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Agriculture, Electrification and Gendered Time Use in Rural Bangladesh

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Abstract

We study the linkages between electrification, activity participation and time use of individuals in rural Bangladesh. We find that households' access to grid electricity positively correlates with the likelihood of males participating in non-farm work and females participating in agriculture. In electrified households, females reallocate time from domestic work and caregiving to more leisure and farming. Household access to electricity is positively associated with greater ownership of appliances like fans, refrigerators, televisions, and mobile phones. Moreover, we observe a greater likelihood of electrified households irrigating via electrical pumps and using female family labor on their farms. Electrification is also positively associated with women's involvement in decisions regarding farm-related activities and household expenses. The findings suggest that in farming communities, agriculture may play a critical role in the link between rural electrification, women's workforce participation, and household bargaining power.

Keywords: Electrification, agriculture, time use, gender, labor, Bangladesh
JEL Classification: H41, J16, J22, O13

1 Introduction

Women bear a disproportionate share of unpaid work globally (Addati et al., 2018). While such specialization may possibly be an artifact of rational time allocation based on comparative advantage, human capital, and market wages; factors such as gender norms also determine participation and time use in different activities (Becker, 1993; Fafchamps and Quisumbing, 2003; Eswaran et al., 2013). In developing countries, however, women may also devote more time to unpaid work due to energy poverty which impedes the use of time-saving technologies (Köhlin et al., 2012; Feenstra and Özerol, 2021). Therefore, interventions designed to reduce energy poverty can have the additional benefit of reducing gender gaps in paid work and time use in different activities (Köhlin et al., 2012; Sedai et al., 2022, 2021b).

In this paper, we study how access to electricity shapes the labor market participation and time use decisions of individuals in rural Bangladesh. Starting from a rural electrification rate of 20 percent in the early 2000s, Bangladesh has now achieved almost complete electrification in rural areas (Khandker et al., 2012; Ministry of Power, 2019). While such dramatic expansion in household electrification is bound to spur the rural economy, the ways in which rural electrification influences the nature of work and time allocation of individuals within households remain an important and much debated question (Barkat et al., 2002; Dinkelman, 2011; Lipscomb et al., 2013; Grogan, 2018; Akpandjar and Kitchens, 2017; Chhay and Yamazaki, 2021). Even with mass electrification and high economic growth in recent years, Bangladesh remains a predominantly rural country. Over 60 percent of the population of 170 million lives in rural areas and agriculture is the dominant employer, engaging over half of the workforce (Finance Division, 2023).

Rural households in developing countries generally participate in multiple economic activities. Moreover, such households exhibit a strong age-gender division of labor (Jacoby, 1991). In such settings, access to grid electricity can influence individuals' time allocation in multiple ways. For example, electricity can help induce the use of time-saving technology and help women reallocate time from domestic chores to other productive employment activities (Grogan and Sadanand, 2013; Richmond and Urpelainen, 2019; Khandker et al., 2014). Electricity can also generate local employment opportunities and induce individuals to shift labor from cultivation to nonfarm activities (Barkat et al., 2002; Khandker et al., 2012; Rathi and Vermaak, 2018). Electricity can create demand for new services, such as electricians and repair technicians for appliances and electrical equipment. Electricity can also induce the adoption of electrical pumps for irrigation, which in turn can lead to agricultural intensification and higher farm productivity (Nagpal and Sovera, 2022). This itself has implications for how labor is allocated across farming, domestic chores, and nonfarm employment (Rathi and Vermaak, 2018). Finally, electricity can also make leisure time more desirable by making the use of modes of entertainment like televisions and radios possible (Richmond and Urpelainen, 2019; Fujii and Shonchoy, 2020; Grimm et al., 2015).

Beyond easing domestic burdens, electrification can also trigger a shift within household dynamics, particularly in enhancing women's bargaining and decision-making power (Köhlin et al., 2012). As women gain more time for economic activities, their contribution to the resource pool and influence within the household grows (Cecelski, 2002; Winther et al., 2018). For example, in Bangladesh, electrified households report a higher rate of women participating in financial decisions, which correlates with their increased economic involvement and personal agency (Khandker et al., 2012). By enabling the use of radios, televisions, and mobile phones, electricity also enhances access to information, education, and recreational content. Access to newer information can empower individuals, especially women, to participate in economic activities and reallocate time toward greater labor market engagement (Jensen and Oster, 2009; Dettling, 2017; Barkat et al., 2002).

Gender disparities, particularly in time use and labor market participation, however, still remain pronounced with women disproportionately engaged in unpaid domestic work. While electrification can potentially reduce these disparities, its influence on time allocation and labor market outcomes is complex and underexplored. In this paper, we utilize data from the Bangladesh Integrated Household Survey (BIHS) to explore how household electrification influences gendered participation and time use in paid and unpaid work. The BIHS is the only nationally representative rural household panel survey that collects detailed data on economic activities, agricultural practices, demographics, and asset holdings of households in rural Bangladesh (Ahmed, 2013). The BIHS was conducted in three rounds, starting from the baseline conducted in 2011-12, the intermediate round in 2015, and the endline in 2018-19. In each round, the survey records whether the household has a grid electricity connection and the quality of the electricity supply in terms of the frequency of power cuts. The unique feature of the BIHS is that it also records the daily time use of an adult male and female from each of the sampled households. For majority of the cases, these respondents are husband-wife pairs. We use this feature of the data to study how changes in household electrification status change the gender gaps in activity participation and time use of married couples in rural Bangladeshi households. Another unique feature of the BIHS is that it provides geocoded location of the sampled households. We use this feature along with Bangladesh's geocoded electrical grid network to test the robustness of our results to endogenous targeting of electrification at the village and household level.

We first record the age-gender division of labor in our sample of households and also document the difference in the time use of males and females in these households. Not surprisingly, we find males showing greater participation in non-farm activities, wage labor, and cultivation and females devoting greater time to domestic work. Household's access to grid electricity positively correlates with males' participation in non-farm work and females' participation in agriculture. With electricity, females reallocate time from domestic work and caregiving to more time watching television and farming. While males also spend time watching TV, they reallocate it from outdoor activities like shopping. In terms of mechanisms, we observe that household electricity access is positively associated with greater ownership of household appliances like fans, refrigerators, televisions, and mobile phones. Moreover, we also observe electrification associated with the use of groundwater irrigation via electrical pumps and the use of female family labor on their own farms. These results generally stand robust to various tests, including when we instrument household electrification status with village proportion of electrified households or when we use distance to features of the national electrical grid as instruments.

A large body of literature studies the economic impacts of improved access to energy on households in developing countries. Clean cooking technology, for example, has been shown to have time-saving benefits and increase employment for both genders (Su and Azam, 2023; Verma and Imelda, 2023; Krishnapriya et al., 2021). Su and Azam (2023) in the context of India, found that access to clean energy in the form of Liquefied Petroleum Gas significantly reduced women's time spent on cooking. However, electricity access can have complex and ambiguous time allocation effects. On the one hand, access to electricity can save time on domestic chores via its effect on ownership of time-saving durables like washing machines and refrigerators (Tewari and Wang, 2021; Bose et al., 2022; Greenwood et al., 2005; Coen-Pirani et al., 2010). Such time savings may not necessarily translate into greater time spent on paid work as electricity may also make leisure more desirable.

A sub-strand of literature has examined the gendered impacts of electricity access on activity participation and time use allocation decisions. Ribeiro et al. (2021) in the context of Brazil, observed that electricity access reduced time devoted to the labor market and increased time devoted to subsistence for females. Comparing electrification in India and South Africa, Rathi and Vermaak (2018) found that electrification did not affect employment in South Africa but reduced market work hours for both genders in India. Meanwhile, Sedai et al. (2021b) showed that electricity reliability increased the likelihood of employment in India with higher effects for females. Grogan (2018) found that rural electrification increased time spent in market work for women in Guatemala, while Salmon and Tanguy (2016) found an increase in working hours only for males in Nigeria. We contribute to this discourse in two ways: one; while there is some evidence on the positive impacts of Bangladesh's rural electricity program on income, education, fertility and child health (Fujii and Shonchoy, 2020; Khandker et al., 2012), there is no evidence on time use, and two, our data allows us to study how access to electricity influences the time use difference among husband and wife pairs within our sample of households.

Finally, as a contribution, we also provide empirical support to the arguments about the potential role of electrification in enhancing female bargaining and decision-making power within the household (Köhlin et al., 2012; Cecelski, 2002; Pachauri and Rao, 2013). Using data on indicators of participation in household decision-making, we do find evidence of women in electrified households reporting greater involvement in decisions regarding farm-related activities and household expenses. Critically, this positive association is observed for decisions on farm-related activities where women also increase participation. This could be either because electrification leads to higher agricultural productivity and greater demand for female labor or because men move out of agriculture (Fried and Lagakos, 2021; Van de Walle et al., 2017). Nevertheless, our findings suggest that in predominantly farming communities, electrification may influence women's decision-making power via greater involvement in farming and agricultural operations.

The rest of the paper is laid out as follows. The next section lays out the background and conceptual framework. Section 3 presents data and descriptive statistics. Section 4 explains our main empirical framework. Section 5 presents the main results, the potential mechanisms, and some robustness tests. The last section presents conclusions and key policy implications.

2 Background and Literature

Given that electrification programs in developing countries are a major investment and often executed with financial help from international organizations, a large and growing body of literature has studied their impacts on economic development and socioeconomic outcomes.[1] Studies have found electrification leading to higher incomes in Vietnam and India (Khandker et al., 2013; Sedai et al., 2021a), reduced poverty and higher consumption in India (Van de Walle et al., 2017; Sedai et al., 2022), increased irrigation rates and agricultural yields in Ethiopia (Fried and Lagakos, 2021), lower fertility in Indonesia (Grimm et al., 2015), higher school enrollment in Nigeria (Nano, 2022) and Vietnam (Khandker et al., 2013), improved school attendance and human development index in Brazil (Ribeiro et al., 2021; Lipscomb et al., 2013), and increased non-agricultural employment in Cambodia (Chhay and Yamazaki, 2021) and South Africa (Dinkelman, 2011).

[1]see Sedai et al. (2021b) and Lee et al. (2020) for background and an extensive review of the literature.

Bangladesh's rural electrification program has also had financial and technical support from international organizations (Barkat et al., 2002; Mukherjee and Sovacool, 2012). However, relatively little is known about its effects on the local economy and socioeconomic outcomes. Khandker et al. (2012) found that electricity access increased household income, expenditure, and education and lowered poverty rates in Bangladesh. Fujii and Shonchoy (2020) found that access to electricity in Bangladesh reduced fertility by about 0.2 children and improved height-for-age z-scores for children under five. Samad and Zhang (2019) found that frequent power outages negatively affected household income and increased kerosene consumption.

