Solar Home System in Nepal: Subsidy, Adoption & Welfare

Bishal Bharadwaj[1], Ngawang Dendup[2] Subhrendu K. Pattanayak[3], David Pullar[1]

[1] School of Earth and Environmental Science, The University of Queensland, St Lucia, QLD, Australia

[2] Faculty of Political Science and Economics, Waseda University, Tokyo-Japan

[3] Sanford School of Public Policy, Duke University, Durham, NC, USA

Introduction

Around a billion people lack access to electricity, reducing their employment and educational opportunities in several ways. It is difficult to study in poor light. Doing household activities limits to day light or household cannot use electronic appliances.

In Nepal one in ten household use Kerosene lights, especially in high hills and mountainous areas where accessibility is restricted due to geographical hardship. Government is subsidizing solar home system (SHS) since 2000AD. Subsidy is highest in very remote areas (High) and lowest in accessible areas (Low). The high areas could receive additional 50% of subsidy as compared to NRs 8000 (USD1~NRs70 in 2011) entitled to low areas. Around half a million households has adopted SHS by 2011.

However, the effect of subsidy and its household welfare effect is unknown. This study aims to fulfil this evaluation gap by estimating the effect of additional subsidy (gap between high and low) and its effect on household time allocation and child education.

We exploit the variation on subsidy across the subsidy (geographical) boundary (between low and high) with reasonable assumption that household characteristics along the boundary line doesn't vary significantly. We use local linear estimates, complemented with parametric test and several robustness checks, to estimates the effect.

So doing we contribute to small number of research estimating the welfare effect of subsidy through clean energy transition in Nepal.

We found additional subsidy increased SHS adoption and contributes to increased women participation in agricultural work and men on household work. Effect on education is limited to intensive margins only.

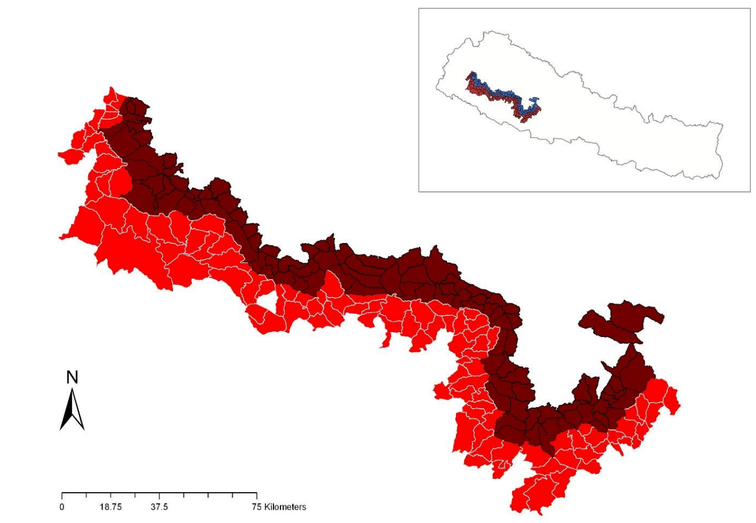

Figure 1The orange line is the subsidy boundary. North of boundary gets higher subsidy than the south. The small boundary is ward. There are 36000 wards in Nepal. The study areas lies in the western mid-hills of Nepal.

Method

Empirical Strategy

To identify the effect of additional subsidy on the adoption of SHS, we estimate following model:

$$s_h = \alpha + \tau \cdot t_h + f(d_h) + \epsilon \qquad (1)$$

where s_h is our outcome variables indicating whether household h has adopted SHS or not, τ is the parameter to estimate that captures the causal effect of additional subsidy.

The $f(d_h)$ is a continuous function of assignment variable with *n*-order polynomial. In order to avoid the functional form assumptions, we employ non-parametric approach to estimate the parameter τ. Following Calonica et al. (2014), we use the method proposed by Imbens et al. (2012) to obtain the optimal bandwidth. We use cost distance from the subsidy boundary as a running variables (Figure 1)

As highlighted by Lee et al., (2010) that geography regression discontinuity can be implemented if we can be sure that the households cannot perfectly manipulate treatment or control condition. In the case of Nepal, this is unlikely as farmer has to forgo their livelihood strategy to reallocate for the subsidy and they have to register migration in the civil registration system.

We also conduct other standard falsification test such as hypothetical line test and balancing of covariate

Data:

In this study, we use National Population and Housing Census 2011 (census 2011 hereafter) for the main analysis. The census 2011 data was collected by Central Statistics Bureau of Nepal, an agency that collects and maintains the data for the government of Nepal. It has collected both individual and household level data from about 84,1567households (CBS, 2011). To compare the SHS adoption before subsidy we use census 2001 (see figure 2).

