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# Electrification and Welfare for the Marginalized: Evidence from India

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**Keywords** Electricity access, Electricity reliability, Instrumental variables, Marginalized groups, Welfare

**JEL Classification** D12, D31, E12, I32

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# Electrification and welfare for the marginalized: Evidence from India

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January 15, 2021

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Uneven electrification can be a source of welfare disparity. Given the recent progress of electrification in India, we analyze the differences in access and reliability of electricity, and its impact on household welfare for marginalized and dominant social groups by caste and religion. We carry out longitudinal analysis from a national survey, 2005-2012, using OLS, fixed effects, and panel instrumental variable regressions. Our analysis shows that marginalized groups (Hindu Schedule Caste/Schedule Tribe and Muslims) had higher likelihood of electricity access compared to the dominant groups (Hindu forward castes and Other Backward Caste). In terms of electricity reliability, marginalized groups lost less electricity hours in a day as compared to dominant groups. Results showed that electrification enabled marginalized households to increase their consumption, assets and move out of poverty; the effects were more pronounced in rural areas. The findings are robust to alternative ways of measuring consumption, and use of more recent data set, 2015-2018. We posit that electrification improved the livelihoods of marginalized groups. However, it did not reduce absolute disparities among social groups.

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# 1 Introduction

Socioeconomic disparities between dominant and marginalized groups has been widely documented in India [Thorat and Neuman, 2012, Drèze and Sen, 2013, Thorat et al., 2017, Zacharias and Vakulabharanam, 2011]. However, less is understood about the effects of public policies on these disparities [Aklin et al., 2020, Kennedy et al., 2019, Pelz et al., 2020]. Social discrimination can have negative welfare impacts, but can public policies counter these effects? Marginalized groups[1] face higher risk of falling into poverty as inter-group differences consistently persist, even during phases of growth and development [Thorat et al., 2017, Pueyo et al., 2020]. These private and public inter-group inequalities hamper 'social empowerment', a notion essential to the fabric of inclusive growth.[2]

In recent years, public policies in India have set targets to improve employment opportunities and infrastructure for the 'poor' and the disadvantaged [Saxena and Bhattacharya, 2018, Kemmler, 2007]. One such public policy has been the 'electrification drive' that started with the 2005 Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) with the goal of increasing electricity access [Rao, 2013, Khandker et al., 2014, Sedai et al., 2020a]. In 2014, the program changed political hands, and is currently being carried out as the Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY), with the dual objective to electrify all households by 2022 and improve the quality of electricity post-electrification [Rathi and Vermaak, 2018, Burgess et al., 2020].[3] The electrification push since 2005, especially in rural areas [Rao, 2013], presents an opportunity to examine changes in the access and quality of electrification, and the effects on welfare outcomes for dominant and marginalized groups.

Available studies on caste and electrification have focused only on the extensive margin—i.e., the likelihood of electricity access for marginalized caste groups. Empirical studies have used either cross-sectional estimations at the national level or village and household fixed effects analysis at the regional level to quantify the likelihood of electricity access for the marginalized groups [Dugoua et al., 2017, Saxena and Bhattacharya, 2018, Aklin et al.,

[1]Social organization based on caste and religion in India differs in its structure from 'ethnic' or 'race' segregation. The caste structure transforms the horizontal and unconnected co-existences of ethnically segregated groups into a vertical social system of super-ordination and sub-ordination [Gerth and Mills, 2014]. Based on religious marginalization, Hindus form the majority, and Muslims form a minority. Therefore, in our study, the marginalized groups are Hindu Schedule Caste/Schedule Tribe and Muslims (analyzed separately), while the dominant groups are Hindu forward castes and Other Backward Caste.

[2]In addition, societal discrimination (tacit/implicit/passive forms of it) limits individual achievements due to enduring 'stereotype threats' despite the removal of legal barriers [Hoff and Pandey, 2006]. For instance the continued link between caste, structural inequities and poverty despite the prohibition of discrimination against an Indian citizen due to their caste in 1950 [Hoff and Pandey, 2006, Pelz et al., 2020].

[3]Although neither program directly addresses the marginalized groups in India, the objectives of providing electrification to the poor at a subsidized rate indirectly affects the disadvantaged groups compared to others [Pelz et al., 2020].

2020, Pelz et al., 2020]. These studies have generally found that marginalized communities, at best, did not have a higher likelihood of gaining electrification as compared to the dominant groups. There have been contradicting results on the effects of electrification on household outcomes. Some studies have found strong effects of electrification on individual and household welfare while others have found little to no effect.[4] Given the mixed results and the disproportionate likelihood of electrification for the disadvantaged groups in rural areas [Rathi and Vermaak, 2018, Dugoua et al., 2017, Pelz et al., 2020], it is crucial to examine how the marginalized groups performed in comparison to the dominant groups in terms of the likelihood of electrification, and in utilizing household electrification for welfare gains—increases in household consumption, wealth, and transitioning out of poverty.

The study is relevant from a policy perspective as the sustainable development target of reducing energy poverty entails reducing disparity in access to sustainable energy for the poor and the disadvantaged [Sedai et al., 2020a]. In addition, the ultimate objective of welfare in terms of improvements in living standards, reduction in poverty and inequality are a part of the sustainable development goals. However, to our knowledge, there is no national level longitudinal examination of the causal effects of the electrification drive on household electrification (both access and reliability) for marginalized groups. In addition to the lack of a national study on electrification, there are two major gaps in the literature on the nexus of caste and electrification: (i) an examination of the intensive margin of electricity reliability (electricity hours available in a day)[5], and (ii) an analysis of utilization of household electrification for welfare gains in terms of household consumption, wealth and status of poverty for marginalized groups.

Filling these gaps in the literature is important for several reasons. First, studies have found large variation and redistribution of electricity hours at the household level despite the progress in providing electricity connections [Sedai et al., 2020a, Aklin et al., 2020]. Aklin et al. [2020] found that the poor quality of electricity connection in rural areas was driven by socio-economic inequalities and political motivations.[6] Second, electrification is only a

[4]For example, see Dinkelman [2011], Sedai et al. [2020a], Churchill and Ivanovski [2020], Allcott et al. [2016], Rao [2013], Khandker et al. [2014], Samad and Zhang [2019], Sedai et al. [2020b], Chakravorty et al. [2014] for positive effects. See Burlig and Preonas [2016], Lee et al. [2020] for no effects.

[5]Hours of electricity available on a typical day is argued to be the main determinant of satisfaction with electricity [Aklin et al., 2016]. Electricity reliability is a major concern causing social unrest in India, and despite the willingness to pay, households in India have electricity for about 60% of the day, on average [Aklin et al., 2016, Sedai et al., 2020a].

[6]While RGGVY and DDUGJY have increased electricity connections considerably, the available infrastructures to deliver reliable electrification are weak [Allcott et al., 2016, Chindarkar and Goyal, 2019]. Lack of supply quality entails rationing of electricity supply hours to households [Kennedy et al., 2019]. Saxena and Bhattacharya [2018] argue that it is not uncommon for many villages and also urban areas to be supplied with electricity for only a few hours in a day.

means to welfare, the utilization of the available electricity matters given the socio-economic constraints faced by marginalized communities. In this context, electrification in poor and disadvantaged areas does not entail reduction in socio-economic inequalities if the welfare effects are not materialized for marginalized groups. Third, the lack of a national study masks the policy effort by the central government due to political motivations at the state level [Joseph, 2010, Baskaran et al., 2015, Allcott et al., 2016].[7] In addition to the above mentioned gaps in the literature, it is critical to study the performance during the initial period of reforms, this is because there could be frictions in policy efforts with changing political regimes, as has been argued to be the case in India by Baskaran et al. [2015].

Our study addresses the gaps in the literature by examining differences in electricity access and reliability followed by the post electrification outcomes at the national level between 2005-2012. We do this by categorizing individuals into three groups—(i) Hindus of forward or other backward caste (OBC), (ii) Hindus of scheduled caste (SC) or scheduled tribe (ST), and (iii) Muslims.[8] Unlike previous studies which have only focused on the likelihood of electrification and have remained agnostic about the reliability, we focus on both the intensive and extensive margins of electrification. We also analyze the likelihood and reliability of electrification by sub-grouping the national effect into seven regions which allows us to infer the regional variations in electrification outcomes for the marginalized groups. For the analysis of electrification as a means, we use panel fixed effect regressions to analyze the welfare outcomes for the marginalized groups, and compare it to dominant groups.

We use a balanced sample of individuals from the two waves (2005 and 2012) of India Human Development Survey (IHDS). For the analysis of the likelihood of electrification (electricity as an outcome), we use ordinary least squares (OLS), panel fixed effects, and panel fixed effects instrumental variable regressions with standard deviations clustered at the individual level. As Burlig and Preonas [2016], Dang and La [2019] and Sedai et al. [2020a] have argued, electrification (access and reliability) is non-random and is endogenous to household outcomes, such as household consumption. Therefore, we use 'ownership of motor vehicles' as an instrument—one that affects household consumption, but presumably does not affect household's access and reliability of electricity [Saxena and Bhattacharya, 2018]. For the second analysis of the effects of electricity access and reliability (hours) on

[7]A national analysis is critical as the electrification drive is based on center-state collaborations. Political motivations at the state level may bias the results—some states driven by electoral gains and populist policies might do better than other [Baskaran et al., 2015]. Also, in context of marginalized groups, choosing a few states might not fully represent the socio-economic inequalities as social organizations differ by state and regions in India due to cultural, historical and political reasons [Thorat and Neuman, 2012].

[8]In practice the Muslim population is also categorized into all the four caste groups. However, due to data limitations, we categorize all Muslims as a separate marginalized group primarily because they are minority in terms of population, and are generally socio-economically weaker than other religions in India.

household's annual consumption expenditure, wealth (proxied by total assets) and poverty, we use panel fixed effects regressions to estimate the effect of electrification controlling for household's income, age of the respondent, highest adult education in the household, and size of the household.

Our analysis shows that the marginalized communities (SC/ST/Muslims) gained more access to electricity between 2005 and 2012 compared to the dominant groups. However, Muslims gained less access than marginalized Hindus (SC/ST). In terms of reliability, between 2005-2012, average household electricity hours fell (conditional on access) at the national level (as also shown by [Sedai et al., 2020a,b, Aklin et al., 2016]). Hindu SC/ST had a smaller decline in electricity hours compared to the forward caste Hindus. Muslims had a higher but insignificant decline compared to all Hindus, they also had a higher and significant decline as compared to marginalized Hindus. The differences in electricity reliability between Muslims and all Hindus, and Muslims and SC/ST groups were stronger and significant in rural areas, but weaker and insignificant in urban areas. At the regional level, there were marked differences—eastern, western and southern regions saw a higher increase in electricity access for the marginalized groups, with the SC/ST/Muslims gaining more access than the dominant groups in these regions.

