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Remittances and Asset Accumulation in Bangladesh: A Study using Generalized Propensity Score

by

Mehdi Chowdhury and Dragana Radicic

Abstract

Drawing on a sample of households in Bangladesh, we utilize the Generalized Propensity Score (GPS) method to investigate the impact of internal and international remittances on households' net assets. The analysis suggests an inverted U shaped relationship between the amount of internal remittances and net assets. Concerning the effect of international remittances on net assets, the results do not indicate a clear cut relationship between international remittances and assets. The paper also indicates not only the source but also the size of remittances has a role to play in the utilization.

JEL Classification: D01, F24, O53

Keywords: Remittances, Bangladesh, Assets, Generalized Propensity Score

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1. Introduction

The importance of international migration and remittances to the economies of poor developing countries is well known to academics and policy makers. With respect to the economy of Bangladesh, the contribution of international remittances to the balance of payments of the country is well known. However, at the household level, the effects of remittances are less clear and understudied, in particular accounting for effects of internal (from other parts of the country) as well as international remittances. Data from the Household Income and Expenditure Survey (HIES) 2010, conducted by the Bangladesh Bureau of Statistics, demonstrates that about 12% of Bangladeshi households received internal and about 9% received international remittances (Chowdhury 2015). The recent academic and policy literature largly ignores the vital role played by internal remittances. This study aims to address this gap by analysing the effects of both internal and international remittances on the purchase of assets by Bangladeshi Households using HIES 2010.

This study regards internal and international remittances as treatments and then evaluates the impact of these treatments on net assets. The data on internal and international remittances are available as continuous variables. Our research question and availability of data allow us to utilize the Genaralized Propensity Score (GPS) method developed by Hirano and Imbens (2004) that made possible evaluation of the impact of a continuous treatment variable. Though a number of papers on remittances have evaluated the impact of binary treatment via the Propensity Score Method, this paper is likely to be the first application of the GPS method to the remittances literature.

The paper aims to address the hypothesis of the fungibility of remittances. If remittances are fungible, that is, if they are regarded as any other income by households, there should be no difference between the impacts of internal and international remittances. However, previous studies revealed that internal and international remittances are used differently by households of developing countries. In Bangladesh, it is commonly perceived that international remittances are used mainly in acquiring assets, but there is currently no empirical evidence.

An additional contribution of the study is its focus on the Asian region. Many Asian countries including Bangladesh have significant positions in the global economy in terms of migration and remittances. However, most existing studies focus on a Latin American countries. There is a great need for studies, irrespective of the availability of quality data, aiming to analyze the effects of remittances in Asian countries. This study should be considered as a step towards filling this gap.

Through the utilization of GPS method we aim to identify the relationship between remittances and net assets. For internal remittances we find an inverted U-shaped relation, which implies that for a higher amount of remittances the assets accumulation falls. With respect to international remittances, we do not observe a clear cut relation between remittances and assets. The results also indicate that the amount of remittances is likely to be an important factor for the accumulation of assets. This finding therefore generates an important understanding on the utilization of remittances in Bangladeshi households, which could also be tested for other South Asian countries such as India, Pakistan and Sri Lanka.

The remaining sections are as follows. Section 2 provides a brief review of literature on migration and remittances. Section 3 provides a brief description of the Generalized Propensity Score method. Section 4 discusses data and descriptive statistics. Section 5 estimates the impact of internal and international remittances on assets using semi-parametric techniques. Section 6 runs further analysis using a parametric method. Section 7 discusses the results and concludes.

2. A Literature Review

The remittances literature looks at the effects of remittances on poverty, health, education, investment, labor force participation, economic growth etc. As the literature is large and growing (although Asian countries remain relatively under-represented), we do not attempt any comprehensive survey of the literature here, rather the readers are referred to recent surveys like Adams (2011), Yang (2011) and Sirkeci et al. (2012).

The focus of our study is the impacts of internal and international remittances on accumulation of assets in Bangladesh. Though limited, a number of studies have

estimated the effects of remittances on assets and investment of households in various parts of the world. In a pioneering study, Adams (1998) looked at both internal and external remittances in rural Pakistan and found that external remittances have a positive and significant effect on land accumulation while internal remittances have a positive and significant effect on the accumulation of agricultural capital. Mansuri (2007) found that migration has a large positive effect on land purchase in Pakistan. Quisumbing and McNiven (2010) found that in Philippines, remittances have a positive impact on housing, consumer durables, non-land assets. De and Ratha (2012) found that, in Sri Lanka, remittances contribute to an increase in human capital accumulation among children; however they did not find any evidence of a significant increase of households' asset accumulation. Garip (2014) studied the effects of internal migration and remittances on wealth accumulation in rural Thailand and found equalizing effects of migration, as rich households lose productive assets with migration while poor households gain productive assets. Ahmed et al. (2016) studied the asset accumulation pattern in Pakistan and found that foreign remittances resulted in a substantial increase in assets however no such pattern was observed for domestic remittances.

A few studies looked at the effects of migration and remittances in Bangladesh. Mahmud and Osmani (1980), in a pioneering work, investigated the relationship between overseas workers remittances, balance of payment, income and savings of households. Stahl and Habib (1989) using CGE modelling demonstrated that that remittances may increase the production of domestic consumption and intermediate products. Among the recent studies, Siddique et al. (2012) using time series data over a 25-year period found positive effects of remittances on economic growth in Bangladesh. Khandker et al. (2012) using the survey data of 480,918 households, found that seasonal migration helped households to smooth consumption and that the probability of migration was higher in the households with a high dependency ratio, a high dependency on wage employment and in villages with high unemployment. Chowdhury and Rabbi (2014) using the annual data from 1971 to 2008 showed that influxes of workers' remittances significantly appreciates the real exchange rate and deteriorates the external trade competitiveness. Hatemi-J and Salah Uddin (2014) found that poverty reduction and remittances in Bangladesh affect each other. Chowdhury (2015) utilized Household Income and Expenditure Survey data of 2010

to associate households' characteristics with the mode of remittances in Bangladesh. Though the possibility of existence of other studies cannot be excluded, it appears that the amount of studies on migration and remittances in Bangladesh is rather limited relative to the position of Bangladesh in terms of migration and remittances in the world economy. The use of survey data in Bangladesh is rare and to our knowledge, no study assessed the effects of remittances on households' assets or wealth in Bangladesh using the HIES data.

