# Poverty and Migration in the Digital Age: Experimental Evidence on Mobile Banking in Bangladesh*

Jean N. Lee, Jonathan Morduch, Saravana Ravindran, Abu S. Shonchoy and Hassan Zaman†

April 23, 2018

**Abstract**

Mobile banking technology makes it cheaper and easier to move money across distances. Against a background of rapid urbanization in Bangladesh, we estimate the impact of mobile banking in a sample of "ultra-poor" rural households paired to relatives who migrated to find jobs in the capital. The study shows that diffusion of the gains from urbanization is constrained by barriers to remitting money. The technology substantially improved rural economic conditions by better connecting villagers to urban migrants, an idea that contrasts with (and complements) innovations like microfinance that focus on rural self-employment. Participants were trained on how to sign up for and use mobile banking accounts in a randomized encouragement design costing less than $12 per family. Active use of accounts increased substantially, from 22% in the rural control group to 70% in the rural treatment group, and urban-to-rural remittances increased by 30% one year later (relative to the control group). For active users, rural consumption increased by 7.5% and extreme poverty fell. Rural households borrowed less, saved and invested more, and fared better in the lean season. The rate of child labor fell, and we find weak but positive evidence that schooling improved. Rural health indicators were unchanged. Migrants, however, bore costs. They were slightly more likely to be in garment work, saved more, and were less likely to be poor. However, migrants actively using mobile banking reported worse physical and emotional health.

JEL Codes: R23, O16, I32, O33

*We are grateful to the Bill and Melinda Gates Foundation; the Institute for Money, Technology and Financial Inclusion; and the International Growth Centre for financial support. We are grateful for comments from seminar participants at the University of Chicago, Booth School of Business; Indian Statistical Institute, Delhi; Delhi School of Economics; 2017 Northeast Universities Development Consortium Conference; New York University; Graduate Institute of International and Development Studies, University of Geneva; and Rutgers University. MOMODa Foundation and Gana Unayan Kendra provided invaluable support in the study's implementation, and we are grateful to Masudur Rahman, Sujan Uddin and Niamot Enayet for excellent research assistance. All views and any errors are our own.

†Lee: Millennium Challenge Corporation, leejn@mcc.gov; Morduch: New York University Robert F. Wagner Graduate School of Public Service, jonathan.morduch@nyu.edu; Ravindran: New York University Department of Economics, saravana.ravindran@nyu.edu; Shonchoy: New York University Robert F. Wagner Graduate School of Public Service and IDE-JETRO, parves.shonchoy@gmail.com; Zaman: World Bank, hzaman@worldbank.org.

# 1 Introduction

Global income inequality has been driven in part by growing economic gaps between cities and rural areas (Young 2013). In 1970, most of the world's population lived in rural areas, with just 37 percent in cities, but by 2016, 55 percent lived in urban areas (United Nations 2016). Migration has taken people, especially the young, from the periphery into the center, turning urban hubs into mega-cities, creating congestion and social challenges alongside economic opportunities (Lopez-Acevedo and Robertson 2016). The population of Bangladesh's capital city, Dhaka, for example, grew by 3.6% per year between 2000 and 2016, growing in size from 10.3 million people to 18.3 million. By 2030, Dhaka is projected to be home to 27 million people (United Nations 2016), and demographers estimate that Bangladesh's rural population has now started declining in absolute numbers.

Early theories of modernization and economic growth saw progress as the movement of workers from subsistence sectors to modern, industrial sectors through rural-to-urban migration (e.g., Lewis 1954). By the 1970s, however, concern with rural poverty turned attention to programs to raise rural incomes through direct interventions like farm mechanization, improved agricultural marketing, and credit schemes (Bardhan 1984).

Today, rapid urbanization, coupled with new money transfer technologies, opens a relatively unexplored possibility to reduce rural poverty: promoting the rural-to-urban movement of people coupled with the efficient urban-to-rural movement of money (Ellis and Roberts 2016, Suri and Jack 2016). Mobile money technologies make sending money quick and relatively cheap (Gates Foundation 2013), but their social and economic impacts have been hard to evaluate since, especially in early stages, adoption is highly self-selected.

To assess the migration/remittance mechanism and address self-selection, we provided a randomly-assigned treatment group in Bangladesh with training on bKash mobile financial services and facilitated account set-up if needed. Referred to as "mobile banking" or as "mobile money," these services can penetrate markets previously unreached by traditional banks due to the relatively high costs of expanding brick-and-mortar bank branches, particularly in rural areas (Aker and Mbiti, 2010; Aker, 2010; Jensen, 2007). Mobile money allows individuals to deposit, transfer, and withdraw funds to and from electronic accounts or "mobile wallets" based on the mobile phone network, cashing in or cashing out with the help of designated agents. Kenya's M-Pesa mobile money service, for example, started in 2007 and grew by promoting its use to simply "send money home." M-Pesa is used by at least one person in 96% of Kenyan households (Suri and Jack 2016).

The study follows both senders (urban migrants) and receivers (rural families) in Bangladesh, allowing measurement of impacts on both sides of transactions. The rural site is in Gaibandha district in northwest Bangladesh, part of Rangpur division, about 8 hours from Dhaka by bus (12-14 hours with stops and traffic). Rangpur is one of the poorest divisions of Bangladesh, and Gaibandha is historically vulnerable to seasonal food insecurity during the *monga* season (Khandker 2012, Bryan et al 2014). The Gaibandha sample includes rural households that had been identified as "ultra-poor."[1] As extreme poverty falls globally, the households that remain poor are increasingly like those in Gaibandha, facing the greatest social and economic challenges. NGOs have responded with "ultra-poor" programs that provide a bundle of assets, training, and social support to facilitate income growth through rural self-employment – a goal similar to microfinance (Armendáriz and Morduch 2010). Results have been encouraging in Bangladesh (Bandiera et al 2017) and other countries (Banerjee et al 2015).[2] The intervention here involves a complementary approach closer to efforts to "just give money to the poor" through cash transfers (Hanlon et al 2010, Haushofer and Shapiro 2016). Here, though, the mechanism works by facilitating the sharing of workers' own earnings rather than through external cash transfers.

The training/facilitation intervention, which cost less than $12 per family, led to a large increase in use of mobile banking accounts. By the endline, 70% of the rural treatment group

[1] Bryan et al (2014) also focus on districts in Rangpur (although not Gaibandha), and, like us, they focus on households with limited land-holding and vulnerability to seasonal hunger.

[2] Bauchet et al 2015 report on an "ultra-poor" program akin to those studied by Bandiera et al (2017) and Banerjee et al (2015). In South India, participants faced high opportunity costs such that many in the program eventually abandoned it in order to participate in the (increasingly tight) local wage labor market, showing that self-employment was not preferred when viable jobs were available.

had an actively-used mobile banking account relative to 22% of the control group.

Migrants actively using bKash mobile banking accounts increased remittances sent by 30% in value one year after the intervention (relative to the control group). For rural recipients of remittances, daily per capita consumption among active users increased by 7.5% and extreme poverty fell, although overall rural poverty rates were unchanged. Rural households borrowed less, were more likely to save, and fared better in the lean season. Investment increased as seen in a rising rate of self-employment and increased out-migration for work. The rate of child labor fell relative to the trend in the control group, and we find weak but positive evidence that schooling improved and farmers used more non-labor agricultural inputs such as fertilizer. Rural health indicators were unchanged, and we do not find evidence of spillovers to the control group. The results show that strengthening rural-urban links through mobile banking sharply improved rural economic conditions, partly by facilitating access to resources at key times.

The results for migrants to Dhaka show tradeoffs of these rural gains. Migrant workers report declines in physical and emotional health, consistent with pressures to work longer hours and increase remittances enabled by the mobile banking technology. Overall, the results show how technology can facilitate income redistribution, overcoming constraints in money-transfer mechanisms and broadening the gains from economic development. Yet, while mobile banking in this setting increased the welfare of rural households, it created costs for migrant workers.

## 2 Framework and Related Literature

Bryan et al (2014) also evaluate urban-rural migration using a randomized expriment in a rural sample in northwest Bangladesh (near the population we study). Their focus is on inducements to migrate temporarily during the lean agricultural season (and then return for the remainder of the year). The $8.50 incentive studied by Bryan et al (2014) was just enough to buy a bus ticket to Dhaka, and the payment led 22% of their sample to out-migrate seasonally. Migrating increased consumption by about a third in households in origin villages. As in our study, the mechanism studied by Bryan et al (2014) involves taking advantage of urban job opportunities while maintaining strong ties to rural villages. Our focus is instead on migration, especially by young adults, which spans years rather than months and may be permanent. Bryan et al (2014) note that in 2005 data only 5% of households in vulnerable districts in northwest Bangladesh received domestic remittances, suggesting little development of migration-remittance mechanisms prior to the introduction of mobile money.

Mobile money services in Bangladesh started later than in Kenya, but have grown rapidly. By the end of 2016, 33 million registered clients used mobile financial services in Bangladesh, an increase of 31 percent from 2015 (Bilkis and Khan 2016); this growth is attributed to the spread of mobile financial services in "far-flung" areas like the rural northwest (Bhuiyan 2017). An advertisement for the bKash service highlights the appeal of easing urban-to-rural remittances, featuring a young female worker in an urban garment factory with the words, "Factory, overtime, household chores...and the added hassle of sending money home? Now I send money through bKash. It's safe and convenient, and money reaches home instantly!"

The Global Findex Survey shows that 7% of adults (age 15 and above) reported making or receiving a digital payment in 2014 in Bangladesh. Thanks to mobile banking services like bKash, the share rose to 34% in 2017 (Demirguç-Kunt et al 2018). Usage is widest among better-off Bangladeshis: 39% of the top three income quintiles reported digital payments in 2017 versus 26% of the bottom 2 income quintiles. Just 14% of adults with primary schooling (or less)—a group overlapping most of our rural sample—had mobile money accounts. Still, Bangladesh is a global leader overall: just 5% of adults in developing economies had mobile banking accounts in 2017 (Demirguç-Kunt et al 2018).

The relatively low diffusion rates contrast with the potential value of the technology for the poorest households. Urban-to-rural remittances from family members share advantages of information-intensive informal transfer networks together with the ability to mobilize relatively large sums from outside local economies. Remittances can have particularly large impacts when local, rural financial markets are imperfect and incomplete (Rapoport and Docquier 2006). The spread of mobile banking has potential economic impacts for families receiving remittances through four main channels: (1) direct impacts on consumption; (2) increases in liquidity in the face of adverse shocks; (3) impacts on investment, in part by overcoming financing constraints; and (4) general equilibrium effects and spillovers to non-users.

*Direct consumption impacts.* The most direct way that remittances help receiving households is by providing money to spend on basic needs. Munyegera and Matsumoto (2016), for example, investigate mobile money in rural Uganda with a difference-in-difference method and IV using the log of the distance to the nearest mobile money agents as an instrument for mobile money adoption (as well as propensity score matching methods). The identifying assumption is that distance is exogenous, conditional on control variables. Under the assumption, they find that the adoption of mobile money services led to a 13% increase in household per capita consumption and an increase in food consumption. They also present evidence of increased expenditure on non-food basic expenditures, education and health services, and social contributions including toward local savings and credit associations. Similar to our findings below, they find that in households with at least one mobile money subscriber, the total annual value of remittances is 33% higher than in non-user households.

*Shocks and liquidity.* Mobile money may help receiving households by providing resources that can be saved for later or that can facilitate borrowing (or substitute for credit). Mbiti and Weil (2011), for example, find that M-Pesa users send more transfers and switch from informal savings mechanisms to storing funds in their M-Pesa accounts (with a drop in the propensity to use informal savings mechanisms such as ROSCAS by 15 percentage points). Blumenstock et al (2015) run an RCT, focusing on the impact of paying salaries via mobile money rather than cash in Afghanistan. Employers found immediate and significant cost savings. Workers, however, saw no impacts as measured by individual wealth; small sums were accumulated but total savings did not increase as users substituted savings in mobile money accounts for alternative savings mechanisms.

In the absence of adequate saving by rural households, the ability to instantly send and receive money also means that remittances can function as an insurance substitute, helping to protect consumption in the face of negative shocks. Jack and Suri (2014) and Suri and Jack (2016) use the plausible exogeneity of the timing and place of M-Pesa's expansion in Kenya to identify impacts. Jack and Suri (2014) show the impact of M-Pesa's mobile money service through reducing the transaction costs of risk sharing. They use the timing and location of M-Pesa's rollout in different parts of Kenya to estimate impacts, finding that, in the face of a negative shock, households that used mobile money were more likely to receive remittances and to do so from a wider network of sources. As a result, the households were able to maintain consumption levels in the face of shocks, while non-users of mobile money experienced consumptions dips averaging 7%. The effects were strongest for the bottom three quintiles of the income distribution.

Batista and Vicente (2016) provide the only other RCT studying the impact of mobile money in financially-underserved areas. While they do not find an increase in the value of remittances in rural Mozambique, they find increases in remittances received by rural households. Rural households in the treatment group were less vulnerable to adverse shocks, particularly for episodes of hunger. No impact was found on savings, assets, or overall consumption, and there was evidence of reduced investment in agriculture and business. Batista and Vicente (2016) recruited mobile money agents in the treatment area, essentially setting up the agent network in the villages themselves. In contrast, we work in a setting already served well by mobile money operations.

*Investment and liquidity.* Remittances can provide investible funds for capital-constrained households. Angelucci (2015), for example, shows that remittances from Mexican migrants helps fund migration by other family members previously constrained by lack of capital.

Turning to remittances sent as mobile money, Suri and Jack (2016) extend their analysis of M-Pesa to consider long-run impacts with five rounds of household panel data from 2008-2014. They find that access to M-Pesa increased per capita consumption levels and lifted 194,000 (or 2% of) Kenyan households out of poverty. The impacts are more pronounced for female-headed households (the impact on consumption for female-headed households was more than twice the average impact). The impacts they find are driven by changes in financial behavior and labor market outcomes, again especially for women, who were more likely than others to move out of agriculture and into business. Suri and Jack estimate that the spread of mobile money helped induce 185,000 women to switch into business or retail as their main occupation.

*Wider impacts* By facilitating cash flows from outside of a local economy, mobile money can generate general equilibrium effects that affect users as well as non-users. Riley (2016) uses a difference-in-difference approach in Tanzania to investigate consumption smoothing in communities served by mobile banking. She considers the impacts of large aggregate shocks like droughts and floods, focusing on both users and non-users of mobile banking. While it is plausible that non-users would benefit from the increased liquidity introduced into communities during times of covariate difficulty, she does not find evidence to support wide impacts. Instead, Riley (2016) finds that the main beneficiaries are the users themselves, who weather the aggregate shocks without declines in average consumption.

# 3 Theoretical Predictions

To clarify economic mechanisms, we derive predictions from a simple model in which villagers (rural households) receive remittances from migrants over two periods. The first period is the lean season and the second is a "normal" season with greater resources. We derive predictions on the effect of a drop in the price of remittances for consumption, borrowing, remittances, and hours of work. A similar question about the price elasticity of remittances is asked in the literature on international remittances (Yang 2011), and here we interpret "the drop in price" broadly as access to a qualitatively different (more convenient, secure, and flexible) mode of sending money. In the sections that follow, we empirically examine the theoretical predictions.

## 3.1 Setup

### 3.1.1 Preferences

Let $c_{m,t}$ and $c_{h,t}$ denote the period $t \in \{1, 2\}$ consumption of the migrant and villager respectively. In addition, let $l_{m,t}$ and $h_{m,t}$ denote migrant's period $t$ hours of leisure and work respectively, such that $l_{m,t} + h_{m,t} = \bar{h}$, where $\bar{h}$ represents the total number of hours available to allocate between leisure and work (typically, $\bar{h} = 24$). Furthermore, we assume that migrants and villagers have period $t$ felicity functions denoted by $u_m(c_{m,t}, l_{m,t})$ and $u_h(c_{h,t})$ respectively. For simplicity, we work with a Cobb-Douglas representation for the migrant such that $u_m(c_{m,t}, l_{m,t}) = (1-\alpha)ln(c_{m,t}) + \alpha ln(l_{m,t})$, where $0 \leq \alpha \leq 1$ represents the weight placed on leisure. For the villager, we abstract from the labor-leisure choice problem and simply let $u_h(c_{h,t}) = ln(c_{h,t})$.

Following Rapoport and Docquier (2005), migrants are assumed to exhibit altruistic preferences of the weighted average form $U_{m,t} = (1 - \phi)u_m(c_{m,t}, l_{m,t}) + \phi u_h(c_{h,t})$ where $0 \leq \phi \leq \frac{1}{2}$ represents the weight placed on the paired villager. Villagers do not exhibit altruistic preferences, and derive utility from own consumption $U_{h,t} = u_h(c_{h,t})$. Rapoport and Docquier (2005) refer to such preferences between the migrant and villager as *unilateral altruism*. This assumption is consistent with the exclusively urban-to-rural direction of remittances in our sample.

### 3.1.2 Timing

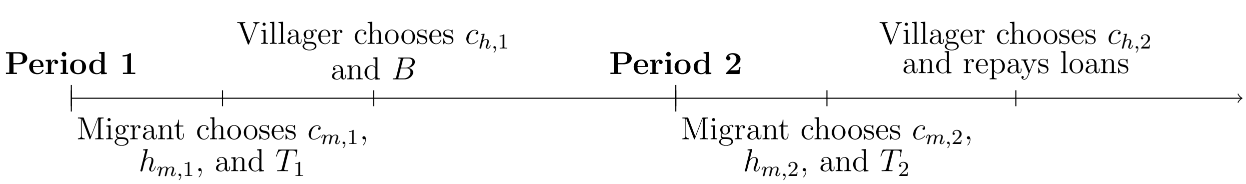
Period 1 represents *monga*, or the lean season, a time when rural incomes are particularly low and families sometimes skip meals. We assume that villager income during the lean season is $\underline{y}$.

Period 2 represents the "normal", non-lean season.[3] Rural incomes are higher during these months due to the increased availability of work. We assume that villager income during the non-lean season is $\bar{y}$, where $\bar{y} > \underline{y} > 0$. Migrants earn income $w \cdot h_{m,t}$ in period $t$, where $w \geq 0$ is the exogenously set hourly wage. Migrants and villagers discount period 2 utility by discount factor $0 \leq \beta \leq 1$. Within each period, the migrant makes choices before the villager. Each period, the villager optimizes taking as given the remittances sent by the migrant.