Since the late 1970s, rural electrification has been a key component of Bangladesh's development strategy to improve the quality of life in rural areas. The Bangladesh Rural Electrification Board (BREB) was established in 1977 and has since played a crucial role in expanding the national grid. Over the past five decades, this expansion has added thousands of kilometers of transmission lines and numerous substations, increasing the total installed capacity from 500 MW to 22,482 MW by the end of 2021-2022 (Ministry of Power, 2019). The BREB has established *Palli Bidyut Samities* (PBS) for the implementation of the rural electrification program. The PBSs are autonomous cooperative entities responsible for maintaining and operating rural distribution systems within their respective franchise areas (Barkat et al., 2002). This cooperative framework has been fundamental to BREB's success. The past two decades have witnessed a remarkable increase in the proportion of households with electricity connections, rising from 40 percent in 2011 to 90 percent in 2019. As of July 2022, BREB's electrification program has provided 20,58,443 electricity connections.[2]

Electrification can act as as a central force in transforming gender roles, predominantly in areas where women are stuck with unpaid household duties like cooking, fetching water, and collecting firewood. These tasks are not only time-consuming but also physically demanding, limiting women's ability to pursue education, paid work, or other economic opportunities. However, access to electricity opens doors for women to shift their focus to education, income

[2]https://reb.gov.bd/site/page/b0d556fb-1030-4b0d-9c57-f3b01b624893/- accessed on May 6, 2024.

generation, and broader community participation by reducing the time required for such chores (Cecelski, 2002; Winther et al., 2018). Research demonstrates that electricity access substantially mitigates women's "time poverty," allowing them to transition from unpaid household labor to more productive economic activities (Cecelski, 2002; Dinkelman, 2011; Sedai et al., 2022, 2021b). This redistribution of time, traditionally spent on labor-intensive tasks like cooking and fuel collection, empowers women to engage more fully in income-generating work and critical household decisions.

In agricultural contexts, electrification plays a vital role in boosting agricultural productivity. With access to electricity, rural households can utilize electric pumps for irrigation, enhancing crop yields and improving food security. In Ethiopia, for instance, electrification has been linked to increased agricultural output due to mechanized irrigation and better storage solutions (Fried and Lagakos, 2021). Similarly, in India, rural electrification has diversified agricultural activities, leading to improved productivity and poverty reduction (Van de Walle et al., 2017). The time women save from domestic chores allows them to participate more actively in farming or agri-business, which further strengthens household income and rural economies.

Access to electricity also opens up new avenues for information and entertainment, fundamentally reshaping household life. Electrification facilitates the use of devices like televisions and radios, which not only offer leisure but also alter family dynamics. Fujii and Shonchoy (2020) found that electrification makes leisure time more desirable while simultaneously lowering fertility rates by changing household priorities. In South Africa, research has shown that access to electricity increases women's autonomy and bargaining power by providing access to income and information resources (Dinkelman, 2011). Similarly, in Rwanda, electricity allows women to have a stronger influence over household spending and greater participation in economic and social spheres (Peters and Sievert, 2016).

Electrification impacts extend beyond the household, fostering women's participation in public life and community decision-making. In Nepal, for example, access to electricity enabled women to shift time from domestic work to community governance, allowing them to take on leadership roles and contribute to decision-making beyond the household (Winther et al., 2018). In education, electrification proves equally transformative, particularly for girls who often shoulder a disproportionate share of household responsibilities. By providing better lighting and reducing the time needed for chores, electricity allows girls to dedicate more time to their studies, improving school enrollment and academic outcomes (Khandker et al., 2013). Electrification has been shown to reduce dropout rates among girls by alleviating their household duties (Samad and Zhang, 2019). In addition, electricity access can improve health outcomes by reducing the need for biomass fuels, which cause respiratory illnesses. The shift to cleaner energy sources reduces indoor air pollution, resulting in improved health for women and children and supporting broader participation in economic and social activities (Barron and Torero, 2017; Burlando, 2014).

3 Data and Summary Statistics

3.1 The Bangladesh Integrated Household Survey

The Bangladesh Integrated Household Survey (BIHS) is a nationally representative rural household panel survey that captures comprehensive insights into the agricultural practices, nutritional outcomes, and overall household welfare of rural Bangladeshi households. The BIHS were implemented by the International Food Policy Research Institute (IFPRI) and administered by Data Analysis and Technical Assistance, Dhaka. The BIHS employed a detailed and rigorous multi-stage, stratified sampling strategy to ensure that the data collected were comprehensive and statistically representative. In the first sampling stage, primary sampling units (PSU), typically villages or clusters of villages, were selected based on rural enumeration areas from the latest population and housing censuses. Subsequently, households within the selected PSUs were randomly sampled in the second stage to represent the living conditions and household types within each area. The first two survey rounds—conducted in 2011-12 and 2015—covered 6,500 households across 325 primary sampling units. The third round, conducted in 2018-2019, covered 5,604 households while maintaining the same number of primary sampling units.

The surveys collect information on various aspects of rural households, including household composition, employment, asset ownership, agricultural production, inputs, land, consumption expenditure, and electrification status. The employment module records the employment status over the last seven days for each household member aged above 6 years. We categorize all employment activities into the following: non-agriculture wage labor, non-farm work, self-employed, livestock, cultivation, and agricultural wage labor. Non-agriculture wage labor includes occupations like construction labor, sweeper, factory workers, and transport workers, while non-farm work includes services, housemaids, NGO workers, and teachers. Self-employed includes tailoring, blacksmith, potter, and masonry, among others. Cultivation includes working on own farm, sharecropping, and homestead farming.[3]

The time use module records the time spent in various activities by an individual within a 24-hour reference period, with 15-minute intervals starting 4:00 AM on the day before the survey to 4:00 AM on the day of the survey. The advantage of using time-use data lies in its comprehensive coverage, capturing information on time spent on not only paid activities but also unpaid activities, including domestic work, caregiving, recreation, and other leisure activities. We classify them into categories such as eating, sleeping, and personal care, non-farm work, own business work, farming, home production, watching TV, recreation, and others. Non-farm work includes time spent in services, construction, and wage labor. Home production includes cooking, domestic work, caregiving, shopping, sewing, and textile care, while recreation comprises reading, hobbies, religious and social activities, and exercising. The remaining activities are grouped as “others”.

To capture a household’s electrification status, we rely on a question that asked whether the household has an electricity connection. We create an indicator variable if the household reports having an electricity connection. Additionally, we also use “Electricity Quality” as an alternative measure. The survey further asks how often the electricity supply goes off. We use this information to create a dummy variable to capture electricity quality, which takes three categorical values: 2 if the quality of electricity is good, 1 if bad, and 0 if the household has no

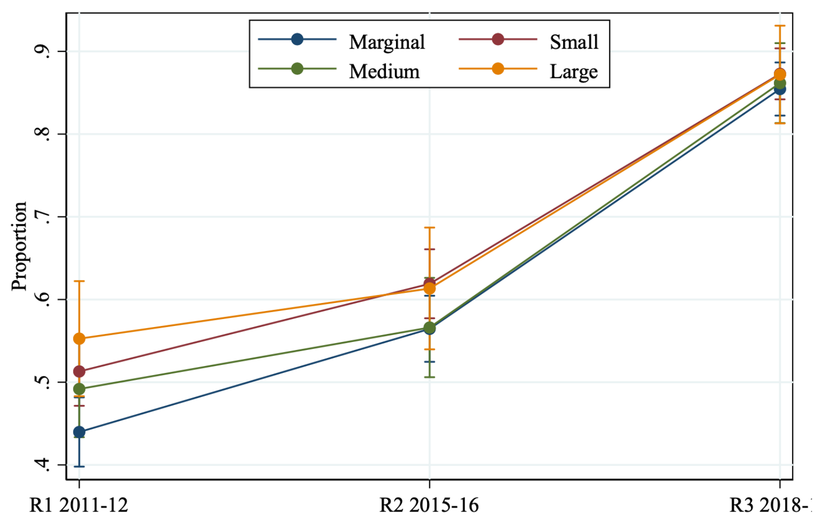
[3]See Appendix Table A1 for more detailed description on these activities.

electricity. The electricity quality is classified as "Good" if the household reports the electricity supply going off rarely or never and "Bad" if it goes off sometimes or always. Household level controls include dependency ratio (defined as number of children and elderly divided by total adult members), land ownership, logarithm of household consumption expenditure, and household size.

For our main dataset, we combine the modules on employment, time use, assets, agriculture operations, and housing conditions. Though the survey collects employment information for every household member above the age of 6 years, the time use information is only collected for one adult male and female member of the household. We therefore restrict our analysis to adults males and females, aged 15-60 years, for whom both the time-use and employment data is collected for at least two rounds. This results in a sample of 3319 adult males and 5868 adult females. Additionally, to understand how electrification affects intra-household time use, we conduct a separate analysis for 3707 married couples that are available in our final dataset.

3.2 Summary Statistics

Figure 1: Proportion of Electrified Households Over Survey Rounds



Note: Proportion of households reporting having an electricity connection in each survey round with 95% confidence intervals. Households are categorized as marginal if the total owned land if less than 0.5 hectares, small if [0.5, 2], medium if [2, 4] and large if owned land if $\geq$ 4 hectares.

Figure 1 shows the trends in rural household electrification over the three survey rounds. The dramatic improvement in rural electrification achieved in Bangladesh is also visible in our sample of households as the proportion of households reporting having an electricity connection almost doubled from 0.48 in the baseline to 0.86 by the endline survey. Figure 1 also shows that the improvement in rural household electrification was comparable across smaller and larger farmers. This is consistent with the evidence that household assets and wealth status show a low correlation with access to electricity in Bangladesh (Khandker et al., 2012).

