

Abstract

Mobile phones have been widely adopted in developing countries with potential to enhance opportunities for employment and entrepreneur. Although the effects of mobile phones on income have been documented by many studies, the potential to increase income diversification has not been studied as much. To fill this gap, we investigate the link between mobile phone ownership, income diversification, and poverty reduction. We use nationally representative panel data and fixed-effect models to control confounding factors and unobserved heterogeneity. We find that mobile phone ownership increases income diversification, especially on-farm enterprises, off-farm enterprises, and non-earned income. This association is larger in less educated households and households in deprived areas. Furthermore, mobile phone ownership reduces poverty channeled through income diversification. Therefore, policies to improve access to mobile technologies could create resilient income portfolio by reducing transaction cost and improving market efficiency, which would subsequently alleviate poverty in rural areas.

Keywords: ICT, Mobile phones, Income diversification, Poverty reduction, Bangladesh

JEL code: C23, I32, Q12

1. Introduction

Mobile phones (MP) have been widely adopted in developing countries, contributing to economic development. Bangladesh, too, has experienced expansion of mobile phone subscription, which become almost 100% in 2019 while it was less than 50% in 2010 as shown in Figure A 1 (World Bank, 2023). Mobile technologies are believed to lead economic growth by driving productivity and efficiency gains in other sectors of the economy. For example, mobile phone ownership is positively associated with the likelihood of participating in some types of off-farm job through reduction of transaction cost (Rajkhowa & Qaim, 2022) and may generate income opportunities by helping job market participation, expanding social networks and reducing households' exposure to risks (Aker & Mbiti, 2010). It also improves smallholder farmers' productivity by supplying access to vital information on weather, cultivation techniques, and market prices (Sekabira & Qaim, 2017; GSM Association, 2021). Furthermore, mobile platforms lead to human capital development by enabling remote delivery of academic lessons, reading materials and diffusion of knowledge (Asongu & Nwachukwu, 2016; GSM Association, 2021). However, little is known whether mobile phone ownership increases income diversification, which is a possible economic channel to affect poverty and vulnerability (Yang et al., 2023). Given that the importance of mobile phone technologies has been acknowledged, understanding the link between mobile phone ownership, income diversification, and poverty reduction would provide important policy implications, especially for developing countries.

In this paper, first, we investigate whether mobile phone ownership increases income diversification, and contributes to monetary and non-monetary poverty reduction in the context of rural Bangladesh. Second, in addition to the average effect of mobile phone ownership, we investigate the heterogeneous effect of mobile phone ownership for several types of households, differentiating by educational level, geographical inequality, and gender. To achieve these goals,

1 we use a recently collected nationally representative panel dataset of Bangladeshi rural
2 households, spanning eight years and two data points from 2011 to 2019.

3 There is large literature looking at the relationship between mobile phone ownership and
4 household welfare. Many studies found that mobile phone ownership increases household
5 income (Asongu S., 2015; Ma et al., 2018; Miyajima, 2022; Munyegera & Matsumoto , 2016;
6 Rajkhowa & Qaim, 2022; Sekabira & Qaim, 2017). However, there is scant literature on the
7 effect of mobile phone on income diversification, to the best of our knowledge, only Leng, Ma ,
8 Tang, & Zhu, 2020; Ma et al., (2020); and Rajkhowa & Qaim (2022) examine the effects of
9 mobile phones or ICT adoption on income diversification or off-farm income. In addition, the
10 effect of mobile phone ownership on monetary and non-monetary poverty have been
11 documented but the mechanism through income diversification is not.

12 The contribution of this paper is threefold. First, we provide the first empirical micro-
13 econometric evidence on the effect of mobile phones on both income diversification and
14 poverty in the context of rural Bangladesh. Second, we use a new and nationally representative
15 panel household dataset that allows controlling for time-invariant unobserved heterogeneity at
16 the household level to generate robust evidence in South Asia setting. Third, we investigate the
17 heterogeneous impact of mobile phone ownership, in terms of human capital, geographical
18 inequality, and gender. To this end, we use interaction terms in models to find who benefits
19 more from owning mobile phones, thus providing more proper policy implications.

20 We find that mobile phone ownership accelerates income diversification as well as alleviates
21 monetary and non-monetary poverty. Mobile phone ownership is positively associated with
22 farm income, off-farm self-employment income, off-farm employment income and non-earned
23 income. Moreover, farm income, off-farm self-employment income, and non-earned income
24 contribute to poverty reduction, suggesting that the income diversification of rural households
25 through mobile phone ownership improves the overall welfare of the rural society. Furthermore,

1 heterogeneous analyses reveal that mobile phones are particularly beneficial for households
2 where the head has a low level of education and those located in relatively impoverished areas.

3 The rest of this article is organized as follows. Section 2 presents the data, key variables, and
4 empirical framework including the identification strategy and model specifications. Section 3
5 presents the empirical results and discussion. In Section 4, the results of robustness checks are
6 discussed while Section 5 concludes with policy implication and suggestions for future
7 research.

8 **2. Materials and methods**

9 **2.1 Data**

10 We use data from a nationally representative household panel survey conducted in 2011/12
11 and 2019 titled the Bangladesh Integrated Household Survey (BIHS) designed and supervised
12 by the International Food Policy Research Institute (IFPRI). The sample is a representative of
13 rural Bangladesh as well as of the seven division of the country (Islam et al., 2018; Ahmed &
14 Tauseef, 2022). The sample design of the BIHS follows a two staged stratified sampling.
15 Following the sampling strategy used in the community series of the 2001 Population and
16 Housing Census of Bangladesh, villages are identified as primary sampling units (PSUs) and
17 were randomly selected in the first stage. From each PSU, 20 households were selected at
18 random for the second stage (Ahmed & Tauseef, 2022). The original sample size in the 2011/12
19 wave is 6503 households in 325 PSUs allocated among seven divisions while the sample size
20 in the 2019 wave is 5604 households. For this study, we use the balanced subsample of rural
21 households included in both survey rounds, resulting in 7,636 observations from
22 3,818 households as shown in Table 1 and 2¹. Since our analysis uses panel data, our estimates

¹ Due to the attrition of the households and split households because of marriage etc. in round 3 of BIHS, the number of observations is decreased from the original sample size. We do not take into its households who are split into several households. We follow the original household head to create a balanced panel dataset.

1 would be biased if the attrition is related to some household characteristics. However, Ahmed
 2 & Tauseef (2022) shows that the attrition between 2011/12 and 2019 is random. Therefore, the
 3 estimates presented in this paper are not adjusted for attrition. Descriptive statistics of the whole
 4 sample are presented in Table 3.