#### 3.1.3 Choices

Migrants choose the amount of remittances to transfer to the paired villager in each period, $T_t$, in addition to their own consumption, $c_{m,t}$, and hours of work, $h_{m,t}$. For simplicity, we assume that migrants do not borrow or save. As a result, we implicitly assume that migrants cannot choose to set $h_{m,t} = 0$. Migrants incur a transaction fee $p > 0$ proportional to the size of the remittance. The choice of a proportional fee as opposed to a fixed fee maps directly to our setting, where bKash charges a transaction fee of 2% for withdrawals. Villagers have access to credit and can borrow $B \geq 0$ at interest rate $r \geq 0$. Villagers also choose their consumption in each period, $c_{h,t}$.

To summarize, we have the following timeline:




[3]An equivalent way of setting up the problem would be to define period 1 as the non-lean season and period 2 as the lean season. The setup can then be thought of as a savings problem, rather than a borrowing problem.

## 3.2 Theoretical Predictions

Solving the model set up above, we obtain the following results (see Appendix for proofs):

**1. Remittances increase with a decrease in $p$: $\frac{\partial T_1}{\partial p} < 0$, $\frac{\partial T_2}{\partial p} < 0$.** Remittances can be thought of as spending on consumption of the paired villager, through which the migrant altruistically derives utility. Thus a decrease in the price of sending remittances $p$ has positive income and substitution effects on remittances in each period. These predictions require that (i) the hourly wage rate for migrants in each period is sufficiently large that flows of remittances only go from migrants to villagers (and never in the opposite direction), and (ii) the interest rate in each period is sufficiently large to make borrowing, and hence the movement of money from the non-lean season to the lean season, prohibitively costly for villagers.[4] (See Appendix for the exact conditions.)

**2. Villager consumption increases with a decrease in $p$: $\frac{\partial c_{h,1}}{\partial p} < 0$, $\frac{\partial c_{h,2}}{\partial p} < 0$.** The extra remittances received (due to the drop in price $p$) increases the disposable income of villagers in each period. The positive income effect then raises villager consumption in each period.

**3. Villager borrowing decreases with a decrease in $p$: $\frac{\partial B}{\partial p} > 0$.** In general, remittances reduce villagers' need for loans, but this is not necessarily so if villagers already have good access to credit at low interest rates. The main effect is that a decrease in $p$ leads to an increase in period 1 (lean season) remittances. The income effect then reduces borrowing in period 1. But a decrease in $p$ also leads to an increase in period 2 remittances, and, in order to optimize their inter-temporal consumption problem, villagers would like to borrow more (to move some of this future income to period 1). An interest rate that is large enough deters this inter-temporal smoothing motive by making borrowing prohibitively expensive (see the Appendix for the exact condition). Under the interest rate assumption,

[4] We do not impose a borrowing constraint in the model, but the restriction that the interest rate be sufficiently large acts as an equivalent credit market imperfection. Large interest rates and borrowing constraints limit the ability of villagers to optimize their inter-temporal consumption problem, leading migrants, who care about villager consumption via altruism, to respond through remittances.

the net income effect dominates and villagers decrease borrowing when $p$ falls.

**4. Migrant consumption decreases with a decrease in $p$: $\frac{\partial c_{m,1}}{\partial p} > 0$, $\frac{\partial c_{m,2}}{\partial p} > 0$.** If sending remittances gets cheaper, it would seem that migrants would have surplus with which to increase their own consumption. This income effect arises for two reasons: (i) the reduction in $p$ leads to a direct income effect, and (ii) as we shall see below, a reduction in $p$ causes the migrant to work more, thereby increasing income further. At the same time, however, a decrease in $p$ leads to a substitution effect away from migrant's own consumption towards villager consumption. Given the set-up, the substitution effect outweighs the income effect here, leading to decreases in migrant consumption with a decrease in $p$.

**5. Migrant hours of work increase with a decrease in $p$: $\frac{\partial h_{m,1}}{\partial p} < 0$, $\frac{\partial h_{m,2}}{\partial p} < 0$.** A decrease in $p$ leads to a substitution effect, shifting the migrant's own leisure towards villager consumption. This substitution away from leisure leads to an increase in the migrants' hours worked. Effectively, one can think of $p$ as a tax on part of the migrant's spending. A reduction in the tax leads to a positive labor supply effect.

**6. Fraction of migrant income remitted increases with a decrease in $p$: $\frac{\partial\left(\frac{T_1}{wh_{m,1}}\right)}{\partial p} < 0$, $\frac{\partial\left(\frac{T_2}{wh_{m,2}}\right)}{\partial p} < 0$.** We saw that both remittances and hours worked by migrants increase in each period with a decrease in $p$ (predictions 1 and 5, respectively). Thus, the impact of a price reduction on the fraction of migrant income remitted is not immediately clear. Under the assumptions of the model, however, the positive income and substitution effects on remittances outweigh the substitution effect away from leisure, thereby leading to an increase in the fraction of migrant income remitted in each period with a decrease in $p$.

**Summary:** These results speak to several key mechanisms of the mobile money intervention described in Section 2. First, we obtain direct impacts on consumption (prediction 2). Second, the model demonstrates the shocks and liquidity mechanism by outlining how mobile money can substitute for credit (prediction 3).

Below, we show empirical results that match predictions 1, 2, 3, 5, and 6. We are unable, however, to match prediction 4. This may be due to the exogenously determined wage rate

$w$. In fact, we present results that show that migrants in the treatment group are more likely to be employed in garments work, which pays significantly more. This represents a large income effect, which could outweigh the substitution effect described in prediction 4 to deliver $\frac{\partial c_{m,1}}{\partial p} < 0$ and $\frac{\partial c_{m,2}}{\partial p} < 0$. To remain tractable, the simple model presented above abstracts from this occupation choice problem, while still matching most of the empirical results. The empirical model also allows us to explore villagers' investment choices and to explore spillovers and general equilibrium effects.

# 4 Sample and Randomization

The study starts with 815 rural household-urban migrant pairs randomized at the individual level in a dual-site design. The study took place between 2014 and 2016, a window during which mobile money had spread widely enough that the networked service was useful for adopters—but not so widely that all markets had been fully served.

The two connected sites are: (1) Gaibandha district in Rangpur Division in northwest Bangladesh and (2) Dhaka Dhaka Division, the administrative unit in which the capital is located. We follow migrants in Dhaka and their families in rural Gaibandha. Gaibandha is in one of the poorest regions of Bangladesh, with a headcount poverty rate of 48 percent and, historically, exposure to the *monga* seasonal famine in September through November (Bryan et al 2014, Khandker 2012). Even measured outside of the *monga* season, Gaibandha has lower rates of food consumption per capita than other regions in the country.

The intervention was targeted to "ultra-poor" households in and around Gaibandha. The project put a priority on serving the most disadvantaged residents, including female-headed households, those with poor housing, and those with insufficient public assistance. To recruit participants, we took advantage of a pre-existing sampling frame from SHIREE, a garment worker training program run by the nongovernmental organization Gana Unnayan Kendra (GUK) with funding from the United Kingdom Department for International Development.

GUK's criteria for targeting "ultra-poor" households included: (1) no ownership of cultivable land, (2) having to skip a mean during the lean season, (3) no financial/microfinance access, (4) residence in an environmentally fragile area, (5) household consumption under 2000 Tk per month (roughly \$25 per month at the nominal exchange rate), and (6) productive asset ownership valued no more than 8000 Tk (roughly \$100).[5] We restricted the sample to households in Gaibandha with workers in Dhaka. Beginning from this roster, we then snowball-sampled additional Gaibandha households with migrant members in Dhaka to reach a final sample size of 815 migrant-household pairs. All rural households are from Gaibandha district, and roughly half are from Gaibandha *upazila* (subdistrict). The remaining families are from one of the six other *upazilas* within the district.

Participants were recruited between September 2014 and February 2015. We randomized which migrant-household pairs received treatment and which were in the control group following the min-max t-stat re-randomization procedure described in Bruhn and McKenzie (2009). The baseline survey was run from December 2014 to March 2015 and the endline survey followed one year later (February 2016 to June 2016). The intervention was started shortly after the baseline was completed, taking place in April and May 2015. In addition to the baseline and endline surveys, we obtained account-specific administrative data from bKash directly for the user accounts in the sample. These data allow us to determine whether user accounts were active at endline.

Attrition was very low. For the rural sample, we lost 2 of 815 households, an attrition rate of 0.2%. For the urban sample, we lost 6 of 815 migrant, an attrition rate of 0.7%. The final samples for analysis thus include 813 rural households and 809 migrants.

Baseline summary statistics for the sample by treatment status are shown in Table 1. P-values are given for tests of differences in means for these variables, showing balance on observables for assignment to treatment or control in the main experiment (an F-test

[5] The GUK project was named "Reducing Extreme Poor by Skill Development on Garment." For more, see http://www.gukbd.net/projects/. SHIREE is an acronym for Stimulating Househol Improvements Resulting in Economic Empowerment, a program focused on ending extreme poverty. The program ended in late 2016. See www.shiree.org.

similarly shows balance). Table 1 shows that treatment status is balanced on key observables, including ownership of a mobile phone, having a bank account, whether the migrant has a formal job, the urban migrant's income, the urban migrant's gender, and migrant age.[6]

Nearly everyone (99%) of individuals in the sample had access to a mobile phone at baseline. Financial inclusion was low, however, as reflected by the 11% rate of bank accounts at baseline.

About 90% of urban migrants are employed in the formal sector, about 70% are male, and the average age is 24. At baseline the treatment group earned on average 7830 taka (105 dollars) per month and sent a substantial portion of these earnings home as remittances. The variable "Remittances in past 7 months, urban" refers to remittances sent over a 7-month period (the current month and the past 6 months), so the average monthly remittances sent at baseline by the treatment group was $17356/7 = 2479$ Taka, which is nearly one third of monthly migrant income ($2479/7830 = 31.7\%$).

At baseline, income from remittances was already an important income source for rural households. The largest share of rural household income (65%) came from wage labor, and remittances from migrants formed the second largest contribution to household income (21%). Self-employment and agriculture contributed 7% and 5% of rural household income, respectively. Income from livestock and asset rental together accounted for only 2% of household income.

The low level of income from agriculture is consistent with the fact that most of the rural households are functionally landless, possessing about 10 decimals of land (0.1 acre), essentially the size of their homestead, with no land to farm. Instead, they earn income by selling their labor. Among rural households, the average household size is 3.8 members while most households have fewer than two children resident, likely reflecting the fact that young migrants are now out of the household and are not yet married.

[6]The summary statistics are for the 815 households in the treatment and control groups as originally constructed. Initially two other households had been included in the baseline sample, but they were dropped because all household members had migrated from Gaibandha and were working in Dhaka.

Three-quarters of rural households are poor as measured by the local poverty line in 2014. The global $1.90 poverty line (measured at 2011 PPP exchange rates and converted to 2014 taka with the Bangladesh CPI) is 21% lower than the national line, and 51% are poor according to the global line. These poverty figures are comparable to the sample analyzed by Bandiera et al (2017) in which 53% of the Bangladesh "ultra-poor" sample was below the global poverty line at baseline.[7]

Fewer than half of migrants (47% in the treatment group) completed primary schooling. Most migrants in the sample had moved to Dhaka in recent years, with the average migrant living fewer than three years in Dhaka prior to the study and working fewer than 2 years of tenure at their current job.

[7] The Bandiera et al (2017) data are from a 2007 baseline and use the $1.25 global poverty line at 2007 international (PPP) prices (their Table 1). The $1.25 and $1.90 thresholds were chosen to deliver similar rates of poverty (globally) when using the associated PPP exchange rates. In our sample, the 2016 average exchange rate obtained from Bangladesh Bank is 1 USD = 78.4 Taka. The 2011 PPP conversion factor for Bangladesh from the World Bank is 23.145. The inflation factor for converting 2011 prices to 2016 prices is 1.335. As such, the international poverty line at 2016 prices = 1.9 * 23.145 * 1.335 = 58.72 Taka per person per day. (At baseline in 2014, we estimate the global threshold at 54.8 taka per person per day, and the median rural household member spent 54.5 taka per day.) As comparison, the 2016 Bangladesh urban poverty line is 92.86 Taka, and the 2016 Bangladesh rural poverty line is 74.22 Taka.

Figure 1: Location of Rural and Urban Samples


Notes: The dark dots represent the location of rural households in the study. GPS co-ordinates were recorded for 811 out of 815 rural households at baseline. GPS co-ordinates were not recorded for migrants in Dhaka.

Table 1: Summary Statistics by Treatment Assignment (Baseline)

| | Treatment Mean | Treatment SD | Treatment N | Control Mean | Control SD | Control N | Treatment-Control p-value |
|---|---|---|---|---|---|---|---|
| Any mobile, rural | 0.99 | 0.10 | 413 | 0.98 | 0.13 | 402 | 0.340 |
| Any bank account, urban | 0.11 | 0.31 | 413 | 0.11 | 0.32 | 402 | 0.892 |
| Formal employee, urban | 0.91 | 0.28 | 413 | 0.88 | 0.32 | 402 | 0.161 |
| Average monthly income, urban (‘000) | 7.83 | 2.58 | 413 | 7.77 | 2.44 | 402 | 0.702 |
| Female migrant | 0.29 | 0.45 | 413 | 0.31 | 0.46 | 402 | 0.631 |
| Age of migrant | 24.0 | 5.3 | 413 | 24.0 | 5.1 | 402 | 0.987 |
| Migrant completed primary school | 0.47 | 0.50 | 413 | 0.45 | 0.50 | 402 | 0.402 |
| Tenure at current job, urban | 1.69 | 1.58 | 413 | 1.66 | 1.47 | 402 | 0.785 |
| Tenure in Dhaka, urban | 2.43 | 1.85 | 413 | 2.50 | 1.74 | 402 | 0.571 |
| Remittances in past 7 months, urban (‘000) | 17.4 | 11.9 | 413 | 18.3 | 12.5 | 402 | 0.296 |
| Daily per capita expenditure, urban | 120.3 | 45.1 | 413 | 120.7 | 40.7 | 402 | 0.900 |
| Household size, rural | 3.8 | 1.6 | 413 | 3.8 | 1.6 | 402 | 0.547 |
| Number of children, rural | 1.2 | 1.0 | 413 | 1.2 | 1.1 | 402 | 0.380 |
| Household head age, rural | 47.3 | 13.0 | 413 | 46.2 | 13.4 | 402 | 0.243 |
| Household head female, rural | 0.12 | 0.33 | 413 | 0.13 | 0.34 | 402 | 0.721 |
| Household head education, rural | 0.19 | 0.39 | 413 | 0.16 | 0.37 | 402 | 0.229 |
| Decimal of owned agricultural land, rural | 9.4 | 28.6 | 413 | 10.8 | 30.8 | 402 | 0.498 |
| Number of rooms of dwelling, rural | 1.82 | 0.73 | 413 | 1.8 | 0.762 | 402 | 0.999 |
| Dwelling owned, rural | 0.94 | 0.23 | 413 | 0.94 | 0.24 | 402 | 0.807 |
| Daily per capita expenditure, rural (Taka) | 63.6 | 35.2 | 413 | 60.9 | 31.9 | 402 | 0.264 |
| Poverty rate (national threshold), rural | 0.73 | 0.44 | 413 | 0.77 | 0.42 | 402 | 0.188 |
| Poverty rate (global $1.90 threshold), rural | 0.49 | 0.50 | 413 | 0.53 | 0.50 | 402 | 0.341 |
| Gaibandha subdistrict | 0.50 | 0.50 | 413 | 0.53 | 0.50 | 402 | 0.456 |
| Other subdistrict | 0.50 | 0.50 | 413 | 0.47 | 0.50 | 402 | 0.456 |

p-value of F-test for joint orthogonality = 0.954.

# 5 Experimental Intervention and Empirical Methods

We conducted the experiment in cooperation with bKash, a subsidiary of BRAC Bank and the largest provider of mobile banking services in Bangladesh.[8] The bKash service has experienced rapid growth in accounts since its founding, and our study took advantage of a window before the service had fully penetrated the Gaibandha market. Since bKash was already available as a commercial product, we were not in a position to experimentally introduce it from scratch. Instead, we used an encouragement design in which adoption was facilitated for part of the sample.

The intervention that took place in April and May 2015 consisted of a 30 to 45 minute training about how to sign up for and use the bKash service. This training was supplemented with basic technical assistance with enrollment in the bKash service. If requested, our field staff assisted with gathering the necessary documentation for signing up for bKash and completing the application form.

A key reason that the intervention had a high potential impact is that mobile banking services in Bangladesh use Unstructured Supplementary Service Data (USSD) menus. The USSD menus allow mobile banking services to be used on any mobile device. The menus, however, are in English, creating a large hurdle for poorer villagers in Gaibandha with only basic levels of numeracy and literacy even in Bangla (Bengali). The intervention was designed to overcome the hurdle. It included teaching the basic steps and protocols of bKash use, together with practical, hands-on experience sending transfers at least five times to establish a degree of comfort.[9] The training materials were based on marketing materials provided

[8]In July 2011, bKash began as a partnership between BRAC Bank and Money in Motion, with the International Finance Corporation (IFC) and the Bill and Melinda Gates Foundations later joining as investors. The service dominated mobile banking during our study period, but competition is growing with competitors including Dutch Bangla Bank.

[9]Within the treatment group, we also cross-randomized: (1) whether migrants were approached before or after their sending households (whether they were first or second movers) and (2) whether migrant-household pairs received a pro-social marketing message that emphasized the benefits of the technology for their family as well as for themselves as individuals. We also cross-randomized whether households received a midline survey that measured willingness-to-pay that was priming respondents to think of bKash, or priming respondents to think of cash. This paper focuses on the first randomization, that of assignment of a household-migrant pair to the bKash training intervention and control.

by bKash, simplified to increase accessibility. Since the phone menus are in English, we also provided menus translated into Bangla (Bengali).

Table 2 gives the breakdown of administrative, salary, and transportations costs per family (i.e., treating a family member in Gaibandha plus treating a migrant in Dhaka). Total costs were 885.84 taka., or US$11.36 at the prevailing exchange rate ($1 = 78 taka in mid-2015) per family-migrant pair. The costs include a small payment (200 taka, or approximately $2.50) given to each participant in the training to cover their time and to encourage participantion (not made contingent on adoption of the bKash service). Other costs totalled 485.84 taka.

