	0.000	33	0.000	20	0.000	0.002	0.002	0.002
		[0.002]		[0.000]		[0.000]		[0.000]			
1 if Dhaka respondent's job: Business, Other industries' employee, else	611	0.007	59	0.000	33	0.000	20	0.000	0.007	0.007	0.007
		[0.003]		[0.000]		[0.000]		[0.000]			
1 if using mobile money through agent account	611	0.311	59	0.356	33	0.364	20	0.300	-0.045	-0.053	0.011
		[0.019]		[0.063]		[0.085]		[0.105]			
1 if using mobile money through own account	611	0.453	59	0.424	33	0.364	20	0.400	0.030	0.090	0.053
		[0.020]		[0.065]		[0.085]		[0.112]			
1 if using mobile money through family members' account	611	0.057	59	0.068	33	0.091	20	0.050	-0.011	-0.034	0.007
		[0.009]		[0.033]		[0.051]		[0.050]			
Household income of last 30 days (Taka)	611	15484.710	59	15822.153	33	15325.091	20	15021.000	-337.442	159.619	463.710
		[232.548]		[835.301]		[1323.507]		[1110.035]			
Total value of assets (Taka) per HH member	611	5796.609	59	8960.113	33	6910.354	20	5387.500	-3163.504***	-1113.744	409.109
		[297.001]		[2428.207]		[1389.711]		[960.854]			
Consumption of last 30 days alltypes per capita (Taka)	611	5598.645	59	5599.949	33	5509.683	20	5923.665	-1.303	88.962	-325.020
		[71.368]		[198.994]		[244.950]		[489.705]			
Amount of sent remittances to original HH (Taka)	611	3064.746	59	3296.610	33	3424.242	20	2575.000	-231.864	-359.496	489.746
		[109.534]		[338.266]		[520.472]		[389.458]			
Cognitive skill measure of Dhaka respondent (low~high:0~6)	611	4.108	59	4.085	33	3.879	20	4.300	0.023	0.229	-0.192
		[0.067]		[0.208]		[0.304]		[0.424]			

(village) age of HH head	611	54.227	59	54.339	33	53.909	20	56.200	-0.111	0.318	-1.973
		[0.538]		[1.643]		[1.684]		[2.545]			
(village) 1 if HH head is male	611	0.728	59	0.695	33	0.727	20	0.800	0.033	0.001	-0.072
		[0.018]		[0.060]		[0.079]		[0.092]			
(village) 1 if HH head is married	611	0.828	59	0.780	33	0.818	20	0.900	0.048	0.010	-0.072
		[0.015]		[0.054]		[0.068]		[0.069]			
(village) 1 if HH head is widow/widower/divorced/separated	611	0.160	59	0.220	33	0.182	20	0.100	-0.060	-0.021	0.060
		[0.015]		[0.054]		[0.068]		[0.069]			
(village)HH head: wife/husband/son/daughter of Dhaka respondent	611	0.074	59	0.034	33	0.061	20	0.050	0.040	0.013	0.024
		[0.011]		[0.024]		[0.042]		[0.050]			
(village)HH head: father/mother/brother/sister/grandfa/grandmo of Dhaka respondent	611	0.710	59	0.746	33	0.667	20	0.750	-0.035	0.044	-0.040
		[0.018]		[0.057]		[0.083]		[0.099]			
(village)HH head: (In law) father/mother/brother/sister of Dhaka respondent	611	0.187	59	0.203	33	0.242	20	0.200	-0.017	-0.056	-0.013
		[0.016]		[0.053]		[0.076]		[0.092]			
(village) # of household members	611	4.597	59	4.627	33	4.364	20	4.700	-0.030	0.234	-0.103
		[0.065]		[0.213]		[0.307]		[0.309]			
(village) HH head did not get PSC or did not attend school	611	0.661	59	0.695	33	0.818	20	0.650	-0.034	-0.157*	0.011
		[0.019]		[0.060]		[0.068]		[0.109]			
(village) HH head completed PSC	611	0.124	59	0.186	33	0.091	20	0.150	-0.062	0.033	-0.026
		[0.013]		[0.051]		[0.051]		[0.082]			
(village) HH head completed grade 6 ~ grade 9	611	0.154	59	0.051	33	0.030	20	0.150	0.103**	0.124*	0.004
		[0.015]		[0.029]		[0.030]		[0.082]			
(village) HH head graduated from SSC or above SSC	611	0.061	59	0.068	33	0.061	20	0.050	-0.007	-0.000	0.011