The analysis of electrification and household welfare shows that electricity access significantly increased household assets, annual consumption and reduced poverty for both dominant and marginalized groups. However, in comparison, the effects were mixed across the dominant and marginalized groups. For example, with electricity access, Hindu forward caste had the highest increase in assets in urban areas followed by Muslims and then marginalized Hindus, while in rural areas Muslims had the highest increase. Electricity reliability had significant positive effects on household consumption and assets for the Hindu SC/ST and forward castes. In terms of transitioning out of poverty with electricity access, Muslim households had the highest reduction in poverty, and there was no discernible difference between the dominant and marginalized Hindus. Overall, results suggest that electrification enabled marginalized households to increase their consumption, assets and move out of poverty, but the effects were marginally smaller or at best equivalent to dominant groups. We posit that electrification increased household welfare of marginalized groups, but did not reduce absolute disparities among social groups. The findings of this study are significant in designing effective intensive margin based electrification policies as our findings focuses on the winners and looser of electrification across different societal segments in India.

## 2 Literature Review

Despite substantial improvements in income levels among all population groups in India, poverty remains concentrated among the most traditionally disadvantaged [Jaffrelot, 2006]. In the most progressive period of India's economic growth, 2004-2012, forward and OBC castes had their poverty rates fall by almost half, while poverty for Dalits and Adivasis (SC/ST) declined by a little over a third [Thorat et al., 2017]. Despite these improvements, poverty levels are still high for the Adivasis [Jaffrelot, 2006, Thorat et al., 2017]. With the continued practice of 'untouchability' and persistent caste based inequalities[9], public programs such as the employment guarantee program and the electrification drive have a significant role to play in reducing socioeconomic disparities.

In general, the idea that social inequality and discrimination could affect electricity provisioning and utilization has not received due attention in the literature. The earliest study on caste based inequities in access to electricity was carried out by Kemmler [2007]. The study uses a utility based binary choice model of electricity along with cross-sectional data from the 55th round of the National Sample Survey (NSS). The study found that the SC and ST groups were 0.14 pp and 0.15 pp less likely to have access to electricity. Although being the first of their kind, these results had many caveats which more recent studies have attempted to address.[10]

Dugoua et al. [2017] addressed the issue of caste-based social exclusion by looking at the differential effect of the RGGVY on the likelihood of electrification by caste groups at the village level for six relatively poorer states in India. Aklin et al. [2020] looked at the caste based electrification rate in Uttar Pradesh between 2001 to 2011. Both studies found that the likelihood of electrification was significantly higher for villages with more forward caste communities than Dalit (SC) communities. Interestingly, in terms of electricity reliability, Dugoua et al. [2017] find that an increase in the population of lower caste households in the village increases the reliability of household electricity supply. They argue that 'hours of electricity available depends largely on the supply of power to the rural feeder connected to the village, so that caste discrimination at the village level would be very difficult in practice' (p. 281).

More recently, Saxena and Bhattacharya [2018] posited that caste based residential segregation is a strong determinant of electricity consumption. Their study argues that marginal-

[9]The 2011–2012 India Human Development Survey shows that 41% of non-Dalit rural households across the country practice "untouchability", while 38% of Dalit rural households reported experiencing caste discrimination [Desai and Vanneman, 2018].

[10]Namely, the issue of cross-sectional simultaneity bias, exclusion of Muslims as marginalized groups, lack of examination of recent thrust on electrification for the poor (2012-), and utilization of electricity for household welfare.

ized households disproportionately reside in segregated hamlets in rural areas, or poorer neighborhoods/slums in the urban areas. They argue that residing outside the main perimeter of the localities makes it possible to discriminate against them by the suppliers of energy goods, such as Liquified Petroleum Gas (LPG) and electricity. The authors use a cross-sectional instrumental variable estimation technique with data from the 2011-2012 NSS consumer expenditure survey of electricity usage in Kilo Watt hours for the SC/ST and Muslims. Their analysis finds that being an ST or SC household reduces electricity consumption by 10% and 5.6%, while the effect for Muslims was small and insignificant.

Kennedy et al. [2019] found that, in general, electrified villages in India have a lower proportion of scheduled caste population. However, interestingly, when Kennedy et al. [2019] move from an OLS model of willingness to pay for electricity to a Heckman selection model with the first stage "being a member of a backwards caste increases the probability of having an electricity connection". However, members of these castes have a lower willingness to pay (WTP). They argue that the low WTP can be explained by the subsidies for electrical connections which lowers the costs of connection for members of backwards castes. A recent study by Pelz et al. [2020] used the panel survey of rural North India (ACCESS, 2015-2018) and applied linear regression techniques with household fixed effects to examine the electricity connection for households belonging to Scheduled Caste and Tribes. Their study found that SC/ST households did not have a higher likelihood of electricity connection as compared to the forward castes. The gain in electricity connection for the marginalized groups were similar to that of the forward castes. They found that the SC/ST groups did not benefit more than the dominant groups from the DDUGJY in terms of grid based electricity connection. Their analysis covers a relatively short period of time (2015-2018), and only six relatively poor and populous states in India. Therefore, their study does not capture the full extent of the effect of electricity reforms at the national level from the start of the electricity reforms period. Also, since the ACCESS survey covers only rural areas, the effects in the urban areas are missed in their analysis.

Although electricity access and reliability are by themselves sustainable development goals, and as such household electrification is predictor of household welfare, but it is only a means to welfare [Burlig and Preonas, 2016, Harish et al., 2014]. The ability to utilize electrification for welfare gains may vary by social groups, as has been argued by Deshpande [2001]. Marginalized groups may be blocked by social constraints in their ability to utilize electricity for welfare gains, as has been found by Thorat and Neuman [2012]. As such having electrification becomes a neccessary, but not a sufficient condition to determine household welfare [Sedai et al., 2020b, Winther et al., 2017, Thorat and Neuman, 2012]. Progress in electrification could hide considerable variations in the ability to use electricity for household welfare across social groups. In this context, questions arise: do all social groups benefit equally from electrification? Who benefits most in terms of increases in consumption, assets, and in transitioning out of poverty?

On one hand, electrification stands to benefit the rich who have existing social capital to gain from utilization of electricity, such as the large farm-owning rural households who are mostly the dominant social groups [Khandker et al., 2014, Rao, 2013]. On the other hand, improved quality of electricity in the household stands to increase the consumption of the poor relatively more than the rich, especially in rural areas, given their history of higher deprivation of labor saving technologies [Sedai et al., 2020a].

# 3 Data

We use publicly available data from the 2005 and 2012 waves of India Human Development Survey (IHDS), a nationally representative longitudinal dataset [Desai and Vanneman, 2018].[11] IHDS covers wide-ranging topics at the individual and household level on demographic and socioeconomic characteristics. One caveat in the use of public IHDS data for caste based analysis is that classification of Muslims into caste groups is masked for privacy. This limitation restricts a clear caste based analysis of the entire sample. Alternatively, we categorize individuals into three groups—(i) Hindus of forward caste or OBC, (ii) SC/ST Hindus, and (iii) Muslims.

As only 83% of the observations are matched across survey waves [Desai and Vanneman, 2018], we create an analytically balanced sample including households with observations in both rounds. This gives a sample of 301,966 observations (150,983 in each round). We drop respondents below 18 years of age, which leaves us with a balanced sample of 91,831 observations in each wave. We then drop Christians, Sikhs and other religious minorities which leaves us with 88,142 observations for each period when analyzing electricity access. When we analyze electricity reliability, we condition our analysis on having electricity access in both waves.[12] This further reduces the sample size to 66,002 observations in each period.

Electricity access is derived from the survey question: “Does your household have electricity access?” Electricity reliability is measured conditional on electricity access and is derived from the question: “How many hours of electricity is available in your household on

[11] The population of caste groups in the IHDS survey are representative of the national level population of various caste groups in India if we use the population weights [Desai and Vanneman, 2018]. For summary statistics, we weight the sample using a population weighted measure, while for the regression analysis, we do not use the population weights.

[12] This is because when we include households with no electricity access in the first wave and access in the second wave, the variation in electricity hours could be mostly driven by the movement from no access to access in the two waves. We wish to observe the variation for households that had access in both periods.

a typical day?" The above two variables are used as dependent variables for the first part of the analysis (electricity as a outcome). For the first analysis, the control covariates include log of household annual consumption expenditure, household head's education, age in years, below poverty line card with the household (0/1), and household size. Annual household consumption expenditure (in rupees) is deflated using the IHDS deflator (see [Desai and Vanneman, 2018]).[13]

For the welfare analysis, the dependent variables are household consumption, assets and status of poverty. Log of household consumption expenditure is the same as used in the first analysis. We analyze assets as a proxy for wealth from the IHDS survey, which comprises of 30 durable assets (both electrical and non-electrical). In terms of the status of poverty, we look at the likelihood of transitioning out of poverty with electrification (access and reliability). IHDS data has the categorical variable poor and non-poor created using the 'Tendulkar poverty line', 2012[14] [Desai and Vanneman, 2018].

# 4 Empirical Framework

## 4.1 Likelihood of electrification

We first examine electrification as an outcome and analyze the likelihood and reliability of electrification for marginalized groups. We run three basic comparisons using three slightly modified models. First, we exclude Muslims from the sample and compare marginalized Hindus (SC/ST) to other Hindus (Forward caste and OBC). Second, we use the full analytic sample to compare Muslims to all Hindus. Third, we restrict the sample to only marginalized groups and compare Muslims to marginalized SC/ST Hindus.

In the first comparison, the estimation model for examining caste inequalities among Hindus is given by:

$$Y_{it} = \alpha 2012_t + \delta Caste_i \times 2012_t + X_{it}^{'}\gamma + \sigma_i + \epsilon_{it} \tag{1}$$

where $Y_{it}$ is electricity access or reliability (hours); 2012 is an indicator for the second wave; $Caste$ is an indicator for SC/ST Hindus; $X_{it}^{'}$ is a vector of observable individual characteristics; $\sigma_i$ is an individual fixed effect; and $\epsilon_{it}$ is the error term (clustered at the individual level).

[13]Having a below poverty line (BPL) card does not mean that the household is classified as poor in the IHDS or the ACCESS data. Below poverty line card dummy is not based on the Tendulkar Committee, 2012, for details, see Ram et al. [2009].

[14]Tendulkar poverty line categorizes individuals above 18 years earning less than Rs. 33 a day as poor in rural India, and Rs. 38 a day as poor in urban India [Commission et al., 2011]. The line is primarily meant to be an indicator for tracking progress in combating extreme poverty.