Table 2: Cost of intervention per family

| | Cost |
|---|---|
| *Costs in Taka:* | |
| Participation payment x 2 | 400 |
| Material cost (printed pictorial color poster on "how to use bKash") x 2 | 100 |
| Trainer's salary + transportation (Gaibandha) | 97.48 |
| Trainer's salary + transportation (Dhaka) | 178.34 |
| Supervisor and RA time for administration | 110.02 |
| Total (Bangladesh Taka) | 885.84 Tk |
| Total (US Dollars) | $11.36 |

Notes: Taka are converted to dollars at the June 30, 2015 exchange rate. One US Dollar equals about 78 Taka.

The household survey data collected in 2014/15 and 2016 were combined with administrative data from bKash to estimate impacts. For most outcomes, we estimate intention-to-treat (ITT) effects using an Analysis of Covariance (ANCOVA) specification:

$$Y_{i,t+1} = \beta_0 + \beta_1 Treatment_i + \beta_2 Y_{i,t} + \mathbf{X}_{i,t} + \epsilon_{i,t+1} \tag{1}$$

where $\mathbf{X}_i$ is a vector of baseline controls: gender, age, and primary school completion of household head or migrant, and household size. Periods $t$ and $t+1$ refer to the baseline and endline, respectively. The regressions are run separately for the rural household and urban migrant sample. Since randomization took place at the household level, we do not cluster standard errors.

We also estimate treatment-on-the-treated (TOT) effects using instrumental variables (IV). We first define the variable *Active bKash account*, an indicator that takes the value 1 if the household performed any type of bKash transaction over the 13 month period from June 2015 - June 2016. These transactions include (but are not limited to) deposits, withdrawals, remittances, and airtime top-ups. This variable is constructed using administrative data from bKash that details every transaction recorded in accounts of the study population. We then instrument for *Active bKash account* using treatment assignment. The exclusion restriction requires that any impact from the treatment acts through active use of bKash accounts.

The surveys include questions on a range of outcome indicators, and we address problems of multiple inference by creating broad"families" of outcomes such as health, education, and consumption. Outcome variables are transformed into z-scores and then aggregated to form a standardized average across each outcome in the family (i.e. an index). We then test the overall effect of the treatment on the index (see Kling, Liebman, and Katz 2007).

For remittances and earnings, we collected monthly data (for the current month and the previous six). To exploit the temporal variation in these variables within households, we estimate equation (2) on the stacked baseline and endline household-month level data:

$$Y_{i,t} = \beta_1 Endline_t + \beta_2 Treatment_i * Endline_t + \sum_{t=1}^{12} \beta_{3,t} Month_t + \beta_{4,i} + \epsilon_{i,t} \tag{2}$$

Here , $\beta_{3,t}$ captures month fixed effects and $\beta_{4,i}$ refers to household fixed effects. $Endline_t$ is an indicator for an endline observation. The coefficient of interest is $\beta_2$, the coefficient on the interaction between $Treatment_i$ and $Endline_t$. The coefficient captures the difference in the dependent variable at endline between migrants in the treatment group and migrants in the control group, after controling for differences between baseline and endline, household fixed effects, and month fixed effects. Standard errors for all regressions run using Equation (2) are clustered at the household level.

# 6 Results

## 6.1 Mobile Banking and Remittances Sent

The initial obstacles to signing up for mobile banking services were high for the poor in Gaibandha. As noted above, the bKash menus on the telephones are in English, although few members of the rural sample know written English. The training intervention thus provided Bangla-language translations, simple hands-on experiences with the mobile money service, and guidance on how to sign up for bKash.

Table 3: First Stage

| | (1) Rural: Active bKash Account | (2) Rural: Active bKash Account | (3) Urban: Active bKash Account | (4) Urban: Active bKash Account |
|---|---|---|---|---|
| bKash Treatment | 0.48*** | 0.48*** | 0.48*** | 0.48*** |
| | (0.03) | (0.03) | (0.03) | (0.03) |
| $R^2$ | 0.23 | 0.24 | 0.23 | 0.25 |
| Baseline Controls | No | Yes | No | Yes |
| Endline Control Group Mean | 0.22 | 0.22 | 0.21 | 0.21 |
| Observations | 813 | 813 | 809 | 809 |

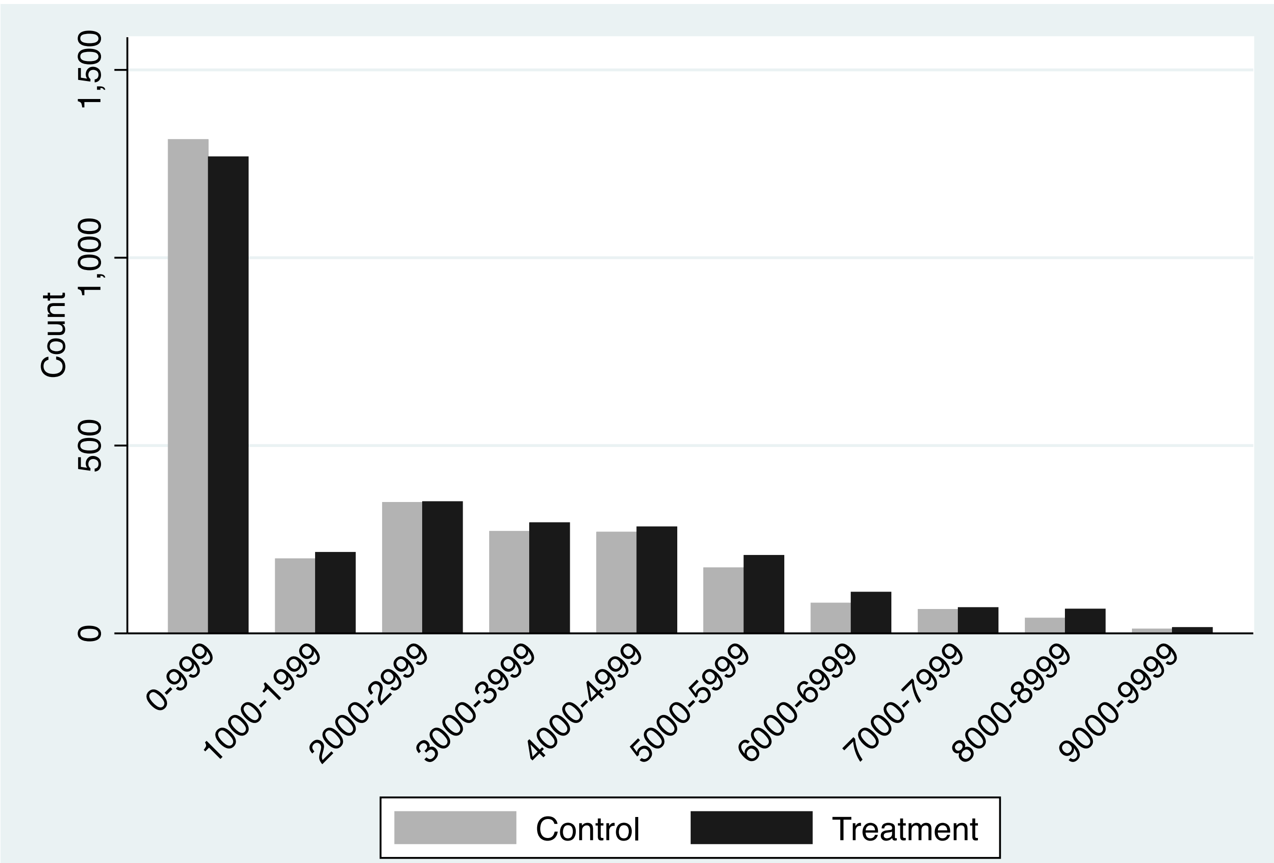
Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The impact of the training intervention was substantial. Table 3 presents results on take-up from the first stage of the instrumental variable regressions. Columns (1) and (2) show that households in the rural treatment group were 48 percentage points more likely to have an actively-used bKash account than those in the control group, on a control mean base of 22%. Column (1) presents results without baseline controls, while the column (2) specification includes gender, age, and primary school completion of head of the household, and household size. Adding the baseline controls changes the point estimate in the third decimal place only, and both results are statistically significant at the 1% level.The result shows that the short intervention, together with facilitation of sign-up, not only led to a substantial increase in accounts but also to their active use. By the endline, 70% of the rural treatment group were active bKash users.

The results show a wide gap between access to financial services and their active use. The third and fourth columns of Table 3 give results for the urban migrants. Again, the treatment has a large impact on account use. Migrants in the urban treatment group were 47 percentage points more likely to have an active bKash account than those in the control group, on a control mean base of 21%. It is not surprising that the rural and urban numbers are very similar since sending and receiving urban-to-rural remittances is the primary use of mobile money in this context.

The treatment led to a strong response in remittance-sending consistent with the theoretical prediction in section 3.2. Figure 2 shows monthly remittances (from all sources) drawn from the endline survey. While a large mass of migrants sent no remittances or very little in a given month (less than 1000 Taka = $13 in 2016), many sent large amounts, and migrants in the treatment group were more likely to send larger sums than migrants in the control group. A Kolmogorov-Smirnov test confirms that the distributions in Figure 2 are significantly different between the treatment and control groups at p-value = 0.04.

Figure 2: Monthly Remittances Sent (Taka)




Notes: Based on endline data with 5661 migrant-month observations.

Table 4: Remittances Sent

| | (1) Total, Taka (OLS) | (2) Total, Taka (IV) | (3) bKash, Taka (OLS) | (4) bKash, Taka (IV) | (5) Total, Share (OLS) | (6) Total, Share (IV) |
|---|---|---|---|---|---|---|
| Treatment * Endline | 316.1* | | 385.9*** | | 0.030* | |
| | (163.0) | | (130.1) | | (0.016) | |
| Active Account * Endline | | 660.6* | | 806.6*** | | 0.062* |
| | | (342.1) | | (274.9) | | (0.034) |
| Endline | -327.8*** | -466.2** | -119.0 | -287.9** | -0.030*** | -0.043** |
| | (121.7) | (181.1) | (96.76) | (144.7) | (0.012) | (0.017) |
| $R^2$ | 0.29 | 0.29 | 0.44 | 0.43 | 0.24 | 0.24 |
| Month Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Household Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Control Mean (Endline) | 2198 | 2198 | 1162 | 1162 | 0.22 | 0.22 |
| Observations | 10,526 | 10,526 | 10,526 | 10,526 | 10,526 | 10,526 |

Standard errors in parentheses, clustered by household.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The dependent variable in columns (1) and (2) is total remittances (sent through any means) sent in the prior 7 months as self-reported by urban migrants. The dependent variable in columns (3) and (4) is remittances sent through bKash. The dependent variable in columns (5) and (6) is total remittances as a share of migrant income.

The increase in remittances sent by migrants is summarized in Table 4. The table gives regression results for remittances sent by migrants to the rural households, based on data on monthly remittances sent in the past seven months in baseline and endline surveys. All regressions control for household-level and month fixed effects. Column (1) shows the intention-to-treat impact of the treatment on remittances sent (from all sources); migrants in the treatment group sent 14% more remittances at endline (316.1 on a control mean base of 2197.8) than migrants in the control group (statistically significant at a p-value of 0.05). Column (2) presents treatment-on-treated results that account for active use of the bKash accounts. The 660.6 coefficient in the second row of column (2) indicates a 30% increase in the value of remittances sent by migrants induced by the experimental intervention to actively use bKash (661/2198). There is considerable heterogeneity in the samples, though, and the estimate is fairly noisy.[10]

The third and fourth columns of Table 4 present results for bKash remittances sent (in contrast to the results on remittances from all sources). Column (3) shows that migrants in the treatment group sent, on average, 385.9 Taka more in bKash remittances at endline in comparison to migrants in the control group, controling for differences between baseline and endline, month fixed effects, and household fixed effects. The coefficient is slightly larger than that obtained for total remittances in column (1), and shows limited substitution from other means of remittances to bKash remittances. As such, the increase in total remittances from migrants in the treatment group is largely driven by an increase in new remittances rather than from substitution from other existing means of remittances to bKash. Columns (5) and (6) show that, consistent with theoretical predictions in section 3.2, migrants also sent a substantially higher share of their income as remittances relative to the control group. The TOT results in column (6) show that the share of income sent as remittances increased by 28% relative to the control group mean (0.062/0.22).

While the value and composition of remittances changed, their frequency did not. In addition to remitting via mobile money, migrants also sent money through remittance services and through relatives and friends. Physically returning home to bring money back was also common, forming a large share of the "other" category in Figure 3. The top panel of Figure 3 shows a 27% (10540/8270) increase in the value of remittances sent using mobile money, which is similar to the 30% increase in the total value of remittances seen in Table 4.[11] The

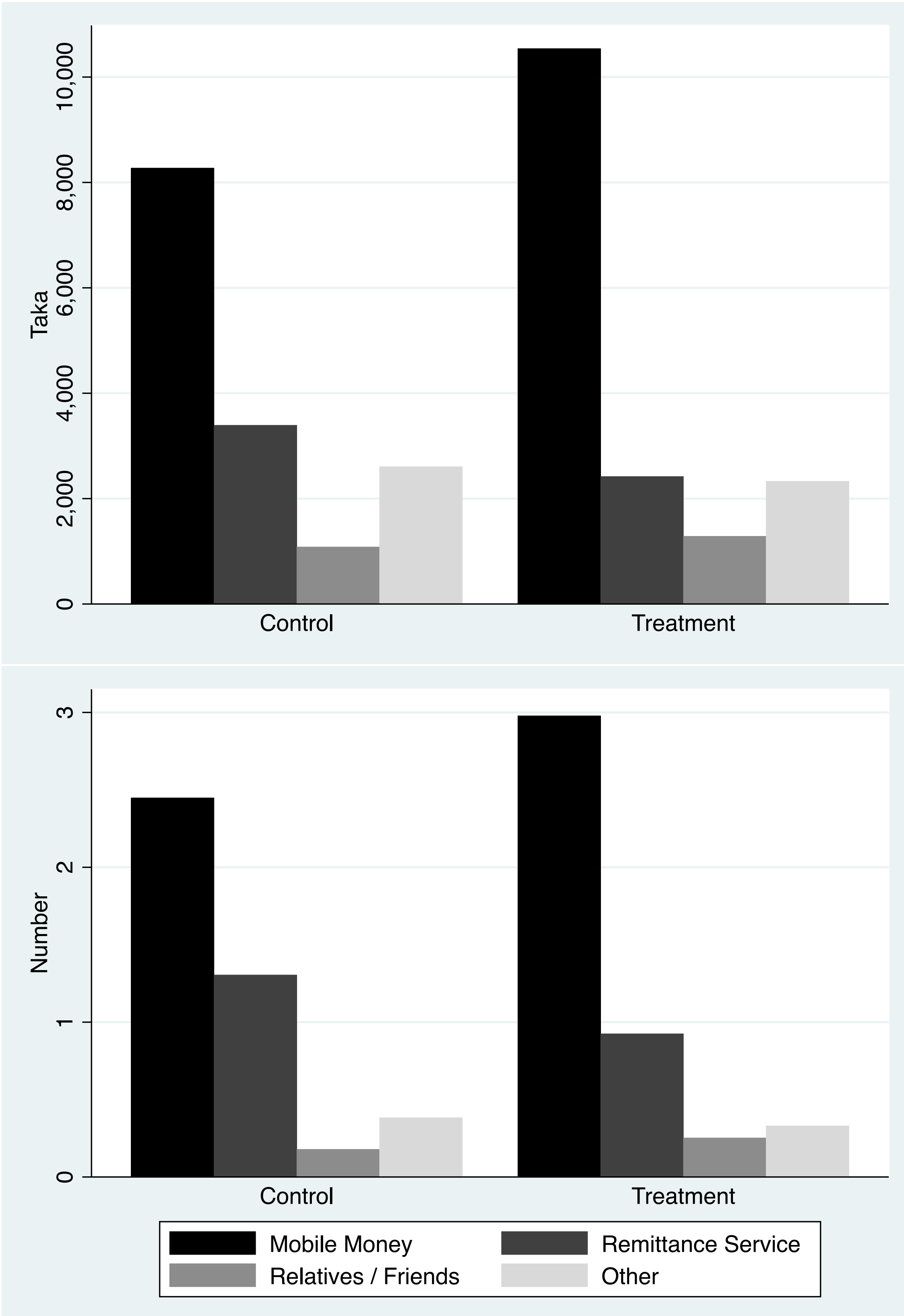
[10]One source of variation arises because some in the sample lack jobs and thus are not remitting money. To gauge the impact, we ran an exploratory regression adding a dummy variable for whether the migrant earned money in a given month, recognizing that employment is at least in part endogenous to the intervention. The coefficient on the dummy is -777, nearly eliminating the remittance impact for migrants without income (as expected), and the TOT parameter rose slightly to 834. In a study in the Philippines, Pickens (2009) found that one third of a sample of 1,042 users of mobile money services did not use remittances at all, using mobile money to purchase airtime. He found that about half of active users (52%) used the service twice a month or less while a "super-user" group (1 in every 11 mobile money users) made more than 12 transactions per month.

[11]It is notable that mobile money remittances form 52% of total remittances for the control group, though only 21% of migrants in the control group have an active bKash account. There are two reasons. First, there is likely some mis-classification in the self-reported data: some respondents said that they remitted money

bottom panel of Figure 3 gives the frequency of remittances. Overall, there is no significant difference in the total number of remittances sent between the treatment and control groups: on average, migrants sent one remittance every six weeks. The composition shifts, however, as migrants in the treatment group increased the number of remittances sent using mobile money by 22% (significant at the 10% level), while reducing the number of remittances sent using non-mobile money means by 19% (significant at the 5% level). This is primarily due to a reduction in the number of remittances sent using remittance services by 29% (significant at the 1% level).

using "mobile money" when, in fact, they used a bKash agent to perform an agent-assisted (also known as over-the-counter or OTC) transaction. OTC transactions are not permitted by regulation and, for users, do not provide the speed, convenience, and privacy of user-to-user transactions. An active bKash account is not required for such a transaction. A comparison of the endline data and bKash administrative data confirms this for the control group. Second, migrants with active bKash accounts in the control group chose to sign up for bKash of their own accord (i.e., without the experimental training intervention). Having an account thus signals particular interest in remitting money, and it is not surprising that they are particularly active in using the accounts.