As the present study applies a variant of Propensity Score Matching (PSM) technique, we now attempt a short review of the literature that used PSM in the analysis of the effects of remittances. Cox-Edwards and Rodriguez-Oreggia (2009) is among the first studies to use Propensity Score Method to analyze the effects of remittances on labor force participation. The study found that persistent remittances do not significantly alter the income levels of the recipient households in Mexico. As remittances mainly replace the pre-migration contribution with no significant surplus, the labor supply price remains unchanged. Acosta (2011) studied the effect of remittances on school attendance and child labor in El Salvador. The study found evidence of a strong reduction of child wage labor in remittance-recipient households and an increase in unpaid family work activities for children in those households. The overall impact of remittances on schooling is insignificant although the school attendance of girls seems to increase upon remittances receipt. Mueller and Sharif (2011) studied the effects of international remittances on schooling in India and found evidence of positive correlation between remittances and schooling of teens. Jimenez-Soto and Brown (2012) found that the net improvement in income from remittances contributes substantially to poverty alleviation in Tonga. Bertoli and Marchetta (2014) analyzed the effects of migration of poverty reduction in El Salvador. They have found that the effect of migration of poverty reduction is positive and significant although sensitive to possible violations of the identifying assumption of selection on observables. Fransen and Mazzucato (2014) studied the effects of international remittances on post conflict urban Burundi and found evidence of strong effects on non-productive assets, such as living conditions and food security and weak effects on productive assets, such as asset ownership.

Instead of using binary treatments, we applied Generalized Propensity Score developed by Hirano and Imbens (2004) that allows for utilizing continuous

treatments. Though we have not seen any application of the method in analysing the effects of remittances, it has been applied in a number of studies in relation to migration such as Egger et al. (2012) and Serrano-Domingo and Requena-Silvente (2013).

3. Generalized Propensity Score

Generalized Propensity Score (GPS) method has close association with the Propensity Score Matching technique developed by Rosenbaum and Rubin (1983). The general idea of Propensity Score method (PSM) is that in field data or observational studies, comparable control and treatment groups are not available. Therefore propensity scores, which is the probability of receiving treatment, are calculated for each individual unit. These scores serve as the basis for calculating effects of treatments on individual units. GSP develops on PSM by using continuous treatment values instead of binary values. Suppose that there exists a potential set of outcomes $Y_i(t)$ where t is defined over an interval $T_i \in \lfloor t_{0,} t_1 \rceil$ whereas for binary treatment of PSM is it $T_i \in \{0,1\}$. The potential outcomes are referred as dose-response functions and the objective of the estimation is to estimate the average dose-response function $E[Y_i(t)]$ at particular levels of treatments.

Hirano and Imbens (2004) generalizes the *unconfoundedness* assumption for binary treatments made by Rosenbaum and Rubin (1983) to the continuous case as,

$$Y(t) \perp T \mid x \text{ for all } T_i \in \lfloor t_{0,} t_1 \rceil . \quad (1)$$

It is referred as *weak unconfoundedness*, as it only requires conditional independence to hold for each value of the treatment, rather than joint independence of all potential outcomes. Assuming that the conditional density of the treatment given the covariates is given by $r(t,x) = \int_{T|x}(t \mid x)$, the generalised propensity score defined by Hirano and Imbens (2004) is,

$$R = r(T,x) \quad (2)$$

The GPS has a balancing property similar to the balancing property of the propensity score. Within strata with the same value of the $r(t,x)$ probability that $T=t$, does not depend on the value of x, i.e. the GPS has the property that $x \perp 1\{T=t\} \mid r(t,x)$. In other words, when looking at two pairs with the same probability, their treatment level is independent of observed covariates. The definition of GPS does not require unconfoudedness, however, in combination with unconfoundedness, it implies that assignment to treatment is unconfounded given the GPS.

Hirano and Imbens (2004) stated that GPS can be used to eliminate any biases associated with differences in the covariates. The procedure consists of two steps. First estimation of the conditional expectation of the outcome as a function of two scalar variables, the treatment level T and R, i.e.

$$\beta(t,r) = E[Y \mid T=t, R=r] \tag{3}$$

Second, to estimate the dose-response function at a particular level of the treatment by averaging this conditional expectation over the GPS at that particular level of the treatment,

$$\mu(t) = E[\beta(t,r)] \tag{4}$$

It is important to note that equation (8) does not imply averaging over R; rather over the treatment level of interest.

GPS has a useful role in our present study because of possible selection bias problem as households that received lower amount of remittances can be different from the households that received higher amount of remittances (See Adams 2011). GPS provides a solution to this selection bias problem as equation (7) specifies conditional output as a function of two variables only, i.e. GPS and the treatment level.

Hirano and Imbens (2004) estimated dose-response functions using a parametric method. Bia et al. (2014) developed a STATA routine in line with the semi-parametric method employed by Flores et al. (2012). Bia et al. (2014) first estimates

GPS, and then estimates dose-response functions using non-parametric techniques. The GPS is estimated employing a suitable functional form. Specifically,

$$g(T_i|X_i) \sim \psi(h(\gamma, X_i), \theta).$$

Where g is a link function, ψ is a probability density function, h is a flexible function of covariates depending of unknown parameter vector γ, and θ is scale parameter. The probability distributions allowed are normal, inverse Gaussian or Gamma distributions. Maximum likelihood model is used to fit the models. Common support is imposed by Bia et al. (2014) using the procedure developed by Flores et al. (2012) which in turn utilizes an extension of the method employed by Dehejia and Wahba (2002). Firstly the sample is divided in K intervals according to the distribution of treatments. For each interval GPS is evaluated at the median level of treatment in that interval for all units. The common support region with respect to that interval is obtained by comparing the support of the distribution of GPS for the units in the interval with the individuals not in that interval. Finally sample is restricted to the units who are comparable across all intervals.

Another important ingredient of estimation of GPS is testing the balancing property. The balancing property refers to the characteristics of correctly specified GPS to render statistically insignificant mean difference of covariates. In PSM the balancing of covariates are generally evaluated through comparing the mean differences of treated and comparison groups. The balancing property in the case of a continuous treatment can be tested by dividing the sample into sub-intervals and evaluating statistical significance of the differences of the mean of an interval against other intervals, which has been implemented by Hirano and Imbens (2004). Flores et al. (2012) developed a procedure utilizing the likelihood ratio test which has been implemented in this paper following the STATA routine of Bia el al (2014) and to be discussed in due course.

After the GPS sufficiently balances covariates, the next step is the estimation of dose-response functions (DRF). Bia et al. (2014) applies Spline and Kernel techniques, implemented through utilizing a partial mean approach. Specifically they apply three methods (i) Radial Spline Method, (ii) Penalized Spline Method, and (iii) Inverse Weighting (I-W Kernel Method.