The $\alpha$ coefficient captures the aggregate change in the outcome between waves for forward caste Hindus, while $\delta$ captures the additional change for SC/ST households. We can also sum $\alpha$ and $\delta$ to estimate the absolute change in the outcome between 2005 and 2012 for SC/ST households. The observable vector $X'_{it}$ includes socioeconomic and demographic characteristics which are likely to affect household's access and reliability of electricity: household consumption, household head's education, age in years, ownership of a below poverty line card and household size.

When comparing Muslims with Hindus, we use the following modified specification:

$$Y_{it} = \alpha 2012_t + \delta Muslim_i \times 2012_t + X'_{it}\gamma + \sigma_i + \epsilon_{it} \tag{2}$$

where $Muslim$ indicates self-reported Muslim status and other variables are as previously defined.

We use household consumption expenditure as a covariate in our analysis, as it is argued to be a critical factor affecting household decision to be electrified [Saxena and Bhattacharya, 2018, Sedai et al., 2020a]. However, there is an issue of endogeneity involved when using household consumption expenditure as a covariate. The main argument for endogeneity being that consumption and distribution of electricity are non-random, there is self-selection and sorting involved.[15] From a policy standpoint, Lee et al. [2020] argued that 'electricity grid infrastructures are costly and long-lived, their planning, allocation decisions and construction requires the inputs of multiple stakeholders, hence, it is rarely randomized, instead it is endogenous to a variety of economic and political factors' (p. 131). From the supply standpoint, Burlig and Preonas [2016] argue that energy infrastructure projects in developing economies target relatively wealthy or quickly-growing regions, while in contrast, Rathi and Vermaak [2018] and Sedai et al. [2020a] argued that the grid infrastructure expansion in India targeted the poor and the disadvantaged in rural areas. Dang and La [2019] argue that economic and infrastructural developments in districts could simultaneously affect electricity variables and household outcomes.

From the demand side, electrification decisions are dependent on household income, location, and social-cultural factors [Sedai et al., 2020b, Khandker et al., 2014, Dang and La, 2019]. Households that are more willing to get electrified or purchase better quality of electricity (for instance, because they are richer or better educated) are also more likely to live in areas that are better electrified or are less exposed to outages. Income effects could imply that higher employment or better economic outcomes (consumption expenditure) for the household could lead to an increase in demand and consequently, higher consumption of

[15] The issue of simultaneity bias between household income/consumption and electrification has been found to be true in many developing economies in Africa and Asia [Millien, 2019].

electricity [Saxena and Bhattacharya, 2018].

Given that the likelihood of electrification through program placements is non-random and not independent of households consumption and income levels[16], we use the instrument 'ownership of motor vehicle', as also used by Saxena and Bhattacharya [2018] to control for the endogeneity between household consumption and electricity access. The instrument is argued to affect household's consumption expenditure, but is presumed to not affect households access and reliability of electricity [Saxena and Bhattacharya, 2018]. We check for the validity of the instrument using the over and under identification criteria given by Staiger and James [1997], and various other tests for instruments given in the *xtoverid, nois* command in Stata.

### 4.2 Electrification as a means

The second part of our analysis considers electricity as a means to household welfare (consumption, assets and status of poverty). To estimate the relationship between electricity (access and reliability) and household outcomes based on caste. We use fixed effects and fixed effects instrumental variable regressions to estimate the effects of electrification. The panel fixed effects model is as follows:

$$Y_{it} = \beta E_{it} + X_{it}^{'}\delta + \theta_i + \gamma_t + \epsilon_{it} \tag{3}$$

where $Y_{it}$ represents the outcome of interest for household $i$ at time $t$: annual consumption expenditure, assets and status of poverty. $E_{it}$ is the access/hours of electricity in the household of individual $i$ at time $t$. $X_{it}^{'}$ is a vector of individual and household observable socioeconomic and demographic characteristics: household wealth measured by total assets, education, age, below poverty line card, and household size. The unobserved $\theta_i$ is modeled as a fixed effect with no restriction on the correlation with other model regressors. $\gamma_t$ is a survey wave intercept. The error term $\epsilon_{it}$ is assumed to be randomly distributed.

## 5 Results

### 5.1 Descriptive Statistics

Before discussing the results from regression analysis, we look at the state of electrification and associated covariates by social groups. Table 1 shows that between 2005 and 2012,

[16]See Burlig and Preonas [2016], Sedai et al. [2020a], Dang and La [2019], Saxena and Bhattacharya [2018].

households from all Hindu caste groups along with Muslims saw an increase in electricity access. The increase was highest for the ST group (61 to 80%). Forward caste households registered the smallest increase (90 to 95%), albeit from a comparatively higher base than scheduled castes. The OBC, SC and Muslims all saw relatively similar increases from similar bases, 79–88%, 73–85%, 76–86%, respectively. From 2005-2012, the RGGVY scheme covered 229 districts under the so-called 10th plan (2002-2007) and 331 districts under the 11th plan (2007-2012) [Burlig and Preonas, 2016]. Given the wide coverage of the RGGVY plan, and the statistics reported in table 1, we can state that RGGVY was positively correlated with increasing electricity connections at the national level.

[Table 1 about here]

In terms of household electricity hours on a typical day, Table 1 shows that the forward caste groups, on average, were the biggest losers of electricity quality (1.44 hours of electricity in a day) from 2005-2012. Both OBC and SC groups lost approximately 0.80 hours of electricity in a day, on average. Whereas on average, Muslims lost 1.25 hours of electricity in a day, while the least reduction was for the ST groups of 0.09 hours of electricity in a day. The change in electricity reliability did not quite follow the change in electricity access in rural and urban areas. While the change in electricity access was more prominently a rural phenomenon, change in electricity reliability was observed more equally in rural and urban areas, albeit a stronger decrease in rural areas, on average. The higher decline in electricity reliability in rural areas during the period could be attributed to the lack of infrastructure to support the growing demand for electricity [Kennedy et al., 2019, Aklin et al., 2020], more so in a time when electricity access increased rapidly.

The trend in electricity reliability is contrasting to that of electricity access. Figure 1 shows that between 2005-2012, Muslims and nearly all Hindu caste groups (except ST) saw a decline in electricity hours. The highest decline was for Muslims households and the smallest decline was for the forward caste. This general decline has been attributed to the lack of policy focus on the reliability of electricity supply during the RGGVY scheme [Sedai et al., 2020a]. Also, lack of commercial viability of electricity distribution utilities, inefficient tariff schemes and low billing collection are being argued to be the major cause of the decline in electricity reliability [Kennedy et al., 2019].

[Figure 1 about here]

To illustrate the lack of electricity reliability, figure 2 shows the district wise distribution of household electricity hours in 2012. The figure underscores within state and regional variations, and the lack of reliable electricity across India. To illustrate the point of redistribution and the lack of household electricity hours further, figure 3 shows the differences in electricity hours at the household level from 2005-2012.

[Figure 2 about here]

[Figure 3 about here]

Table 2 shows that the lack of electricity access and reliability is more of a rural phenomenon in India. The table also shows that there has been relatively more improvements in electricity access in rural areas as compared to urban areas. ST groups had the highest improvement in electricity access in rural areas followed by Muslims and SC groups. Barring the ST groups in rural areas, all other social groups registered a decline in electricity reliability in both rural and urban areas, the highest decline being for the OBC groups in urban areas and for the forward caste (Brahmins) in rural areas.[17]

[Table 2 about here]

## 5.2 Electrification as an outcome

Table 3 shows the gain in electricity access for the marginalized compared to dominant groups. Column 1 provides simple OLS estimates comparing SC/ST Hindus to forward caste Hindus (and excluding all Muslims). In 2005, marginalized Hindus were 5.1 percentage points (pp) less likely to have electricity access after controlling for other observed covariates. Between 2005 and 2012, forward caste Hindus saw their probability of access increase by 11.8 pp.[18] However, marginalized Hindus saw a significantly larger increase of 17.7 pp (11.8 + 5.9). Column 2 shows results from the same model specification with the inclusion of individual fixed effects to control for time invariant unobserved heterogeneity. Results continue to show relatively higher gains for marginalized Hindus, though somewhat smaller gains overall. For example, SC/ST Hindus saw an increase in access probability of 15.4 pp (8.9 + 6.5) compared to 8.9 pp for forward castes. Finally, column 3 provides results from the same model after instrumenting for consumption. Controlling for the positive selection between consumption and access reduces the estimated gain in access for all groups. However, the relative gain for marginalized Hindus continues to outpace the forward castes—13.1 pp (6.4 + 6.7) compared to 6.4 pp.

[17] The distinction between Brahmins and OBCs is shown only for the descriptive statistics. For the analysis, we combine the two categories into a dominant group.

[18] The coefficient of 11.8 pp is higher than as suggested in table 1, this could be due to the simultaneity between consumption expenditure and electricity access in the cross-sectional analysis.

[Table 3 about here]

Column 4 of Table 3 shows the IV results comparing Muslims to Hindus using the full analytic sample. Overall, Muslims saw a slightly higher gain in access than Hindus between 2005 and 2012—10.0 pp compared to 8.9 pp. However, column 5 shows contrasting results when excluding forward caste Hindus. Point estimates suggest that Muslims gained about 4.0 pp *less* than marginalized (SC/ST) Hindus. Overall, the results in Table 3 show electricity access increased significantly more for marginalized than dominant groups between 2005 and 2012. Within the marginalized groups Hindus fared better than Muslims in terms of electricity access.

The use of instrument in the fixed effects regressions in column 3, 4 and 5 corrects for the simultaneity between household consumption expenditure and household electrification.[19] Using instrumental variable in a fixed effects model captures the program effort of RGGVY to electrify the unelectrified, mostly low-income and disadvantaged households, and reduces the dominant group selection into electricity access based on higher consumption, on average. In this regard, our results are robust, and add to the previous literature by Saxena and Bhattacharya [2018] who use the cross sectional technique and instrument for the household consumption only (used as a covariate in their study), while disregarding the selection bias of social groups, i.e, the likelihood of electricity access when the individual belongs to a dominant or a marginalized group.

Table 4 presents IV results separately for urban and rural areas for further examination. Results confirm that the increase in electrification between 2005 and 2012 was more of a rural phenomenon. In rural areas, the likelihood of electricity access increased 6.8 pp more for SC/ST Hindus than forward caste Hindus (column 1). In urban areas, the analogous gain was only 3.9 pp higher for marginalized Hindus (column 2). In fact, there was little gain at all for urban forward caste Hindus between 2005 and 2012, likely due to their already high level of access in 2005 (97% for forward caste and 95% for OBC). Column 3 shows that access increased 4.5 pp more for rural Muslims than rural Hindus overall. However, such a premium did not exist when comparing Muslims to Hindus in urban areas (column 4). When excluding forward caste Hindus (column 5), we find no difference in electricity gains between Muslims and SC/ST Hindus in rural areas. However, Muslims gained significantly less (3.0 pp) than marginalized Hindus in urban areas.