Figure 3: Value and Number of Remittances Sent over Last 7 Months (Endline)

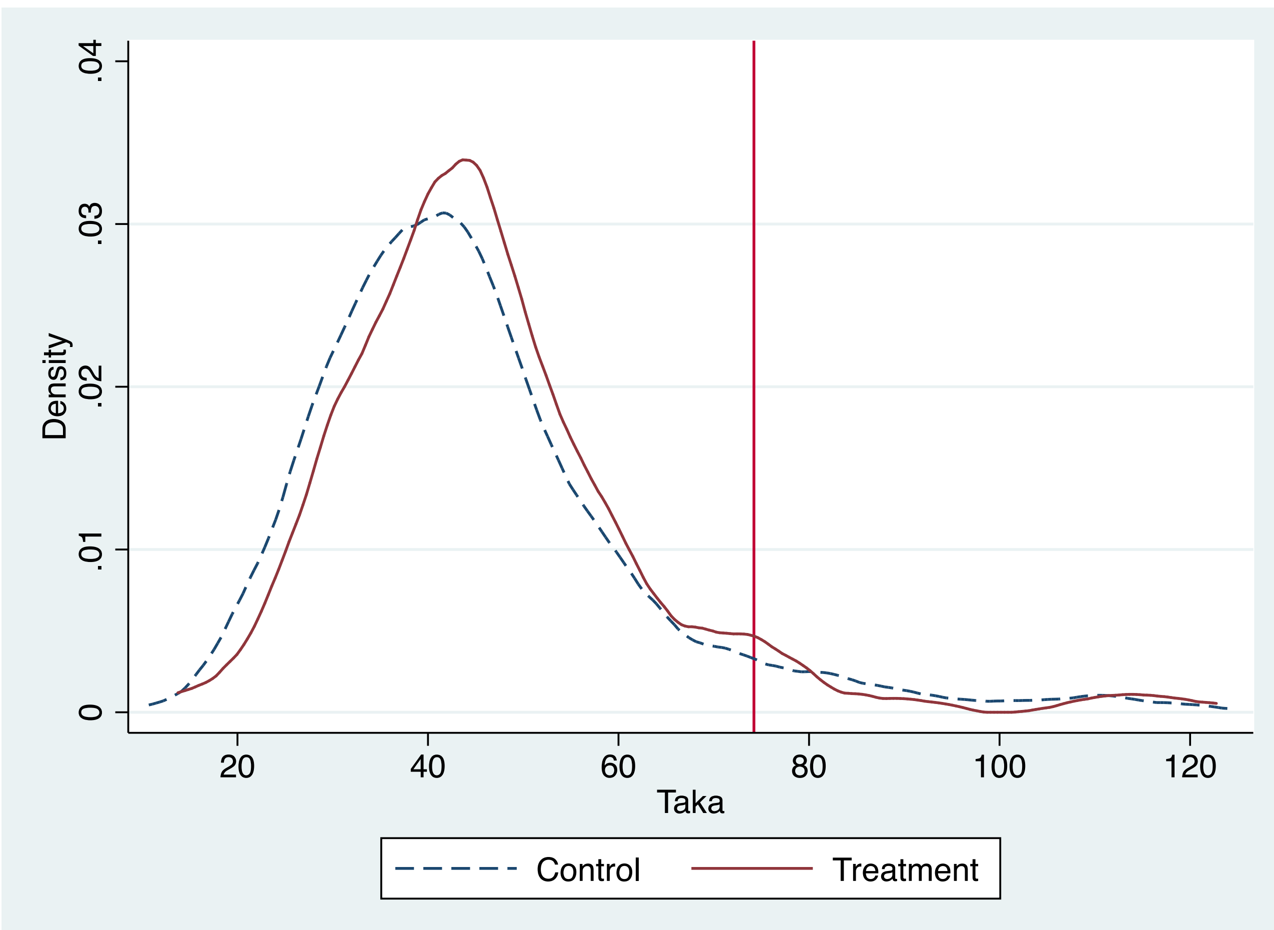


## 6.2 Impacts on Rural Households

### 6.2.1 Direct Consumption Effect: Consumption, Poverty, Education, and Health

The theoretical model in section 3.2 predicts an increase in rural consumption. We show that directly first, then turn to impacts on poverty, education, and health. The roughly 30% increase in remittances sent by urban migrants in the treatment group (relative to the control group) transferred substantial resources back to families in Gaibandha. Figure 4 presents kernel density plots of per capita daily expenditure separately for the treatment and control groups. In line with the remittance flows, the distribution of per capita expenditure shifts to the right for the treatment group. A Kolmogorov-Smirnov test for equality of the distribution functions confirms the difference in distributions (p-value = 0.017).

Figure 4: Kernel Density Plots of Rural Per Capita Daily Expenditure (Endline)



The vertical line in Figure 4 marks the poverty line of 74.2 Taka in rural Bangladesh, adjusted to 2016 prices using the rural Consumer Price Index from the Bangladesh Bureau of Statistics. Most of the rural households fall substantially below the poverty line, consistent with the ultra-poor sample.

Given the extreme poverty of much of the sample, the increase in consumption was insufficient to bring many families over the rural poverty line, and column (1) of Table 5 shows the impacts on the poverty headcount are effectively zero and not statistically significant. To investigate impacts on extreme poverty, we tranform expenditure following the distributionally-sensitive Foster-Greer-Thorbecke (FGT) index. This squared poverty gap measure places greatest weight on the deprivations of the poorest households and is constructed for each rural household as follows:

$$P_i = \begin{cases} \left(\frac{z-y_i}{z}\right)^2 & \text{if } y_i < z \\ 0 & \text{otherwise} \end{cases} \tag{3}$$

where $P_i$ denotes the squared poverty gap, $y_i$ denotes per capita daily expenditure, and $z$ denotes the poverty line. Column (2) of Table 5 presents ITT and TOT regressions showing a TOT decrease in the extreme poverty metric by 0.038 relative to a control mean of 0.20, a decline of 19% (statistically significant at the 5% level).

Table 5: Rural Consumption, Poverty, Education, and Health

| | (1) Poor? | (2) Squared Poverty Gap | (3) Consumption Index | (4) Education Index | (5) Health Index |
|---|---|---|---|---|---|
| *Intention-to-treat:* | | | | | |
| bKash Treatment | 0.008 | -0.018** | 0.14** | 0.171* | 0.022 |
| | (0.02) | (0.009) | (0.053) | (0.094) | (0.068) |
| *Treatment-on-treated:* | | | | | |
| Active bKash Account | 0.02 | -0.038** | 0.285** | 0.35* | 0.05 |
| | (003) | (0.018) | (0.11) | (0.19) | (0.14) |
| $R^2$ (ITT) | 0.02 | 0.18 | 0.39 | 0.03 | 0.02 |
| $R^2$ (ToT) | 0.04 | 0.16 | 0.38 | 0.02 | 0.02 |
| Control Mean (Endline) | 0.77 | 0.20 | 0 | 0 | 0 |
| Observations | 813 | 813 | 813 | 397 | 813 |

Standard errors in parentheses.

All regressions are estimated with baseline control variables and the baseline dependent variable.

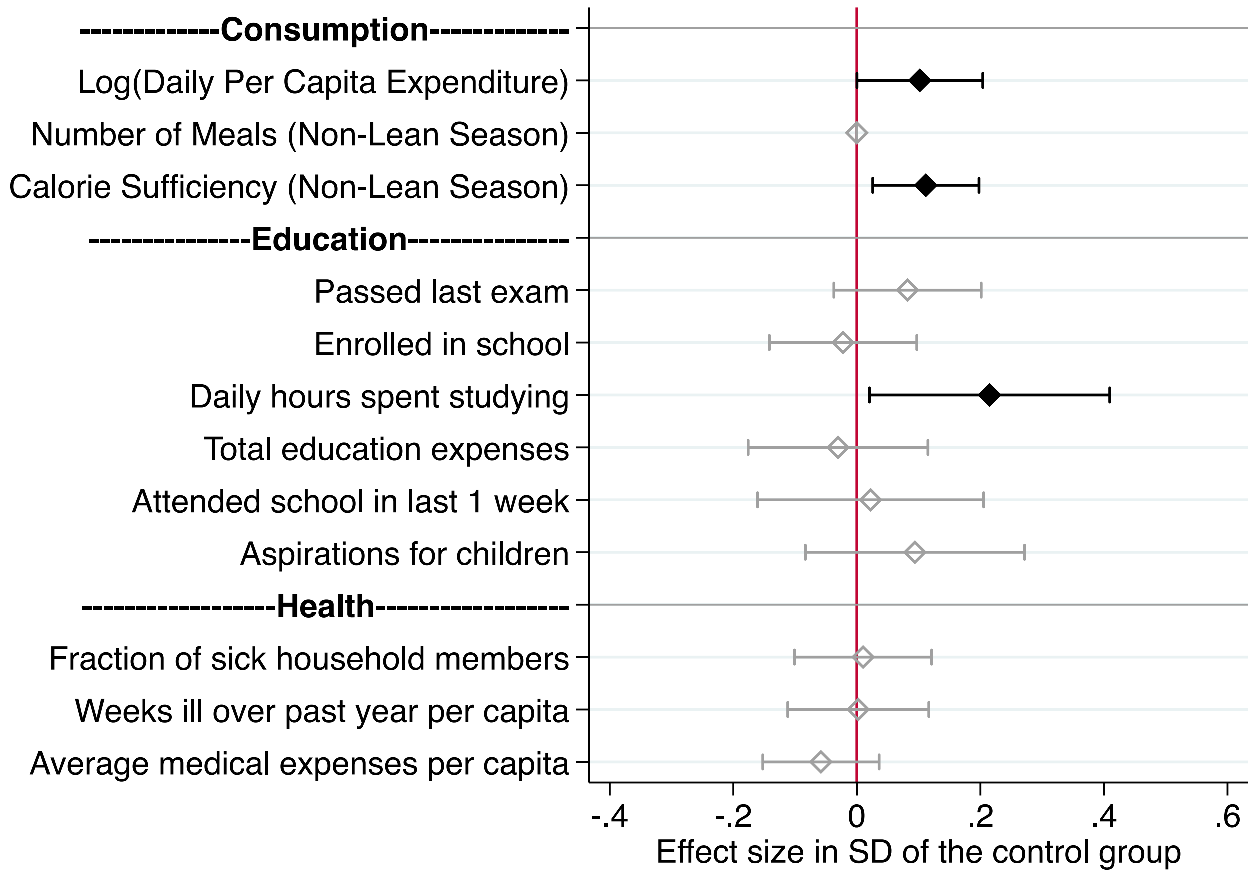
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 5 presents treatment effects on consumption, education, and health. Coefficients are normalized relative to the control group standard deviation, and the 90% confidence interval is displayed. The first row of the figure shows an intention-to-treat increase on the log of daily per capita expenditures of 0.1 of a standard deviation. The associated treatment-on-treated coefficient implies daily per capita expenditures 7.5% greater in the treatment group than the control. All households ate three meals a day during regular seasons (i.e., not the lean season), and there was no variation across time or across samples. Calorie sufficiency improved, however, in the treatment group by 0.11 of a standard deviation (an increase of 10.4%). As the rightward shift of the treatment distribution in Figure 4 shows, the treatment impact is largest at the bottom of the distribution, i.e. for the poorest households.[12]

We constructed a consumption index for each household using the three consumption variables in Figure 5 (and two consumption variables in Figure 6 below), with equal weight given to the normalized variables. Column (3) of Table 5 shows that the treatment increased the consumption index of households in the treatment group by 0.14 standard deviation units. The TOT result shows an increase in the consumption index by a relatively large 0.29 standard deviation units relative to the control group (statistically significant at the 5% level).

[12]Calorie sufficiency was computed as the gap between the calorie needs and the calorie consumption of the household. We asked households about their monthly consumption of eggs, meat, fish, fruits, and milk. We then calculated the calorie consumption from these various food groups using calorie conversion factors provided by the Food and Agriculture Organization. Calorie needs were computed using the household roster and age and gender-specific calorie requirements provided by the United States Department of Agriculture (USDA). Accounting for member-specific needs is important since particular types of household members migrated more from treatment households for work. In particular, 70% of such migrants were male, and the average age of these migrants was 25. Males aged 25 have a USDA calorie requirement of 3,000 calories per day, one of the highest requirements of all ages and gender groups. (Only males aged 16-18 have a higher calorie requirement: 3200 calories per day.)

Figure 5: Impact on Rural Consumption, Education, and Health




Notes: Each line shows the OLS point estimate and 90 percent confidence interval for the outcome. The regressions are run with baseline controls as well as control for baseline value of the dependent variable, and treatment effects are presented in standard deviation units of the control group. Consumption and health: 813 observations. Education: 397 observations (restricted to households with school-age children).

The treatment effects on child education in Figure 5 are from regressions run at the household-level for 397 households with at least one child aged 5-16 years. All regressions were run using OLS, with the exception of aspirations for child education, which was run using an ordered logit over a list of ordered categories that included high school, college, and post-graduate studies.[13] We see a positive treatment effect on the average number of hours spent studying per day (0.21 of a standard deviation). In absolute terms, children of households in the treatment group that actively used bKash spent 0.52 hours more studying per day than children in the control group (baseline control average 2.55 hours studying per day). The point estimates for school attendance, exam performance, and parents' aspirations for their children are consistently positive, but are not statistically significant at the 10% level. The mechanism for increased study hours is hard to pin down. One path is that parents could spend part of the increased remittances directly on child education. However, we do not see this in Figure 5. Second, children in treated households might study longer if they are in better health. We do not, however, find significant treatment impacts on child health. Third, children may be substituting study hours with time spent helping at home or in agriculture and/or other business activities of the household (although we see only a low incidence of paid child labor overall).

The final three rows of Figure 5 give treatment effects on health of rural households. Outcomes include the fraction of household members who were sick for a week or more over the past year, the number of weeks that individuals were ill per capita, and the average medical expenses per capita. All health coefficients are very close to zero.

Table 5 summarizes results on education and health indices using the variables in Figures 5 with equal weight given to the variables. The education index was only constructed for the 397 households with at least one child aged 5-16 years. The sign of the health index has been reversed so that a decrease in the fraction of sick household members, for example, is an improvement in the health index. Column (4) of Table 5 shows that children in the treatment

[13] We obtain a larger coefficient and smaller p-value when standard OLS is used instead.

group saw an increase in the education index by 0.17 standard deviation units (ITT) and 0.35 units (TOT), though noisily measured. Column (5) shows no overall treatment impact on health, consistent with Figure 5.

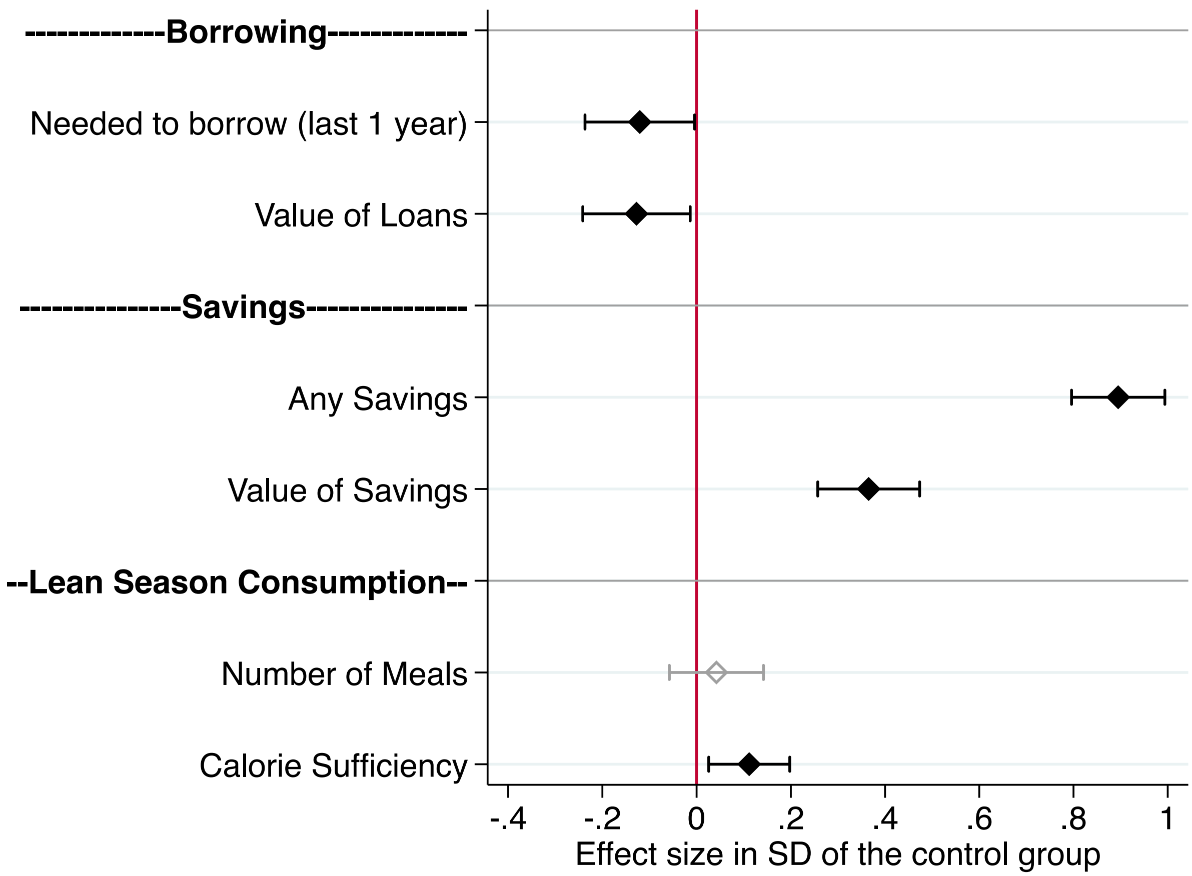
#### 6.2.2 Shocks and liquidity: Borrowing, Saving, and Lean Season Consumption

Remittances can be used in place of credit or can be saved for later use. In times of particular need, like the lean season, well-timed remittances can also be a saving or insurance substitute. The theoretical model in section 3.2 delivers a decline in borrowing tied to increases in consumption during the lean season.