5 Table 1 shows the number of households owning and not owning mobile phones in our
 6 sample. In 2011/12, about 23% households in our sample did not own a mobile phone which
 7 dropped to 2% in 2019 indicating wide adoption of mobile phone in rural Bangladesh over this
 8 period. With respect to poverty, the rate fell from 13% in 2011/12 to about 7% in 2019 in our
 9 sample as shown in Figure 1. The measurement of poverty rate is calculated by Foster-Greer-
 10 Thorbecke (FGT) class of poverty method, using the \$1.90 Purchasing Power Parity in 2011 per
 11 person per day. The detail explanation of the rate of the poverty headcount is described in the
 12 following sub-section 2.2. Considerable regional heterogeneity exists in the rate of poverty with
 13 Rangpur Division having the highest poverty rate compared to the other six divisions, which is
 14 consistent with Khandker (2012). In the subsection 0, we examine how much mobile phone
 15 ownership increased income resilience through diversification, especially in the poorest
 16 division, Rangpur.

17

18 Table 1 Number of households by mobile phone ownership

	2012	2019
Non-ownership	877 (23%)	58 (2%)
Ownership	2,941 (77%)	3,760 (98%)
Total	3,818	3,818

19 Note: Authors' calculations from BIHS 2011/12 and 2019.

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コメントの追加 [ST1]: I think before talking about regional variation, we should mentioned overall poverty

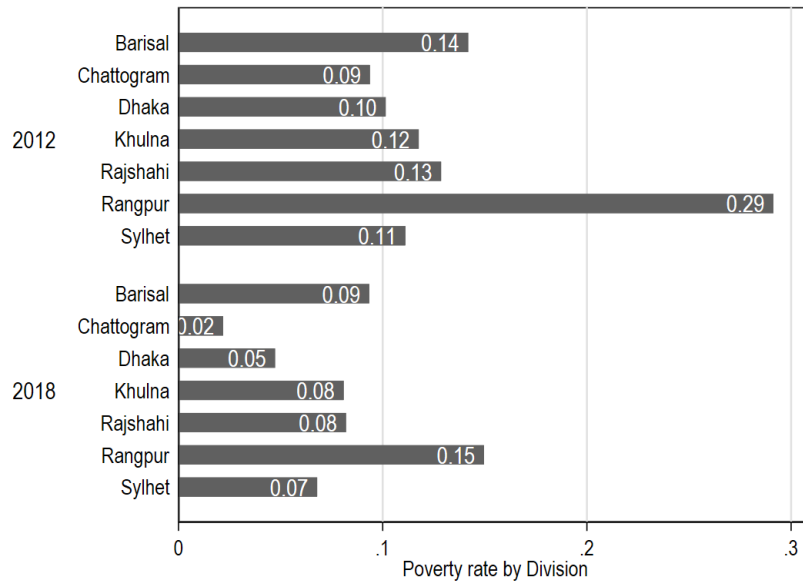


Figure 1 Poverty rate of Division by year

Note: Authors' calculations from BIHS 2011/12 and 2019. The poverty rate is estimated as stated in sub-section 2.2.

2.2 Measurement of key variables

Our main explanatory variable of interest is mobile phone ownership². We consider a household to be a mobile phone owner if at least one household member owns a mobile phone during a survey year. We construct a dummy variable of mobile phone ownership at the household level which is equal to 1 if household owns a mobile phone and 0 otherwise.

In terms of outcome variables, we are particularly interested in income diversification and measures of monetary and non-monetary poverty. Moreover, we introduce an income diversification index that is derived from the Simpson index usually used to indicate the degree of diversity (Asfaw et al., 2019; Matsuura, Luh, & Islam, 2023) as shown below:

² Due to the data availability, we cannot distinguish mobile phones with or without internet access. They include cellular phones and smartphones.

$$Simpson = 1 - \sum_{k=1}^n \left[\frac{s_k}{S} \right]^2$$

where s_k is income for income k , and S is total income. A highly diversified household has an index close to 1, while a fully specialized one has an index of 0. We divide 12-month income sources into farm income, farm wage, non-farm wage, non-farm self-employment, and non-earned income which includes remittance and social network program transfer, etc., following Khandker (2012). Table 2 shows the breakdown of each income source of households. It indicates that the share of non-farm income including non-farm wage, and non-farm self-employment is more than 50% of the total income of households. For monetary indicators of poverty, we use two measures from the [Foster-Greer-Thorbecke \(FGT\)](#) class of poverty indicators (Foster et al., 1984), namely the poverty headcount and poverty gap measure. Let $s = (s_1, s_2, \dots, s_n)$ be the income distribution among n households, where $s_i \geq 0$ is the income of the household i . The poverty line is denoted by z (\$1.90 per person per day). The household i is poor if $s_i < z$. The normalized deprivation of household i who is poor with respect to z is given by the relative shortfall from the poverty line:

$$d_i^\alpha = \left(\frac{z - s_i}{z} \right)^\alpha$$

where α is a parameter. When $\alpha = 0$, we get the incidence or headcount of poverty “Poverty headcount” since the normalized deprivation is always set equal to 1 for all the poor. When $\alpha = 1$, normalized deprivation reflects “Poverty gap” or “Depth of poverty”, with a higher value of d_i being assigned to poorer households. We used the US\$1.90/per person per day international poverty line, which is the standard for low-income countries (World Bank, 2020)³. The normalized deprivation score for the rich, i.e., those whose income weakly exceeds z , is set equal to 0 (Tauseef, 2022).

³ Bangladesh was a low-income country in 2011/12, when the first round survey was conducted.

1 To capture a more comprehensive view of household wellbeing, we further look at non-
2 monetary aspects of deprivation such as education, health, and living standards. We use the
3 Alkire and Foster (AF) counting approach to construct a multidimensional poverty index (MPI)
4 score which is similar to the global MPI published by the Oxford Poverty and Human
5 Development Initiative (OPHI) and adopted by the United Nations Development Program
6 (UNDP) (Alkire et al., 2018). The MPI score is calculated using three dimensions of welfare
7 which includes health, education, and living standards. The indicators used for health are the
8 nutrition status of the household members and dietary diversity in the household, for education,
9 years of schooling of household members and school attendance for school-aged children, and
10 for living standards, cooking fuel, sanitation, drinking water, electricity, housing condition, and
11 assets⁴. Table A 2 shows the description and dimensions of MPI score.

⁴ The dataset is available at <https://www.ifpri.org/blog/ifpris-bangladesh-integrated-household-survey-bihs-second-round-dataset-now-available>.