Table 1: Summary Statistics

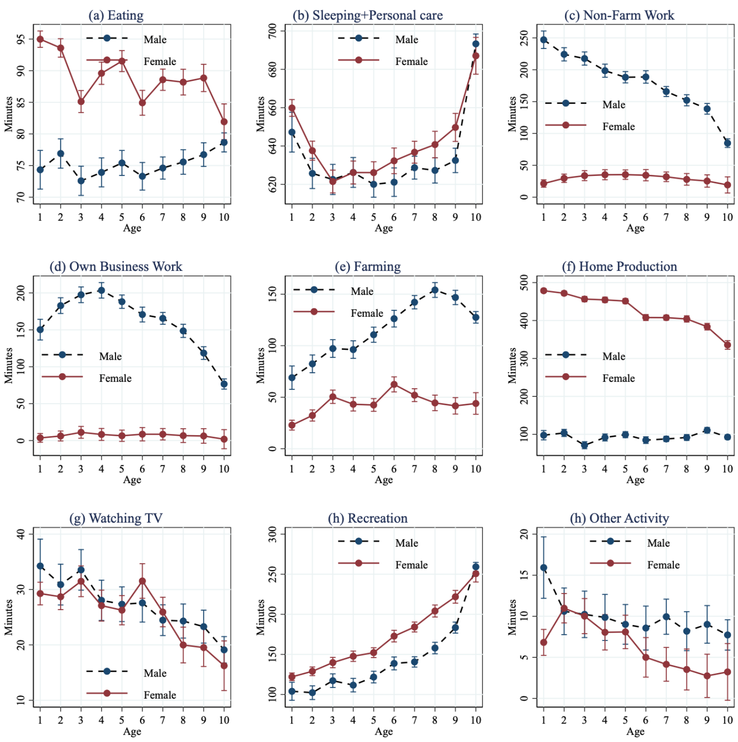
	(1)	(2)	(3)	(4)
	No Electricity		Electricity	
Variables	Male	Female	Male	Female
A. Activity Participation				
Non-agriculture Wage Labor	0.115	0.0181	0.0943	0.00917
	(0.319)	(0.133)	(0.292)	(0.0953)
Non-Farm Work	0.0349	0.0125	0.0790	0.0216
	(0.184)	(0.111)	(0.270)	(0.145)
Self-employed	0.175	0.0133	0.202	0.0278
	(0.380)	(0.114)	(0.401)	(0.165)
Livestock	0.370	0.251	0.357	0.188
	(0.483)	(0.434)	(0.479)	(0.391)
Cultivation	0.472	0.0162	0.466	0.0177
	(0.499)	(0.126)	(0.499)	(0.132)
Agricutural Wage Labor	0.260	0.0252	0.126	0.0122
	(0.438)	(0.157)	(0.332)	(0.110)
Cultivation+Agricutural Wage Labor	0.620	0.0378	0.529	0.0263
	(0.486)	(0.191)	(0.499)	(0.160)
Cultivation+Agricutural Wage Labor	0.704	0.277	0.615	0.207
+Livestock	(0.457)	(0.448)	(0.487)	(0.405)
B. Time Use Allocation				
Eating	77.30	96.87	73.25	86.46
	(29.25)	(43.56)	(27.31)	(39.33)
Sleeping+Personal Care	632.2	646.6	621.1	632.1
	(119.0)	(110.9)	(120.7)	(117.4)
Non-Farm Work	194.7	31.17	176.6	29.26
	(244.1)	(96.10)	(237.4)	(89.45)
Own Business Work	143.9	6.655	186.5	7.360
	(247.0)	(49.18)	(269.9)	(47.25)
Farming	128.4	36.19	119.0	45.65
	(198.3)	(77.83)	(182.6)	(82.10)
Home Production	117.2	461.3	81.30	433.3
	(151.0)	(155.8)	(127.5)	(153.6)
Watching TV	13.89	7.081	33.52	39.52
	(43.67)	(29.47)	(61.33)	(67.33)
Recreation	118.2	145.8	141.0	159.4
	(140.5)	(116.4)	(148.1)	(118.8)
Other Activities	13.88	8.09	7.64	6.76
	(69.62)	(38.24)	(50.21)	(32.59)

Note: The table shows means and standard deviation for main outcome variables for estimable sample. The sample includes married males and females of 15-60 years. Standard deviations are in parentheses. The description of activities is given in Table A1.

Table 1 shows the summary statistics by males and females in our sample.[4] Panel A of the table shows that men are more likely to report participation in activities demanding physical labor than women. Men in electrified households report greater participation in non-farm work and self-employment, whereas men in unelectrified households show greater participation in agriculture and non-agricultural wage labor. A similar pattern holds true for women.

Women tend to spend more time in home production than men; however, this difference shrinks within electrified households (Table 1 Panel B). In electrified households, men and women spend significantly more time watching TV and recreation than in non-electrified households. Moreover, women's time allocation in farming is notably higher within electrified households.

Figure 2: Daily Time Allocation of Males and Females by Age Deciles



Note: Age deciles are defined as [15, 26], [27, 30], [31, 33], [34, 36], [37, 40], [41, 43], [44, 48], [49, 53], [54, 60] and ≥60.

Figure 2 shows the age and gender-based differences in daily time use of individuals in our sample. Females, in general, report spending more time doing domestic chores and eating. Males, on the other hand, spend more time in out-of-home farming, small-scale business,

[4] See Appendix Figure A1 for the age distribution of males and females in our sample.

and employment activities. Older males, however, report less time spent on employment and business activities and more time spent on farming, personal care, and recreation activities. Older females also report more time spent on recreation and personal care activities. Interestingly, younger individuals report more time watching television with no discernible differences across genders.

Given that the BIHS provides geocoded locations of the sampled households, we also calculate the household's distance to the nearest electrical substation.[5] To do that, we first geocoded all the existing electrical substations on Bangladesh's national electrical grid network in 2002. Appendix Figure A2 shows the electrical grid network for 2002. The rationale for using the grid network for 2002 is that we will use features of the grid as instruments to test the robustness of our results, and grid status way back in 2002 remains uninfluenced by investments and improvement in grid infrastructure during the period of the surveys. Figure A3 shows the non-parametrically estimated relationship between a household's linear distance to the nearest electrical substation and the likelihood of having an electricity connection. In general, we observe a negative relationship between distance to the nearest electrical substation and household electrification status.

4 Empirical Framework

Household electrification status will be influenced by factors at the village as well as at the household level. At the household level, observable characteristics like household size and composition, educational qualifications, and wealth status can jointly influence activity participation and electrification status. Likewise, unobservables like household preferences can also affect a household's eagerness for electricity connection and women's participation in the labor market. Such unobservables can also lead to endogeneity and influence our estimates.

At the village level, distance to the grid, complementary infrastructure like roads and highways and geographical variables will influence whether the village has access to grid electricity. Likewise efficiency and discretion of the local electricity cooperatives responsible for

[5] To maintain some anonymity, the geocoded household latitude and longitude are offset by 2.5 kilometers.

the management and operation of the rural electricity distribution system within their community can also influence household electrification (Fujii and Shonchoy, 2020). Village infrastructure and local management cannot be considered as independent of the time allocation decisions of the members within the household hence need to be accounted for in our estimation. Consider the following empirical specification:

$$\mathbf{Y}_{ihvt} = \alpha_{1h} + \mu_{1vt} + \delta_1 \textbf{Electricity}_{hvt} + \mathbf{X}_{1ihvt}\beta_1 + \varepsilon_{1ihvt} \tag{1}$$

where Y is either a dummy variable capturing participation in different paid or unpaid activities or time in minutes spent on different daily activities by an individual i in household h in village v at time t. $\textbf{Electricity}_{hvt}$ is a dummy variable that indicates whether the household has a connection to grid electricity. We include household fixed effects α_{1h} to control for household-specific time-invariant observable and unobservable variables.[6] Village-time fixed effects μ_{1vt} account for any changes in infrastructure, local management, governance, policy changes and economic shocks that can jointly influence local labor markets and electrification status. Additionally, vector $\mathbf{X}_1$ includes important individual and household level time varying controls like individuals' age, dummies for educational qualifications, household size, dependency ratio, operated land, and consumption expenditure. We estimate Equation (1) on adult males and females separately.

While Equation (1) accounts for household fixed effects, changes in households situation or preference for electrification overtime can influence the estimates in Equation (1). Consider the variant of Equation (1) where we exploit the fact that our dataset essentially comprises of husband wife-pairs within a household:

$$\mathbf{Y}_{ihvt} = \alpha_{2i} + \mu_{2ht} + \delta_2 \textbf{Female}_{ih} \times \textbf{Electricity}_{hvt} + \mathbf{X}_{2ihvt}\beta_2 + \varepsilon_{2ihvt} \tag{2}$$

where the dependent variables remain the same as before, but now, we include indi-

[6]Household fixed effects will also subsume village/community fixed effects and will control for community level time-invariant factors.

vidual fixed effects α_{2i} and household-specific time fixed effects μ_{2ht}. Individual fixed effects absorbs all time invariant individual (including gender), household and village level variables influencing electrification and time allocation decisions. The inclusion of household time fixed effects subsumes all changes experienced by the household, including the change in household electrification status. The differential effect of electrification on the wife's outcome ($\textbf{Female}_{ih}$) vis-a-vis the husband (the omitted category), however, can be estimated by the interaction of the female dummy with household electrification status ($\textbf{Female}_{ih} \times \textbf{Electricity}_{hvt}$). Coefficient δ_2 is akin to a double difference estimate of the difference in time use of the wife and the husband before and after household electrification. The critical assumption is that the difference in time use of husband and wife in different activities does not change overtime if the household remains unconnected to electricity grid. Given that household level time varying observables are collinear with μ_{2ht}, vector $\mathbf{X}_2$ now only includes age and educational qualification dummies.

5 Results

5.1 Activity Participation and Time Use

Table 2: Electrification and Activity Participation

	(1) Non-agriculture Wage Labor	(2) Non-Farm Work	(3) Self Employed	(4) Livestock	(5) Cultivation	(6) Agricultural Wage Labor	(7) 5+6	(8) 4+5+6
A. Males								
Electricity	-0.016	0.019**	0.011	0.004	0.029*	-0.040**	0.008	-0.012
	(0.014)	(0.008)	(0.016)	(0.021)	(0.017)	(0.017)	(0.018)	(0.017)
Observations	8071	8071	8071	8071	8071	8071	8071	8071
R^2	0.656	0.782	0.777	0.697	0.766	0.698	0.763	0.757
Mean	0.101	0.064	0.193	0.361	0.468	0.172	0.560	0.646
B. Females								
Electricity	-0.004	-0.000	0.002	0.018	0.008	0.007	0.014**	0.027*
	(0.004)	(0.004)	(0.005)	(0.015)	(0.005)	(0.005)	(0.006)	(0.016)
Observations	14585	14585	14585	14585	14585	14585	14585	14587
R^2	0.522	0.655	0.656	0.575	0.500	0.647	0.544	0.571
Mean	0.012	0.018	0.022	0.211	0.017	0.017	0.031	0.233

Note: The description of activities is given in Table A1. All regressions include household and village-survey year fixed effects. Other control variables are dummies for age and educational qualifications, household size, dependency ratio, owned land, and log consumption expenditure. Village clustered standard errors reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 2 presents the estimates of Equation (1) with indicators for participation in different activities as dependent variables. For males, household electrification seems to suggest a re-allocation of labor from agricultural labor to non-farm work and cultivation. However, the estimated coefficient on agricultural activities is small and statistically insignificant. For females, household electrification seems to induce greater participation in agricultural activities. In terms of magnitude, for males, household electrification is associated with a 2 percentage point increase in non-farm work and a 4 percentage point decline in agricultural wage labor. For females, electrification is associated with 3 percentage point increase in agricultural activities (Table 2 Column 8). We also test and find no evidence of household electrification correlated with migration of the household members.

Our finding that males diversify out of agriculture while females increase participation in agricultural activities, often referred to as "feminization of agriculture", aligns with Sen et al. (2021), who observes that in rural Bangladesh, the share of employment in non-agriculture for men and the share of employment in agriculture for women increased between 2000 and 2013. Our empirical findings suggest that electrification has played a role in facilitating these trends in Bangladesh.

