2-2018

Impact of electrification on children's nutritional status in rural Bangladesh

Tomoki FUJII
Singapore Management University, tfujii@smu.edu.sg

Abu S. SHONCHOY
Institute of Developing Economies

Sijia XU
New York University

Impact of Electrification on Children's Nutritional Status in Rural Bangladesh

Tomoki FUJII, Abu S. SHONCHOY,*
and Sijia XU

Abstract

We offer micro-econometric evidence for a positive impact of rural electrification on the nutritional status of children under five as measured by height-for-age Z-score (HAZ) in rural Bangladesh. In most estimates, access to electricity is found to improve HAZ by more than 0.15 points and this positive impact comes from increased wealth and reduced fertility, even though the evidence for the latter is weak. We also analyze the causal channels through the local health facility and exposure to television. We find no evidence for the presence of the former channel and mixed evidence for the latter.

Keywords: electrification, height-for-age Z score, malnutrition, television, wealth.
JEL classification: I15, O15, O22

---

*Research Fellow, Development Studies Center, IDE (Abu_Shonchoy@ide.go.jp)

The Institute of Developing Economies (IDE) is a semigovernmental, nonpartisan, nonprofit research institute, founded in 1958. The Institute merged with the Japan External Trade Organization (JETRO) on July 1, 1998. The Institute conducts basic and comprehensive studies on economic and related affairs in all developing countries and regions, including Asia, the Middle East, Africa, Latin America, Oceania, and Eastern Europe.

INSTITUTE OF DEVELOPING ECONOMIES (IDE), JETRO
3-2-2, WAKABA, MIHAMA-KU, CHIBA-SHI
CHIBA 261-8545, JAPAN

Impact of Electrification on Children's Nutritional Status in Rural Bangladesh*

Tomoki Fujii[†], Abu S. Shonchoy[‡], and Sijia Xu[§]

March 10, 2016

Abstract

We offer microeconometric evidence for a positive impact of rural electrification on the nutritional status of children under five as measured by height-for-age Z-score (HAZ) in rural Bangladesh. In most estimates, access to electricity is found to improve HAZ by more than 0.15 points and this positive impact comes from increased wealth and reduced fertility, even though the evidence for the latter is weak. We also analyze the causal channels through the local health facility and exposure to television. We find no evidence for the presence of the former channel and mixed evidence for the latter.

JEL Classification: I15, O15, O22

Keywords: electrification, height-for-age Z score, malnutrition, television, wealth

*We are very grateful to IDE-JETRO for providing us with funding for this research. We are also grateful to Md. Abdus Sattar Biswas of BREB for providing us with MIS booklets of PBS operation. We received useful comments from the participants of the conference and seminars held at the International Growth Centre, IDE-JETRO, and the University of Tokyo. All remaining errors are ours.

[†]Singapore Management University (email: tfujii@smu.edu.sg)

[‡]Institute of Developing Economies - JETRO (email: parves.shonchoy@gmail.com)

[§]Singapore Management University (email: sijia.xu.2013@phdecons.smu.edu.sg)

1 Introduction

Access to electricity can potentially play a significant role in poverty reduction and the promotion of economic growth in developing countries.[1] It is an essential element for the adoption of information and communications technology, provision of improved education and health care services, and a range of industrial activities. Moreover, extended lighted hours allow people to engage in various gainful activities—especially at night—which enable more flexible use of time. While recent decades have witnessed a significant expansion in access to electricity, the electricity supply coverage still remains low in many parts of the developing world.

Recognizing the importance of electrification for rural development, Bangladesh established the Rural Electrification Board (REB) as early as 1977 to provide access to affordable and reliable electricity in rural areas. However, because of a lack of resources and capacity, the availability of electricity in rural areas has been severely limited in Bangladesh. As of the year 2000, only 21 percent of rural households had access to electricity in Bangladesh (NIPORT, MA, and ORC Macro, 2001). However, the pace of electrification has substantially accelerated over the last decade. As of 2014, 51 percent of rural households had access to electricity from the national grid. Once electricity from solar power is included, the proportion of electrified households in the rural area rises to 65 percent (NIPORT, MA, and ICF International, 2014).

This significant improvement in the access to electricity has been accompanied by a noticeable improvement in the status of child nutrition. In the year 2000, about 47 percent of rural children under five were stunted, or abnormally short for their age and gender (NIPORT, MA, and ORC Macro, 2001). The prevalence of stunting in rural areas dropped to 38 percent in 2014 (NIPORT, MA, and ICF International, 2014).

While the spread of the access to electricity and improvement in children's nutritional status may have simultaneously occurred by just pure coincidence, there are at least four reasons to believe that a causal relationship may exist between them.

First, access to electricity may create new income opportunities. As a result, households may be able to have more and better food and medication, which in turn leads to better

[1] For example, Yang (2003) and Shiu and Lam (2004), find that electricity consumption leads to poverty reduction and economic growth in China. In Bangladesh, a similar finding is made by Ahamad and Islam (2011). Also see Cook (2011) for a review of related literature.

nutritional status. Second, access to electricity allows people to use lights at night, which enables them to engage in gainful activities that were previously difficult. This in turn may reduce fertility (Fujii and Shonchoy, 2015) and improve the nutritional outcome through the effect of the quantity-quality trade-off for children.

Third, the quality of the health care service provided in local clinics and hospitals may improve as a result of electricity access, because much of the basic equipment in modern medicine requires electricity. Finally, nutritional status may improve through the spread of information. In particular, mass media such as television could act as a powerful device for spreading important information about child care and nutrition to rural households.[2]

Using three rounds of the individual-level Bangladesh Demographic and Health Surveys (BDHS) data, we investigate the impact of rural electrification on the nutritional status of children under five. To address the potential endogeneity of the households' access to electricity, we adopt the instrumental variable (IV) approach whereby the household electrification status is instrumented by indicators of infrastructure development and quality of service delivery. Our results confirm that rural electrification positively affects child nutritional status in Bangladesh. We also investigate other plausible causal channels. Our empirical results show that the household's wealth and fertility explain at least some of the positive effect, though the evidence for fertility is weak. However, we find no evidence that the positive impact of electrification is channelled through the local health facilities. We have inconclusive evidence for the existence of causality through the channel of exposure to television.

As elaborated in Section 8, there may be causal channels other than these four. However, circumstantial evidence suggests that some of them are not particularly relevant in Bangladesh. Some other potentially important channels cannot be tested due to data limitation and these channels may explain the remaining positive impact of electrification after taking into account the causal channels of wealth and fertility. Therefore, even though our analysis of causal channels rests on somewhat strong assumptions and its scope is limited by the availability of data, this study offers a reasonably clear picture about some of the most important causal channels. To the best of our knowledge, this is one of very few studies of the impact of rural

[2] For example, a popular TV show called *Ujan Ganger Naiya* (Sailing Against the Tide) aims to improve maternal and newborn health through improved knowledge, though it started after our study period (see http://www.bbc.co.uk/mediaaction/where-we-work/asia/bangladesh/mch).

electrification on the nutritional status of children and the first study to analyze four distinct channels of causality going from electrification to child nutrition.

This paper is organized as follows. Section 2 reviews the related studies and discusses the relevance to and difference from existing studies. Section 3 provides a description of the data and key summary statistics. Section 4 discusses the econometric specification and identification strategy. Our main empirical results are presented in Section 5, followed by an exploration of the channels through which electrification affects child nutritional status in Section 6. Section 7 checks the robustness of our main results and Section 8 concludes.

2 Review of Related Literature

The motivation for this study partly comes from Fay et al. (2005), who ran regressions of child health indicators on, among others, a basic infrastructure index—a principal component made from indices of floor material, sanitation, and access to water and electricity—using aggregate data from 39 countries and five asset quintiles. They find broadly positive effects of basic infrastructure on child health. However, this result is not robust (Ravallion, 2007) and does not directly show the impact of rural electrification. We contribute to the literature on the impact of basic infrastructure on child nutrition by providing microeconometric evidence.

This study also relates to a growing body of literature on the impact of rural electrification in developing countries. In this literature, researchers have investigated various aspects of the socioeconomic impact of rural electrification. For example, positive employment or income effects were found in Bangladesh (Khandker et al., 2009), Kenya (Kirubi et al., 2009), Benin (Peters et al., 2011), South Africa(Dinkelman, 2011), and Nicaragua (Grogan and Sadanand, 2013). Several studies show that rural electrification is associated with lower fertility in Bangladesh (Fujii and Shonchoy, 2015), Brazil (Potter et al., 2002), Colombia (Grogan, 2015), Indonesia (Grimm et al., 2014), and Côte d'Ivoire (Peters and Vance, 2011). Studies also indicate that the schooling of children is positively associated with rural electrification in Bangladesh (Khandker et al., 2009), Brazil (Lipscomb et al., 2013) and Colombia (Grogan, 2015). Our study adds to this body of literature by examining a new dimension of impact that has not previously been studied.

This study also makes a contribution to a large body of literature on the consequences of child undernutrition and the determinants of children's nutritional status. Nutritional status during early childhood is known to play a significant role in the determination of children's physical and cognitive development and various studies have underscored the importance of early childhood investment in the literature (see, for example, Heckman and Masterov (2007) for the case of the US and Nores and Barnett (2010) for a review of non-US studies). Studies have also indicated that good nutrition is an essential element for good performance in school (e.g., Glewwe et al. (2001) in the Philippines, Alderman (2006) in Zimbabwe, and Maluccio et al. (2009) in Guatemala). While the current study focuses on the impact on the nutritional outcome of children and not on their educational outcomes, our results suggest that rural electrification may have an indirect long-term positive impact on schooling through improved nutritional status in addition to a direct impact through better lighting and access to various electric devices for studying.

We build our model of nutrition using the extensive literature on the determinants of the nutritional status of children. Existing studies show that the age and sex of the child, parental education and sanitary facilities are among the most important determinants of a child's nutritional status (e.g., Frongillo et al. (1997); Haughton and Haughton (1997); Li et al. (1999); Novella (2013)) and these indicators are also used in this study. Income and health care are also found to be important in some studies such as those of Banerjee et al. (2004) in India and Glewwe et al. (2002) in Vietnam. So we also include proxies for these variables in our model. We also control for community-level characteristics, because the location of residence may be important even after controlling for various individual- and household-level characteristics (Alderman, 2000).

Despite a large body of literature on the determinants of the child nutrition, there is a dearth of studies on the impact of rural electrification. To our knowledge, Glewwe et al. (2002) is the only study that has some discussion on the nutritional impact of electrification. They find that the lack of electrification in the commune health center negatively affects child nutrition but the statistical significance disappears once the effect of unsanitary toilets in the commune health center is included in their regression.

This study differs from Glewwe et al. (2002) in several aspects. First, we address the endogeneity of the electrification. Second, we consider the impact of electrification at the household level rather than at the level of the commune health center. Third, we examine four channels of causality and conduct robustness checks unlike Glewwe et al. (2002) whose primary interest was not the impact of electrification.

Finally, this study relates to a body of empirical studies in developing countries on the quantity-quality trade-off for children first theorized by Becker and Lewis (1973). The existing empirical studies so far provide mixed evidence for the presence of a quantity-quality trade-off. For example, consistent with the quantity-quality trade-off theory, Li et al. (2008) and Rosenzweig and Zhang (2009) find a negative effect of family size on children's education. Liu (2014) also finds a significant and negative impact of child quantity on child height. In Bangladesh, a quasi-experimental study by Joshi and Schultz (2013) evaluated the impact of the Maternal Child Health and Family Planning program in the Matlab subdistrict. They found that the treatment area had a significantly lower fertility and significantly higher schooling for children aged between 6 and 14, a result which is deemed to be consistent with the quantity-quality trade-off.

On the other hand, there are also studies that are at odds with, or provide no empirical support for, the existence of a quantity-quality trade-off. For example, Qian (2009) finds a positive effect from an additional child on the school enrollment of first-born children in China, and Angrist et al. (2005) find no evidence for a quantity-quality trade-off in Israel.

