# Appendices

**Table A1: Descriptive Statistics for households with and without electricity for 2005 and 2012**

| | No Electricity | | | No-Electricity | | |
|---|---|---|---|---|---|---|
| | 2005 | | | 2012 | | |
| | Obs. | Mean | sd | Obs. | Mean | sd |
| Monthly Per Capita Consumption Expenditure (Rs) | 5543 | 525.15 | 398.87 | 3495 | 1227.60 | 1447.68 |
| Real Income (Rs) | 5543 | 22226.86 | 23123.84 | 3496 | 30496.30 | 34828.89 |
| Assets (0-29) | 5543 | 5.50 | 2.70 | 3496 | 6.71 | 3.05 |
| Non-Poor | 5543 | 0.64 | 0.48 | 3495 | 0.64 | 0.48 |
| Household head Education | 5543 | 3.99 | 4.24 | 3496 | 4.28 | 4.51 |
| Household Head Age | 5543 | 44.88 | 13.45 | 3496 | 49.51 | 13.06 |
| Household Head Sex | 5543 | 1.11 | 0.32 | 3496 | 1.18 | 0.38 |
| Loan Banks | 5543 | 0.07 | 0.25 | 3496 | 0.11 | 0.31 |
| Membership Credit and Savings Group | 5543 | 0.06 | 0.24 | 3495 | 0.04 | 0.19 |
| Social Network | 5453 | 0.15 | 0.35 | 3491 | 0.03 | 0.16 |
| Urban | 5543 | 0.10 | 0.30 | 3496 | 0.08 | 0.28 |
| | **With Electricity** | | | **With Electricity** | | |
| | 2005 | | | 2012 | | |
| | Obs. | Mean | sd | Obs. | Mean | sd |
| Monthly Per Capita Consumption Expenditure (Rs) | 21958 | 1039.64 | 1050.83 | 25762 | 2452.87 | 2856.61 |
| Real Income (Rs) | 21958 | 58010.48 | 85353.68 | 25773 | 81256.47 | 135797.78 |
| Assets (0-29) | 21958 | 13.81 | 5.57 | 25761 | 16.99 | 5.96 |
| Non-Poor | 21958 | 0.85 | 0.35 | 25762 | 0.86 | 0.35 |
| Household head Education | 21958 | 8.25 | 4.91 | 25768 | 9.02 | 4.96 |
| Household Head Age | 21958 | 47.05 | 13.17 | 25769 | 51.56 | 12.41 |
| Household Head Sex | 21958 | 1.09 | 0.29 | 25769 | 1.15 | 0.35 |
| Loan Banks | 21958 | 0.13 | 0.33 | 25773 | 0.20 | 0.40 |
| Membership Credit and Savings Group | 21930 | 0.07 | 0.26 | 25730 | 0.13 | 0.33 |
| Urban | 21958 | 0.40 | 0.49 | 25773 | 0.38 | 0.48 |
| Electricity Hours | 21958 | 16.19 | 6.68 | 25712 | 15.27 | 6.89 |
| Social Network | 21672 | 0.40 | 0.49 | 25716 | 0.07 | 0.26 |

Source: IHDS 2005-2012

**Table A2: First Stage Results of Instrumental Variable Regression with 2sls dependent variable: Monthly per capita consumption expenditure**

| VARIABLES | FE Electricity (0/1) MPCE | FE Hours of Electricity (0/24) |
|---|---|---|
| Mean Village Level of Electricity Access | 0.56*** | |
| | (0.09) | |
| Mean Village Level Electricity Hours | | 0.95*** |
| | | (0.01) |
| Log Real Income | 0.01*** | 0.09*** |
| | (0.00) | (0.05) |
| Household Head Education | 0.00*** | 0.00 |
| | (0.00) | (0.01) |
| Household Head Sex | -0.00 | 0.27* |
| | (0.01) | (0.01) |
| Household Head Age | 0.00 | 0.00 |
| | (0.00) | (0.00) |
| Household Size | 0.00*** | 0.02 |
| | (0.00) | (0.02) |
| Social Network | 0.06*** | 0.07 |
| | (0.00) | (0.09) |
| Prob>F | 0.00 | 0.00 |
| F statistic | 189.3 | 394.64 |
| Corr (u_i, Xb) | 0.29 | -0.10 |
| Observations | 55,469 | 47356 |
| Group | 1.9 | 1.8 |
| R Square | 0.38 | 0.57 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