4. Data and descriptive statistics

The study utilizes the data of Households Income and Expenditure Survey (HIES) of 2010 conducted by Bangladesh Bureau of Statistics (BBS). In total 12,240 households were surveyed of which 7,840 were from rural areas and 4,400 from urban areas. The survey asked direct questions about the sources of remittances which enabled classifiying the houselhods in 4 categories i.e. 9,524 households received 'No Remittances', 1,490 received only 'Internal Remittances', 1,106 households received only 'International Remittances' and 120 households received 'Both Internal and International Remittances'. The category 'No remittances' and 'Both Internal and International Remittances' have been excluded from the subsequent analysis and are not presented in the Table 1 below.

Table 1: Sources of remittances

Modes	Urban		Rural		Total	
	No.	%	No.	%	No.	%
Internal Remittances	451	30%	1,039	70%	1,490	100%
International Remittances	344	31%	762	69%	1,106	100%

Table 1 presents these statistics by segregating the households in rural and urban locations. The incidence of both internal and international remittances is higher in rural households compared to the urban households.

The study treats the internal and international remittances received by households as treatments and net assets as outcomes. The net assets in our paper equals the purchase of land, property and other valuables minus the sale of any assets in the survey year. As not many households received internal remittances above Tk 200000, we treat remittances above Tk 200000 or 2 Lac[1] as outliers and drop them from subsequent analysis. Table 2 presents the summery statistics of households with remittances up to Tk 200000. The dropping of households above Tk 2 lac resulted in

1 1 Lac=100000. Lac is a common denominator used in the Indian subcontinent. Another commonly used denominator is Crore, 1 Crore=10000000.

only 15 households being dropped. The table shows that the average amount of internal remittances is 21055.58 Takas and the minimum amount is 100 Takas. The distribution of remittances is right-skewed. The standard deviation of remittances is 28770.29. Table 2 presents other variables utilized in construction of GPS. Table 2 shows that most households (70 %) are located in rural areas. About half of the members of the households are male. About 29% households have female heads, while the average age of the household head is 49 years. On average, households are comprised of 60% adults (age between 15 to 65) and 30% young (age below 15). The dominant religion is Islam as 90% households are Muslims. These statistics indicate that the sampling is representative of the total population of Bangladesh. However, only a very small number of households have a member that lived abroad (around 1.7%). Finally, about 17% households have at least one member with education higher than SSC. Table 2 also shows that a handful of households reported to have cultivable land, received pension, gratuity, profit and interest. Another important variable is per capita consumption. Though it varies substantially, the mean of remittances is about 40% of the average per capita consumption. It shows that remittances play a substantial role in the average household expenditure. Note also that average of the net assets is 3946.915, which is about 5 times smaller than the average remittances.

Table 2: Summary statistics for internal remittances* (up to Tk 200000)

	Mean	**St. Dev.**	**Min.**	**Max.**
Internal remittances	21055.58	28770.29	100	200000
Net assets	3946.915	105078.9	-500000	3600000
Dummy, rural-urban(Rural=1)	0.699661	0.458561	0	1
Ratio of male members	0.44155	0.209415	0	1
Dummy, Sex of heads (Female=1)	0.277966	0.448149	0	1

Age of the households' heads	49.39729	15.34827	17	100
Ratio, adult to total members	0.613802	0.254482	0	1
Ratio, young to total members	0.294525	0.226952	0	0.857143
[2]Dummy, Religion (Islam=1)	0.896271	0.305012	0	1
Dummy, any member abroad (Abroad=1)	0.016949	0.129125	0	1
Dummy, higher education (1 if $\geq$ SSC)	0.166102	0.372298	0	1
Total cultivable land	58.51254	146.4447	0	2500
Per capita consumption	52584.89	35262.04	10015	738469.8
Pension and gratuity	1363.529	16927.09	0	600000
Profit and interest	466.1708	4881.547	0	100000

* Remittance is in Taka. 1 Taka=$0.013. 1475 Observations

Table 3 represents the summary statistics of international remittances for international remittances up to Tk 200000, to allow some form of comparability with the Table 2. Table 3 shows that the minimum amount of international remittances is 4. Though the minimum looks very low, on the average international remittances is Tk 90623.91 which is about 6 times higher than the average internal remittances in Table 2. Comparing between the net assets from Table 2 and 3, we see that it is about 2.5 times higher in the Table 3, however 10 times smaller than the average international remittances. Interestingly about 44% households receiving remittances has a female as the head of the household. On Table 3 we also see that more households reported to have members abroad though it is still only about 4%. The per capita consumption figures in Table 3 are interestingly almost the same as the one in Table 2.

2 The survey asked a specific question about the religion of individual members of the households. We regard the religion of the household the same as the religion of the head. For detailed description of how the variables have been constructed using the survey data see Chowdhury (2015).

Table 3: Summary statistics for international remittances* (up to Tk 200000)

	Mean	St. Dev.	Min.	Max.
International remittances	90623.91	55633.44	4	200000
Net assets	7573.312	75822.99	-370000	1300000
Dummy, rural-urban(Rural=1)	0.697749	0.45948	0	1
Ratio of male members	0.424249	0.205127	0	1
Dummy, Sex of heads (Female=1)	0.445874	0.497328	0	1
Age of the households' heads	47.69668	15.89643	11	122
Ratio, adult to total members	0.590749	0.238809	0	1
Ratio, young to total members	0.348535	0.239533	0	0.833333
Dummy, Religion (Islam=1)	0.950697	0.216617	0	1
Dummy, any member abroad (Abroad=1)	0.046088	0.209788	0	1
Dummy, higher education (1 if $\geq$ SSC)	0.170418	0.376201	0	1
Total cultivable land	71.10289	143.2392	0	2000
Per capita consumption	61886.23	39025.97	6839.977	538224
Pension and gratuity	1122.444	11955.52	0	300000
Profit and interest	217.5991	4139.5	0	120000

* 933 Observations

In the tables we presented summary statistics for households with remittances up to Tk 2 Lac. For the estimation of GPS we utilized, as well, other intervals of remittances such as between Tk 25000 to Tk 2 Lac for both internal and international remittances, and up to Tk 8 Lac for international remittances. We skipped presentation of all the summary statistics for the sake of brevity.

5. Estimation of GPS and the dose-response functions

The section discusses the estimation of GPS and dose-response functions. The treatment variables in our sample are internal remittances and international remittances received by the households. The histograms and summary statistics indicate that the treatment variables are not normally distributed. Therefore, the estimations of GPS and dose-response functions are conducted using a Gamma distribution.