		[0.010]		[0.033]		[0.042]		[0.050]			
(village) HH head's occupation: farming	611	0.411	59	0.356	33	0.515	20	0.450	0.055	-0.104	-0.039
		[0.020]		[0.063]		[0.088]		[0.114]			
(village) HH head's occupation: self-employment, trader, wage-labor	611	0.124	59	0.153	33	0.091	20	0.150	-0.028	0.033	-0.026
		[0.013]		[0.047]		[0.051]		[0.082]			
(village) HH head's occupation: salaried workers (i.e.goverment, teacher)	611	0.016	59	0.017	33	0.061	20	0.000	-0.001	-0.044*	0.016
		[0.005]		[0.017]		[0.042]		[0.000]			
(village) HH head's occupation: non-earning occupations (i.e.housewife)	611	0.448	59	0.475	33	0.333	20	0.400	-0.026	0.115	0.048
		[0.020]		[0.066]		[0.083]		[0.112]			
(village) Has anyone of household ever used mobile money	611	0.399	59	0.356	33	0.364	20	0.300	0.043	0.036	0.099
		[0.020]		[0.063]		[0.085]		[0.105]			
(village) 1 if using mobile money through agent account	611	0.403	59	0.373	33	0.424	20	0.400	0.030	-0.022	0.003
		[0.020]		[0.063]		[0.087]		[0.112]			
(village) 1 if using mobile money through own account	611	0.064	59	0.068	33	0.030	20	0.200	-0.004	0.034	-0.136**
		[0.010]		[0.033]		[0.030]		[0.092]			
(village) 1 if using mobile money through family members' account	611	0.134	59	0.203	33	0.182	20	0.100	-0.069	-0.048	0.034
		[0.014]		[0.053]		[0.068]		[0.069]			
(village) minutes to the closest mobile money agent by foot	611	17.136	59	17.220	33	17.121	20	14.400	-0.084	0.015	2.736
		[0.593]		[1.603]		[2.067]		[1.989]			
(village) Total value of assets (Taka) per HH member	611	3857.787	59	3284.187	33	4258.086	20	5059.345	573.600	-400.299	-1201.559
		[201.107]		[445.041]		[954.470]		[1282.645]			
(village) Total value of productive assets (Taka)	611	4921.773	59	3564.338	33	5544.535	20	5478.976	1357.435	-622.762	-557.203
		[332.246]		[730.122]		[1162.860]		[1389.736]			

(village) Total value of lands (Taka) per hh member	611	1.08e+05	59	81377.253	33	1.05e+05	20	1.33e+05	26219.025	2490.219	-2.55e+04
		[7391.360]		[13545.484]		[49556.924]		[29454.478]			
(village) Consumption of last 30 days alltypes per capita (Taka)	611	2851.187	59	2642.342	33	2754.905	20	2993.482	208.845	96.282	-142.294
		[53.279]		[110.625]		[115.007]		[309.807]			
(village) Educational consumption (~SSC) (Taka)	611	1772.473	59	1678.158	33	1707.823	20	1907.958	94.315	64.650	-135.485
		[50.508]		[114.098]		[199.203]		[215.255]			
(village) number of students (~ssc)	611	1.714	59	1.898	33	1.848	20	1.800	-0.185	-0.135	-0.086
		[0.035]		[0.089]		[0.138]		[0.172]			
F-test of joint significance (F-stat)									1.503**	0.742	1.410**
F-test, number of observations									670	644	631

Notes: 1) The value displayed for t-tests are the differences in the means across the groups. The value displayed for F-tests are the F-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level. 2) Taka is the currency of Bangladesh. As of December 21st,2020, 1 USD is 85 Taka.