[Table 4 about here]

[19]Note, using the IV model changes the coefficient of household consumption expenditure from positive to negative, this could reflect the targeting of RGGVY towards poorer households who were less likely to be electrified.

Moving beyond simple access to the grid, in table 5 we analyze the reliability of electricity by social groups in a period when, on average, household electricity hours on a typical day decreased at the national level. Results from the simple OLS regression (column 1) show that SC/ST Hindus experienced a *smaller decrease* in electricity hours (0.70 hours per day) compared to forward caste Hindus (1.32 hours per day). Subsequent analyses including individual fixed effects and instrument for consumption changed results relatively little (columns 2 and 3). Column 4 shows that the average fall in reliability was not significantly different for Muslims compared to Hindus overall. However, Muslims did realize an additional average decline of 0.38 hours compared to SC/ST Hindus (column 5). Overall, the decrease in electricity hours was highest for forward caste Hindus, followed by Muslims and then SC/ST Hindus.

[Table 5 about here]

Lastly, Table 6 provides reliability results separately for rural and urban areas. Caste-based differences are similar in rural and urban groups—smaller declines for marginalized Hindus compared to forward caste Hindus (columns 1 and 2). However, rural Muslims experienced larger declines in electricity hours than rural Hindus, while Hindus saw the larger decline in urban areas (columns 3 and 4). Moreover, this pattern is largely because rural Muslims experienced much larger declines in electricity hours than urban Muslims. Finally, patterns are similar between Muslims and SC/ST Hindus in both rural and urban areas (columns 5 and 6).

[Table 6 about here]

#### 5.2.1 Electrification at the regional level

In this section, we examine differences in the likelihood and reliability of electrification across seven regions in India. A combination of different social reform histories, cultures, and other factors could all contribute to substantial regional variation. Moreover, post-independence development seems to have sustained general patterns of regional disparities rather than diminished them [Deshpande, 2001]. Understanding any regional variation in electrification is important not only to acquire a sense of how different historical processes work, but also to design electrification policies better suited to regional needs.

Table 7 shows the likelihood (panel a) and reliability (panel b) of electrification at the household level by regions in India (see the table footnote for states included in each region). Here, we club SC/ST Hindus and Muslims as a single marginalized group for ease of exposition. In each of the seven regions, the marginalized group saw a greater average increase in access than forward caste Hindus. Moreover, in the Hills, North, and South regions, forward caste Hindus saw almost no average increase in access. The North Central region saw the largest increase in access for both marginalized (24 pp) and dominant (21 pp) groups. However, the largest *premium* for the marginalized occurred in the East (8.5 pp) and West (6.5 pp).

[Table 7 about here]

In terms of electricity reliability, panel (b) in Table 7 shows that marginalized groups in the East, West, and South saw a smaller decline in average hours than forward caste Hindus. These results generally mirror the national level results presented in the last section. However, marginlzied groups in the Hills region saw a *larger decline* in average hours than forward caste Hindus. Moreover, in the North, North Central, and Central Plains, the marginalized saw an *increase* in hours, though in the Central Plains this increase was smaller than that of the dominate group.

Overall, there are regional variations in the dynamics of household access and reliability of electrification. Regions such as the East, West, and North Central did comparatively better in terms of electricity access and reliability for marginalized groups. However, only for hours of electricity in the Hills and Central Plains did the marginalized fare worse on average than forward caste Hindus.

## 5.3 Electrification as a means

Table 8 shows the effect of electricity on household assets in urban and rural areas. Our asset measure ranges from 0 to 30 and is a cumulative count of 30 asset categories (e.g. house ownership). Panel (a) shows the effect of electricity access and panel (b) shows the effect of electricity reliability for forward caste Hindus, SC/ST Hindus and Muslims separately. Columns 1 and 2 in panel (a) show that electricity access led to 2.0 more assets for the forward caste groups in rural areas and 3.3 more assets in urban areas. The analogous rural/urban increases were 1.8/2.9 for SC/ST Hindus and 2.4/2.9 for Muslims. Overall, panel (a) shows that each social group benefited from electricity access on average, but the dominant group benefited relatively more than the marginalized groups, exceptions are rural Muslims. Results in panel (b) show the effects of electricity reliability on assets for each social group. Here again, the forward caste Hindus benefited from electricity reliability both in rural and urban areas, while more electricity hours had a significant effect only in rural areas for SC/ST Hindus. For Muslims, increased electricity hours had no significant effect on asset ownership (though results are somewhat noisier).

[Table 8 about here]

In Table 9, we examine the effect of electricity on household annual consumption expenditure. Columns 1 and 2 in panel (a) show that electricity access increased the annual consumption expenditure of Hindu forward caste households by more than 12.0 percent in both rural and and urban areas. Columns 4 and 5 show that electricity access increased the consumption expenditure of Hindu SC/ST households by 8.7 percent in rural areas, while in urban areas there was a negligible and insignificant effect. For Muslims, electricity access increased consumption expenditure by 11.8 and 6.2 percent in rural and urban areas, respectively. Overall, panel (a) shows that electricity access increased the consumption of marginalized groups less than dominant groups.

[Table 9 about here]

In panel (b) of Table 9, we examine the effect of electricity reliability on consumption expenditure. Here the effect on Hindu SC/ST groups is such that a 10 hour increase in electricity hours on a typical day increased average annual consumption expenditure by 2 percent in rural and 3 percent in urban areas. The effect on consumption for the Hindu forward caste is similar at 2 percent in rural areas, but is marginally lower and insignificant in urban areas. For Muslims, the magnitude of the effect of electricity hours is similar to other groups, about 2 percent, but the coefficients are insignificant due to smaller sample size. Overall, the analysis shows that marginalized households tend to have similar benefits as dominant groups with electricity reliability, but the same is not true for electricity access.

Finally, in Table 10 we examine the effect of electricity access and reliability on the likelihood of transitioning out of poverty for all social groups. Columns 1 and 2 in panel (a) show that access reduced the probability of poverty for forward caste Hindus by 8.4 pp in rural areas and 5.8 pp in urban areas. For SC/ST Hindus, access reduced poverty by 6.3 pp in both rural and urban areas. Access effects were largest for Muslims, with poverty reductions of 10.5 pp in rural areas and 14.4 pp in urban. In panel (b), we examine the effects of electricity reliability on poverty. Results suggest that increasing electricity hours reduced the likelihood of being poor mostly for the forward caste groups. For SC/ST Hindus and Muslims, increasing household electricity hours had no significant effect on poverty status (though point estimates are similar across all social groups in urban areas).

[Table 10 about here]

# 6 Robustness Checks

We carry out two robustness checks (i) effect of electricity access on OECD per capita equivalent annual consumption expenditure, (ii) likelihood of electricity access by social groups using alternative data set: the panel of the Access to Clean Cooking and Energy Services (ACCESS, 2015-2018) survey. The first robustness check is for the analysis of electrification as a means to welfare and the second robustness check is for the analysis of electrification as an outcome.

For the first analysis, we create the OECD equivalent per capita annual consumption variable, calculated as: OECD= reported consumption*[1+ 0.7*(Number of Adults-1) + 0.5*(Number of Children)]. The OECD equivalent variable gives higher weight to adult consumption, in effect showing a more realistic consumption expenditure figure based on household's adult and child composition. In panel (a) of table 11, we examine the effect of electricity access on the OECD equivalent consumption. In panel (b), we examine the effect of electricity reliability on the consumption variable.

[Table 11 about here]

Columns 1 and 2 in panel (a) show that the forward caste Hindus had a 12.7 and 12.9 percentage point increase in per capita adult equivalent consumption expenditure in rural and urban areas, respectively. Columns 3 and 4 show that the Hindu SC/ST groups had a 9 percentage point increase in the consumption expenditure in rural areas and no effect in urban areas. Adult consumption expenditure increased significantly for Muslims only in rural areas (12.5 percentage points), while in urban areas the coefficient was positive but insignificant. Results from panel (a) match the results derived on electricity access and consumption expenditure in table 9 with regards to the relative effects of electricity access on consumption expenditure for the social groups. The only exception is for the Muslim group's consumption expenditure, which was positive and significant at the household level, but was positive but insignificant at the adult per capita level.

Panel (b) of table 11 shows the effect of electricity reliability. Here again, similar to results in panel (b) of table 9, electricity reliability had similar effects on the adult equivalent consumption expenditure of Hindu forward caste and SC/ST groups. Here, the exception was Muslim group who had a positive and significant effect of electricity reliability, 10 hours increase in electricity availability leading to 3 pp increase in adult equivalent consumption expenditure. While in table 9, there was a positive but insignificant effect of electricity relaibility on household consumption expenditure.

As a second robustness check, we examine panel data from the ACCESS survey and see if the marginalized groups had a higher likelihood of electricity access compared to the dominant groups as shown by our analysis in table 3, using the same set of independent variables. Pelz et al. [2020] conducted a similar analysis using the same panel of the ACCESS survey, albeit without an instrumental variable analysis. They found that marginalized groups (SC/ST)[20] were not more likely than forward caste groups to gain electricity access between 2015 and 2018.[21]

[Table 12 about here]

The panel fixed effects analysis in column 2 of table 12 gives similar results to the analysis by Pelz et al. [2020] in that the marginalized groups were no more likely than the forward caste groups in receiving electricity access. Their study shows that both caste groups had 17.8 pp likelihood of getting electrified between 2015-2018, while our analysis shows the likelihood to be 16.5 pp. The difference could be because they take an unbalanced sample and we use a balanced sample analysis. Also, we add additional controls such as household head's education and age in years of the respondent.

Pelz et al. [2020] do not conduct an instrumental variable analysis, however, our study motivated by the endogeneity between consumption expenditure and electricity access has a instrumental variable analysis in column 3. The panel fixed effects instrumental variable analysis in table 12 shows that the marginalized groups had a higher likelihood of electricity access as compared to the forward caste groups, which is also seen in table 3. Given that the focus of the DDUGJY program was to electrify the remaining unelectrified households which were presumably poor and from marginalized groups, capturing the potential positive selection bias between higher consumption expenditure and better electricity access led to a significant positive effect. Overall, the two robustness checks show that our results hold for both electricity as a means, and as an outcome analysis when we use alternate dependent variables and alternative data-set.

