Migration and economic activity among origin households: the role of female household headship

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Abstract:

International migration is an important source of employment and remittances for households in the developing world. In a male-dominated international migration system, females are more likely to head households after the exit of a migrant. In this study, we decompose impacts of international migration into effects attributable to a change in the gender of the household head and effects attributable to other mechanisms. We use an unbalanced panel dataset collected over fourteen years from 2000-2014 in Bangladesh, where international migrants are almost all men. Combining instrumental variable estimation with causal mediation methods, we find that sending an international migrant reduces household participation in crop farming, livestock production, and non-farm businesses at the intensive and extensive margins. However, the average impacts of changes in the gender of the household head due to migration show an opposite effect. We find similar results for input expenditure, capital stock, and time allocation in farming, livestock, and business activities as well. Results show that migration increases household expenditures in food and non-food items, but the newly formed female-headed households induced through migration spend less on food and non-food items and invest more on productive activities.

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1 Introduction

International migration (hereafter, migration) is an important source (Quisumbing et al., 2001; Bridges et al., 2011) of employment and income for the developing world. At present, more than 3.4% of individuals throughout the world live in a country different from the one in which they were born, and a significant portion of migrants send remittances back home. Recent statistics show that total remittances received by developing countries added up to $432 billion in 2015(Ratha et al., 2016). Despite the large macro-level impacts of migration, its effects on productive activities of migrant-sending households are somewhat ambiguous. While some empirical studies find that migration positively affects income generating activities and investments in migrant-sending households (Böhme, 2015; Yang, 2008; Woodruff and Zenteno, 2007; Dustmann and Kirchkamp, 2002), other studies point to null or negative effects (Castelhano et al., 2016; Wouterse and Taylor, 2008; De Brauw and Rozelle, 2008; Taylor et al., 1996; Durand et al., 1996). The contributions of different mechanisms to the net impact of migration on origin households are complex and even less understood. For example, if the male head of the household migrates abroad, a female member may assume household headship. If male and female workers are imperfect substitutes in the local labor market, due to differences in managerial capacity or ability to access other markets, then a change in the gender of the household head may shape the overall impacts of migration on migrant-sending households. In other words, gender as a source of intra-household heterogeneity may play a critical role in household resource re-allocation in the post-migration regime (Udry, 1996; Schultz, 1990).

In this study, we examine the impact of migration on the economic activities of migrant-sending households in Bangladesh. More specifically, we decompose the total average impact of sending a migrant into effects that operate through the increase in the likelihood of having a female household head (which we call the average indirect effect of sending a migrant) and effects that operate through all other channels (the average direct effect of sending a migrant). To isolate the role of changes in household headship, we apply instrumental variable estimation and causal mediation techniques to an unbalanced four-round panel data set consisting of 7,980 rural Bangladeshi households, where 10% percent of households have at least one migrant member. Among migrants, 97% are men (BBS, 2013), resulting in more female-headed households in the post-migration period. We find that migration reduces the probability of participation in crop agriculture, livestock produc-

tion, and non-farm businesses by 73%, 92%, and 41%, respectively, relative to average participation rates in the sample. The impact of migration on the magnitude of participation as measured by changes in the amount of cultivated land, number of cows owned, and number of non-farm businesses run by the household, respectively, are also negative, exhibiting decreases of 129%, 70%, and 48% relative to their sample averages.

We then turn to decomposing the average impacts of sending a migrant into an average indirect effect that operates through impacts on household headship and an average direct effect that operates through other mechanisms. Our results show that sending a migrant raises the probability of female household headship by 30 percentage points. We estimate the average indirect effect of sending a migrant under two states of the world. First, we hold the migration decision for all households fixed at having sent a migrant. The resulting estimates capture the average impact of shifting the gender of the household head from what would be observed when not sending a migrant to what would be observed when sending a migrant, given that the effects of sending a migrant arising through other mechanisms have already been realized. Under this state of the world, changes in the gender of the household head brought about by sending a migrant increase area cultivated by 32% on average relative to the sample mean. We do not find any significant indirect effects on other variables.

Next, we again estimate the average indirect effect, holding the migration decision for all households fixed at not having sent a migrant. In other words, the impacts of sending a migrant that arise through mechanisms other than female household headship have not been realized. Under this second state of the world, the average impacts of changes in the gender of the household head brought about by sending a migrant are negative for all measures of participation rates and intensities of economic activities. Under this assumption, participation rates fall by 13%, 11%, and 9% for crop agriculture, livestock production, and non-farm businesses, respectively. Similarly, intensity of participation is reduced by 11%, 14%, and 9% for area cultivated, number of cows owned, and number of non-farm businesses run by the household, respectively.

We use detailed information on capital stock, input expenditures, and time allocation to substantiate our findings on the impact of migration on household economic activities. Given our findings for the average effect of migration on different economic activities, we would expect to find that migration reduces input expenditures and time spent in crop farming, livestock farming,

and non-farm business on average for all migrant-sending households, while potentially decreasing capital stock for each of these economic activities as well. Reduced input expenditures and time allocation would suggest a short-run reduction in activity levels, whereas decreases in capital stock would suggest a long-run shift away from each activity.

We find that sending a migrant reduces expenditures on farming inputs (fertilizer, irrigation, labor, and other inputs), but has no discernible impact on variable input expenditures for non-farm businesses. In addition, sending a migrant strongly decreases time spent in each category of economic activity. However, estimated average indirect effects through changes in female household headship serve to increase expenditures by 44% for fertilizer and 20% for other costs, relative to their sample averages, given that the effects of sending a migrant arising through other mechanisms have already been realized. Average indirect effects on time allocation and expenditures on other inputs are varied in sign and statistical significance. As before, average direct effects are negative and are large enough in absolute value that the average impacts of sending a migrant on crop agriculture expenditures are negative. The average impacts of sending a migrant on capital stock for crop farming, livestock farming, and non-farm businesses are statistically insignificant. Overall, results for input expenditure, capital stock, and time use support our findings on participation in economic activities.

Combining our results on participation, intensity, input expenditures, and time allocation, we find that international migration decreases household involvement in income-generating productive activities. This conclusion begs the question of how households are spending remittances if not on farming and non-farm businesses. We find that sending a migrant raises expenditures on food and non-food items. However, changes in the gender of the household head caused by sending a migrant reduce expenditures by 30% for food, 20% for clothing, and 44% for education relative to their sample averages, conditional on all households sending migrants. In other words, households sending migrants would increase spending on consumption goods at the expense of reduced expenditures on economic activities to a greater degree, if there were no positive impacts of increased female household headship on expenditures on productive activities.

Previous studies that have explored the role of female headship in household consumption, investment, and poverty include Klasen et al. (2011), Quisumbing et al. (2001), and Rahman et al. (2013). However, none of these studies focuses on the interplay between migration and female

headship in determining household economic activity levels and expenditure patterns. To our knowledge, our study is the first to isolate the portion of the impact of migration brought about through changes in household headship from impacts that arise through all other channels. Findings in our study contrast to some previous studies on the role of gender in economic activity levels among households in Bangladesh and other developing countries. Whereas previous authors have found that women tend to have low participation rates in economic activities in Bangladesh (BBS, 2011; Salway et al., 2003) and participate mostly in unpaid work in Tanzania (Fontana and Natali, 2008), we show impacts arising through a higher probability of female headship serve to improve the effects of sending a migrant on origin households' economic activities.

2 Economic activities, female headship, and migration in rural Bangladesh

Around 70% of the population of Bangladesh lives in rural areas, where agriculture has historically been the main source of employment and income generation. Agriculture sector hosts about two-thirds of total employment in rural areas and works as a major income source for about 87% of rural households (WorldBank, 2016; Wood and Mayer, 2004). Although the rate of female participation in paid economic activities has increased over time, it is still significantly lower than that of men. According to BBS (2011), the rate of labor force participation among the population aged 15 years or older is only 36% for females compared to 83% for males. Moreover, female labor participation in formal economic activities is sector-specific (Salway et al., 2003). Female workers in agricultural sector work in activities such as vegetable gardening, livestock production, and aquaculture within or near their homesteads, and many of them tend to be unpaid laborers (Khan et al., 2009; Kabeer, 2012). As for the tasks they take on, female farm workers have historically been involved in post-harvesting tasks such as drying, parboiling, or husking (Jaim and Hossain, 2011).

Inequality in access to major production factors is considered to be a primary reason for relatively low female participation in agricultural activities. For example, FAO (2011) reports that female-headed households own less than one-third of the total land that male-headed households own in Bangladesh. Considerable gender differences are noticeable in access to other factor markets as well. For example, even though female farm workers are heavily involved in seed processing,

germination, and storage, they depend on the male workers to purchase the seeds from the marketplace, or to obtain the necessary training in quality control of seeds (Jaim and Akter, 2012). Another branch of literature on rural Bangladesh suggests that the relatively low rates of female participation in productive activities are partly due to social norms dictating gender roles.Bridges et al. (2011) attribute low rates of Bangladeshi women in economic activities to the traditional view that men should be the main breadwinners while women should solely work in domestic activities. 38% of women abstain from working in any income generating activity because their husbands do not allow them to work (Rahman et al., 2013).

International migration has been an important source of employment and remittances in Bangladesh since the late 1980s (figure 1). Bangladesh is one of the top recipients of remittances in the world, with remittances making up approximately 8.7% of its Gross Domestic Product (GDP) (Ratha et al., 2016). Out-migration from Bangladesh is almost entirely dominated by males, as only 3% of expatriates are females. 72% of migrants have less than 10 years of schooling and 10% are illiterate (BBS, 2013). The average time spent abroad by migrants is typically quite long, with about 74% of migrants living outside Bangladesh for more than three years, and 57% living outside of Bangladesh for more than five years (BBS, 2013).

[Figure 1 here]

Household heads in Bangladesh are predominantly male (BBS, 2010), and the country is characterized by strong patriarchal social norms (Amin, 1997) that limit women's autonomy. Although there is an upward trend in the proportion of female-headed households, the level of female-headed households is still low. In our sample, 5%, 7%, 12%, and 16% rural households are observed to be female-headed in 2000, 2004, 2008, and 2014, respectively. On the other hand, the proportion of female-headed, migrant households is around 35% over the study period, suggesting that migration likely causes a switch in the household headship structure.

3 Theoretical model

To understand the channels through which international migration affects household economic activity choices, we consider the following unitary household model in which the household maximizes

utility (U) from consumption (C) and leisure (L) :

$$U(C, L) \tag{1}$$

U is a strictly concave function, where $\partial U/\partial C \geq 0$ and $\partial U/\partial L \geq 0$. Household production technology, $Q_j(l_0, l_1, h; \phi(F, X))$, is a function of hired labor (l_0), family labor(l_1), and other inputs (h) allocated in the sector $j = 1.....J$. Other than observed inputs allocated, efficiency or managerial capacity (ϕ) of the household also affects output realization. The efficiency parameter (ϕ) depends on the gender of the household head (F) as well as the vector of household and individual-level characteristics (X). Each household faces a budget constraint such that the value of consumption and input expenditures are constrained to be no more than the total household income:

$$\sum_{j=1}^{J} P_j Q_j(.) + R + wl_2 \geq C + wl_0 + rh \tag{2}$$

Equation (2) shows that households can earn income from activity $j(j = 1....J)$, remittances (R), and income from wage labor (wl_2), and spend their income for consumption and purchases of production inputs. We set the price of the consumption good (C) equal to one and savings equal to zero for simplicity. In addition, each household also faces a time constraint, $T = L + l_1 + l_2 + M$, in other words, total time allocated to leisure (L), labor ($l_1 + l_2$), and migration (M) cannot exceed the household's time endowment (T). For the theoretical framework, we assume that migration (M) is a continuous variable; however, it is a binary indicator in the empirical section. Substituting the production function and the time constraint into the budget constraint, we solve the household's maximization problem assuming an interior solution. The first order conditions are as follows:

$$\begin{gathered}
U_c(.) - \lambda = 0 \\
-U_{l_1}(.) + \lambda p_j Q_{j_{l_1}}(.) = 0 \\
-U_{l_2}(.) + \lambda w = 0 \\
\lambda(p_j Q_{jl_0}(.) - w) = 0 \\
\lambda(p_j Q_{jh}(.) - r) = 0 \\
(\sum_{j=1}^{J} P_j Q_j(.) + R + wl_1 - C - wl_0 - rh) = 0
\end{gathered} \tag{3}$$

We can rewrite the first three lines of the equation (3) as $U_c(.) = U_{l1}(.)/p_j Q_{jl_1}(.) = U_{l2}(.)/w$: a condition which defines the relationship between household consumption and labor used in equilibrium. Line two (three) shows that the marginal utility of household labor used in production (used in wage labor) must be equal to the marginal utility of leisure, while the third (fourth) line of equation (3) indicates that the marginal utility of hired labor (other inputs) in production must be equal to the marginal utility of the income used to hire the last unit of labor (other inputs). Lines two and three of equation (3) can be written as an optimal condition for the household labor allocation decision on family enterprises and wage labor jobs, $U_{l_1}(.)/U_{l_2}(.) = p_j Q_{jl_1}(.)/w$. Line three and four of equation (3) can be written into an optimal condition for hired labor and other inputs,$Q_{jl_o}(.)/Q_{jh}(.) = w/r$. The conditions in equation (3) implicitly define a set of optimal points for household time allocation (l^*), input choice (h^*), and expenditure on consumption (c^*).

