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Brian Blankenship
Columbia University

Ryan Kennedy
University of Houston

Aseem Mahajan
Harvard University

Jason Chun Yu Wong
Columbia University

Johannes Urpelainen
Johns Hopkins SAIS

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Abstract

In September 2017, the Indian government launched its "Saubhagya" initiative, aimed at achieving universal rural electrification. However, there is little academic study of strategies to increase electrification rates. We argue that a key and underappreciated barrier to expanding electrification is the transaction costs that households face in applying for a connection. Before applying, households must first obtain information on the costs of an application and the requirements for submitting one. Additionally, distribution companies' lack of capacity impedes electrification even when households seek connections. We conducted a randomized controlled trial in Uttar Pradesh, consisting of an informational campaign which provided information about the costs and procedure of applying for connections. We find that households exposed to the campaign were three times as likely to apply for a connection, and expressed lower perceptions of the cost and difficulty of applying. However, actual connection rates remained unchanged. The results suggest that transaction costs are an important barrier to electrification, but limited capacity is also an obstacle.

CPP Working Paper 01-2019

1 Introduction

In 2010, the United Nations launched the Sustainable Energy for All initiative, aimed at achieving universal energy access. Since then, the percentage of the world population without electricity dropped from over sixteen percent to under thirteen percent in 2016 [1]. Among rural households, however, almost 23% still lack electricity. This represents a barrier to growth, as studies suggest electrification is a boon for productivity and employment [2, 3].

The obstacles to electrifying rural households are manifold. For one, households may be either unable to come up with funds for the application fee or the monthly tariff or unwilling to sacrifice spending on other goods. Alternatively, households may have little interest in gaining a connection because service quality is poor [4]. These are structural problems which largely stem from low levels of income, however, and short of providing subsidized connections – which themselves carry a host of negative consequences for service quality and the environment – are difficult to overcome in the short-to-medium-term [5].

We argue that an understudied and directly manipulable barrier to electrification stems from *transaction costs*. To apply for a connection, households must not only understand the procedure and obtain information on the cost of the connection, but also sacrifice the time needed to fill out forms and attending appointments with representatives of the utility. All of these take time and effort away from activities such as farming and housework. In recent months the Indian government has attempted to tackle these barriers with its "Saubhagya" connection campaign initiative, which not only offers free or heavily subsidized connections to poorer households, but also reduces transaction costs by establishing camps near rural habitations to raise awareness of the initiative.[1] However, households face an additional hurdle in the form of distribution companies' limited capacity to process applications.

Here we report results from a preregistered randomized controlled trial in rural India to reduce the transaction costs of household electrification. We conducted a survey of 2,000 households in the state of Uttar Pradesh, half of which participated in an electrification campaign. Participating households received a tutorial explaining the procedure and costs of applying for a connection, and

[1] For more on the Saubhagya connection campaign, see Section A2 in the appendix.

were also offered transportation to deliver their applications. In this way, our approach mirrors that of the Saubhagya connection campaign initiative, although our implementation preceded the Saubhagya camps. Thus, our findings allow us to provisionally test the effectiveness of such a campaign.

We find that twenty-seven percent of households exposed to the electrification campaign applied for electricity connections (confidence intervals from 22.8% to 31.2%), compared to nine percent in the control group (confidence intervals from 6.2% to 11.8%). The electrification campaign succeeded in reducing informational barriers and transaction costs, with treated households indicating that they perceived the costs and difficulty of applying for a connection as lower than households in the control group. However, there was no difference in the rates at which treated and control households received connections. Thus, while our findings indicate that transaction costs are a formidable barrier to expanding electrification rates, they also show that only sixteen percent of applications resulted in connections. This suggests that capacity is major obstacle, as utilities were either unwilling or unable to act on the applications they received.

2 Obstacles to Household Electrification

Households face a variety of barriers to obtaining electricity connections. Some of these are outside their control, such as corruption or capacity issues in the utility, as well as poor service quality. Others stem from households' overall economic situations; some households may simply lack the disposable income to pay. Yet other obstacles, however, can be immediately overcome, such as lack of awareness of the application process and requirements.

First, households may lack the funds to pay for a connection. Households face both an upfront cost to acquire a connection, as well as the monthly cost associated with maintaining access. As a result, it is possible that even households which can afford to get connected may not be able to afford the monthly fee. Alternatively, households may be unwilling to spend less on other goods to gain access to the grid. Existing evidence suggests that popular support for lower prices is a formidable barrier to the price reform that would otherwise be necessary to finance improvements in service [6, 7].

Second, households may be unwilling to pay for an electricity connection because the quality is

poor. Data from 2011-2012 showed that the average electrified rural household in India had access to less than fourteen hours a day of service.[2] The figures are even worse in Uttar Pradesh, where the average rural household enjoys eight hours of daily service and suffers several blackouts per month [4]. Existing scholarship suggests that poor quality has a strong, negative effect on households' willingness to pay for electricity, as well as satisfaction with their connections [4, 8].

Third are capacity problems. Distribution companies (discoms) may be unwilling or unable to extend connections and provide quality service. In the Indian context, the central government forces them to supply electricity at an artificially low rate [9, 10]. As a result, discoms may neglect the needs of rural consumers both because they lack the capacity to extend and improve service and because they lack the incentive to do so [5, 11].

Finally, households face *transaction costs* to obtaining an electricity connection. To apply for a connection, households must not only know the process and cost of doing so, but also must be able to deliver their applications. A lack of knowledge may thus artificially suppress electrification rates, such that there is latent demand for connections. A long line of literature in economics argues that transaction costs can impede efficient operating in the market [12, 13]. North distinguishes three types of transaction costs: search and information costs, consisting of the difficulty in determining the price of a good or service and discovering alternative goods and services; bargaining costs, consisting of the time and effort required to strike a deal; and policing and enforcement costs, consisting of the need to monitor that one's partner complies [14, 15].

Our intervention directly reduces search and information costs while also alleviating the burden of completing and delivering applications. Indeed, evidence suggests that these electrification transaction costs are substantial. Our baseline survey showed that 76.6% of households did not know the cost of a connection, while initial piloting found a lack of awareness of the procedure and overestimation of the application cost. Ultimately, our results shed light on the relative importance of these obstacles to households electrification – affordability, quality, capacity, and transaction costs.

[2] India Human Development Survey, http://www.ihds.umd.edu/.

3 Research Design and Results

Our experiment took place in the Sitapur and Bahraich districts of Uttar Pradesh, shown in Figure 1. In the intervention, we provided a brief tutorial on the requirements and costs of applying for an electricity connection, as well as offering to provide transportation to deliver applications. 1,000 households spread evenly across 100 households in our sample participated in the electrification campaign, while an equal number of households and habitations composed the control group. We measure four main outcome variables in an endline survey conducted three months after the treatment: whether the household applied for a connection, whether it received a connection, the perceived ease of applying, and the perceived affordability of applying.[3]

[Figure 1 about here.]

The specification equation for studying the effect of the electrification campaign on our outcomes is as follows:

$$Y_{ij} = \alpha + \beta_1 \text{Campaign}_j + \gamma \mathbf{X}_{ij} + \zeta \mathbf{Z}_k + \epsilon_{ij}, \tag{1}$$

where Y_{ij} is the indicator for one of our outcome variables. Campaign is an indicator for whether habitation j participated in an electrification campaign, $\mathbf{X}$ is a vector of control variables, $\mathbf{Z}$ is a vector of fixed effects by feeder k[4], and ϵ_{ij} is the error term. We estimate robust standard errors clustered by habitation.

The main findings are shown in Figure 2. These results show that households exposed to the electrification campaign applied for connections at a rate that was almost twenty percentage points higher than that of the control group (27.2% vs. 8.6%). Similarly, treated households thought the difficulty and cost of applying for a connection were lower than the households which did not participate in the electrification campaign. At the same time, however, treated households did not have higher electrification rates.[5]

[3] Additional explanation of the study procedures can be found in section A1 in the appendix.
[4] Feeder fixed effects allow us to account for variation in service quality. See Section A1 for more detail.
[5] Tabular results can be found in Tables A5-A8.

[Figure 2 about here.]

On the one hand, these results suggest that the campaign operated as intended – lowering perceptions of the cost and difficulty of applying and ultimately resulting in more applications. On the other hand, however, stagnant connection rates indicate that the barriers to electrification extend far beyond lack of awareness. Of particular interest is a lack of utility capacity to process new applications in a timely manner, as it is clear from the rate of application that many households wanted to be connected.