1 Table 2 Breakdown of household income

Income sources	2011/12					2019				
	MP ownership		Non-ownership		Diff	MP ownership		Non-ownership		Diff
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Farm self-income (taka)	23,955	89,814	12,730	34,032	***	44,765	368,607	13,252	35,186	
Farm wage (taka)	7,049	22,072	14,323	24,506	***	10,835	44,919	7,003	25,774	
Off-farm self-income (taka)	61,044	97,809	33,038	42,920	***	96,007	123,689	40,198	55,814	***
Off-farm wage (taka)	13,728	33,609	9,332	29,345	***	29,741	71,833	11,079	34,585	**
Non-earned (taka)	7,620	120,845	2,278	16,690		4,441	22,669	2,277	7,911	
Total household income (taka)	162,925	228,462	87,483	78,000	***	260,705	452,964	103,738	103,025	***

2 Source: BIHS 2011/12 and 2019.

3 Note: Calculation by authors based on a balanced panel. Taka is a nominal value and the currency of Bangladesh. Mean values are shown along
4 with standard deviations (SD). Diff is the results of t-tests on the equality of means of mobile phone ownership and non-ownership. *Significant
5 at the 10% level; **Significant at the 5% level; ***Significant at the 1% level.

2.3 Conceptual framework

Mobile phones have the potential to reduce transaction costs and improve communication with potential employers and business partners as well as provide better access to relevant market information (Leng, Ma , Tang, & Zhu, 2020; Rajkhowa & Qaim, 2022). As a result, households have more options to diversify their income sources, which reduces poverty and thus improves household welfare. The conceptual model is specified as follows:

$$W = f(D(MP, X), X; Z)$$

Where W is poverty status of households, D is decision of income diversification, M is the mobile phone ownership, X is the vector of covariates, and Z is the vector of unobserved characteristics. The impact of mobile phone ownership and income diversification are described as follows:

$$\frac{\partial f(D(MP, X), X; Z)}{\partial D} < 0 \quad (1)$$

Mobile phones are hypothesized to influence income diversification decisions, denoted by $D(MP, X)$, similar to Leng, Ma , Tang, & Zhu (2020) who show that ICT adoption enhances income diversification. In our conceptual framework, income diversification plays a role in “push” factors that reduce transaction cost at labor market and uncertainties of agricultural marketing (Leng, Ma , Tang, & Zhu, 2020). We thus hypothesize $\frac{\partial W}{\partial D} < 0$ in Equation (1). The conceptual framework is also depicted in Figure 2.

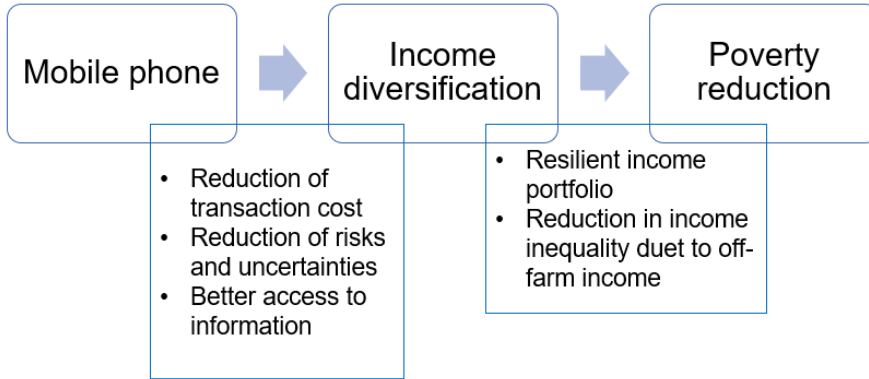


Figure 2 Conceptual framework

Source: Authors' design

2.4 Empirical strategy

2.4.1. Association among mobile phone ownership, income diversification, and poverty

Given the above preliminaries, we estimate the following panel data models to examine the effect of mobile phone ownership on income diversification and household poverty:

$$D_{it} = \beta_0 + \beta_1 MP_{it} + \beta_2 X_{it} + a_i + t_t + \varepsilon_{it} \quad (2)$$

$$Y_{it} = \gamma_0 + \gamma_1 MP_{it} + \gamma_2 X_{it} + a_i + t_t + \varepsilon_{it} \quad (3)$$

where D_{it} is the income diversification index (Simpson index) derived from each income source shown in Table 2; Y_{it} denotes our outcome variables, namely poverty headcount, depth of poverty, and MPI score which are estimated separately; X_{it} a vector of controls which includes household characteristics; a_i and t_t are household Fixed Effects (FE) and year FE, respectively; while ε_{it} is an error term. Both Equation (2) and (3) are estimated by OLS with Fixed Effects. We are particularly interested in the coefficients for mobile phone ownership i.e. the estimates for β_1 and γ_1 . For β_1 , a positive and statistically significant coefficient would imply that mobile phone ownership significantly accelerates income diversification, while negative γ_1 would imply that mobile phone ownership significantly reduces the monetary and

non-monetary poverty, after controlling for other factors included in the vector X_{it} . In the regression analysis, we do not differentiate between farm households and non-farm households, but we include a control farmland size, as this may influence the likelihood of employment opportunities (Rajkhowa & Qaim, 2022).

Moreover, mobile phones ownership can be negatively associated with poverty through various mechanisms, of which income diversification is a path. Mobile phone expansion is associated with farm incomes, off-farm income, and non-earned income (Aker & Ksoll, 2016; Fu & Akter, 2016; Rajkhowa & Qaim, 2022). To assess whether income diversification is a relevant mechanism and which income sources play an important role, we additionally estimate the following model:

$$Y_{it} = \theta_0 + \theta_1 MP_{it} + \theta_2 D_{it} + \theta_3 X_{it} + a_i + t_t + \varepsilon_{it} \quad (4)$$

In this regression, θ_2 should be negative and statistically significant when D_{it} is the income diversification index, which would imply that income diversification reduces monetary and non-monetary poverty. Comparing the estimates in Equation (3) and (4), $|\theta_1| < |\gamma_1|$ would support our hypothesis, which mobile phones are negatively associated with monetary and non-monetary poverty at least partly through the income diversification mechanism.

The main variable of interest, mobile phone ownership, is itself a decision variable. Hence, it may be correlated with the error term in the outcome equation because of possible self-selection into mobile phone ownership. Rural households can decide the adoption of mobile phones on their own, thus, unobserved factors and attributes would affect their decision making. Systematic differences among households might affect their decision, such as socioeconomic and demographic factors. Given these conditions, the fixed effects estimator is a better choice because it controls time-invariant unobserved heterogeneity (Cameron & Trivedi, 2005)⁵.