Most of these and other studies in the literature try to identify the quantity-quality trade-off using twining, exogenous variations in family-planning policies, or both. Our approach to the quantity-quality trade-off differs from these studies. Based the empirical study of rural households in Bangladesh by Fujii and Shonchoy (2015), we first hypothesize that the fertility-reducing effect of electrification is small when there is only one child but it is larger when there are multiple children in the household. Thus, the fertility-reducing effect of rural electrification does not have much impact on child nutrition for children without siblings. On the other hand, the observed nutritional impact of electrification on children with siblings would come in part from reduced fertility, because the sibling number may have been larger had the household not had access to electricity. While our results are not strong, they provide some support for a causal impact through the fertility channel in Bangladesh, which is consistent with the theory of a quantity-quality trade-off for children.

3 Data

The main data source for this study is three rounds of BDHS data for the years 2000, 2004, and 2007. The BDHS is a nationally representative survey and a part of the worldwide Demographic and Health Survey program. We use the records for children under the age of five in a rural household with a mother aged between 15 and 49. While the BDHS data are also available for the year 2011, we chose not to use them because the data do not allow us to distinguish between electricity from the national grid and electricity from home solar panels. While this point is true for earlier years, the electricity from the home solar panels is a relatively new phenomenon and is not very important for earlier rounds of the BDHS (see Khan and Azad (2014)).

The BDHS data provide us with demographic and nutritional indicators, including the height-for-age Z-score (HAZ) and a number of other individual- and household-level covariates. The HAZ used in this paper is included in the BDHS data and is based on the WHO standard, which is a widely used indicator for the long-term nutritional status of children (Behrman and Deolalikar, 1988). We construct our nutrition models based on existing studies of the determinants of a child's nutritional status. Our model includes both the proximal determinants and socioeconomic determinants, where the former are closely related to the biological functions of mothers and children or to specific maternal practices related to food intake, health, and care giving, and the latter represent the resources necessary for achieving adequate food security, care, and a healthy environment. As proximal determinants, we include demographic information about the child and parents, height and weight of the mother, and toilet facility indicators as a proxy for the sanitary condition of the household. As socioeconomic determinants, we include the number of children, roof material, land ownership, and asset holdings.

Table 1 presents summary statistics for individual- and household-level variables from the BDHS for 2000 to 2007 disaggregated by the electrification status of the household, where a unit record is a child under the age of five. The first row of Table 1 shows that children in electrified households are on average better nourished than those in non-electrified households. As Figure 1

Table 1: Summary statistics by household electrification status.

	Year 2000			Year 2004			Year 2007		
	Nonelec	Electrified	All	Nonelec	Electrified	All	Nonelec	Electrified	All
Child's HAZ	-2.19	-1.69	-2.08***	-2.15	-1.72	-2.02***	-1.94	-1.58	-1.81***
	(1.39)	(1.32)	(1.39)	(1.32)	(1.32)	(1.34)	(1.32)	(1.26)	(1.31)
Basic									
Child's age (mth)	28.59	28.12	28.49	29.50	28.53	29.22	30.28	30.27	30.28
	(17.35)	(17.88)	(17.46)	(17.04)	(17.23)	(17.10)	(16.97)	(17.40)	(17.12)
Child is a boy	0.51	0.48	0.50	0.51	0.51	0.51	0.49	0.48	0.49
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)
Mother's age (yrs)	25.97	25.59	25.90	25.79	25.00	25.56	25.85	25.69	25.79
	(6.61)	(5.97)	(6.48)	(6.52)	(5.73)	(6.31)	(6.29)	(6.20)	(6.26)
Mother's education (yrs)	2.09	5.14	2.73***	2.60	5.00	3.30***	3.40	5.99	4.31***
	(2.97)	(3.82)	(3.40)	(3.16)	(3.62)	(3.47)	(3.59)	(4.12)	(3.98)
Mother's height (cm)	150.27	151.12	150.44***	150.42	150.46	150.43	150.11	150.87	150.38***
	(5.20)	(5.46)	(5.26)	(5.30)	(5.21)	(5.27)	(5.24)	(5.16)	(5.22)
Mother's weight (kg)	42.39	45.63	43.06***	43.27	45.91	44.03***	43.72	46.90	44.85***
	(5.79)	(6.98)	(6.20)	(5.89)	(7.75)	(6.60)	(6.04)	(7.81)	(6.88)
Father's education (yrs)	2.65	6.36	3.42***	2.84	5.43	3.59***	2.95	6.18	4.09***
	(3.70)	(4.69)	(4.21)	(3.68)	(4.40)	(4.08)	(3.92)	(4.79)	(4.52)
No. of surviving children	2.92	2.50	2.83***	2.90	2.40	2.75***	2.75	2.37	2.62***
	(1.74)	(1.51)	(1.70)	(1.73)	(1.41)	(1.66)	(1.57)	(1.42)	(1.53)
Use flush toilet	0.02	0.14	0.04***	0.01	0.07	0.03***	0.05	0.29	0.14***
	(0.12)	(0.35)	(0.20)	(0.12)	(0.26)	(0.17)	(0.23)	(0.45)	(0.34)
Use pit latrine	0.38	0.63	0.43***	0.42	0.70	0.50***	0.20	0.21	0.21
	(0.48)	(0.48)	(0.49)	(0.49)	(0.46)	(0.50)	(0.40)	(0.41)	(0.40)
Wealth Proxy									
Cement roof	0.03	0.10	0.04***	0.02	0.07	0.04***	0.00	0.07	0.03***
	(0.17)	(0.30)	(0.21)	(0.15)	(0.25)	(0.19)	(0.07)	(0.26)	(0.16)
Rudimentary roof	0.68	0.82	0.71***	0.84	0.91	0.86***	0.87	0.91	0.89***
	(0.47)	(0.38)	(0.46)	(0.37)	(0.29)	(0.35)	(0.33)	(0.28)	(0.32)
Own land	0.48	0.64	0.51***	0.50	0.63	0.54***	0.42	0.57	0.47***
	(0.50)	(0.48)	(0.50)	(0.50)	(0.48)	(0.50)	(0.49)	(0.49)	(0.50)
Have wardrobe	0.13	0.51	0.21***	0.15	0.45	0.24***	0.23	0.60	0.36***
	(0.34)	(0.50)	(0.41)	(0.36)	(0.50)	(0.43)	(0.42)	(0.49)	(0.48)
Have table/chair	0.51	0.85	0.58***	0.58	0.85	0.66***	0.61	0.88	0.71***
	(0.50)	(0.36)	(0.49)	(0.49)	(0.36)	(0.47)	(0.49)	(0.32)	(0.45)
Have bike	0.17	0.29	0.20***	0.20	0.31	0.23***	0.19	0.36	0.25***
	(0.38)	(0.46)	(0.40)	(0.40)	(0.46)	(0.42)	(0.39)	(0.48)	(0.43)
Observations	3,029	814	3,843	2,905	1,167	4,072	2,061	988	3,049

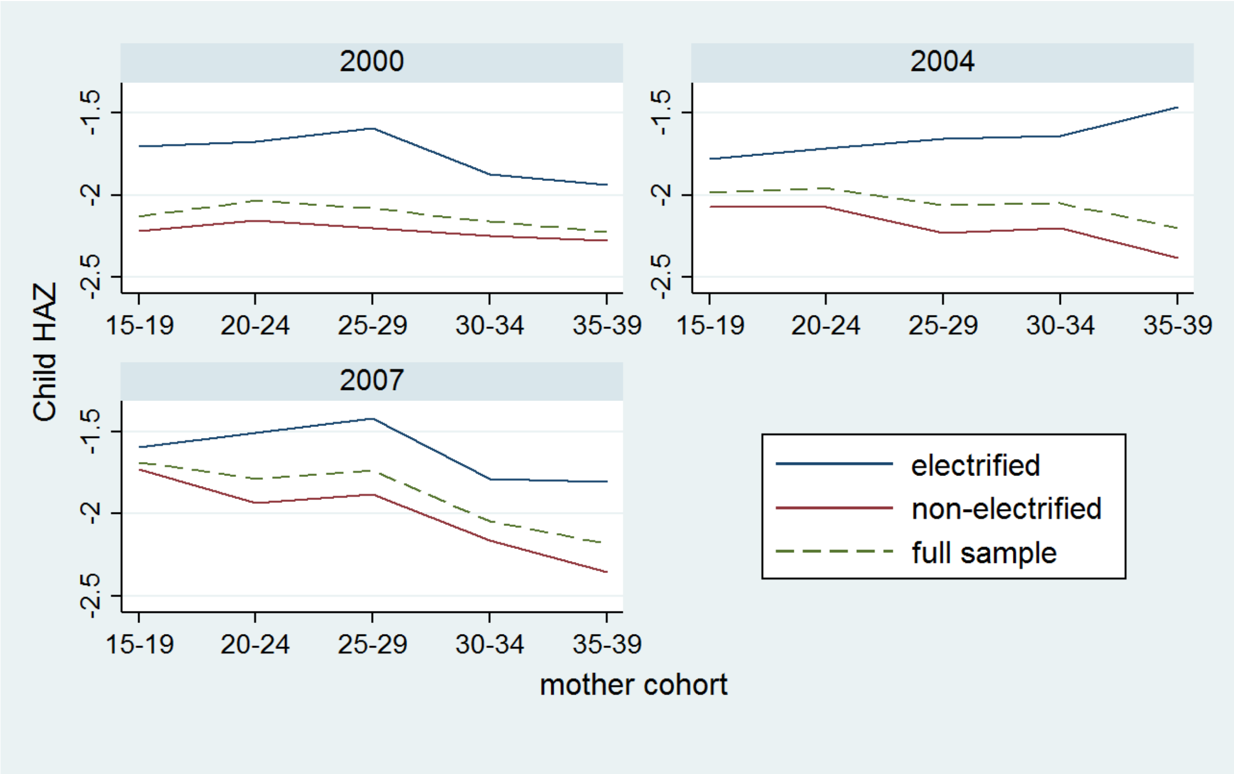
Sample is weighted by the sample weight. The sample standard deviations are reported in parentheses. ***, **, and * indicate that the difference in means between electrified and nonelectrified households is statistically significant at the 1, 5, and 10 percent levels, respectively.

shows, this observation is true even when we look at the difference between electrified and nonelectrified households by mother's age cohort for each round of the BDHS.[3]

The observed difference in nutritional status between electrified and nonelectrified households cannot be attributed to the household's access to electricity because electrified and nonelectrified households are systematically different. Table 1 shows that children in electrified households have better educated parents and healthier mothers and enjoy better living conditions than those in nonelectrified households, and these differences are significant. Therefore,

[3]Because the number of observations for children with a mother aged 40 and above is small, we only show the cohorts of mothers aged between 15 and 39.

Figure 1: Mean HAZ by mother's cohort and survey year



we control for these indicators in the subsequent regression analysis.

As noted in the previous section, we will also consider specifications that include key community-level characteristics, which are the time to district headquarters, ratio of certified doctors, distance to the nearest health facility, existence of a pharmacy in the community, and the distance to the nearest pharmacy. The community-level variables are taken from the community survey component of the BDHS dataset and are available for only years 2004 and 2007. The community in the BDHS data corresponds to a census enumeration area for the 2001 Population Census and is equivalent to a *mauza* in rural areas, with about 100 households on average (NIPORT, MA, and ORC Macro, 2005; NIPORT, MA, and Macro International, 2009).

Even after controlling for a rich set of observable characteristics mentioned above, there may remain unobserved heterogeneity that simultaneously affects the electrification status and nutritional status of children. Therefore, we compiled indicators of infrastructure development and service delivery for each Palli Bidyut Samity (PBS), or electricity cooperative, from the

Management Information System (MIS) published by the REB.[4] With technical support from the REB, PBSs play a central role in the delivery of electricity to rural households in their area of operation. There are currently over 70 PBSs in Bangladesh and each PBS typically supplies an area of 600-700 square miles covering 5-10 subdistricts (upazilas/thanas).