In Figure A2, we explore causal mechanisms by limiting our sample to treated households and then comparing differences in application rates on the basis of various mediating variables. We expected that households who expressed greater satisfaction with the tutorial and who learned the most from the campaign would be more likely to apply. The results are consistent with these expectations. Households indicating (1) higher levels of satisfaction with the campaign and (2) that they had their questions answered in the tutorial applied for a connection at higher rates. Similarly, households saying they learned more from the campaign were more likely to apply, though this effect is not quite statistically significant.[6]

These results show that the effectiveness of the campaign shaped application rates. It was the respondents who benefited the most from the tutorial who were most likely to apply for connections. In terms of substantive effects, each of these is measured using a five-point scale. Going from 1 to 5 on satisfaction would increase application rates by nearly fifty percentage points, while the same increase in having questions answered by the tutorial would produce a twenty-five percentage point increase.

Finally, in Figure A3, we estimate heterogeneous treatment effects as specified in the pre-analysis plan. We expected that households' feelings of trust in others would condition the effect of the treatment, with more trusting respondents responding more to the treatment. However, the results are somewhat weak. The interaction term between the campaign and trust is not statistically significant, and the marginal effects reported in Figure A4 show that the confidence intervals for the effect of the treatment at each level of trust overlap entirely. But the substantive effects are fairly

[6]Tabular results can be found in Table A9.

large; among households with the lowest levels of trust, the campaign had essentially no effect, while among those with high trust, the campaign increased application rates by twenty percentage points.[7]

Taken together, our results indicate that the campaign succeeded in reducing households' barriers to applying for connections. Nevertheless, connection rates showed no significant increase among treated households, producing a substantial gap between applications and actual connections. Our data only allow us to speculate as to cause of this gap, but two related possibilities stand out. The first is a lack of administrative or infrastructural capacity. Discoms, for instance, may not have secured the resources necessary process all submitted applications and, as pointed out by skeptics of the Saubhagya scheme, such shortfalls in capacity may hinder implementation [11].[8] Second, the utilities may have refused to extend service to avoid providing electricity to more households at an artificially low rate.[9]

4 Conclusion

This study sought to determine whether an informational campaign could increase electrification rates in rural India. To do so, we implemented a randomized controlled trial in which we treated half of households with such a campaign. Our results show that the campaign decreased the transaction costs associated with applying for an electricity connection by increasing awareness of the procedure and costs of applying for connection, thus resulting in lower perceptions of the difficulty and cost of applying and, in turn, more applications. Nevertheless, these applications did not result in a significant increase in connection rates among treated households, suggesting that formidable barriers to electrification still remained.

The theoretical implications of these results are clear. Transaction costs are a major barrier to expanding electrification. But they are not the only or even necessarily the most important obstacle; our results show that applications did not result in connections. Thus, capacity issues – in terms of the utility's ability to both process new applications and act upon them – appear to

[7] Figure A5 shows that the results are similar when breaking down the trust index into a series of dummy variables. Tabular results can be found in Tables A10 and A11.

[8] Sarita Singh, "Saubhagya rollout may pose challenge: Ex-cabinet secy," *Economic Times*, September 28, 2017.

[9] Rahul Tongia, "Can the Saubhagya scheme work?" *Live Mint*, October 30, 2017.

be a crucial barrier. Of perhaps equal importance is the utility's lack of incentive to process new applications, as each new connection represents a financial drain [9, 10].

From a policy perspective, the findings suggest that informational campaigns are necessary but not sufficient. Households are unlikely to apply for connections unless the informational barriers preventing them from understanding the procedure and costs of applying are reduced. Nevertheless, tackling the issue of capacity is paramount to convert applications into connections. The challenge, however, is that increasing capacity will likely require increasing prices. This, in turn, would reduce affordability and be difficult politically.

To mitigate and potentially circumvent this challenge, future research might investigate whether similar campaigns could expand rates of access to alternative, affordable sources of energy, such as solar power. These campaigns could be especially effective if accompanied with a subsidy or voucher. Alternatively, to focus more on grid connections, further investigation could identify the conditions under which households are willing to accept price increases.

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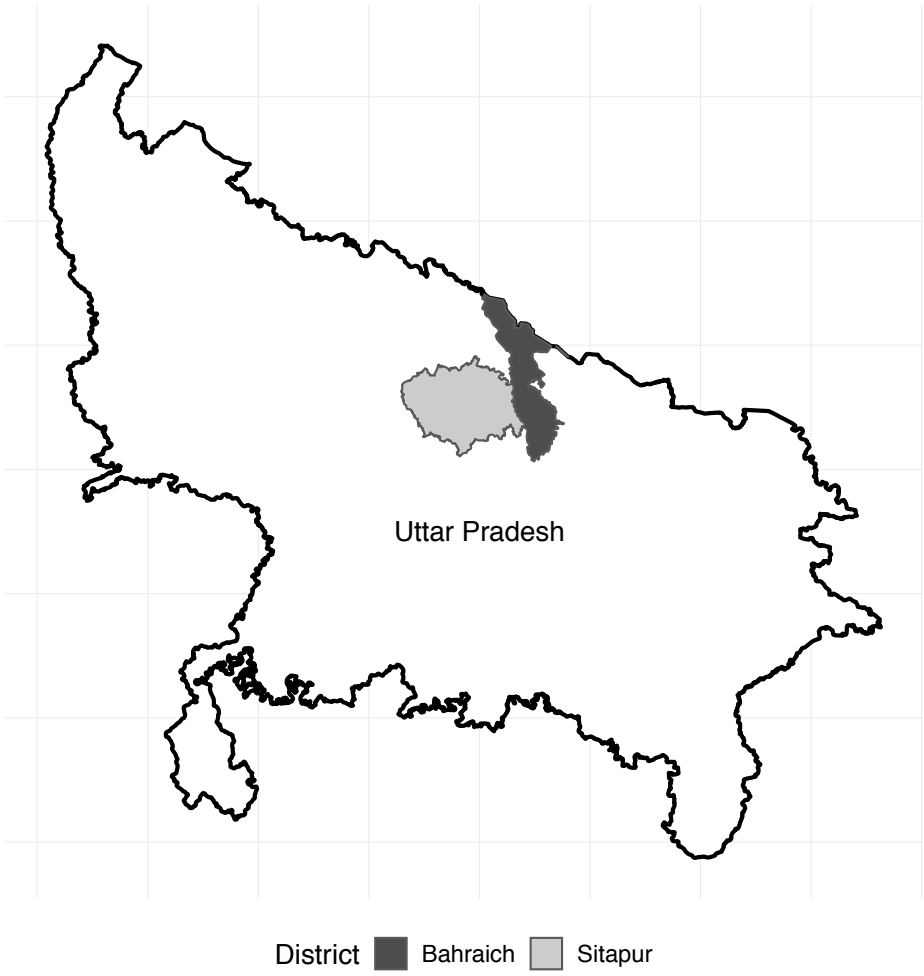
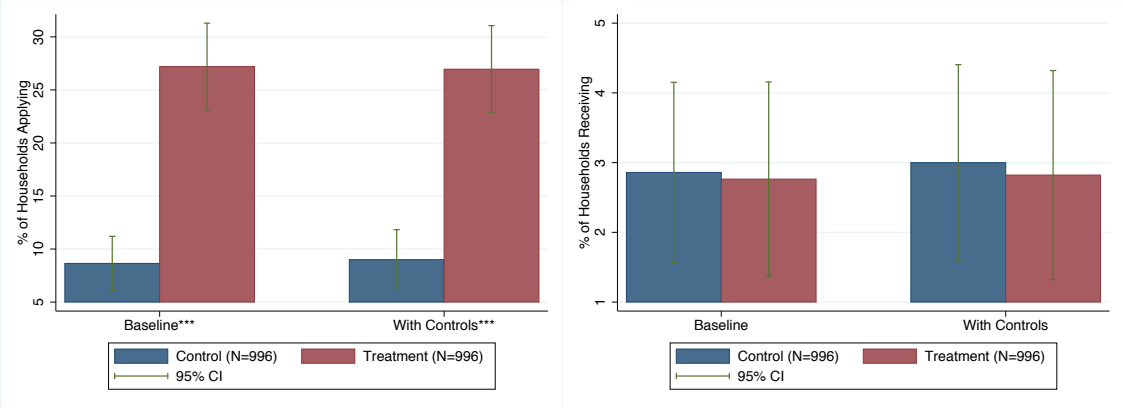
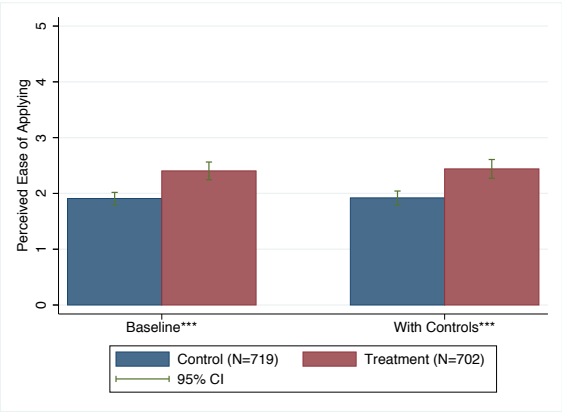


Figure 1: Bahraich and Sitapur districts in Uttar Pradesh, India, where the experiment was conducted.