⁵ To address the unobserved time-variant characteristics, instrumental variable (IV) approach can be used. However, the use of IV requires that IV affects an endogenous variable but do not affect outcome variables (Angrist et al., 1996). Based on economic literature on the important role of peer effect in the decision to

1 We do not consider reverse causality to be a major issue in our context, as mobile phones
2 are nowadays used widely even among the very poor households in rural Bangladesh, including
3 households with and without income diversification and poverty status (Rajkhowa & Qaim,
4 2022). However, there is another concern about dynamic causal relationships between past
5 treatment and current outcome (Imai & Kim, 2019). There are two important identification
6 assumptions of fixed effects model – past treatments do not directly affect current outcome,
7 and past outcomes do not influence current treatment (Imai & Kim, 2019). Imai & Kim (2019)
8 suggests that lagged outcomes can be included in an outcome equation to address the
9 correlation between past outcomes and current treatment. Unfortunately, since we use only two
10 rounds of data, we cannot follow the reasonable test. We emphasize that our interpretation of
11 the empirical results are associations rather than causality.

12 In robustness checks, we employ a doubly robust (DR) method and Propensity Score
13 Matching combined with Difference in Difference (PSM-DID) to further reduce potential bias
14 due to time-varying differences between adopters and non-adopters of mobile phones. One
15 potential source of endogeneity that neither the FE estimator, the DR, nor the PSM-DID can
16 control is reverse causality⁶.

17 **2.4.2. Heterogeneous associations**

18 The association between mobile phone ownership and income diversification may vary
19 depending on household characteristics. Aside from the average association evaluated with
20 Equation (1), we also analyze heterogeneous associations with respect to some household

adopt mobile phone, the instrumental variable used in some studies is the share of household owning mobile phones within a local community (Ma et al. 2020; Zheng, Zhou, & Rahut 2022). However, our falsification test cannot reject the null hypothesis of the exclusion restriction of the social network IV in Table A 1, violating the important condition for instrument validity. Hence, we do not use IV approach in this paper.

⁶ We conduct the PSM-DiD as follows. First, we match the observations from sub-samples of the two groups “obtained phones between the two waves” and “never own phones”. In this matching, we assume common support, which there is enough similarity between the traits of treated and untreated units to establish suitable matches. After matching, we estimate an ordinary difference in differences so that we can account for unobserved time-invariant characteristics and observed characteristics.

characteristics, namely, education of household head, location of residence, gender of household head, and distance to the nearest town. We estimate heterogeneous associations using a FE model as follows:

$$D_{it} = \eta_o + \eta_1 MP_{it} + \eta_2 X_{it} + \eta_3 MP_{it} \times H_{it} + a_i + t_t + \varepsilon_{it} \quad (5)$$

where H_{it} is one of the household characteristics mentioned which is interacted with M_{it} (note that H_{it} is also included in X_{it}). The other variables are defined as before. We estimate separate models for each household characteristic of interest with a particular focus on the interaction term estimate η_3 .

3. Results and discussion

3.1 Descriptive statistics

Table 3 shows the mean comparison of the outcome variables between households who own a mobile phone and those who do not as well as test on the statistical significance of the difference in mean between mobile phone owners and non-owners. We find that mobile phone owners are more likely to diversify income sources, have higher total household income as well as higher per capita income than non-owners. These observed differences are consistent with Sekabira & Qaim (2017) and Rajkhowa & Qaim (2022). Furthermore, the incidence of poverty of households owning mobile phones is lower than households not owning mobile phones. At the same time, the poverty gap and MPI score of households not owning mobile phones are worse than mobile phone owners. The results are reasonable that non-poverty households can afford to own mobile phones and utilize them.

Moreover, Table 3 presents descriptive statistics for the socioeconomic characteristics that we use as control variables in the econometric models, differentiating between mobile phone users and non-users. In most of the variables, we observe significant differences. Mobile phone owners are likely to be male, younger, have more family members, with better educated household head. Furthermore, households who own mobile phones have larger farmland than

1 households not owning mobile phones. The detailed description of the variables is provided in
2 Table A 3. The covariates are chosen based on relevant literature such as Leng, Ma , Tang, &
3 Zhu (2020); Rajkhowa & Qaim (2022); Fowowe (2023); Amber & Chichaibelu (2023).

1

Table 3 Summary statistics by MP ownership

Outcome Variables	2011/12					2019				
	MP ownership		Non-ownership			MP ownership		Non-ownership		
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Income diversification	0.444	0.273	0.408	0.268	***	0.407	0.261	0.278	0.267	***
Poverty headcount	8.637	28.095	26.910	44.374	***	6.702	25.009	6.897	25.561	
Depth of poverty	1.316	5.505	4.979	10.686	***	0.867	4.242	0.831	4.575	
MPI score	38.131	17.486	55.118	16.342	***	27.326	15.293	40.310	13.118	***
Socioeconomic variables										
Female household head	0.154	0.361	0.141	0.349	***	0.182	0.386	0.483	0.504	***
Age of HH	44.200	13.267	43.926	13.539	***	47.566	12.847	55.5	13.6937	***
Household size	4.523	1.669	4.011	1.490	***	5.672	2.157	4.759	1.967	***
Schooling year of HH	3.917	4.089	1.725	2.941	***	3.787	4.076	1.276	2.441	***
Farm Size	116.497	169.791	65.269	104.016	***	104.142	143.890	71.836	116.991	*
Livestock ownership	0.929	0.256	0.921	0.269		0.246	0.431	0.172	0.381	
Access to the nearest town	25.624	15.105	25.407	14.713		26.167	14.748	25.483	14.571	

2

Note: Authors' calculations from BIHS 2011/12 and 2019. Mean values are shown along with standard deviations (SD). Diff is the results of t-

3

tests on the equality of means of mobile phone ownership and non-ownership. *Significant at the 10% level; **Significant at the 5% level; ***

4

Significant at the 1% level. 100 decimals are equal to 0.4 ha. Table A 3 provides the description of the variables.

3.2 Association between mobile phone ownership and income diversification

Table 4 shows the regression results of Equation (2) from Section 2.4.1. First, we find that mobile phone ownership is positively and significantly associated with income diversification in Column (1). Ownership of mobile phone is associated with a 3.1% higher probability of income diversification⁷. It indicates that mobile phone ownership enriches the income portfolio of rural households for building livelihood resilience.

As Column (1) shows that mobile phone ownership increase income diversification, we further decompose the relationship between mobile phone ownership and income diversification with five income sources. Column (2) shows that mobile phone ownership increases income of those in farm self-employment, i.e. income from agricultural production, while it decreases income from on-farms employment in Column (3). The result is similar to Jensen (2007). In general, non-farm sectors offer ~~relatively and~~ relatively stable wages than on-farm employment does. The plausible explanation is that rural people are more likely to have off-farm employment rather than on-farm employment, due to the better access to labor market information through using mobile phones. Furthermore, Column (4) and (5) show that mobile phone ownership increases off-farm income by both employment and self-employment. This is consistent with the findings of Rajkhowa & Qaim (2022). Non-earned income is also positively and significantly associated with mobile phone ownership. It indicates that mobile phone ownership increases non-earned income. The possible explanation is that mobile phone expansion enables households to receive non-earned income easily (Lee, Morduch, Ravindran, Shonchoy, & Zaman, 2021).