We take the age of PBS as an indicator of infrastructure development at the location of residence, because older PBSs tend to have a greater network within their geographic area of operation. As an indicator of service delivery, we use the system loss from the grid because a large system loss is an indication of poor delivery service in the area.[5] We expect the age to be positively correlated with the electrification and negatively correlated with the system loss. On the other hand, it is unlikely that these PBS-level indicators have a direct impact on the nutritional status of children. Thus, we use them as instrumental variables for the household's electrification status. In the next section, we further discuss our identification strategy and the potential threats to our identification.

Unfortunately, the BDHS data do not identify the PBS that serves the households in the sample. Further, we do not have reliable digital boundary data for each PBS. Therefore, we chose to merge the BDHS and PBS data by the district in which BDHS households and PBSs are located. To this end, we combine the BDHS data with the Administrative Division of Bangladesh (ADM) data using the coordinates (longitude and latitude) of the community that BDHS households belong to.[6] This combined BDHS-ADM dataset allows us to find the district that each BDHS household belongs to. Next, we convert the PBS data into district-level data. Because the number of districts is slightly smaller than number of PBSs, there may be multiple PBSs in a given district.[7] In this case, we take the maximum value for the age of PBS and average value over all the PBSs in the district for the system loss from the grid. The resulting data were then merged into the BDHS-ADM data.

[4]See `http://www.reb.gov.bd/maps.`

[5]In the MIS data we obtained, the system loss from the grid is available only for the years 2004 and 2007.

[6]The ADM data was extracted from the GADM database, version 2.0, December 2011. For further details, see `http://www.gadm.org/country`.

[7]While the coverage of districts varies slightly across survey years, the BDHS data cover about 60 districts each year.

4 Econometric Specification and Identification Strategy

The basic nutrition model we adopt in this study is

$$HAZ_i = \beta E_i + \gamma X_i + \epsilon_i \tag{1}$$

where HAZ_i is the HAZ for child i, E_i is a dummy variable for an electrified household, and X_i is a set of covariates, which may include household demographic information, parental education, mother's health, wealth proxy variables, and community characteristics, depending on the specification. The coefficient β on the electrified household dummy E_i is the main coefficient of interest. The error term ϵ_i is clustered at the community level.

When the Ordinary Least Squares (OLS) estimator is used to estimate eq. (1), the estimated coefficient is biased if ϵ_i is conditionally correlated with E_i. For example, suppose that the wealth level of the child's household is not controlled for. Then, it is likely that ϵ_i is correlated with E_i as richer households are more likely to adopt electricity. At the same time, children in richer households tend to enjoy more food and better sanitation. In this case, the OLS estimate of β will be biased upward because it also captures the effect of more food and better sanitation. Therefore, we control for a variety of wealth proxy indicators, such as the land ownership, asset holdings, and roof material.[8] We also include the child's demographic characteristics, maternal health indicators, and parental education to control for the heterogeneity across households. Further, we include several community-level variables, such as the distance to the nearest health facility in the community, because they are potentially important for the nutritional outcome of children.

While it appears likely that these covariates would lessen potential concerns about the omitted variable bias, it is not possible to exclude the possibility that ϵ_i is still conditionally correlated with E_i. For example, it may be the case that children in electrified households enjoy better nutritional status because their parents are the type who would take better care of children than their counterparts in non-electrified households. In this case, the estimated coefficient of β simply reflects the unobserved heterogeneity in parenting between electrified

[8]The wealth index included in the BDHS data is inappropriate for our purpose. See Appendix A for details.

and non-electrified households.

To address this issue, we use the age of the PBS and system loss from the grid in the household's district as instrumental variables for E_i. The age of the PBS reflects the infrastructure development in the district because older PBSs tend to have more extensive distribution networks than newer PBSs. We interpret the age of the PBS as a supply-side instrumental variable. The system loss from the grid is interpreted as a measure of service delivery efficiency. When this measure is high, the management of the PBS is likely to be poor and households may be less likely to adopt electricity. Thus, we take the system loss from the grid as a demand-side instrumental variable. Both instrumental variables are highly unlikely to have a direct impact on the nutritional status of children.

However, there are some potential threats to our identification. For example, it may be argued that better infrastructure development and service delivery are a result of better local governance, which also leads to better local policy or a better environment for the children's nutrition. Alternatively, it could be argued that both the household's electrification status and the child's nutritional status reflect the level of overall economic development in the location of residence. In each of these cases, the instrumental variables estimator will be biased.

Therefore, we also run OLS regressions for a subsample of households in electrified communities, because this analysis allows us to remove the effect of unobserved heterogeneity between electrified and non-electrified communities. We also run regressions with district-level fixed effects λ_d to control for district-level heterogeneity. As we shall show below, our main finding that children in electrified households are better nourished is not overturned by these analyses.

5 Main Results

OLS regression results

Table 2 shows the OLS regression of the child's HAZ on the electrification status of the household based on eq. (1) for various specifications. Panel A reports the estimated coefficient β on the household's electrification status for each survey year. The set of covariates for each column is specified at the bottom of each panel. Basic (demographic, education, and sanitary condition) and Wealth Proxy (roof material, land ownership, and asset holdings) covariates are those variables listed in Table 1 under these headings. Community variables are the time to district headquarter, ratio of certified doctors, distance to the nearest health facility, existence of a pharmacy in the community, and the distance to the nearest pharmacy. The constant term is included in all specifications. In this section, we focus on the coefficient β but the detailed results are available in Tables 10 and 11 in Appendix A.

Column (1) of Panel A in Table 2 shows that there is a strong positive relationship between the household's electrification status and a child's nutrition status. Without any other covariates, the HAZ for children in electrified households tends to be higher than that for children in non-electrified households by around 0.4 or more, depending on the survey round. Obviously, this correlation is partly driven by the systematic difference between electrified and non-electrified households.

Thus, we control for basic covariates in column (2) and additionally for wealth proxies in column (3). The addition of these covariates reduces the size of the coefficient to around 0.2, but the coefficient remains both statistically and economically significant.

As noted earlier, there may be unobserved heterogeneity between electrified and non-electrified communities. To address this issue, we analyze subsamples of households in electrified communities, where the status of electrification of the community is taken from the community survey data. As shown in Panel B, the results are similar both quantitatively and qualitatively to those in Panel A. Therefore, there is no evidence that the results in Panel A are driven by the unobserved differences between electrified and non-electrified communities.

Table 10 in Appendix B also shows that the community-level variables are not important for our purpose. First, they are individually mostly not significant and also jointly not significant. Second, the inclusion of community-level variables does not change the absolute value of the coefficient on the electrified household dummy much, as a comparison between columns (3) and (4) makes clear. Furthermore, the community variables are not available in 2000. For these reasons, we mostly omit the community-level variables from our analysis hereafter. The results of column (5) will be discussed in the next section.

Table 2: OLS regressions of household electrification status on child HAZ.

Child HAZ	(1)	(2)	(3)	(4)	(5)	Obs
Panel A (Full sample)						
Coefficient on electrified household dummy						
2000	0.515***	0.180***	0.171***	.	.	3843
	(0.056)	(0.055)	(0.057)	.	.	
	.	.	[1.50]	.	.	
2004	0.453***	0.211***	0.181***	0.179***	0.206***	4072
	(0.052)	(0.046)	(0.048)	(0.048)	(0.054)	
	.	.	[4.03***]	[1.19]	[0.68]	
2007	0.398***	0.203***	0.174***	0.147**	0.123*	3049
	(0.056)	(0.057)	(0.058)	(0.058)	(0.064)	
	.	.	[1.21]	[1.82]	[1.48]	
Controls						
Basic	No	Yes	Yes	Yes	Yes	
Wealth Proxy	No	No	Yes	Yes	Yes	
Community	No	No	No	Yes	Yes	
Community×Ele com.	No	No	No	No	Yes	
Panel B (Households in a electrified Community only)						
Coefficient on electrified household dummy						
2004	0.492***	0.265***	0.220***	0.218***	.	2551
	(0.059)	(0.052)	(0.055)	(0.055)	.	
	.	.	[2.66**]	[0.52]	.	
2007	0.355***	0.146**	0.134**	0.127*	.	1832
	(0.065)	(0.067)	(0.066)	(0.066)	.	
	.	.	[1.44]	[0.37]	.	
Controls						
Basic	No	Yes	Yes	Yes		
Wealth Proxy	No	No	Yes	Yes		
Community	No	No	No	Yes		

***, **, and * denote statistical significance at the 1, 5, and 10 percent levels. Standard errors clustered at the community level are reported in parentheses. Below the parentheses, F-statistics for the test of joint significance for the set of wealth proxy variables, community variables and community variables interacted with the dummy variable for an electrified community are reported in square brackets in columns (3) to (5), respectively. Basic and wealth proxy variables are those listed under these headings in Table 1. Community variables are the time to district headquarters, ratio of certified doctors, distance to the nearest health facility, existence of a pharmacy in the community, and the distance to the nearest pharmacy in the community. The number of observations for columns (4) and (5) are slightly smaller because community-level variables are not observed for some households. Detailed results are reported in Tables 10 and 11 in Appendix B.

Table 3: IV regressions of the household electrification status on child HAZ

Child HAZ	(1)	(2)	Obs
Coefficient on electrified household dummy			
2004	5.218	3.860	4072
	(8.408)	(10.825)	
Endogeneity test statistic	[5.869**]	[1.910]	
OIR test statistic	[0.039]	[0.631]	
2007	0.895**	0.901**	3049
	(0.396)	(0.423)	
Endogeneity test statistic	[3.443*]	[3.262*]	
OIR test statistic	[0.094]	[0.092]	
Controls			
Basic	Yes	Yes	
Wealth Proxy	No	Yes	

***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively. Clustered errors at community level are reported in parentheses. Basic and wealth proxy variables are those listed under these headings in Table 1. In all regressions, the household's electrification status is instrumented by the age of PBS and system loss from the grid. The endogeneity and OIR test statistics are reported in square brackets. Detailed results are reported in Table 12 in Appendix B.

IV Regression Results

Panel B of Table 2 allows us to address the potential issue of an unobserved heterogeneity between electrified and non-electrified communities. However, it does not allow us to rule out the possibility that unobserved household-level heterogeneity may be driving our results in Table 2. Therefore, we use the age of the PBS and system loss from the grid as instrumental variables for electrification.

Table 3 reports the instrumental variables estimation of eq. (1) for the full sample.[9] As this table shows, the null hypothesis for the overidentification restriction test cannot be rejected even at the 10 percent level in any of the reported regressions, indicating that there is no indication of specification errors in our IV regression results. For the year 2004, the estimated

[9]See Table 12 in Appendix B for the detailed regression results.

coefficient remains positive but is no longer significant because of the large standard error. On the other hand, the coefficient is positive and significant in 2007. This difference may stem from the fact that the IV is substantially weaker for the year 2004 than for the year 2007. This may be because the recent expansion of rural electrification is better captured in 2007 and provides more variation across districts.

While the results for year 2004 should be taken with caution due to the problem of weak instrumental variables, the balance of evidence provided in this section suggests that the positive impact of household electrification on the nutritional status of children cannot be attributed to unobserved heterogeneity between electrified and non-electrified communities or between electrified and non-electrified households.

6 Exploring the Channels of Causality

We now explore the channels through which the household electrification status positively affects the nutritional status of children. As mentioned earlier, we investigate wealth, fertility, health facilities, and television as potential channels of causality.

Wealth

The access to electricity may help households become richer through increased income opportunities made available from extended lighted time or through economic activities in which electricity is vital. The increase in household wealth may in turn allow parents to afford, for example, more food and better medicine for their children, leading to improvement in the nutritional status of their children. Because we do not have a direct measure of wealth, we use wealth proxies such as asset holdings and housing conditions for our analysis.

As can be verified from a comparison of columns (2) and (3) of Table 2, the inclusion of wealth proxy variables reduces the estimated coefficient of β by around 0.045. This is not very large relative to the standard error of the coefficient. Table 2 also shows that the joint test of significance for the wealth proxy variables is statistically significant for the year 2004 but not for the years 2000 and 2007, indicating the potential importance of wealth.