Appendix 2.5. Comparison between complete cases and attrition cases of migrant workers (full table)

Table A2.3 Comparison of full list of baseline characteristics of Dhaka households and village households for Dhaka workers' attrition

	(1)		(2)		t-test
	Dhaka HH complete cases		Attrition in Mar-Aug2020		Difference
Variable	N	Mean/SE	N	Mean/SE	(1)-(2)
age of Dhaka respondent	611	28.856	112	26.652	2.204***
		[0.271]		[0.599]	
1 if Dhaka respondent is male	611	0.565	112	0.429	0.136***
		[0.020]		[0.047]	
1 if Dhaka respondent is married	611	0.768	112	0.634	0.134***
		[0.017]		[0.046]	
1 if Dhaka respondent is widow/widower/divorced/separeted	611	0.049	112	0.089	-0.040*
		[0.009]		[0.027]	
1 if respondent is household head	611	0.655	112	0.580	0.074
		[0.019]		[0.047]	
1 if respondent is spouse of the household head	611	0.314	112	0.366	-0.052
		[0.019]		[0.046]	
# of household members in Dhaka	611	2.013	112	1.830	0.183*
		[0.039]		[0.077]	
Dhaka respondent did not get PSC or did not attend school	611	0.133	112	0.196	-0.064*
		[0.014]		[0.038]	
Dhaka respondent completed PSC	611	0.188	112	0.188	0.001
		[0.016]		[0.037]	
Dhaka respondent completed grade 6 ~ grade 9	611	0.401	112	0.402	-0.001
		[0.020]		[0.047]	
Dhaka respondent graduated from SSC or above SSC	611	0.272	112	0.214	0.057
		[0.018]		[0.039]	
1 if Dhaka respondent's job: RMG worker	611	0.992	112	0.982	0.010

		[0.004]		[0.013]	
1 if Dhaka respondent's job: Housewifery	611	0.002	112	0.000	0.002
		[0.002]		[0.000]	
1 if Dhaka respondent's job: Business, Other industries' employee, else	611	0.007	112	0.000	0.007
		[0.003]		[0.000]	
1 if using mobile money through agent account	611	0.311	112	0.348	-0.037
		[0.019]		[0.045]	
1 if using mobile money through own account	611	0.453	112	0.402	0.052
		[0.020]		[0.047]	
1 if using mobile money through family members' account	611	0.057	112	0.071	-0.014
		[0.009]		[0.024]	
Household income of last 30 days (Taka)	611	15484.710	112	15532.634	-47.924
		[232.548]		[615.988]	
Total value of assets (Taka) per HH member	611	5796.609	112	7718.199	-1921.590**
		[297.001]		[1353.894]	
Consumption of last 30 days alltypes per capita (Taka)	611	5598.645	112	5631.159	-32.514
		[71.368]		[153.323]	
Amount of sent remittances to original HH (Taka)	611	3064.746	112	3205.357	-140.611
		[109.534]		[244.843]	
Cognitive skill measure of Dhaka respondent (low~high:0~6)	611	4.108	112	4.063	0.046
		[0.067]		[0.160]	
(village) age of HH head	611	54.227	112	54.545	-0.317
		[0.538]		[1.090]	
(village) 1 if HH head is male	611	0.728	112	0.723	0.005
		[0.018]		[0.042]	
(village) 1 if HH head is married	611	0.828	112	0.813	0.016
		[0.015]		[0.037]	
(village) 1 if HH head is widow/widower/divorced/separeted	611	0.160	112	0.188	-0.027
		[0.015]		[0.037]	
(village)HH head: wife/husband/son/daughter of Dhaka respondent	611	0.074	112	0.045	0.029