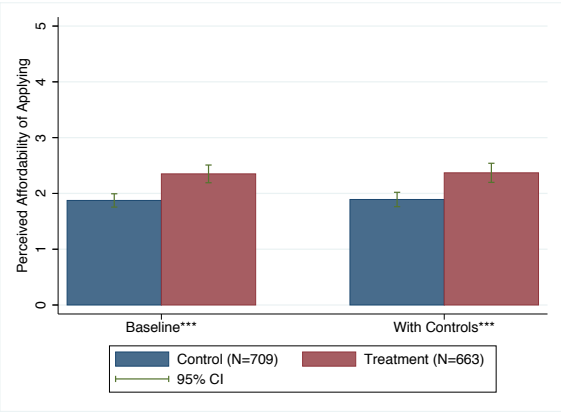


(a) Applying for a Connection

(b) Receiving a Connection



(c) Perceived Ease of Application



(d) Perceived Affordability of Application

Figure 2: Results showing the effects of participating in a campaign. Each subfigure contains both the results from a bivariate ordinary least squares regression (including feeder fixed effects) on the left, as well as the results after including additional control variables (the household's economic situation; the household's ration card status; and whether the household had heard of the Saubhagya scheme). The left (blue) bars within each set of results represents the control group mean, while the right (red) bars represents the treatment mean. Note that the actual number of observations are smaller in the models with control variables due to non-responses to some questions – namely that on ration cards. (See Section A3 in the appendix for more details.) 95% confidence intervals are shown at the top of each bar. Standard errors are clustered by habitation. Statistical significance of difference between treatment and control means indicated by: $^{*}p < 0.05$,** $p < 0.01$,*** $p < 0.001$

Increasing Rural Electrification through Connection Campaigns
Supplementary Information

Brian Blankenship
Columbia University

Ryan Kennedy
University of Houston

Aseem Mahajan
Harvard University

Jason Chun Yu Wong
Columbia University

Johannes Urpelainen
Johns Hopkins SAIS

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A1 Data and Methods

Pre-Analysis Plan, Power Analysis, and Ethical Review

Institutional Review Board (IRB) approval was obtained on August 23, 2017, and a pre-analysis plan with a power analysis was subsequently registered on the Evidence in Governance and Politics (EGAP) registry on January 11, 2018. The IRB number is HIRB00006327 and the registration ID is 20180109AB. The pre-analysis plan with power analysis can be accessed here: http://egap.org/registration/3044.

Study Site and Sampling

The study occurred in the Sitapur and Bahraich districts of Uttar Pradesh, which are located between 100 and 150 km from the regional capital of Lucknow. Uttar Pradesh is among the poorest states in India, and Sitapur and Bahraich are among the state's poorest districts. Because both districts generally have an adequate supply of electricity but low connection rates, the electrification profile works well for the purposes of our study. Sitapur and Bahraich have household electrification rates of 63.99% and 57.16%, respectively, compared to 65.98% in all of Uttar Pradesh [1]. Each of them also has a literacy rate lower than the state average (67.7%) – 61.1% in Sitapur and 49.4% in Bahraich [2].

The sample consists of 2000 non-electrified households, spread evenly across 200 habitations (clusters of households within administrative units of a census village). The list of 200 habitations[1] was gathered by enumerators, who visited the two districts and ensured that habitations met the following three criteria:

- had an adequate supply of electricity (minimum 10 hours, ideally higher) to ensure that household electrification is possible at a level that would be desirable for households;
- had low electrification rates (below 25%) to ensure that there is still potential demand; and
- were located at least 1km from other habitations in the sample.

The list was then sent to the researchers for randomization. In parallel, the enumerators recruited participant households from each village. In doing so, they used general language, asking if households were generally interested in a connection. Participation was limited to households that

- were non-electrified;
- were located within 40 meters of a power pole, which is the maximum distance a household can be for a connection to be possible;
- and expressed interest in electricity connection when asked by enumerators.

Randomization and Covariate Balance

Habitations are assigned to treatment and control groups using block randomization across strata of electricity feeders, each of which serves multiple habitations. Feeders serve as conduits in the distribution process between electricity transmission systems or sub-systems and neighborhoods. This stage of distribution has a critical impact of the quality of household electricity in India. To avoid extensive blackouts when electricity demand outstrips supply, the government cuts supply at some feeders, containing the impact. Moreover, the limited use of feeder segregation to separate electricity used by households and that used by industrial or agricultural produces also leads to variation in service. Blocking on electrical feeder improves balance in the quality of service available treatment and control habitations.

[1]Ten additional households were also chosen as back-ups.

To block, habitations were associated with their electrical feeders and then assigned pseudo-random numbers. The data was then sorted by feeder name and the random number. Within each set of habitations served by a given feeder, the first half of the randomly ordered set were assigned to the treatment and the remainder were assigned to the control.[2] Then, from each habitation, 10 households were selected to be surveyed, with the researchers ensuring that the households were non-electrified, located within 40 meters of a power pole, and expressed interest in receiving an electricity connection.

Prior to administering any treatments, enumerators conducted a baseline survey across habitations in the treated and control groups. This survey included questions on respondents' awareness of the cost and process of applying for connections, households' perceptions of the barriers to gaining access to grid electricity, household economic conditions, and institutional and social trust. A summary of the main variables from the baseline survey, as well as the outcome measures from the endline survey (discussed in greater details below), can be found in Table A1. Combined summary statistics on all the variables can be found in Table A2.

In order to ensure that our treatment and control group were balanced, we regressed households' responses to the baseline questions on a dummy variable indicating whether households were in the treatment group. Figure A1, which compares responses of households in treated habitations against those in controlled habitations, suggests that the sample was generally well-balanced. Across treatment groups, there was little to no difference in households' familiarity with Saubhagya and the application process, the obstacles preventing households from obtaining a connection, household economic conditions, and their trust in the government and in utility companies.

Compared to households in control habitations, those in treated habitations self-reported slightly less trust in their neighbors and more trust in the *pradhan* (village leader), though as shown in Table A3 these variables do not predict our outcomes of interest, and our results are also robust to controlling for these measures as shown in Table A4.

[2]Our partners identified a limited number of feeders that served an odd number of habitations. In these cases, the excess case was set aside as a possible replacement for treatment or control habitations which could not be surveyed.

Name	Description	Scale	Survey
Campaign	Whether a household participated in a connection campaign.	0 or 1	Baseline
Applied	Whether a household applied for a connection.	0 or 1	Endline
Received	Whether a household received a connection.	0 or 1	Endline
Perceived ease	Household rating of the ease of applying for electricity.	1-5	Endline
Perceived affordability	Household rating of the cost of applying for electricity.	1-5	Endline
Economic Situation: Struggling	Household describes their economic situation as struggling to pay bills.	0 or 1	Baseline
Economic Situation: Can pay bills	Household describes their economic situation as able to pay bills but not to save.	0 or 1	Baseline
Economic Situation: Can pay bills and save	Household describes their economic situation as able to pay bills and also to save.	0 or 1	Baseline
Ration Card	Whether household has an APL ration card (1), a BPL ration card (2), or no ration card (0).	0-2	Baseline
Trust in neighbors	Extent to which respondent trusts their neighbors.	1-5	Baseline
Trust in pradhan	Extent to which respondent trusts their pradhan.	1-5	Baseline
Trust in utility	Extent to which respondent trusts their utility.	1-5	Baseline
Trust in state government	Extent to which respondent trusts their state government.	1-5	Baseline
Trust	Average of trust in neighbors, pradhan, utility, and state government.	1-5	Baseline

Table A1: Summary of key independent, dependent, and control variables. The scale for perceived ease ranges from 1 (very difficult) to 5 (very easy), and the scale for perceived affordability ranges from 1 (very unaffordable) to 5 (very affordable).