Table 2 indicates that our main results are not driven by the better standards of living enabled by access to electricity. This is because the estimated coefficient remains positive and significant even after controlling for the wealth proxy covariates. To further elucidate this point, we constructed a non-electricity-related wealth index for all households that are comparable across all three rounds.[10] We then run a locally smoothed nonparametric regression (lowess) of HAZ on this wealth index separately for electrified and non-electrified households. As Figure 2 shows, the graph is generally upward-sloping for both electrified and non-electrified households for all rounds, though the comparison of HAZ for both low and high ends requires a special caution because outliers can affect the results substantially and the estimates may not be reliable as a result.

The upward slopes of the graphs in Figure 2 strongly indicate that wealth is indeed an important determinant of the nutritional status of children. Figure 2 also shows that HAZ for electrified households almost always lies above that for non-electrified household regardless of the value of wealth index or the survey round. Consistent with this observation, we find that the point estimates of β are all positive when regressions similar to column (2) of Table 2 are run separately by wealth quintiles.[11] However, the statistical significance of these estimates depends on the year and wealth quintile, partly because the power of the test is weak due to the small sample size. Our results overall indicate that although wealth is important, it is not the only channel through which the positive impact of electrification on the nutritional status of children occurs.

Fertility

Besides wealth, fertility is another possible channel through which electrification could affect nutritional outcomes. This possibility is in part motivated by the empirical findings of Fujii and Shonchoy (2015), who show with a panel data set that the expansion of rural electrification leads to a reduction in fertility, especially for those households that already have multiple children. To see whether their findings apply to the BDHS data, we regress the number of children ever born to a woman aged between 15 and 49 in the household on the household's

[10] Details are presented in Appendix A

[11] Results are available upon request.

Figure 2: Nonparametric regression (lowess) of HAZ on wealth index by household electrification status and survey year

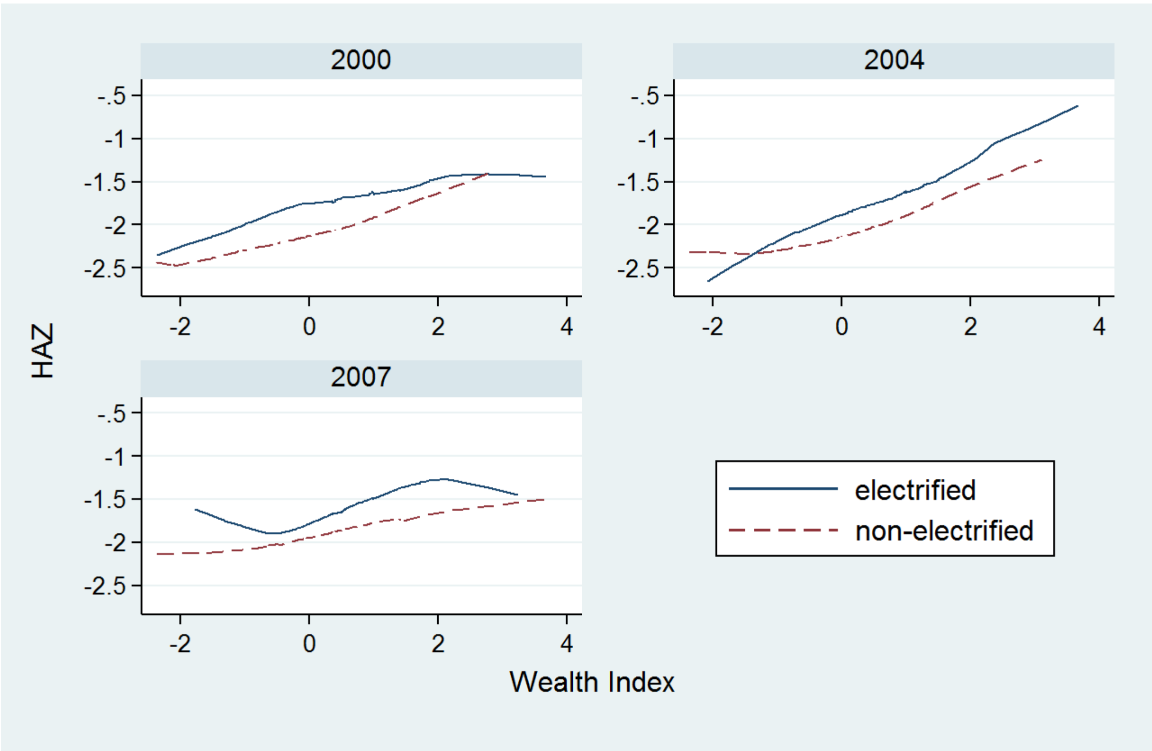


Table 4: Impact of household electrification on fertility

No. of Children Ever Born	OLS			IV	
	2000	2004	2007	2004	2007
Electrified household dummy	-0.22***	-0.20***	-0.24***	-4.81	-1.56***
	(0.05)	(0.05)	(0.06)	(3.18)	(0.46)
Boy ratio	-0.10*	-0.02	-0.12**	-0.03	-0.13**
	(0.06)	(0.05)	(0.05)	(0.11)	(0.06)
Mother's age (yrs)	0.07**	0.02	0.10***	0.16	0.10**
	(0.03)	(0.03)	(0.04)	(0.12)	(0.04)
Mother's age sq	0.00***	0.00***	0.00**	0.00	0.00*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Father's age (yrs)	0.13***	0.10***	0.07**	0.10**	0.09***
	(0.02)	(0.03)	(0.03)	(0.04)	(0.03)
Father's age sq	-0.00***	-0.00***	-0.00	-0.00**	-0.00*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Mother completed primary educ	-0.19***	-0.26***	-0.38***	0.08	-0.31***
	(0.06)	(0.06)	(0.06)	(0.27)	(0.07)
Mother completed secondary educ	-0.52***	-0.57***	-0.69***	0.42	-0.39***
	(0.07)	(0.07)	(0.07)	(0.69)	(0.13)
Mother has some higher educ	-1.38***	-1.24***	-1.17***	0.07	-0.70***
	(0.15)	(0.11)	(0.12)	(0.95)	(0.22)
Father completed primary educ	-0.10*	-0.06	-0.06	0.43	0.05
	(0.05)	(0.05)	(0.06)	(0.36)	(0.08)
Father completed secondary educ	-0.15**	-0.21***	-0.17**	0.57	0.10
	(0.07)	(0.06)	(0.07)	(0.53)	(0.13)
Father has some higher educ	-0.38***	-0.38***	-0.24**	0.67	0.11
	(0.10)	(0.08)	(0.10)	(0.75)	(0.17)
Observations	3,005	3,238	2,493	3,238	2,493
R-squared	0.65	0.66	0.64		0.55
Endogeneity test statistic				16.68***	13.67***
OIR test statistic				0.95	0.13

Clustered standard errors at community level are in parentheses. ***, **, and * represent statistical significance at the 1, 5, and 10 percent levels, respectively. Electrification status is instrumented by the age of the PBS and system loss from the grid for IV regressions.

electrification status E_i as well as some demographic and education variables also used in Fujii and Shonchoy (2015). As shown in Table 4, the estimated coefficients on E_i are all negative and mostly significant. Thus, our results are consistent with the findings of Fujii and Shonchoy (2015), even though our results are based on simple cross-sectional regressions.

Because there are fewer children in electrified households, more resources can be potentially allocated to each child in these households. This in turn means that each child may enjoy more food and better care. Therefore, electrification may improve the nutritional status of children through reduced fertility in the household. The most naïve way to test this possibility is to include the number of children who are alive at the time of interview in the set of regressors.

This is indeed what was done in Table 2. As the detailed regression results reported in Table 10 in Appendix B show, the coefficient on the number of surviving children is always negative and significant, which is consistent with the presence of the fertility channel.

To rigorously test the presence of a causal channel through fertility, it would be ideal if we could exploit exogenous variations in sibling numbers using twining or heterogeneity in the enforcement of a family planning policy, as is done in the empirical literature on the quantity-quality trade-off for children. However, because we do not have clear exogenous variations to exploit, we first take the indirect approach discussed in Section 2.

Based on the findings of Fujii and Shonchoy (2015), we assume that the fertility-reducing effect of rural electrification is small for children without siblings but significantly positive for households with two or more children. If this assumption holds, the observed nutritional impact of electrification on children with siblings would come in part from reduced fertility, because the number of siblings may have been larger had the household not adopted electricity. Further, because a direct competition among siblings exists in these households but not in households with only one child, the positive impact of electrification on the nutritional status of children is less pronounced in the households with only one child.

Columns (1) and (2) of Table 5 report the OLS regression results for the subsample of households with only one child. As the comparison of these results and those in Table 2 indicates, the point estimate for the subsample is noticeably smaller than that for the full sample for the years 2000 and 2007. For example, when both Basic and Wealth Proxy covariates are included in the model, the point estimate for the full sample is 0.171 in the year 2000, whereas the corresponding figure for the only-child subsample is 0.101. However, the differences in estimates between Tables 2 and 5 are smaller than the standard errors reported in Table 5. Furthermore, there is no clear pattern for the year 2004. Therefore, we are unable to draw a strong conclusion about the quantity-quality trade-off.

As an alternative way to address the potential endogeneity of fertility decisions, we have also used the desired fertility, or the number of children that the respondent wishes to have, as an instrument for the number of surviving children. Because this instrumental variable reflects household preferences, one may argue it is endogenous. However, there is no strong reason to believe that it should be conditionally correlated with the nutritional status of children. More important, the overidentification restriction test detects no sign of specification errors at the conventional levels of significance.

In columns (3) and (4) of Table 5, we report the results of instrumental variables regression of HAZ on, among others, the household's electrification status and the number of surviving children with the latter instrumented by the desired fertility.[12] However, in all years and regardless of whether the Wealth Proxy variables are included, the null hypothesis that the number of surviving children is exogenous could not be rejected.

Therefore, we take the OLS analysis of the fertility channel as being a valid analysis. Further, taking the analysis of the only-child sample as supporting evidence, our empirical results are, by and large, consistent with the presence of the fertility channel, though the evidence is admittedly weak.

Local Health Facilities

The third channel through which access to electricity may affect the nutritional status of children is through the improvement of the conditions of local health facilities. With electricity, the construction, operation, and management of local health facilities may become easier and more talented health workers can be attracted. However, this causal channel is difficult to identify because we do not have direct observations of local health facilities. Given this constraint, we take community-level covariates, such as the time to district headquarters, ratio of certified doctors, distance to the nearest health facility, existence of a pharmacy in the community, and the distance to the nearest pharmacy, as proxies for the condition of local health facilities.

As a comparison of columns (3) and (4) of Table 2 shows, the orders of magnitude of the estimated coefficients are not changed much relative to the sizes of their standard errors by the inclusion of these community-level variables. One may argue that the community-level variables affect the nutritional outcome differently for electrified and non-electrified communities. Therefore, we have also included in the set of regressors the interactions between community-level variables and a dummy variable for electrified communities, as reported in column (5) of Table 2. The inclusion of the interaction terms makes the point estimate larger in 2004

[12]Based on endogeneity test statistics, the electrification status of the household is treated as exogenous in columns (3) and (4).

Table 5: Regression results for the analysis of the fertility channel

Child HAZ	Only Child OLS		Full Sample IV	
	(1)	(2)	(3)	(4)
2000				
Electrified household	0.109	0.101	0.119	0.097
	(0.092)	(0.092)	(0.091)	(0.102)
No. of surviving children			-0.725	-0.670
			(0.587)	(0.551)
			[2.110]	[1.859]
Observations	743	743	3842	3842
2004				
Electrified household	0.195*	0.193**	0.192***	0.168***
	(0.101)	(0.097)	(0.051)	(0.052)
No. of surviving children			-0.245	-0.210
			(0.173)	(0.174)
			[0.696]	[0.410]
Observations	867	867	4072	4072
2007				
Electrified household	0.171*	0.121	0.167***	0.136**
	(0.095)	(0.095)	(0.063)	(0.065)
No. of surviving children			-0.293	-0.298
			(0.191)	(0.196)
			[1.649]	[1.642]
Observations	690	690	3049	3049
Controls				
Basic	Yes	Yes	Yes	Yes
Wealth Proxy	No	Yes	No	Yes

Clustered standard errors at community level are in parentheses. ***, **, and * represent statistical significance at the 1, 5, and 10 percent levels, respectively. The number of surviving children is instrumented by desired fertility for IV regressions. Endogeneity test statistics are shown in square brackets.

but smaller in 2007. Further, the change is substantially smaller than the standard errors of estimated coefficients. Therefore, we have no evidence that the condition of the local health facility is relevant to the positive impact of electrification on the nutritional status of children.