Table 3: Electrification and Time Use

	(1) Eating	(2) Sleeping+ Personal care	(3) Non-Farm Work	(4) Own business work	(5) Farming	(6) Home Production	(7) Watching TV	(8) Recreation	(9) Other Activity
A. Males									
Electricity	2.079*	3.556	18.034	-3.496	-7.020	-10.740*	9.675***	-7.262	-4.596
	(1.250)	(5.934)	(11.183)	(11.179)	(8.057)	(6.454)	(2.632)	(6.743)	(2.916)
Observations	8071	8071	8071	8071	8071	8071	8071	8071	8071
R^2	0.600	0.564	0.635	0.695	0.676	0.601	0.568	0.616	0.495
Mean	74.641	624.873	182.848	171.843	122.258	93.660	26.762	133.133	9.787
B. Females									
Electricity	-2.567**	-0.323	-0.612	-1.161	5.609**	-10.680*	11.670***	-0.794	-1.104
	(1.168)	(4.040)	(3.685)	(1.483)	(2.733)	(5.564)	(1.815)	(4.114)	(1.495)
Observations	14587	14587	14587	14587	14587	14587	14587	14587	14587
R^2	0.659	0.516	0.570	0.511	0.606	0.573	0.590	0.571	0.466
Mean	90.325	637.480	29.996	7.097	42.127	443.707	27.444	154.365	2.376

Note: All regressions include household and village-survey year fixed effects. Other control variables are dummies for age and educational qualifications, household size, dependency ratio, owned land, and log consumption expenditure. Village clustered standard errors reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 3 presents the estimates of Equation (1) with time (in minutes) allocated to different activities by males and females. We observe household electrification is associated with females devoting more time to farming and less time to domestic activities and eating. In contrast, for males, we observe an increase in time spent on non-farm work (though statistically insignificant) and a reduction in time allocated to domestic duties. Access to electricity is positively correlated with time spent watching television for both males and females. In terms of magnitude, electrification is associated with 11 additional minutes of time spent watching television, which seems to be reallocated from time spent on domestic duties. While both males and females reallocate time from domestic activities, females spend a disproportionately large amount of time on domestic chores compared to males.

Table A2 presents heterogeneity in our estimates based on land size. Among males, the notable increase in non-farm work engagement is statistically significant only among medium and marginal landowners, while the decline in agricultural labor is observed only among small landowners. This indicates that electrification may induce non-farm diversification specifically for smaller landowners. Table A3 indicates no difference in time spent on watching TV across different landholding categories for both genders. However, when it comes to females, the substantial time shift from home production to farming is apparent for all land categories except marginal.

A recent literature highlights that Two-Way Fixed Effects (TWFE) estimates can be biased when the treatment effects are heterogeneous across groups and over time (Imai and Kim, 2021; De Chaisemartin and d'Haultfoeuille, 2020; Goodman-Bacon, 2021).[7] This bias arises because the fixed-effects regression can generate negative weights. These negative weights can lead to biased estimates, especially when treatment effects are heterogeneous. To address this issue, we present alternative estimates using the method proposed by De Chaisemartin and d'Haultfoeuille (2020). This estimator provides a weighted average of the treatment effects for two groups: "switchers in" (units that begin receiving treatment) and "switchers out" (units that stop receiving treatment). A limitation of this estimator is the trade-off between the bias and power. While the estimator provides unbiased or less biased estimates in the presence of treatment effect heterogeneity, they do so by being more conservative. This conservatism reduces the precision of the estimates, leading to lower statistical power (De Chaisemartin and d'Haultfoeuille, 2020; Weiss, 2024; Borusyak et al., 2024).

Appendix Tables A4 and A5 provide estimates from the new estimator. Findings using this method are consistent with the baseline results from the TWFE model. However, the

[7]We thank two anonymous reviewers for suggesting us to look into this literature.

estimates from alternative method suffer from low statistical power. We also calculate the ratio of positive and negative weights attached in our TWFE model. According to De Chaisemartin and d'Haultfoeuille (2020), if the ratio is greater than 1, the TWFE estimate may still serve as a reasonable approximation of the average treatment effect, particularly when the magnitude of negative weights is small relative to positive weights. A higher ratio indicates that the TWFE model is more reliable, as the influence of negative weights is minimized. In our case, the ratio is 3, which is greater than 1, suggesting that the TWFE estimator provides a reasonable approximation of the true treatment effect. Note that our main estimates differ from the traditional TWFE model because we include village-time fixed effects, along with household and time fixed effects. The estimator proposed by De Chaisemartin and d'Haultfoeuille (2020) is not designed for more than two fixed effects. Hence, we generate these estimates in two steps. In the first step, we regress each outcome variable on village-time fixed effects to obtain the predicted values. In the second step, we regress these predicted values on electrification status and other controls.

We next present the results using "electricity quality" as an alternative measure. Evidence suggests that the reliability of electricity supply and frequency of power cuts may actually be more relevant for individuals to engage in productive economic activity rather than just connection to the national grid (Sedai et al., 2021b). Table A6 shows that the results for participation in different activities generally align with the main findings. Table A7 presents the results for time allocation and shows that the increase in time spent watching TV is uniform across electricity quality for both genders. However, the increment in men's time for non-farm activity and women's time for farming is significant only when electricity quality is good. This shows that males and females engage in market work only when electricity quality is good.

5.2 Differential Effects on Wives

In this section, we explore how household electrification influences activity participation and time use between the husband and wife within a household. For this, we estimate Equation 2 on a sample of 3707 unique husband-wives pairs for whom time-use information is available for at least two rounds. Table 4 shows the differential effect of electrification on the participation

Table 4: Electrification and Activity Participation for Couples

	(1) Non-agriculture Wage Labor	(2) Non-Farm Work	(3) Self Employed	(4) Livestock	(5) Cultivation	(6) Agricultural Wage Labor	(7) 5+6	(8) 4+5+6
Electricity × Female	0.002	-0.009	0.012	-0.065**	-0.018	0.064***	0.020	-0.015
	(0.010)	(0.006)	(0.011)	(0.030)	(0.017)	(0.015)	(0.016)	(0.024)
Observations	18708	18708	18708	18708	18708	18708	18708	18710
R^2	0.804	0.857	0.885	0.714	0.895	0.843	0.906	0.827
Mean	0.050	0.036	0.094	0.283	0.245	0.089	0.295	0.434

Note: The description of activities is given in Table A1. All regressions include individual and household-survey year fixed effects. Other control variables are dummies for age and educational qualifications. Village clustered standard errors reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 5: Electrification and Time Use for Couples

	(1) Eating	(2) Sleeping+ Personal care	(3) Non-Farm Work	(4) Own business work	(5) Farming	(6) Home Production	(7) Watching TV	(8) Recreation	(9) Other Activity
Electricity × Female	-6.012***	2.024	4.694	-3.104	9.593	-17.466**	7.862***	-0.181	2.528
	(2.074)	(6.696)	(9.702)	(7.632)	(7.416)	(7.872)	(2.886)	(6.993)	(2.422)
Observations	18710	18710	18710	18710	18710	18710	18708	18710	18708
R^2	0.762	0.756	0.819	0.860	0.834	0.900	0.787	0.792	0.718
Mean	80.359	634.565	98.001	81.815	88.303	265.592	26.462	156.796	7.930

Note: All regressions include individual and household-survey year fixed effects. Other control variables are dummies for age and educational qualifications. Village clustered standard errors reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

activities of the wife vis-a-vis the husband. With household electrification, compared to the husband, the wife is 6.4 percentage points more likely to work as agricultural labor and 6.5 percentage points less likely to work in livestock activities. Table 5 shows that electrification has a differential effect on the wife's time allocated to home production and watching TV. Wives in electrified households spend more time watching TV and experience a much greater decline in home production in comparison to husbands.

Electrification can manifest differential effects on both genders, as pointed out by previous studies. For instance, Salmon and Tanguy (2016) find that in rural Nigeria, electrification increases husbands' working time without altering that of wives. Alternatively, a handful of empirical studies show that electrification could disproportionately benefit women, compared to men (Köhlin et al., 2012; Clark, 2021; Sedai et al., 2022; Samad and Zhang, 2019). For instance, in households with electricity, women spend less time on household chores and are more likely to participate in market work (Grogan, 2018). Our results suggest that electrification can have a differential effect even on married couples, shaping intra-household time-use dynamics.

5.3 Mechanisms

5.3.1 Electrical Appliances, Domestic Work and Entertainment

Electrification enables the use of electric appliances such as refrigerators and washing machines, which can automate and expedite domestic tasks. As a result, individuals can allocate their time more efficiently to other activities, thereby reducing the overall time devoted to household chores and leaving free time to do other activities (Bose et al., 2022; Coen-Pirani et al., 2010). In addition to this, electrification provides greater flexibility to individuals in planning domestic duties, enabling them to spend more time in income-generating activities during daytime (World Bank, 2002).

Table 6: Household Appliances and Time Use in Home Production

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Household Appliances								Time Use (minutes/day)			
									Shopping		Domestic work+Caregiving	
	TV	VCR	Radio	Mobile	Fan	Sewing Machine	Refrigerator	Washing Machine	Male	Female	Male	Female
Electricity	0.146***	0.041***	0.001	0.083***	0.518***	-0.010	0.007*	-0.002	-8.640**	1.280	-2.100	-11.961**
	(0.014)	(0.005)	(0.004)	(0.012)	(0.015)	(0.007)	(0.004)	(0.002)	(3.505)	(1.789)	(5.786)	(5.616)
Observations	15609	15609	15609	15609	15609	15609	15609	15609	8071	14587	8071	14587
R^2	0.754	0.661	0.630	0.628	0.838	0.698	0.411	0.411	0.523	0.514	0.606	0.579
Mean	0.329	0.042	0.024	0.858	0.567	0.071	0.004	0.004	29.281	14.795	64.379	428.912

Note: The dependent variables in columns 1-8 are dummy variables, which measures the ownership of given asset. Columns 9-12 measure time use as number of minutes per day. All regressions include household and village-survey year fixed effects. Other control variables are household size, dependency ratio, owned land, and log consumption expenditure. Village clustered standard errors reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

To explore this mechanism, we examine whether electrification correlates with greater ownership of time-saving electric appliances. We use the asset module and create a dummy variable if the household owns any specific asset. The asset module collects information on assets like TVs, VCRs, radios, mobile phones, fans, and sewing machines. The survey further asks if a household has made any large purchases like refrigerators and washing machines in the last year. We use this information in the case of refrigerators and washing machines. The empirical evidence presented in Table 6 column 7 shows that electrified households are 0.7 percentage points more likely to own refrigerators. We, however, do not observe a correlation between electricity and ownership of sewing and washing machines. Electricity allows the household to use refrigerators for the long-term preservation of perishable food items. As a result, households can buy food in bulk and reduce the frequency of shopping trips and the time spent on regular grocery shopping. Furthermore, refrigeration allows for advanced meal preparation, reducing the amount of time spent cooking each day. Historically, in the absence of refrigerators, other preservation processes, including drying, salting, canning, and pickling, were used, all of which required significantly more time (Bose et al., 2022).

In addition, we find that households with electricity have increased access to electric fans (Column 5). Research in office settings has shown that improved indoor environmental conditions, including temperature control and ventilation, can enhance productivity (Seppanen et al., 2006; Wargocki et al., 2020). While these studies focus on office environments, similar principles apply to household settings. Access to fans can alleviate heat stress and improve comfort, thereby improving work efficiency in domestic tasks. Table 6, columns 9-12, further shows that men spend less time on shopping and women spend less time on domestic tasks. This decline corresponds to a decrease in home production for both genders.

The adoption of electrification-enabled technologies generates a surplus of time for both men and women, which can be reallocated to income-generating activities, such as non-farm work and agriculture (Greenwood et al., 2005; Dinkelman, 2011) or for entertainment like watching TV (Grogan, 2018). Tewari and Wang (2021) find that in Chinese households, ownership of durable goods such as refrigerators, washing machines, and motorcycles significantly reduced work time and increases labor market time for females. Similarly, Coen-Pirani et al. (2010) and Bose et al. (2022) find that ownership of appliances like freezers, washers, and dryers increased women's labor force participation in the United States.