Variable	Mean	Std. Dev.	Min.	Max.	N
Campaign	0.5	0.5	0	1	2000
Applied for connection	0.179	0.384	0	1	1992
Received connection	0.028	0.165	0	1	1992
Perceived ease	2.153	1.337	1	5	1421
Perceived affordability	2.104	1.32	1	5	1372
Trust	4.245	0.53	1.75	5	1768
Heard of Saubhagya	0.001	0.032	0	1	2000
Ration Card	1.457	0.883	0	2	1760
Economic situation: Struggling	0.697	0.46	0	1	2000
Economic situation: Can pay bills but can't save	0.261	0.439	0	1	2000
Economic situation: Can pay bills and save	0.043	0.202	0	1	2000
Trust in state gov't	4.508	0.72	1	5	1987
Trust in utility	3.759	1.097	1	5	1778
Trust in pradhan	4.132	1.235	1	5	1994
Trust in neighbors	4.594	0.796	1	5	1997
Obstacle: High Cost	0.854	0.353	0	1	1623
Obstacle: Poor Service	0.571	0.495	0	1	1714
Obstacle: Lack Cash	0.77	0.421	0	1	964
Obstacle: No Need	0.097	0.296	0	1	1818
Know how to apply	0.031	0.172	0	1	2000
Connection cost	0.922	0.812	0	6	468
Connection cost (Don't Know)	0.766	0.423	0	1	2000

Table A2: Summary statistics.

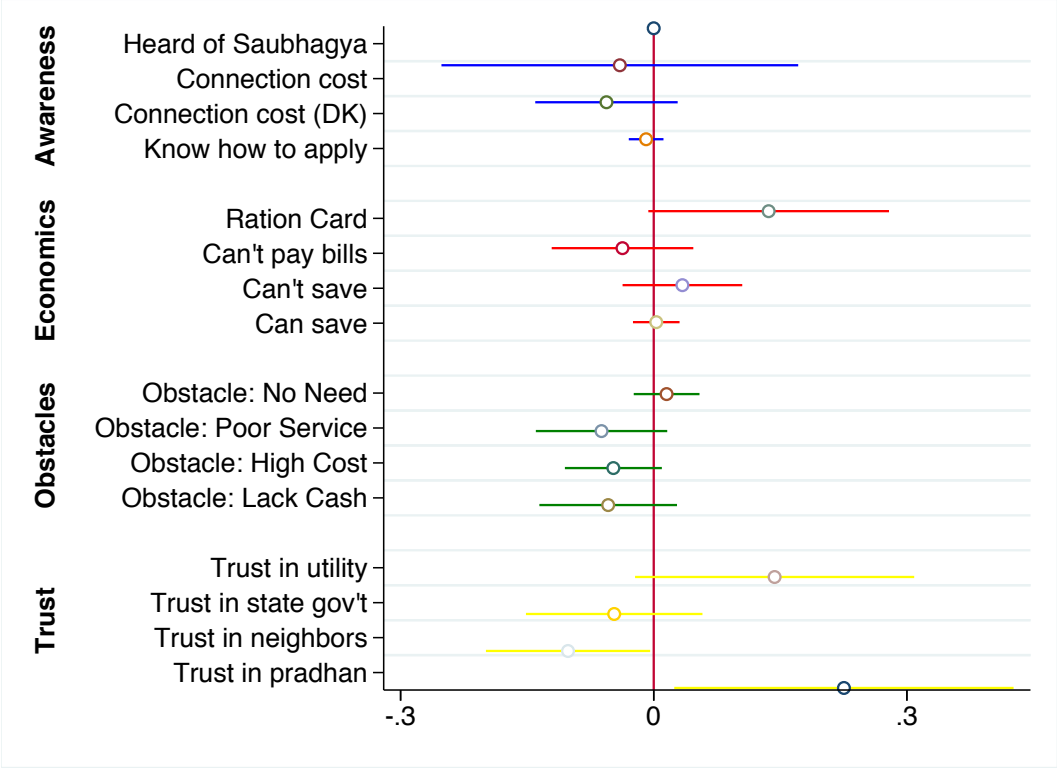


Figure A1: Balance diagnostics obtained by regressing baseline responses on assignment to treatment. The difference in means and associated confidence intervals, calculated using habitation-clustered standard errors, suggest that randomization succeeded. Note that "connection cost" is in 1000s of rupees.

	(1) Applied for connection	(2) Received connection	(3) Perceived ease	(4) Perceived affordability
Trust in pradhan	0.007	-0.003	0.073*	0.099**
	(0.008)	(0.004)	(0.035)	(0.033)
Trust in neighbors	-0.000	0.004	-0.032	-0.004
	(0.012)	(0.003)	(0.048)	(0.048)
Constant	0.122+	0.040+	1.880***	1.561***
	(0.064)	(0.024)	(0.287)	(0.271)
N	1983	1983	1414	1365
R^2	0.023	0.014	0.017	0.024

Standard errors clustered by habitation in parentheses.
$^{+}p < 0.10,^{*} p < 0.05,^{**} p < 0.01,^{***} p < 0.001$

Table A3: Results showing the effects of trust in pradhan and neighbors on outcomes.

	(1) Applied for connection	(2) Received connection	(3) Perceived ease	(4) Perceived affordability
Campaign	0.186***	0.000	0.474***	0.460***
	(0.024)	(0.010)	(0.098)	(0.099)
Trust in neighbors	0.009	0.004	-0.010	0.018
	(0.011)	(0.003)	(0.047)	(0.046)
Trust in pradhan	-0.001	-0.003	0.052	0.081*
	(0.008)	(0.004)	(0.034)	(0.032)
Constant	0.025	0.040+	1.617***	1.299***
	(0.062)	(0.023)	(0.275)	(0.256)
N	1983	1983	1414	1365
R^2	0.081	0.014	0.048	0.054

Standard errors clustered by habitation in parentheses.
$^{+}p < 0.10,^{*} p < 0.05,^{**} p < 0.01,^{***} p < 0.001$

Table A4: Results showing the effects of participating in the electrification campaign, controlling for trust in pradhan and neighbors.

Treatment

Treatment consisted of a household visit in which an enumerator provided households with information about how to apply for an electricity connection, and assisted them with the application. Prior to conducting the experiment, the local power house was contacted to inquire about any steps that need to be taken for the electrification campaign and acquire a memorandum of understanding, if needed.

As noted above, treatment was assigned to households on the basis of their habitation, which was identified in advance by one Morsel enumerator. Because households were recruited prior to the assignment of treatment, enumerators used the same recruiting language to recruit participants in treated and non-treated habitations. Potential participants were not told about the procedure or cost of receiving a connection prior to the treatment's initial administration (i.e., provision of application), and the control group was not provided this information at all.

Following the baseline survey, which was administered in treated and untreated habitations, the electrification campaign in treated habitations consisted of the following steps, undertaken individually with each participating household

- Those in the treatment condition were given a detailed introduction to electricity application, its cost, the associated procedure and timeline, and the support offered. Information provided during this introductory meeting is tailored to the household (e.g. only Below Poverty Line (BPL) households, who are provided with free electricity connections, are told BPL requirements).[3]

- Treated participants were reminded that all new connections are metered and that the fixed meter rent is 50 rupees per month.

- Participants were provided with three-page cheat sheets that summarize relevant information and requirements.

[3]BPL households are defined according to the 2011 Socio Economic and Caste Census (SECC). Whether a household qualifies as BPL is based on an index system that takes into account items like household possessions, deprivation, and occupation. Seventy-two percent of our respondents had BPL ration cards, including seventy-five percent in the treatment condition and sixty-nine percent in the control condition. The balance tests in Figure A1 show that this difference is not statistically significant.

- Treatment participants were also shown pictures of necessary application materials to obtain an electrical connection: an application form, photos, housing information, identification (BPL if appropriate), and payment.
- Participants decided whether to submit an application for an electrical connection.
- Participants filled out a survey about the electrification campaign and the usefulness of the information provided.