**Table A3: Principal Component Analysis of Household Assets: Impact of electrification on household Assets**

| VARIABLES | (1) Fixed Effects Household Assets | (2) Fixed Effects-IV Household Assets | (3) Fixed Effects Household Assets | (4) Fixed Effects-IV Household Assets |
|---|---|---|---|---|
| Electricity Access (0/1) | 0.40*** | 2.72** | | |
| | (0.06) | (1.07) | | |
| Log real income | 0.05*** | 0.03** | 0.06*** | 0.05*** |
| | (0.01) | (0.01) | (0.01) | (0.02) |
| Household Head Education | 0.02*** | 0.01*** | 0.02*** | 0.02*** |
| | (0.00) | (0.00) | (0.00) | (0.00) |
| Household Head Sex | 0.11*** | 0.14*** | 0.09** | 0.04 |
| | (0.04) | (0.04) | (0.04) | (0.05) |
| Household Head Age | 0.00 | 0.00 | -0.00 | -0.00 |
| | (0.00) | (0.00) | (0.00) | (0.00) |
| Household size | 0.01** | 0.02** | 0.01* | 0.00 |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| Social network | 0.27*** | 0.28*** | 0.25*** | 0.27*** |
| | (0.02) | (0.02) | (0.02) | (0.03) |
| Loan banks | -0.10*** | -0.12*** | -0.10*** | -0.15*** |
| | (0.03) | (0.03) | (0.03) | (0.04) |
| Membership ROSCA | -0.06* | -0.10*** | -0.06** | -0.15*** |
| | (0.03) | (0.04) | (0.03) | (0.06) |
| Year | 0.04** | 0.07*** | 0.00 | 0.08* |
| | (0.02) | (0.02) | (0.02) | (0.04) |
| Electricity hours | | | 0.02*** | 0.15** |
| | | | (0.00) | (0.06) |
| Constant | -0.58*** | -3.32*** | -1.29*** | -3.17*** |
| | (0.15) | (0.96) | (0.14) | (0.93) |
| Observations | 42,264 | 42,264 | 38,771 | 38,771 |
| R-squared | 0.023 | | 0.030 | |
| Number of id | 29,016 | 29,016 | 25,997 | 25,997 |

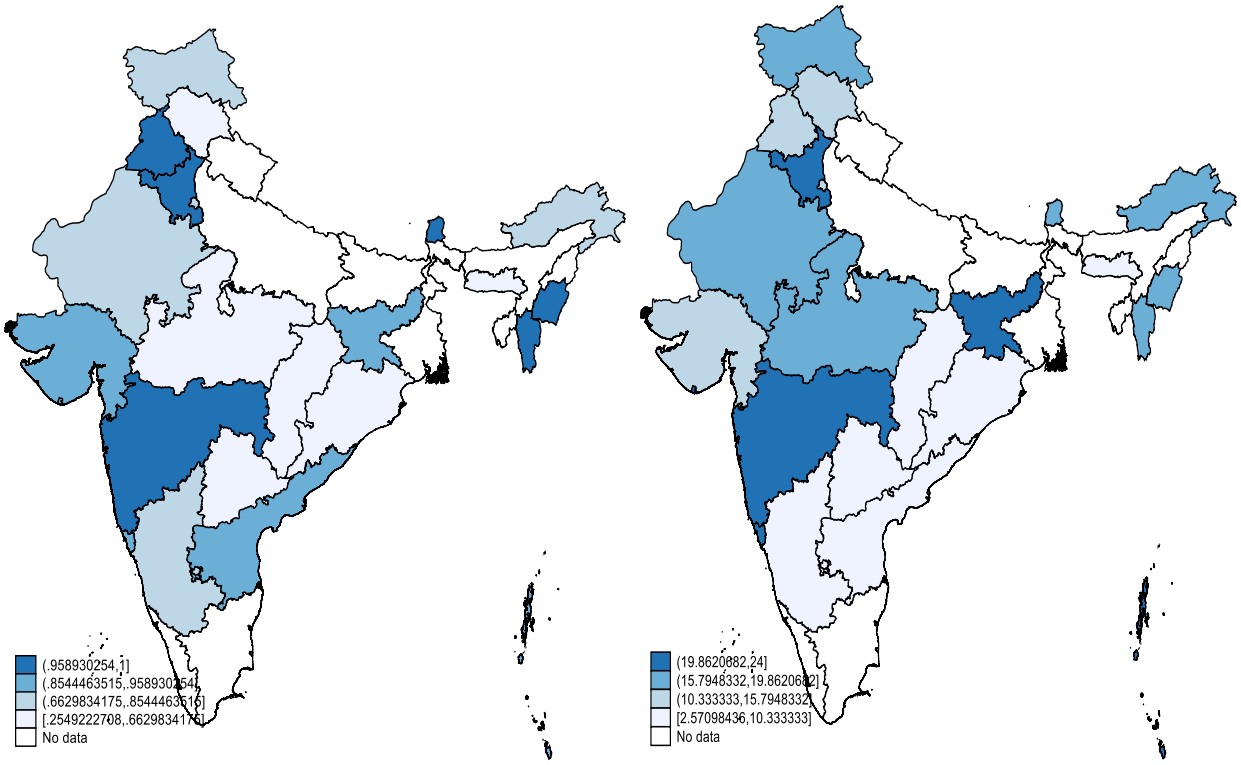
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