5.1. Internal remittances

This subsection estimates GPS and dose-response functions regarding internal remittances as treatments. It should be noted that many households received only a small amount of remittances which seems negligible compared to the asset price in Bangladesh. An analysis therefore has been conducted dropping the households that received remittances below Tk 25000. Two households reported to have net assets above Tk 10 Lac. Those households were dropped with the truncation of the sample. The treatment variable has been divided by 1000 and following treatment intervals have been used – (0/10/25/40/60/80/100/120/140/170/200). For the sample excluding the remittances below Tk 25000 the intervals are (25/30/40/60/80/100/120/140/160/180/200). The interval selections are arbitrary though they are aligned with the common practice of counting and perceiving monetary amounts.

The regression results for estimation of GPS are presented in the Table A1 of the appendix. Following Hirano and Imbens (2004), the purpose of the regression is regarded as the estimation of GPS, however it should be also noted that a good number of covariates depict statistical significance in the results (See table A1 and A2). To ensure that the individual units are comparable, all estimations are conducted after imposition of the common support condition which results in 14 observations being dropped. To test that GPS sufficiently balances the covariates, LR tests have been performed following Flores et al. (2012) which has been incorporated in the STATA routine of Bia et al. (2014). The results of the tests are presented below:

Table 4: Balancing test for internal remittances

Unrestricted model: T on GPS, GPS^2, GSP^3, and covariates		
	Up to Tk 2 Lac	**From Tk 25000 to Tk 2 Lac**
Restricted Log likelihood	-4709.261	-1849.8909
Unrestricted Log likelihood	-4702.6078	-1849.7238
T-statistics	13.306327	0.33407536
p-value	0.42443834	1
Number of restrictions	13	13
Test restriction that GPS coefficients can be excluded from the unrestricted model		
Restricted Log likelihood	-5761.7687	-1885.8017
Unrestricted Log likelihood	-4702.6078	-1849.7238
T-statistics	2118.3219	72.155676
p-value	0	0
Number of restrictions	3	3
Number of observations	1461	373

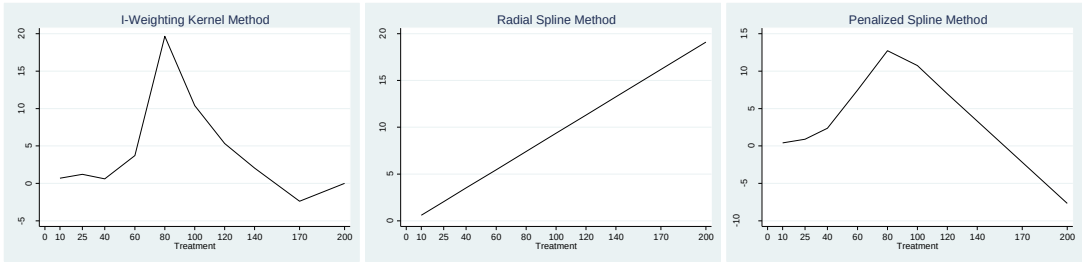
The balancing test is conducted performing three regressions. They are (1) Restricted, which included all the covariates, (2) Unrestricted, includes both Covariates and GPS terms, and lastly (3) GPS, which only includes the GPS terms. If GPS sufficiently balances the covariates then they should have little explanatory power conditional on the GPS. This is observed in the top panel as restricted model that excluded the covariates cannot be rejected (p value is 0.424). On the other hand the bottom panel shows that the restricted model that excludes GPS is clearly rejected (p value is 0). Following Flores et al. (2012) and Bia et al. (2014) we regard this as the evidence of satisfying the balancing property.

Dose-response functions are estimated using (i) Radial Penalized method, Penalized Spline method, and (iii) I-W Kernel method. The estimated does-response functions and estimates treatment effects are presented below. Figure 1 shows dose-responses and derivatives for internal remittances up to Tk 2 lac. Essentially we are looking for any significant patterns in the diagrams. It should be noted that the scaling of the diagrams are not equal therefore caution is needed for interpreting the diagrams. It is observed that both I-W Kernel and Penalized Spline method initially demonstrated an increase in the dose-responses and derivatives, and decline at a later level of treatment. Similarly the derivatives for the two estimators register an increasing trend at the beginning, however later decline by registering negative

values. The Radial Spline method however shows an increasing trend throughout with the derivatives later becoming almost flat.

Figure 1: Internal remittances up to Tk 2 Lac

Dose-responses:



Derivatives:

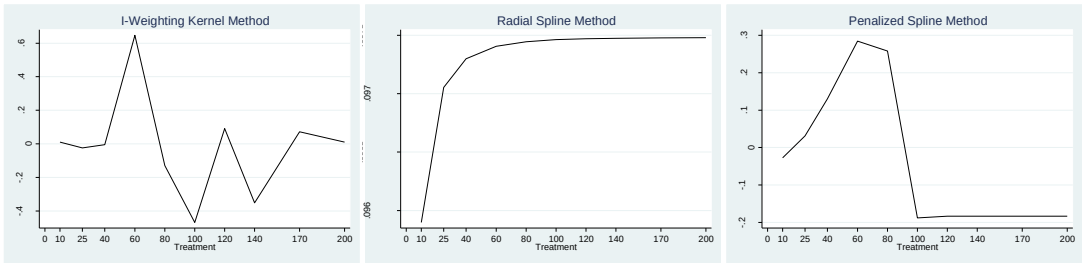
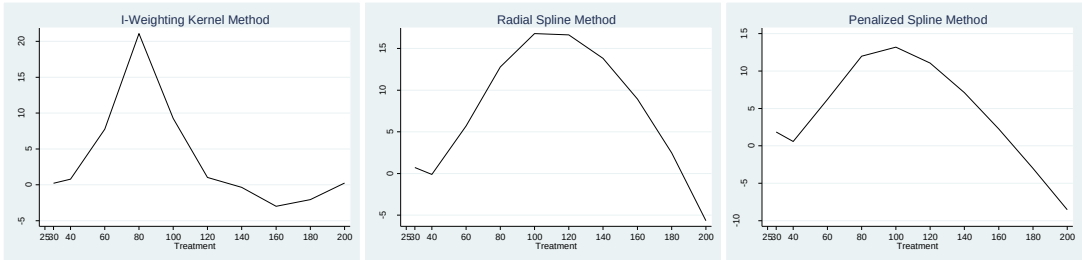


Figure 2: Internal remittances Tk 25000 to 2 Lac

Dose-responses:



Derivatives:

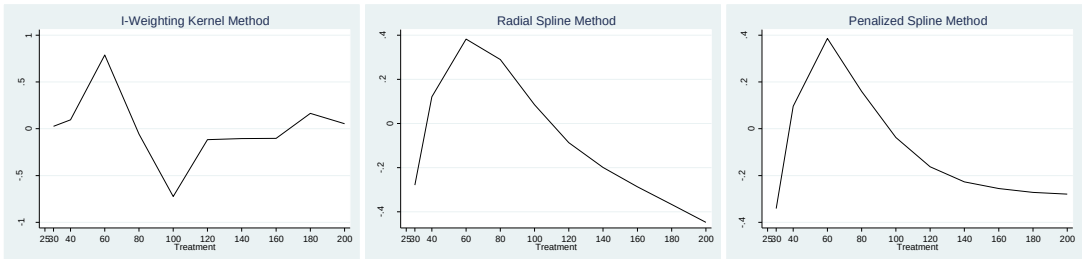


Figure 2 shows estimated dose-responses and derivatives when the sample excludes the households with remittances less than Tk 25000. The Radial Spline and Penalized Spline both generate similar dose-responses which show an improvement in the estimation of the dose-responses. The I-W Kernel method also depicts a similar upward, and later a downward trend. The derivatives of all methods produce similar diagrams with initially positive values and later going down to negative values. Comparing with what has been observed in the Figure 2, we may conclude that net assets increase at a lower level of remittances however declines as the size of internal remittances goes up.

5.2. International remittances:

A total of 1106 households reported to have received international remittances. The analysis in this section has been conducted using international remittances up to Tk 2 lac[3] and from Tk 25000 to Tk 2 Lac. The average size of international remittances is larger than internal remittances, we therefore have also conducted an analysis for international remittances up to Tk 8 Lac. The intervals used are similar to the ones used for the internal remittances. For the sample with international remittances up to Tk 8 Lac, intervals are (0/25/60/100/150/200/300/400/500/600/800).

The imposition of the common support condition results in 22 observations being dropped for the sample from 0 to Tk 2 lac. Similar numbers have been dropped in other samples. The balancing test is reported in the Table 4. As before the LR-test results presented in Table 4 reveals that GPS sufficiently balances covariates. This is evident from the p-values of the LR tests. As the balancing test produces satisfactory result, we proceed to estimation of dose-responses and derivatives.

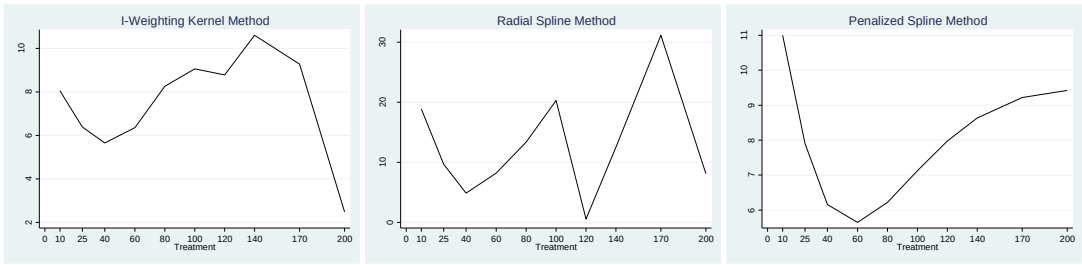
3 We encountered some issues in running the program while calculating the standard errors for I-W Kernel estimator in the case of international remittances up to Tk 2 Lac. Other estimations encountered no issues. All estimations produced the diagrams as required.

Table 4: Balancing test for International remittances

Unrestricted model: T on GPS, GPS^2, GSP^3, and covariates			
	Up to Tk 2 Lac	**From Tk 25000 to Tk 2 Lac**	**Up to Tk 8 Lac**
Restricted Log likelihood	-4937.085	-4367.6564	-5880.31
Unrestricted Log likelihood	-4932.3422	-4364.7277	-5875.82
T-statistics	9.4855048	5.8573403	8.977885
p-value	0.7353674	0.95119107	0.774612
Number of restrictions	13	13	13
Test restriction that GPS coefficients can be excluded from the unrestricted model			
Restricted Log likelihood	-4969.7345	-4382.4145	-6205.58
Unrestricted Log likelihood	-4932.3422	-4364.7277	-5875.82
T-statistics	74.784572	35.373676	659.5187
p-value	0	0	0
Number of restrictions	3	3	3
Number of observations	905	778	1065

Figure 3: International remittances up to Tk 2 lac

Dose-responses:



Derivatives:

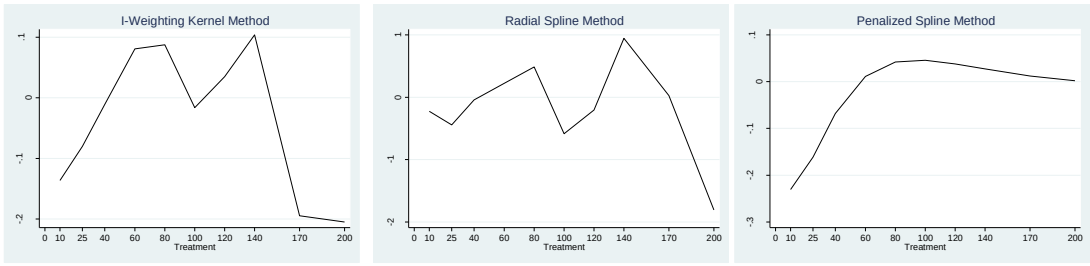
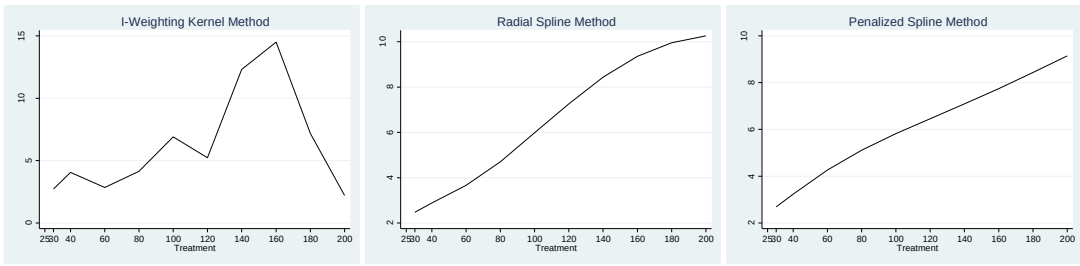


Figure 3 shows dose-responses and derivatives for international remittances up to Tk 2 Lac. The dose-responses of I-W Kernal and Radial Spline initially show an increasing tendency and later a decreasing tendency, however for Penalized Spline Method it shows the opposite tendency. When looking at the derivatives we observe close to inverted U shaped patterns with initially upward sloping and later downward sloping trends.