# 7 Conclusions and policy implications

Underscoring the socio-economic inequalities between the marginalized and dominant groups in accessing and utilizing basic infrastructures in India, we analyze the likelihood and reliability of electricity for these groups, during a time period when massive strides were made to electrify the unelectrified households, especially in rural areas. Before the universal electrification program, marginalized communities were less likely to have electricity connection as compared to dominant groups, therefore we anticipated that the RGGVY (program for

[20]In the ACCESS survey, Muslims are not a separate group and are accounted within the caste system).
[21]The ACCESS panel is for rural areas only.

universal electrification) would have disproportionately increased marginalized community's electricity access. However, existing studies indicate otherwise, and show that the marginalized communities had comparatively lower or at best similar increases in electricity connection compared to the dominant groups. In the light of these counter-intuitive results, we conduct a robust causal analysis using the panel of the national level IHDS survey, 2005-2012 to examine household level electrification across social groups in India. Correcting for the issues of endogeneity and simultaneity, we find that the marginalized communities benefited more in terms of electricity access, in line with our hypothesis.

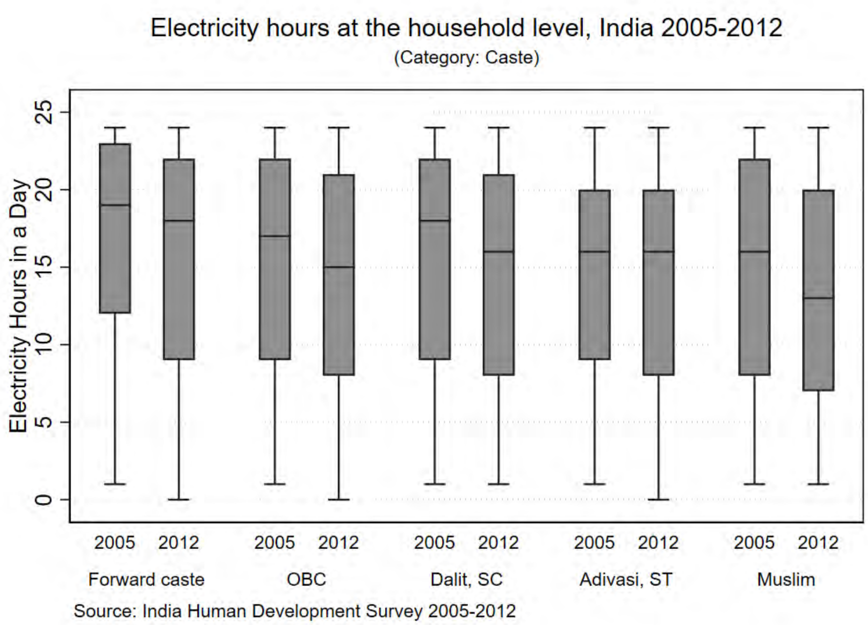
The major findings of our paper relate to the higher predicted probabilities of accessing electricity connection by the households belonging to the marginalized social groups viz. the Hindu scheduled caste, scheduled tribe and Muslims. Controlling for the over-estimation bias in the OLS and FE models, the IV-FE model shows that SC/ST Hindus were 6.7 percentage points more likely to get electricity access at the national level between 2005 and 2012. When national level household electricity hours dropped on average, the drop for SC/ST groups was relatively lower as compared to the forward caste groups. Looking at the likelihood and reliability of electricity at the regional level between 2005-2012, results show that there were variations in electricity access and reliability—while the Eastern regions did better both in terms of electricity access and reliability for the marginalized groups, the Hills and Central Plains fared poorly. Expectedly, results show that the increase in likelihood of electrification for all social groups was higher in rural areas as compared to urban areas.

In terms of utilization of electricity for welfare gains, our study is the first to analyze if marginalized households were able to translate electricity access into improved consumption, wealth and status of poverty. Results show that the marginalized groups were able to utilize electricity access to increase their consumption levels, assets and also to transition out of poverty. However, in all the household welfare related measures we analyze, the effect of electricity access and reliability was smaller for the marginalized groups as compared to the forward caste groups, indicating that there were other forms of restrictions to household welfare even when electrification was no longer a barrier.

Better access to electricity with national level policy efforts, such as the RGGVY and DDUGJY could be argued to be a means to energy equity, however, the hurdles to equitable welfare lies in utilizing those infrastructures for welfare gains. Our study highlights the need for multi-dimensional policies targeting not just energy access, but also employment, health and education. Any sound public policy such as the electrification program may fail to deliver on the objective of equitable welfare if it is not accompanied by other policies with a multi-dimensional approach to tackle other socio-economic inequalities. Our analysis shows that marginalized groups, on average, did benefit more in terms of electricity access and reliability compared to the dominant groups at the national level, but saw lower gains in consumption, assets and economic status through the utilization of electricity. Therefore, a nation–wide policy impetus on electricity, water, transportation, roads, among others could reduce social disparities in access to basic infrastructures, but it does not guarantee equitable welfare. Comprehensive reforms targeting multi-dimensional aspects of socio-economic inequalities are imperative to reduce age old social disparities.

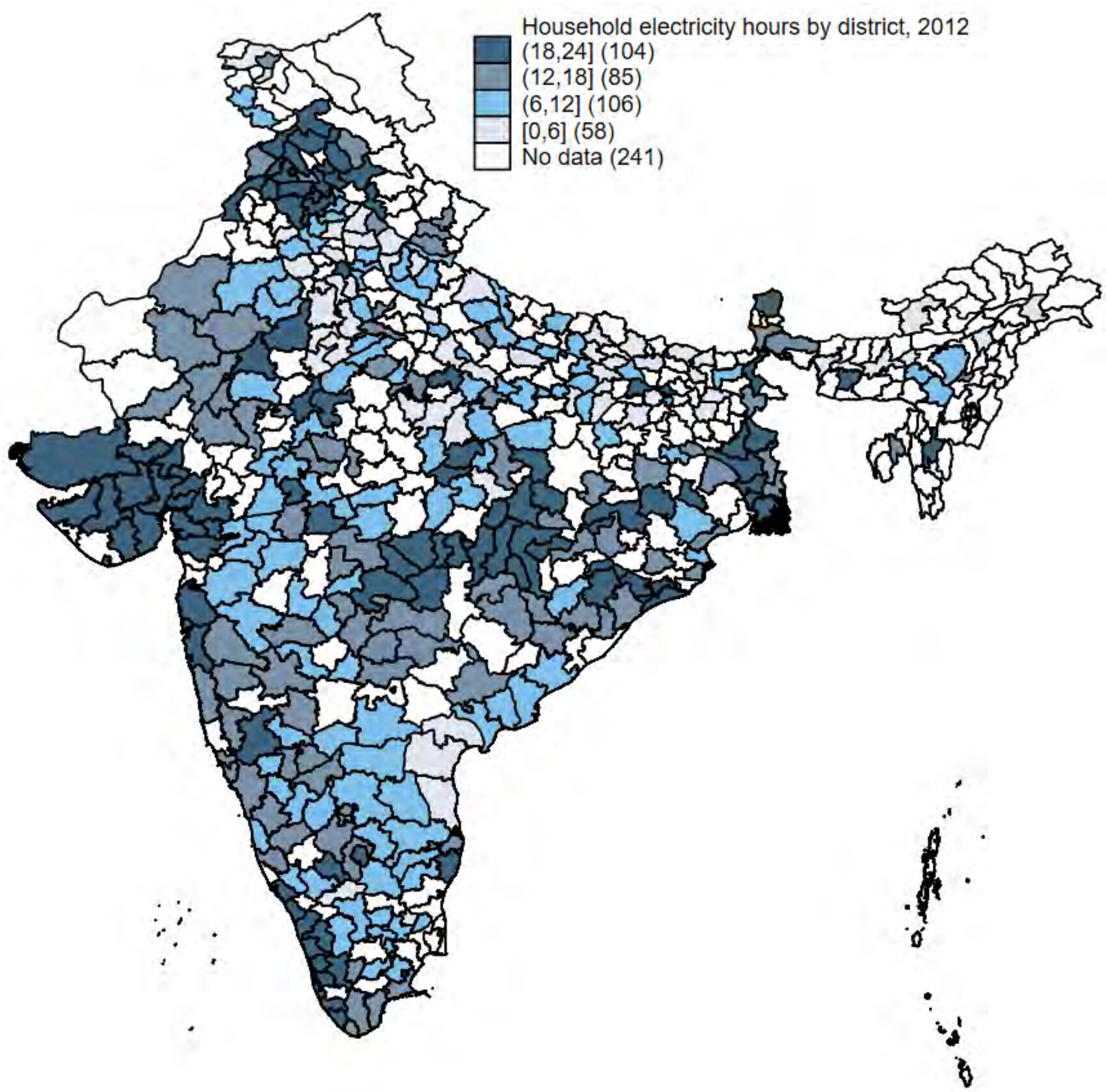
# 8 Figures and tables

Figure 1: Grid electrification hours at the household level in India, IHDS, 2005-2012.



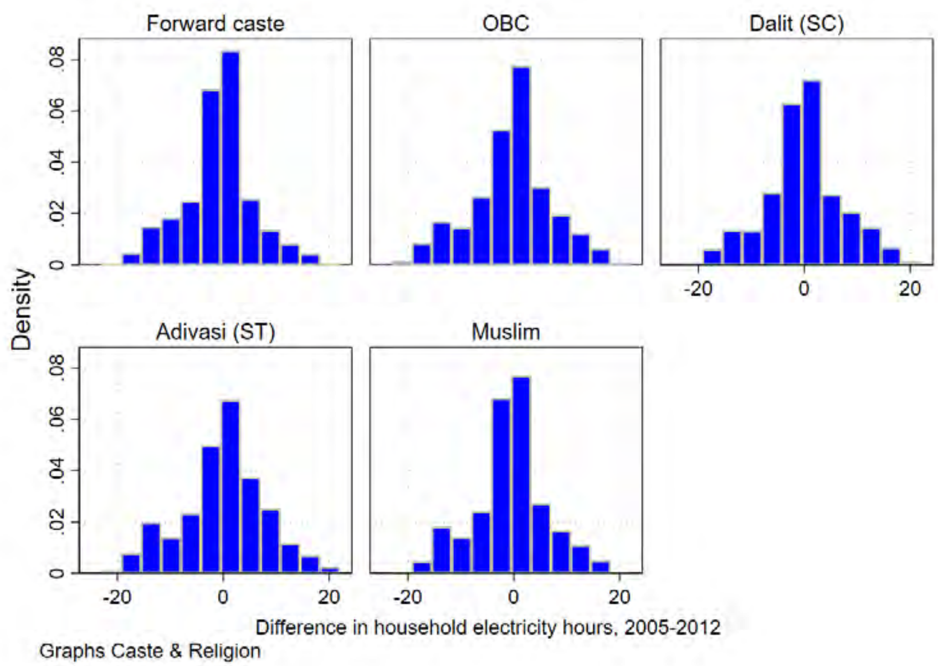

Source: Authors calculations, IHDS, 2005-2012.

Figure 2: Hours of electricity available on a typical day in the household at the district level in India, 2012, IHDS




Source: Authors elaboration, IHDS, 2012.

Figure 3: Difference in the hours of electricity received by households on a typical day by social groups, 2005-2012.