		[0.011]		[0.020]	
(village)HH head: father/mother/brother/sister/grandfa/grandmo of Dhaka respondent	611	0.710	112	0.723	-0.013
		[0.018]		[0.042]	
(village)HH head: (In law) father/mother/brother/sister of Dhaka respondent	611	0.187	112	0.214	-0.028
		[0.016]		[0.039]	
(village) # of household members	611	4.597	112	4.563	0.035
		[0.065]		[0.154]	
(village) HH head did not get PSC or did not attend school	611	0.661	112	0.723	-0.062
		[0.019]		[0.042]	
(village) HH head completed PSC	611	0.124	112	0.152	-0.027
		[0.013]		[0.034]	
(village) HH head completed grade 6 ~ grade 9	611	0.154	112	0.063	0.091**
		[0.015]		[0.023]	
(village) HH head graduated from SSC or above SSC	611	0.061	112	0.063	-0.002
		[0.010]		[0.023]	
(village) HH head's occupation: farming	611	0.411	112	0.420	-0.009
		[0.020]		[0.047]	
(village) HH head's occupation: self-employment, trader, wage-labor	611	0.124	112	0.134	-0.010
		[0.013]		[0.032]	
(village) HH head's occupation: salaried workers (i.e.goverment, teacher)	611	0.016	112	0.027	-0.010
		[0.005]		[0.015]	
(village) HH head's occupation: non-earning occupations (i.e.housewife)	611	0.448	112	0.420	0.029
		[0.020]		[0.047]	
(village) Has anyone of household ever used mobile money	611	0.399	112	0.348	0.051
		[0.020]		[0.045]	
(village) 1 if using mobile money through agent account	611	0.403	112	0.393	0.010
		[0.020]		[0.046]	
(village) 1 if using mobile money through own account	611	0.064	112	0.080	-0.017
		[0.010]		[0.026]	

(village) 1 if using mobile money through family members' account	611	0.134	112	0.179	-0.044
		[0.014]		[0.036]	
(village) minutes to the closest mobile money agent by foot	611	17.136	112	16.688	0.448
		[0.593]		[1.096]	
(village) Total value of assets (Taka) per HH member	611	3857.787	112	3888.132	-30.345
		[201.107]		[431.844]	
(village) Total value of productive assets (Taka)	611	4921.773	112	4489.689	432.084
		[332.246]		[573.779]	
(village) Total value of lands (Taka) per hh member	611	1.08e+05	112	97599.560	9996.718
		[7391.360]		[17001.569]	
(village) Consumption of last 30 days alltypes per capita (Taka)	611	2851.187	112	2738.212	112.976
		[53.279]		[87.035]	
(village) Educational consumption (~SSC) (Taka)	611	1772.473	112	1727.935	44.538
		[50.508]		[91.844]	
(village) number of students (~ssc)	611	1.714	112	1.866	-0.152*
		[0.035]		[0.069]	
F-test of joint significance (F-stat)					1.517**
F-test, number of observations					723

Notes: 1) The value displayed for t-tests are the differences in the means across the groups. The value displayed for F-tests are the F-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level. 2) Taka is the currency of Bangladesh. As of December 21st,2020, 1 USD is 85 Taka.