Figure 6 begins with treatment effects on borrowing by rural households. The results indicate that increased remittances from migrants sharply reduced the need of rural households to borrow. Households that actively used bKash accounts in the treatment group were 12.2 percentage points less likely to need to borrow than households in the control group (at endline, 60.9% of households in the control group borrowed in the previous year). The total value of loans among treatment households also fell sharply: the average was 882 Taka lower than the control group average of 4039.5 Taka. (The estimate combines the extensive and intensive margins of borrowing.) These large magnitudes are consistent with the magnitudes of transfers: the total size of loans taken over the last 12 months was 6798 Taka at baseline, and monthly remittances are large in comparison (2198/6798 = 32.3%).

Figure 6 shows significant positive impacts results on savings for rural households. Total savings are the sum of the value of various forms of saving plus bKash balances held at the time of endline survey. On the extensive margin, households in the treatment group were 44.3 percentage points more likely to save, on a control mean base of 42%. This is because bKash can act as a savings device for households, in addition to the remittance facility it provides. This is seen in the month-end balances of households in the bKash administrative data. The results for the value of savings are not conditional on having saved, and thus combine the extensive and intensive margins of savings. Households in the treatment group saved roughly 143% more than households in the control group. Accounting for active use of the bKash accounts gives a TOT impact of 296%. These estimates are large and statistically significant at the 1% level. The borrowing and saving results are summarized in the first four columns of Table 6.

Figure 6: Impact on Rural Borrowing, Savings, and Lean Season Consumption




Notes: Each line shows the OLS point estimate and 90 percent confidence interval for the outcome. The regressions are run with baseline controls as well as control for baseline value of the dependent variable, and treatment effects are presented in standard deviation units of the control group.

Table 6: Rural Borrowing, Saving, and Lean Season (*Monga*) Consumption

| | (1) Any Borrowing? | (2) Loan Value | (3) Any Saving? | (4) Savings Value | (5) No *Monga* Problem? |
|---|---|---|---|---|---|
| *Intention-to-treat:* | | | | | |
| bKash Treatment | -.059* | -0.55* | 0.44*** | 1.43*** | 0.044** |
| | (0.035) | (0.30) | (0.03) | (0.26) | (0.021) |
| *Treatment-on-treated:* | | | | | |
| Active bKash Account | -0.122* | -1.14* | 0.92*** | 2.96*** | 0.092** |
| | (0.071) | (0.62) | (0.066) | (0.53) | (0.045) |
| $R^2$ (ITT) | 0.02 | 0.05 | 0.22 | 0.05 | 0.01 |
| $R^2$ (ToT) | 0.02 | 0.04 | 0.11 | 0.03 | 0.00 |
| Control Mean (Endline) | 0.61 | 4.96 | 0.42 | 2.78 | 0.082 |
| Observations | 813 | 813 | 813 | 813 | 813 |

Standard errors in parentheses.

All regressions are estimated with baseline control variables and the baseline dependent variable.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Column (2) dependent variable is the inverse hyperbolic sine of total loan value.

Column (4) dependent variable is the inverse hyperbolic sine of total savings value.

Column (5) dependent variable is an indicator for households reporting no difficulty during the lean (*monga*) season in response to a survey question about ways of coping during *monga*.

The financial impacts are consistent with improvements in *monga* (lean season) consumption. The estimated coefficient for number of meals during the lean season is positive for the treatment group, but it is small and not statistically significant at the 10% level (Figure 6). However, households in the treatment group were more likely to consume sufficient calories relative to households in the control group (an improvement by 0.11 of a standard deviation) during the lean season. In absolute terms, households that actively used their bKash accounts in the treatment group saw a 11% improvement in calorie sufficiency during the lean season relative to the control group (statistically significant at the 5% level). The improvement in calorie sufficiency during the lean season is consistent with the flexibility that bKash provides migrants to more easily time remittances during the lean season when households are hit the hardest, and it is also consistent with rural households saving more on their own.

Column (5) of Table 6 summarizes the lean season impact. Households that actively used their bKash accounts in the treatment group were 9.2 percentage points more likely to declare that the lean season was not a problem. On a control mean base of 8.2%, this represents a large, 112% increase. For households that declared *monga* to still be a problem, the key coping strategies were purchasing goods on credit and drawing down savings, with no significant differences in strategies used by the treatment and control groups.

#### 6.2.3 Investment and liquidity: Migration and Labor

The impacts on remittances can also be seen in rural investment. The surveys focus on three key contributors to rural household income: migration, wage labor, and self-employment. The increase in remittances facilitated the migration of other household members beyond the original migrant. The first column of Table 7 shows a treatment-on-treated decrease in household size in household size by 0.28 household members for the treatment group relative to the control group. This is consistent with the TOT result in column (2) showing increased migration by 0.24 people (this result excludes the "paired migrants" that were exposed to the initial treatment). The result is large relative to the control group mean household size at endline of 4.02 household members (a 6% change), and it is large relative to the control group mean rate of migration of 0.60 household members (a 42% increase).[14]

There are at least five mechanisms (which cannot be isolated in the data). First, the larger remittances sent through bKash in the treatment group may help to finance the costs of migration. Migration to Dhaka is expensive: Bryan et al (2014) show that purchase of a bus ticket alone was enough to induce migration in 22% of the treated households, though their study focused on seasonal migration rather than long-term moves. The initial costs of housing and job search are also important. Second, household members in the treatment group could have revised their priors on expected income from migration upon observing the larger remittances received. When such migrants were asked at endline their primary reason for migrating for work, 90% noted the an expectation of a higher income was the main reason for migrating. Third, migrants in the treatment group may have built employment networks that could help other family members who migrate. Fourth, access to bKash makes sending remittances easier, raising the effective return to migration. Fifth, migrants in the treatment group could have actively encouraged further migration to help shoulder the stress and burden of having to support rural families.

[14] We observe migration of household members using two sources: (i) the household roster that tracks movement of individuals into and out of the household, and (ii) the employment history of each individual, which tracks their location and duration of work in each month for the past one year. Individuals who worked more than or equal to 312 days in the past year (more than or equal to 6 days per week) in Dhaka were classified as migrating for work. (Migration here refers to permanent migration, as opposed to seasonal migration, which is very common in Bangladesh.)

Table 7: Rural Household Size and Labor

| | (1) Household Size | (2) Number Migrating For Work | (3) Any Wage Labor? | (4) Number Self-Employed | (5) Any Child Labor? |
|---|---|---|---|---|---|
| *Intention-to-treat:* | | | | | |
| bKash Treatment | -0.137* | 0.116** | -0.060* | 0.037* | -0.048*** |
| | (0.07) | (0.057) | (0.031) | (0.023) | (0.017) |
| *Treatment-on-treated:* | | | | | |
| Active bKash Account | -0.284* | 0.240** | -0.123* | 0.077* | -0.095*** |
| | (0.159) | (0.119) | (0.063) | (0.047) | (0.035) |
| $R^2$ (ITT) | 0.51 | 0.05 | 0.13 | 0.42 | 0.05 |
| $R^2$ (ToT) | 0.52 | 0.04 | 0.13 | 0.41 | 0.00 |
| Control Mean (Endline) | 4.02 | 0.60 | 0.71 | 0.17 | 0.05 |
| Observations | 813 | 813 | 813 | 813 | 397 |

Standard errors in parentheses.

All regressions are estimated with baseline control variables and the baseline dependent variable.

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Column (3) of Table 7 presents results for the impact of the intervention on households engaged in any wage labor. A household is defined to engage in wage labor if at least one household member is engaged in wage labor. Notably, 71% of households in the control group at endline engaged in some wage labor. Households in the treatment group that actively used bKash accounts were 0.12 percentage points, or 17% *less* likely to engage in any wage labor. The magnitude of the decline in the number of wage laborers in the treatment group is consistent with the magnitude of decrease in the household size due to migration for work. We see no treatment impact on the intensive margins of wage labor, i.e. number of wage laborers conditional on engaging in any wage labor, and the mean number of days worked by the wage laborers.

The bKash service may facilitate self-employment by providing capital for investment and by providing a financial cushion that encourages risk-taking. Column (4) of Table 7 presents results on the number of household members engaged in self-employment. The treatment-on-treated estimate shows that households in the treatment group that actively used bKash accounts had 0.08 more household members engaged in self-employment relative to the control group. Relative to the control group mean of 0.17, this represents a large, 45% increase in self-employment on the intensive margin. We do not observe statistically significant treatment impacts on the extensive margin on self-employment, although the estimated coefficients are consistently positive.

Few children were engaged in child labor (just 4 children out of 397 at baseline and 12 at endline), so interpretation of child labor results requires caution. Column (5) of Table 7 shows a relative decrease in the number of children working in the treatment group. The ITT results imply that child labor decreased by 88% in the treatment group relative to the 5.4% of households with children in the control group were engaged in any child labor at baseline. These regressions are run only for the 397 households with at least one child aged 5-16 and results are statistically significant at the 1% level.[15]

#### 6.2.4 Investment and liquidity: Agriculture

Most workers in the rural sample are involved in wage work, but some are farmers. The results on agriculture should be seen as exploratory since sample sizes are small: 27 observations in the *Aman* season sample and 60 observations in the *Boro* season sample. As a result of the the small samples, standard errors are large and outliers are a concern. Still, we see evidence that remittances are especially large during the *Boro* season, the irrigated rice season requiring outlays for irrigation and related inputs.

Figure 7 uses administrative data from bKash to show patterns of remittances within the year sent by the treatment group. Figure 7 reveals significant seasonality in the value of remittances sent per active account. The spikes in remittances roughly coincide with the

[15]The TOT result indicates that child labor is more than eliminated in the treatment group relative to the baseline control group average, a coefficient that seems "too large." But the treatment effect should be interpreted against the control trend. The number of child laborers in the treatment group increased from 0 at baseline to 2 at endline. In the control group, the increase was from 4 to 10 child laborers. The small sample size makes results particularly sensitive to outliers, and we would need a larger sample to be confident of the results despite the high level of statistical significance.

harvest periods of the agricultural seasons: *Aman* planting (July and August), *Aman* harvest (rainfed, November), and *Boro* (irrigated, January-June). These remittances may help to offset labor and other costs incurred during the harvest and planting periods. A decrease in remittances sent is seen in the months immediately after the Eid festivals, possibly due to a decrease in income earned during the festival months or because migrants returned home during Eid bringing gifts.

Figure 7: Total Value of bKash Remittances Sent Per Active Account in Treatment Group

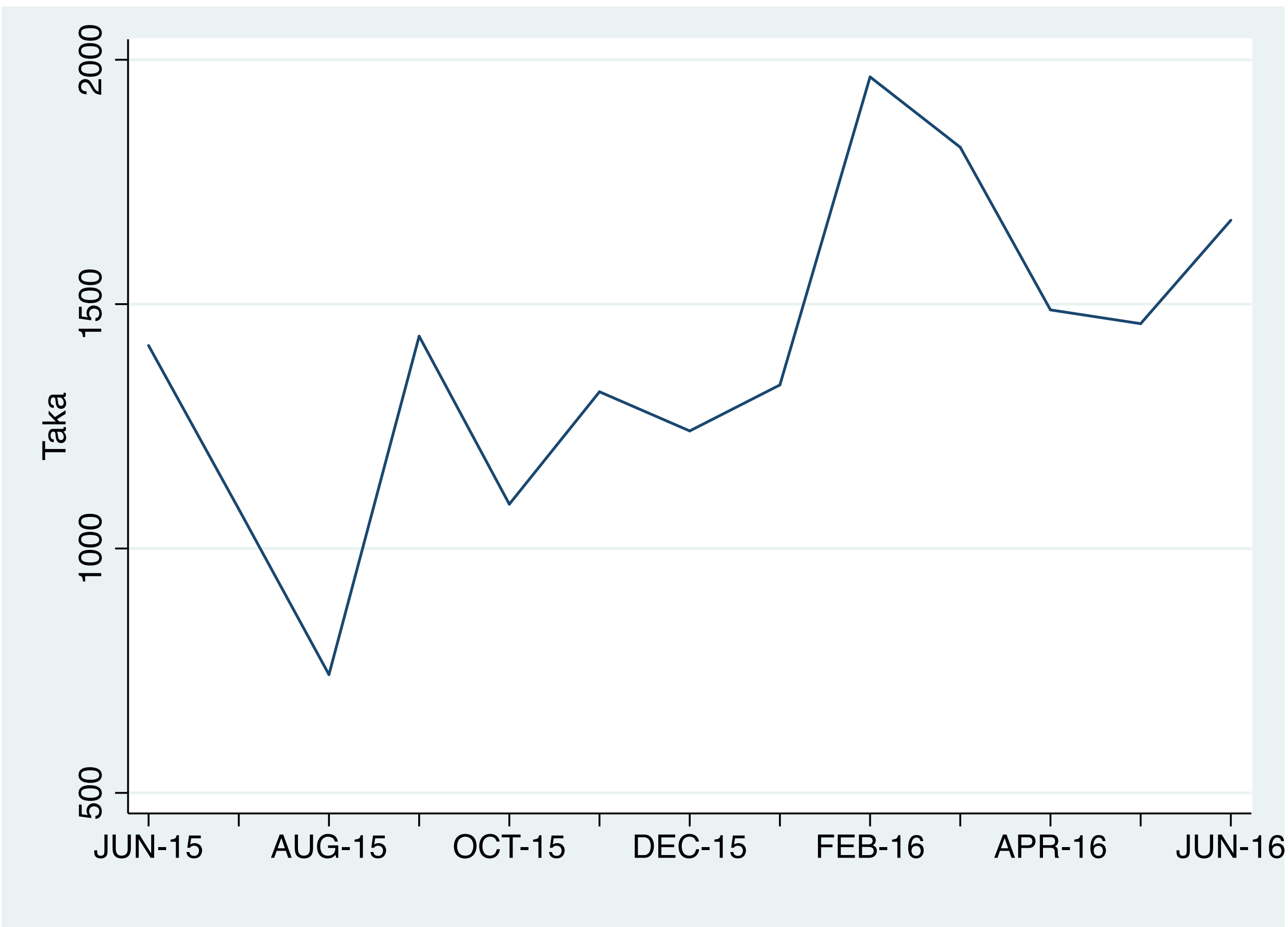
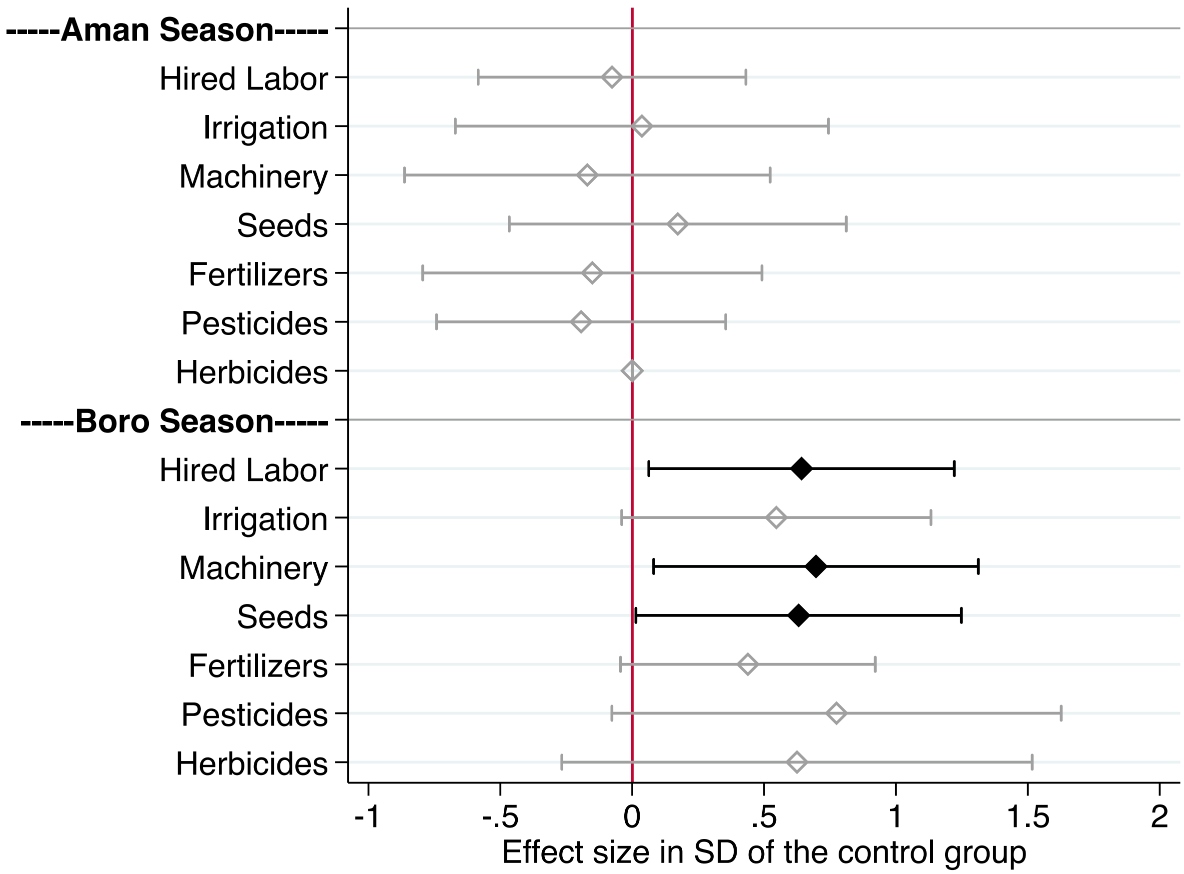


Figure 8: Expenditure on Agricultural Inputs




Notes: Each line shows the OLS point estimate and 90 percent confidence interval for the outcome. The regressions are run with baseline controls as well as control for baseline value of the dependent variable, and treatment effects are presented in standard deviation units of the control group. Regressions for the *Aman* season have 27 observations. For *Boro*: 60 observations.

Figure 8 presents the impacts on the intervention on agriculture during the two main agricultural seasons, *Aman* and *Boro*. *Aman* season, which typically runs from July to December, is rain-fed and requires fewer purchased inputs. *Boro* season, which typically runs from January to June, is irrigation-fed and requires substantially more inputs, such as High Yielding Variety (HYV) seeds. Since the ultra-poor nature of the sample means that few households owned land sufficient to farm on a meaningful scale (excluding wage labor on agricultural plots for others), the results should be treated with caution as the regressions run are conditional on farming (and that, itself, may be endogenous).