**Table A4: Summary Literature Review**

| | Purpose | Methodology | Sample and Time Frame | Relevant Findings |
|---|---|---|---|---|
| **Ferguson et al. (2000)** | Examine the correlations between electricity consumption/capita and GDP/capita and between total primary energy supply/capita (*e*/*E)* and GDP/capita | Correlations | 100 countries (1960-1995) | Strong correlation between electricity use and wealth creation. Stronger for wealthy countries than do poor countries. In wealthy countries, increase in wealth over time correlates with increases in the proportion of energy used in the form of electricity. |
| **Rao (2013)** | Examine the effect of electricity hours on the income of non-farm enterprises | Linear regression with an instrument variable (village electrification rate) and propensity-score matching with multiple treatment levels | 41554 households India Human Development Survey (IHDS), 2012 | Aggregate income impact across existing non-farm enterprises of improving electricity supply to 16 hours a day has been in the order of 0.1% of GDP |
| **Khandker et al. (2014)** | Examine the average and distributional effects of electrification (binary) on household welfare | Linear Regressions with an instrumental variable (village electrification rates) | Rural Households in India 22675<br><br>IHDS, 2005 | Rural electrification reduces fuel collection time for boys and girls and increases the time allocated to studying. It increases the labor supply of men and women. However, the benefits accrue mostly to wealthier rural households |
| **Ghosh (2002)** | Examine the causality between on electricity consumption and economic growth (GDP per capita) in India | Bi-directional Granger Causality Approach | Annual data 1950–51 to 1996–97 National Accounts Statistics of India, Public Electricity Supply, All India Statistics published by Central Electricity Authority | Absence of bi-directional long-run equilibrium relationship, but there exists unidirectional Granger causality running from economic growth to electricity consumption without any feedback effect. |
| **Kemmler (2007)** | Examine the approaches and emphasis of rural household electrification. | Binary Choice model: Probit | 55th round of the National Sample Survey India (1999-2000) | Marginal impact of electrification of log per capita expenditure has a coefficient of 0.29. The use of electricity depends on household characteristics and the attributes of the electricity supply. |
| **Nouni et al. (2008)** | Examining the financial viability of provisioning electricity through renewable energy-based decentralized generation options | Cost Benefit Analysis | Village census data for 1991 census has been utilized to determine state wise number of villages | Electricity (generated in a coal thermal power plant) in remote areas, located in the distance range of 5–25km varies widely from Rs.13 to 231/kWh.[9] depending on peak load and load factor. |

[9] Note: US India exchange rate in 2008 in $ terms was Rs. 49/$ on April 2008.

| | | | | |
|---|---|---|---|---|
| | | | | Renewable energy-based decentralized electricity supply options (e.g., micro hydro, dual fuel biomass gasifier systems, small wind electric generators and photovoltaics) could be financially attractive as compared to grid extension for providing access in small remote villages. |
| **Aklin et al. (2016)** | Examined the relationship between various dimensions of quality of supply (duration, reliability and voltage stability) and household's subjective satisfaction with their electricity | 45-min survey of Household Satisfaction with the quality of electricity | 8,568 households in 714 villages in Six Indian States: Bihar, Madhya Pradesh, Jharkhand, Orissa, Uttar Pradesh, West Bengal | Household satisfaction responding strongly to the average hours of electricity on a typical day.<br>The magnitude of positive effect of increasing the number of electricity hours per day by one standard deviation on satisfaction is almost as large as that of electrifying a non-electrified household. |
| **Joseph (2010)** | Examined the political economy of ongoing theft, corruption, and subsidized pricing structures in India in the quest to improve service | Contemporary perspectives on electricity reforms (Electricity Act, 2003) and evidences | Data collected across al l35 Indian districts (1994–2005)<br><br>Annual reports from the Central Electricity Authority (CEA) | Partial reforms and institutional failures have led industrial consumers across India to exit the state-run system and rely on their own on-site power generation.<br>The *generation* sector is open to private sector, but the *distribution* sector is largely state run with subsidized electricity to households and agriculture especially in the rural sector.<br>Subsidy and theft have also led the public run SEBS to operate with precarious financial positions, rendering them incapable of investing in needed infrastructural improvements, and thus unable to keep up with growing demand. |
| **Bose & Shukla (1999)** | Examined the econometric relationship between electricity consumption and income, price of electricity and diesel usage and the reliability of supply from utilities in five major consumer categories in India | Short- and long-run elasticity of electricity consumption: one without lagged effect and another with lagged effect of real electricity tariff | Time series data for 9 years (from 1985/86 to 1993/94) pooled over 19 Indian states1 | The study finds that electricity consumption in commercial and large industrial sectors are income elastic (>1), while residential, agricultural and small and medium industries are income inelastic (<1). They also find that the short-run price elasticities vary from -1.35 in agriculture, -0.65 in residential, -0.45 in large industry, -0.26 in commercial and insignificant in small and medium industry. |




(a) (b)

**Figure A1: Access and Hours of Electricity in India at the State Level, 2005**