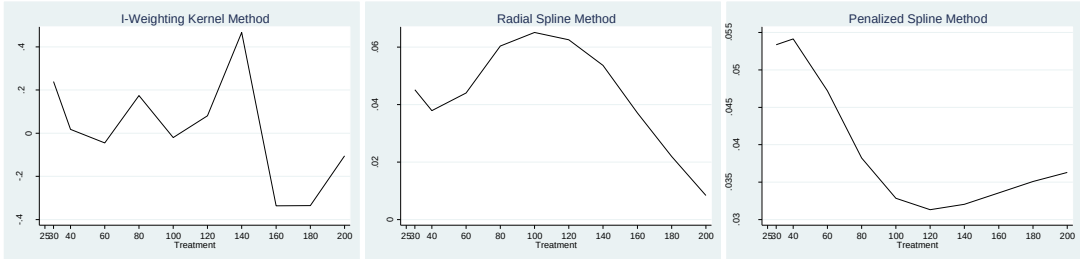
Figure 4 estimates dose-responses and derivatives for the households who received remittances between Tk 25000 to Tk 2 Lac. The dose-response of I-W Kernal is similar to the one in Figure 3, however for Radial and Penalized Spline they are increasing. The derivatives show mixed tendency though, they tend to be positive except for the I-W Kernal estimator. It is interesting to note that the diagrams of Figure 3 and 4 look similar to the diagrams obtained for internal remittances in Figure 1 and 2. It therefore suggests that internal and international remittances have similar impacts on net assets.

Figure 4: International remittances from Tk 25000 to Tk 2 lac

Dose-responses:



Derivatives:

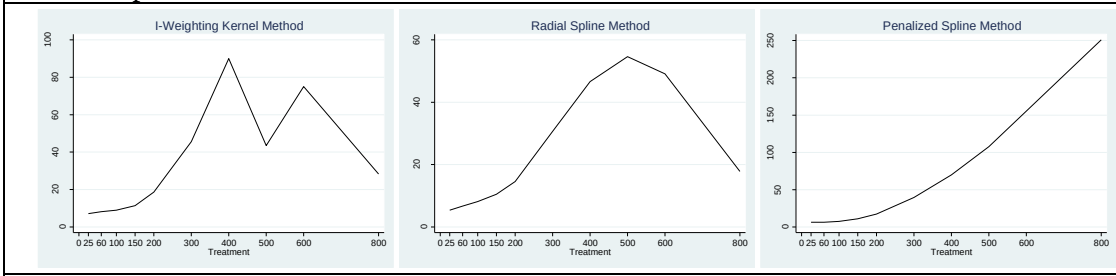


As mentioned earlier, international remittances are larger on average, therefore we furthered this analysis by estimating dose-responses and derivatives for international remittances up to Tk 8 Lac. The Figure 5 presents the relevant diagrams. Dose-responses of I-W Kernel and Radial Spline show initially an increasing and later a decreasing graph. For Penalized Spline, it is throughout increasing. The derivatives of I-W Kernel and Radial Spline on the other hand become negative as the size of remittances increase.

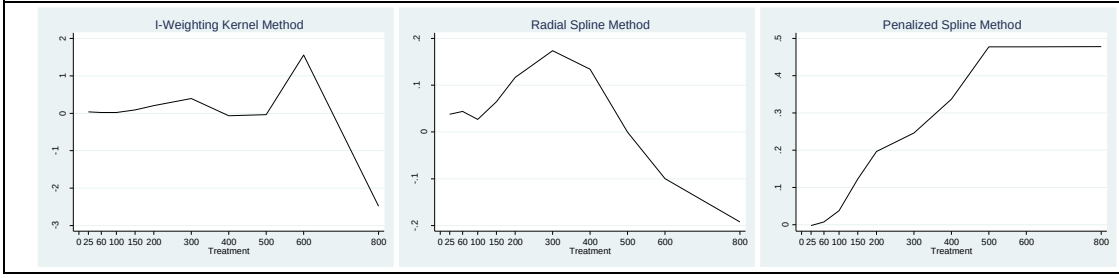
The results of this section are mixed, though can be summarized as follows. For a lower level of remittances we observe that the net assets go up, however when the level is high we do no observe similar impact rather observe a decreasing tendency. The results show that internal and international remittances have some similarities in utilization, and a higher level of remittances may result in a decrease of assets.

Figure 5: International remittances to Tk 8 lac

Dose-responses:



Derivatives:



6. Parametric estimation of GPS and Dose-response functions

The estimation of dose-response functions here utilized a non-parametric approach, which is different from the parametric approach used by Hirano and Imbens (2004). To investigate further, below we employ a parametric method of estimation following the STATA routine of Guardabascio and Ventura (2014). The STATA routine developed by Guardabascio and Ventura (2014) closely follows the approach adopted by Hirano and Imbens (2004) and Bia and Matei (2008). The implementation is conducted in following steps:

Step 1: Estimate GPS using a generalised linear model, as in Bia et al. (2014)

Step 2: Balancing property is checked by utilizing the blocking on GPS approach developed by Hirano and Imbens (2004). Potential treatment values are divided in K intervals and GPS is estimated at user specified representative points (e.g. mean of each interval) for each units. Within each treatment interval, estimated GPS is divided in m intervals. Within the same GPS interval, the mean differences of covariates are tested for the unit that belongs to the same treatment interval with the mean difference of the covariate for the units that belong to other treatment intervals. Then the mean differences weighted by the number of observations in each GPS group are combined. The balancing property is satisfied if the mean differences of covariates are insignificant which is demonstrated through t-tests.

Step 3: Estimating the conditional expectation of outcomes given the treatment and GPS using a parametric regression function, i.e

$$Y_i = \beta_0 + \beta_1 T_i + \beta_2 T_i^2 + \beta_3 GPS_i + \beta_4 GPS_i^2 + \beta_5 T_i GPS_i$$

Step 4: Estimate the dose-response function by averaging over the conditional output for each level of treatments.

$$E[\widehat{Y(t)}] = \frac{1}{N}\sum_{i=1}^{N} \hat{\beta}_0 + \hat{\beta}_1 t + \hat{\beta}_2 t^2 + \hat{\beta}_3 \hat{r}(t, X_i) + \hat{\beta}_4 \hat{r}(t, X_i)^2 + \hat{\beta}_5 t\, \hat{r}(t, X_i)$$

Below we present the diagrams of GPS and dose-response functions.