Appendix 2.6. Comparison between complete cases and attrition cases of village households (full table)

Table A2.4 Comparison of full list of baseline characteristics of Dhaka households and village households for village respondents' attrition

	(1)		(2)		t-test
		Village HH complete cases		Village HH Attrition in Mar-Aug2020	Difference
Variable	N	Mean/SE	N	Mean/SE	(1)-(2)
age of Dhaka respondent	667	28.573	56	27.821	0.751
		[0.257]		[0.947]	
1 if Dhaka respondent is male	667	0.549	56	0.482	0.067
		[0.019]		[0.067]	
1 if Dhaka respondent is married	667	0.760	56	0.589	0.171***
		[0.017]		[0.066]	
1 if Dhaka respondent is widow/widower/divorced/separeted	667	0.049	56	0.125	-0.076**
		[0.008]		[0.045]	
1 if respondent is household head	667	0.642	56	0.661	-0.019
		[0.019]		[0.064]	
1 if respondent is spouse of the household head	667	0.327	56	0.268	0.059
		[0.018]		[0.060]	
# of household members in Dhaka	667	1.994	56	1.875	0.119
		[0.037]		[0.111]	
Dhaka respondent did not get PSC or did not attend school	667	0.136	56	0.214	-0.078
		[0.013]		[0.055]	
Dhaka respondent completed PSC	667	0.186	56	0.214	-0.028
		[0.015]		[0.055]	
Dhaka respondent completed grade 6 ~ grade 9	667	0.405	56	0.357	0.048
		[0.019]		[0.065]	
Dhaka respondent graduated from SSC or above SSC	667	0.267	56	0.214	0.053
		[0.017]		[0.055]	
1 if Dhaka respondent's job: RMG worker	667	0.990	56	1.000	-0.010

		[0.004]		[0.000]	
1 if Dhaka respondent's job: Housewifery	667	0.001	56	0.000	0.001
		[0.001]		[0.000]	
1 if Dhaka respondent's job: Business, Other industries' employee, else	667	0.006	56	0.000	0.006
		[0.003]		[0.000]	
1 if using mobile money through agent account	667	0.310	56	0.393	-0.083
		[0.018]		[0.066]	
1 if using mobile money through own account	667	0.453	56	0.357	0.096
		[0.019]		[0.065]	
1 if using mobile money through family members' account	667	0.058	56	0.071	-0.013
		[0.009]		[0.035]	
Household income of last 30 days (Taka)	667	15469.334	56	15763.696	-294.362
		[225.251]		[869.700]	
Total value of assets (Taka) per HH member	667	5835.663	56	9174.628	-3338.965***
		[282.155]		[2552.897]	
Consumption of last 30 days alltypes per capita (Taka)	667	5609.905	56	5529.568	80.337
		[67.920]		[214.030]	
Amount of sent remittances to original HH (Taka)	667	3078.051	56	3187.500	-109.449
		[104.993]		[322.974]	
Cognitive skill measure of Dhaka respondent (low~high:0~6)	667	4.081	56	4.339	-0.258
		[0.065]		[0.193]	
(village) age of HH head	667	54.436	56	52.375	2.061
		[0.506]		[1.693]	
(village) 1 if HH head is male	667	0.729	56	0.714	0.014
		[0.017]		[0.061]	
(village) 1 if HH head is married	667	0.823	56	0.857	-0.034
		[0.015]		[0.047]	
(village) 1 if HH head is widow/widower/divorced/separeted	667	0.166	56	0.143	0.024
		[0.014]		[0.047]	
(village)HH head: wife/husband/son/daughter of Dhaka respondent	667	0.070	56	0.054	0.017
		[0.010]		[0.030]	