We see little impact of the treatment during the *Aman* season. Coefficients are a mix of positive and negative coefficients and confidence intervals are wide. In contrast, however, all coefficients on inputs during *Boro* are positive, and some are very large. For example, the regressions show an increase in expenditures on hired labor by 0.64 standard deviation, machinery by 0.70, and seeds by 0.63 during the *Boro* season, all of which are statistically signifiant. The small sample size (60 observations for *Boro*) and correspondingly wide standard errors mean that the results on expenditures on irrigation, fertilizers, and pesticides are not statistically significant at the 10% level (p-values are 0.12, 0.13, and 0.13 respectively). But, taken together, households engaged in agriculture during the *Boro* season in the treatment group invest more in agricultural inputs relative to the control group. Panel A of Table 8 shows that the *Boro* input index increased substantially by 0.86 standard deviation units (significant at the 10% level).

To explore whether the increase in inputs was due to the timing of remittances, we investigate whether migrants in the treatment group whose paired households engaged in Boro cultivation at endline sent more remittances during the months of the *Boro* season. For the results presented in Panel B of Table 8, we supplement the panel regression specification (2) with dummies for *Boro* month and any *Boro* cultivation, as well as all possible interactions between the variables Endline, Treatment, *Boro* Month, and Any *Boro* Cultivation.

Table 8: Results for Agriculture

| **Panel A:** | | |
|---|---|---|
| | (1) *Aman* Input Index (OLS) | (2) *Boro* Input Index (OLS) |
| bKash Treatment | -0.0808 | 0.863$^{*}$ |
| | (0.354) | (0.450) |
| $R^2$ | 0.091 | 0.161 |
| Baseline Controls | Yes | Yes |
| Baseline Dependent Variable Control | Yes | Yes |
| Endline Control Group Mean | 0 | 0 |
| Observations | 27 | 60 |
| **Panel B:** | | |
| | (1) Value of Remittances (OLS) | (2) Value of Mobile Money Remittances (OLS) |
| Treatment $*$ Endline $*$ *Boro* | 1243.0$^{+}$ | 1146.1$^{+}$ |
| Month $*$ Any *Boro* Cultivation | (848.7) | (734.9) |
| $R^2$ | 0.291 | 0.442 |
| Baseline Controls | No | No |
| Month Fixed Effects | Yes | Yes |
| Household Fixed Effects | Yes | Yes |
| Endline Control Group Mean | 2197.8 | 1161.6 |
| Observations | 10526 | 10526 |

Notes: Controls in Panel B include Endline, Treatment, *Boro* Month, Any *Boro* Cultivation, and all possible interactions between these variables. *Boro* Months are January to to June (inclusive). Standard errors in parentheses. Standard errors clustered by household in Panel B only.

$^{+}$ $p < 0.15$, $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Panel B of Table 8 shows that the coefficient on the quadruple interaction term is large in columns (1) and (2), though not statistically significant at conventional p-values. The value of remittances increases by 1243 taka relative to a control endline mean of 2198 taka. This implies that migrants in the treatment group send substantially larger remittances during the months of the *Boro* season when their paired households are engaged in *Boro* cultivation at endline.[16] The results provide suggestive evidence that both the value and timing of remittances matter for the results on agriculture, though we would need a larger sample to be confident of robustness.

#### 6.2.5 Wider impacts: Spillovers to non-users

As Riley (2016) argues based on her work in Tanzania, the impacts of mobile money may spill widely since the technology facilitates movement of money into rural areas, including during times of generalized shortages. The benefits of liquidity and spending increases may filter through the community from users to non-users.

There is a second concern which is specific to the experimental set-up. Randomization took place at the individual level, not at the village level. Thus, there might be spillovers from the treatment group to the control group. Positive spillovers may be good for the control group but problematic for interpretation of the results above since the control group would be contaminated in a statistical sense.

We check for potential spillovers in the rural and urban samples using variation in treatment density to assess the likelihood of spillovers. Treatment density is defined as the ratio of the number of treatment households to total households surveyed in a given geographic unit. We focus on two key outcome variables in the control group, bKash adoption and active bKash accounts, both obtained from the bKash administrative data. The equations estimate whether take-up of bKash by the control group increases in villages with a greater

[16] We do not observe similar results for the number of remittances sent, although the estimated coefficients are positive. Although it is possible that "Any *Boro* Cultivation" could be endogenous, we do not observe a treatment impact on this variable.

density of treatment members.

Row 1 of Panel A of Table 9 presents results for rural households. Here treatment density was defined at the village level. Column (1) presents results for bKash adoption and column (2) presents results for active bKash accounts.[17] Control group households in villages with a higher treatment density were not more likely to adopt bKash or have active bKash accounts.[18] In fact, all the point estimates are small and negative in Panel A, showing that if anything, control group households in villages with a higher treatment density were somewhat *less* likely to adopt bKash and have active bKash accounts. As a further check, we ran the regressions using logit and probit specifications, and the results on spillovers remained small and not statistically significant.

It is also possible that spillovers occur in villages with higher treatment density due to sharing of incoming remittances (Emma Riley, 2016). We can directly test for this in the data, and the results are in columns 3 and 4 of Panel A. As Riley (2016) found, there is no evidence of consumption spillovers. In fact, the point estimates are small and negative for potential spillovers to daily per capita expenditures.

[17] We were only able to obtain bKash administrative data for the one-year period from June 2015 to June 2016, while the intervention took place in April and May 2015. As a result, we are unable to control for the baseline values of the dependent variables in this analysis.

[18] We repeated the analysis at a higher geographic level, the union level, and the results remained insignificant. Households in the study were part of 281 villages in 35 unions in Bangladesh.

Table 9: Spillover Analysis

| | (1) Adopted bKash? | (2) Active bKash Account? | (3) Daily per capita Spending | (4) Consumption Index |
|---|---|---|---|---|
| **Panel A: Rural** | | | | |
| Treatment Density | -0.038 | -0.027 | -1.21 | 0.54 |
| | (0.098) | (0.088) | (11.41) | (0.55) |
| $R^2$ | 0.01 | 0.02 | 0.20 | 0.46 |
| Control Mean (Endline) | 0.30 | 0.22 | 44.8 | 0 |
| Observations | 402 | 402 | 402 | 402 |
| **Panel B: Rural** | | | | |
| Nearest neighbor adopted bKash | 0.017 | 0.092 | | |
| | (0.080) | (0.089) | | |
| $R^2$ | 0.01 | 0.00 | | |
| Control Mean (Endline) | 0.30 | 0.22 | | |
| Observations | 402 | 402 | | |
| **Panel C: Urban** | | | | |
| Treatment Density | 0.01 | 0.09 | | |
| | (0.17) | (0.16) | | |
| $R^2$ | 0.07 | 0.05 | | |
| Control Mean (Endline) | 0.23 | 0.22 | | |
| Observations | 397 | 397 | | |

Standard errors in parentheses.
First and third row coeffcients are from OLS regressions estimated with baseline control variables. Second row coeffcients are from IV regressions estimated with baseline control variables.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

As a further check, Panel B presents results that use the status of treatment assignment, bKash adoption, and active use of the nearest neighbor for each rural household. GPS coordinates of each rural household were recorded during the surveys, and this allows us to ask: (i) Are control group households whose nearest neighbor in our sample adopted bKash also more likely adopt bKash? (ii) Are control group households whose nearest neighbor in our sample actively used bKash also more likely to actively use bKash? As in Panel A, there is little evidence of spillovers to the control group. These results speak to both the internal validity of the experiment and to the barriers to adoption of bKash in this setting.

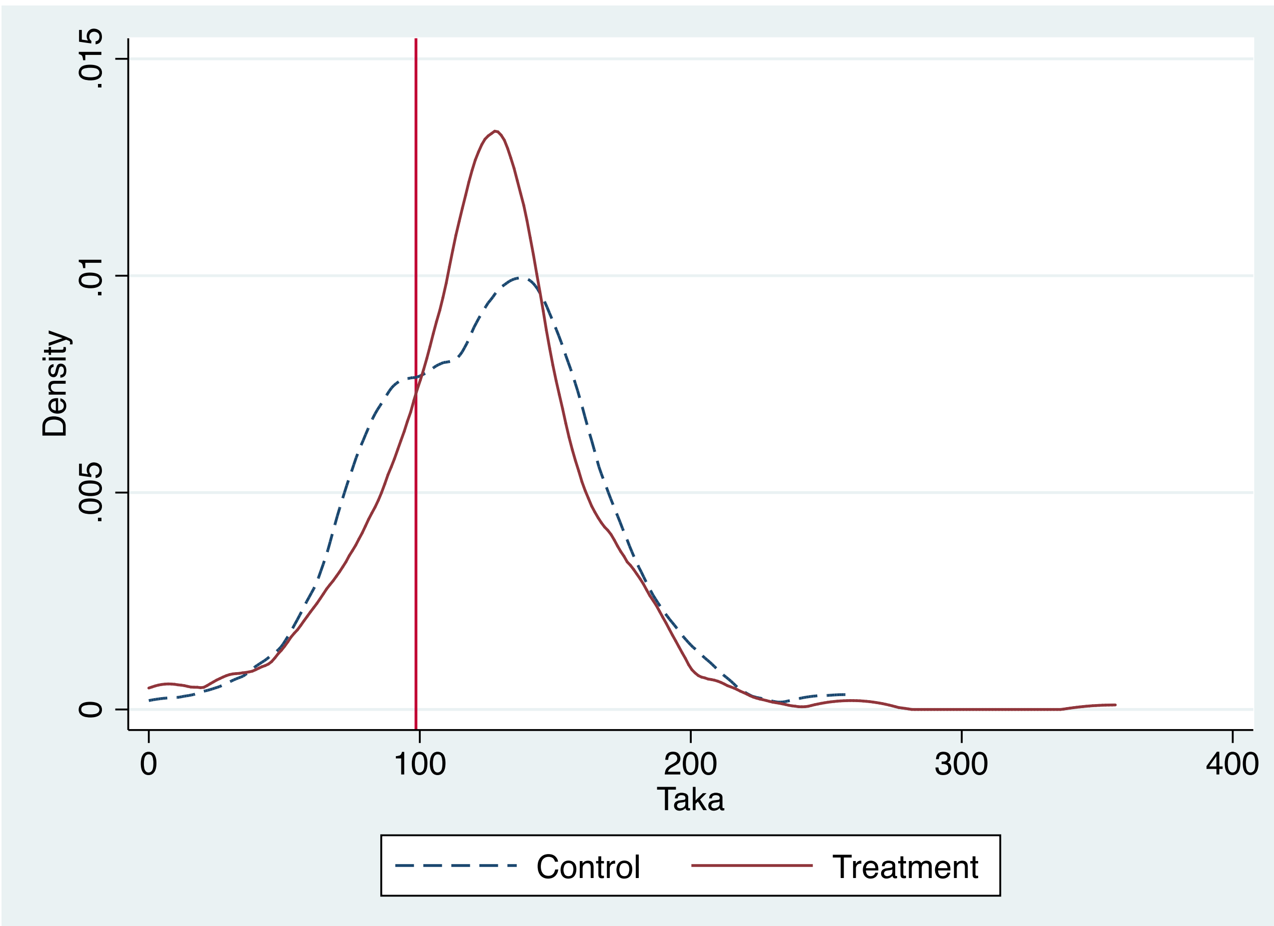
We turn to the spillover analysis for urban migrants in Panel C of Table 9. Treatment density is defined at the city-*upazila* level, the lowest geographic level at which data was collected for migrants. Again, control group migrants in city-upazilas with a higher treatment density were not more likely to adopt bKash or have active bKash accounts. These results are robust to the use of logit and probit specifications.

## 6.3 Impacts on Urban Migrants

We next turn to urban migrants, who face their own struggles with liquidity and low incomes (e.g., Breza et al 2017). The theoretical prediction in section 3.2 is that the treatment would reduce consumption by migrants (since increases in remittances would draw resources from consumption). We find the opposite, however. Figure 9 presents kernel density plots of per capita daily expenditure separately for the treatment and control groups. The vertical line depicts the urban poverty line of 98.6 Taka, which was constructed in a similar manner to the rural poverty line. The distribution of per capita expenditure has shifted to the right for the treatment group around the poverty line, but we cannot reject equality of the distribution functions.

Figure 9 shows the basis for finding a drop in the poverty headcount – a decrease in the share of the urban treatment group (relative to control) with per capita daily expenditures below the poverty line. Column (1) of Table 10 shows that migrants in the treatment group that actively used their bKash accounts were 11 percentage points less likely to be below the poverty line, on a control mean base of 24.2% (p-value = 0.055).[19] The large points estimates suggest that, taken at face value, bKash might serve as an effective poverty reduction tool for the urban poor, though below we note the costs associated with those gains.[20]

Figure 9: Kernel Density Plots of Migrant Per Capita Daily Expenditure (Endline)




[19]The rate of poverty in the control group is slightly higher than the latest urban poverty headcount ratio at national poverty line of 21.3% for Bangladesh, estimated by the World Bank.

[20]As a robustness check, we repeated the poverty analysis using per capita income instead of expenditures, and obtained qualitatively similar estimates. We did not, however, find significant reductions in poverty for extremely poor migrants, as measured by the squared poverty gap.

Table 10: Migrant Poverty, Occupation, Saving, and Health

| | (1) Poor? | (2) Garment Worker? | (3) Any Saving? | (4) Value of Saving | (5) Health Index |
|---|---|---|---|---|---|
| *Intention-to-treat:* | | | | | |
| bKash Treatment | -0.05* | 0.05 | 0.18*** | 0.47* | -0.13* |
| | (0.03) | (0.03) | (0.024) | (0.27) | (0.07) |
| *Treatment-on-treated:* | | | | | |
| Active bKash Account | -0.11** | 0.11 | 0.38*** | 0.99* | -0.28* |
| | (0.06) | (0.07) | (0.05) | (0.56) | (0.15) |
| $R^2$ (ITT) | 0.14 | 0.03 | 0.09 | 0.04 | 0.09 |
| $R^2$ (ToT) | 0.14 | 0.03 | 0.07 | 0.04 | 0.09 |
| Control Mean (Endline) | 0.24 | 0.55 | 0.76 | 6.19 | 0 |
| Observations | 809 | 809 | 809 | 809 | 809 |

Standard errors in parentheses.

All regressions are estimated with baseline control variables and the baseline dependent variable. Column (4) dependent variable is inverse hyperbolic sine of savings.

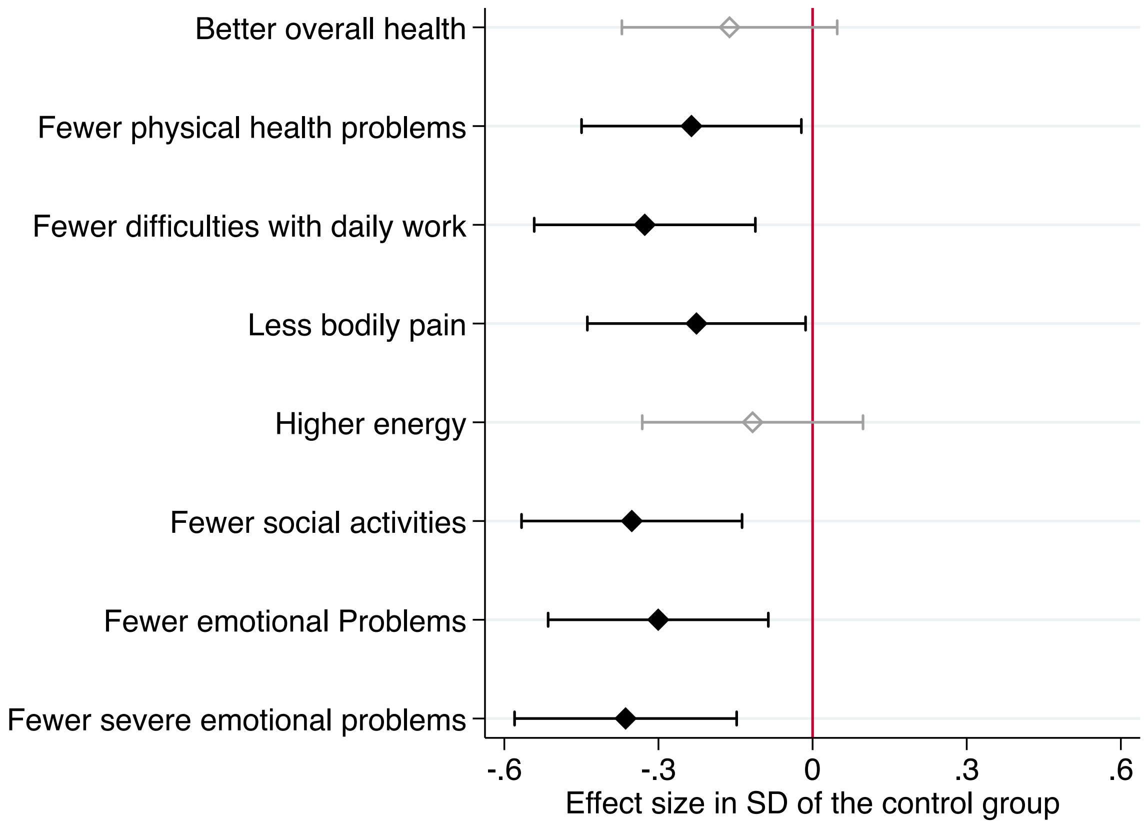
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The increase in consumption and income of migrants is consistent with greater work intensity as predicted by the theoretical model. Column (2) of Table 10 presents treatment effects on employment in the garments and textiles industry. Migrants in the treatment group that actively used their bKash accounts were 11 percentage points more likely to be employed in the garments industry at endline than those in the control group, on a control mean base of 55% (p-value = 0.12).[21] We show below that garment work pays well but involves substantial overtime work.

Column (3) presents results for the extensive margin on savings. Migrants in the treatment group that used their bKash accounts were 38 percentage points more likely to save, on a control mean base of 76%. This is because many migrants in the treatment group use their bKash accounts as a means of saving, as seen in their month-end balances in the bKash administrative data. The point estimate in column (4) suggests that migrants in the treatment group save nearly 50% more than migrants in the control group (and nearly double in the TOT estimate). This result is not conditioned on having saved, and hence combines the extensive and intensive margins of savings.