To show how migration affects outcome variables of interest, we concentrate on one of the outcome variables: participation in economic activity j. Comparable results will hold for other outcome variables as well. We define an indicator function (I_{ij}) to represent household $i's$ participation decision in sector j. The indicator function (I_{ij}) is dependent on all the choice variables and other parameters discussed above. We write the indicator function as follows,

$$I_{ij} = \begin{cases} 1 & \text{if} \quad g(p, w, r, T(M), R(M), \phi(F(M), X)) > 0 \\ 0 & \text{if} \quad g(p, w, r, T(M), R(M), \phi(F(M), X)) \leq 0 \end{cases} \tag{4}$$

Where $I_{ij} = 1(g > 0)$ and 0 otherwise. In equation (4), we show that household participation in activity directly depends on total time available and subsequent remittance receipt and indirectly depends on inefficiency through the change in headship. Taking the total derivative of $g(.)$ with respect to M yields:

$$\begin{aligned} dg/dM &= g_T dT/dM + g_R dR/dM + (g_\phi \phi_F) dF/dM \\ &= (dg/dM|F = f) + (dg/dF|M = m)(dF/dM) \end{aligned} \tag{5}$$

The first two components of the right hand side of equation (5) show what we define as the "direct effect" of sending a migrant, i.e. the impact of sending a migrant on participation in sector j holding female headship fixed. The first term, $g_T dT/dM$, is expected to be negative because

sending a migrant reduces the labor endowment of the household ($dT/dM < 0$), and dR/dM is positive as sending a migrant increases the probability of receiving remittances. The sign of g_R, however, is ambiguous as it consists of both an income effect (remittances may reduce the probability of participation in productive activities) and a capital effect (remittances may relax local credit constraints, allowing for increased participation in productive activities). If labor and other input markets are imperfect in the migrant-sending economy, g_R will more likely to be negative. The last two components of the equation (5) show the impact of the change in household headship on participation holding migration status fixed, which we define as the indirect effect of sending a migrant. dF/dM is clearly positive, g_ϕ is also expected to be positive, but the sign of ϕ_F is ambiguous. Based on the above, we have the following propositions:

Proposition 1: Suppose that household headship is fixed. Participation in activity j after migration will fall (i.e., $(dg/dM|F = f) \leq 0$) if the income effect outweighs the capital effect ($g_R < 0$) of international migration. On the other hand, participation will depend on the relative strength of g_M versus $g_R dR/dM$ if the capital effect dominates the income effect.

Proposition 2: Suppose migration status is fixed. Participation in economic activity j will fall $(dg/dF|M = m)(dF/dM) \leq 0$ if a change in headship from male to female reduces household's productive efficiency ($\phi_F < 0$).

Proposition 3: Total effect of migration (dg/dM) will depend on the relative strength of two components $(dg/dM|F = f)$ and $(dg/dF|M = m)(dF/dM)$.

4 Data

We use a four-round unbalanced panel data set as part of the "Livelihood Systems in Bangladesh" project. The survey collected data on household demography, asset holdings, production, income, and expenditures. Although five rounds of the survey were completed, we exclude the earliest round that was conducted in 1988 due to the long gap between the first and second survey rounds. Our analysis is based on the data from the last four rounds of the survey administered in 2000, 2004, 2008, and 2014. Households were selected using a multi-stage random sampling procedure in order to ensure representation of rural areas throughout Bangladesh. In the first stage, 62 villages were randomly selected from 57 districts in Bangladesh. Next, a village-level census was conducted

in each of the 62 villages to obtain information about household land holdings and land tenure status.Households in each village were classified into eight groups based on four land ownership categories as well as their tenure status. Finally, a stratified random sample was selected using each of the eight groups. Some households attrited over time, and some others were split into new households (e.g. as a result of marriage). The research team added additional households as needed in different rounds to keep the sample representative of the population. The sample used for our study includes 1,626 households in 2000, 1,705 in 2004, 1,803 in 2008, and 2,846 households in 2014. Among these 7,980 observations, 5,312 observations consist of panel households for which we have information in all four rounds.

Table 1 shows summary statistics by year. We define a household as a migrant-sending household if it had at least one member abroad in the past 12 months. About 8% of sample households had at least one international migrant member in 2000, while 9%, 12%, and 13% had at least one migrant in 2004, 2008, and 2014, respectively. Household headship is defined using the response to a survey question asking who makes decisions for the household. In our sample, female-headed households comprised 6%, 7%, 12%, and 16% of the sample in 2000, 2004, 2008, and 2014, respectively.

[Table 1 here]

We categorize household economic activities according to whether they are related to crop farming, livestock production, or non-farm businesses. We measure household participation in each activity at the intensive and extensive margins. At the intensive margin, crop farming participation is measured by the amount of land cultivated by the household, livestock participation is measured by the number of cows owned by the household, and non-farm business participation is measured by the number of non-farm businesseses operated by the household. At the extensive margin, a household is considered to be participating in a given activity if the relevant intensity measure is non-zero. In addition, we measure capital stock in each type of economic activity. Capital stock is defined as the monetary value of physical capitals used for activity in each sector at current prices reported by the respondent. We also use input expenditures (or variable expenditures) for farming and non-farm businesses as outcome variables. Expenses made for crop farming is include expenditures for fertilizer, irrigation, labor, and other farm inputs, while non-farm expenditures are reported as total cash expenditures made in the previous twelve months for non-farm businesses

held. Finally, we measure the amount of time that working-aged household members allocate to each activity, as well as time spent in wage labor, domestic work, and personal care. For time allocation, we use individual-level data for members aged between 14-64 years.

5 Empirical methodology

Based on the theoretical framework presented in the previous section, we specify the following two-equation linear approximation for an outcome of interest and female headship status for household i:

$$Y_i = \gamma_o + \gamma_1 M_i + \gamma_2 F_i + \gamma_3 (M_i \times F_i) + X_i'\theta + \varepsilon_i \tag{6}$$

$$F_i = \delta_o + \delta_1 M_i + X_i'\theta + \zeta_i \tag{7}$$

where Y_i is the value of the outcome of interest for household i, F_i is a dummy variable equal to one if household i has a female head, M_i also a dummy variable indicating whether household i has a migrant or not, X_i is a vector of time-varying household characteristics that are correlated with F_i and Y_i, and ζ_i and ε_i contain unobserved heterogeneity of F_i and Y_i, respectively. The total effect of M_i on Y_i measures the average change in the outcome of interest,Y_i, resulting from sending a migrant relative to the counterfactual scenario of not having sent a migrant. As in our theoretical model, the total effect of international migration can be decomposed into effects that operate through a shift from a male head to a female head (if such a shift occurs) and effects that operate through other mechanisms (e.g. a loosening of liquidity constraints or loss of labor). In other words, F_i, is a mediator that shapes the total effect of M_i on Y_i. The portion of the total effect of migration on the outcome variable that operates through changes in gender status of the household headship is known in the mediation analysis literature as the Average Causal Mediation Effect (ACME), or the indirect effect (Imai, Keele, and Yamamoto 2010). The portion of the total effect of migration on the outcome variable that operates through all other mechanisms is known as the Average Direct Effect (ADE), or the direct effect.

Let $F_i(M)$ represent household headship when the decision to send a migrant takes on value $M \in \{0, 1\}$. For each household, we observe either $F_i(1)$ or $F_i(0)$, depending on the decision to send a migrant. Let $Y_i(M, F_i(M))$ be similarly defined for the outcome of interest. Depending on

the decision to send a migrant, one of $Y_i(1, F_i(1))$ and $Y_i(0, F_i(0))$ is observed for each household. $Y_i(1, F_i(0))$ and $Y_i(0, F_i(1))$ represent additional counterfactual values of the outcome of interest that are never observed in the data. However, their conditional means can be identified under appropriate assumptions, allowing for identification of the ACME and ADE, as will be discussed below. Following the notation above, the average impact of sending a migrant, $\bar{\rho} = E(\rho_i(M))$, is given by:

$$\begin{gathered} E\{Y_i(1, F_i(1)) - Y_i(0, F_i(0))\} = \\ E\{Y_i(1, F_i(1)) - Y_i(1, F_i(0)) + Y_i(1, F_i(0)) - Y_i(0, F_i(0))\} \end{gathered} \tag{8}$$

Note that we can write an expression equivalent to equation (8) as follows:

$$E\{Y_i(M, F_i(1)) - Y_i(M, F_i(0))\} + E\{Y_i(1, F_i(M)) - Y_i(0, F_i(M))\} \text{for} M = 0, 1 \tag{9}$$

Using the first two components of the second line of equation (9), we define the ACME as:

$$\bar{\tau}(M) = E(\tau_i(M)) = E\{Y_i(M, F_i(1)) - Y_i(M, F_i(0))\} \text{for} M = 0, 1 \tag{10}$$

The term in curly brackets, $Y_i(M, F_i(1)) - Y_i(M, F_i(0))$, is the indirect effect for household i, $\tau_i(M)$. Suppose that we set $M_i = 1$ for household i. Suppose further that household i would have a male household head when not sending a migrant and a female household head when sending a migrant. The indirect effect in this scenario, $\tau_i(1)$, is the effect of moving the household from a situation where they have sent a migrant but still have a male household head to a scenario where they have sent a migrant but have a female household head. In other words, the indirect effect obtained when setting $M_i = 1$ measures the impact of any change in the gender of the household head brought about by migration, conditional on already having enjoyed any impacts of migration arising through other mechanisms. Note that the indirect effect is equal to zero for household i if sending a migrant does not change the gender of the household head. The ACME is obtained by taking the expected value of the household-level indirect effects.

Using equations (6) and (7), we can define the ACME with migration (i.e., fixing migration

status at $M_{it} = 1$ for all i) as follows:

$$\begin{aligned}\bar{\tau}(1) &= (\gamma_0 + \gamma_1 + \gamma_2\bar{F}^1 + \gamma_3\bar{F}^1 + \theta\bar{W}) - (\gamma_0 + \gamma_1 + \gamma_2\bar{F}^0 + \gamma_3\bar{F}^0 + \theta\bar{W}) \\ &= (\gamma_2 + \gamma_3) \times (\bar{F}^1 - \bar{F}^0) \\ &= (\gamma_2 + \gamma_3) \times \delta_1\end{aligned} \tag{11}$$

where $\bar{F}^1$ and $\bar{F}^0$ are the means of the headship gender variable with and without migration, respectively, for the population. In other words, $\bar{F}^1$ gives the proportion of households that would be female headed if all households sent a migrant, whereas $\bar{F}^0$ gives the proportion of households that would be female headed if no households sent a migrant. The parameter δ_1 is the average treatment effect of sending a migrant on female household headship, γ_2 is the average treatment effect of sending a migrant on male-headed households, and $\gamma_2 + \gamma_3$ is the average treatment effect of migration on female-headed households. Similarly, the ACME obtained when fixing $M_i = 0$ for all i is:

$$\begin{aligned}\bar{\tau}(0) &= (\gamma_0 + \gamma_2\bar{F}^1 + \theta\bar{W}) - (\gamma_0 + \gamma_2\bar{F}^0 + \theta\bar{W}) \\ &= \gamma_2 \times (\bar{F}^1 - \bar{F}^0) \\ &= \gamma_2\delta_1\end{aligned} \tag{12}$$

The ACME obtained when setting $M_i = 0$ for all households, $\bar{\tau}(0)$, is the average impact of changes in the gender of the household head brought about by migration, conditional on all households not having enjoyed any impacts of migration arising through other mechanisms. The ACME with and without sending a migrant are identical if either δ_1 or γ_3 is zero. A nonzero γ_3 would indicate that the effect of female headship depends on whether a household has sent a migrant, and that the effect of sending a migrant depends on the gender of the household head. For example, suppose $\gamma_3 < 0$. Interpreting γ_3 as indicative of the role of migration in shaping the effects of household headship, $\gamma_3 < 0$ would occur if the loss of male labor resulting from sending a migrant decreases the impact of having a female household head on household outcomes. Alternatively, we could interpret $\gamma_3 < 0$ as being informative about the role of the gender of the household head in shaping the impacts of migration. Seen in this light, $\gamma_3 < 0$ would occur if female-headed households earn lower returns on invested remittances because of poorer access to markets relative to their male-headed counterparts, among other possible explanations.