(village)HH head: father/mother/brother/sister/grandfa/grandma of Dhaka respondent	667	0.708	56	0.768	-0.060
		[0.018]		[0.057]	
(village)HH head: (In law) father/mother/brother/sister of Dhaka respondent	667	0.196	56	0.125	0.071
		[0.015]		[0.045]	
(village) # of household members	667	4.586	56	4.661	-0.075
		[0.063]		[0.171]	
(village) HH head did not get PSC or did not attend school	667	0.675	56	0.625	0.050
		[0.018]		[0.065]	
(village) HH head completed PSC	667	0.118	56	0.250	-0.132***
		[0.013]		[0.058]	
(village) HH head completed grade 6 ~ grade 9	667	0.147	56	0.054	0.093*
		[0.014]		[0.030]	
(village) HH head graduated from SSC or above SSC	667	0.060	56	0.071	-0.011
		[0.009]		[0.035]	
(village) HH head's occupation: farming	667	0.420	56	0.321	0.098
		[0.019]		[0.063]	
(village) HH head's occupation: self-employment, trader, wage-labor	667	0.115	56	0.250	-0.135***
		[0.012]		[0.058]	
(village) HH head's occupation: salaried workers (i.e.goverment, teacher)	667	0.016	56	0.036	-0.019
		[0.005]		[0.025]	
(village) HH head's occupation: non-earning occupations (i.e.housewife)	667	0.448	56	0.393	0.055
		[0.019]		[0.066]	
(village) Has anyone of household ever used mobile money	667	0.388	56	0.429	-0.040
		[0.019]		[0.067]	
(village) 1 if using mobile money through agent account	667	0.409	56	0.304	0.106
		[0.019]		[0.062]	
(village) 1 if using mobile money through own account	667	0.067	56	0.054	0.014
		[0.010]		[0.030]	
(village) 1 if using mobile money through family members' account	667	0.135	56	0.214	-0.079
		[0.013]		[0.055]	

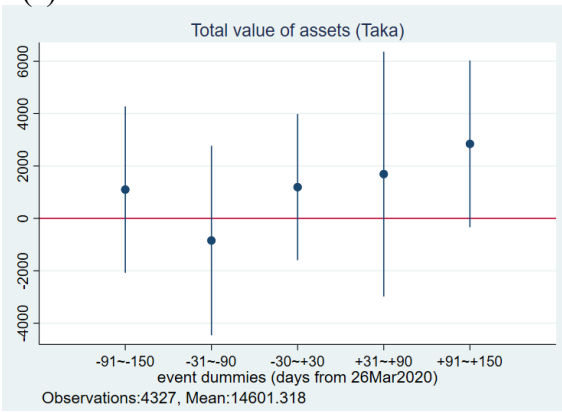
(village) minutes to the closest mobile money agent by foot	667	16.997	56	17.893	-0.896
		[0.556]		[1.703]	
(village) Total value of assets (Taka) per HH member	667	3884.350	56	3602.090	282.260
		[189.895]		[666.869]	
(village) Total value of productive assets (Taka)	667	4903.956	56	4269.820	634.135
		[312.124]		[796.783]	
(village) Total value of lands (Taka) per hh member	667	1.06e+05	56	1.12e+05	-6069.923
		[6843.191]		[32033.092]	
(village) Consumption of last 30 days alltypes per capita (Taka)	667	2848.842	56	2653.175	195.667
		[49.620]		[136.848]	
(village) Educational consumption (~SSC) (Taka)	667	1777.547	56	1622.955	154.592
		[47.713]		[118.637]	
(village) number of students (~ssc)	667	1.730	56	1.821	-0.091
		[0.034]		[0.089]	
F-test of joint significance (F-stat)					1.580***
F-test, number of observations					723

Notes: 1) The value displayed for t-tests are the differences in the means across the groups. The value displayed for F-tests are the F-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level. 2) Taka is the currency of Bangladesh. As of December 21st,2020, 1 USD is 85 Taka.