To summarize, mobile phone ownership generally enhances income diversification. Specifically, it increases income from on-farm self-employment, off-farm self-employment,

⁷ In Table 4, we use year-division interaction terms to control for possible unequal regional developments over time.

1 off-farm employment, and non-earned. We hypothesize that the increase in such sources of
2 income would reduce poverty, and test this hypothesis in the following section.

1

Table 4 Association between MP ownership and income diversification

	(1)	(2)	(3)	(4)	(5)	(6)
	Income diversification	<i>Income source</i>				
		Farm self	Farm wage	Off-farm self	Off-farm wage	Non-earned
MP ownership	0.031** (0.013)	0.343* (0.204)	-0.505** (0.199)	0.433*** (0.159)	0.729*** (0.207)	0.628*** (0.210)
Female household head	-0.152*** (0.016)	-1.165*** (0.258)	-1.572*** (0.199)	-2.832*** (0.227)	-1.645*** (0.267)	3.969*** (0.270)
Age of HH	0.001 (0.001)	0.025*** (0.009)	-0.018** (0.008)	0.014* (0.008)	-0.003 (0.010)	0.039*** (0.011)
Household size	0.007** (0.004)	-0.107* (0.062)	0.013 (0.049)	0.103** (0.049)	0.107 (0.071)	-0.133* (0.070)
Schooling year of HH	0.001 (0.003)	0.024 (0.048)	-0.087** (0.035)	-0.011 (0.039)	-0.010 (0.047)	0.051 (0.047)
Farm size	0.000*** (0.000)	0.010*** (0.001)	-0.003*** (0.001)	0.005*** (0.001)	-0.001 (0.001)	0.002** (0.001)
Livestock ownership	0.035*** (0.010)	0.750*** (0.181)	-0.333** (0.148)	0.785*** (0.119)	0.090 (0.178)	0.193 (0.194)
Access to nearest town	-0.000 (0.000)	0.005 (0.004)	0.012*** (0.004)	-0.002 (0.003)	-0.000 (0.004)	-0.001 (0.005)
Household FE	No	No	No	No	No	No
Year × Division FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,582	7,636	7,636	7,636	7,636	7,636

2 Note: *Significant at the 10% level; **Significant at the 5% level; ***Significant at the 1% level. Outcome variables in Columns (2) to (6) are
3 logarithm of income. Standard errors are clustered by households in parenthesis. Because if all the income sources are 0, the index cannot be
4 calculated, resulting in missing values of the income diversification index in Column (1).

コメントの追加 [TS(BC2): Why is this lower than 7636?
We have information on income for 7636 so index should be
for 7636?

3.3 Association between mobile phone ownership and household poverty

Table 5 presents the association between mobile phone ownership and poverty, estimated using a FE model to account for the endogeneity of mobile phone ownership. Mobile phone ownership decreases the prevalence of poverty as depicted by the statistically significant negative coefficient presented in Column (1). The probability of being poor decreased by 8.3% as a result of mobile phone ownership. The poverty reduction effect of mobile phone adoption is consistent with Asongu (2015). Moreover, Column (2) shows that mobile phone ownership reduces the depth of poverty as seen by the statistically significant negative impact on the poverty gap measure which decreased about 2.0% as seen in Column (3). The magnitude of the coefficients are similar to those in Beuermann et al., (2012) for Peru. Furthermore, mobile phone ownership has an impact on non-monetary aspects of poverty, reducing the multidimensional poverty score by 7.9% as seen in Column (4). The results, thus, indicate that adoption of mobile phones not only contributes to reduction in the monetary poverty but has a holistic impact on the non-monetary dimensions of poverty as well.

These significant associations may be channelled through higher resilience of household income due diversification of income sources. Table 6 shows the results of the channel analysis by additionally controlling for the income diversification index in Panel A and each income source in Panel B. The first important result is that income diversification itself has a negative association with poverty headcount in Column (1) while coefficients of income diversification in Column (2) and (3) are insignificant. It indicates that income diversification reduces the probability of being poor. Moreover, an absolute value of the coefficient of mobile phone ownership in Column (1), which is $|\theta_1|$ in Equation (4), is smaller than the one in Column (1) of Table 5, which is $|\gamma_1|$ in Equation (3). The results confirm that mobile phone ownership is negatively associated with monetary poverty, at least partly through the income diversification mechanism, as hypothesized. Our results are consistent with the findings on welfare enhancing

1 effects of mobile phones by Munyegera and Matsumoto (2016); Sekabira and Qaim (2017);
2 Ma et al., (2018); Rajkhowa and Qaim (2022); and Miyajima (2022).

3 Furthermore, we investigate which income sources contribute to poverty reduction rather
4 than just income diversification. In Column (4), income from on-farm self employment, off-
5 farm self employment, and non-earned income are negatively associated with poverty
6 headcount, indicating that they reduce the incidence of poverty. In Column (5), income from
7 on-farm self employment and non-earned income are negatively associated with depth of
8 poverty while off-farm self employment is significantly associated with MPI. The results
9 confirm that a more diversified income source for households such as those from onb-farm self
10 employment, off-farm self employment,and non-earned income are beneficial for households
11 with respect to poverty reduction.

1	Table 5 Association between MP ownership and poverty (FE model)			
		(1)	(2)	(3)
		Poverty Headcount	Depth of poverty	MPI score
	MP ownership	-8.325*** (1.773)	-1.962*** (0.365)	-5.782*** (0.639)
	Female household head	3.595** (1.808)	0.727* (0.404)	0.394 (0.813)
	Age of HH	-0.009 (0.065)	-0.000 (0.016)	0.059* (0.032)
	Household size	3.424*** (0.441)	0.490*** (0.087)	1.061*** (0.204)
	Schooling year of HH	-0.416 (0.260)	-0.050 (0.062)	-0.350** (0.149)
	Farm size	-0.012*** (0.004)	-0.002*** (0.001)	-0.004 (0.003)
	Livestock ownership	-0.211 (1.208)	-0.081 (0.225)	-1.421*** (0.539)
	Access to the nearest town	0.025 (0.029)	0.004 (0.006)	-0.024* (0.014)
	Household FE	Yes	Yes	Yes
	Year × Division FE	Yes	Yes	Yes
	Observations	7,636	7,636	6,972
2	Note: *Significant at the 10% level; **Significant at the 5% level; ***Significant at the 1%			
3	level. Robust standard errors clustered by households in parenthesis.			