Figure 6: Dose-response functions and derivatives for internal remittances

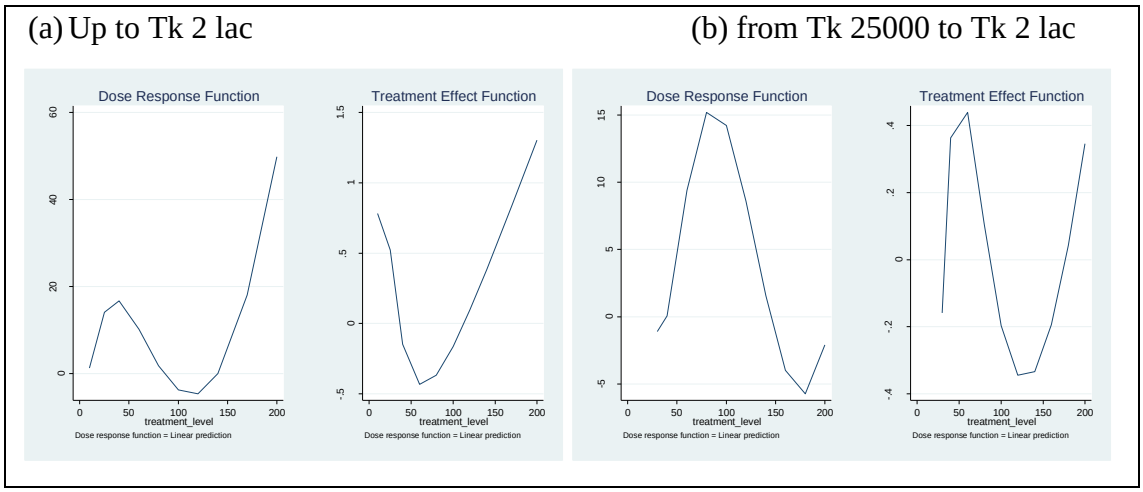
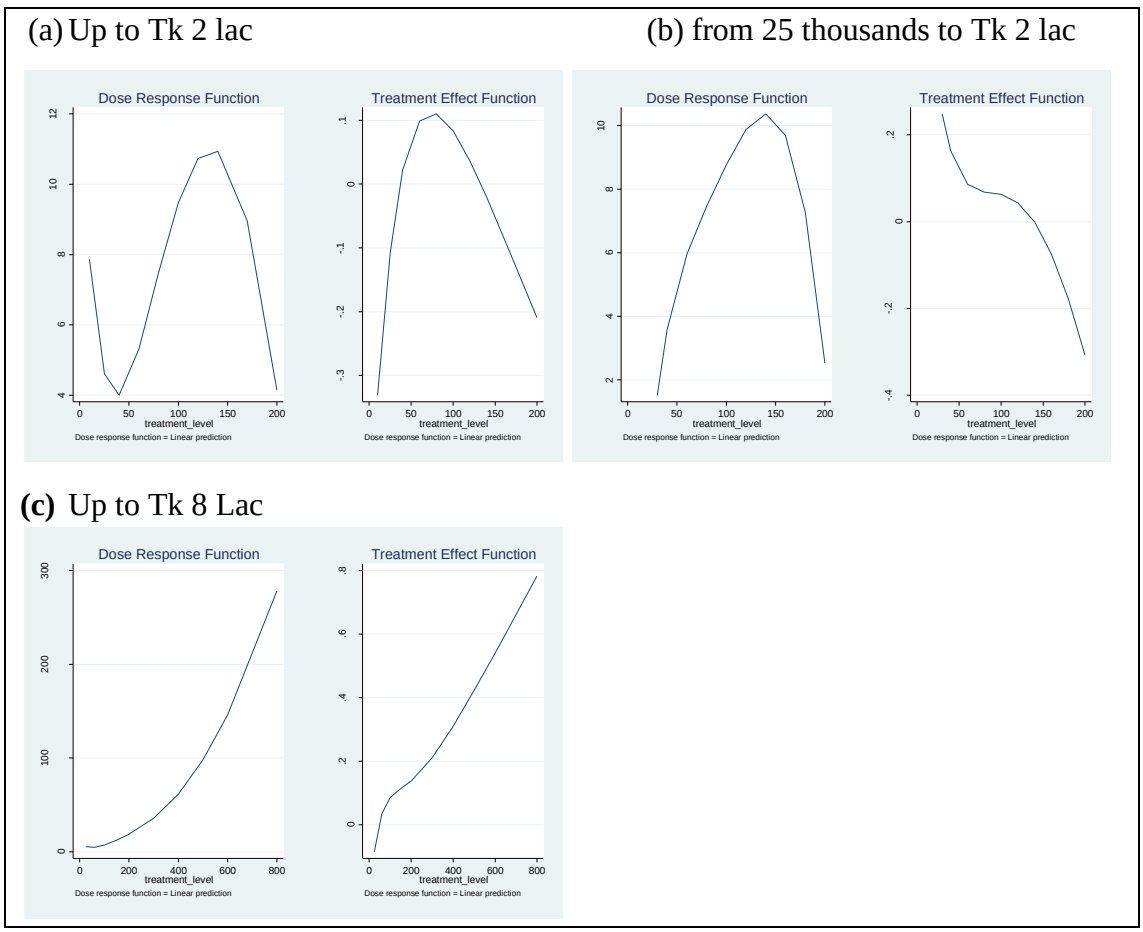


Figure 7: Dose-response functions and derivatives for International remittances



As can be observed from Figures 7 and 8, the estimated dose-responses and derivatives obtained in the non-parametric approaches are to some extent replicated in the parametric approach. We observe that the derivatives for the internal remittances

from Tk 2500 to Tk 2 Lac are downward sloping implying a decrease in assets with the increase of remittances. For international remittances, the dose-responses and derivatives demonstrate similar tendencies for the remittances up to Tk 2 lac. However for international remittances up to Tk 8 Lac, the dose-response and derivative show an increasing trend. This specific result is dissimilar to the one obtained using the non-parametric approach.