Television

The influence of television in developing countries has been documented in the recent economics literature (e.g., Ferrara et al. (2012); Jensen and Oster (2009)) and the impact of watching television on the nutritional status of children has been debated in Bangladesh as well (Das et al., 2014). While the literature appears to have focused on weight-related indices, it is plausible that watching television also has a long-term effect on children's nutritional status. For example, people with a television may be more aware of health-related information, which in turn may lead to changes in health-related behaviors and improve the health outcomes of children (World Bank, 2008).

In what follows, we use the possession of a television as a proxy for watching television. While we observe some indicators related to watching television, the data are not comparable across years and may be subject to respondents' bias.[13] The possession of a television, on the other hand, is a clearly defined variable and comparable across years. Note, however, that the possession and use of a television are not necessarily the same. There may be people who watch television without possessing one (e.g., watch in a neighbor's house). There may be also people who do not watch television even though they own one. To try to understand the importance of this issue, a regression of a dummy variable for watching television weekly on television possession dummy was run using the data for the year 2000. This regression shows that the coefficient is large (0.75) and is even significant at the 1 percent level.

To analyze the causal channel through the exposure to television, we start with the OLS regression in which the dummy variable for the possession of a television is added to the set of covariates, including the household's electrification status. We exclude about 3 percent of observations for each year where the household has a television without access to electricity.

[13]In the year 2000, the respondents were asked whether the mother watches TV every week. In the years 2004 and 2007, the respondents were asked to choose the frequency of watching TV from the following four options: not at all, less than once a week, at least once a week, and almost every day.

As reported in columns (1) and (2) of Table 6, the OLS results are mixed.[14] In the years 2000 and 2007, we do not see any significant impact of television. The estimated coefficient of β on the household's electrification status does not change much from the corresponding results in columns (2) and (3) of Table 2. Further, the coefficient for the possession of a television is close to zero.

However, this is not true for the year 2004, in which the coefficient for the possession of a television is positive and significant. Further, the absolute value of the estimated coefficient on the household's electrification status decreases by more than 0.6 when the television possession dummy is included in the set of regressors in year 2004.

The OLS result is biased if the possession of a television is endogenous. Ideally, we would like to exploit exogenous variations of television possession.[15] However, because we do not have such variations and because the OLS results are not consistent across years, we only have inconclusive evidence about the causal channel through exposure to television.

7 Robustness Checks

So far, we have reported standard errors that are clustered at the community level. However, it could be argued that the error terms may be correlated at a higher level of aggregation, which in turn may make our estimated standard errors too optimistic. For example, the local disease environment, which affects the nutritional status of children, is likely to be correlated at a level that is larger than a community. It could also be argued that local infrastructure or levels of development that go beyond the boundaries of the communities may simultaneously affect the household's electrification status and the nutritional status of children.

To address these concerns, we also ran OLS regressions of HAZ on the household's electri-

[14]Detailed results are reported in Table 13 in Appendix B.

[15] We ran instrumental-variables regressions using the bordering with India on the west as an instrument for the possession of television. This is potentially a valid instrument because people have been watching Indian channels since the late 1980s when the only official channel on a ir was the state-run Bangladesh Television (Rahman, 2011) and people living close to the Indian border generally have better reception of television signals from India. Indeed, those living in districts sharing their western borders with India have a higher rate of television possession (26 percent of households in 2007) than the rest of Bangladesh (18 percent of households in 2007). While we did not get results that overturn our main conclusion that the impact of electrification has a positive impact on the nutritional status of children, regression results using this IV are not robust because the instrument is weak.

Table 6: The impact of television on child HAZ using the OLS method.

HAZ			
	(1)	(2)	Observations
2000			
Electrified household	0.196***	0.191***	3744
	(0.068)	(0.068)	
TV possession	-0.018	-0.022	
	(0.101)	(0.102)	
2004			
Electrified household	0.138***	0.116**	3927
	(0.052)	(0.052)	
TV possession	0.242***	0.223***	
	(0.068)	(0.070)	
2007			
Electrified household	0.177***	0.152**	2925
	(0.066)	(0.067)	
TV possession	0.083	0.056	
	(0.077)	(0.079)	
Controls			
Basic	Yes	Yes	
Wealth Proxy	No	Yes	

***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively. Clustered errors at community level are reported in parentheses. Detailed results are reported in Table 13.

fication status and other covariates with various fixed-effects terms. Columns (1), (2), and (3) of Table 7 report regression results with district-specific fixed-effects terms (λ_d) for years 2000, 2004, and 2007, respectively. As a comparison of the coefficients for the household's electrification status in these columns and column (3) of Table 2 show, the inclusion of the district-specific fixed effects did not alter the results much. We also ran a similar regression using the data pooled across three rounds. In column (4), we include both time-specific fixed-effects terms (λ_t) in addition to district-specific fixed-effects terms. In column (5), on the other hand, we include district-time-specific fixed-effects terms (λ_{dt}). In both cases, the order of magnitude of coefficients for the electrified household dummy is comparable to those in Table 2.

Our reported regression results so far ignore sample weights. Therefore, we have also checked the robustness of our results by running regressions with sample weights and verified that the results are generally similar. Thus, our main result that electrification has a positive impact on the nutritional status of children is robust with respect to the choice of the survey round, the choice of error structure, and whether we apply sample weights.

8 Conclusion and Discussion

In this paper, we have demonstrated that access to electricity has a positive and statistically and economically significant impact on the nutritional status of children with most point estimates exceeding 0.15. This main conclusion does not change even when we allow for the potential endogeneity of the electrification. It is also robust with respect to the choice of the year of analysis, assumption about the underlying error structure, and whether sample weight is applied.

We have also investigated the mechanisms through which electrification positively affects the nutritional status of children. We have considered wealth, fertility, local health facilities, and exposure to television as plausible channels of causality. Among these, we have some support for the wealth and fertility channels, even though the evidence for the latter is weak. On the other hand, we have no clear evidence for local health facility channel and the evidence for causality through the channel of exposure to television is also inconclusive.

These four channels are not the only possible channels through which electrification may

Table 7: Fixed-effects regression of household electrification status on HAZ.

HAZ	2000 (1)	2004 (2)	2007 (3)	Pooled (4)	Pooled (5)
Electrified household	0.159***	0.178***	0.135**	0.163***	0.159***
	(0.060)	(0.048)	(0.059)	(0.029)	(0.030)
Child's age (mth)	-0.077***	-0.074***	-0.078***	-0.076***	-0.076***
	(0.005)	(0.005)	(0.005)	(0.003)	(0.003)
Child's age sq	0.001***	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Child is a boy	-0.013	-0.036	0.090**	0.004	0.006
	(0.041)	(0.038)	(0.044)	(0.022)	(0.022)
Mother's age (yrs)	0.079***	0.055**	0.021	0.056***	0.057***
	(0.023)	(0.023)	(0.029)	(0.014)	(0.014)
Mother's age sq	-0.001**	-0.001	-0.000	-0.001***	-0.001***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Mother's education (yrs)	0.022**	0.008	-0.003	0.010**	0.009*
	(0.009)	(0.007)	(0.008)	(0.005)	(0.005)
Mother's height (cm)	0.046***	0.046***	0.059***	0.050***	0.050***
	(0.005)	(0.005)	(0.005)	(0.003)	(0.003)
Mother's weight (kg)	0.021***	0.020***	0.012***	0.018***	0.018***
	(0.004)	(0.004)	(0.004)	(0.002)	(0.002)
Father's education (yrs)	0.016**	0.003	0.016**	0.012***	0.012***
	(0.007)	(0.006)	(0.006)	(0.004)	(0.004)
No. of surviving children	-0.079***	-0.082***	-0.027	-0.066***	-0.065***
	(0.019)	(0.020)	(0.023)	(0.012)	(0.012)
Use flush toilet	0.062	0.248*	0.092	0.136**	0.103*
	(0.094)	(0.130)	(0.072)	(0.055)	(0.056)
Use pit latrine	0.021	0.085	0.098*	0.072**	0.065**
	(0.053)	(0.052)	(0.057)	(0.032)	(0.032)
Cement roof	0.143	0.115	0.066	0.076	0.123*
	(0.112)	(0.119)	(0.187)	(0.071)	(0.073)
Rudimentary roof	0.036	0.033	0.025	0.045	0.031
	(0.064)	(0.081)	(0.094)	(0.045)	(0.045)
Own land	0.035	0.082*	0.031	0.048*	0.050*
	(0.046)	(0.044)	(0.053)	(0.028)	(0.028)
Have wardrobe	0.025	0.117**	0.040	0.050	0.061*
	(0.054)	(0.053)	(0.063)	(0.033)	(0.032)
Have table/chair	0.062	0.101**	0.048	0.081***	0.081***
	(0.051)	(0.050)	(0.058)	(0.031)	(0.031)
Have bike	-0.070	0.000	0.055	-0.004	-0.012
	(0.061)	(0.053)	(0.054)	(0.033)	(0.033)
Specification	λ_d	λ_d	λ_d	$\lambda_d + \lambda_t$	λ_{dt}
Observations	3,843	4,072	3,049	10,964	10,964
R^2	0.219	0.238	0.237	0.219	0.231

***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively. Standard errors clustered at the community level are reported in parentheses.

affect children's nutritional status. For example, the use of refrigerators may lead to better preparation and preservation of food. This in turn may reduce the prevalence of diarrhea and malnutrition. However, in rural Bangladesh, the impact of refrigerators is likely to be limited because only 6.2 percent of the households had a refrigerator even in 2011 (NIPORT, MA, and ICF International, 2013). Similarly, electricity can potentially replace the use of traditional fuel for cooking, which in turn may improve the health environment in the household. However, the use of electricity for cooking is rare in Bangladesh. Therefore, this is unlikely to be an important channel, although it is worth noting that electrification is associated with the switching from traditional to modern fuels in urban areas (Barnes et al., 2005, p.32).

There are at least two possible channels of causality that may be potentially important and able to explain the positive impact of electrification on the nutritional status of children but cannot be empirically tested due to limitations of the data. First, as Fujii and Shonchoy (2015) show, time use may be altered as a result of electrification. It is plausible that the use of lighting allows households to take a better care of children at night. The improved lighting also helps them keep their house tidy and improve the indoor air quality by switching away from candles and kerosene lamps.

The second potentially important channel of causality is the reduction of the burden of fuel collection due to the electrification of the household. As Srilatha Batliwala (1982) discusses in the case of India, this reduced burden may in turn reduce caloric consumption and lessen the burden on the mother's body, leading to a better nutritional status for the children. Our empirical results are consistent with this possibility, because the mother's health indicators are positive and significant in most specifications (See also Tables 7 and 10 in Appendix B). However, direct observation of fuel collection would be needed to establish this causal channel.

This study also has some policy implications. First, it is critically important to evaluate infrastructure programs such as rural electrification from a broad perspective. This is because the impact may go well beyond the narrowly-defined economic benefits in a typical cost-benefit analysis. Second, once the additional social benefits of electrification—such as the improved nutritional status of children— are well recognized, governments around the developing world may be encouraged to invest in basic infrastructure, which is severely lacking in Bangladesh as well as in the rest of South Asia and sub-Saharan Africa.

References

Ahamad, M. G. and A. N. Islam (2011): "Electricity consumption and economic growth nexus in Bangladesh: Revisited evidences," *Energy Policy*, 39, 6145–6150.