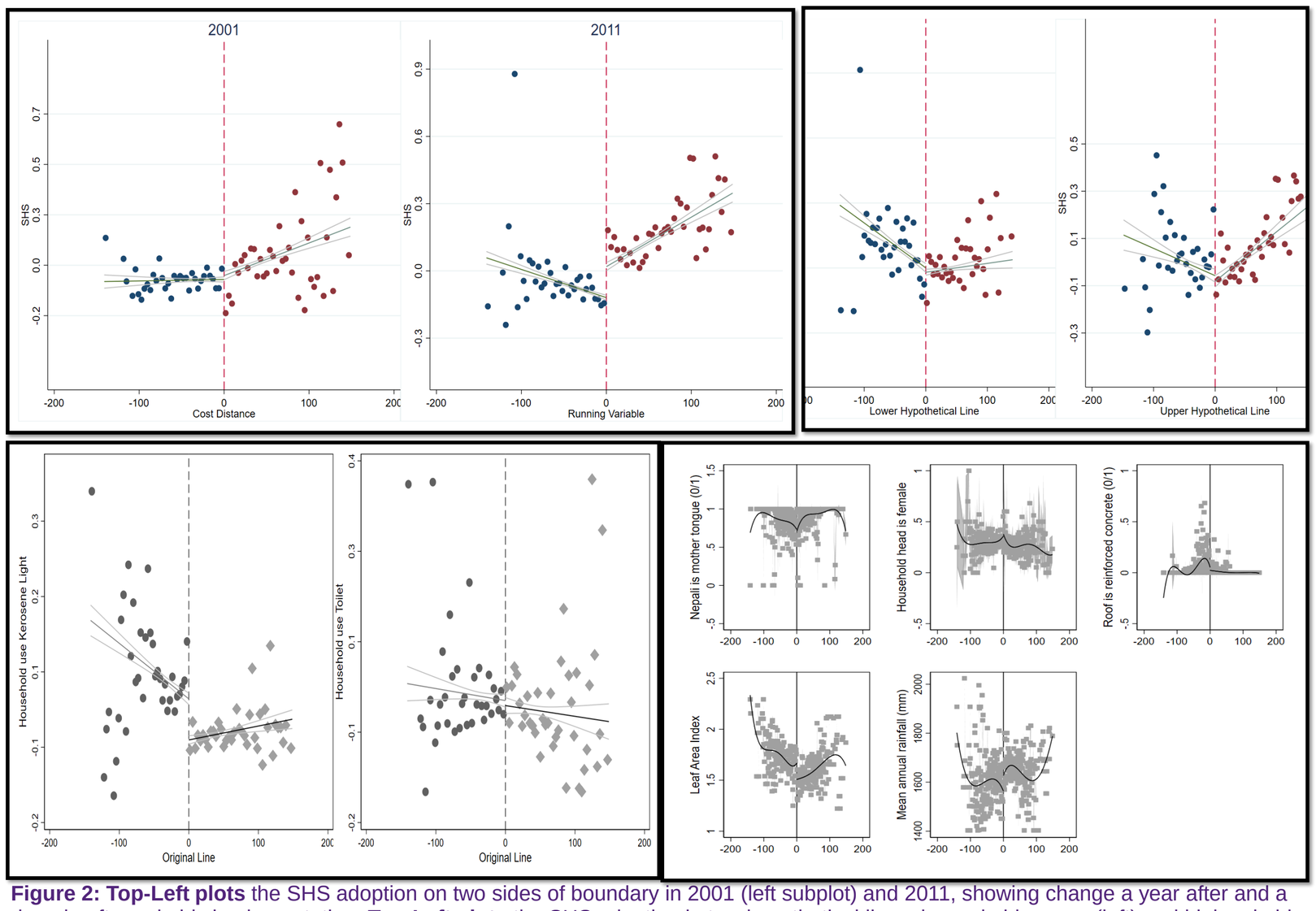

Figure 2: Top-Left plots the SHS adoption on two sides of boundary in 2001 (left subplot) and 2011, showing change a year after and a decade after subsidy implementation. **Top-Left plots** the SHS adoption in two hypothetical lines; low subsidy areas (left) and high subsidy areas (Right). We see the adoption didn't changed across the hypothetical boundary suggesting adoption change is not due to geographical or administrative but due to subsidy. **Bottom-Left** plots the effect of subsidy on substitute (Kerosene light) and placebo (Toilet), suggesting SHS adoption reduces the use of substitute but no change on the placebo. The Bottom-Right plots shows control covariates are balanced across the boundary. X-axis is cost distance from boundary (cost distance = running variable= Original line) .

Results

Subsidy and adoption

Eligible Households for additional subsidy are about 43% more likely to adopt SHS compared to not eligible and 17% less likely to use Kerosene lights. We don't see significant change neither in placebo, other areas or 2001 (Figure 2), with no significant change on covariate and placebo.