Using the last two components of equation (9), we can define the ADE as follows:

$$\bar{\xi} = E(\xi_i(M)) = E\{Y_i(1, F_i(M)) - Y_i(0, F_i(M))\} \text{for} M = 0, 1 \tag{13}$$

The term in curly brackets, $Y_i(1, F_i(M)) - Y_i(0, F_i(M))$, gives the direct effect for a single household i, $\xi_i(M)$. Suppose that we fix $M_i = 1$ for household i, thereby setting the gender of the household head equal to the value it would take on when sending a migrant, i.e. $F_i = F_i(1)$. Suppose further that household i would have a female household head when sending a migrant, so that the direct effect for household i is $Y_i(1, 1) - Y_i(0, 1)$. The direct effect of sending a migrant in this scenario is the impact of shifting household i from not sending a migrant to sending a migrant, holding the gender of the household head fixed at female. If the gender of the head of household i would be the same regardless of sending a migrant, then the direct effect and the total effect of sending a migrant are identical for household i. The ADE is given by the expected value of the household-level direct effects.

The ADE with and without migration can be computed from equations (6) and (7) as follows:

$$\begin{aligned} \bar{\xi}(M = 1) &= (\gamma_0 + \gamma_1 + \gamma_2 \bar{F}^1 + \gamma_3 \bar{F}^1 + \theta \bar{W}) - (\gamma_0 + \gamma_2 \bar{F}^1 + \theta \bar{W}) = \gamma_1 + \gamma_3 \bar{F}^1 \\ \bar{\xi}(M = 0) &= (\gamma_0 + \gamma_1 + \gamma_2 \bar{F}^0 + \gamma_3 \bar{F}^0 + \theta \bar{W}) - (\gamma_0 + \gamma_2 \bar{F}^0 + \theta \bar{W}) = \gamma_1 + \gamma_3 \bar{F}^0 \end{aligned} \tag{14}$$

The ADE obtained when fixing $M_i = 1$ for all households, $\bar{\xi}(M = 1)$, is the average effect of migration on the outcome of interest that would be obtained if we could fix the gender of all household heads at the value each would take on when sending a migrant. In other words, $\bar{\xi}(M = 1)$ measures the average impact of sending a migrant, conditional on all households having already enjoyed any impacts of changes in the gender of the household head brought about by sending a migrant. Similarly, $\bar{\xi}(M = 0)$ gives the average effect of sending a migrant conditional on all households not having enjoyed any impacts arising from changes in the gender of the household head brought about by sending a migrant. The ADE will differ depending on whether we fix M_i at 0 or 1 for all households if sending a migrant has a non-zero average effect on female headship (i.e., $\delta_1 \neq 0$) and if the impact of migration depends on the gender of the household head (i.e., $\gamma_3 \neq 0$).

We can combine the ACME and ADE to obtain the total effect as described in equation

(8), i.e. the average impact of sending a migrant:

$$\begin{aligned} & E\{Y_i(1, F_i(1)) - Y_i(1, F_i(0)) + Y_i(1, F_i(0)) - Y_i(0, F_i(0))\} \\ & = E\{Y_i(M, F_i(1)) - Y_i(M, F_i(0))\} + E\{Y_i(1, F_i(M)) - Y_i(0, F_i(M))\} \\ & = \bar{\tau}(M) + \bar{\xi}(1 - M) \\ & = \gamma_1 + \gamma_2 \delta_1 + \gamma_3 \bar{F}^1 \end{aligned} \tag{15}$$

We identify the effect of M_i in equations (6) and (7) by two-stage least squares (2SLS), where M_i is instrumented using the ratio of the number of international migrants sent by a village (as recorded in our dataset) to the total number of international migrants from Bangladesh at time t. This instrument is associated with the village-level migration network, and it has been extensively used in previous migration literature (Mansuri, 2006; Mendola, 2008; Cuecuecha, 2009; Elbadawy et al., 2009; Acosta, 2011). To identify the effect of F_i in equation (8), we assume that the error term, ε_i, is uncorrelated with F_i conditional on all other variables in our regression model. In addition to migration, whether a household is female headed will depend on the number of working-aged male household members, customs, and religious beliefs relevant to marriage and household structure, and various unobserved characteristics. We control for the number of adult male members and religion of the household in equations (6) and (7).

6 Results

In this section, we present our empirical results on direct and indirect effects of migration on household economic activities at the intensive and extensive margins, capital stock, input expenditures, and time allocation of household members. We also show the impact of migration on food and non-food expenditures to corroborate our results for economic activities. In appendix table 1, we show first stage results from the 2SLS model. In the lower panel of appendix table 1, we present test statistics on weak identification of our instrument (migration network). All the test statistics reject the null hypothesis of weak identification. In appendix table 2, we show that sending a migrant raises the probability of female household headship by 30 percentage points, or 300%, relative to the proportion of female household heads in the sample. Thus, we find that one necessary condition for female headship to serve as a potential mediator for the effects of migration is met,

i.e. a non-zero average effect of sending a migrant on the probability of female household headship. Appendix tables 2 through 10 show detailed 2nd stage results for all outcome variables both with female headship as a mediator and without having a female-headship variable, respectively.

6.1 *Impact of migration on participation and intensity in economic activities*

Table 2 shows the ACME, ADE, and ATE of migration. The top panel of table 2 shows impacts on the extensive margin (i.e., non-zero participation in each income-generating activity) while the bottom panel shows impacts at the intensive margins. Looking at the upper portion of column 1, the average impact of changes in the gender of the household head brought about by sending a migrant on the likelihood of participating in an economic activity is indistinguishable from zero, conditional on impacts of migration arising through all other mechanisms having already occured. The intensity of participation shown in the bottom panel of column 1 point to similar results except for the amount of cultivated land, where the estimated impact of 23 decimals represents a 32% increase in cultivated area relative to the sample average.

[Table 2 here]

In contrast, all estimated ADEs in column 2 are negative and statistically significant, with probability of participation in crop farming, livestock, and non-farm business reduced by 13%, 12%, and 4%, respectively relative to their sample averages. At the intensive margin, cultivated area, number of cows held, and number of non-farm businesses operated fall by 11%, 14 and 8% relative to their sample averages. The stark differences between the results in column 1 and column 2 indicate that sending a migrant offsets the otherwise negative impacts of female headship on household economic activities. As shown in column 1 of table 2, conditional on having received the benefits of sending a migrant that arise through other mechanisms, the average impacts of changes in the gender of the household head caused by sending a migrant are either positive or statistically indistinguishable from zero. However, as shown in column 2 of table 2, the impact of changes in headship are uniformly negative if households have not received benefits from sending a migrant that arise through mechanisms other than household headship.

Columns 3 and 4 show the average impact of sending a migrant net of any effects attributable to changes in household headship. All impacts are negative and statistically significant. The impacts reported in columns 3 and 4 of the top panel of table 2 correspond to participation

reductions of 61% and 75%, respectively, for farming, 97% and 108% for livestock farming, and 30% for of non-farm businesses, all relative to their sample averages. The impacts reported in the bottom panel of column 3 and 4 correspond to reductions of 120% and 163%, respectively, for area cultivated, 58% and 62% for number of cows, and 43% and 52% for number of non-farm businesses, all relative to their sample averages. For all outcomes, the impacts of migration are smaller in absolute value in column 3, where we fix the gender of the household head at the value we would observe when sending a migrant. Given the positive average impact of sending a migrant on female headship, it appears that female headship partly offsets the negative effects of migration on the economic outcomes shown in table 2.

Column 5 shows the estimated ATE of sending a migrant obtained by combining the ACME and ADE as in equation (16), while column 6 shows the ATE obtained by estimating equation (6) without F_{it}. The ATE estimates in column 6 will be close to population parameters, if the linear model is a good approximation to the true conditional mean function, and if the usual assumptions for instrumental variables estimation hold. In contrast, the estimated ATE obtained from the mediation model (i.e., the sum of the ACME and the ADE) requires additional assumptions, including the exogeneity of F_{it} (conditional on the model) to identify the ATE.[1] Given the validity of our instrument, testing the difference between the two ATE estimates serves as a robustness check on our results (Gold et al., 2017). We see that in each case presented in table 2, there is no statitically significant difference between the two estimates of the ATE, even for cultivated land where we see a large ACME. In addition, the average effects of migration are negative and statistically significant for all outcomes in table 2.[2]

6.2 *Impact of migration on input expenditures and capital stock*

In the top panel of table 3, we see estimated average impacts on fertilizer, irrigation, labor, and other input expenditures for crop farming, as well as expenditures on variable inputs for non-farm businesses operated by households. In general, impacts in the upper panel of table 3 are precisely estimated, except for non-farm business expenditures. For the indicators with statistically

[1] See Imai et al. (2010a) or Imai et al. (2010b) for a complete description of the assumptions needed to identify the parameters of interest in a mediation model.

[2] In appendix table 11, we estimate all results using only panel households as an additional robustness check our results. We find a similar result although magnitudes of coefficients are different.

significant impacts, we observe the same pattern in the top panel of table 3 that was reported in table 2. A comparison of columns 1 and 2 of table 3 suggests that sending a migrant offset the negative impacts of female headship on household farm input expenditures. The impacts reported in the top panel of column 1 correspond to increases of 44% for fertilizer and 20% for other input costs, relative to their sample averages. In the top panel of column 2, estimated impacts correspond to decreases of 19% for fertilizer, 22% for irrigation, 14% for labor, and 18% for other input costs, relative to their sample averages.

[Table 3 here]

Similarly, the results shown in columns 3 and 4 of the top panel of table 3 show that switching to female household headship serve to offset the negative impacts of migration on expenditures for fertilizer, irrigation, hired labor, and other agricultural inputs, with no discernible impact on variable costs for non-farm businesses. Estimated impacts on fertilizer, irrigation, hired labor, and other farm inputs shown in the bottom panel of columns 3 and 4 of table 3 correspond to reductions of 190% and 252%, 131% and 172%, 48%, and 52%, and 120% and 158%, respectively, relative to the sample average for each indicator. In columns 5 and 6 we report the ATE obtained from the two different estimation methods described above, with the difference between the two ATE estimates given in column 7. In each case, we fail to detect a statistically significant difference between the two ATE estimates. The sign and magnitude of each ATE are what we would expect given our results for the ACME and ADE of each outcome variable. The bottom panel of table 3 shows the average impact of migration on capital stock for crop farming, livestock production, and non-farm businesses. None of the average impacts on capital stock are statistically significant.

6.3 *Impact of migration on time allocation*

In table 4, we present estimated impacts of sending a migrant on time allocated by remaining household members to different activities. Columns 5 and 6, which give the ATE of sending a migrant estimated using the two different methods described above, clearly show a pattern of a reduction in time allocated to income-earning activities and an increase in time allocated for unpaid household work. Results for time allocation are, therefore, aligned with the results for input expenditures and participation reported in tables 3 and 2, respectively. All of these results nearly across the board point to reductions in economic activities after sending a migrant.

[Table 4 here]

Results for the ACME and ADE on time allocation are less clear-cut, however. For crop farming, we observe the same pattern obtained in tables 1, 2, and 3: sending a migrant appears to offset the negative overall impacts of female headship on time allocated to crop farming and vice versa. It should be noted, however, that we find a statistically significant difference between the two ATE estimates for time allocated to crop farming, suggesting that our identification strategy might fail in this instance. In contrast, the ACME and ADE estimates for livestock farming suggest that changes to female headship play no role in the impact of sending a migrant on time allocated to livestock production. For time allocated to non-farm businesses, sending a migrant appears to exacerbate the overall negative impact of female household headship, as shown by the ACME and ADE estimates reported in columns 1 and 4, respectively. For time spent in wage work, changes in female headship appear to play no role in shaping the impacts of sending a migrant, as both ACME estimates are small and statistically insignificant, while the ADE estimates are very similar. The ACME, ADE, and ATE for domestic work and leisure are nearly all positive, reflecting that migration increases time allocation in non-paid activities through female headship and other mechanisms.