1
2 Table 6 Possible mechanisms underlying the effects of MP ownership on poverty (FE model)

	(1)	(2)	(3)
Panel A	Poverty Headcount	Depth of poverty	MPI score
Income diversification index	-4.077** (2.024)	-0.535 (0.422)	-0.689 (0.908)
MP ownership	-8.219*** (1.775)	-1.936*** (0.367)	-5.708*** (0.642)
Household l FE	Yes	Yes	Yes
Year × Division FE	Yes	Yes	Yes
Control variables	Yes	Yes	Yes
Observations	7,582	7,582	6,918
	(4)	(5)	(6)
Panel B	Poverty Headcount	Depth of poverty	MPI score
Farm self	-0.204* (0.110)	-0.038* (0.022)	-0.037 (0.052)
Farm wage	0.472*** (0.169)	0.080** (0.034)	0.084 (0.066)
Off-farm self	-0.431** (0.167)	-0.029 (0.037)	-0.217*** (0.073)
Off-farm wage	-0.068 (0.124)	-0.004 (0.025)	-0.071 (0.055)
Non-earned	-0.266*** (0.093)	-0.047*** (0.018)	-0.030 (0.047)
MP ownership	-7.613*** (1.763)	-1.864*** (0.367)	-5.578*** (0.642)
Household FE	Yes	Yes	Yes
Year × Division FE	Yes	Yes	Yes
Control variables	Yes	Yes	Yes
Observations	7,636	7,636	6,972

3 Note: *Significant at the 10% level; **Significant at the 5% level; ***Significant at the 1%
4 level. Robust standard errors clustered by households in parenthesis. Control variables used in
5 regression models are gender of household head, age of household head, household size,
6 schooling year of household head, farm size, livestock ownership, access to the nearest town.
7 A full regression table is available in Table A 4 and Table A 5.
8

3.4. Who benefits more from mobile phones?

In this section, we disentangle the relationships between mobile phone ownership and the outcome variables by certain household characteristics to explore whether there are any heterogeneous effects with respect to these characteristics. Using the models detailed in Equation (4) above, we interact mobile phone ownership with education of household head, place of residence, gender of household head, and access to the nearest town.

The results summarized in Table 7 show the estimated coefficients on the interaction between the household characteristics and mobile phone ownership. In Column (1), the coefficient of the interaction term for income diversification is negatively significant. It indicates that less educated households are more likely to engage in income diversification when the households own mobile phones. This is an insightful result that mobile phone ownership can enhance income diversification which improves livelihood, especially for less educated households.

Moreover, we find that households living in Rangpur Division, which is the poorest Division in Bangladesh (see Figure 1), benefit more from mobile phones than households in other Divisions as shown in Column (2). This highlights the potential of mobile phones in reducing geographical inequality and having a pro-poor effect. It is, therefore, an important finding from a social development perspective.

The coefficient for the interaction term between mobile phone ownership and female household head in Column (3) is insignificant. Moreover, in Column (4), we look at the role of access to the nearest town, as it may be an alternative to mobile phones for accessing information on job opportunities. Note that a longer time to a town indicates worse access to information. Contrary to our expectation, the coefficient of the interaction term between the distance and mobile phone ownership is insignificant.

1 **Table 7 Heterogeneous associations based on various household characteristics**
2 **(summary results)**

	(1) Income diversification	(2) Income diversification	(3) Income diversification	(4) Income diversification
MP ownership	0.052*** (0.014)	0.017 (0.014)	0.033** (0.014)	0.042* (0.023)
Schooling year of HH × MP ownership	-0.013*** (0.004)			
Rangpur Division × MP ownership		0.109*** (0.037)		
Female of HH × MP ownership			-0.015 (0.032)	
Access to the nearest town × MP ownership				-0.000 (0.001)
Household FE	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Year × Division FE	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Control variables	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Observations	7,582	7,582	7,582	7,582

3 Note: *Significant at the 10% level; **Significant at the 5% level; ***Significant at the 1%
4 level. Robust standard errors clustered by household in parenthesis. Control variables used in
5 regression models are gender of household head, age of household head, household size,
6 schooling year of household head, farm size, livestock ownership, access to the nearest town.
7 The full regression table is in Table A 6.
8

4. Robustness check

In this section, we carry out robustness checks to examine whether the results vary when we use different estimation methods. Specifically, we employ the doubly robust (DR) and Propensity Score Matching combined with Difference in Difference (PSM-DID) method instead of the household FE model to estimate the robustness of the association between mobile phone ownership, income diversification, and poverty. The DR method, or more precisely, an inverse-probability weighted regression with adjustment of covariates, combines the regression and propensity score weighting. It is more robust than the PSM estimator and the inverse-probability-weighting estimator (Mano et al., 2022). Furthermore, the PSM-DID overcomes limitations of PSM using cross-sectional data, which are systematic differences between mobile phone owners and non-owners even after controlling on household's observed characteristics (Imai & Azam, 2012). Estimates from DR in Table A 7 and PSM-DID in Table A 8 show similar results to those in Table 4 and Table 5, but the association between mobile phone ownership and income diversification index is statistically insignificant in Table A 8. It indicates that mobile phone ownership enhances off-farm income, farm self-employment income, and non-earned income but reduces on-farm wage income. Because the Simpson diversification index measures evenness of each income source, the result implies that mobile phones ownership improves not evenness of income sources, but portfolio of income sources for resilient livelihood. Overall, it underlines the robustness of our main results.

5. Conclusion and policy implication

Mobile phones have rapidly spread in the developing countries, and the trend is also observed in rural Bangladesh. While previous studies have analyzed effects of mobile phone ownership on economic indicators – such as input and output prices, profits, and income – research on implications for broader social development is scarce. Better understanding the social welfare effects is of particular importance against the backdrop of the United Nations'

1 Sustainable Development Goals (SDGs). This study uses a nationally representative panel
2 dataset, spanning eight years of rural households in Bangladesh to analyze average and
3 heterogeneous effects of mobile phone ownership on income diversification, poverty
4 headcount, depth of poverty, and a multidimensional poverty index (MPI).

5 Our results indicate that mobile phone ownership has a positive and significant association
6 with income diversification. At the same time, it reduces the incidence and depth of poverty as
7 well as non-monetary poverty as measured by the MPI. The channel analysis confirms that
8 mobile phones are significantly associated with poverty reduction through income
9 diversification, decomposing the diversification into on-farm self-employment, off-farm self-
10 employment, and non-earned income. Furthermore, our findings show that less educated
11 households and households living in impoverished areas benefit over-proportionally from
12 mobile phones, which are encouraging findings to accelerate income diversification for poverty
13 reduction.

14 This study, thus, sheds new light on the importance of access to mobile technologies for the
15 masses. We find that that mobile phones can increase opportunities, and generate income
16 sources for less educated households and households living in poorer areas. Access to mobile
17 technologies and networks for all households, even those in rural areas, can lower transaction
18 costs and boost the effectiveness of the labor market. It would make up for the disadvantage of
19 low human capital accumulation and geographical inequality.