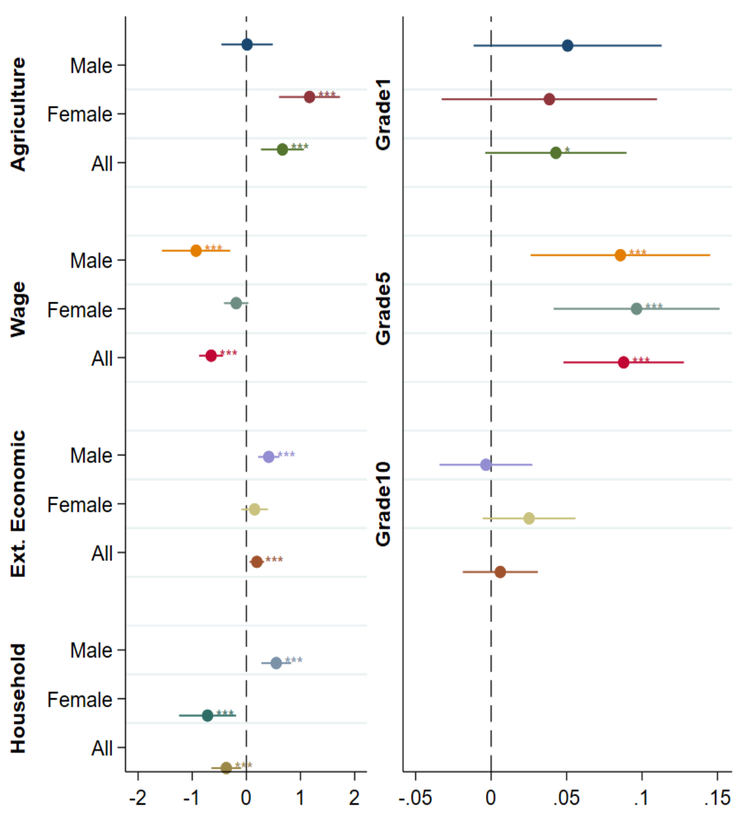

Figure 3: Welfare Effect of SHS adoption. The figure shows SHS increases education and employment but the effect is different for male and female **Left Plot** shows the effect of SHS adoption on time-allocation (month) by four sectors for **male**, **female** and **All**. **Right Plot** is the size of effect (coefficient) on education—age for school (Say, 6 year for Grade1, 10 year for Grade5 and 15 for Grade10) for male, female and other. **Dots** are estimates and **spike** is the robust error. ***, **, * indicate significant at 1, 5 and 10% respectively.

Welfare effect

Time allocation: SHS adopters spend about 0.67 more months in agricultural activities, female 1.17 months. SHS adoption reduces household work by **0.71 month** for female while male contribution increases **by 0.55 month**. SHS adoption increases male engagement on household work by **0.41 month** while no significant change was observed in female's contribution. Our result shows SHS adoption reduces the wage work by **0.65 month** for all member with no significant change in female but reduction of **0.92 month** by male, may be due to supply of female in agricultural work

Education: The results show that, 10 years old children from household with SHS are about **8.8 percent** more likely to complete grade 5, compared to children from non SHS adopters. female and female children are about **9.6% and 8.6%** respectively more likely to complete grade 5. We see no effect on the extensive margins. The no change in Grade10 is due to short period of SHS subsidy while universal child education program has resulted in almost 100% enrolment of child in Grade1.

Conclusions

Given the implementation and political challenges of correcting market failures using 'Pigouvian' taxes, it is all the more critical to understanding the effectiveness of subsidies. Our results shows additional subsidy on SHS (50% of base subsidy) has helped the adoption at rural household of Nepal.

The second important conclusion is the effect on household welfare. We show SHS effects child education on the intensive margins, which are critical when school drop rate is high in higher grades. Similarly, we see SHS adoption increases the time allocation across different nature of work.

However, given the limited economic opportunities supply of additional labor force may reduce the wage work. Adoption of SHS has also increases female work outside the house and male increased contribution in house activities. This change in time allocation among male and female can lead to gender equality or empowerment in long-term.

Reference:

Calonica et al. (2014) Econometrica, 82(6), 2295-2326

Imbens et al. (2012) The Review of Economic Studies, 79(3), 933-959

Lee et al., (2010) Journal of Economic Literature, 48(2), 281-355

b.bharadwaj@uq.edu.au

@Bishal_Bhardwaj

Bishal Bharadwaj

Sees.uq.edu

School of Earth and Environmental Science

Acknowledgements

Mr. Bharadwaj is a recipient of Endeavour Postgraduate Leadership Award, Australia.

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA
CREATE CHANGE