Electrification can also increase the use of entertainment gadgets like televisions, radios, and DVDs (Richmond and Urpelainen, 2019). Access to electricity can free up time from manual tasks but can also make leisure more desirable (Kannan and Bessette, 2023; Grimm et al., 2015). We find a positive association between access to electricity and ownership of entertainment appliances, including TVs, VCRs, and mobile phones. Table 6, columns 1-4, show that electrified households are more likely to own TVs (14.6 percentage points), VCRs (4.1 percentage points), and mobile phones (8.3 percentage points). Richmond and Urpelainen (2019) observe that in rural Indian households, electrification has significantly increased the ownership of key appliances like TVs, fans, and pressure cookers. Likewise, Grogan (2018) find that household electrification increased the probability of having cable TV connections in

Guatemala.

5.3.2 Productivity-Enhancing and Labor-Saving Technologies on Farm

Table 7: Agricultural Labor and Irrigation

	(1) Family Labor	(2) Male Fam. Lab.	(3) Female Fam. Lab.	(4) Hired Labor	(5) Electric Pump Irrigation	(6) Diesel Irrigation	(7) Manual Irrigation	(8) Groundwater Irrigation	(9) Used Power Tiller	(10) Used Tractor	(11) Used Plough	(12) Fertilizer (kg/hect)	(13) Yield: All crops (kg/hec)	(14) Yield: Paddy (kg/hec)
Electricity	67.445	13.859	53.586**	34.597	0.020*	0.005	-0.012**	0.021**	0.011	-0.001	-0.004	2.659	134.174	120.409*
	(45.220)	(31.033)	(23.481)	(21.461)	(0.012)	(0.013)	(0.006)	(0.010)	(0.017)	(0.013)	(0.003)	(10.831)	(227.467)	(72.442)
Observations	42132	42132	42132	42132	56289	56289	56289	56289	42132	42132	42132	42132	54772	35668
R^2	0.506	0.489	0.452	0.419	0.667	0.612	0.468	0.687	0.681	0.711	0.495	0.514	0.388	0.545
Mean	564.668	514.630	50.038	393.277	0.196	0.426	0.037	0.536	0.801	0.127	0.005	422.903	5189.953	4484.202

Note: Fam. Lab. stands for Family Labor. Columns 1-4 measure labor time in hours. The dependent variables in columns 5-11 are dummy variables, which measures whether the given equipment is used. All regressions include crop, household and village-survey year fixed effects. Village clustered standard errors reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Electrification not only facilitates the adoption of household technologies but also promotes the uptake of labor-saving technologies in agriculture, such as better irrigation systems, planting and harvesting machinery, and processing equipment. For instance, households with access to electricity often utilize electric pumps for irrigation instead of relying on manual labor (Richmond and Urpelainen, 2019; Khandker et al., 2012). These technologies have the potential to make cultivation more productive and increase the demand for labor. To investigate this mechanism, we examine whether electrification is correlated with usage of electric pumps and other machinery on farms. We use available plot-level information on total labor hours used (including hired labor and male and female family labor), irrigation methods (electric pumps, diesel pumps, or manual methods), and the use of power tillers, tractors, or plows, along with plot-level crop yields for all crops. Table 7 presents estimates on all these variables. Our findings indicate that within electrified households, female family labor hours on the farm increase, while male family labor and hired labor hours remain unchanged (Columns 2-4). Moreover, the adoption of electric pumps for irrigation in electrified households rises by 2 percentage points (Column 5), accompanied by a decline in manual labor for irrigation (Column 7). However, the adoption rates of power tillers, tractors, plows, and fertilizer remain unaffected by electrification.

We also observe a positive correlation between electrification and paddy productivity. Since women often specialize in planting and weeding during rice cultivation and rice yields require more irrigation, the increase in female labor hours and electric irrigation is consistent with a positive correlation between electrification and rice yields.

5.3.3 Women's Decision-Making

Electrification often enhances access to information, technology, and economic opportunities, which can lead to an increase in women's decision-making power within the household. Access to electricity facilitates engagement in income-generating activities and improves productivity in tasks that traditionally fall within household's domain. Women can thus become more involved in economic activities and gain a greater influence in household decision-making process (Dinkelman, 2011; Cecelski, 2002; Winther et al., 2018). In this section, we explore the possible association of electrification with women's decision-making and mobility. Table 8 presents the correlations between electrification and women's participation and involvement in decisions about farm and non-farm activities, mobility, and decision-making power over household expenses.

Table 8: Decision-Making

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Participation		Input in Decision		Mobility			Decision-Making	
	Farm	Non-Farm/Wage	Farm	Non-Farm/Wage	Relatives/Market	Hospital	Movie/Training	Minor	Major
Electricity	0.026*	0.004	0.025*	0.010	-0.010	0.015	0.012	0.029**	0.025**
	(0.013)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.012)	(0.012)	(0.011)
Observations	16735	16735	16735	16735	14919	14919	14919	16729	16729
R^2	0.677	0.610	0.634	0.584	0.601	0.609	0.533	0.649	0.657
Mean	0.573	0.314	0.504	0.275	0.264	0.298	0.139	0.193	0.172

Note: The dependent variables in columns 1 and 3 are indicator variables if the women has participated in farm and non-farm activity in the last 12 months respectively, whereas in columns 2 and 4 are dummy variable which takes value 1 if the given woman has takes most/all decisions regarding farm and non-farm work, respectively. The dependent variable in Column 5, 6, and 7 are indicator variables if the given woman can herself decide whether she can visits market or relatives/friend outside the community; hospital, movie theater/fair; or NGO/training programs, respectively. The dependent variable in columns 8 and 9 are indicator variables if the given woman is sole decision-maker in minor (food and clothing); and major (education, healthcare and housing) household expenses, respectively. All regressions include household and village-survey year fixed effects. Village clustered standard errors reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Our findings indicate that electrification positively influences women's participation in farm work (column 1) and their involvement in decision-making regarding farm-related activities (column 3). This is consistent with the increased efficiency and productivity that electricity brings to agriculture, especially in tasks that involve the use of modern electrical machinery. The enhanced productivity likely increases women's role in farm operations, giving them a more prominent position in related decision-making. Previous studies support this finding, showing that when women contribute economically, their bargaining power in household decisions grows (Dasso et al., 2015).

However, these positive associations seem largely confined to farm work, as no statistically significant association is observed for non-farm work activity (columns 2 and 4). This could be due to the persistence of social norms, which restrict women's engagement in non-farm employment or wage-based work outside the home. While electrification may create opportunities for home-based economic activities, such as those related to agriculture, it may not be sufficient to dismantle the societal barriers that prevent women from entering the non-farm labor market. As Dasso et al. (2015) point out, cultural constraints often remain even when infrastructure improves, curtailing women's participation in formal employment or wage-earning activities (Jayachandran, 2015; Grogan, 2018).

The persistence of traditional norms is also evident in our findings on mobility. Columns 5-7 show that electrification does not influence women's mobility. This aligns with literature suggesting that even when electricity improves access to information and economic opportunities, social conservatism may still limit women's physical freedom and participation in activities outside the home. In regions where patriarchal norms are entrenched, women may continue to face restrictions on their movement and engagement in the public sphere, regardless of improvements in household infrastructure (Van de Walle et al., 2013).

Electrification does seem to be positively associated with women's decision-making power in household expenses, both minor and major (columns 8-9). This may be linked to enhanced access to information through television, radio, and other electric devices, which allows women to become more informed and confident in their financial decisions. Studies have shown that electrification improves women's access to information and resources, enhancing their agency in household spending decisions (Jensen and Oster, 2009; Sedai et al., 2022).

5.3.4 Non-Farm Business, Relative Wages and Migration

We also test whether electrification had any influence on migration and non-farm enterprises. One possible reason for males shifting towards non-farm work could be due to a relative increase in non-agricultural wages in electrified villages. To examine this, we use the community survey which provides village-level male and female wage for different agricultural and non-agricultural activities. We use relative non-agricultural wage, which is defined as non-agricultural wages divided by agricultural wages. Table A8 columns 2-3 present these estimates using the proportion of households electrified in the village as a measure of village electrification. The results show no significant effect on village-level non-agricultural wage for any gender. Electrification can also lead to the development of local businesses, providing employment opportunities within communities. However, we do not observe a statistically significant correlation between electrification and the number of business enterprises at the village level (column 4). Moreover, electrification does not seem to affect migration (column 1).

5.4 Robustness Tests

A household's electrification status is non-random and can be influenced by various factors at the household and community level. While we do include household fixed effects in our regressions, time-varying factors can still influence change in the household's electrification status over the survey rounds. For instance, the availability of electricity in neighboring households may change a household's preference for electrification over time. The presence of such spillovers rationalizes an instrumental variable strategy where we utilize the proportion of electrified households in the village, excluding the household's own status, as an instrument for household electrification status. A similar instrumental variable strategy has been used in Van de Walle et al. (2017) and Sedai et al. (2021a) to address the endogeneity of household electrification status.[8] The second-stage instrumental variable (IV) estimates for activity participation and time-use allocation are presented in Tables A9 and A10, respectively. These results align with our baseline findings. In regions with greater electrification, males shift from agricultural labor to non-farm work and cultivation, whereas females engage more in agricultural activities. Both genders show an increase in time watching television. Moreover, women reallocate time from home production to farming activities.

Village's access to electricity can also be endogenous, especially because the rural electricity cooperatives had a lot of say in which communities should first be connected to the grid. Given this feature of Bangladesh's rural electrification program, discretion and endogene-

[8]The correlation between household electrification status and village electrification rates is strong, with an F-statistic exceeding 100 for both genders.

ity can also arise at the village level. Moreover, spillovers that make leave-out IV relevant may also cause the violation of exclusion restriction. For instance, if village electrification leads to better infrastructure that reduces the time required for, say, fetching water, might directly affect time allocation in other activities independent of household electrification.[9] To address these concerns, we use a household's distance from the nearest electrical substation as an instrument for household electrification. While electrical power is generated in power plants, it is transmitted to the final consumers through the transmission network. The electricity generated in power plants is fed into the national grid network at extremely high voltages, which is unusable by the final consumer. This high-voltage electricity is lowered to a safe, usable level at the electrical substations, which are terminal points in the national grid. This lowered voltage then flows into branch lines, which take it to the final consumers. Figure A2 shows the distribution of substations on the national grid of Bangladesh for 2002. As can be observed from the figure, these substations are spread all across the country. Distance to electrical grid features like substations have been used as instruments in Nano (2022) and Squires (2015). We calculate this distance based on the grid network in 2002. This distance is time-invariant and uninfluenced by investments in the grid network during the survey years, hence exogenous to changes in village and household electrification during the survey period. Since the distance to the nearest substation is time-invariant, we just include district-fixed effects in these regressions. Tables A11 and A12 show that the distance to the substation instrument is strongly correlated with household electrification status, and the instrumented results are consistent with what we observe with our baseline specifications.

The final test is in the context of Equation 2, which compares the difference in activity participation and time use of husband-wife pairs before and after the electrification. The key assumption is that the difference in time use of husband and wife in different activities does not change over time if the household remains unconnected to the electricity grid. We test this through a placebo check. Specifically, we identify a subset of households without electricity throughout the survey period and randomly assign electrification status. Subsequently, we rerun our estimates using the placebo electrification status. The results with the placebo are

[9] We thank an anonymous reviewer for pointing this out to us.

presented in Tables A13 and A14. Apart from cultivation, these estimates have no discernible differential effect on activity participation and time use allocation.