Following the electrification campaign, enumerators engaged in phone calls with households who chose to submit an application to ensure its timely preparation and associated payment. The enumerators and participants also agreed to a date (no later than two weeks after the baseline survey was administered) on which the enumerators could pick up the application. After conferring with the applicant about when they could expect their applications, an enumerator contacted the power house to remind them about the experiment and to inform them that the enumerators would collect the applications.

On the date agreed upon by the enumerator and applicant, the enumerator visited each habitation to collect application materials, which were taken to the power house.[4] For each household, enumerators recorded whether the application was successfully submitted. One month and three months after the submission of the applications, enumerators called respondents to inquire about their electrification rates. Three months after submission, household heads filled out short endline questionnaires, which measured their attitudes toward and familiarity with the application process and their rates of satisfaction.

Primary and Secondary Outcomes

Primary outcome variables were collected using an endline survey[5], in which households were asked to provide a binary response ("yes"/"no") indicating whether they had filled out an application and whether they obtained a legal electricity connection at home. Household applications and

[4] In some cases, an employee of the power house accompanied the enumerator to help collect the applications and payments.

[5] Where possible, endline survey data was collected using a mobile phone survey, and in remaining cases, enumerators returned to conduct in-person surveys.

successful connections were measured separately in anticipation of a potential divergence between the two outcomes occurring due the electricity company's failure to send an employee to make the connection, shortages in its stock of supplies to make the connection (e.g., meters), and unexpected financial events wherein households no longer found it viable to pursue a connection. Pilot surveys of the program revealed one case in which the electricity company failed to follow-up on an application within the period between submission and the endline survey, and one in which a household applied for a connection but was unable to obtain it due to financial difficulties arising from a member's illness. Our hypotheses based on the two variables were as follows:

Hypothesis 1 Individuals who are exposed to the electrification campaign will be more likely to *submit applications* for electricity connections than those not exposed.

Hypothesis 2 Individuals who are exposed to the electrification campaign will be more likely to *receive electricity connections* than those not exposed.

As secondary outcome variables, in the endline survey we also measured households' perceptions about the ease and affordability of applying for a connection, which we expected to change depending on their exposure to the electrification campaign. Households were asked to rate their perceptions of the ease in applying from 1 ("very difficult") to 5 ("very easy"); and the affordability of applying, from 1 ("very unaffordable") to 5 ("very affordable"). Based on our previous work, we anticipated that households tend to underestimate both the ease and affordability of the application process, and so households exposed to electrification campaigns would perceive the application process to be significantly easier and more affordable than unexposed households. The hypotheses based on these two variables were as follows:

Hypothesis 3 Exposure to an electrification campaign increases the perceived ease of application for electricity access.

Hypothesis 4 Exposure to an electrification campaign will increases perceived affordability of application for electricity access.

To better understand the causal mechanism generating the outcomes of interest, we measured a number of additional items which directly measure how effective the electrification campaign was. Following the campaign tutorial, in a short survey we asked treated households whether they would

want to apply for an electricity connection within two weeks, in a later period, or whether they would never want to apply. The same households were also asked to rate their satisfaction with the tutorial, how much they learned from it, and the extent to which it answered their questions.[6] Thus, we regress the decision to apply within two weeks on these measures of the effectiveness of the electrification campaign. In combination with household perceptions about the ease and affordability of applying for electricity (which in this case is as measured in the baseline), these offer greater insight into the aspects of the electrification campaign that were most effective in increasing application rates.

Estimation

Our primary explanatory variable of interest is whether a household participated in an electrification campaign, while our outcome variables are the four described in the previous section: 1) whether the household applied for a connection; 2) whether the household received a connection; 3) the perceived ease of applying for a connection; and 4) the perceived affordability of applying for a connection. Each of these is measured in the endline survey.

In the baseline survey we asked a number of additional items that serve as control variables. In particular, we asked respondents about their perception about their own household's economic situation, as well as whether they have a ration card.[7] In the pre-analysis plan we also indicated that we would control for whether households had heard of the Saubhagya scheme, as well as their pre-treatment estimates of the cost of applying for a connection. However, only 2 of 2,000 respondents knew what Saubhagya knows, and thus there is essentially no variation. Additionally, 76.6% of households did not know how much the cost of a connection was, and thus including this variable causes us to lose the vast majority of our observations.

To estimate the probability applying for an electricity connection (Hypothesis 1) and receiving it (Hypothesis 2), the perceived ease of applying for electricity access (Hypothesis 3) and its perceived

[6] Satisfaction was rated on a scale from 1, "very unsatisfied" to 5, "very satisfied"; and the amount learned and the extent to which questions were answered on a scale from 1, "nothing" to 5, "a great deal."

[7] Households were given options to indicate that they did not have a ration card, had a BPL ration card, or an APL ration card. With respect to their own economic situation, households indicated that they are "struggling to pay expenses" (coded as 1), "able to pay for current expenses, but not able to put money away for future" (2), and "can pay current expenses and [are] able to put away some money for future expenses" (3).

affordability (Hypothesis 4), we use the following models specification:

$$Y_{ij} = \alpha + \beta_1 \text{Campaign}_j + \gamma \mathbf{X}_{ij} + \zeta \mathbf{Z}_k + \epsilon_{ij} \tag{1}$$

where, for each household i in habitation j, Y_{ij} is one of our outcome variables, Campaign_j is an indicator variable describing whether the household's habitation participated in an electrification campaign, $\mathbf{X}_{ij}$ is a vector of control variables, $\mathbf{Z}$ is a vector of fixed effects by feeder k, α is the intercept, and ϵ_{ij} is the error term.

As described in the pre-analysis plan, we also considered potential heterogeneous treatment effects on primary outcomes based on the level of individual trust. Households were asked their degree of trust in the state government, the utility company, the pradhan, and their neighbors. Responses, measured on a scale from 1 ("strongly distrust") to 5 ("strongly trust"), were then combined using a standard Likert Scale to produce an index of trust. We expect that high trust individuals are more willing to trust our enumerators to submit their applications and the government to follow through, and thus more likely to apply for and receive connections. To test this conjecture, we consider estimated coefficients of the following specification

$$Y_{ij} = \alpha + \beta_1 \text{Campaign}_j + \beta_2 \text{Trust}_{ij} + \beta_3 (\text{Campaign}_j * \text{Trust}_{ij}) + \gamma \mathbf{X}_{ij} + \zeta \mathbf{Z}_k + \epsilon_{ij} \tag{2}$$

which adds an indicator Trust_{ij}, describing the household's trust index, to the specification given in equation 1.

Finally, to understand the underlying causal mechanisms, we test whether households who perceived the electrification campaign to be the most effective were also the households who were most likely to agree to submit an application in the next two weeks after the treatment was administered. In particular, we measure several characteristics related to the tutorial: their overall satisfaction with the tutorial, how much they learned in the tutorial, and the extent to which they felt their questions were answered. We also controlled for their rating of the ease of gaining electricity access, their rating of the affordability of the application process, and their perceptions of their own economic situations.

Agreeing to submit an application within two weeks can be modeled as:

$$Y_{ij} = \alpha + \beta \mathbf{X}_{ij} + \zeta \mathbf{Z}_k + \epsilon_{ij}, \tag{3}$$

where Y_{ij} is the indicator for whether household i in habitation j wants to submit an application in the next two weeks and α overall intercept, $\mathbf{X}$ is a vector of the mechanism measures from the previous paragraph, and $\mathbf{Z}$ is a vector of fixed effects by feeder (k). ϵ_{ij} is the error term.

In all models, we estimate robust standard errors clustered by habitation.

A2 Background on the Saubhagya Scheme

In September 2017, the Indian government launched the Sahaj Bijli Har Ghar Yojana (Saubhagya) scheme, aimed at providing grid electricity connections to all rural households. The initiative offers poor households connections at no or reduced cost. Specifically, households with an Above Poverty Line (APL) ration card can apply for a connection at the reduced cost of 500 rupees, and households with a Below Poverty Line (BPL) can apply for a connection free of charge. APL and BPL households receive a meter to measure consumption, while BPL households also receive forty meters of cable, one LED light bulb, and one electricity board.

In order to apply, households needed to provide identification and proof of address, such as a passport or voter ID card, as well as their ration card. Additionally, households needed to provide a certificate from their pradhan (village head) to verify that the household lived in the village.