Alderman, H. (2000): "Anthropometry," in *Designing Household Survey Questionnaires for Developing Countries: Lessons from Ten Years of LSMS Experience*, ed. by M. Grosh and P. Glewwe, Oxford University Press, 251–272.

——— (2006): "Long term consequences of early childhood malnutrition," *Oxford Economic Papers*, 58, 450–474.

Angrist, J. D., V. Lavy, and A. Schlosser (2005): "New Evidence on the Causal Link Between the Quantity and Quality of Children," Working Paper 11835, National Bureau of Economic Research.

Banerjee, A., A. Deaton, and E. Duflo (2004): "Health, health care, and economic development: Wealth, health, and health services in rural Rajasthan," *American Economic Review*, 94, 326.

Barnes, D., K. Krutilla, and W. Hyde (2005): *The Urban Household Energy Transition: Social and Environmental Impacts in the Developing World*, Routledge.

Becker, G. and H. Lewis (1973): "On the interaction between the Quantity and Quality of Children," *Journal of Political Economy*, 81, S279–S288.

Behrman, J. R. and A. B. Deolalikar (1988): "Health and nutrition," in *Handbook of Development Economics*, Elsevier, vol. 1, chap. 14, 631–711.

Cook, P. (2011): "Infrastructure, rural electrification and development," *Energy for Sustainable Development*, 15, 304–313.

Das, J., S. Das, M. Chisti, F. Farzana, F. Ferdous, M. Malek, A. Rahman, A. Faruque, and A. Mamun (2014): "Association of Television Watching Practices of Mothers on Overweight and Obesity of Their Under-5 Offspring in Urban Bangladesh," *Food and Nutrition Sciences*, 5, 1811.

Dinkelman, T. (2011): "The effects of rural electrification on employment: New evidence from South Africa," *American Economic Review*, 3078–3108.

Fay, M., D. Leipziger, Q. Wodon, and T. Yepes (2005): "Achieving child-health-related Millennium Development Goals: The role of infrastructure," *World Development*, 33, 1267–1284.

Ferrara, E., A. Chong, and S. Duryea (2012): "Soap operas and fertility: Evidence from Brazil," *American Economic Journal: Applied Economics*, 4, 1–31.

Frongillo, E., M. de Onis, and K. Hanson (1997): "Socioeconomic and demographic factors are associated with worldwide patterns of stunting and wasting of children," *Journal of Nutrition*, 127, 2302–2309.

Fujii, T. and A. Shonchoy (2015): "Fertility and Rural Electrification in Bangladesh," IDE Discussion Paper 521, Institute of Developing Economies.

Glewwe, P., H. Jacoby, and E. King (2001): "Early Childhood Nutrition and Academic Achievement: a Longitudinal Analysis," *Journal of Public Economics*, 81, 345–368.

Glewwe, P., S. Koch, and B. L. Nguyen (2002): "Child nutrition, economic growth, and the provision of health care services in Vietnam in the 1990s," World bank working paper, World Bank.

Grimm, M., R. Sparrow, and L. Tasciotti (2014): "Does Electrification Spur the Fertility Transition?: Evidence from Indonesia," IZA Discussion Paper 8146, Institut zur Zukunft der Arbeit.

Grogan, L. and A. Sadanand (2013): "Rural Electrification and Employment in Poor Countries: Evidence from Nicaragua," *World Development*, 43, 252–265.

Grogan, L. A. (2015): "Household electrification, fertility and employment: Evidence from the Colombian censuses," Working paper, University of Guelph.

Haughton, D. and J. Haughton (1997): "Explaining Child Nutrition in Vietnam," *Economic Development and Cultural Change*, 45, 541–556.

Heckman, J. J. and D. V. Masterov (2007): "The Productivity Argument for Investing in Young Children," *Review of Agricultural Economics*, 29, 446–493.

Jensen, R. and E. Oster (2009): "The power of TV: Cable television and women's status in India," *Quarterly Journal of Economics*, 124, 1057–1094.

Joshi, S. and T. P. Schultz (2013): "Family Planning and Women's and Children's Health: Long-Term Consequences of an Outreach Program in Matlab, Bangladesh," *Demography*, 50, 149–180.

Khan, S. A. and A. A. M. Azad (2014): "Social Impact of Solar Home System in Rural Bangladesh: A Case Study of Rural Zone," *IAFOR Journal of Sustainability, Energy and the Environment*, 1, 5–22.

Khandker, S., D. Barnes, and H. Samad (2009): "Welfare impacts of rural electrification: A case study from Bangladesh," World Bank Policy Research Working Paper 4859, The World Bank.

Kirubi, C., A. Jacobson, D. M. Kammen, and A. Mills (2009): "Community-based electric micro-grids can contribute to rural development: evidence from Kenya," *World Development*, 37, 1208–1221.

Li, H., J. Zhang, and Y. Zhu (2008): "The quantity-quality trade-off of children in a developing country: identification using Chinese twins." *Demography*, 45, 223–243.

Li, Y., G. Guo, A. Shi, Y. Li, T. Anme, and H. Ushijima (1999): "Prevalence and Correlates of Malnutrition Among Children in Rural Minority Areas of China," *Pediatrics International*, 41, 549–556.

Lipscomb, M., M. Mobarak, and T. Barham (2013): "Development Effects of Electrification: Evidence from the Topographic Placement of Hydropower Plants in Brazil," *American Economic Journal: Applied Economics*, 5, 200–231.

Liu, H. (2014): "The quality-quantity trade-off: evidence from the relaxation of China's one-child policy," *Journal of Population Economics*, 27, 565–602.

Maluccio, J. a., J. Hoddinott, J. R. Behrman, R. Martorell, A. R. Quisumbing, and A. D. Stein (2009): "The impact of improving nutrition during early childhood on education among Guatemalan adults," *Economic Journal*, 119, 734–763.

NIPORT, MA, and ICF International (2013): *Bangladesh Demographic and Health Survey BDHS 2011*, Dhaka, Bangladesh and Calverton, Maryland, USA: NIPORT, Mitra and Associates, and ICF International.

——— (2014): *Bangladesh Demographic and Health Survey BDHS 2014: Key Indicators*, Dhaka, Bangladesh and Calverton, Maryland, USA: National Institute of Population Research and Training (NIPORT), Mitra and Associates, and ICF International.

NIPORT, MA, and Macro International (2009): *Bangladesh Demographic and Health Survey 2007*, Dhaka, Bangladesh and Calverton, Maryland, [USA]: National Institute of Population Research and Training, Mitra and Associates (MA), and Macro International.

NIPORT, MA, and ORC Macro (2001): *Bangladesh Demographic and Health Survey 1999-2000*, Dhaka, Bangladesh and Calverton, Maryland, [USA]: National Institute of Population Research and Training (NIPORT), Mitra and Associates (MA), and ORC Macro.

——— (2005): *Bangladesh Demographic and Health Survey 2004*, Dhaka, Bangladesh and Calverton, Maryland, [USA]: National Institute of Population Research and Training, Mitra and Associates (MA), and ORC Macro.

Nores, M. and W. S. Barnett (2010): "Benefits of early childhood interventions across the world: (Under) Investing in the very young," *Economics of Education Review*, 29, 271–282.

Novella, R. (2013): "Parental education, gender preferences and child nutritional status: evidence from four developing countries," ISER Working Paper Series 2013-06, Institute for Social and Economic Research, University of Essex.

Peters, J. and C. Vance (2011): "Rural electrification and fertility: Evidence from Côte d'Ivoire," *Journal of Development Studies*, 47, 753–766.

Peters, J., C. Vance, and M. Harsdorff (2011): "Grid Extension in Rural Benin: Micro-Manufacturers and the Electrification Trap," *World Development*, 39, 773–783.

Potter, J., C. Schmertmann, and S. Cavenaghi (2002): "Fertility and development: Evidence from Brazil," *Demography*, 39, 739–761.

Qian, N. (2009): "Quantity-Quality and the One-Child Policy: The Only-Child Disadvantage in School Enrollemnt in Rural China," NBER Working Paper 14973, National Bureau of Economic Research.

Rahman, J. (2011): "The Power of Television," *Forum: A Monthly Publication of The Daily Star*, 5, available from `http://archive.thedailystar.net/forum/2011/May/power.htm`.

Ravallion, M. (2007): "Achieving Child-Health-Related Millennium Development Goals: The Role of Infrastructure: A Comment," *World Development*, 920–928.

Rosenzweig, M. R. and J. Zhang (2009): "Do Population Control Policies Induce More Human Capital Investment? Twins, Birth Weight and China's "One-Child" Policy," *Review of Economic Studies*, 76, 1149–1174.

Rutstein, S. O. (2008): "The DHS Wealth Index: Approaches for rural and urban areas." DHS Working Paper 60, Macro International.

Rutstein, S. O. and K. Johnsons (2004): "The DHS wealth index," DHS Comparative Report 6, ORC Macro.

Shiu, A. and P.-L. Lam (2004): "Electricity consumption and economic growth in China," *Energy Policy*, 32, 47–54.

Srilatha Batliwala (1982): "Rural Energy Scarcity and Nutrition: A New Perspective," *Economic and Political Weekly*, 17, 329–333.

World Bank (2008): *The Welfare Impact of Rural Electrification: A Reassessment of the Costs and Benefits*, World Bank.

Yang, M. (2003): "China's rural electrification and poverty reduction," *Energy Policy*, 31, 283–295.

Appendix A: Construction of Wealth Scores

BDHS data include a single wealth index for each household derived from a principle component analysis, details of which are discussed in Rutstein and Johnsons (2004). However, as noted in NIPORT, MA, and Macro International (2009), the BDHS wealth index is a single asset index developed for the entire sample with no distinction made between urban and rural households (see also Rutstein (2008)). Therefore, the scoring matrix may not be the most appropriate one for a rural-focused analysis like this study. Moreover, the BDHS wealth index is calculated separately year by year, which makes it impossible to compare over time. Furthermore, the set of variables used for the BDHS wealth index includes dummy variables for living conditions representing intermediate quality. This makes the interpretation of the BDHS wealth index difficult. In addition to these issues, the constructed wealth index should not directly reflect the electrification status of the household for the analysis in Figure 2 to be meaningful. However, the BDHS wealth index violates this constraint.

Therefore, we choose to use the possession of non-electric durable goods and dwelling characteristics corresponding to the worst quality among all choices in the data in our principal component analysis. To ensure the comparability of the wealth index across different rounds, we only use those variables which are available in all three rounds of the BDHS. The exact set of variables used for the principal component analysis and the scoring coefficients for the first principal component are reported in Table 8. The wealth index used in Figure 2 is simply the first principal component. As Table 8 shows, the coefficients have a positive [negative] sign for indicators associated with higher [lower] wealth. The eigenvalue of the first principal component is 2.520, which is much larger than those of second (1.187) and higher-order principal components.