Source: Authors calculations, IHDS, 2005-2012.

Table 1: Summary Statistics by Caste for Hindus, and for Muslims, 2005-2012

| | Forward caste | | | OBC | | | SC | | | ST | | | Muslims | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2005 | 2012 | | 2005 | 2012 | | 2005 | 2012 | | 2005 | 2012 | | 2005 | 2012 |
| Variable | Obs. | Mean | | Obs. | Mean | | Obs. | Mean | | Obs. | Mean | | Obs. | Mean | |
| Electricity Access (0/1) | 20538 | 0.90 | 0.95 | 31941 | 0.79 | 0.88 | 17985 | 0.73 | 0.85 | 6976 | 0.61 | 0.80 | 10138 | 0.76 | 0.86 |
| | | (0.31) | (0.20) | | (0.41) | (0.32) | | (0.45) | (0.34) | | (0.49) | (0.39) | | (0.43) | (0.33) |
| Electricity Hours (0-24) | 18387 | 17.14 | 15.70 | 25325 | 15.49 | 14.68 | 13053 | 15.73 | 14.95 | 4262 | 14.83 | 14.72 | 7665 | 15.16 | 13.91 |
| | | (6.41) | (6.91) | | (6.82) | (6.77) | | (6.82) | (6.77) | | (6.41) | (6.93) | | (6.83) | (7.11) |
| Log real annual Con. Exp. | 20600 | 12.20 | 11.74 | 32088 | 11.92 | 11.46 | 18143 | 11.75 | 11.30 | 7009 | 11.46 | 11.12 | 10215 | 12.00 | 11.60 |
| | | (0.68) | (0.68) | | (0.70) | (0.69) | | (0.66) | (0.65) | | (0.73) | (0.72) | | (0.69) | (0.69) |
| Log real annual hh Inc. | 20333 | 12.11 | 11.68 | 31474 | 11.67 | 11.25 | 18007 | 11.51 | 11.19 | 6922 | 11.40 | 10.95 | 10103 | 11.74 | 11.36 |
| | | (1.01) | (1.08) | | (1.01) | (1.06) | | (0.90) | (0.92) | | (0.99) | (1.08) | | (0.95) | (0.98) |
| HH Head Education | 20623 | 10.42 | 11.03 | 32086 | 8.18 | 8.71 | 18119 | 6.59 | 7.43 | 7014 | 5.69 | 6.61 | 10204 | 6.88 | 7.74 |
| | | (4.22) | (4.04) | | (4.72) | (4.73) | | (4.88) | (4.90) | | (4.98) | (5.05) | | (4.97) | (5.02) |
| Assets (0-30) | 20638 | 15.66 | 18.19 | 32115 | 11.97 | 15.07 | 18157 | 10.44 | 13.46 | 7014 | 7.92 | 10.93 | 10218 | 12.09 | 15.15 |
| | | (5.78) | (5.42) | | (5.62) | (5.82) | | (5.48) | (5.63) | | (5.00) | (5.83) | | (5.62) | (5.64) |
| Poor | 20600 | 0.09 | 0.08 | 32088 | 0.21 | 0.16 | 18143 | 0.28 | 0.23 | 7009 | 0.46 | 0.36 | 10215 | 0.27 | 0.18 |
| | | (0.28) | (0.27) | | (0.41) | (0.36) | | (0.45) | (0.42) | | (0.50) | (0.48) | | (0.44) | (0.38) |
| Age in years | 20638 | 40.55 | 47.81 | 32115 | 39.49 | 46.71 | 18157 | 38.15 | 45.33 | 7014 | 38.37 | 45.40 | 10218 | 37.81 | 44.73 |
| | | (14.55) | (14.84) | | (14.24) | (14.61) | | (13.77) | (14.14) | | (13.43) | (13.54) | | (13.93) | (14.29) |
| Below Poverty Line Card | 20638 | 0.17 | 0.19 | 32115 | 0.34 | 0.36 | 18157 | 0.41 | 0.44 | 7014 | 0.50 | 0.51 | 10218 | 0.29 | 0.32 |
| | | (0.38) | (0.39) | | (0.47) | (0.48) | | (0.49) | (0.49) | | (0.50) | (0.49) | | (0.45) | (0.46) |
| Household Size | 20638 | 6.04 | 5.41 | 32115 | 6.27 | 5.49 | 18157 | 6.04 | 5.39 | 7014 | 5.94 | 5.33 | 10218 | 7.03 | 6.50 |
| | | (2.98) | (2.70) | | (3.27) | (2.79) | | (2.78) | (2.44) | | (2.93) | (2.41) | | (3.31) | (3.09) |

Source: Authors elaboration, IHDS, 2005-2012. Standard deviations in parenthesis. Muslims is separately listed in the in IHDS, therefore we cannot disaggregate the Muslim group by caste. All castes listed are for Hindus. Observations for Sikhs, Jains and Christians are dropped from the summary statistics, and all consequent analyses.

Table 2: Descriptive Statistics of electricity access and reliability by social groups in rural and urban areas, India, IHDS, 2005-2012

| | **Urban** | | | | | **Rural** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2005 | | | 2012 | | 2005 | | | 2012 | |
| Variable | Obs. | Mean | SD | Mean | SD | Obs. | Mean | SD | Mean | SD |
| | **Forward Caste** | | | | | | | | | |
| Electricity Access (0/1) | 8022 | 0.98 | 0.15 | 0.99 | 0.08 | 12516 | 0.84 | 0.36 | 0.93 | 0.26 |
| Electricity Hours (0-24) | 7839 | 19.08 | 5.51 | 18.46 | 6.10 | 10548 | 15.71 | 6.66 | 13.75 | 6.80 |
| | **OBC** | | | | | | | | | |
| Electricity Access (0/1) | 8820 | 0.95 | 0.21 | 0.98 | 0.15 | 23121 | 0.73 | 0.44 | 0.85 | 0.36 |
| Electricity Hours (0-24) | 8414 | 18.53 | 6.24 | 16.93 | 6.66 | 16911 | 13.97 | 6.59 | 13.62 | 6.57 |
| | **SC** | | | | | | | | | |
| Electricity Access (0/1) | 4630 | 0.90 | 0.30 | 0.96 | 0.20 | 13355 | 0.67 | 0.47 | 0.82 | 0.38 |
| Electricity Hours (0-24) | 4171 | 18.60 | 5.93 | 17.96 | 5.91 | 8882 | 14.38 | 6.80 | 13.59 | 6.69 |
| | **ST** | | | | | | | | | |
| Electricity Access (0/1) | 860 | 0.89 | 0.31 | 0.94 | 0.23 | 6116 | 0.57 | 0.49 | 0.78 | 0.41 |
| Electricity Hours (0-24) | 766 | 19.33 | 5.92 | 18.45 | 6.53 | 3496 | 13.84 | 6.08 | 14.04 | 6.78 |
| | **Muslims** | | | | | | | | | |
| Electricity Access (0/1) | 4465 | 0.94 | 0.25 | 0.97 | 0.18 | 5673 | 0.62 | 0.49 | 0.79 | 0.41 |
| Electricity Hours (0-24) | 4175 | 16.43 | 6.69 | 16.14 | 6.36 | 3490 | 13.65 | 6.68 | 11.57 | 7.13 |

Source: Authors elaboration, IHDS, 2005-2012. The sample is balanced for households with electricity access in both the survey waves

Table 3: OLS, FE and IV-FE: likelihood of electricity access for social groups, IHDS, 2005-2012

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | Electricity Access (0/1) | | | | |
| | OLS | FE | IV-FE | IV-FE | IV-FE |
| 2012 | 0.118*** | 0.089*** | 0.064*** | 0.089*** | 0.132*** |
| | (0.002) | (0.003) | (0.005) | (0.005) | (0.009) |
| Hindu SC/ST | -0.051*** | | | | |
| | (0.003) | | | | |
| SC/ST v Others Hindu (2012) | 0.059*** | 0.065*** | 0.067*** | | |
| | (0.004) | (0.003) | (0.003) | | |
| Muslims v All Hindu (2012) | | | | 0.011*** | |
| | | | | (0.004) | |
| Muslims v Hindu SC/ST (2012) | | | | | -0.040*** |
| | | | | | (0.005) |
| Log annual HH. Cons. | 0.137*** | 0.038*** | -0.028*** | -0.034*** | -0.067*** |
| | (0.002) | (0.002) | (0.009) | (0.009) | (0.019) |
| Household Head Education | 0.015*** | 0.002*** | 0.004*** | 0.003*** | 0.002*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.001) |
| Age in years | 0.000* | 0.001* | 0.001 | 0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.001) |
| Household size | -0.016*** | 0.000 | 0.006*** | 0.006*** | 0.013*** |
| | (0.000) | (0.001) | (0.001) | (0.001) | (0.002) |
| Below Poverty Line Card | 0.023*** | 0.010*** | 0.007** | 0.004 | -0.005 |
| | (0.002) | (0.003) | (0.003) | (0.003) | (0.005) |
| F test (instrument) | | | 8,113 | 9,219 | 4,005 |
| Observations | 154,824 | 154,824 | 154,697 | 174,992 | 70,450 |
| Number of Individuals | | 78,064 | 78,011 | 88,131 | 37,952 |

Robust standard errors are clustered at the individual level. p-values—*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Age is above 18 years for respondents. The instrument is used to capture the non-random correlation between household consumption and electricity access. Following Saxena and Bhattacharya [2018], the instrument used is ownership of motor vehicles which is argued to affect household consumption but not electricity access. The instrument is strong as per the criteria for weak instrument given by Staiger and James [1997], and various other tests for instruments given in the *xtoverid, nois* command in stata.

Table 4: Panel fixed effects instrumental variables regression: likelihood of electrification in rural and urban areas for social groups, IHDS, 2005-2012

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Electricity access (0/1) | | | | | |
| | Rural | Urban | Rural | Urban | Rural | Urban |
| 2012 | 0.097*** | 0.005 | 0.125*** | 0.018*** | 0.174*** | 0.041*** |
| | (0.007) | (0.005) | (0.007) | (0.004) | (0.013) | (0.009) |
| SC/ST v Others Hindu (2012) | 0.068*** | 0.039*** | | | | |
| | (0.004) | (0.004) | | | | |
| Muslims v All Hindu (2012) | | | 0.045*** | 0.003 | | |
| | | | (0.007) | (0.004) | | |
| Muslims v SC/ST Hindu (2012) | | | | | -0.000 | -0.030*** |
| | | | | | (0.007) | (0.006) |
| Log annual HH. Cons. | -0.030** | -0.015* | -0.034** | -0.019*** | -0.029 | -0.049*** |
| | (0.014) | (0.008) | (0.014) | (0.007) | (0.031) | (0.018) |
| F test (instrument) | 6510 | 3211 | 7221 | 4100 | 3798 | 1122 |
| Observations | 109,010 | 45,687 | 120,140 | 54,852 | 49,819 | 20,631 |
| Number of Individuals | 55,608 | 23,680 | 61,271 | 28,322 | 26,883 | 11,668 |

Robust standard errors are clustered at the individual level in parentheses, p-values—***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Age is above 18 years for respondents. Following Saxena and Bhattacharya [2018], the instrument used is ownership of motor vehicles which is argued to affect household consumption but not electricity reliability. The instrument variable is used to capture the non-random correlation between household consumption and electricity reliability. The instrument is strong as per the criteria for weak instrument given by Staiger and James [1997], and various other tests for instruments given in the *xtoverid, nois* command in stata.