As part of the scheme's implementation, the Indian distribution companies set up connection camps in each state. Households can travel to one of these camps and register for an electricity connection in-person, provided they have the relevant forms of identification and the application fee (if applicable). The cost of the scheme is estimated to be over 140 billion rupees (or 14,025 crore) for the rural households, of which sixty percent is funded by the central government, ten percent by state governments, and thirty percent by loans.[8]

[8]Nithya Palani, "All you want to know about... Saubhagya Scheme," *The Hindu Business Line*, May 21, 2018.

A3 Additional Tables

- Table A5 presents bivariate results showing the effects of participating in the electrification campaign, without controls but while including feeder fixed effects. Table A6 replicates the results from Table A5 but uses logit models to test the effect of the treatment on applications and connections and ordered logit models to test the effect of the treatment on perceived ease and affordability.

- Table A7 presents bivariate results showing the effects of participating in the electrification campaign, including feeder fixed effects and controlling for households' economic conditions and whether they have a ration card. Note that the missing data compared to Table A5 stem from missing data in the ration card variable, which in turn is caused by a large number of non-responses to this question. Thus, in Table A8 we exclude the ration card variable. The results from Supplementary Tables A5 and A7 are shown in figure-form in Figure 2 in the main text.

- Table A9 describes the electrification campaign's effectiveness in respondents' decisions to submit an application in the two weeks following the campaign. These results can be found in figure-form in Figure A2 below.

- Table A10 describes variation in the effectiveness of the electrification campaign based on respondents' self-reported trust, measured using an index (1-5) aggregating their trust in the state government, the utility company, the pradhan, and their neighbors. These results can be found in figure-form in Figure A3 below.

- Table A11 uses dummy variables to describe the variation in the effectiveness of the electrification campaign across participants classified by their trust index (1-5), which aggregates their trust in the state government, the utility company, the pradhan, and their neighbors. This allows us to detect whether trust has a non-linear conditional effect on the campaign's effectiveness. These results can be found in figure-form in Figure A5 below.

	(1) Applied for connection	(2) Received connection	(3) Perceived ease	(4) Perceived affordability
Campaign	0.186***	-0.001	0.495***	0.476***
	(0.024)	(0.010)	(0.096)	(0.099)
Constant	0.060**	0.043***	1.782***	1.719***
	(0.021)	(0.012)	(0.093)	(0.094)
N	1992	1992	1421	1372
R^2	0.081	0.014	0.047	0.047

Standard errors clustered by habitation in parentheses.

$^{+}p < 0.10,^{*} p < 0.05,^{**} p < 0.01,^{***} p < 0.001$

Table A5: Bivariate results showing the effects of participating in the electrification campaign.

	(1) Applied for connection	(2) Received connection	(3) Perceived ease	(4) Perceived affordability
Campaign	1.403***	-0.035	0.550***	0.571***
	(0.191)	(0.357)	(0.140)	(0.146)
Constant	-2.585***	-3.088***		
	(0.206)	(0.306)		
N	1992	1992	1421	1372
Log-likelihood	-852.097	-240.672	-1941.392	-1865.304

Village-clustered standard errors in parentheses.

$^{+}p < 0.10, ^{*}p < 0.05, ^{**}p < 0.01, ^{***}p < 0.001$

Table A6: Bivariate results showing the effects of participating in the electrification campaign, using logit (Models 1-2) and ordered logit models (Models 3-4).

	(1) Applied for connection	(2) Received connection	(3) Perceived ease	(4) Perceived affordability
Campaign	0.180***	-0.002	0.520***	0.478***
	(0.025)	(0.010)	(0.104)	(0.107)
Ration Card	0.025*	0.006	0.123**	0.096*
	(0.010)	(0.005)	(0.044)	(0.041)
Can't save	-0.027	-0.012	-0.143	-0.065
	(0.023)	(0.007)	(0.096)	(0.098)
Can save	0.062	0.034	-0.097	-0.018
	(0.063)	(0.041)	(0.186)	(0.176)
Constant	0.018	0.039**	1.673***	1.633***
	(0.028)	(0.014)	(0.121)	(0.120)
N	1753	1753	1248	1205
R^2	0.082	0.019	0.058	0.050

Standard errors clustered by habitation in parentheses.
$^{+}p < 0.10,^{*} p < 0.05,^{**} p < 0.01,^{***} p < 0.001$

Table A7: Results showing the effects of participating in the electrification campaign, including controls. Note that the variables *Can't save* and *Can save* describe households' economic situation and correspond to the responses "able to pay for current expenses, but not able to put money away for future" and "can pay current expenses and able to put away some money for future expenses." Both responses are treated as affirmative and compared to the reference response "struggling to pay current expenses."

	(1) Applied for connection	(2) Received connection	(3) Perceived ease	(4) Perceived affordability
Campaign	0.186***	-0.000	0.507***	0.484***
	(0.024)	(0.010)	(0.096)	(0.099)
Can't save	-0.030	-0.016*	-0.155+	-0.086
	(0.022)	(0.007)	(0.090)	(0.090)
Can save	0.037	0.021	-0.196	-0.154
	(0.054)	(0.034)	(0.167)	(0.154)
Constant	0.064**	0.045***	1.821***	1.743***
	(0.021)	(0.013)	(0.097)	(0.098)
N	1992	1992	1421	1372
R^2	0.082	0.016	0.050	0.048

Standard errors clustered by habitation in parentheses.
$^{+}p < 0.10,^{*} p < 0.05,^{**} p < 0.01,^{***} p < 0.001$

Table A8: Results showing the effects of participating in the electrification campaign, including controls except for ration card. Note that the variables *Can't save* and *Can save* describe households' economic situation and correspond to the responses "able to pay for current expenses, but not able to put money away for future" and "can pay current expenses and able to put away some money for future expenses." Both responses are treated as affirmative and compared to the reference response "struggling to pay current expenses."

	(1) Submit within two weeks
Satisfaction	0.119***
	(0.029)
Perceived ease	0.073**
	(0.025)
Perceived affordability	-0.021
	(0.013)
Amount learned	0.040
	(0.033)
Questions answered	0.065^{+}
	(0.033)
Can't save	-0.086*
	(0.038)
Can save	-0.030
	(0.090)
Constant	-0.797***
	(0.197)
N	797
R^2	0.228

Standard errors clustered by habitation in parentheses.
$^{+}p < 0.10,^{*} p < 0.05,^{**} p < 0.01,^{***} p < 0.001$

Table A9: Results showing how the effectiveness of the electrification campaign contributed to treated households' decisions to apply. Estimates are obtained using responses from the 797 of the 1,000 treated households who gave responses to all relevant questions. Note that the variables *Can't save* and *Can save* describe households' economic situation and correspond to the responses "able to pay for current expenses, but not able to put money away for future" and "can pay current expenses and able to put away some money for future expenses." Both responses are treated as affirmative and compared to the reference response "struggling to pay current expenses."

	(1) Applied for connection	(2) Received connection	(3) Perceived ease	(4) Perceived affordability
Campaign	-0.037	0.028	-0.010	0.464
	(0.150)	(0.062)	(0.650)	(0.655)
Ration Card	0.020^{+}	0.006	0.093*	0.087*
	(0.011)	(0.005)	(0.047)	(0.043)
Can't save	-0.042^{+}	-0.013^{+}	-0.235*	-0.140
	(0.024)	(0.008)	(0.103)	(0.108)
Can save	0.057	0.038	-0.147	-0.068
	(0.064)	(0.043)	(0.195)	(0.180)
Trust	0.010	0.000	0.052	0.215*
	(0.022)	(0.009)	(0.090)	(0.106)
Campaign * Trust	0.050	-0.006	0.126	0.002
	(0.036)	(0.014)	(0.149)	(0.156)
Constant	-0.017	0.039	1.515***	0.761^{+}
	(0.098)	(0.044)	(0.411)	(0.458)
N	1552	1552	1118	1081
R^2	0.088	0.023	0.059	0.059

Standard errors clustered by habitation in parentheses.
$^{+}p < 0.10,^{*}p < 0.05,^{**}p < 0.01,^{***}p < 0.001$

Table A10: Results showing the influence of trust on the effectiveness of the electrification campaign. Note that the variables *Can't save* and *Can save* describe households' economic situation and correspond to the responses "able to pay for current expenses, but not able to put money away for future" and "can pay current expenses and able to put away some money for future expenses." Both responses are treated as affirmative and compared to the reference response "struggling to pay current expenses."