We report the ATE obtained from the two different estimation methods described above in columns 5 and 6, with the difference between the two ATE estimates presented in column 7. In column 5, we show that migration reduces time allocation in crop farming by 85%, livestock farming by 122%, non-farm businesses by 49%, and wage labor by 73%. On the other hand, migration increases time allocated to domestic work by 35% and leisure by 79%. In each case, we fail to detect a statistically significant difference between the two ATE estimates except for crop farming at the 5% level of significance.

6.4 Impact of migration on food and non-food expenditure

To complement earlier results on economic activities, we present in table 5 the impacts of sending a migrant on expenditures in food and non-food categories. As in previous tables, column 1 reports the average impacts of changes in the gender of the household head arising after sending a migrant, conditioning on all households having sent a migrant. In column 1, we find negative and statistically significant impacts for food (-30%), clothing (-20%), and education (-44%) relative to their sample

averages. In column 2, we see the average impact of changes in the gender of the household head through migration, conditional on all households not sending a migrant. In general, impacts in column 2 are also negative but smaller in absolute values than results shown in column 1. In contrast to our results for economic activities, migration appears to deepen the negative impacts of female household headship on expenditures for uses other than household non-farm businesses.

[Table 5 here]

Columns 3 and 4 show that all the estimated ADEs of migration are positive and statistically significant. For example, the impacts reported in columns 3 and 4 correspond to increases of 151% and 172%, respectively, in food expenditures relative to the sample average. Similar patterns hold for non-food expenditures. Column 5 shows that the average total effect of migration is positive and significant for all food and non-food categories. As before, we find that difference between ATEs from models with and without female-headship as a mediator is statistically insignificant, indicating the robustness of these results.

7 Conclusions

We study the role of international migration on participation and investment in farm and non-farm activities as well as time allocation and consumption patterns of remaining household members in rural Bangladesh. A rural household in Bangladesh is more likely to be headed by a female after migration takes place. As a result, we pay special attention to how migration-induced changes in the gender status of the household headship affect migration's overall net impact on economic decisions of the migrant-sending households. Using instrumental variables estimation and mediation analysis as applied to a nationally representative data set from Bangladesh, we isolate the portion of the effect of migration attributable to the increased proportion of households headed by female and the portion of the effect of migration attributable to all other mechanisms such as local labor market conditions or availability of rural credits. We find that migration negatively affects involvement in economic activities while increasing household expenditures on consumption goods. We explore the role that female household headship plays in the economic activities of migrant-sending households. We find that the increase in female household headship brought about by the exit of migrants from origin households serves to offset negative impacts arising through mechanisms other than the

gender of household heads.

We estimate two types of indirect effects in this study: the average indirect effect of sending a migrant attributable to changes in female headship when all households have sent a migrant (i.e., $(\gamma_2+\gamma_3) \times \delta_1$as shown in equation (13)), and the average indirect effect of sending a migrant attributable to changes in female headship when all households have not sent a migrant ($\gamma_2\delta_1$ as shown in equation (14). The estimated differences between these two effects (i.e.,$\gamma_3\delta_1$) suggest that the increase in female household headship caused by sending migrants serves to offset the otherwise negative impacts of female headship on household economic activities. Positive impacts on input expenditures suggest that the beneficial effects on female headed households of migrant-sending households may come about as a result of access to remittances.

In addition, we estimate two separate direct effects, i.e. the effect of migration attributable to all mechanisms other than changes in household headship: the average direct effect conditional on the gender of all household heads taking on the value that would be observed when sending a migrant (i.e., $(\gamma_1 + \gamma_3\bar{F}^1$) in equation (15)), and the average direct effect conditional on the gender of all household heads taking on the value that would be observed when not sending a migrant (i.e., ($\gamma_1 + \gamma_3\bar{F}^0$) in equation (15)). The difference between the two average direct effects is given by $\gamma_3\delta_1$, just as was the case with the average indirect effect. Therefore, we have an additional interpretation for $\gamma_3\delta_1$. The impacts of sending a migrant on female household headship serve to mitigate the negative effects of sending a migrant on household economic activity levels arising through other mechanisms, while also increasing impacts on productive expenditures. Whether this mitigating effect can be attributed to differences in preferences across male and female household heads for how remittances are used, or differences in the characteristics or economic circumstances of households that become female headed as a result of sending a migrant versus those that become female headed for other reasons, is unclear. Since we cannot observe which individual household would only become female headed when sending a migrant, we cannot directly compare these two groups of female headed households.

As for the average total impact of sending a migrant, the fact that we would observe negative effects on participation or expenditures in the farming sector is unsurprising given the overall economic transformation of rural Bangladesh. First, participation in the farming sector has declined consistently over time, as has the share of agriculture sector in total GDP. Earlier

studies show that climate change, low farm output prices, the loss of arable land from population growth, and inadequate availability of inputs are important contributors to the declining role of the farming sector (Mondal, 2010). When migrant-sending households receive remittances, they may be reluctant to invest in what they perceive as a declining agricultural sector.

While the decline of agriculture does not explain the negative results, we find for non-farm businesses, the economic conditions faced by rural Bangladeshi households may explain the negative effects of migration on participation and investment in various economic activities. Around 35.3% of rural households in Bangladesh live below the poverty line (UnnayanOnneshan, 2014); therefore, poor households may prioritize basic needs like food, health, education, and housing over investment. When a household member migrates abroad and sends remittances back to the family, the priority of migrant-sending households may be to meet basic needs. Previous studies in Bangladesh also document that remittances from international migration are mainly used for consumption purposes (Siddiqui et al., 2003). Depending on the definition of consumption, 80% to 90% of remittances are used for consumption purposes in Bangladesh (Mamun and Nath, 2010). In fact, the small or insignificant effect of migration on productive activities and investment choices is not surprising given the remittance-use pattern of migrant-sending households in Bangladesh. According to BBS (2013), only 25% of remittance-receiving households are involved in any sort of productive investment in Bangladesh, and 88% of total investment from remittances is for housing. We find a similar pattern of remittance use in our data. Almost half of total remittances are spent on food, followed by education and health expenditures. Only 5% of total remittances are invested in agricultural input purchases, and less than 1% of remittances are invested in non-farm business activities.

Although the impact of migration-induced female-headship (the mediator) is positive on participation in crop agriculture, this positive effect is not sufficiently large to ensure a positive total effect of migration on farming. Instead of investing their remittances in productive economic activities, households with migrant members appear to spend remittances mostly on necessities. On the other hand, the portion of the average effect of sending a migrant on consumption that is brought about by changes in household headship is generally negative, while this same impact is generally positive for input expenditures. Female household headship and sending migrants serve to positively reinforce the effects of one another on economic activities. Our results suggest that the

effects of out-migration on household structure may benefit the rural economy of Bangladesh, as female headed households put remittances to productive use. More broadly, our results underscore the importance of putting capital in the hands of women and female-headed households, a conclusion that has important implications for antipoverty programs.

References

Acosta, P. (2011). School attendance, child labour, and remittances from international migration in el salvador. *Journal of Development Studies*, 47(6):913–936.

Amin, S. (1997). The poverty–purdah trap in rural bangladesh: implications for women's roles in the family. *Development and Change*, 28(2):213–233.

BBS (2010). Report of the income & expenditure survey 2010. *Bangladesh Bureau of statistics, Bangladesh*.

BBS (2011). Report on labor force survey 2010. *Bangladesh Bureau of statistics, Bangladesh*.

BBS (2013). Report on survey on the use of remittance (sur). *Bangladesh Bureau of statistics, Bangladesh*.

Böhme, M. H. (2015). Does migration raise agricultural investment? an empirical analysis for rural mexico. *Agricultural Economics*, 46(2):211–225.

Bridges, S., Lawson, D., and Begum, S. (2011). Labour market outcomes in bangladesh: The role of poverty and gender norms. *The European Journal of Development Research*, 23(3):459–487.

Castelhano, M., Lawell, C., Sumner, D. A., and Taylor, J. E. (2016). The effects of migration and remittances on productive investment in rural mexico.

Cuecuecha, A. (2009). The effect of remittances and migration on human capital: evidence from mexico.

De Brauw, A. and Rozelle, S. (2008). Migration and household investment in rural china. *China Economic Review*, 19(2):320–335.

Durand, J., Kandel, W., Parrado, E. A., and Massey, D. S. (1996). International migration and development in mexican communities. *Demography*, 33(2):249–264.

Dustmann, C. and Kirchkamp, O. (2002). The optimal migration duration and activity choice after re-migration. *Journal of development economics*, 67(2):351–372.

Elbadawy, A., Roushdy, R., et al. (2009). Impact of international migration and remittances on child schooling and child work: The case of egypt. *Paper for the World Bank's MENA International Migration Program funded by the European Commission, World Bank, Washington, DC.*

FAO (2011). Gender differences in assets. *ESA working paper no.11-12, Food and Agriculture Organization (FAO).*

Fontana, M. and Natali, L. (2008). Gendered patterns of time use in tanzania: public investment in infrastructure can help. *IFPRI Project on 'Evaluating the Long-Term Impact of Gender-focused Policy Interventions', New York: IFPRI.*

Gold, R., Dippel, C., Heblich, S., and Pinto, R. (2017). Instrumental variables and causal mechanisms: Unpacking the effect of trade on workers and voters.

Imai, K., Keele, L., and Tingley, D. (2010a). A general approach to causal mediation analysis. *Psychological methods*, 15(4):309.

Imai, K., Keele, L., Yamamoto, T., et al. (2010b). Identification, inference and sensitivity analysis for causal mediation effects. *Statistical science*, 25(1):51–71.

Jaim, W. and Akter, S. (2012). Seed, fertilizer and innovation in bangladesh: industry and policy issues for the future. *Washington, DC: International Food Policy Research Institute.*

Jaim, W. and Hossain, M. (2011). Women's participation in agriculture in bangladesh 1988-2008: Changes and determinants. In *preconference event on Dynamics of Rural Livelihoods and Poverty in South Asia, 7th Asian Society of Agricultural Economists (ASAE) International Conference, Hanoi, Vietnam.*

Kabeer, N. (2012). Women's economic empowerment and inclusive growth: labour markets and enterprise development. *International Development Research Centre*, 44(10):1–70.

Khan, M., Ali, M. Y., Quayyum, M., Nazrul, M., and Hossain, M. (2009). Year round homestead vegetable production: a means of reducing poverty and nutritional deficiency for small farm. *Bangladesh Journal of Agricultural Research*, 34(1):169–174.

Klasen, S., Lechtenfeld, T., and Povel, F. (2011). What about the women? female headship, poverty and vulnerability in thailand and vietnam. Technical report, Courant Research Centre: Poverty, Equity and Growth-Discussion Papers.

Mamun, K. A. and Nath, H. K. (2010). Workers' migration and remittances in bangladesh. *Journal of Business Strategies*, 27(1):29.

Mansuri, G. (2006). Migration, school attainment, and child labor: evidence from rural pakistan.

Mendola, M. (2008). Migration and technological change in rural households: Complements or substitutes? *Journal of Development Economics*, 85(1):150–175.

Mondal, M. H. (2010). Crop agriculture of bangladesh: Challenges and opportunities. *Bangladesh Journal of Agricultural Research*, 35(2):235–245.

Quisumbing, A. R., Haddad, L., and Peña, C. (2001). Are women overrepresented among the poor? an analysis of poverty in 10 developing countries. *Journal of Development Economics*, 66(1):225–269.

Rahman, R. I., Islam, R., et al. (2013). *Female labour force participation in Bangladesh: trends, drivers and barriers*. International Labour Organization, DWT for South Asia and Country Office for India.

Ratha, D., Eigen-Zucchi, C., and Plaza, S. (2016). *Migration and remittances Factbook 2016*. World Bank Publications.

Salway, S., Rahman, S., and Jesmin, S. (2003). A profile of women's work participation among the urban poor of dhaka. *World Development*, 31(5):881–901.

Schultz, T. P. (1990). Testing the neoclassical model of family labor supply and fertility. *Journal of Human resources*, pages 599–634.

Siddiqui, T., Abrar, C. R., et al. (2003). Migrant worker remittances and micro-finance in bangladesh. *Prepared for Social Finance Programme, Working paper*, (38).

Taylor, J. E., Arango, J., Hugo, G., Kouaouci, A., Massey, D. S., and Pellegrino, A. (1996). International migration and community development. *Population Index*, pages 397–418.

Udry, C. (1996). Gender, agricultural production, and the theory of the household. *Journal of political Economy*, 104(5):1010–1046.