7. Discussion and conclusion

In the previous section 5 and 6 we have analysed how remittances affect net purchase of assets in Bangladesh. The idea of fungibility of remittances implies that households should treat remittances like any other sources of income and there should be no impact of the sources of remittances on the use of remittances. However, in Bangladesh, it is in general believed that international remittances are largely used for asset accumulation. From the diagrams of dose-responses and derivatives obtained in various sections, it can be interpreted that with a lower level of internal remittances households increase the purchase of assets slightly, however at a higher level of internal remittances assets purchase falls.

For the international remittances, we observe that international remittances may be used for assets accumulation however a clear cut relationship is not observed. The results obtained using non-parametric and parametric approach produce dissimilar results. Therefore the results do not allow us to reach the decision that the international remittances are used for asset accumulation. It is also likely to be linked with the size of remittances. De and Ratha (2012) found that international remittances are not fungible as they are targeted better and senders closely monitor the uses. In our paper we have however found some evidences supporting the fungibility hypothesis. In this regard it should be noted that remittances are private transfers which constitute incomplete contracts between senders and receivers. Torero and Viceisza (2015) conducting an experiment, identified that migrants prefer how receivers spend remittances. Therefore the motivation of remittances is important as well as is the interest/cost of the sender to monitor the use of remittances. Rapoport and Docquir (2006) identified inheritance as an important motivation for remittances.

As households assets are tangible assets the remitters have direct claim and interest in the ensuring that use of remittances. However assets/wealth acquisition requires a larger amount of remittances, relative to other motivation of remittances, such as altruism or exchange. On the other hand, assets require a significant endeavour in monitoring and maintaining. If mechanism for that is absent, a household may not invest by accumulating assets.

The above paragraph therefore points to one of the limitations of our study, that is the presence of household level unobservables. Though the HIES provides a substantial amount of household level data, it surely misses many. Though GPS sufficiently balanced the household in our analysis, the constructed GPS could not take unobservables into consideration; hence the validity of the unconfoundedness assumption can be still questioned.

Our paper does not look at different components of assets such as whether remittances are used for acquisition of lands or property or to buy valuable assets. We aim to do it in a separate paper as the current paper is already dense in tables and diagrams. Note that households may maintain a portfolio of assets, accordingly may acquire different types of assets. Therefore just looking at one or two types of assets may not deliver a proper understanding of assets acquisition behavior of households.

Nevertheless, this paper provides important understanding on households' utilization of remittances. The impact of remittances in Asian countries is relatively understudied. Though we only worked with Bangladesh it can be easily replicated in other countries of Asia subject to the availability of data. Additionally it importantly looks at internal remittances which are currently neglected in migration research. We expect that therefore this paper will attract significant academic and policy level interest in the near future.

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Appendix:

Regression results for the estimation of GPS.

Table A1: Regression results of estimation of GPS for internal remittances

Covariates	Internal remittances (Up to Tk 2 Lac)	Internal remittances (from Tk 25 Thousand to Tk 2 Lac)
Dummy, rural-urban(Rural=1)	0.152792 (0.082702)*	-0.048659 (0.069641)
Ratio of male members	0.159129 (0.195404)	0.013909 (0.159171)
Dummy, Sex of heads (Female=1)	0.639745 (0.092930)***	0.049263 (0.074495)
Age of the households' heads	0.015234 (0.002897)***	0.001336 (0.002480)
Ratio, adult to total members	0.688828 (0.206197)***	0.326155 (0.188437)*
Ratio, young to total members	1.370025 (0.252483)***	0.675857 (0.233162)***
[4]Dummy, Religion (Islam=1)	0.074484 (0.114791)	0.075989 (0.096991)
Dummy, any member abroad (Abroad=1)	0.566699 (0.270161)**	0.170753 (0.189098)
Dummy, higher education (1 if ≥ SSC)	0.417707 (0.102229)***	0.025184 (0.074362)
Total cultivable land	0.000104 (0.000273)	0.000015 (0.000186)
Per capita consumption	0.00000912 (0.000001)***	0.000004 (0.000001)***
Pension and gratuity	-0.0000010 (0.000002)	0.000002 (0.000004)
Profit and interest	-0.0000023 (0.000006)	0.000002 (0.000005)
Constant	0.3862972 (0.328755)	3.276493 (0.308832)***
Number of observations	1474	379

Notes: *** p<0.01, ** p<0.05, * p<0.10

Table A2: Regression results of estimation of GPS for international remittances

Covariates	Up to Tk 2	From Tk 25	Up to Tk 8

4 The survey asked a specific question about the religion of individual members of the households. We regard the religion of the household the same as the religion of the head. For detailed description of how the variables have been constructed using the survey data see Chowdhury (2015).

	Lac	Thousand to Tk 2 Lac	Lac
Dummy, rural-urban(Rural=1)	-0.035306 (0.047321)	-0.022498 (0.037946)	-0.023454 (0.064509)
Ratio of male members	-0.005966 (0.113224)	-0.037863 (0.090362)	0.126729 (0.152929)
Dummy, Sex of heads (Female=1)	0.304874 (0.057898)***	0.110572 (0.046753)**	0.315675 (0.075726)***
Age of the households' heads	0.003708 (0.001785)**	0.001094 (0.001446)	0.006756 (0.002305)***
Ratio, adult to total members	0.348956 (0.165847)**	0.321747 (0.133470)**	0.680719 (0.235363)***
Ratio, young to total members	0.312325 (0.182233)*	0.290472 (0.146930)**	0.666699 (0.254787)***
[5]Dummy, Religion (Islam=1)	0.153186 (0.095223)	0.147222 (0.077308)*	0.272950 (0.135237)**
Dummy, any member abroad (Abroad=1)	0.251467 (0.099348)**	0.185966 (0.078250)**	0.287461 (0.129197)**
Dummy, higher education (1 if $\geq$ SSC)	-0.028061 (0.057214)	-0.011889 (0.046363)	0.071745 (0.075531)*
Total cultivable land	0.000012 (0.000164)	-0.000023 (0.000135)	0.000331 (0.000192)
Per capita consumption	0.000002 (0.000001)***	0.000002 (0.0000005)***	0.000004 (0.000001)***
Pension and gratuity	0.000001 (0.000002)	0.0000001 (0.000002)	-0.000003 (0.000003)
Profit and interest	-0.000003 (0.000005)	-0.000004 (0.000004)	0.000004 (0.000007)
Constant	3.584634 (0.241822)***	4.011844 (0.194386)***	3.144426 (0.329031)***
Number of observations	931	799	1093

Notes: *** p<0.01, ** p<0.05, * p<0.10

5 The survey asked a specific question about the religion of individual members of the households. We regard the religion of the household the same as the religion of the head. For detailed description of how the variables have been constructed using the survey data see Chowdhury (2015).