[21]Due to the broad occupational classes used at baseline, we could not run the regressions in column 1 with a control for the baseline value of the dependent variable. There are two possible reasons for the result on garment work: it could either be the case that more migrants decided to move into garment work (higher entry), or more migrants decided to stay on in their current jobs in the garment sector (lower exit). Given that we saw in Table 1 that the mean tenure at their current jobs among migrants in the treatment group was 1.7 years (longer than the duration of the intervention), it is likely that lower exit from the garments sector among migrants in the treatment group drives the above result. An OLS regression of tenure in the current job on garments work, treatment indicator, and an interaction term between garments work and treatment yields a positive coefficient on the interaction term.

Figure 10: Impact on Migrant Health




Notes: Each line shows the point estimate and 90 percent confidence interval from an ordered logit specification. The regressions are run with baseline controls as well as control for baseline value of the dependent variable, and treatment effects are presented in standard deviation units of the control group.

As noted above, harder work and the 30% increase in remittances sent home came at a cost to migrants. Figure 10 presents treatment effects on the physical and emotional health of migrants using an ordered logit specification that captures qualitiative responses (e.g., options to the question on overall health were Poor, Fair, Good, Very Good, and Excellent).[22]

The treatment had negative impacts on the health of migrants across a series of measures. For example, migrants in the treatment group have notably more difficulties with daily work and more emotional problems. The negative health impact overall is shown in Column (5) of Table 10, which presents results for the health index variable, constructed with equal weight on each of the variables in Figure 10. The treatment decreased the health index by 0.13 standard deviation units, significant at the 10% level. The treatment-on-treated estimate shows a large decrease in the health index by 0.28 standard deviation units (again only significant at the 10% level).

To explore further, we present correlational regressions that describe garment workers. Table 11 shows that while garment workers earn more overtime income and work longer, they do so at the expense of their health (results are large and significant at the 1% level.) In particular, migrants in the garments sector receive over 300% more overtime pay than migrants in other sectors (column 2). However, this comes at the expense of their health, as migrants in the garments sector have worse health (a drop by 0.16 standard deviation units in the index) than migrants employed in other sectors (column 4).

[22] We obtain qualitatively similar results when the regressions are run using standard OLS. The estimates are more precise and the responses to "fewer physical health problems" and "less bodily pain" are no longer significant at the 10% level.

Table 11: Overtime Income, Hours Worked, and Health of Garment Workers (Migrants)

| | (1) Income | (2) Overtime Income | (3) Hours Worked Weekly | (4) Health Index |
|---|---|---|---|---|
| Garments Worker | 1.44*** | 3.43*** | 1.79*** | -0.16** |
| | (0.17) | (0.32) | (0.17) | (0.07) |
| $R^2$ | 0.14 | 0.31 | 0.16 | 0.10 |
| Baseline Controls | Yes | Yes | Yes | Yes |
| Baseline Dep. Var. Control | Yes | Yes | Yes | Yes |
| Endline Control Group Mean | 11.6 | 5.08 | 9.75 | 0 |
| Observations | 809 | 809 | 809 | 809 |

Standard errors in parentheses
All equations estimated with ordinary least squares.
Column (1) and (2) dependent variables are transformed with the inverse hyperbolic sine.
$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

While garments workers worked longer in general, garments workers in the treatment group worked significantly longer hours at endline (p-value = 0.12). The additional 0.8 hours per week on a base of 9.1 hours represents an additional 9% increase. We note, however, that the variable *Garments Worker* is endogenous. These results provide suggestive evidence that longer work hours in the garments sector is one mechanism for the negative health impacts on migrants in the treatment group.

These results are in line with results from financial diaries that provide a close look at the lives of 180 garment workers in Bangladesh (available at www.workerdiaries.org). The garment worker diaries show that the workers averaged 60 hours per week in the factories during the study period, and 53% of the time they worked beyond the 60-hour/week legal limit. Moreover, factory conditions tended to be harsh and financial stress high. Blattman and Dercon (2016) similarly show that workers randomly assigned to industrial jobs in Ethiopia, also an export hub for garments and textiles, had significant health problems after a year. The authors note the longer hours in these jobs as a mechanism for this deterioration in health. Similar results have been reported for factory workers in China (Akay et al 2012, Knight and Gunatilaka 2010) and Pakistan (Chen et al 2017).

# 7 Conclusion

The movement of people and money suggests the possibility of broadening ways to improve rural conditions. We show that rural conditions can be improved by facilitating mechanisms to connect urban and rural areas financially. The study here is unique in following two (paired) groups simultaneously, one in rural Gaibandha in northwest Bangladesh and the other in Dhaka division, home to factories offering industrial jobs. The migrants in Dhaka are the adult children of families in Gaibandha.

At a mechanical level, the movements of people and money lead to questions about the nature of households. One common definition holds that a household is a group that lives together and regularly eats together. In the digital age, though, a son or daughter living in a city hundreds of miles away (or even in another country) may be in regular communication and may participate in their parents' economic lives in a day-to-day or week-to-week way. The growing speed and ubiquity of mobile banking transfers, together with relatively cheap communication, suggests that researchers may need to revisit traditional notions of the household.

The intervention at the heart of the randomized controlled trial was relatively inexpensive, costing under \$12 per family for a 30-45 minute training intervention on how to use the bKash mobile banking service on a mobile telephone (carried out with family members in both urban and rural sites). The short intervention sharply increased take-up of bKash from 22% in the rural control group to 70% in the rural treatment group—itself a substantial result.

The high take-up rate is partly a function of the time and place. First, education levels are low in the sample, and, while most families have members with a mobile telephone, adoption of mobile banking technologies was limited, constrained especially by the use of English-language menus. The intervention included teaching the basic steps and protocols, providing hands-on practice sending transfers five times to establish a degree of comfort, sharing translations of menus into Bangla (Bengali), and, if needed, facilitating the sign-up process. Second, the experiment was started when mobile money was still relatively new in

Bangladesh, especially in poorer rural areas like Gaibandha. The nature of the service and use of English made the technology intimidating to villagers with limited education. Still, the experiment shows that the barriers were not insurmountable. As a result, the setting provided a window (now closing as bKash and its peers penetrate widely) that made it possible to identify the impact of the new technology in both rural and urban settings.

For "ultra-poor" villagers receiving remittances, the technology was a major help. Active users of bKash sent larger remittances home (relative to the control group), an increase of about 30%, both in value and as a fraction of the monthly income of migrants. As a result, extreme poverty fell in rural households in the treatment group. Households also reduced borrowing levels, increased savings, and had less difficulty during the *monga* (lean) season. Self-employment activity, agricultural investment and additional migration increased.

The migrants to Dhaka, though, had mixed experiences. We find increases in garment work, and reductions in poverty, but declines in self-reported health status (a finding parallel to conclusions from financial diaires of garment workers in Bangladesh and analysis of factory workers in Ethiopia, Pakistan, and China). The study demonstrates that technology can bring social and economic improvements, but technology adoption faces hurdles, especially for the poorest, least literate populations. Moreover, traditional challenges faced by low-skilled wage workers – especially relating to poor labor and health conditions – remain and can worsen as mobile money technology adds pressure to already-stressed relatives.

# Appendix: Theoretical Results

## Step 1: Solve for Consumption, Borrowing, Hours of Work, and Remittances

The model is solved by starting at the last stage of the problem and working backwards.

**Period 2: Villager (Rural Household) Problem**

$$\max_{c_{h,2}} \ ln(c_{h,2})$$

$$\text{subject to budget constraint: } c_{h,2} \leq \bar{y} + T_2 - B(1+r)$$

In period 2, the villager exhausts its budget constraint, hence:

$$c_{h,2} = \bar{y} + T_2 - B(1+r) \tag{4}$$

**Period 2: Migrant Problem**

$$\max_{c_{m,2}, T_2, h_{m,2}} \ (1-\phi)\big[(1-\alpha)ln(c_{m,2}) + \alpha ln(\bar{h} - h_{m,2})\big] + \phi ln(c_{h,2})$$

$$\text{subject to budget constraint: } c_{m,2} \leq wh_{m,2} - T_2(1+p)$$

Using (4) and Lagrange multiplier $\lambda$, the Lagrangian for this problem is as follows:

$$\begin{aligned}\mathcal{L} =& (1-\phi)(1-\alpha)ln(c_{m,2}) + (1-\phi)\alpha ln(\bar{h} - h_{m,2}) \\ &+ \phi ln(\bar{y} + T_2 - B(1+r)) - \lambda(c_{m,2} - wh_{m,2} + T_2(1+p))\end{aligned}$$

Assuming interior solutions, we obtain the following first order conditions:

$$\frac{\partial \mathcal{L}}{\partial c_{m,2}} = 0 : \qquad \frac{(1-\phi)(1-\alpha)}{c_{m,2}} - \lambda = 0 \tag{5}$$

$$\frac{\partial \mathcal{L}}{\partial T_2} = 0 : \qquad \frac{\phi}{\bar{y} + T_2 - B(1+r)} - \lambda(1+p) = 0 \tag{6}$$

$$\frac{\partial \mathcal{L}}{\partial h_{m,2}} = 0 : \qquad -\frac{(1-\phi)\alpha}{\bar{h} - h_{m,2}} + \lambda w = 0 \tag{7}$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = 0 : \qquad c_{m,2} - w h_{m,2} + T_2(1+p) = 0 \tag{8}$$

Solving this system of equations, we obtain:

$$T_2 = \frac{\phi w \bar{h}}{1+p} - (1-\phi)\bar{y} + (1-\phi)(1+r)B \tag{9}$$

$$h_{m,2} = \bar{h}\big[1 - \alpha(1-\phi)\big] + \frac{\alpha(1-\phi)(1+p)}{w}\Big[(1+r)B - \bar{y}\Big] \tag{10}$$

$$c_{m,2} = (1-\alpha)(1-\phi)\big[w\bar{h} + (1+p)\bar{y} - (1+p)(1+r)B\big] \tag{11}$$

Plugging (9) into (4), we also obtain:

$$c_{h,2} = \phi\bar{y} + \frac{\phi w \bar{h}}{1+p} - \phi(1+r)B \tag{12}$$

**Period 1: Villager (Rural Household) Problem**

$$\max_{c_{h,1}, B} \; ln(c_{h,1}) + \beta ln(c_{h,2})$$

$$\text{subject to budget constraint: } c_{h,1} \leq \underline{y} + T_1 + B$$

Using (12) and Lagrange multiplier $\mu$, the Lagrangian for this problem is as follows:

$$\mathcal{L} = ln(c_{h,1}) + \beta ln\big[\phi\bar{y} + \frac{\phi w \bar{h}}{1+p} - \phi(1+r)B\big] - \mu(c_{h,1} - \underline{y} - T_1 - B)$$

Assuming interior solutions, we obtain the following first order conditions:

$$\frac{\partial \mathcal{L}}{\partial c_{h,1}} = 0: \qquad \frac{1}{c_{h,1}} - \mu = 0 \tag{13}$$

$$\frac{\partial \mathcal{L}}{\partial B} = 0: \qquad -\frac{\beta\phi(1+r)}{\phi\bar{y} + \frac{\phi w\bar{h}}{1+p} - \phi(1+r)B} + \mu = 0 \tag{14}$$

$$\frac{\partial \mathcal{L}}{\partial \mu} = 0: \qquad c_{h,1} - \underline{y} - T_1 - B = 0 \tag{15}$$

Solving this system of equations, we obtain:

$$B = \frac{1}{(1+\beta)(1+r)}\bar{y} - \frac{\beta}{1+\beta}\underline{y} + \frac{w\bar{h}}{(1+\beta)(1+r)(1+p)} - \frac{\beta}{1+\beta}T_1 \tag{16}$$

$$c_{h,1} = \frac{1}{1+\beta}\Big[\frac{1}{1+r}\bar{y} + \frac{w\bar{h}}{(1+r)(1+p)} + \underline{y} + T_1\Big] \tag{17}$$

Plugging (16) into (9), (10), (11), and (12) we also obtain:

$$T_2 = \frac{w\bar{h}(1+\beta\phi)}{(1+p)(1+\beta)} - \frac{\beta(1-\phi)}{1+\beta}\Big[(1+r)(T_1+\underline{y}) + \bar{y}\Big] \tag{18}$$

$$h_{m,2} = \bar{h}\Big[1 - \frac{\alpha\beta(1-\phi)}{1+\beta}\Big] - \frac{\alpha\beta(1-\phi)(1+p)}{w(1+\beta)}\Big[(1+r)(T_1+\underline{y}) + \bar{y}\Big] \tag{19}$$

$$c_{m,2} = \frac{\beta(1-\alpha)(1-\phi)}{1+\beta}\Big[(1+p)\big[(1+r)\underline{y} + \bar{y}\big] + w\bar{h} + (1+p)(1+r)T_1\Big] \tag{20}$$

$$c_{h,2} = \frac{\beta\phi}{(1+\beta)(1+p)}\Big[(1+p)\big[(1+r)\underline{y} + \bar{y}\big] + w\bar{h} + (1+p)(1+r)T_1\Big] \tag{21}$$

**Period 1: Migrant Problem**

$$\max_{c_{m,1},T_1,h_{m,1}} \quad (1-\phi)\big[(1-\alpha)ln(c_{m,1}) + \alpha ln(\bar{h} - h_{m,1})\big] + \phi ln(c_{h,1})$$
$$+ \beta\Big[(1-\phi)\big[(1-\alpha)ln(c_{m,2}) + \alpha ln(\bar{h} - h_{m,2})\big] + \phi ln(c_{h,2})\Big]$$
$$\text{subject to budget constraint: } c_{m,1} \leq wh_{m,1} - T_1(1+p)$$

Using (17), (19), (20), (21), and Lagrange multiplier $\psi$, the Lagrangian for this problem is as follows:

$$
\begin{aligned}
\mathcal{L} =&(1-\phi)(1-\alpha)ln(c_{m,1}) + (1-\phi)\alpha ln(\bar{h} - h_{m,1}) \\
&+ \phi ln\Big(\frac{1}{1+\beta}\Big[\frac{1}{1+r}\bar{y} + \frac{w\bar{h}}{(1+r)(1+p)} + \underline{y} + T_1\Big]\Big) \\
&+ \beta(1-\phi)(1-\alpha)ln\Big(\frac{\beta(1-\alpha)(1-\phi)}{1+\beta}\Big[(1+p)\big[(1+r)\underline{y} + \bar{y}\big] + w\bar{h} + (1+p)(1+r)T_1\Big]\Big) \\
&+ \beta(1-\phi)\alpha\Big(\frac{\bar{h}\alpha\beta(1-\phi)}{1+\beta} + \frac{\alpha\beta(1-\phi)(1+p)}{w(1+\beta)}\Big[(1+r)(T_1+\underline{y}) + \bar{y}\Big]\Big) \\
&+ \beta\phi ln\Big(\frac{\beta\phi}{(1+\beta)(1+p)}\Big[(1+p)\big[(1+r)\underline{y} + \bar{y}\big] + w\bar{h} + (1+p)(1+r)T_1\Big]\Big) \\
&- \psi(c_{m,1} - wh_{m,1} + T_1(1+p))
\end{aligned}
$$

Assuming interior solutions, we obtain the following first order conditions:

$$
\frac{\partial \mathcal{L}}{\partial c_{m,1}} = 0: \qquad \frac{(1-\phi)(1-\alpha)}{c_{m,1}} - \psi = 0 \tag{22}
$$

$$
\frac{\partial \mathcal{L}}{\partial h_{m,1}} = 0: \qquad -\frac{\alpha(1-\phi)}{\bar{h} - h_{m,1}} + \psi w = 0 \tag{23}
$$

$$
\begin{aligned}
\frac{\partial \mathcal{L}}{\partial T_1} = 0: \qquad & \frac{\phi(1+r)(1+p)}{w\bar{h} + (1+p)\big[(1+r)(T_1+\underline{y}) + \bar{y}\big]} \\
&+ \frac{\beta(1-\phi)(1-\alpha)(1+r)(1+p)}{w\bar{h} + (1+p)\big[(1+r)(T_1+\underline{y}) + \bar{y}\big]} \\
&+ \frac{\beta\alpha(1-\phi)(1+r)(1+p)}{w\bar{h} + (1+p)\big[(1+r)(T_1+\underline{y}) + \bar{y}\big]} \\
&+ \frac{\beta\phi(1+r)(1+p)}{w\bar{h} + (1+p)\big[(1+r)(T_1+\underline{y}) + \bar{y}\big]} - \psi(1+p) = 0
\end{aligned} \tag{24}
$$

$$
\frac{\partial \mathcal{L}}{\partial \psi} = 0: \qquad c_{m,1} - wh_{m,1} + T_1(1+p) = 0 \tag{25}
$$

Solving this system of equations, we obtain:

$$T_1 = \frac{1}{(1+r)(1+\beta)}\Big[\frac{w\bar{h}\big[(1+r)(\phi+\beta)-(1-\phi)\big]}{1+p} - (1-\phi)\big[(1+r)\underline{y}+\bar{y}\big]\Big] \tag{26}$$

$$h_{m,1} = \frac{w\bar{h}\big[1+\beta+r(1+\beta-\alpha(1-\phi))-2\alpha(1-\phi)\big]-\alpha(1+p)(1-\phi)\big[(1+r)\underline{y}+\bar{y}\big]}{w(1+r)(1+\beta)} \tag{27}$$

$$c_{m,1} = \frac{(1-\phi)(1-\alpha)}{(1+r)(1+\beta)}\Big[w\bar{h}(2+r)+(1+p)\big[(1+r)\underline{y}+\bar{y}\big]\Big] \tag{28}$$