20 The results from this study should not be widely generalized and need more rigorous
21 estimation methods such as randomized controlled trials or other causal inference strategies,
22 but the rural households surveyed in rural Bangladesh are quite typical for the South Asian
23 rural settings. Despite the setting of this study, some valuable lessons can be held for rural
24 development in the digital age. Follow-up studies in other settings and with longer panel data

- 1 and methodologies will surely be needed to corroborate our findings on rural development in
- 2 the digital age.

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1 **Appendix tables**

2 Table A 1 Test on the validity of the instruments

	(1)	(2)	(3)	(4)	(5)
	MP ownership	Income diversification	Poverty Headcount	Depth of poverty	MPI score
Share of households adopting mobile phone in the village	0.458*** (0.047)	-0.099* (0.059)	-11.842 (8.631)	-3.866* (2.024)	-10.918*** (3.573)
Year × Division FE	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Control variables	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Observations	7,636	926	935	935	920

3 Note: *Significant at the 10% level; **Significant at the 5% level; ***Significant at the 1% level. Parameters for all the other variables are not
4 reported. The full table is available ~~upon~~upon requests. Control variables used in regression models are gender of household head, age of household
5 head, household size, schooling year of household head, farm size, livestock ownership, access to the nearest town. The full table is available upon
6 request.

1 Table A 2 Dimensions, indicators, deprivation cut-offs and weights of the MPI

Dimensions of poverty	MPI indicator	Deprived if...	Weight
Health	Nutrition	Any person below the age of 70 is undernourished+	1/6
	Dietary diversity	Dietary diversity score++ is less than 42	1/6
Education	Years of schooling	No household member aged ten years or older has completed six years of schooling	1/6
	School attendance	Any school-aged child is not attending school up to the age at which he/she would complete class 8	1/6
Living standards	Cooking fuel	The household cooks with dung, wood, or charcoal	1/18
	Sanitation	The household's sanitation facility is not improved (according to SDG guidelines) or it is improved but shared with other households*	1/18
	Drinking water	The household does not have access to improved drinking water (according to SDG guidelines) **	1/18
	Electricity	The household has no electricity	1/18
	Housing condition	The household has inadequate housing: the floor is of natural materials, or the roof or wall are of rudimentary materials***	1/18
	Assets	The household does not own more than one of these assets: radio, TV, telephone, computer, animal cart, bicycle, motorbike, or refrigerator, and does not own a car or truck	1/18

2 Source: Adopted from Tauseef (2022).

3 Notes: Adults 20 to 70 years are considered malnourished if their Body Mass Index (BMI) is below 18.5 m/kg². Those aged five to 20 are identified as
4 malnourished if their age-specific BMI cut-off is below minus two standard deviations. Children under five years are considered malnourished if their z-score
5 of either height-for-age (stunting) or weight-for-age (underweight) is below minus two standard deviations from the median of the World Health Organization
6 2006 reference population. ++ Measured using the food consumption score (FCS). The FCS is calculated as a weighted summation (out of 112) of the number
7 of days a household has consumed a food group (staples, pulses, vegetables, fruits, meat/fish, milk, sugar, and oil) in the past seven days, where the weights
8 reflect the differential nutritional benefit of each food group. * A household is considered to have access to improved sanitation if it has some type of flush toilet
9 or latrine, or ventilated improved pit or composting toilet, provided that this is not shared. ** A household has access to clean drinking water if the water source
10 is any of the following types: piped water, public tap, borehole, or pump, protected well, protected spring or rainwater purified before consumption. *** Deprived
11 if the floor is made of mud/clay/earth, sand or dung; or if the dwelling has no roof or walls or if either the roof or walls are constructed using natural materials
12 such as cane, palm/trunks, sod/mud, dirt, grass/reeds, thatch, bamboo, sticks, or rudimentary materials such as carton, plastic/ polythene sheeting, bamboo with
13 mud/stone with mud, loosely packed stones, uncovered adobe, raw/reused wood, plywood, cardboard, unburnt brick or canvas/tent.

1 Table A 3 Description of variables used in this study.

Variables	Description of variables
Outcome Variables	
Income diversification	Measured by income diversification index from 0 to 1
Farm self-income	Income from running farm (Taka)
Farm wage	Income from on-farm employment (Taka)
Off-farm self-income	Income from off-farm self-employment (Taka)
Off-farm wage	Income from off-farm employment (Taka)
Non-earned income	Income by neither employment nor self-employment such as social protection, remittance, and pension (Taka)
Poverty headcount	100 if household is poor, 0 otherwise
Depth of poverty	Measures poverty gap and takes 0 to 100
Multidimensional poverty index (MPI) score	Measures multidimensional poverty and takes 0 to 100
Socioeconomic variables	
Female household head	1 if household head is female, 0 otherwise
Age of household head	Age of household head
Household size	Number of household member
Years of schooling of household head	Years that household head attend a school
Farm size	Farm size that household owns (in decimals)
Livestock ownership	1 if household owns livestock, 0 otherwise
Access to the nearest town	Time to the nearest town from homestead (minute)

2 Note: 100 decimal is equivalent to 0.4 ha

1 Table A 4 Possible mechanisms underlying the effects of MP ownership and income
2 diversification on poverty (FE-models)

	(1) Poverty Headcount	(2) Depth of poverty	(3) MPI score
Income diversification index	-4.077** (2.024)	-0.535 (0.422)	-0.689 (0.908)
MP ownership	-8.219*** (1.775)	-1.936*** (0.367)	-5.708*** (0.642)
Female household head	3.069* (1.860)	0.686 (0.417)	0.385 (0.838)
Age of HH	-0.002 (0.066)	-0.001 (0.016)	0.056* (0.032)
Household size	3.463*** (0.443)	0.495*** (0.088)	1.081*** (0.204)
Schooling year of HH	-0.447* (0.260)	-0.057 (0.062)	-0.349** (0.150)
Farm size	-0.011** (0.005)	-0.002** (0.001)	-0.004 (0.003)
Livestock ownership	-0.108 (1.212)	-0.081 (0.225)	-1.394** (0.542)
Access to the nearest town	0.024 (0.029)	0.004 (0.006)	-0.025* (0.014)
Household FE	Yes	Yes	Yes
Year × Division FE	Yes	Yes	Yes
Observations	7,582	7,582	6,918

3 Note: *Significant at the 10% level; **Significant at the 5% level; ***Significant at the 1%
4 level. Robust standard errors clustered by households in parenthesis.