6 Conclusion

Rural electrification has long been proclaimed as a critical driver of economic development and social transformation in developing countries. Bangladesh's ambitious Total Electrification Program, headed by the Bangladesh Rural Electrification Board (BREB), exemplifies this effort. Despite substantial investments and international support for electrification in Bangladesh, the nuanced impacts of electrification on gender roles and time use within households remain underexplored. Our study addresses this gap by leveraging longitudinal household data from the Bangladesh Integrated Household Survey (BIHS) to examine how access to electricity reshapes activity participation and time allocation between genders in rural Bangladesh.

We find household electrification associated with a reallocation of labor within the household, with males moving from agricultural labor to non-farm work and females increasing their participation in farming activities. This trend aligns with Sen et al. (2021), who observed similar shifts in employment patterns in rural Bangladesh, and Grogan (2018), who found that rural electrification increased women's market work in Guatemala. Household electrification appears to support the feminization of agriculture, where females take on agricultural roles as males diversify into non-farm work. We also observe a positive association between electrification and women's say in decision-making on household expenses and farm activities. These findings suggest that electrification not only reshapes labor allocation but may also contributes to enhanced female bargaining power in the household.

Electrified households report increased ownership of time-saving appliances, which allow for advanced meal preparation and reduced time spent on grocery shopping. This supports the notion that access to electricity can free up time for both males and females, enabling them to engage more in income-generating activities or leisure, such as watching television. A critical contribution of our study is the examination of intra-household dynamics, explicitly focusing on husband-wife pairs. We uncover that household electrification influences husbands and wives differently. The wife is more likely to work as agricultural laborers than the husband and spend more time watching TV while experiencing a more significant decline in home production. This differential effect is consistent with studies by Clark (2021) and Sedai et al. (2022), which suggest that electrification can disproportionately benefit women by reducing the burden of domestic chores and increasing their participation in market work.

In terms of policy implications, our findings indicate that there may be benefits in incorporating a gendered approach to rural electrification programs, recognizing that access to electricity can differentially impact men and women. Reliable electricity access will first alleviate the burden of unpaid domestic work on women, enabling greater participation in productive economic activities. This aligns with the United Nations' Sustainable Development Goals (SDGs) 7 (Affordable and Clean Energy) and SDG 5 (Gender Equality) UN (2015). Another important insight is that there may be additional benefits in coupling rural electrification with complementary agricultural infrastructure and irrigation systems to maximize economic benefits. The positive correlation between electrification and agricultural productivity, mainly through electric irrigation pumps, highlights the potential for integrated development strategies that combine electrification with agricultural support. Our findings show that such coupled investments can potentially enhance women's participation in the workforce and bargaining power in the household. This supports SDG 8 (Decent Work and Economic Growth) by highlighting the link between electrification and increased labor force participation, especially among women UN (2015). We also find evidence that the quality of electricity may be important, and therefore, electrification programs should expand coverage and target the provision of a good quality, uninterrupted power supply. Our findings contribute to the growing body of evidence on the socioeconomic benefits of electrification and provide valuable insights for future policy and research.

While we conduct several robustness tests to test the credibility of our estimates, some limitations remain. The first is the absence of natural experiment or policy-based exogenous variation in electrification status in our setting. While the associations observed in this paper are consistent with the possible channels and mechanisms through which electrification influences activity participation and time use and are generally consistent with evidence available in the literature, the absence of exogenous variation remains a limitation of this analysis. Second, there are inherent limitations related to the self-reported time-use data employed in our study. Self-reporting can introduce recall bias, and such data may not fully capture seasonal variations in time use, particularly in agricultural communities. Another limitation could be that although the three periods of the survey span eight years, the span may not be enough for electrification to induce significant changes in the village economy. Based on the availability of subsequent rounds of the BIHS, longer-run analysis remains an important future extension of this work.

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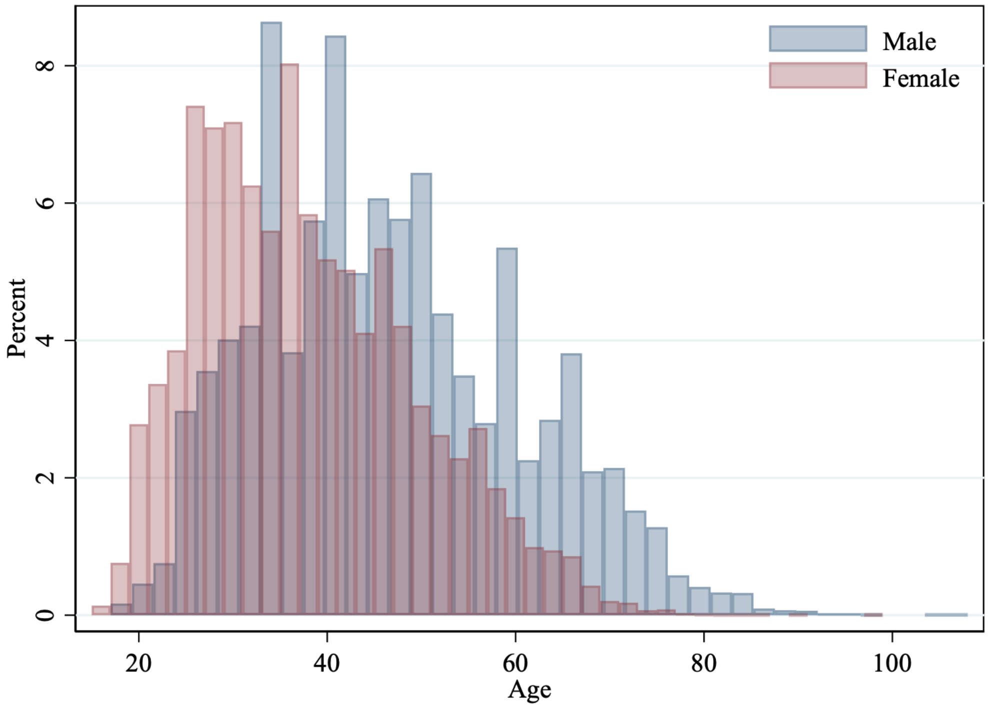
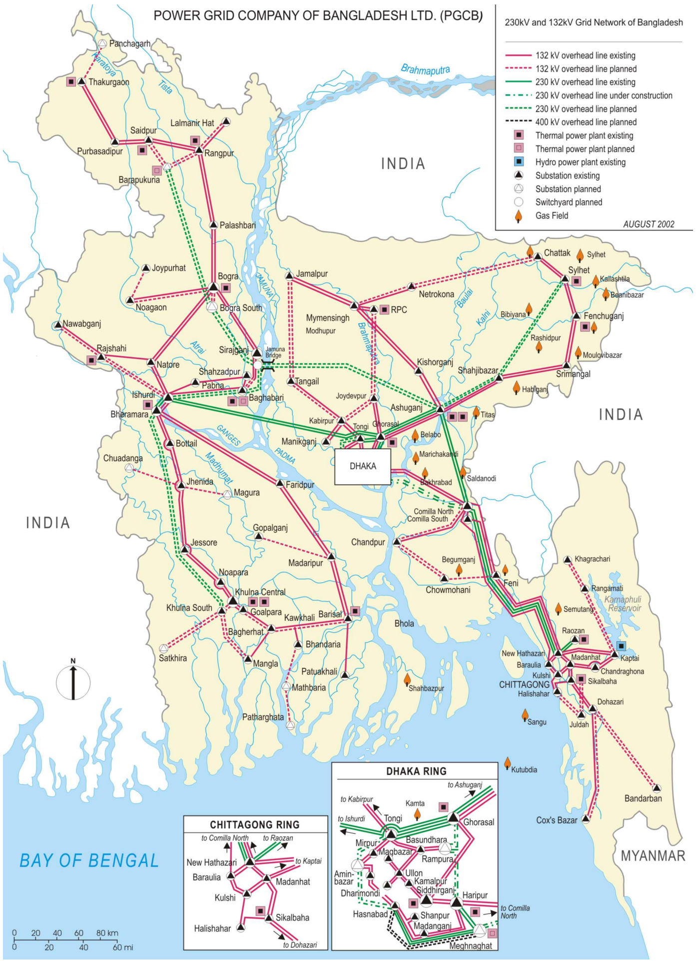
Appendix

Figure A1: Age Distribution by Gender



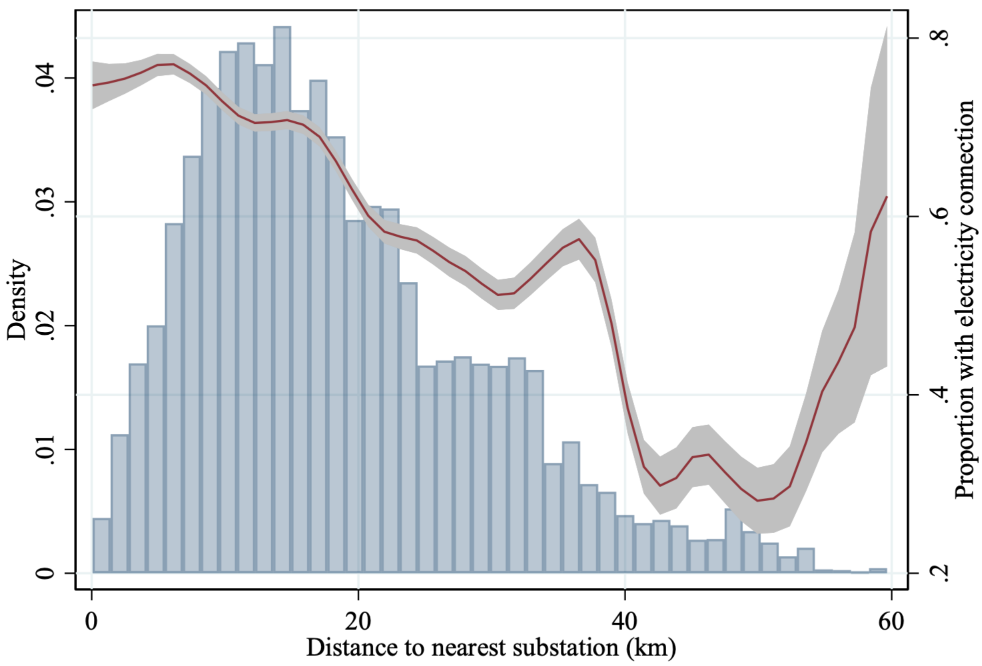
Note: This figure shows the age density of husband wife pairs in the survey.

Figure A2: Electricity Grid Map for Bangladesh



Note: The grid network map is extracted from the website of Power Grid Company of Bangladesh Limited (PGCB).
Source: https://pgcb.gov.bd/.

Figure A3: Distance to Electrical Substation and Likelihood of Electricity Connection



Note: The histogram denotes the density of distance to nearest electrical substation on the national power grid for 2002. The curve plots the non-parametric relationship between indicator for household electricity connection status and the distance to nearest substation.