Table 5: OLS FE and IV-FE: Electricity reliability (hours of electricity available on a typical day) by social groups in India, 2005-2012

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | Electricity hours (0-24) | | | | |
| | OLS | FE | IV-FE | IV-FE | IV-FE |
| 2012 | -1.320*** | -1.425*** | -1.409*** | -1.332*** | -0.776*** |
| | (0.050) | (0.077) | (0.123) | (0.113) | (0.213) |
| Hindu SC/ST | -0.065 | | | | |
| | (0.060) | | | | |
| SC/ST v Others Hindu (2012) | 0.616*** | 0.689*** | 0.692*** | | |
| | (0.084) | (0.065) | (0.065) | | |
| Muslims v All Hindu (2012) | | | | -0.054 | |
| | | | | (0.085) | |
| Muslims v SC/ST Hindu (2012) | | | | | -0.386*** |
| | | | | | (0.103) |
| Log real HH. Cons. | -0.036 | -0.170*** | -0.118 | -0.139** | -0.165*** |
| | (0.035) | (0.045) | (0.245) | (0.230) | (0.473) |
| Household head education | 0.208*** | -0.010 | -0.013 | 0.003 | 0.004 |
| | (0.005) | (0.009) | (0.010) | (0.010) | (0.016) |
| Age in years | 0.007*** | 0.056*** | 0.056*** | 0.049*** | 0.039*** |
| | (0.001) | (0.009) | (0.009) | (0.008) | (0.014) |
| Household Size | -0.308*** | -0.016 | -0.020 | 0.032 | 0.228*** |
| | (0.007) | (0.011) | (0.023) | (0.021) | (0.043) |
| Below Poverty Line Card | -0.673*** | 0.087 | 0.089 | 0.061 | 0.095 |
| | (0.044) | (0.061) | (0.062) | (0.058) | (0.097) |
| Constant | 16.481*** | 16.178*** | 15.600*** | 20.993*** | 38.264*** |
| | (0.399) | (0.629) | (2.825) | (2.655) | (5.417) |
| F test (instrument) | | | 9658 | 10,113 | 4201 |
| Observations | 116,909 | 116,909 | 116,805 | 131,777 | 43,896 |
| Number of individuals | | 58,545 | 58,545 | 66,056 | 22,014 |

Robust standard errors are clustered at the individual level in parentheses, p-values—***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Analysis of electricity hours is conditional on electricity access. Age is above 18 years for respondents. The instrument is used to capture the non-random correlation between household consumption and electricity access. Following Saxena and Bhattacharya [2018], the instrument used is ownership of motor vehicles which is argued to affect household consumption but not electricity access. The instrument is strong as per the criteria for weak instrument given by Staiger and James [1997], and various other tests for instruments given in the *xtoverid, nois* command in stata.

Table 6: Panel fixed effects instrumental variables regression: electricity reliability (hours of electricity in a typical day) in rural and urban areas for social groups, IHDS, 2005-2012

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Electricity Hours (0-24) | | | | | |
| | Rural | Urban | Rural | Urban | Rural | Urban |
| 2012 | -1.400*** | -1.248*** | -1.376*** | -1.226*** | -0.822*** | -0.641*** |
| | (0.164) | (0.199) | (0.155) | (0.174) | (0.166) | (0.195) |
| Hindu SC/ST v Other Hindu (2012) | 0.654*** | 0.719*** | | | | |
| | (0.083) | (0.108) | | | | |
| Muslims v All Hindu (2012) | | | -0.941*** | 0.671*** | | |
| | | | (0.134) | (0.114) | | |
| Muslims v SC/ST Hindu (2012) | | | | | -0.278*** | -0.213 |
| | | | | | (0.153) | (0.168) |
| Log real HH. Cons. | 0.081 | -0.280 | -0.482 | -0.672* | -0.603*** | -0.925*** |
| | (0.323) | (0.394) | (0.311) | (0.356) | (0.298) | (0.268) |
| F test (instrument) | 6701 | 4552 | 7093 | 4671 | 3239 | 1998 |
| Observations | 74,262 | 42,543 | 80,747 | 51,030 | 27,312 | 16,584 |
| Number of individuals | 37,754 | 21,875 | 41,104 | 26,217 | 13,947 | 8,547 |

Robust standard errors are clustered at the individual level in parentheses, p-values—*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Age is above 18 years for respondents. Electricity reliability is conditional on electricity access. Following Saxena and Bhattacharya [2018], the instrument used is ownership of motor vehicles which is argued to affect household consumption but not electricity reliability. The instrument variable is used to capture the non-random correlation between household consumption and electricity reliability. The instrument is strong as per the criteria for weak instrument given by Staiger and James [1997], and various other tests for instruments given in the *xtoverid, nois* command in stata.

Table 7: Panel fixed effects instrumental variable regressions: Differences in electricity access and reliability between marginalized households and all other households by region, India, 2005-2012.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| **Variables** | Electricity Access (0/1) | | | | | | |
| | Hills | North | North Central | Central Plains | East | West | South |
| **Panel (a)** | | | | | | | |
| 2012 | 0.006 | 0.005 | 0.211*** | 0.132*** | 0.124*** | 0.027*** | 0.007 |
| | (0.009) | (0.007) | (0.019) | (0.014) | (0.013) | (0.010) | (0.008) |
| SC/ST/Muslims*2012 | 0.024*** | 0.017*** | 0.035*** | 0.036*** | 0.085*** | 0.065*** | 0.052*** |
| | (0.006) | (0.005) | (0.010) | (0.008) | (0.008) | (0.007) | (0.005) |
| Log real HH. Cons. | -0.063*** | -0.017 | 0.201*** | 0.040 | -0.021 | -0.045*** | -0.071*** |
| | (0.016) | (0.011) | (0.039) | (0.029) | (0.024) | (0.016) | (0.016) |
| F test (instrument) | 139 | 264 | 289 | 399 | 491 | 654 | 424 |
| Observations | 12,478 | 15,311 | 26,138 | 30,206 | 26,804 | 25,314 | 38,741 |
| Number of Individuals | 6,281 | 7,739 | 13,164 | 15,184 | 13,489 | 12,741 | 19,533 |
| | Electricity Hours (0-24) | | | | | | |
| **Panel (b)** | | | | | | | |
| 2012 | -1.955*** | 0.388 | 0.083 | 1.467*** | -3.789*** | -1.141*** | -3.784*** |
| | (0.337) | (0.357) | (0.349) | (0.230) | (0.312) | (0.300) | (0.248) |
| SC/ST/Muslims*2012 | -0.581*** | 1.361*** | 1.143*** | -0.545*** | 1.061*** | 0.988*** | 0.837*** |
| | (0.140) | (0.203) | (0.156) | (0.119) | (0.165) | (0.153) | (0.127) |
| Log real HH. Cons. | -1.521** | 0.976 | -0.609 | 0.225 | -1.849*** | -0.583 | -0.962* |
| | (0.651) | (0.773) | (0.609) | (0.486) | (0.563) | (0.494) | (0.562) |
| F test (instrument) | 146 | 254 | 207 | 318 | 385 | 618 | 408 |
| Observations | 11,821 | 14,445 | 12,486 | 20,858 | 15,995 | 21,794 | 34,378 |
| Number of individuals | 5,934 | 7,257 | 6,247 | 10,445 | 8,016 | 10,925 | 17,232 |

Robust standard errors (clustered at the individual level) in parentheses, p-values—*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Results in panel (b) are conditional on electricity access. Additional independent variables in all regressions. States according to regions– Hills: Jammu & Kashmir, Himachal Pradesh, Uttarakhand, North: Punjab, Haryana, Chandigarh, Delhi, North Central: Uttar Pradesh, Bihar, Jharkhand, Central Plains: Rajasthan, Chattisgarh, Madhya Pradesh, East: Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Meghalaya, Assam, West Bengal, Odisha, West: Gujarat, Daman and Diu, Dadra and Nagar Haveli, Maharashtra, Goa, South: Andhra Pradesh, Karnataka, Kerela, Tamil Nadu, Pondicherry. Note some of the states mentioned are Union Territories, the classification is following IHDS (2005-2012). Following Saxena and Bhattacharya [2018], the instrument used is ownership of motor vehicles which is argued to affect household consumption but not electricity reliability. The instrument is strong as per the criteria for weak instrument given by Staiger and James [1997], and various other tests for instruments given in the *xtoverid, nois* command in stata.

Table 8: Panel fixed effects: Electrification and household assets by social groups in India, 2005-2012

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Assets (0-30), IHDS, 2005-2012 | | | | | |
| | Rural | Urban | Rural | Urban | Rural | Urban |
| | Forward caste Hindus | | SC/ST Hindus | | Muslims | |
| **Panel (a)** | | | | | | |
| Electricity Access (0/1) | 2.099*** | 3.399*** | 1.896*** | 2.923*** | 2.471*** | 2.972*** |
| | (0.050) | (0.150) | (0.053) | (0.182) | (0.103) | (0.200) |
| Log real HH. income | 0.538*** | 0.690*** | 0.678*** | 0.810*** | 0.555*** | 0.710*** |
| | (0.019) | (0.028) | (0.027) | (0.069) | (0.050) | (0.058) |
| Wave dummy | 3.195*** | 2.801*** | 3.008*** | 2.835*** | 3.022*** | 2.824*** |
| | (0.045) | (0.066) | (0.057) | (0.131) | (0.105) | (0.109) |
| Observations | 68,854 | 34,030 | 38,344 | 11,426 | 10,994 | 9,111 |
| R-squared | 0.503 | 0.442 | 0.509 | 0.495 | 0.526 | 0.477 |
| Number of individuals | 37,100 | 18,581 | 21,175 | 7,015 | 5,811 | 4,795 |
| **Panel (b)** | | | | | | |
| Electricity hours (0-24) | 0.012*** | 0.014*** | 0.016*** | 0.009 | 0.007 | 0.012 |
| | (0.003) | (0.004) | (0.004) | (0.008) | (0.009) | (0.008) |
| Log real HH. income | 0.542*** | 0.694*** | 0.765*** | 0.808*** | 0.652*** | 0.730*** |
| | (0.022) | (0.029) | (0.036) | (0.073) | (0.064) | (0.059) |
| Wave dummy | 3.474*** | 2.835*** | 3.589*** | 2.810*** | 3.444*** | 2.822*** |
| | (0.054) | (0.067) | (0.077) | (0.142) | (0.162) | (0.113) |
| Observations | 50,418 | 32,442 | 22,577 | 9,880 | 6,299 | 8,287 |
| R-squared | 0.494 | 0.422 | 0.501 | 0.455 | 0.491 | 0.445 |
| Number of individuals | 27,006 | 17,592 | 12,507 | 6,019 | 3,341 | 4,335 |

Robust standard errors (clustered at the individual level) in parentheses, p-values—*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Results in panel (b) are conditional on electricity access. Additional independent variables in all regressions: household head education, age , below poverty line card (0/1), household size.