UnnayanOnneshan (2014). State of unemployment and poverty. *Bangladesh Economic Update*, 5(5).

Wood, A. and Mayer, J. (2004). Promoting the rural non-farm sector in bangladesh. report 29719-bd.

Woodruff, C. and Zenteno, R. (2007). Migration networks and microenterprises in mexico. *Journal of development economics*, 82(2):509–528.

WorldBank (2016). World bank open data. *Washington, DC: World Bank*.

Wouterse, F. and Taylor, J. E. (2008). Migration and income diversification:: Evidence from burkina faso. *World Development*, 36(4):625–640.

Yang, D. (2008). International migration, remittances and household investment: Evidence from philippine migrants' exchange rate shocks. *The Economic Journal*, 118(528):591–630.

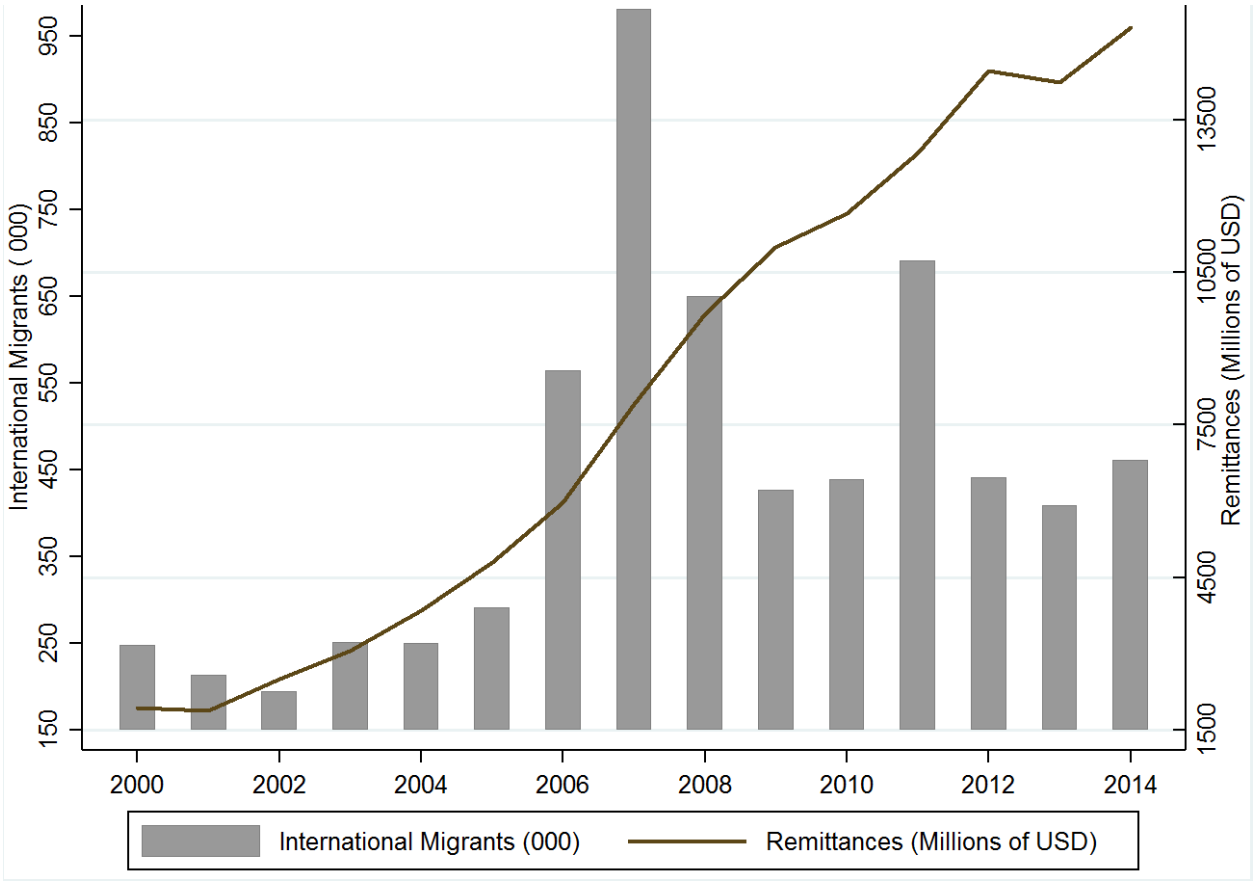

Figure 1: Trends of international migration and remittance inflow in Bangladesh.

Table 1. Summary statistics

	2000		2004		2008	2004	2014	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Migrant household (1 if yes)	0.08	0.27	0.09	0.28	0.12	0.32	0.13	0.34
Female headed (yes=1)	0.06	0.23	0.07	0.26	0.12	0.32	0.16	0.36
Male working aged member (No.)	1.61	1.01	1.6	1.02	1.52	1.11	1.26	0.91
Non-Muslim (yes=1)	0.09	0.29	0.09	0.28	0.09	0.29	0.08	0.27
Education of household head (years)	3.81	4.23	3.76	4.31	3.87	4.22	4.47	4.34
Age of household head (years)	44.93	12.98	46.91	13.43	48.5	13.98	47.31	14.27
Participation and magnitude of economic activities								
Have farming activities (yes=1)	0.6	0.49	0.65	0.48	0.6	0.49	0.58	0.49
Have business activities (yes=1)	0.28	0.45	0.22	0.42	0.19	0.4	0.22	0.41
Have livestock activities (yes=1)	0.41	0.49	0.42	0.49	0.45	0.5	0.53	0.5
Cultivated land (decimals)	67.52	150.51	93.79	152.5	51.19	114.35	73.8	125.35
Number of businesses	0.31	0.53	0.24	0.46	0.21	0.45	0.24	0.46
Number of cows	0.99	1.66	0.97	1.95	1.04	1.74	1.12	1.57
Farming capital (BDT)	544.87	799.88	16233.1	26552.46	985.4	1361.76	144.54	1170.78
Business capital (BDT)	88.59	1002.85	686.06	7749.12	22.4	140.43	35.88	334.43
Livestock capital (BDT)	465.48	651.61	13965.76	23765.62	875.72	1211.43	838.88	1339.57
Investment in farming and non-farm businesses (BDT/yearly)								
Fertilizer	673.6	1511.61	1214.53	3529.27	1646.14	4040.47	4174.34	8303.24
Irrigation	426.83	1787.76	1124.89	2086.01	1593.17	3223.59	3384.13	7118.59
Labor	1348.69	3397.51	1555.77	4328.52	2347.73	6738.86	6015.1	13115.12
Other inputs	801.07	1738.25	1559.26	6838.89	2081.47	6236.99	6437.88	13383.1
Non-farm business investment (BDT)	125.13	1009.48	1881.74	23279.11	274.96	3806.33	581.93	9131.03
Expenditures (BDT/ yearly)								
Food	14761	14547	17937	20488	35729	25289	87685	54136
Clothing	2373	2519	2540	2643	3188	3493	7028	4833
Education	2993	11066	3832	8640	3576	9029	11255	29889
Medical	1900	5353	3311	9171	3741	16347	11491	29656
Housing	3862	22166	5031	38006	4910	27757	13417	8321
Leisure/Social events	2501	5002	5952	47066	5031	12321	13925	39375

Note: Sample size is 1,626, 1,705, 1,803, and 2,846 in 2000, 2004, 2008, and 2014, respectively. Value of capital is not precisely estimated in the survey, so we notice jumps in mean values of capital across years.

Table 2. Indirect, direct, and total effects on participation and intensity

	ACME (M=1)	ACME (M=0)	ADE (M=1)	ADE (M=0)	ATE (1+4) =(2+3)	Total (No mediator)	Difference (5-6)	Difference (1-2) =(3-4)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Probability of participation (extensive margin)								
Crop farming	0.005	-0.079***	-0.374***	-0.459***	-0.454***	-0.455***	-0.001	0.085***
	(0.024)	(0.012)	(0.049)	(0.068)	(0.048)	(0.048)	(0.005)	(0.030)
Livestock production	0.002	-0.052***	-0.462***	-0.517***	-0.514***	-0.515***	-0.001	0.004
	(0.021)	(0.011)	(0.047)	(0.062)	(0.046)	(0.046)	(0.004)	(0.018)
Non-farm businesses	-0.017	-0.021***	-0.070**	-0.073	-0.090***	-0.090***	-0.000	0.054**
	(0.015)	(0.006)	(0.032)	(0.045)	(0.032)	(0.032)	(0.001)	(0.026)
Degree of participation (intensive margin)								
Land cultivated (Decimals)	23.065***	-7.999***	-85.334***	-116.398***	-93.333***	-93.632***	-0.299	31.063***
	(6.107)	(1.510)	(10.560)	(15.604)	(10.500)	(10.455)	(1.697)	(6.821)
Number of cows held	-0.087	-0.148***	-0.580***	-0.640***	-0.728***	-0.729***	-0.001	0.021
	(0.068)	(0.024)	(0.135)	(0.195)	(0.137)	(0.138)	(0.004)	(0.019)
Number of non-farm businesses	0.000	-0.020***	-0.104***	-0.125**	-0.124***	-0.125***	-0.000	0.060
	(0.017)	(0.006)	(0.035)	(0.049)	(0.034)	(0.034)	(0.002)	(0.072)

Note: Bootstrapped standard errors are in parenthesis based on 1000 replication. ***, **, and * indicate significance at 1% level, 5 % and 10 % levels, respectively. Column 1 and column 2 measure the impact of any change in the gender of the household head brought about by migration, conditional on whether they enjoyed any impacts of migration arising through other mechanisms or not, respectively. Colum 3 and column 4 measure the average impact of sending a migrant, conditional on whether all households have already enjoyed any impacts of changes in the gender of the household head brought about by sending a migrant or not, respectively.

Table 3. Indirect, direct, and total effects on input expenditures and capital stock

	ACME (M=1)	ACME (M=0)	ADE (M=1)	ADE (M=0)	ATE (1+4) =(2+3)	Total (No mediator)	Difference (5-6)	Difference (1-2) =(3-4)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Input expenditure (BDT/Yearly)								
Fertilizer	990.026***	-433.836***	-4,273.396***	-5,697.257***	-4,707.231***	-4,720.931***	-13.700	1,423.861***
	(237.121)	(82.759)	(406.671)	(600.893)	(406.066)	(409.291)	(78.927)	(286.011)
Irrigation	365.836	-410.663***	-2,492.945***	-3,269.443***	-2,903.607***	-2,911.079***	-7.471	776.498***
	(242.611)	(79.559)	(482.702)	(665.532)	(478.610)	(473.405)	(49.523)	(294.043)
Labor	-343.262	-472.074***	-1,578.554**	-1,707.365*	-2,050.628***	-2,051.867***	-1.239	128.811
	(330.344)	(138.939)	(719.831)	(967.993)	(716.217)	(716.206)	(19.089)	(367.760)
Other inputs	666.563**	-588.380***	-3,922.907***	-5,177.850***	-4,511.287***	-4,523.362***	-12.075	1,254.943***
	(278.736)	(117.832)	(506.988)	(741.979)	(534.630)	(536.213)	(84.925)	(341.126)
Non-farm businesses	-323.059	138.091	-200.103	261.047	-62.012	-57.575	4.437	-461.150
	(257.080)	(96.947)	(497.380)	(744.525)	(515.371)	(517.257)	(28.363)	(308.349)
Capital stock (BDT)								
Crop farming	-113.305	159.714	-729.158	-456.140	-569.444	-566.817	2.627	-273.018
	(484.286)	(148.467)	(996.545)	(1,428.992)	(1,010.122)	(1,012.838)	(31.713)	(551.041)
Livestock farming	-418.646	-35.430	-232.028	151.187	-267.459	-263.771	3.687	3.368
	(452.072)	(120.773)	(938.671)	(1,339.790)	(955.530)	(956.538)	(39.165)	(99.489)
Non-farm businesses	2.475	-0.893	-21.749	-25.116	-22.641	-22.674	-0.032	-383.216
	(95.866)	(17.225)	(187.051)	(279.975)	(189.065)	(189.431)	(4.696)	(505.112)

Note: Bootstrapped standard errors are in parenthesis based on 1000 replication. ***, **, and * indicate significance at 1 % level, 5 % and 10 % levels, respectively. Column 1 and column 2 measure the impact of any change in the gender of the household head brought about by migration, conditional on whether they enjoyed any impacts of migration arising through other mechanisms or not, respectively. Colum 3 and column 4 measure the average impact of sending a migrant, conditional on whether all households have already enjoyed any impacts of changes in the gender of the household head brought about by sending a migrant or not, respectively.