Table 9 provides summary statistics for our wealth index. This table clearly shows the increasing trend of the wealth index over time, reflecting the healthy economic growth Bangladesh

Table 8: Scoring coefficients

Variable	Scoring coefficients
Have radio	0.195
Have bike	0.183
Have motorcycle	0.112
Have phone	0.088
Have wardrobe	0.252
Have table/Chair	0.266
Own land	0.204
Surface water	-0.058
Bush/field latrine	-0.166
Natural wall	-0.237
Natural roof	-0.205

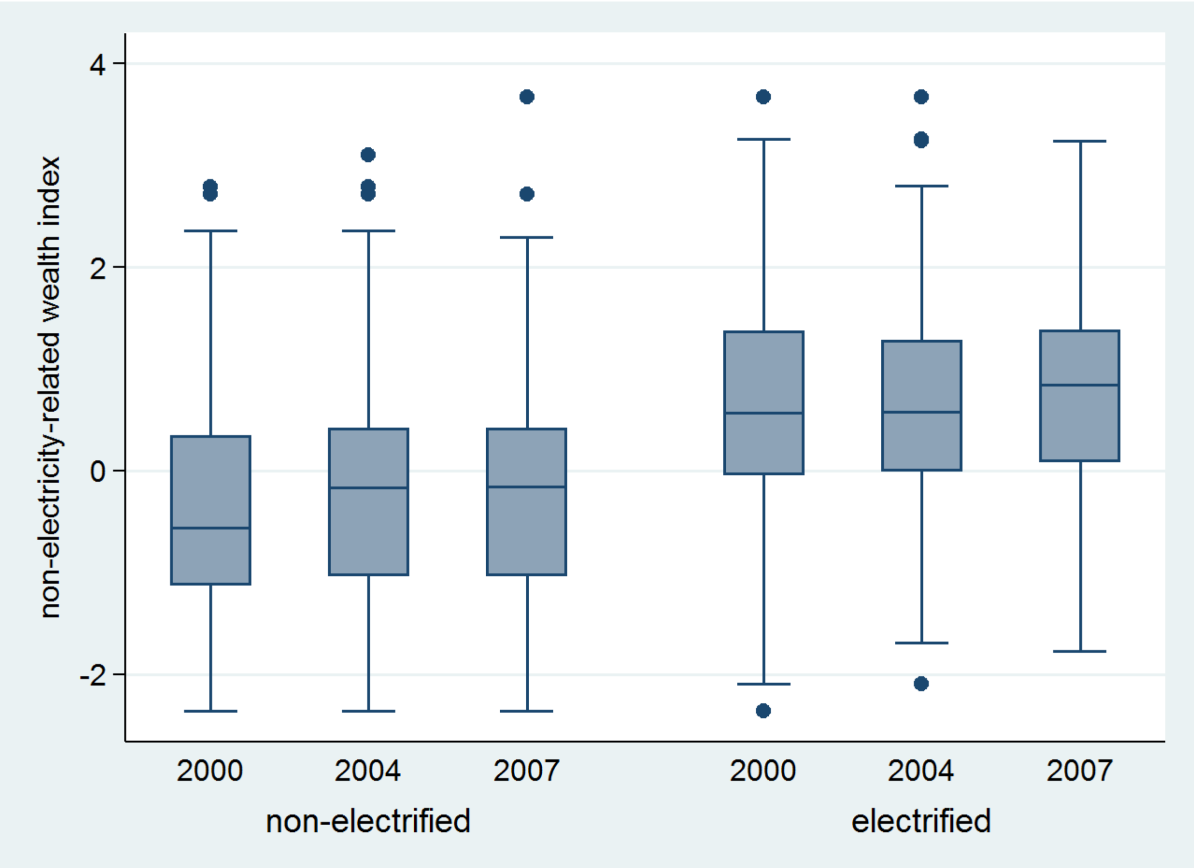
Surface water refers to getting drinking water from rivers, lakes, ponds, etc. Natural wall refers to wall materials such as bamboo and mud. Natural roof refers to roof materials such as bamboo or thatch.

Table 9: Summary statistics for wealth index by survey year.

Survey year	Obs	Mean	SD	Min	Max
2000	3843	-0.2577	1.0566	-2.3621	3.6670
2004	4072	0.0385	1.0019	-2.3621	3.6670
2007	3049	0.0954	0.9577	-2.3621	3.6670

Unweighted sample statistics

Figure 3: Boxplots of wealth index by survey year and household's electrification status.



has experienced during our study period. Figure 3 provides a box plot of wealth index by electrification status. This plot shows that electrified households are generally wealthier. This figure also shows that few non-electrified households have a wealth index above 2.3 and few electrified households have a wealth index below -1.8. Therefore, the comparison of HAZ in Figure 2 for wealth scores outside the range between -1.8 and 2.3 requires a special caution because the estimates are not very reliable for electrified households, non-electrified households, or both.

Appendix B: Detailed Regression Tables

Tables 10 and 11 show the detailed regression results for Table 2. Tables 12 and 13 provide the detailed results for Tables 3 and 6, respectively.

Table 10: Detailed OLS regression results for Panel A, Table 2.

HAZ	2000	2004	2007	2000	2004	2007	2000	2004	2007	2004	2007	2004	2007
Electrified household	0.515***	0.453***	0.398***	0.180***	0.211***	0.203***	0.171***	0.181***	0.174***	0.179***	0.147**	0.206***	0.123*
	(0.056)	(0.052)	(0.056)	(0.055)	(0.046)	(0.057)	(0.057)	(0.048)	(0.058)	(0.048)	(0.058)	(0.054)	(0.064)
Child's age (mth)				-0.076***	-0.073***	-0.076***	-0.076***	-0.074***	-0.076***	-0.074***	-0.075***	-0.074***	-0.075***
				(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Child's age sq				0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
				(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Child is a boy				-0.009	-0.050	0.089**	-0.010	-0.042	0.090**	-0.038	0.084*	-0.027	0.086*
				(0.041)	(0.038)	(0.043)	(0.041)	(0.038)	(0.044)	(0.038)	(0.044)	(0.038)	(0.045)
Mother's age (yrs)				0.068***	0.058**	0.024	0.071***	0.056**	0.026	0.054**	0.018	0.056**	0.014
				(0.023)	(0.023)	(0.029)	(0.023)	(0.023)	(0.029)	(0.024)	(0.029)	(0.024)	(0.030)
Mother's age sq				-0.001*	-0.001	-0.000	-0.001*	-0.001	-0.000	-0.001	-0.000	-0.001	-0.000
				(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
Mother's education (yrs)				0.024***	0.016**	0.002	0.020**	0.009	-0.002	0.007	-0.003	0.006	-0.004
				(0.009)	(0.007)	(0.008)	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)
Mother's height (cm)				0.044***	0.046***	0.057***	0.044***	0.046***	0.057***	0.046***	0.057***	0.046***	0.055***
				(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Mother's weight (kg)				0.023***	0.022***	0.014***	0.023***	0.022***	0.013***	0.022***	0.013***	0.021***	0.016***
				(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Father's education (yrs)				0.017**	0.008	0.016**	0.014*	0.003	0.013**	0.004	0.012*	0.003	0.010
				(0.007)	(0.006)	(0.006)	(0.008)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.007)
No. of surviving children				-0.091***	-0.100***	-0.048**	-0.093***	-0.098***	-0.047**	-0.096***	-0.046**	-0.098***	-0.044*
				(0.018)	(0.020)	(0.023)	(0.018)	(0.020)	(0.023)	(0.020)	(0.023)	(0.020)	(0.023)
Use flush toilet				0.112	0.353***	0.143**	0.083	0.270**	0.127*	0.252**	0.119	0.247**	0.121
				(0.087)	(0.115)	(0.069)	(0.089)	(0.116)	(0.071)	(0.120)	(0.072)	(0.116)	(0.075)
Use pit latrine				0.064	0.116**	0.127**	0.047	0.077	0.116**	0.068	0.087*	0.087*	0.104*
				(0.052)	(0.049)	(0.056)	(0.054)	(0.050)	(0.056)	(0.051)	(0.053)	(0.052)	(0.054)
Cement roof							0.120	0.194*	0.053	0.198*	0.028	0.209*	0.053
							(0.095)	(0.113)	(0.173)	(0.118)	(0.179)	(0.121)	(0.184)
Rudimentary roof							0.060	0.095	-0.010	0.096	-0.030	0.085	-0.044
							(0.057)	(0.079)	(0.091)	(0.081)	(0.098)	(0.085)	(0.097)
Own land							0.057	0.111**	0.003	0.109**	0.011	0.097**	-0.004
							(0.046)	(0.046)	(0.050)	(0.046)	(0.050)	(0.047)	(0.051)
Have wardrobe							-0.045	0.032	0.028	0.034	0.055	0.058	0.074
							(0.055)	(0.055)	(0.060)	(0.056)	(0.059)	(0.054)	(0.062)
Have table/chair							0.083	0.087*	0.060	0.094*	0.048	0.081	0.031
							(0.052)	(0.051)	(0.057)	(0.052)	(0.058)	(0.051)	(0.059)
Have bike							0.008	0.093*	0.113**	0.087	0.115**	0.094*	0.104*
							(0.057)	(0.052)	(0.053)	(0.053)	(0.053)	(0.053)	(0.054)
Time to district headquarter (hrs)										-0.009	-0.020	-0.022	-0.019
										(0.022)	(0.021)	(0.029)	(0.029)
Ratio of certified doctors										-0.056	0.103	0.075	0.026

										(0.095)	(0.081)	(0.145)	(0.112)
Dist. to nearest health facility (km)										0.001	-0.002	0.006	0.003
										(0.022)	(0.005)	(0.031)	(0.033)
Pharmacy in community										-0.119**	0.111**	-0.155*	0.070
										(0.051)	(0.051)	(0.084)	(0.091)
Dist. to pharmacy (km)										0.054	-0.007	0.051	0.003
										(0.156)	(0.024)	(0.154)	(0.024)
Int time to district hq												0.009	0.044
												(0.031)	(0.035)
Int ratio of cert dr.												-0.206	0.093
												(0.157)	(0.137)
Int dist to nearest fac												-0.017	0.018
												(0.045)	(0.050)
Int pharmacy in comm												0.017	0.011
												(0.103)	(0.102)
Int dist to pharmacy												-0.026	-0.006
												(0.042)	(0.014)
Observations	3,843	4,072	3,049	3,843	4,072	3,049	3,843	4,072	3,049	4,011	2,984	3,943	2,831
R-squared	0.023	0.023	0.020	0.194	0.199	0.211	0.196	0.205	0.213	0.207	0.218	0.208	0.214

Standard errors clustered at community level are reported in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Community data is available from 2004 onwards.

Int* variables are the interaction terms between community variables and the dummy variable for electrified community.

Table 11: Detailed OLS regression results for Panel B, Table 2.

HAZ	2004	2007	2004	2007	2004	2007	2004	2007
Electrified household	0.492***	0.355***	0.265***	0.146**	0.220***	0.134**	0.218***	0.127*
	(0.059)	(0.065)	(0.052)	(0.067)	(0.055)	(0.066)	(0.055)	(0.066)
Child's age (mth)			-0.070***	-0.069***	-0.070***	-0.068***	-0.070***	-0.068***
			(0.006)	(0.007)	(0.006)	(0.007)	(0.006)	(0.007)
Child's age sq			0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Child is a boy			-0.033	0.134**	-0.023	0.130**	-0.021	0.118**
			(0.047)	(0.057)	(0.047)	(0.057)	(0.047)	(0.057)
Mother's age (yrs)			0.089***	0.021	0.087***	0.025	0.085***	0.022
			(0.027)	(0.037)	(0.028)	(0.037)	(0.028)	(0.037)
Mother's age sq			-0.001**	-0.000	-0.001**	-0.000	-0.001**	-0.000
			(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
Mother's education (yrs)			0.014	-0.005	0.006	-0.008	0.006	-0.006
			(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Mother's height (cm)			0.044***	0.060***	0.044***	0.060***	0.044***	0.060***
			(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Mother's weight (kg)			0.025***	0.014***	0.024***	0.014***	0.025***	0.014***
			(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Father's education (yrs)			0.004	0.012	0.000	0.010	0.001	0.009
			(0.007)	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)
No. of surviving children			-0.107***	-0.042	-0.102***	-0.040	-0.101***	-0.043
			(0.022)	(0.028)	(0.022)	(0.028)	(0.023)	(0.029)
Use flush toilet			0.304**	0.200**	0.211*	0.163*	0.210	0.144
			(0.123)	(0.082)	(0.127)	(0.086)	(0.132)	(0.088)
Use pit latrine			0.113*	0.177**	0.082	0.161**	0.084	0.135**
			(0.060)	(0.072)	(0.062)	(0.073)	(0.063)	(0.068)
Cement roof					0.338**	-0.054	0.321**	-0.074
					(0.135)	(0.214)	(0.146)	(0.220)
Rudimentary roof					0.170	-0.238**	0.150	-0.259**
					(0.104)	(0.118)	(0.110)	(0.122)
Own land					0.086	0.038	0.082	0.024
					(0.052)	(0.064)	(0.053)	(0.061)
Have wardrobe					0.066	0.030	0.068	0.063
					(0.066)	(0.080)	(0.066)	(0.078)
Have table/chair					0.061	0.027	0.062	0.017
					(0.063)	(0.077)	(0.063)	(0.076)
Have bike					0.068	0.075	0.069	0.082
					(0.073)	(0.064)	(0.073)	(0.064)
Time to district headquarter (hrs)							0.002	-0.001
							(0.027)	(0.029)
Ratio of certified doctors							-0.048	0.078
							(0.114)	(0.098)
Dist to nearest facility (km)							-0.003	0.020
							(0.034)	(0.038)
Pharmacy in community							-0.060	0.056
							(0.062)	(0.060)
Dist to pharmacy (km)							-0.201	-0.008
							(0.192)	(0.060)
Observations	2,551	1,832	2,551	1,832	2,551	1,832	2,532	1,791
R-squared	0.033	0.018	0.213	0.204	0.218	0.207	0.219	0.213

***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively. Standard errors clustered at community level are reported in parentheses. Only households located in an electrified community are used for the analysis.