We can also use (26) to solve for the following:

$$c_{m,2} = \frac{\beta(1-\alpha)(1-\phi)(\beta+\phi)}{(1+\beta)^2}\Big[w\bar{h}(2+r)+(1+p)\big[(1+r)\underline{y}+\bar{y}\big]\Big] \tag{29}$$

$$c_{h,2} = \frac{\beta\phi(\beta+\phi)}{(1+p)(1+\beta)^2}\Big[w\bar{h}(2+r)+(1+p)\big[(1+r)\underline{y}+\bar{y}\big]\Big] \tag{30}$$

$$h_{m,2} = \frac{w\bar{h}\big[1+\beta\big(2+\beta-\alpha(2+r)(1-\phi)(\beta+\phi)\big)\big]-\alpha\beta(1-\phi)(\beta+\phi)(1+p)\big[(1+r)\underline{y}+\bar{y}\big]}{w(1+\beta)^2} \tag{31}$$

$$\begin{aligned} T_2 &= \frac{w\bar{h}}{(1+p)(1+\beta)^2}\Big[1+\beta\big[2-\beta(1+r)+\phi(2+r)\big(\beta-(1-\phi)\big)\big]\Big] \\ &\quad - \frac{\beta(1-\phi)(\beta+\phi)}{(1+\beta)^2}\Big[(1+r)\underline{y}+\bar{y}\Big] \end{aligned} \tag{32}$$

$$\begin{aligned} B &= \frac{1}{(1+r)(1+\beta)^2}\Big[\big(1+\beta(2-\phi)\big)\bar{y}-\beta(1+r)(\beta+\phi)\underline{y}\Big] \\ &\quad + \frac{w\bar{h}}{(1+p)(1+r)(1+\beta)^2}\Big[1-\beta\big(\beta(1+r)+\phi(2+r)-2\big)\Big] \end{aligned} \tag{33}$$

$$c_{h,1} = \frac{\beta+\phi}{(1+p)(1+r)(1+\beta)^2}\Big[w\bar{h}(2+r)+(1+p)\big[(1+r)\underline{y}+\bar{y}\big]\Big] \tag{34}$$

**Ensuring Remittances are Non-Negative:**

For $T_1 \geq 0$, we require:

$$w \geq \frac{(1-\phi)(1+p)\big[(1+r)\underline{y}+\bar{y}\big]}{\bar{h}\big[(1+r)(\phi+\beta)-(1-\phi)\big]} \tag{35}$$

For $T_2 \geq 0$, we require:

$$w \geq \frac{\beta(1+p)(1-\phi)(\beta+\phi)\big[(1+r)\underline{y}+\bar{y}\big]}{\bar{h}\Big[1+\beta\big[2-\beta(1+r)+\phi(2+r)\big(\beta-(1-\phi)\big)\big]\Big]} \tag{36}$$

Let $\underline{w_1} = \frac{(1-\phi)(1+p)\left[(1+r)\underline{y}+\bar{y}\right]}{\bar{h}\left[(1+r)(\phi+\beta)-(1-\phi)\right]}$ and $\underline{w_2} = \frac{\beta(1+p)(1-\phi)(\beta+\phi)\left[(1+r)\underline{y}+\bar{y}\right]}{\bar{h}\left[1+\beta\left[2-\beta(1+r)+\phi(2+r)\left(\beta-(1-\phi)\right)\right]\right]}$. Then $T_1$ is non-negative if and only if $w \geq \underline{w_1}$ and $T_2$ is non-negative if and only if $w \geq \underline{w_2}$. These conditions are needed to prevent flows of remittances from villagers to migrants when migrant income is too low.

## Step 2: Derive Comparative Statics for Changes in the Price of Remittances

**Remittances:**

$$\frac{\partial T_1}{\partial p} = -\frac{w\bar{h}\big[(1+r)(\phi+\beta)-(1-\phi)\big]}{(1+r)(1+\beta)(1+p)^2}$$

Therefore $\frac{\partial T_1}{\partial p} < 0$ if and only if:

$$(1+r)(\phi+\beta)-(1-\phi) > 0$$
$$r > \frac{1-\phi}{\beta+\phi} - 1$$

Let $\underline{r_1} = \frac{1-\phi}{\beta+\phi} - 1$. Then a decrease in p leads to an increase in period 1 remittances received by villagers if and only if $r > \underline{r_1}$.

$$\frac{\partial T_2}{\partial p} = -\frac{w\bar{h}}{(1+p)^2(1+\beta)^2}\Big[1+\beta\big[2-\beta(1+r)+\phi(2+r)\big(\beta-(1-\phi)\big)\big]\Big]$$

Therefore $\frac{\partial T_2}{\partial p} < 0$ if and only if:

$$1 + \beta\big[2 - \beta(1+r) + \phi(2+r)\big(\beta - (1-\phi)\big)\big] > 0$$
$$r > \frac{1 + 2\beta - \beta^2 + 2\phi\beta(\beta - 1 + \phi)}{\beta\big(\beta - \phi(\beta - 1 + \phi)\big)}$$

Let $\underline{r_2} = \frac{1+2\beta-\beta^2+2\phi\beta(\beta-1+\phi)}{\beta\left(\beta-\phi(\beta-1+\phi)\right)}$. Then a decrease in p leads to an increase in period 2 remittances received by villagers if and only if $r > \underline{r_2}$.

**Fraction of Income Remitted:**

Let the fraction of income remitted in period 1 be $\gamma_1 = \frac{T_1}{wh_{m,1}}$. Then we have:

$$\gamma_1 = \frac{\frac{w\bar{h}}{1+p}\big[(1+r)(\phi+\beta) - (1-\phi)\big] - (1-\phi)\big[(1+r)\underline{y} + \bar{y}\big]}{w\bar{h}\big[1 + \beta + r(1 + \beta - \alpha(1-\phi)) - 2\alpha(1-\phi)\big] - \alpha(1+p)(1-\phi)\big[(1+r)\underline{y} + \bar{y}\big]}$$

Let:

$$\theta_0 = (1-\phi)\big[(1+r)\underline{y} + \bar{y}\big] \ ,$$
$$\theta_1 = \frac{w\bar{h}}{1+p}\big[(1+r)(\phi+\beta) - (1-\phi)\big] \ \text{, and}$$
$$\theta_2 = w\bar{h}\big[1 + \beta + r(1+\beta-\alpha(1-\phi)) - 2\alpha(1-\phi)\big] \ .$$

Then we have:

$$\frac{\partial \gamma_1}{\partial p} = \frac{(\theta_2 - \alpha(1+p)\theta_0)(-\frac{\theta_1}{1+p}) - (\theta_1 - \theta_0)(-\alpha\theta_0)}{(\theta_2 - \alpha(1+p)\theta_0)^2}$$

Therefore $\frac{\partial \gamma_1}{\partial p} < 0$ if and only if:

$$\alpha\theta_0(\theta_1 - \theta_0) < \frac{\theta_1}{1+p}(\theta_2 - \alpha(1+p)\theta_0)$$

$$\theta_0 < \theta_1 \left[1 - \sqrt{1 - \frac{\theta_2}{\alpha(1+p)\theta_1}}\ \right] \text{ or } \theta_0 > \theta_1 \left[1 + \sqrt{1 - \frac{\theta_2}{\alpha(1+p)\theta_1}}\ \right]$$

Since $\theta_0 < \theta_1$ by condition (35), the above set of inequalities is satisfied. Therefore a decrease in $p$ will lead to an increase in the fraction of income remitted in period 1.

Let the fraction of income remitted in period 2 be $\gamma_2 = \frac{T_2}{wh_{m,2}}$. Then we have:

$$\gamma_2 = \frac{\frac{w\bar{h}}{1+p}\Big[1+\beta\big[2-\beta(1+r)+\phi(2+r)\big(\beta-(1-\phi)\big)\big]\Big] - \beta(1-\phi)(\beta+\phi)\Big[(1+r)\underline{y}+\bar{y}\Big]}{w\bar{h}\big[1+\beta\big(2+\beta-\alpha(2+r)(1-\phi)(\beta+\phi)\big)\big] - \alpha\beta(1-\phi)(\beta+\phi)(1+p)\big[(1+r)\underline{y}+\bar{y}\big]}$$

Let:

$$\begin{aligned}
\eta_0 &= \beta(1-\phi)(\beta+\phi)(1+p)\big[(1+r)\underline{y}+\bar{y}\big]\ , \\
\eta_1 &= \frac{w\bar{h}}{1+p}\Big[1+\beta\big[2-\beta(1+r)+\phi(2+r)\big(\beta-(1-\phi)\big)\big]\Big]\ , \text{ and} \\
\eta_2 &= w\bar{h}\big[1+\beta\big(2+\beta-\alpha(2+r)(1-\phi)(\beta+\phi)\big)\big]\ .
\end{aligned}$$

Then we have:

$$\frac{\partial\gamma_2}{\partial p} = \frac{(\eta_2-\alpha(1+p)\eta_0)(-\frac{\eta_1}{1+p}) - (\eta_1-\eta_0)(-\alpha\eta_0)}{(\eta_2-\alpha(1+p)\eta_0)^2}$$

Therefore $\frac{\partial\gamma_2}{\partial p} < 0$ if and only if:

$$\alpha\eta_0(\eta_1-\eta_0) < \frac{\eta_1}{1+p}(\eta_2-\alpha(1+p)\eta_0)$$

$$\eta_0 < \eta_1 \left[1 - \sqrt{1 - \frac{\eta_2}{\alpha(1+p)\eta_1}}\ \right] \text{ or } \eta_0 > \eta_1 \left[1 + \sqrt{1 - \frac{\eta_2}{\alpha(1+p)\eta_1}}\ \right]$$

Since $\eta_0 < \eta_1$ by condition (36), the above set of inequalities is satisfied. Therefore a decrease in $p$ will lead to an increase in the fraction of income remitted in period 2.

**Consumption:**

$$\frac{\partial c_{m,1}}{\partial p} = \frac{(1-\phi)(1-\alpha)\big[(1+r)\underline{y}+\bar{y}\big]}{(1+r)(1+\beta)} > 0$$
$$\frac{\partial c_{m,2}}{\partial p} = \frac{\beta(1-\alpha)(1-\phi)(\beta+\phi)\big[(1+r)\underline{y}+\bar{y}\big]}{(1+\beta)^2} > 0$$
$$\frac{\partial c_{h,1}}{\partial p} = -\frac{w\bar{h}(2+r)(\beta+\phi)}{(1+r)(1+p)^2(1+\beta)^2} < 0$$
$$\frac{\partial c_{h,2}}{\partial p} = -\frac{\beta\phi w\bar{h}(2+r)(\beta+\phi)}{(1+p)^2(1+\beta)^2} < 0$$

Therefore a decrease in $p$ leads to increases in $c_{h,1}$ and $c_{h,2}$ and decreases in $c_{m,1}$ and $c_{m,2}$.

**Villager Borrowing:**

$$\frac{\partial B}{\partial p} = -\frac{w\bar{h}\big[1-\beta\big(\beta(1+r)+\phi(2+r)-2\big)\big]}{(1+r)(1+p)^2(1+\beta)^2}$$

Therefore $\frac{\partial B}{\partial p} > 0$ if and only if:

$$1-\beta\big(\beta(1+r)+\phi(2+r)-2\big) < 0$$
$$r > \frac{1+\beta(2-\beta-2\phi)}{\beta(\beta+\phi)}$$

Let $\underline{r_B} = \frac{1+\beta(2-\beta-2\phi)}{\beta(\beta+\phi)}$. Then a decrease in p leads to a decrease in borrowing by villagers if and only if $r > \underline{r_B}$.

**Migrant Hours of Work:**

$$\frac{\partial h_{m,1}}{\partial p} = -\frac{\alpha(1-\phi)\big[(1+r)\underline{y}+\bar{y}\big]}{w(1+r)(1+\beta)} < 0$$
$$\frac{\partial h_{m,2}}{\partial p} = -\frac{\alpha\beta(1-\phi)(\beta+\phi)\big[(1+r)\underline{y}+\bar{y}\big]}{w(1+\beta)^2} < 0$$

Therefore a decrease in $p$ leads to increases in $h_{m,1}$ and $h_{m,2}$.

# References


Akay, A., Bargain, O., & Zimmerman, K. (2012). Relative concerns of rural-to-urban migrants in China. *Journal of Economic Behavior and Organization*, *81*(2), 421-441.

Angelucci, M. (2015). Migration and financial constraints: Evidence from Mexico. *Review of Economics and Statistics*, *97*(1), 224-228.

Armendáriz, B., & Morduch, J. (2010). *The economics of microfinance, 2nd edition.* Cambridge, MA: MIT Press.

Bandiera, O., Burgess, R., Das, N. C., Gulesci, S., Rasul, I., & Sulaiman, M. (2017). Labor markets and poverty in village economies. *Quarterly Journal of Economics*(Volume 132, Issue 2), 811-870.

Banerjee, A., Duflo, E., Goldberg, N., Karlan, D., Osei, R., Parienté, W., ... Udry, C. (2015). A multifaceted program causes lasting progress for the very poor: Evidence from six countries. *Science*, *348*(6236).

Bardhan, P. (1984). *Land, labor, and rural poverty: Essays in development economics.* New York: Columbia University Press.

Batista, C., & Vicente, P. C. (2013). Introducing mobile money in Rural Mozambique: Initial evidence from a field experiment. *NOVAFRICA Working Paper Series*, *1301*.

Bauchet, J., Morduch, J., & Ravi, S. (2015). Failure vs. displacement: Why an innovative anti-poverty program showed no net impact in South India. *Journal of Development Economics*, *116*, 1 - 16.

Berg, C., & Emran, M. S. (2017). Microfinance and vulnerability to seasonal famine in a rural economy: Evidence from monga in Bangladesh. *MPRA*(79818).

Bhuiyan, M. M. (2017). Mobile financial services gather pace further. *The Financial Express*.

Bilkis, S., & Khan, M. M. R. (2016). Are mobile financial services promoting financial inclusion in Bangladesh: An assessment study. *Bangladesh Bank Working Paper*(1623).

Blattman, C., & Dercon, S. (2018). The impacts of industrial and entrepreneurial work on income and health: Experimental evidence from Ethiopia. *American Economic*

*Journal: Applied Economics (forthcoming)*.

Blumenstock, J., Callen, M., Ghani, T., & Koepke, L. (2015). Promises and pitfalls of mobile money in Afghanistan: Evidence from a randomized control trial. *Proceedings of the 7th IEEE/ACM International Conference on Information and Communication Technologies and Development*.

Breza, E., Kanz, M., & Klapper, L. (2017). Scarcity at the end of the month: A field experiment with garment factory workers in Bangladesh. *International Growth Centre brief 31400*.

Bruhn, M., & McKenzie, D. (2009). In pursuit of balance: Randomization in practice in development field experiments. *American Economic Journal: Applied Economics*, *1*(4), 200-232. doi: 10.1257/app.1.4.200

Bryan, G., Chowdhury, S., & Mobarak, A. M. (2014). Underinvestment in a profitable technology: The case of seasonal migration in Bangladesh. *Econometrica*, *82*, 1671-1758.

Chen, J., Kosec, K., & Mueller, V. (2017). *Moving to despair? Migration and well-being in Pakistan* (Working Paper No. 10853). IZA Institute of Labor Economics.

Demirgüç-Kunt, A., Klapper, L., Singer, D., Ansar, S., & Hess, J. (2018). *The Global Findex Database 2017: Measuring financial inclusion and the fintech revolution*. Washington, DC: World Bank.

Ellis, P., & Roberts, M. (2016). Leveraging urbanization in South Asia: Managing spatial transformation for prosperity and livability. *Washington, DC: World Bank*.

Gates Foundation. (2013). *Fighting poverty, profitably: Transforming the economics of payments to build sustainable, inclusive financial systems* (Report). Financial Services for the Poor.

Hanlon, J., Barrientos, A., & Hulme, D. (2010). *Just give money to the poor: The development revolution from the global south*. Sterling, VA: Kumarian.

Haushofer, J., & Shapiro, J. (2016). The short-term impact of unconditional cash transfers to the poor: Experimental evidence from Kenya. *Quarterly Journal of Economics*, *13*(4), 1973-2042.

Jack, W., & Suri, T. (2014). Risk sharing and transactions costs: Evidence from Kenya's mobile money revolution. *American Economic Review*, *104*(1), 183-223.

Khandker, S. (2012). Seasonality of income and poverty in Bangladesh. *Journal of Development Economics*, *97*, 244-256.

Kikulwe, E. M., Fischer, E., & Qaim, M. (2014). Mobile money, smallholder farmers, and household welfare in Kenya. *PLOS ONE*, *9*(10), 1-13.

Kirui, O. K., Okello, J. J., Nyikal, R. A., & Njiraini, G. W. (2013). Impact of mobile phone-based money transfer services in agriculture: Evidence from Kenya. *Quarterly Journal of International Agriculture*, *52*(2), 141-162.

Knight, J., & Gunatilaka, R. (2010). Great expectations? The subjective well-being of rural-urban migrants in China. *World Development*, *38*(1), 113-124.

Lewis, W. A. (1954). Economic development with unlimited supplies of labor. *Manchester School*, *22*, 139-91.

Lopez-Acevedo, G., & Robertson, R. (2016). *Stitches to riches? Apparel employment, trade, and economic development in South Asia.* World Bank.

Mbiti, I., & Weil, D. N. (2011, June). *Mobile banking: The impact of M-Pesa in Kenya* (Working Paper No. 17129). National Bureau of Economic Research.

Morawczynski, O., & Pickens, M. (2009). Poor people using mobile financial services: Observations on customer usage and impact from M-PESA. *CGAP brief. Washington, DC: World Bank*.

Munyegera, G. K., & Matsumoto, T. (2016). Mobile money, remittances, and household welfare: Panel evidence from Rural Uganda. *World Development*, *79*, 127 - 137.

Pickens, M. (2009). Window on the unbanked: Mobile money in the Philippines. *CGAP brief. Washington, DC: World Bank*.

Rapoport, H., & Docquier, F. (2006). The economics of migrants remittances. In S. C. Kolm

& J. M. Ythier (Eds.), *Handbook of the economics of giving, altruism and reciprocity* (Vol. 2, p. 1135-98). North Holland.

Riley, E. (2016). Mobile money and risk sharing against aggregate shocks. *Oxford University CSAE Working Paper WPS/20*.

Suri, T., & Jack, W. (2016). The long-run poverty and gender impacts of mobile money. *Science*, *354*(6317), 1288–1292.

U.N. (2016a). Urbanization and migration in Bangladesh. *Dhaka: UNFPA Bangladesh Country Office*.

U.N. (2016b). *The world's cities in 2016: Data booklet* (No. ST/ESA/ SER.A/392).

Yang, D. (2011). Migrant remittances. *Journal of Economic Perspectives*, *25*(3), 129-152.

Young, A. (2013). Inequality, the urban-rural gap, and migration. *Quarterly Journal of Economics*, *128*(4), 1727-1785.