Table4. Indirect, direct, and total effects on time allocation (Daily hour/person)

	ACME (M=1)	ACME (M=0)	ADE (M=1)	ADE (M=0)	ATE (1+4) =(2+3)	Total (No mediator)	Difference (5-6)	Difference (1-2) =(3-4)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crop farming	0.046	-0.196***	-0.888***	-1.130***	-1.084***	-1.123***	-0.039**	0.242***
	(0.071)	(0.036)	(0.174)	(0.228)	(0.173)	(0.180)	(0.016)	(0.090)
Livestock farming	0.003	0.002	-0.924***	-0.926***	-0.922***	-0.923***	-0.000	-0.141*
	(0.038)	(0.019)	(0.090)	(0.110)	(0.085)	(0.088)	(0.008)	(0.083)
Non-farm businesses	-0.132**	0.009	-0.408***	-0.267	-0.399***	-0.376**	0.023	0.002
	(0.066)	(0.025)	(0.149)	(0.199)	(0.150)	(0.158)	(0.017)	(0.049)
Wage work	-0.048	-0.001	-0.404***	-0.357**	-0.404***	-0.397***	0.008	-0.047
	(0.058)	(0.024)	(0.133)	(0.175)	(0.132)	(0.138)	(0.013)	(0.071)
Domestic work	0.240**	-0.064	1.405***	1.101***	1.341***	1.292***	-0.049*	0.304**
	(0.114)	(0.044)	(0.253)	(0.302)	(0.245)	(0.252)	(0.029)	(0.142)
Personal care/Leisure	-0.143	0.087*	3.033***	3.263***	3.120***	3.157***	0.037	-0.230
	(0.135)	(0.048)	(0.246)	(0.305)	(0.240)	(0.248)	(0.029)	(0.162)

Note: Bootstrapped standard errors are in parenthesis based on 1000 replication. ***, **, and * indicate significance at 1 % level, 5 % and 10 % levels, respectively. Column 1 and column 2 measure the impact of any change in the gender of the household head brought about by migration, conditional on whether they enjoyed any impacts of migration arising through other mechanisms or not, respectively. Colum 3 and column 4 measure the average impact of sending a migrant, conditional on whether all households have already enjoyed any impacts of changes in the gender of the household head brought about by sending a migrant or not, respectively.

Table 5. Indirect, direct, and total effects on food and non-food expenditures (BDT/Yearly)

	ACME (M=1)	ACME (M=0)	ADE (M=1)	ADE (M=0)	ATE (1+4) =(2+3)	Total (No mediator)	Difference (5-6)	Difference (1-2) =(3-4)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Food	-11,714***	-3,215***	58,974***	67,473***	55,759***	55,840***	82	-8,499***
	(2,414)	(678)	(3,352)	(4,729)	(3,349)	(3,216)	(568)	(2,608)
Clothing	-760***	-854	4,489***	5,164***	4,404***	4,410***	6.49	-674***
	(205)	(57)	(374)	(460.058)	(350)	(353.67)	(36)	(223)
Education	-2,414 ***	451**	11,183***	14,048***	11,634***	11,661***	28	-2,866***
	(936)	(215)	(1,783)	(2,499)	(1,757)	(1,739)	(136)	(999)
Health	-1,233	-809***	13,857***	14,281***	13,047***	13,051***	4.44	-424
	(1,207)	(276)	(2,181)	(2,821)	(2,150)	(2,145)	(92)	(1,356)
Housing	-1,737	-443	16,567***	17,861***	16,124***	16,136***	12.4	-1,294
	(2,558)	(372)	(4,454)	(5,436)	(4,385)	(4,380)	(188)	(2,830)
Leisure/Social events	-2,412*	92	15,704***	18,208***	15,796***	15,820***	24.4	-2,504
	(1,309)	(611)	(2,655)	(3,572)	(2,512)	(2,520)	(15.7)	(1,559)

Note: Bootstrapped standard errors are in parenthesis based on 1000 replication. ***, **, and * indicate significance at 1 % level, 5 % and 10 % levels, respectively. Column 1 and column 2 measure the impact of any change in the gender of the household head brought about by migration, conditional on whether they enjoyed any impacts of migration arising through other mechanisms or not, respectively. Colum 3 and column 4 measure the average impact of sending a migrant, conditional on whether all households have already enjoyed any impacts of changes in the gender of the household head brought about by sending a migrant or not, respectively.

Appendix Table 1. Correlates of International migration

	Female headship as a mediator				No mediator	
	Household level		Member level		Household level	Member level
	Migration	Migration and female headed	Migration	Migration and female headed	Migration	Migration
Migration network	4.282***	0.041***	4.258***	0.022***	5.469***	5.019***
	(0.211)	(0.011)	(0.158)	(0.007)	(0.201)	(0.155)
Migration network * Female-headed	4.951***	9.020***	4.504***	8.608***		
	(0.531)	(0.484)	(0.484)	(0.453)		
Female-Headed (Yes=1)	0.107***	0.117***	0.102***	0.121***		
	(0.016)	(0.015)	(0.014)	(0.014)		
No. of male working aged member	0.001	-0.001	0.002	-0.002**	-0.018***	-0.011***
	(0.004)	(0.001	(0.003	(0.001)	(0.004)	(0.003)
Religion (Non-Muslim=1)	-0.042***	-0.012**	-0.036***	-0.009***	-0.040***	-0.034***
	(0.009)	(0.005)	(0.007)	(0.003)	(0.009)	(0.007)
Education of head (Years)	0.004***	0.002***	0.003***	0.001***	0.004***	0.003***
	(0.001)	(0.000)	(0.001	(0.000)	(0.001)	(0.001)
Age of head (Years)	0.003***	-0.001***	0.003***	0.000***	0.002***	0.003
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
2004	-0.002	0.005	0.005	0.003	0.003	0.008***
	(0.008)	(0.004)	(0.006)	(0.002)	(0.009)	(0.006)
2008	0.015*	0.002	0.026***	-0.001	0.028***	0.035***
	(0.009)	(0.004)	(0.007)	(0.003)	(0.009)	(0.007)
2014	0.021***	-0.001	0.036***	0.000	0.040***	0.051***
	(0.008)	(0.004)	(0.006)	(0.002)	(0.008)	(0.006)
Constant	-0.131***	0.024***	-0.167***	0.014***	-0.084***	-0.137***
	(0.012)	(0.006)	(0.009)	(0.004)	(0.013)	(0.010)
Observations	7,980	7,980	14,575	14,575	7,980	14,575
F-statistic (excluded instruments)	387.24	193.43	548.66	203.28	739.65	1043.57
SW F-Value (excluded instruments)	418.29	741.43	730.57	1062.68	739.65	1043.57
Cragg-Donald Wald F statistic	570.49		946.74		1607.70	2345.61
Kleibergen-Paap Wald rk F statistic	205.68		362.36		739.65	1043.57

Note: Each column shows first stage regression results. Robust standard errors are in parenthesis. ***, **, and * indicate significance at 1 % level, 5% and 10 % levels, respectively. SW F-Value shows Sanderson-Windmeijer multivariate F test of excluded instruments. Stock-Yogo weak ID test critical values at 10% maximal IV size are 7.03 and 16.38 for model with and without mediator, respectively.

Appendix Table 2. Correlates of female headship

	Household level	Working-aged member level
Migrant (Yes=1)	0.305***	0.268***
	(0.030)	(0.022)
No. of male working aged member	-0.0864***	-0.062***
	(0.00426)	(0.003)
Religion (Non-Muslim=1)	0.0335***	0.019**
	(0.0116)	(0.007)
Education of head (Years)	-0.0050***	-0.0040***
	(0.0007)	(0.0004)
Age of head (Years)	-0.0014***	-0.0013***
	(0.00026)	(0.0002)
2004	0.013	0.0096*
	(0.008)	(0.005)
2008	0.048***	0.025***
	(0.009)	(0.007)
2014	0.058***	0.047***
	(0.008)	(0.005)
Constant	0.252***	0.193***
	(0.013)	(0.009)
Observation	7,980	14,575
Score test	4.147	17.64
Score test (p value)	0.0417	0.00
Regression based F-value	4.118	17.48
Prob >F	0.0425	0.00

Note: All regression models are estimated following 2SLS technique for the equation (11). Robust standard errors are in parenthesis. ***, **, and * indicate significance at 1% level, 5% and 10% levels, respectively. We use village level migration network as an instrument for migration. Sore test and Regression based F-value present statistics related to endogeneity hypothesis of the migration variable.

Appendix Table 3. Decomposed effects of migration on participation and magnitude

	Participation			Participation Rate/Intensity			Capital Stock		
VARIABLES	Farming	Livestock	Business	Cultivated land	No. of cow	No. of business	Farming	Livestock	Business
Migrant (Yes=1)	-0.48***	-0.53***	-0.07	-124.24***	-0.66***	-0.13**	-387.24	247.89	-25.97
	(0.07)	(0.07)	(0.05)	(17.75)	(0.24)	(0.05)	(1,516.25)	(1,364.11)	(271.72)
Female Headed (Yes=1)	-0.26***	-0.17***	-0.07***	-26.22***	-0.49***	-0.07***	523.58	-116.15	-2.93
	(0.03)	(0.03)	(0.02)	(4.07)	(0.07)	(0.02)	(493.53)	(365.93)	(50.15)
Female head * Migrant	0.28***	0.18**	0.01	101.83***	0.2	0.07	-895.02	-1,256.28	11.04
	(0.09)	(0.09)	(0.06)	(19.01)	(0.27)	(0.07)	(1,791.77)	(1,570.83)	(293.67)
No. of male working aged member	0.07***	0	0.07***	29.55***	0.12***	0.09***	1,520.95***	1,190.65***	66.86
	(0.01)	(0.01)	(0.01)	(2.37)	(0.02)	(0.01)	(256.32)	(237.50)	(47.36)
Religion (Non-Muslim=1)	-0.04*	0.01	0.11***	-16.92***	0.21***	0.11***	941.3	1,504.30	-133.08**
	(0.02)	(0.02)	(0.02)	(4.99)	(0.08)	(0.02)	(1,009.33)	(993.61)	(67.37)
Education of head (Years)	0.00**	0	0.01***	4.44***	0.02***	0.01***	99.40***	46.61*	26.88
	(0.00)	(0.00)	(0.00)	(0.48)	(0.01)	(0.00)	(31.65)	(25.19)	(18.74)
Age ৩f head (Years)	0.00***	0.00***	0.00	1.26***	0.01***	0.00	29.76**	27.85**	4.63*
	(0.00)	(0.00)	(0.00)	(0.13)	(0.00)	(0.00)	(12.69)	(11.20)	(2.66)
2004	0.05***	0.01	-0.05***	24.53***	-0.02	-0.06***	15,655.86***	13,475.02***	589.99***
	(0.02)	(0.02)	(0.01)	(5.16)	(0.06)	(0.02)	(642.10)	(578.86)	(187.15)
2008	0.02	0.05***	-0.07***	-14.03***	0.08	-0.08***	465.82***	437.39***	-77.15***
	(0.02)	(0.02)	(0.01)	(4.59)	(0.06)	(0.02)	(78.72)	(68.72)	(27.45)
2014	0.04**	0.16***	-0.03*	16.56***	0.21***	-0.04**	7.17	748.79***	-57.77*
	(0.02)	(0.02)	(0.01)	(4.51)	(0.05)	(0.02)	(111.83)	(102.05)	(33.90)
Constant	0.40***	0.39***	0.14***	-43.01***	0.41***	0.11***	-3,690.16***	-3,006.00***	-315.80**
	(0.03)	(0.03)	(0.02)	(6.98)	(0.09)	(0.02)	(546.38)	(435.87)	(152.71)
Score test	81.93	107.2	0.851	104.1	27.51	3.098	2.273	1.16	0.757
Score test (p value)	0.000	0.000	0.654	0.000	0.000	0.212	0.321	0.560	0.685
Regression based F-value	39.62	55.25	0.425	50.62	13.83	1.554	1.163	0.595	0.376
Prob >F	0.000	0.000	0.654	0.000	0.000	0.211	0.313	0.552	0.687

Note: Each column shows estimation result from a separate regression model. Robust standard errors are in parenthesis. All regression models are estimated following 2SLS method using community-level migration density as an instrument for migration variable. ***, **, and * indicate significance at 1% level, 5 % and 10 % levels, respectively. Score test and regression-based F-value test endogeneity of migration variable assuming that errors in our model are not i.i.d.