	(1) Applied for connection	(2) Received connection	(3) Perceived ease	(4) Perceived affordability
Campaign	0.133**	-0.009	0.287	0.390*
	(0.044)	(0.021)	(0.188)	(0.173)
Ration Card	0.019+	0.006	0.096*	0.095*
	(0.011)	(0.005)	(0.047)	(0.043)
Can't save	-0.042+	-0.014+	-0.233*	-0.143
	(0.024)	(0.008)	(0.101)	(0.107)
Can save	0.059	0.036	-0.153	-0.067
	(0.064)	(0.043)	(0.195)	(0.183)
Medium trust	-0.033	-0.018	0.104	0.169
	(0.028)	(0.017)	(0.131)	(0.122)
High trust	0.003	-0.001	-0.183	0.042
	(0.036)	(0.016)	(0.139)	(0.140)
Very high trust	-0.002	-0.012	0.005	0.280+
	(0.033)	(0.019)	(0.137)	(0.145)
Medium trust * Campaign	0.047	0.026	0.272	0.138
	(0.051)	(0.024)	(0.235)	(0.219)
High trust * Campaign	0.032	0.012	0.527*	0.347
	(0.061)	(0.023)	(0.253)	(0.249)
Very high trust * Campaign	0.084	0.008	0.233	-0.098
	(0.055)	(0.024)	(0.236)	(0.247)
Constant	0.037	0.049*	1.718***	1.520***
	(0.038)	(0.021)	(0.153)	(0.143)
N	1552	1552	1118	1081
R^2	0.089	0.025	0.065	0.061

Standard errors clustered by habitation in parentheses.
$^{+}p < 0.10,^{*}p < 0.05,^{**}p < 0.01,^{***}p < 0.001$

Table A11: Results showing the influence of trust on the effectiveness of the electrification campaign, using dummy variables for the trust index. In this analysis, we split the trust index into four dummy variables: low trust, medium trust, high trust, and very high trust – each representing about 25% of the responses. We then interacted each of the latter three dummy variables with the dummy indicator for the campaign, with "low trust" thus representing the reference category. This allows us to detect nonlinear effects in the interactive relationship between trust and the campaign. Low trust represents values between 1.75 and 3.75 (23.47% of observations); Medium trust represents values between 4 and 4.25 (29.30%); High trust represents values at 4.5 (21.21%); and Very high trust represents values between 4.75 and 5 (26.02%). (All ranges inclusive.)

A4 Additional Figures

- Figure A2 describes how the effectiveness of various aspects of the electrification campaign contributed to respondents' decisions to apply for a connection.
- Figure A3 shows the influence of trust on the effectiveness of the electrification campaign. The results are robust to disaggregating trust across each dimension (i.e., trust in the state government, utility, *pradhan*, and neighbors).
- Figure A4 illustrates the marginal effects of the electrification campaign on the rates at which households applied for and received connections, and their perceptions of the ease and affordability of applying, conditional on their levels of trust. Figure A5, in turn, shows the influence of trust on the effectiveness of the electrification campaign using dummy variables to capture households' feelings of trust in place of the continuous index. This allows us to detect whether trust has a non-linear conditional effect on the campaign's effectiveness.

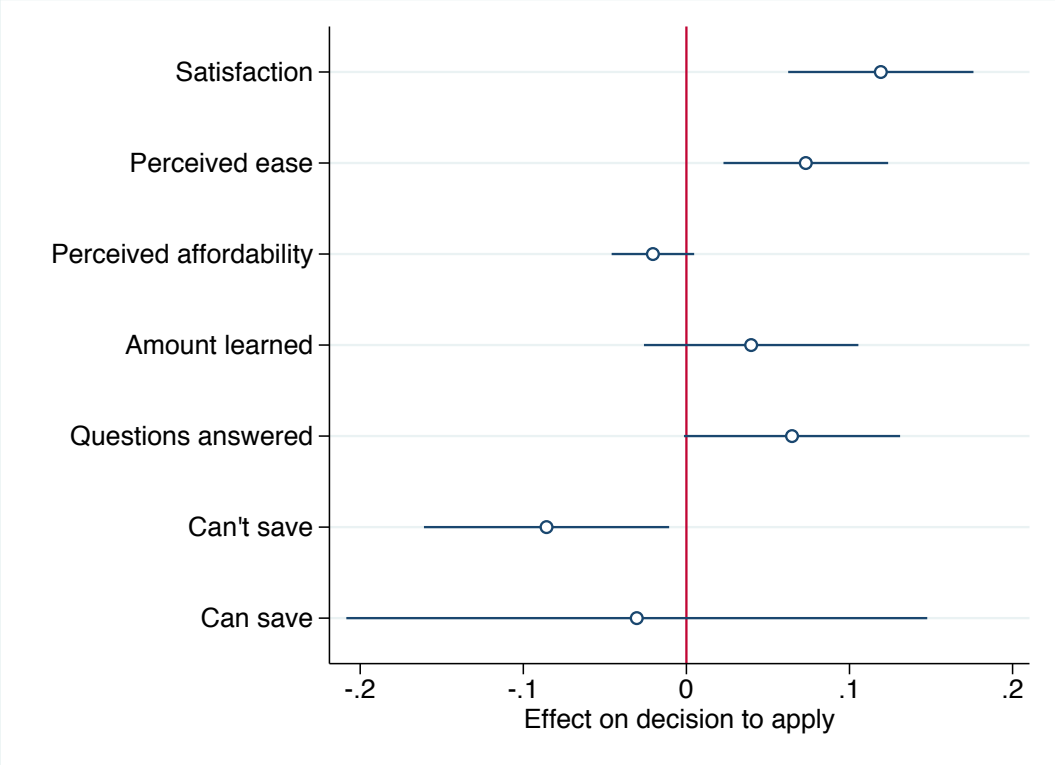


Figure A2: Results showing how the effectiveness of the electrification campaign contributed to respondents' decisions to apply for a connection. We subset treated households on the basis of a number of potentially mediating variables: households' satisfaction with the electrification campaign, their perceptions about the ease and affordability of applying, their assessment of the amount that they learned and the extent to which their questions were answered, and their economic situation. We then compare the difference in application rates on the basis of the mediating variables. The application rates among households who responded affirmatively to questions about each mediating variable (e.g., households satisfied with the campaign, those who believe that appying is easy and/or affordable, etc.) are compared to those with negative responses, whose mean application rates are centered at zero. Associated confidence intervals are calculated using habitation-clustered standard errors. Note that the variables *Can't save* and *Can save* describe households' economic situation and correspond to the responses "able to pay for current expenses, but not able to put money away for future" and "can pay current expenses and able to put away some money for future expenses." Both responses are treated as affirmative and compared to the reference response "struggling to pay current expenses."