Table A1: Activity Description

Non-Wage Labor	**Self-Employment**
Agricultural day labor	Rickshaw/van pulling
Earth work (govt program)	Driver of motor vehicle
Earth work (other)	Tailor/seamstress
Sweeper	Blacksmith
Scavenger	Potter
Construction labor	Cobbler
Factory worker	Hair cutter
Transport worker (bus/truck helper)	Clothes washer
Apprentice	Porter
Other wage labor	Goldsmith/silversmith
	Repairman (appliances)
Non-Farm Work	Mechanic (vehicles)
Government/ parastatal	Plumber
Service (private sector)	Electrician
NGO worker	Carpenter
House maid	Mason
Teacher (GoB-Primary school)	Doctor
Teacher(Non GoB Primary school)	Rural phisician
Teacher (GoB High school)	Midwife
Teacher (Non-GoB High school)	Herbal doctor/Kabiraj
Teacher (college,university)	Engineer
Other salaried worker	Lawyer/deed writer/Moktar
	Religious leader (Imam/Muazzem/Khadem/Purohit)
Cultivation	Lodging master
Working own farm (crop)	Private tutor/house tutor
Share cropper/tenant	Beggar
Homestead Farming	

Note: The table gives a detailed description of different employment activities reported in BIHS and its categorization.

Table A2: Owned Land, Electrification and Activity Participation

	(1) Non-agriculture Wage Labor	(2) Non-Farm Work	(3) Self Employed	(4) Livestock	(5) Cultivation	(6) Agricultural Wage Labor	(7) 5+6	(8) 4+5+6
A. Males								
Electricity	0.024	-0.030	0.006	-0.061	-0.038	0.025	0.009	0.003
	(0.031)	(0.024)	(0.027)	(0.066)	(0.056)	(0.044)	(0.057)	(0.046)
Electricity × Medium	-0.021	0.051*	0.018	0.073	-0.023	-0.033	-0.060	-0.052
	(0.034)	(0.028)	(0.029)	(0.077)	(0.068)	(0.048)	(0.064)	(0.055)
Electricity × Small	-0.043	0.036	0.023	0.104	0.042	-0.104**	-0.013	-0.025
	(0.034)	(0.024)	(0.028)	(0.070)	(0.060)	(0.045)	(0.060)	(0.048)
Electricity × Marginal	-0.045	0.060**	-0.007	0.046	0.105*	-0.054	0.018	-0.005
	(0.034)	(0.027)	(0.031)	(0.069)	(0.058)	(0.045)	(0.061)	(0.051)
Observations	8071	8071	8071	8071	8071	8071	8071	8071
R^2	0.656	0.783	0.777	0.696	0.762	0.698	0.760	0.754
Mean	0.101	0.064	0.193	0.361	0.468	0.172	0.560	0.646
B. Females								
Electricity	0.001	0.000	-0.002	0.062	0.024	0.007	0.023	0.075*
	(0.013)	(0.005)	(0.010)	(0.043)	(0.016)	(0.011)	(0.018)	(0.043)
Electricity × Medium	0.001	0.005	0.016	-0.091*	-0.026	-0.005	-0.024	-0.100*
	(0.012)	(0.008)	(0.013)	(0.049)	(0.017)	(0.009)	(0.018)	(0.052)
Electricity × Small	-0.005	-0.004	0.005	-0.125***	-0.009	-0.004	-0.006	-0.129***
	(0.012)	(0.005)	(0.010)	(0.045)	(0.017)	(0.012)	(0.019)	(0.046)
Electricity × Marginal	-0.007	-0.000	0.002	0.008	-0.021	0.004	-0.010	0.005
	(0.013)	(0.007)	(0.011)	(0.044)	(0.017)	(0.014)	(0.021)	(0.045)
Observations	14585	14585	14585	14585	14585	14585	14585	14587
R^2	0.522	0.655	0.656	0.576	0.500	0.647	0.544	0.572
Mean	0.012	0.018	0.022	0.211	0.017	0.017	0.031	0.233

Note: The description of activities is given in Table A1. All regressions include household and village-survey year fixed effects. Other control variables are dummies for age and educational qualifications, household size, dependency ratio, and log consumption expenditure. Village clustered standard errors reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A3: Owned Land, Electrification and Time Use

	(1) Eating	(2) Sleeping+ Personal care	(3) Non-Farm Work	(4) Own business work	(5) Farming	(6) Home Production	(7) Watching TV	(8) Recreation	(9) Other Activity
A. Males									
Electricity	6.603	-1.032	62.730**	-17.829	-41.138	-17.321	13.403**	0.655	-5.938
	(4.685)	(17.604)	(29.049)	(30.894)	(38.550)	(23.268)	(5.811)	(20.387)	(6.666)
Electricity × Medium	-6.856	2.524	-38.070	34.204	16.477	20.663	2.572	-32.866	1.858
	(5.472)	(18.431)	(32.274)	(36.609)	(41.555)	(27.346)	(7.188)	(24.581)	(8.451)
Electricity × Small	-7.096	3.185	-51.161*	13.369	47.335	-0.922	-5.906	-5.641	6.935
	(4.834)	(18.031)	(30.298)	(29.125)	(39.224)	(23.910)	(6.585)	(21.051)	(7.363)
Electricity × Marginal	-2.901	6.241	-45.816	11.858	32.729	8.436	-4.128	-4.511	-1.898
	(4.825)	(18.125)	(30.351)	(32.180)	(39.023)	(24.465)	(6.012)	(21.437)	(7.504)
Observations	8071	8071	8071	8071	8071	8071	8071	8071	8071
R^2	0.601	0.563	0.635	0.695	0.673	0.601	0.568	0.616	0.495
Mean	74.641	624.873	182.848	171.843	122.258	93.660	26.762	133.133	9.787
B. Females									
Electricity	-2.618	-10.222	1.958	0.705	21.251**	-34.414**	8.252*	15.152	0.613
	(4.134)	(10.979)	(9.105)	(3.993)	(9.968)	(14.943)	(4.758)	(11.159)	(3.077)
Electricity × Medium	0.339	5.406	-5.266	1.042	-5.876	19.284	10.117	-24.978*	-0.776
	(4.809)	(13.809)	(9.443)	(4.219)	(10.786)	(16.029)	(6.299)	(13.032)	(3.733)
Electricity × Small	1.374	14.633	-4.510	-2.351	-4.976	11.274	4.923	-19.166	-2.086
	(4.188)	(11.782)	(8.971)	(4.459)	(10.548)	(15.749)	(4.958)	(11.681)	(2.928)
Electricity × Marginal	-0.794	9.081	-1.190	-2.328	-25.646**	34.657**	1.659	-14.125	-1.867
	(4.171)	(11.763)	(10.208)	(4.365)	(10.496)	(15.315)	(4.826)	(11.835)	(3.259)
Observations	14587	14587	14587	14587	14587	14587	14587	14587	14587
R^2	0.659	0.516	0.570	0.511	0.607	0.573	0.590	0.571	0.466
Mean	90.325	637.480	29.996	7.097	42.127	443.707	27.444	154.365	7.252

Note: All regressions include household and village-survey year fixed effects. Other control variables are dummies for age and educational qualifications, household size, dependency ratio, and log consumption expenditure. Village clustered standard errors reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A4: De Chaisemartin and d'Haultfoeuille (2020) Estimates for Activity Participation

	(1) Non-agriculture Wage Labor	(2) Non-Farm Work	(3) Self Employed	(4) Livestock	(5) Cultivation	(6) Agricultural Wage Labor	(7) 5+6	(8) 4+5+6
A. Males								
Electricity=1	-0.004	0.017*	-0.010	-0.028	0.022	-0.032	0.003	-0.021
	(0.017)	(0.010)	(0.016)	(0.027)	(0.022)	(0.021)	(0.022	(0.022)
N	4423	4423	4423	4423	4423	4423	4423	4423
B. Females								
Electricity=1	0.002	0.003	-0.001	0.040**	0.012	0.016**	0.024**	0.046**
	(0.006)	(0.005)	(0.005)	(0.018)	(0.007)	(0.007)	(0.009)	(0.019)
N	8317	8317	8317	8317	8317	8317	8317	8317

Note: The description of activities is given in Table A1. All the dependent variables are first adjusted by including village-survey year fixed effects. The regression controls for household and year fixed effects, dummies for age and educational qualifications, household size, dependency ratio, owned land, and log consumption expenditure. Village clustered standard errors reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A5: De Chaisemartin and d'Haultfoeuille (2020) Estimates for Time Use

	(1) Eating	(2) Sleeping+ Personal care	(3) Non-Farm Work	(4) Own business work	(5) Farming	(6) Home Production	(7) Watching TV	(8) Recreation	(9) Other Activity
A. Males									
Electricity=1	4.017**	11.837	13.215	-4.132	-9.833	-9.812	2.366	-5.091	-2.497
	(1.855)	(7.440)	(13.503)	(13.235)	(10.802)	(7.944)	(2.652)	(8.795)	4.249
N	4423	4423	4423	4423	4423	4423	4423	4423	4423
B. Females									
Electricity=1	-3.957**	-3.734	-0.871	2.556	8.146**	-7.907	12.996***	-4.369	-2.768
	(1.662)	(5.224)	(4.315)	(2.573)	(3.795)	(6.813)	(1.782)	(5.363)	(1.687)
N	8318	8318	8318	8318	8318	8318	8318	8318	8318

Note: All the dependent variables are first adjusted by including village-survey year fixed effects. The regression controls for household and year fixed effects, dummies for age and educational qualifications, household size, dependency ratio, owned land, and log consumption expenditure. Village clustered standard errors reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A6: Electricity Quality and Activity Participation

	(1) Non-agriculture Wage Labor	(2) Non-Farm Work	(3) Self Employed	(4) Livestock	(5) Cultivation	(6) Agricultural Wage Labor	(7) 5+6	(8) 4+5+6
A. Males								
Electricity Quality = Bad	-0.013	0.021**	-0.006	0.001	0.025	-0.049***	0.011	-0.006
	(0.015)	(0.009)	(0.019)	(0.024)	(0.021)	(0.017)	(0.020)	(0.020)
Electricity Quality = Good	-0.018	0.018**	0.024	0.007	0.031*	-0.035*	0.007	-0.017
	(0.015)	(0.009)	(0.016)	(0.022)	(0.018)	(0.019)	(0.020)	(0.018)
Observations	8071	8071	8071	8071	8071	8071	8071	8071
R^2	0.656	0.782	0.778	0.697	0.766	0.698	0.763	0.757
Mean	0.101	0.064	0.193	0.361	0.468	0.172	0.560	0.646
B. Females								
Electricity Quality = Bad	-0.008*	0.002	0.002	0.006	0.010**	0.007	0.016**	0.014
	(0.004)	(0.005)	(0.005)	(0.017)	(0.005)	(0.005)	(0.007)	(0.018)
Electricity Quality = Good	-0.002	-0.002	0.001	0.026	0.006	0.008*	0.013*	0.036**
	(0.005)	(0.005)	(0.005)	(0.016)	(0.005)	(0.005)	(0.007)	(0.016)
Observations	14585	14585	14585	14585	14585	14585	14585	14587
R^2	0.522	0.655	0.656	0.575	0.500	0.647	0.544	0.571
Mean	0.012	0.018	0.022	0.211	0.017	0.017	0.031	0.233