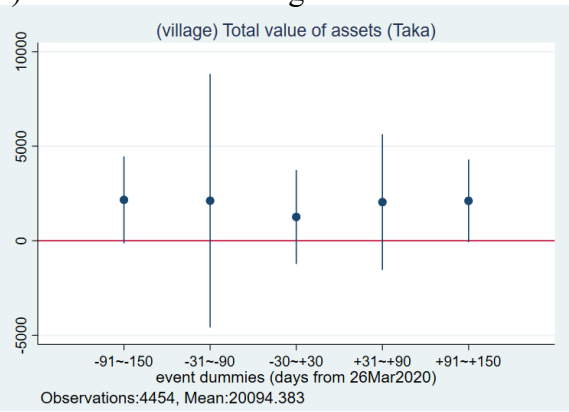
Appendix 2.7. (No) Asset sales in response to COVID-19 shock

Figure A2.2 (No) Asset sales

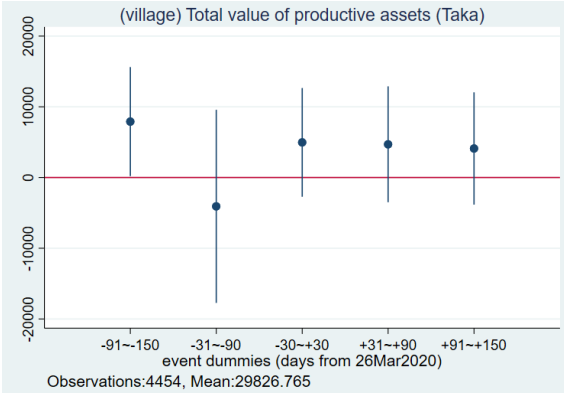
(a) Asset values of Dhaka HHs



(b) Asset values of village HHs



(c) Productive asset values of village HHs

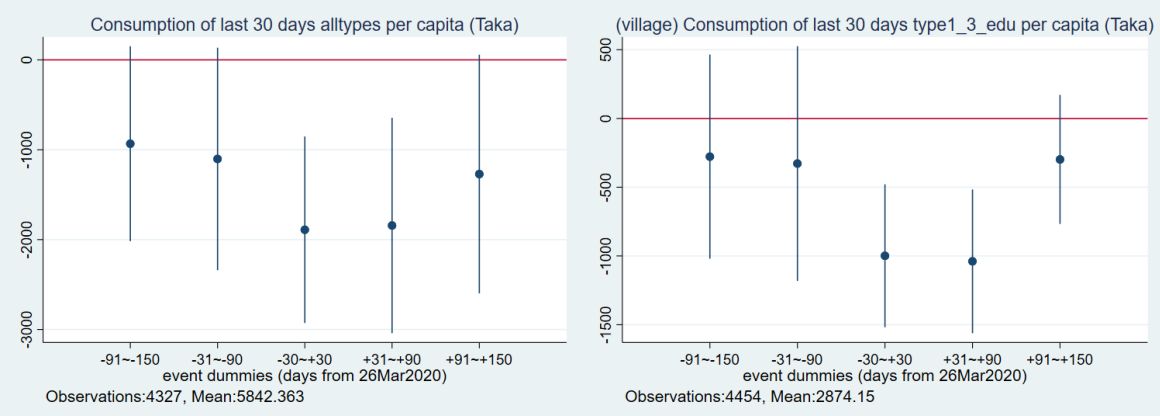


Notes: 1) For figure (a), standard errors are clustered at combinations of factory, year and bi-month. For figure (b) and (c), standard errors are clustered at upazila-level. 2) Together with 95% confidence intervals, the figures report the dynamic coefficients obtained from the specification of equation (3) for figure (a) and equation (4) for figure (b) and (c), respectively, in the main