Appendix Table 4. Decomposed effects of migration on investment in farming and non-farm businesses

VARIABLES	Fertilizer	Irrigation	Labor	Other Inputs cost	Non-farm Businesses
Migrant (Yes=1)	-6,056.57***	-3,465.39***	-1,739.87*	-5,494.54***	377.42
	(629.19)	(691.47)	(960.95)	(790.75)	(856.73)
Female Headed (Yes=1)	-1,422.23***	-1,346.26***	-1,547.58***	-1,928.86***	452.7
	(208.19)	(201.52)	(426.44)	(339.41)	(313.87)
Female head x Migrant	4,667.79***	2,545.56***	422.28	4,114.03***	-1,511.77
	(708.32)	(841.71)	(1,194.81)	(924.71)	(1,073.42)
No. of male working aged member	965.52***	622.61***	1,139.07***	1,572.42***	330.19**
	(117.80)	(68.08)	(310.21)	(278.81)	(139.68)
Religion (Non-Muslim=1)	-1,098.92***	-1,334.41***	-437.49	-408.45	-350.86
	(224.97)	(139.19)	(352.40)	(471.29)	(262.85)
Education of head (Years)	88.14***	34.56**	157.05***	96.97***	171.69***
	(16.92)	(14.07)	(27.25)	(24.80)	(62.35)
Age of head (Years)	30.57***	20.02***	44.72***	42.34***	-0.11
	(5.03)	(4.57)	(8.21)	(6.85)	(11.60)
2004	511.01***	682.27***	166.36	720.91***	1,773.84***
	(108.29)	(76.95)	(137.95)	(181.14)	(579.20)
2008	1,174.88***	1,316.28***	1,088.21***	1,515.35***	158.29*
	(115.26)	(96.56)	(185.06)	(161.81)	(96.19)
2014	4,016.09***	3,332.11***	5,087.79***	6,374.65***	444.52***
	(183.82)	(155.66)	(290.95)	(292.07)	(141.27)
Constant	-2,028.89***	-1,189.59***	-2,839.86***	-3,507.73***	-1,053.59**
	(312.83)	(225.55)	(603.42)	(612.47)	(508.53)
Score test	124.4	45.02	18.83	58.35	2.253
Score test (p value)	0.000	0.000	0.000	0.000	0.324
Regression based F-value	59.01	20.2	9.24	28.59	1.141
Prob >F	0.000	0.000	0.000	0.000	0.319

Note: Each column shows estimation result from a separate regression model. Robust standard errors are in parenthesis. All regression models are estimated following 2SLS method using community-level migration density as an instrument for migration variable. ***, **, and * indicate significance at 1 % level, 5 % and 10 % levels, respectively. Score test and regression-based F-value test endogeneity of migration variable assuming that errors in our model are not i.i.d.

Appendix Table 5. Decomposed effects of migration on time allocation of working aged household members

VARIABLES	Farming	Livestock	Business	Wage Labor	Domestic Work	Leisure/Personal Care
Migrant (Yes=1)	-1.17***	-0.93***	-0.24	-0.35*	1.04***	3.31***
	(0.24)	(0.12)	(0.21)	(0.18)	(0.31)	(0.35)
Female Headed (Yes=1)	-0.73***	0.01	0.03	0	-0.24	0.33*
	(0.11)	(0.06)	(0.10)	(0.10)	(0.16)	(0.19)
Female head x Migrant	0.90***	0.01	-0.53*	-0.18	1.14**	-0.86
	(0.33)	(0.18)	(0.29)	(0.25)	(0.52)	(0.59)
No. of male working aged member	0.12***	-0.02*	0.14***	0.05**	-0.32***	-0.05
	(0.02)	(0.01)	(0.02)	(0.02)	(0.03)	(0.03)
Religion (Non-Muslim=1)	-0.16**	-0.09**	0.39***	0.26***	-0.12	0.06
	(0.08)	(0.04)	(0.08)	(0.07)	(0.09)	(0.10)
Education of head (Years)	-0.05***	-0.01***	0.02***	-0.03***	0.01*	0.04***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Age of head (Years)	0	0.00***	-0.00***	-0.00***	-0.02***	0.03***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
2004	0.15**	-0.01	-0.05	0.27***	-0.73***	-0.61***
	(0.07)	(0.03)	(0.06)	(0.06)	(0.08)	(0.09)
2008	0.39***	0.13***	-0.07	-0.02	-0.36***	-1.76***
	(0.08)	(0.03)	(0.06)	(0.05)	(0.09)	(0.09)
2014	-0.23***	0.05*	0.22***	0.17***	-0.09	-0.83***
	(0.06)	(0.03)	(0.05)	(0.05)	(0.07)	(0.08)
Constant	1.51***	0.78***	0.60***	0.72***	5.17***	3.01***
	(0.11)	(0.05)	(0.09)	(0.09)	(0.13)	(0.14)
Score test	28.73	99.52	4.61	3.179	18.09	87.71
Score test (p value)	0.000	0.000	0.100	0.204	0.000	0.000
Regression based F-value	14.6	52	2.327	1.605	9.382	43.13
Prob >F	0.000	0.000	0.098	0.201	0.000	0.000

Note: Each column shows estimation result from a separate regression model. Robust standard errors are in parenthesis. All regression models are estimated following 2SLS method using community-level migration density as an instrument for migration variable. ***, **, and * indicate significance at 1 % level, 5 % and 10 % levels, respectively. Score test and regression-based F-value test endogeneity of migration variable assuming that errors in our model are not i.i.d.

Appendix Table 6. Decomposed effects of migration on food and non-food expenditures

VARIABLES	Food	Clothing	Education	Medical	Housing	Leisure/Social Events
Migrant (Yes=1)	69,618***	5,334***	14,771***	14,388***	18,188***	18,840***
	(6,241)	(515)	(2,773)	(2,792)	(5,545)	(4,130)
Female Headed (Yes=1)	-10,541***	-281	1,479**	-2,653***	-1,453	301
	(1,763)	(180)	(711)	(879)	(1,053)	(1,994)
Female head * Migrant	-27,862***	-2,211***	-9,395***	-1,391	-4,242	-8,208
	(7,855)	(713)	(3,267)	(4,231)	(8,455)	(5,291)
No. of male working aged member	6,862***	873***	1,837***	672***	1,046***	981***
	(562)	(74)	(268)	(251)	(224)	(318)
Religion (Non-Muslim=1)	3,496**	97	-34	520	-335	-2,174***
	(1,495)	(143)	(738)	(858)	(674)	(580)
Education of head (Years)	1,133***	182***	635***	355***	374***	706***
	(106)	(11)	(60)	(62)	(75)	(94)
Age of head (Years)	-44	4	56***	37**	6	91***
	(36)	(4)	(15)	(16)	(22)	(25)
2004	3,334***	144	707**	1,090***	773	2,704***
	(835)	(90)	(332)	(280)	(969)	(1,002)
2008	19,181***	574***	-56	1,264***	743	1,237***
	(1,026)	(100)	(348)	(477)	(949)	(349)
2014	67,538***	4,367***	6,393***	7,966***	8,788***	8,812***
	(987)	(103)	(572)	(468)	(588)	(569)
Constant	-4,181**	-446**	-6,198***	-3,220***	-1,136	-7,168***
	(1,836)	(198)	(882)	(792)	(1,122)	(1,219)
Score test	116.5	51.42	17.27	14.73	9.85	14.41
Score test (p value)	0.000	0.000	0.000	0.001	0.007	0.001
Regression based F-value	60	26.63	8.684	7.369	4.924	7.178
Prob >F	0.000	0.000	0.000	0.001	0.007	0.001

Note: Each column shows estimation result from a separate regression model. Robust standard errors are in parenthesis. All regression models are estimated following 2SLS method using community-level migration density as an instrument for migration variable. ***, **, and * indicate significance at 1 % level, 5 % and 10 % levels, respectively. Score test and regression-based F-value test endogeneity of migration variable assuming that errors in our model are not i.i.d.

Appendix Table 7. Total effect of migration on participation and magnitude in economic activities

	Participation			Intensity of Participation			Capital stocks		
VARIABLES	Farming	Livestock	Non-farm Business	Cultivated land	No. of cow	No. of non-farm Business	Farming	Livestock	Non-farm Business
Migrant (Yes=1)	-0.45***	-0.51***	-0.09***	-93.63***	-0.73***	-0.12***	-566.82	-263.77	-22.67
	(0.05)	(0.04)	(0.03)	(11.14)	(0.16)	(0.04)	(1,006.94)	(905.67)	(168.27)
No. of male working aged member	0.09***	0.01**	0.07***	29.50***	0.16***	0.09***	1,496.08***	1,229.24***	66.86
	(0.01)	(0.01)	(0.00)	(2.18)	(0.02)	(0.01)	(246.02)	(231.21)	(41.67)
Religion (Non-Muslim=1)	-0.05**	0	0.11***	-17.23***	0.20**	0.11***	953.87	1,493.39	-133.12**
	(0.02)	(0.02)	(0.02)	(4.93)	(0.08)	(0.02)	(1,010.94)	(995.56)	(67.02)
Education of head (Years)	0.00***	0	0.01***	4.55***	0.02***	0.01***	97.01***	47.47*	26.89
	(0.00)	(0.00)	(0.00)	(0.48)	(0.01)	(0.00)	(31.56)	(25.26)	(18.73)
Age of head (Years)	0.00***	0.00***	0.00	1.08***	0.01***	0.00	31.00***	30.78***	4.61**
	(0.00)	(0.00)	(0.00)	(0.11)	(0.00)	(0.00)	(10.78)	(9.53)	(2.24)
2004	0.05***	0.01	-0.05***	25.35***	-0.03	-0.06***	15,652.51***	13,459.18***	590.08***
	(0.02)	(0.02)	(0.01)	(5.12)	(0.06)	(0.02)	(641.15)	(576.85)	(187.57)
2008	0.02	0.05***	-0.07***	-14.14***	0.06	-0.08***	480.82***	417.86***	-77.17***
	(0.02)	(0.02)	(0.01)	(4.55)	(0.06)	(0.02)	(81.74)	(72.00)	(28.65)
2014	0.02	0.15***	-0.03**	16.24***	0.19***	-0.04**	26.91	727.58***	-57.81
	(0.02)	(0.02)	(0.01)	(4.46)	(0.05)	(0.02)	(118.69)	(107.93)	(36.31)
Constant	0.37***	0.36***	0.12***	-36.92***	0.31***	0.10***	-3,669.80***	-3,192.06***	-315.16**
	(0.02)	(0.02)	(0.02)	(6.20)	(0.08)	(0.02)	(482.04)	(386.68)	(129.43)
Score test	86.48	106.3	0.856	106.2	20.58	2.86	1.098	0.13	0.197
Score test (p value)	0.000	0.000	0.355	0.000	0.000	0.091	0.295	0.718	0.657
Regression based F-value	83.48	106.7	0.856	103.4	20.07	2.867	1.095	0.13	0.197
Prob >F	0.000	0.000	0.355	0.000	0.000	0.091	0.295	0.719	0.657

Note: Each column shows estimation result from a separate regression model. Robust standard errors are in parenthesis. All regression models are estimated following 2SLS method using community-level migration density as an instrument for migration variable. ***, **, and * indicate significance at 1% level, 5 % and 10 % levels, respectively. Score test and regression-based F-value test endogeneity of migration variable assuming that errors in our model are not i.i.d.

Appendix Table 8. Total effects of migration on investment in farming and non-farm businesses

VARIABLES	Fertilizer	Irrigation	Labor	Other Inputs cost	Non-farm Business
Migrant (Yes=1)	-4,720.93***	-2,911.08***	-2,051.87***	-4,523.36***	-57.58
	(404.86)	(456.08)	(659.28)	(536.26)	(535.54)
No. of male working aged member	982.24***	681.01***	1,263.12***	1,645.48***	325.46**
	(109.50)	(63.07)	(285.25)	(261.01)	(132.41)
Religion (Non-Muslim=1)	-1,120.57***	-1,365.35***	-487.04	-450.18	-344.12
	(223.48)	(138.25)	(354.80)	(472.55)	(262.24)
Education of head (Years)	94.10***	40.64***	164.62***	105.57***	169.80***
	(16.78)	(13.98)	(27.31)	(24.59)	(62.22)
Age of head (Years)	22.26***	16.28***	45.95***	35.97***	2.59
	(4.41)	(3.82)	(7.32)	(6.22)	(10.04)
2004	545.60***	693.66***	150.91	742.55***	1,762.53***
	(105.73)	(75.94)	(138.74)	(180.01)	(572.64)
2008	1,159.03***	1,280.42***	1,019.12***	1,469.18***	163.05*
	(113.56)	(95.87)	(191.89)	(163.48)	(97.40)
2014	3,988.34***	3,284.17***	5,003.71***	6,311.37***	453.05***
	(183.18)	(155.26)	(295.00)	(294.89)	(141.00)
Constant	-1,805.09***	-1,211.47***	-3,177.48***	-3,480.82***	-1,128.07**
	(280.90)	(191.81)	(527.39)	(567.68)	(470.60)
Score test	123.2	45.04	20.43	57.01	0.0594
Score test (p value)	0.000	0.000	0.000	0.000	0.807
Regression based F-value	117	40.86	19.99	55.98	0.0594
Prob >F	0.000	0.000	0.000	0.000	0.808

Note: Each column shows estimation result from a separate regression model. Robust standard errors are in parenthesis. All regression models are estimated following 2SLS method using community-level migration density as an instrument for migration variable. ***, **, and * indicate significance at 1 % level, 5 % and 10 % levels, respectively. Score test and regression-based F-value test endogeneity of migration variable assuming that errors in our model are not i.i.d.