Note: The omitted base category is No Electricity. The description of activities is given in Table A1. All regressions include household and village-survey year fixed effects. Other control variables are dummies for age and educational qualifications, household size, dependency ratio, owned land, and log consumption expenditure. Village clustered standard errors reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A7: Electricity Quality and Time Use

	(1) Eating	(2) Sleeping+ Personal care	(3) Non-Farm Work	(4) Own business work	(5) Farming	(6) Home Production	(7) Watching TV	(8) Recreation	(9) Other Activity
A. Males									
Electricity Quality = Bad	2.371	11.731*	9.266	-5.649	0.001	-11.484	8.630***	-11.656	-3.027
	(1.495)	(6.906)	(12.093)	(11.255)	(8.748)	(7.144)	(3.290)	(7.422)	(3.254)
Electricity Quality = Good	1.873	-2.177	24.182**	-1.987	-11.944	-10.218	10.408***	-4.182	-5.697*
	(1.363)	(6.168)	(12.117)	(12.678)	(8.849)	(7.168)	(2.726)	(7.344)	(3.099)
Observations	8071	8071	8071	8071	8071	8071	8071	8071	8071
R^2	0.600	0.564	0.636	0.695	0.676	0.601	0.568	0.616	0.495
Mean	74.641	624.873	182.848	171.843	122.258	93.660	26.762	133.133	9.787
B. Females									
Electricity Quality = Bad	-1.369	2.800	0.226	-1.780	2.570	-8.503	11.694***	-2.821	-2.783*
	(1.458)	(4.612)	(3.978)	(1.829)	(3.087)	(6.279)	(2.208)	(4.487)	(1.623)
Electricity Quality = Good	-3.374***	-2.427	-1.176	-0.745	7.657***	-12.147**	11.654***	0.572	0.028
	(1.273)	(4.311)	(3.967)	(1.646)	(2.886)	(5.914)	(1.940)	(4.498)	(1.628)
Observations	14587	14587	14587	14587	14587	14587	14587	14587	14587
R^2	0.659	0.516	0.570	0.511	0.606	0.573	0.590	0.571	0.467
Mean	90.325	637.480	29.996	7.097	42.127	443.707	27.444	154.365	7.252

Note: The omitted base category is No Electricity. All regressions include household and village-survey year fixed effects. Other control variables are dummies for age and educational qualifications, household size, dependency ratio, owned land, and log consumption expenditure. Village clustered standard errors reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A8: Migration, Relative Wages and Non-Farm Business

	(1)	(2)	(3)	(4)
	Any member migrated	Relative non-agricultural wage Male	Female	No. of business enterprises
Household Electricity	0.014			
	(0.017)			
Proportion of households electrified in village		-0.055	0.398	-0.106
		(0.130)	(0.492)	(0.943)
Observations	15611	590	249	911
R^2	0.539	0.520	0.981	0.687

Note: The dependent variable in column 1 is an indicator variable if any member in the household has migrated in the last five years. Variables in columns 2-4 are at village-level. The controls in column 1 include household, village-survey year fixed effects, household size, dependency ratio, owned land, and log consumption expenditure. The controls in columns 2-4 include village and survey year fixed effects. Village clustered standard errors reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A9: Electrification and Activity Participation with Village Electrification as Instrument

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Non-agriculture Wage Labor	Non-Farm Work	Self Employed	Livestock	Cultivation	Agricultural Wage Labor	5+6	4+5+6
A. Males								
Electricity	-0.017	0.017**	0.012	0.005	0.029*	-0.038**	0.013	-0.008
	(0.014)	(0.008)	(0.016)	(0.021)	(0.017)	(0.017)	(0.018)	(0.018)
Observations	8071	8071	8071	8071	8071	8071	8071	8071
R^2	0.001	0.002	0.000	0.005	0.020	0.008	0.012	0.015
Mean	0.101	0.064	0.193	0.361	0.468	0.172	0.560	0.646
B. Females								
Electricity	-0.004	0.000	0.002	0.014	0.008*	0.007	0.014**	0.023
	(0.004)	(0.004)	(0.005)	(0.015)	(0.005)	(0.005)	(0.006)	(0.016)
Observations	14585	14585	14585	14585	14585	14585	14585	14587
R^2	0.001	0.000	0.000	0.003	0.006	0.001	0.004	0.004
Mean	0.012	0.018	0.022	0.211	0.017	0.017	0.031	0.233

Note: The table presents second-stage estimates using proportion of households electrified in village as IV. The description of activities is given in Table A1. All regressions include household and village-survey year fixed effects. Other control variables are dummies for age and educational qualifications, household size, dependency ratio, owned land, and log consumption expenditure. Village clustered standard errors reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A10: Electrification and Time Use with Village Electrification as Instrument

	(1) Eating	(2) Sleeping+ Personal care	(3) Non-Farm Work	(4) Own business work	(5) Farming	(6) Home Production	(7) Watching TV	(8) Recreation	(9) Other Activity
A. Males									
Electricity	2.065*	3.277	16.945	-2.747	-6.258	-10.397	10.158***	-8.559	-4.261
	(1.234)	(5.999)	(11.395)	(11.371)	(7.999)	(6.568)	(2.642)	(6.797)	(2.977)
Observations	8071	8071	8071	8071	8071	8071	8071	8071	8071
R^2	0.002	0.001	0.003	0.004	0.012	0.002	0.003	0.001	0.001
Mean	74.641	624.873	182.848	171.843	122.258	93.660	26.762	133.133	9.787
B. Females									
Electricity	-2.921**	-0.015	-1.085	-1.040	5.143*	-9.366*	11.715***	-0.810	-1.591
	(1.191)	(4.064)	(3.670)	(1.491)	(2.664)	(5.486)	(1.824)	(4.152)	(1.328)
Observations	14587	14587	14587	14587	14587	14587	14587	14587	14587
R^2	0.002	0.002	0.001	0.000	0.002	0.008	0.005	0.004	0.001
Mean	90.325	637.480	29.996	7.097	42.127	443.707	27.444	154.365	7.252

Notes: The table presents second-stage estimates using proportion of households electrified in village as IV. All regressions include household and village-survey year fixed effects. Other control variables are dummies for age and educational qualifications, household size, dependency ratio, owned land, and log consumption expenditure. Village clustered standard errors reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A11: Electrification and Activity Participation with Distance to Substation as Instrument

	(1) Electricity	(2) Non-agriculture Wage Labor	(3) Non-Farm Work	(4) Self Employed	(5) Livestock	(6) Cultivation	(7) Agricultural Wage Labor	(8) 6+7	(9) 5+6+7
A. Males									
Distance to Substation	-0.007***								
	(0.002)								
Electricity		0.066	0.096**	0.224**	-0.048	-0.096	-0.224*	-0.275	-0.269
		(0.080)	(0.046)	(0.110)	(0.120)	(0.148)	(0.127)	(0.182)	(0.164)
Observations	10168	10168	10168	10168	10168	10168	10168	10168	10168
Mean		0.101	0.066	0.191	0.343	0.458	0.174	0.555	0.637
F-stat		17.910	17.910	17.910	17.910	17.910	17.910	17.910	17.910
B. Females									
Distance to Substation	-0.006***								
	(0.001)								
Electricity		-0.007	0.027	0.068***	-0.212*	0.026	0.042	0.021	-0.223*
		(0.017)	(0.019)	(0.023)	(0.115)	(0.020)	(0.076)	(0.058)	(0.112)
Observations	15881	15881	15881	15881	15881	15881	15881	15881	15882
Mean		0.012	0.018	0.023	0.209	0.017	0.017	0.030	0.230
F-stat		25.783	25.783	25.783	25.783	25.783	25.783	25.783	25.797

Notes: The table presents first-stage and second-stage estimates using distance to electricity substation as IV. The description of activities is given in Table A1. All regressions include district fixed effects. Other control variables are dummies for age and educational qualifications, household size, dependency ratio, owned land, and log consumption expenditure. District clustered standard errors reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A12: Electrification and Time Use with Distance to Substation as Instrument

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Electricity	Eating	Sleeping+ Personal care	Non-Farm Work	Own business work	Farming	Home Production	Watching TV	Recreation	Other Activity
A. Males										
Distance to Substation	-0.007***									
	(0.002)									
Electricity		-13.228	-11.561	65.939	-7.056	8.282	-127.884***	9.992	97.963**	-22.203*
		(8.422)	(27.943)	(61.248)	(66.175)	(51.628)	(45.120)	(11.942)	(37.614)	(13.133)
Observations	10168	10168	10168	10168	10168	10168	10168	10167	10168	10168
Mean		74.955	626.956	183.162	167.622	120.834	93.593	27.231	135.727	9.733
F-Stat		17.910	17.910	17.910	17.910	17.910	17.910	17.891	17.910	17.910
B. Females										
Distance to Substation	-0.006***									
	(0.001)									
Electricity		-47.575***	-13.123	49.041*	9.073	77.925***	-175.927***	50.998***	54.627	-4.304
		(13.990)	(29.170)	(29.245)	(6.364)	(27.522)	(60.416)	(11.550)	(38.430)	(6.891)
Observations	15882	15882	15882	15882	15882	15882	15882	15882	15882	15882
Mean		90.308	638.243	30.021	7.000	40.967	443.684	27.273	155.224	7.064
F-Stat		25.797	25.797	25.797	25.797	25.797	25.797	25.797	25.797	25.797

Notes: The table presents first-stage and second-stage estimates using distance to electricity substation as IV. All regressions include district fixed effects. Other control variables are dummies for age and educational qualifications, household size, dependency ratio, owned land, and log consumption expenditure. District clustered standard errors reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A13: Placebo Electrification Status and Activity Participation for Couples

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Non-agriculture Wage Labor	Non-Farm Work	Self Employed	Livestock	Cultivation	Agricultural Wage Labor	5+6	4+5+6
Placebo=1 × Female	-0.016	0.002	-0.006	-0.027	-0.064**	0.037	-0.009	0.030
	(0.023)	(0.014)	(0.017)	(0.055)	(0.029)	(0.029)	(0.032)	(0.043)
Observations	2626	2626	2626	2626	2626	2626	2626	2628
R^2	0.801	0.824	0.889	0.715	0.887	0.866	0.906	0.834
Mean	0.061	0.024	0.071	0.283	0.223	0.154	0.326	0.470

Notes: The description of activities is given in Table A1. All regressions include individual and household-survey year fixed effects. Other control variables are dummies for age and educational qualifications. Village clustered standard errors reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A14: Placebo Electrification Status and Time Use Allocation for Couples

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Eating	Sleeping+ Personal care	Non-Farm Work	Own business work	Farming	Home Production	Watching TV	Recreation	Other Activity
Placebo=1 × Female	-7.281	-8.007	22.761	-2.159	-6.508	1.880	0.739	0.151	1.443
	(4.498)	(14.033)	(16.709)	(15.816)	(13.123)	(16.070)	(3.636)	(13.227)	(3.224)
Observations	2628	2628	2628	2628	2628	2628	2626	2628	2626
R^2	0.795	0.796	0.833	0.848	0.846	0.904	0.768	0.810	0.766
Mean	80.540	650.726	111.436	63.575	87.147	269.543	8.727	159.819	4.967

Notes: All regressions include individual and household-survey year fixed effects. Other control variables are dummies for age and educational qualifications. Village clustered standard errors reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.