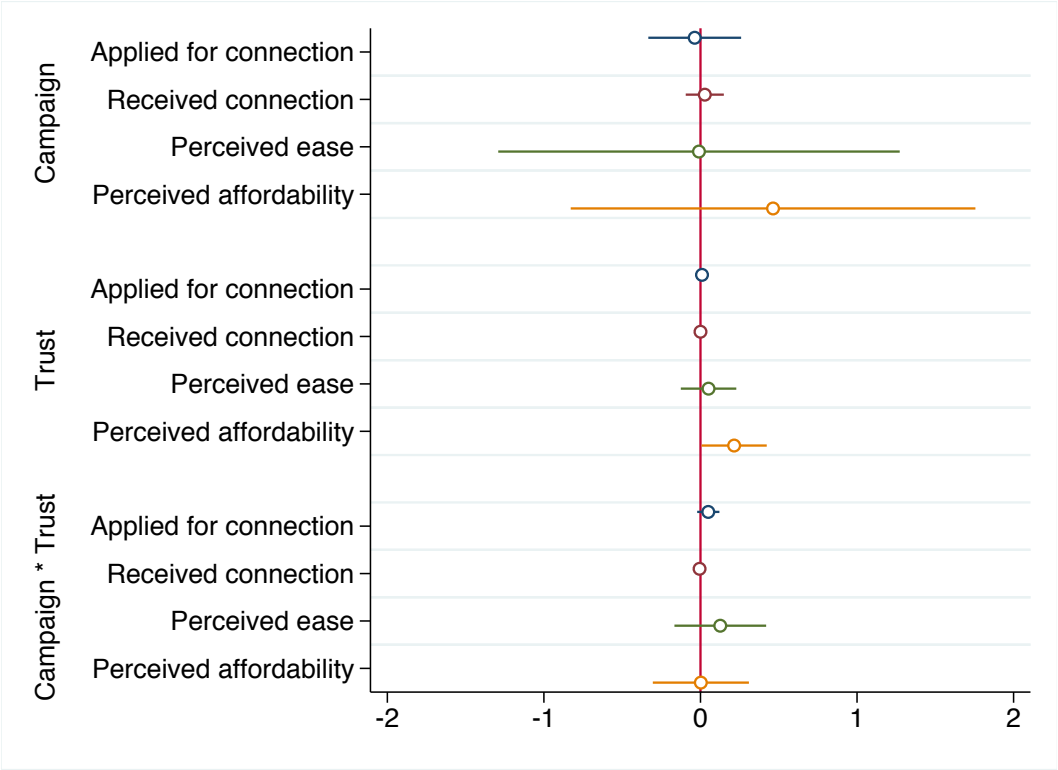
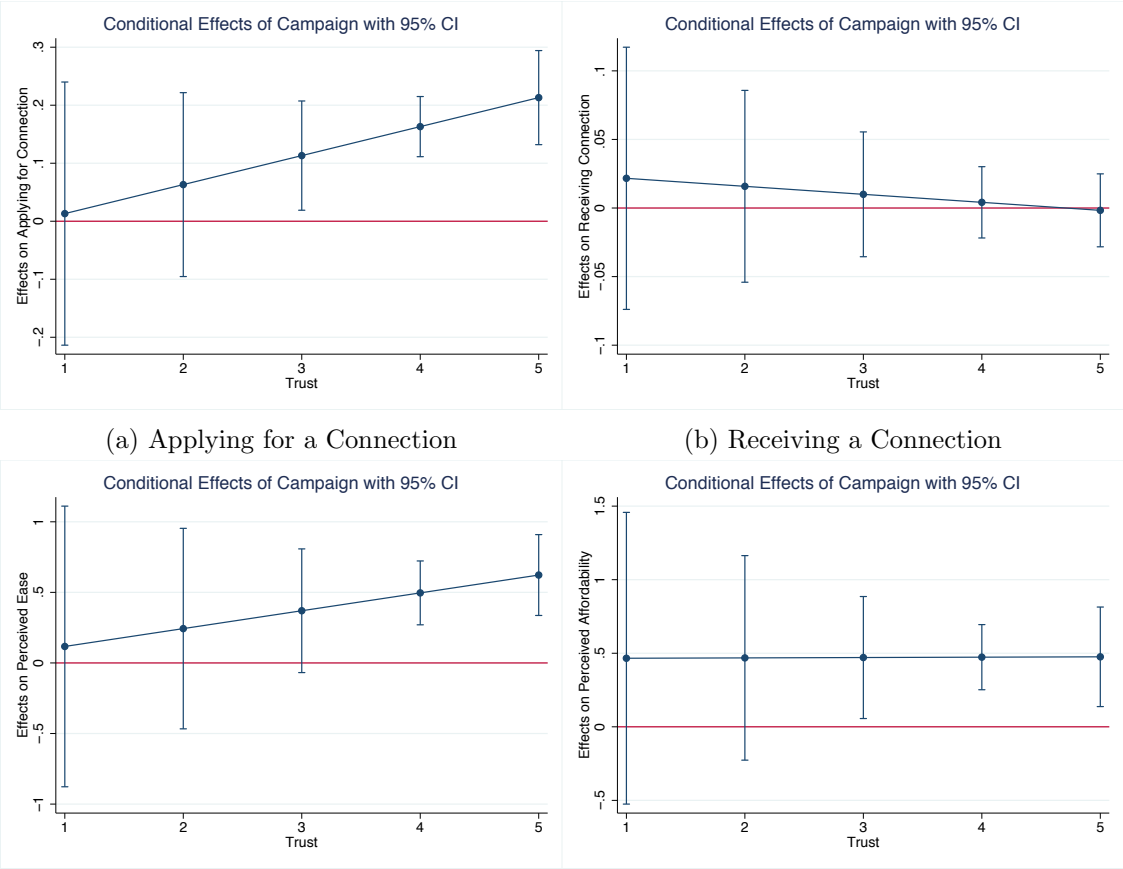


Figure A3: Coefficient plot showing the influence of trust on the effectiveness of the campaign. The coefficients represent those obtained by interacting our dummy variable indicating whether a household participated in a connection campaign with each household's level of trust (1-5).



(a) Applying for a Connection

(b) Receiving a Connection

(c) Perceived Ease of Application

(d) Perceived Affordability of Application

Figure A4: Marginal effects showing the effect of the electrification campaign on our outcomes of interest at each level of trust.

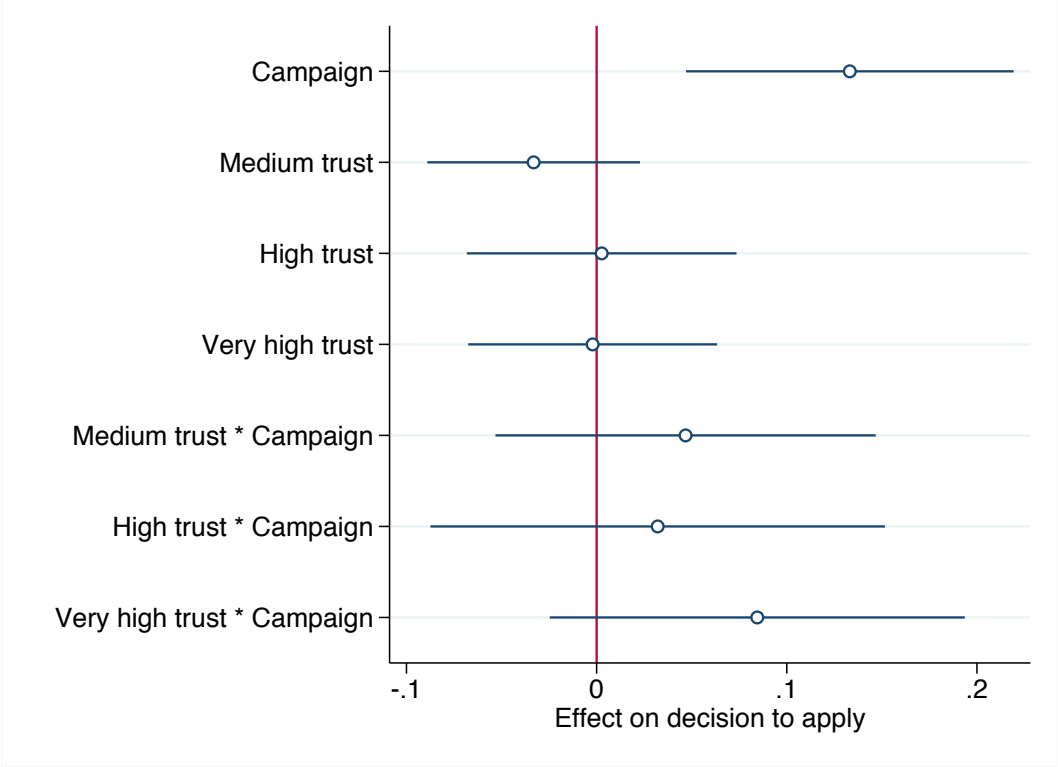


Figure A5: Coefficient plot showing the influence of trust on the effectiveness of the electrification campaign, using dummy variables for the trust index. In this analysis, we split the trust index into four dummy variables: low trust, medium trust, high trust, and very high trust – each representing about 25% of the responses. We then interacted each of the latter three dummy variables with the dummy indicator for the campaign, with "low trust" thus representing the reference category. This allows us to detect nonlinear effects in the interactive relationship between trust and the campaign. Low trust represents values between 1.75 and 3.75 (23.47% of observations); Medium trust represents values between 4 and 4.25 (29.30%); High trust represents values at 4.5 (21.21%); and Very high trust represents values between 4.75 and 5 (26.02%). (All ranges inclusive.) Coefficients for ration card and household economic situation are omitted.

Supplementary Appendix: References

[1] Ministry of Power, Saubaghya Dashboard (2017). http://saubhagya.gov.in/dashboard (accessed March 8, 2018).

[2] Government of India, 2011 Census Report (2011). District Census Hand Book.