Appendix Table 9. Total effect of migration on time allocation of working aged household members

VARIABLES	Farming	Livestock	Business	Wage labor	Domestic	Leisure/Personal Care
Migrant (Yes=1)	55,840***	4,410***	11,661***	13,051***	16,136***	15,820***
	(4,090)	(352)	(1,803)	(1,979)	(4,062)	(2,734)
No. of male working aged member	8,406***	948***	1,923***	932***	1,268***	1,142***
	(522)	(69)	(251)	(240)	(235)	(261)
Religion (Non-Muslim=1)	2,987**	75	-37	424	-408	-2,210***
	(1,479)	(143)	(739)	(855)	(668)	(568)
Education of head (Years)	1,192***	184***	630***	368***	382***	707***
	(104)	(11)	(60)	(62)	(74)	(95)
Age of head (Years)	32	10***	75***	44***	17	109***
	(32)	(3)	(14)	(14)	(16)	(28)
2004	2,878***	115	619*	1,040***	705	2,614***
	(819)	(89)	(334)	(277)	(944)	(980)
2008	18,368***	536***	-90	1,122**	627	1,160***
	(1,000)	(99)	(353)	(477)	(966)	(355)
2014	66,609***	4,326***	6,369***	7,797***	8,655***	8,735***
	(968)	(102)	(567)	(458)	(592)	(612)
Constant	-10,317***	-793***	-6,997***	-4,062***	-2,032**	-8,116***
	(1,693)	(181)	(873)	(723)	(953)	(1,364)
Score test	114.5	48.79	17.2	12.18	9.477	13.35
Score test (p value)	0.000	0.000	0.000	0.000	0.002	0.000
Regression based F-value	117.7	50.41	17.28	12.2	9.498	13.32
Prob >F	0.000	0.000	0.000	0.000	0.002	0.000

Note: Each column shows estimation result from a separate regression model. Robust standard errors are in parenthesis. All regression models are estimated following 2SLS method using community-level migration density as an instrument for migration variable. ***, **, and * indicate significance at 1 % level, 5 % and 10 % levels, respectively. Score test and regression-based F-value test endogeneity of migration variable assuming that errors in our model are not i.i.d.

Appendix Table 10. Total effect of migration on food and non-food expenditures

VARIABLES	Food	Clothing	Education	Medical	Housing	Leisure/Social Events
Migrant (Yes=1)	69,618***	5,334***	69,618***	5,334***	14,771***	14,388***
	(6,241)	(515.3)	(6,241)	(515.3)	(2,773)	(2,792)
Female Headed (Yes=1)	-10,541***	-280.8	-10,541***	-280.8	1,479**	-2,653***
	(1,763)	(180.3)	(1,763)	(180.3)	(710.5)	(879.3)
Female head * Migrant	-27,862***	-2,211***	-27,862***	-2,211***	-9,395***	-1,391
	(7,855)	(713.2)	(7,855)	(713.2)	(3,267)	(4,231)
No. of male working aged member	6,862***	873.2***	6,862***	873.2***	1,837***	671.6***
	(561.6)	(74.45)	(561.6)	(74.45)	(268.4)	(251.0)
Religion (Non-Muslim=1)	3,496**	96.73	3,496**	96.73	-33.86	520.3
	(1,495)	(142.9)	(1,495)	(142.9)	(738.1)	(857.9)
Education of head (Years)	1,133***	182.5***	1,133***	182.5***	635.2***	354.9***
	(106.2)	(11.09)	(106.2)	(11.09)	(59.83)	(61.56)
Age of head (Years)	-43.95	4.472	-43.95	4.472	56.00***	36.78**
	(36.42)	(3.591)	(36.42)	(3.591)	(14.61)	(16.05)
2004	3,334***	143.7	3,334***	143.7	707.2**	1,090***
	(835.3)	(90.32)	(835.3)	(90.32)	(332.4)	(280.3)
2008	19,181***	573.6***	19,181***	573.6***	-56.10	1,264***
	(1,026)	(99.83)	(1,026)	(99.83)	(347.6)	(477.2)
2014	67,538***	4,367***	67,538***	4,367***	6,393***	7,966***
	(987.2)	(102.5)	(987.2)	(102.5)	(572.2)	(467.7)
Constant	-4,181**	-446.0**	-4,181**	-446.0**	-6,198***	-3,220***
	(1,836)	(197.5)	(1,836)	(197.5)	(881.9)	(791.6)
Observations	7,980	7,980	7,980	7,980	7,980	7,980
Score test	0.431	0.340	0.431	0.340	0.064	0.058
Score test (p value)	116.5	51.42	116.5	51.42	17.27	14.73
Regression based F-value	0.00	0.00	0.00	0.00	0.00	0.00
Prob >F	60	26.63	60	26.63	8.684	7.369

Note: Each column shows estimation result from a separate regression model. Robust standard errors are in parenthesis. All regression models are estimated following 2SLS method using community-level migration density as an instrument for migration variable. ***, **, and * indicate significance at 1 % level, 5 % and 10 % levels, respectively. Score test and regression-based F-value test endogeneity of migration variable assuming that errors in our model are not i.i.d.

Appendix Table 11. Indirect, direct, and total effects using the balanced panel

	ACME (M=1)	ACME (M=0)	ADE (M=1)	ADE (M=0)	ATE (1+4) =(2+3)	Total (No mediator)	Difference (5-6)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
				Probability of participation (extensive margin)			
Crop farming	-0.017	-0.064***	-0.356***	-0.403***	-0.420***	-0.421***	-0.001
	(0.025)	(0.012)	(0.066)	(0.085)	(0.065)	(0.065)	(0.005)
Livestock production	-0.019	-0.047***	-0.407***	-0.436***	-0.454***	-0.455***	-0.001
	(0.024)	(0.012)	(0.062)	(0.077)	(0.062)	(0.062)	(0.004)
Non-farm Business	-0.015	-0.016***	-0.058	-0.059	-0.074	-0.074	-0.000
	(0.019)	(0.005)	(0.047)	(0.065)	(0.048)	(0.049)	(0.002)
				Magnitudes of participation (intensive margin)			
Land cultivated (Decimals)	18.434**	-5.896***	-91.215***	-115.545***	-97.111***	-97.685***	-0.573
	(7.454)	(1.595)	(17.183)	(23.742)	(17.431)	(17.556)	(2.124)
Number of cows held	-0.147*	-0.125***	-0.418*	-0.396	-0.544**	-0.543**	0.001
	(0.082)	(0.029)	(0.215)	(0.291)	(0.222)	(0.224)	(0.007)
Number of non-farm of businesses	-0.001	-0.017**	-0.097**	-0.112*	-0.113**	-0.114**	-0.000
	(0.019)	(0.007)	(0.049)	(0.065)	(0.050)	(0.050)	(0.003)
				Input expenditures (BDT/Yearly)			
Fertilizer	669.124**	-262.49***	-3,921.97***	-4,853.58***	-4,184.45***	-4,206.41***	-21.96
	(296.865)	(84.544)	(494.815)	(730.757)	(505.400)	(522.068)	(88.707)
Irrigation	33.624	-241.073***	-2,067.916***	-2,342.613***	-2,308.989***	-2,315.463***	-6.475
	(226.225)	(58.823)	(595.354)	(812.513)	(605.656)	(607.871)	(28.161)
Labor	-574.029*	-183.123	-739.316	-348.410	-922.439	-913.225	9.213
	(334.222)	(122.423)	(910.498)	(1,193.755)	(916.021)	(909.955)	(52.373)
Other inputs	460.806*	-357.300***	-3,434.187***	-4,252.292***	-3,791.487***	-3,810.769***	-19.282
	(252.484)	(118.188)	(614.449)	(797.545)	(639.380)	(636.122)	(72.856)
Non-farm businesses	-348.001	102.331	107.444	557.776	209.775	220.389	10.614
	(342.343)	(102.956)	(760.368)	(1,108.486)	(810.554)	(823.483)	(60.002)

Note: Bootstrapped standard errors are in parenthesis. Standard errors are estimated based on 1000-bootstrapped replication. ***, **, and * indicate significance at 1 % level, 5 % and 10 % levels, respectively. Column 3 shows total effect considering female-headship as a mechanism and column 4 shows total effect without any mechanism.

Appendix Table 12. Indirect, direct, and total effects using the balanced panel

	ACME (M=1)	ACME (M=0)	ADE (M=1)	ADE (M=0)	ATE (1+4) =(2+3)	Total (No mediator)	Difference (5-6)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
				Time allocation (Daily/perperson)			
Crop farming	-0.025	-0.128***	-1.045***	-1.148***	-1.173***	-1.193***	-0.020
	(0.061)	(0.033)	(0.205)	(0.246)	(0.207)	(0.215)	(0.018)
Livestock production	-0.050	0.009	-0.675***	-0.616***	-0.666***	-0.655***	0.012
	(0.035)	(0.017)	(0.103)	(0.126)	(0.102)	(0.106)	(0.012)
Non-farm businesses	-0.065	0.001	-0.277	-0.211	-0.277	-0.264	0.013
	(0.045)	(0.021)	(0.194)	(0.224)	(0.195)	(0.202)	(0.014)
Wage work	0.012	0.015	-0.550***	-0.547***	-0.535***	-0.534***	0.001
	(0.051)	(0.025)	(0.164)	(0.199)	(0.164)	(0.172)	(0.015)
Domestic work	0.097	-0.039	1.517***	1.381***	1.478***	1.451***	-0.027
	(0.089)	(0.040)	(0.292)	(0.298)	(0.280)	(0.278)	(0.027)
Personal care/Leisure	0.039	0.057	2.518***	2.536***	2.575***	2.579***	0.004
	(0.124)	(0.043)	(0.315)	(0.347)	(0.303)	(0.306)	(0.033)
				Expenditures (BDT/yearly)			
Food	-11,725***	-1,711***	59,181***	69,1941***	57,4691***	57,705***	236
	(3,232.419)	(628.524)	(6,249.896)	(8,550.815)	(6,343.489)	(6,270.432)	(831.846)
Clothing	-531.221**	-41.221	4,733.329***	5,223.329***	4,692.108***	4,703.657***	11.549
	(224.723)	(59.925)	(472.502)	(588.051)	(463.524)	(465.384)	(44.564)
Education	-2,043.438*	282.935	11,772.112***	14,098.486***	12,055.047***	12,109.879***	54.832
	(1,131.877)	(206.277)	(2,458.339)	(3,385.593)	(2,433.759)	(2,467.038)	(242.397)
Health	-1,270.542	-605.052**	14,204.703***	14,870.193***	13,599.651***	13,615.337***	15.685
	(1,142.297)	(260.021)	(2,564.578)	(3,270.747)	(2,520.495)	(2,552.119)	(150.415)
Housing	-5,341.045**	163.043	18,177.467***	23,681.555***	18,340.510***	18,470.239***	129.729
	(2,687.962)	(282.629)	(6,253.943)	(8,638.527)	(6,348.237)	(6,379.787)	(573.912)
Leisure/Social Events	-3,507.370**	371.977	15,623.857***	19,503.204***	15,995.834***	16,087.269***	91.435
	(1,583.670)	(843.992)	(4,546.245)	(5,615.315)	(4,346.848)	(4,314.161)	(360.145)

Note: Bootstrapped standard errors are in parenthesis. Standard errors are estimated based on 1000-bootstrapped replication. ***, **, and * indicate significance at 1 % level, 5 % and 10 % levels, respectively. Column 3 shows total effect considering female-headship as a mechanism and column 4 shows total effect without any mechanism.