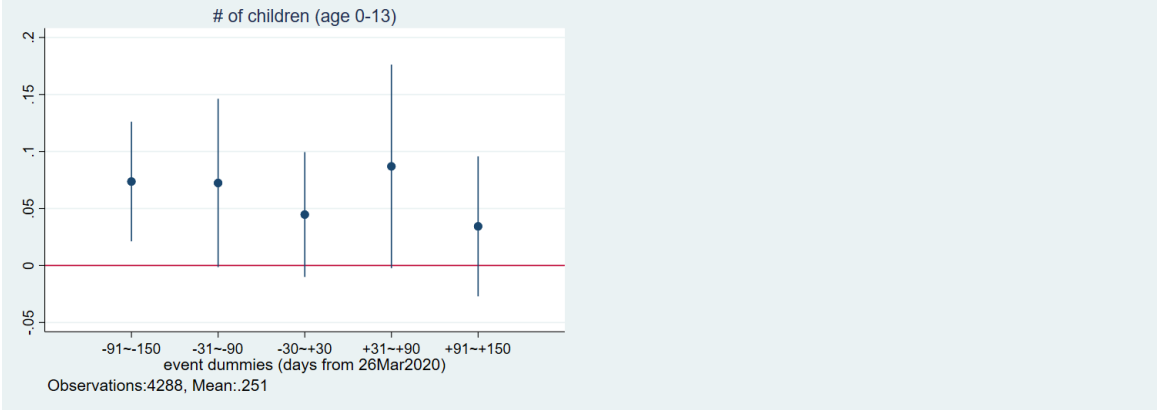
Appendix 2.8. Alternative measure of consumptions: COVID-19 shock to consumption per capita

Figure A2.3 Reduction of consumption per capita in response to COVID-19 shock

(a) Consumption per capita of Dhaka HHs (b) Consumption per capita of village HHs



(c) # of children in Dhaka HHs



Notes: For figure (a) and (c), standard errors are clustered at combinations of factory, year and bi-month. For figure (b), standard errors are clustered at upazila-level. Together with 95% confidence intervals, the figures report the dynamic coefficients obtained from the specification of equation (3) for figure (a) and (c) and equation (4) for figure (b), respectively, in the main text.

Appendix 2.9. Asset items

Table A2.5 Items of assets / productive assets in Dhaka households and village households

	Dhaka households	Village households	
	Assets	Assets	Productive assets
1	Stove/ Gas Burner / Metal cooking pots	Stove/ Gas Burner / Metal cooking pots	[Farming] Tractor
2	Radio / Television	Radio / Television	[Farming] Thresher
3	Cassette Player / Music Player	Cassette Player / Music Player	[Farming] Power pump
4	Motor cycle	Motor cycle / scooter	[Farming] Shallow tube-well
5	Bicycle	Bicycle	[Farming] Treadle pump
6	Electric Fan	Electric Fan	[Farming] Done / Swing basket
7	Almirah/cabinet/self/drawer	Almirah/cabinet/self/drawer	[Farming] Plough and yoke
8	Sewing Machine	Sewing Machine	[Farming] Spray
9	Tube well for drinking	Tube well for drinking	[Farming] Husking machine
10	Wrist watch	Wrist watch	[Farming] Ginning machine
11	Wall clock	Wall clock	[Farming] Power tiller
12	Mobile Phone	Mobile Phone	[Fishery] Country boat
13	Fridge	Fridge	[Fishery] Engine boat
14	Computer	Computer	[Fishery] Fishing net
15	Jewelry	Jewelry	[Chicken] Cage incubator
16	Other Machinery (which is relatively costly)	Other nonproductive assets (if there's any, which is relatively costly)	[Chicken] Brooder
17	Others (if there's any, which is relatively costly).		[Oth Agri] Bees-Box
18			[Oth Agri] Weeder
19			[Oth Agri] Ladder (Moi)
20			[Oth Agri] Sickle / Dao / Axe / Spade
21			[Oth Agri] Gola (grain storage)
22			[Oth Agri] Hacksaw / Wood cutting device
23			[Oth Agri] Dheki
24			[Oth Agri] Jata
25			[Transportation] Rickshaw
26			[Transportation] Van
27			[Transportation] Auto / Auto van / Auto Riskshaw
28			[Livestock] Cow/Buffalo /Horse
29			[Livestock] Goat/Sheep
30			[Livestock] Duck/chicken
31			Others (if there's any, which is relatively costly)

Notes: Dhaki is an agricultural tool used for threshing. Jata is a stone disc.