Table 9: Panel fixed effects: electrification and annual household consumption expenditure by social groups in India,2005-2012

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Log of annual household consumption expenditure, IHDS, 2005-2012 | | | | | |
| | Rural | Urban | Rural | Urban | Rural | Urban |
| | Forward caste Hindus | | SC/ST Hindus | | Muslims | |
| **Panel (a)** | | | | | | |
| Electricity access (0/1) | 0.134*** | 0.120*** | 0.087*** | 0.005 | 0.118*** | 0.062** |
| | (0.009) | (0.028) | (0.010) | (0.027) | (0.018) | (0.029) |
| Log real HH. income | 0.110*** | 0.199*** | 0.105*** | 0.186*** | 0.093*** | 0.166*** |
| | (0.004) | (0.006) | (0.005) | (0.012) | (0.008) | (0.010) |
| Wave dummy | -0.381*** | -0.325*** | -0.358*** | -0.275*** | -0.362*** | -0.271*** |
| | (0.009) | (0.013) | (0.010) | (0.019) | (0.018) | (0.019) |
| Observations | 68,839 | 33,990 | 38,330 | 11,426 | 10,992 | 9,112 |
| R-squared | 0.433 | 0.382 | 0.443 | 0.390 | 0.451 | 0.392 |
| Number of individuals | 37,098 | 18,581 | 21,173 | 7,015 | 5,811 | 4,795 |
| **Panel (b)** | | | | | | |
| Electricity hours (0-24) | 0.002** | 0.001 | 0.002** | 0.003* | 0.002 | 0.002 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Log real HH. income | 0.115*** | 0.200*** | 0.115*** | 0.191*** | 0.103*** | 0.163*** |
| | (0.004) | (0.007) | (0.007) | (0.013) | (0.010) | (0.010) |
| Wave dummy | -0.389*** | -0.326*** | -0.364*** | -0.279*** | -0.379*** | -0.278*** |
| | (0.010) | (0.014) | (0.013) | (0.021) | (0.026) | (0.021) |
| Observations | 50,407 | 32,402 | 22,563 | 9,882 | 6,299 | 8,288 |
| R-squared | 0.435 | 0.379 | 0.458 | 0.390 | 0.446 | 0.392 |
| Number of individuals | 27,007 | 17,592 | 12,505 | 6,019 | 3,341 | 4,335 |

Robust standard errors (clustered at the individual level) in parentheses, p-values—$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Results in panel (b) are conditional on electricity access. Additional independent variables in all regressions: household head education, age , below poverty line card (0/1), household size.

Table 10: Panel fixed effects: electrification and the status of poverty (0/1) for households at the national level, 2005-2012

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Status of Poverty(0/1)), IHDS, 2005-2012 | | | | | |
| | Rural | Urban | Rural | Urban | Rural | Urban |
| | Forward caste Hindus | | SC/ST Hindus | | Muslims | |
| **Panel (a)** | | | | | | |
| Electricity access (0/1) | -0.084*** | -0.058** | -0.063*** | -0.063** | -0.105*** | -0.144*** |
| | (0.008) | (0.027) | (0.010) | (0.032) | (0.018) | (0.035) |
| Log real HH. income | -0.033*** | -0.053*** | -0.042*** | -0.052*** | -0.045*** | -0.087*** |
| | (0.002) | (0.003) | (0.005) | (0.009) | (0.006) | (0.008) |
| Wave dummy | 0.007 | -0.063*** | 0.002 | -0.133*** | -0.016 | -0.160*** |
| | (0.006) | (0.008) | (0.010) | (0.019) | (0.015) | (0.018) |
| Observations | 68,839 | 33,990 | 38,330 | 11,426 | 10,992 | 9,112 |
| R-squared | 0.050 | 0.083 | 0.046 | 0.100 | 0.049 | 0.152 |
| Number of individuals | 37,098 | 18,581 | 21,173 | 7,015 | 5,811 | 4,795 |
| **Panel (b)** | | | | | | |
| Electricity hours (0-24) | -0.002*** | -0.002*** | -0.000 | -0.002 | -0.001 | -0.002 |
| | (0.000) | (0.000) | (0.001) | (0.001) | (0.001) | (0.001) |
| Log real HH. income | -0.024*** | -0.051*** | -0.043*** | -0.052*** | -0.042*** | -0.083*** |
| | (0.002) | (0.003) | (0.005) | (0.009) | (0.005) | (0.008) |
| Wave dummy | 0.001 | -0.061*** | 0.008 | -0.122*** | -0.005 | -0.140*** |
| | (0.006) | (0.008) | (0.012) | (0.019) | (0.017) | (0.019) |
| Observations | 50,407 | 32,402 | 22,563 | 9,882 | 6,299 | 8,288 |
| R-squared | 0.032 | 0.081 | 0.039 | 0.096 | 0.037 | 0.136 |
| Number of individuals | 27,007 | 17,592 | 12,505 | 6,019 | 3,341 | 4,335 |

Robust standard errors (clustered at the individual level) in parentheses, p-values—$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Results on electricity hours are conditional on electricity access. Additional independent regressors include household head's education, household size and age of the respondent. The cut-off point for considering a household being poor is derived from the Tendulkar cut-off line (2012) [Desai and Vanneman, 2018].

Table 11: Panel fixed effects: electrification and OECD annual per capita equivalent expenditure by social groups, IHDS, 2005-2012

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Log OECD per capita annual expenditure, IHDS, 2005-2012 | | | | | |
| | Rural | Urban | Rural | Urban | Rural | Urban |
| | Forward caste Hindus | | SC/ST Hindus | | Muslims | |
| Electricity access (0/1) | 0.127*** | 0.129*** | 0.090*** | 0.009 | 0.125*** | 0.036 |
| | (0.009) | (0.030) | (0.010) | (0.030) | (0.020) | (0.031) |
| Log real HH. income | 0.108*** | 0.188*** | 0.107*** | 0.179*** | 0.093*** | 0.164*** |
| | (0.004) | (0.007) | (0.005) | (0.013) | (0.009) | (0.010) |
| Wave dummy | -0.366*** | -0.339*** | -0.350*** | -0.301*** | -0.362*** | -0.285*** |
| | (0.009) | (0.014) | (0.011) | (0.021) | (0.019) | (0.020) |
| Observations | 68,839 | 33,990 | 38,330 | 11,426 | 10,992 | 9,112 |
| R-squared | 0.267 | 0.282 | 0.273 | 0.278 | 0.282 | 0.293 |
| Number of individuals | 37,098 | 18,581 | 21,173 | 7,015 | 5,811 | 4,795 |
| **Panel (b)** | | | | | | |
| Electricity hours (0-24) | 0.002*** | 0.001 | 0.002*** | 0.002 | 0.001 | 0.003** |
| | (0.001) | (0.001) | (0.001) | (0.002) | (0.002) | (0.002) |
| Log real HH. income | 0.113*** | 0.188*** | 0.116*** | 0.184*** | 0.102*** | 0.160*** |
| | (0.004) | (0.007) | (0.007) | (0.014) | (0.011) | (0.011) |
| Wave dummy | -0.377*** | -0.340*** | -0.348*** | -0.312*** | -0.396*** | -0.293*** |
| | (0.011) | (0.015) | (0.015) | (0.023) | (0.027) | (0.021) |
| Observations | 50,407 | 32,402 | 22,563 | 9,882 | 6,299 | 8,288 |
| R-squared | 0.279 | 0.281 | 0.285 | 0.278 | 0.326 | 0.298 |
| Number of individuals | 27,007 | 17,592 | 12,505 | 6,019 | 3,341 | 4,335 |

Robust standard errors (clustered at the individual level) in parentheses, p-values—***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. OECD per capita equivalent consumption expenditure is calculated as: OECD= 1+ 0.7*( Number of Adults-1) + 0.5*(Number of Children). Analysis of electricity reliability is conditional on electricity access.

Table 12: OLS, FE and IV-FE: likelihood of electricity access for social groups, ACCESS, 2015-2018

| | (1) | (2) | (3) |
|---|---|---|---|
| | Electricity Access (0/1) | | |
| | OLS | FE | IV-FE |
| 2018 | 0.168*** | 0.165*** | 0.137*** |
| | (0.008) | (0.007) | (0.017) |
| SC/ST | -0.012 | | |
| | (0.011) | | |
| SC/ST*2018 | 0.016 | 0.013 | 0.024* |
| | (0.014) | (0.012) | (0.013) |
| Log of HH. Cons. Exp. | 0.099*** | 0.041*** | 0.013 |
| | (0.006) | (0.007) | (0.068) |
| HH head education | 0.041*** | 0.020*** | 0.002 |
| | (0.003) | (0.005) | (0.006) |
| Age in years | 0.001*** | 0.001 | 0.001* |
| | (0.000) | (0.000) | (0.000) |
| Household Size | 0.004*** | 0.003** | 0.016*** |
| | (0.001) | (0.002) | (0.004) |
| Below Poverty Line card | 0.018*** | -0.001 | 0.007* |
| | (0.007) | (0.009) | (0.010) |
| F (test) instrument | | | 231 |
| Observations | 16,939 | 16,939 | 16,939 |
| Number of Households | | 8,563 | 8,563 |

Age is above 18 years for respondents. All households are rural households in the ACCESS data. Hindus and Muslims are classified according to their caste. Status of poverty is measured as yes if the household has a Below Poverty Line card. Column 3 show the results for the instrumental variable regression. The instrument is used to capture the non-random correlation between household consumption and electricity access. Following Saxena and Bhattacharya [2018], the instrument used is ownership of motor vehicles which is argued to affect household consumption but not electricity access. The instrument is strong as per the criteria for weak instrument given by [Staiger and James, 1997], and all other checks for the instruments using the *xtoverid, nois* command in Stata. ACCESS survey states are: Uttar Pradesh, Madhya Pradesh, Bihar,Orissa, Jharkhand and West Bengal.

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