1 Table A 5 Possible mechanisms underlying the effects of MP ownership and income sources
2 on poverty (FE-models)

	(1) Poverty Headcount	(2) Depth of poverty	(3) MPI score
Farm self	-0.204* (0.110)	-0.038* (0.022)	-0.037 (0.052)
Farm wage	0.472*** (0.169)	0.080** (0.034)	0.084 (0.066)
Off-farm self	-0.431** (0.167)	-0.029 (0.037)	-0.217*** (0.073)
Off-farm wage and salary	-0.068 (0.124)	-0.004 (0.025)	-0.071 (0.055)
Non-earned	-0.266*** (0.093)	-0.047*** (0.018)	-0.030 (0.047)
MP ownership	-7.613*** (1.763)	-1.864*** (0.367)	-5.578*** (0.642)
Female household head	3.822** (1.911)	0.904** (0.420)	-0.153 (0.863)
Age of HH	0.021 (0.065)	0.004 (0.016)	0.064** (0.032)
Household size	3.413*** (0.439)	0.483*** (0.087)	1.096*** (0.204)
Schooling year of HH	-0.362 (0.264)	-0.040 (0.062)	-0.343** (0.149)
Farm size	-0.006 (0.005)	-0.002* (0.001)	-0.002 (0.003)
Livestock ownership	0.494 (1.205)	0.007 (0.226)	-1.174** (0.543)
Access to the nearest town	0.019 (0.029)	0.004 (0.006)	-0.025* (0.014)
Household FE	Yes	Yes	Yes
Year × Division FE	Yes	Yes	Yes
Observations	7,636	7,636	6,972

3 Note: *Significant at the 10% level; **Significant at the 5% level; ***Significant at the 1% level.
4 Robust standard errors clustered by households in parenthesis.

1 Table A 6 Heterogeneous associations based on various household characteristics (FE-models)

	(1)	(2)	(3)	(4)
	Income diversification	Income diversification	Income diversification	Income diversification
MP ownership	0.052*** (0.014)	0.017 (0.014)	0.033** (0.014)	0.042* (0.023)
Schooling year of HH × MP ownership	-0.013*** (0.004)			
Rangpur Division × MP ownership		0.109*** (0.037)		
Female of HH × MP ownership			-0.015 (0.032)	
Access to the nearest town × MP ownership				-0.000 (0.001)
Female household head (=1)	-0.152*** (0.016)	-0.152*** (0.016)	-0.139*** (0.032)	-0.152*** (0.016)
Age of HH	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)
Household size	0.007** (0.004)	0.007** (0.004)	0.007** (0.004)	0.007** (0.004)
Schooling year of HH	0.013*** (0.004)	0.001 (0.003)	0.001 (0.003)	0.001 (0.003)
Farm size	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
Livestock ownership	0.034*** (0.010)	0.036*** (0.010)	0.035*** (0.010)	0.035*** (0.010)
Access to the nearest town	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	0.000 (0.001)
Household FE	Yes	Yes	Yes	Yes
Year × Division FE	Yes	Yes	Yes	Yes
Observations	7,582	7,582	7,582	7,582

1 Note: *Significant at the 10% level; **Significant at the 5% level; ***Significant at the 1% level. Robust standard errors clustered by households in
2 parenthesis.

1 Table A 7 Mobile phone ownership, income diversification, and poverty (Doubly robust estimator)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Income diversification	Farm self	Farm wage	Off-farm self	Off-farm wage	Non-earned	Poverty headcount	Depth of poverty	MPI
ATE									
MP ownership	0.054*** (0.018)	0.376 (0.254)	-0.645** (0.253)	0.898*** (0.247)	0.702*** (0.200)	0.934*** (0.275)	-6.991*** (1.558)	-1.520*** (0.384)	-11.012*** (0.862)
Controls	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Year × Division FE	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Observations	7,608	6,795	6,795	6,795	6,795	6,795	7,635	7,635	7,302

2 Note: *Significant at the 10% level; **Significant at the 5% level; ***Significant at the 1% level. Robust standard errors clustered by households in parenthesis. Control
3 variables used in regression models are gender of household head, age of household head, household size, schooling year of household head, farm size, livestock ownership,
4 distance to the nearest town. Outcome variables in Columns (2) to (6) are logarithm of income.

1 Table A 8 Mobile phone ownership, income diversification, and poverty (PSM-DID)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Income diversificatio n	Farm self	Farm wage	Off-farm self	Off-farm wage	Non-earned	Poverty Headcount	Depth of poverty	MPI score
DID (MP ownership×2019)	-0.057 (0.039)	1.158* (0.593)	-0.897 (0.557)	0.594 (0.487)	1.933*** (0.731)	3.288*** (0.627)	-21.798*** (5.530)	-5.314*** (1.293)	-25.449*** (1.906)
Controls	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Household FE	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Year × Division FE	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Observations	1548	1562	1562	1562	1562	1562	1562	1562	1492

2 Note: *Significant at the 10% level; **Significant at the 5% level; ***Significant at the 1% level. Robust standard errors clustered by households in parenthesis. Control
3 variables used in regression models are gender of household head, age of household head, household size, schooling year of household head, farm size, livestock
4 ownership, distance to the nearest town. Outcome variables in Columns (2) to (6) are logarithm of income. A common support condition is imposed by dropping
5 treatment observations whose propensity score is higher than the maximum or less than the minimum propensity score of the controls.

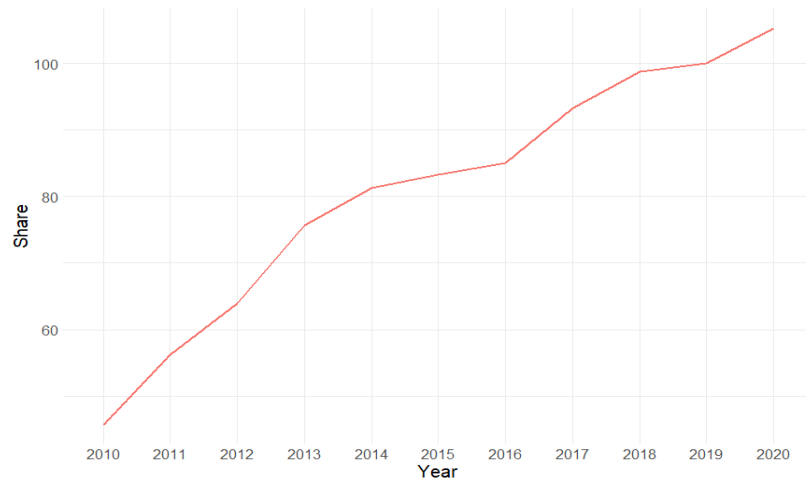


Figure A 1 Expansion of Mobile phone subscription in Bangladesh last 10 years

Source: World Bank (2023)

Note: Mobile cellular subscriptions (per 100 people)