Table 12: Detailed IV regression results for Table 3.

HAZ	2004	2007	2004	2007
Electrified household	5.218	0.895**	3.860	0.901**
	(8.408)	(0.396)	(10.825)	(0.423)
Child's age (mth)	-0.074***	-0.077***	-0.073***	-0.076***
	(0.008)	(0.005)	(0.007)	(0.005)
Child's age sq	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Child is a boy	-0.049	0.101**	-0.076	0.102**
	(0.073)	(0.044)	(0.118)	(0.044)
Mother's age (yrs)	-0.019	0.020	0.018	0.023
	(0.142)	(0.030)	(0.123)	(0.029)
Mother's age sq	0.000	-0.000	-0.000	-0.000
	(0.002)	(0.001)	(0.002)	(0.001)
Mother's education (yrs)	-0.083	-0.009	-0.039	-0.007
	(0.168)	(0.010)	(0.142)	(0.009)
Mother's height (cm)	0.083	0.059***	0.070	0.058***
	(0.063)	(0.005)	(0.073)	(0.005)
Mother's weight (kg)	-0.020	0.010*	-0.003	0.010**
	(0.073)	(0.005)	(0.076)	(0.005)
Father's education (yrs)	-0.043	0.005	-0.022	0.006
	(0.083)	(0.009)	(0.070)	(0.008)
No. of surviving children	-0.007	-0.032	-0.039	-0.032
	(0.160)	(0.025)	(0.175)	(0.025)
Use flush toilet	-1.530	-0.098	-0.666	-0.059
	(3.164)	(0.156)	(2.760)	(0.137)
Use pit latrine	-0.749	0.087	-0.393	0.093
	(1.449)	(0.062)	(1.381)	(0.060)
Cement roof			-0.616	-0.133
			(2.392)	(0.185)
Rudimentary roof			-0.244	-0.089
			(1.023)	(0.096)
Own land			0.188	0.036
			(0.266)	(0.055)
Have wardrobe			-0.569	-0.106
			(1.781)	(0.094)
Have table/chair			-0.193	-0.022
			(0.828)	(0.079)
Have bike			0.006	0.054
			(0.288)	(0.057)
Observations	4,072	3,049	4,072	3,049
R-squared		0.164		0.165

***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively. Clustered errors at community level are reported in parentheses. The instrumental variables for the electrified household dummy are the PBS age and system loss from the grid.

Table 13: Detailed OLS regression results for Table 6.

HAZ	2000	2004	2007	2000	2004	2007
Electrified household	0.196***	0.138***	0.177***	0.191***	0.116**	0.152**
	(0.068)	(0.052)	(0.066)	(0.068)	(0.052)	(0.067)
TV possession	-0.018	0.242***	0.083	-0.022	0.223***	0.056
	(0.101)	(0.068)	(0.077)	(0.102)	(0.070)	(0.079)
Child's age (mth)	-0.077***	-0.073***	-0.078***	-0.077***	-0.073***	-0.078***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Child's age sq	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Child is a boy	-0.013	-0.035	0.073	-0.014	-0.028	0.073
	(0.041)	(0.039)	(0.046)	(0.041)	(0.039)	(0.046)
Mother's age (yrs)	0.075***	0.060**	0.022	0.077***	0.059**	0.022
	(0.022)	(0.023)	(0.029)	(0.022)	(0.023)	(0.030)
Mother's age sq	-0.001**	-0.001	-0.000	-0.001**	-0.001	-0.000
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)
Mother's education (yrs)	0.023**	0.014*	0.000	0.018**	0.007	-0.003
	(0.009)	(0.008)	(0.008)	(0.009)	(0.008)	(0.009)
Mother's height (cm)	0.045***	0.046***	0.057***	0.045***	0.046***	0.057***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Mother's weight (kg)	0.023***	0.022***	0.014***	0.023***	0.021***	0.013***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Father's education (yrs)	0.016**	0.005	0.015**	0.014*	0.001	0.013*
	(0.007)	(0.006)	(0.007)	(0.008)	(0.006)	(0.007)
No. of surviving children	-0.091***	-0.097***	-0.046**	-0.093***	-0.095***	-0.046**
	(0.018)	(0.020)	(0.023)	(0.018)	(0.019)	(0.023)
Use flush toilet	0.120	0.297**	0.141*	0.094	0.235*	0.117
	(0.091)	(0.126)	(0.072)	(0.093)	(0.127)	(0.074)
Use pit latrine	0.054	0.106**	0.121**	0.036	0.072	0.110**
	(0.052)	(0.050)	(0.055)	(0.054)	(0.050)	(0.055)
Cement roof				0.116	0.168	0.113
				(0.096)	(0.116)	(0.180)
Rudimentary roof				0.069	0.087	0.001
				(0.057)	(0.080)	(0.092)
Own land				0.045	0.112**	0.004
				(0.047)	(0.046)	(0.050)
Have wardrobe				-0.061	0.002	0.047
				(0.054)	(0.056)	(0.061)
Have table/chair				0.090*	0.086*	0.057
				(0.052)	(0.052)	(0.057)
Have bike				0.022	0.109**	0.093*
				(0.059)	(0.054)	(0.055)
Observations	3,744	3,927	2,925	3,744	3,927	2,925
R-squared	0.193	0.198	0.216	0.195	0.203	0.217

***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively. Clustered errors at community level are reported in parentheses.

～Previous IDE Discussion Papers ～

No.	Author(s)	Title	
578	Hisatoshi HOKEN	Participation in Farmer's Cooperatives and Its Effects on Agricultural Incomes: Evidence from Vegetable-producing Areas in China	
577	Michikazu KOJIMA and Mariko WATANABE	Effectiveness of Promoting Energy Efficiency in Thailand: the Case of Air Conditioners	2016
576	Bo MENG, Jianguo WANG, Robbie ANDREW, Hao XIAO, Glen PETERS, Jinjun XUE	Spatial Spillover Effects in Determining China's Regional CO2 Emissions Growth: 2007-2010	2016
575	Kumiko MAKINO	The Framing Discourses of 'Honorary White' in the Anti-Apartheid Movement in Japan	2016
574	Souknilanh KEOLA	Measuring Population Mobility Speed from Space	2016
573	Lei LEI	The Environment Dimension of Food Supply Chain Analysis	2016
572	Humayun KABIR	From School to Work: Muslim Youths' Education and Employment Strategies in a Community in Uttar Pradesh, India	2016
571	Lei LEI	Tea Supply Chain in East Asia	2016
570	Kaoru NABESHIMA and Etsuyo MICHIDA	Japanese Import Survey: Descriptive Statistics	2016
569	Aya Suzuki and Vu Hoang Nam	Food Quality Awareness: Cases from Shrimp Producers in Thailand and Vegetable Consumers in Vietnam	2016
568	Ching-mu CHEN and Satoru KUMAGAI	Economic Impacts of the Kra Canal: An Application of the Automatic Calculation of Sea Distances by a GIS	2016
567	Ikumo ISONO, Satoru KUMAGAI, Kazunobu HAYAKAWA, Souknilanh KEOLA, Kenmei TSUBOTA and Toshitaka GOKAN	Comparing the Economic Impacts of Asian Integration by Computational Simulation Analysis	2016
566	Kazunobu HAYAKAWA, Nuttawut LAKSANAPANYAKUL, Taiyo YOSHIMI	Effect of Import Time on Export Patterns	2016
565	Kazunobu HAYAKAWA	Domestic and International Border Effects	2016
564	Bo MENG, Norihiko YAMANO, Satoshi INOMATA, Hao XIAO, Jianguo WANG, Jiabai YE	Compilation and Applications of Extended OECD Inter-country Input-Output Tables: Considering a Target Country's Domestic-regional Heterogeneity	2016
563	Asao ANDO and Bo MENG	A Unified Framework of Trade in Value Added: Physical, Monetary, Exchange Rates, and GHG Emissions	2016
562	Satoru SHIMOKAWA	Dietary Patterns and Nutritional Impacts of Rising Food Prices in Asian Countries	2016
561	Noriyuki OSADA	Housing the Rangoon Poor: Indians, Burmese, and Town Planning in Colonial Burma	2016
560	Tadashi ITO, Toshiyuki MATSUURA and Chih-Hai YANG	Stability of Complementarity between Japanese FDI and Import of Intermediate Goods: Agglomeration Effects and Parent-Firm Heterogeneity	2016
559	Ikumo ISONO and Hikari ISHIDO	Service liberalization in Lao PDR	2016
558	Kaoru NABESHIMA, Byeongwoo KANG, and Mila KASHCHEEVA	Descriptive Analysis of the Knowledge Network Formation in East Asia	2016

No.	Author(s)	Title	
557	Yoko ASUYAMA and Hideaki GOTO	Negative Skill Sorting across Production Chains	2016
556	Yuya KUDO	Malaria Infection and Fetal Growth during the War: Evidence from Liberia	2016
555	Satoshi INOMATA	Adjustment Methods of National Input–Output Tables for Harmonized and Consistent Multi-Regional Input–Output Databases	2016
554	Kiyoyasu TANAKA	Do International Flights Promote Foreign Direct Investment? The Role of Face-to-Face Communication	2016
553	Yasushi HAZAMA	Influence of Economic Performance and Corruption on Voting Behavior in a Predominant Party System	2016
552	Satoshi NAKANO, Kazuhiko NISHIMURA and Jiyoung KIM	Structural Propagation of Productivity Shocks: The Case of Korea	2016
551	Ashwini DESHPANDE, Alain DESROCHERS, Christopher KSOLL and Abu S. SHONCHOY	The Impact of a Computer Based Adult Literacy Program on Literacy and Numeracy: Evidence from India	2016
550	Masahiko GEMMA	Time Preference of Rice Producing Households in the Mekong Delta, Vietnam	2016
549	Lorenzo ROTUNNO, Pierre-Louis VEZINA, and Tadashi ITO	Heckscher-Ohlin: Evidence from virtual trade in value added	2016
548	Toshitaka GOKAN	On the sustainability of a monocentric city: Lower transport costs from new transport facilities	2016
547	Hisaya ODA and Yuko TSUJITA	Rural Electrification Revisited: The Case of Bihar, India	2015
545	Yoko ASUYAMA	Skill Sorting and Production Chains: Evidence from India	2015
544	Yoshihiro HASHIGUCHI	Allocation Efficiency in China: An Extension of the Dynamic Olley-Pakes Productivity Decomposition	2015
543	Satoru SHIMOKAWA	Is Prohibiting Land Reallocation Enough to Promote the Development of Farmland Rental Markets in China?	2015
542	Kazunobu HAYAKAWA, Tadashi ITO, and Toshihiro OKUBO	On the stability of intra-industry trade	2015
541	Kazunobu HAYAKAWA, Nuttawut LAKSANAPANYAKUL, and Shujiro URATA	Measuring the Costs of FTA Utilization: Evidence from Transaction-Level Import Data of Thailand	2015
540	Kazunobu HAYAKAWA, Toshiyuki MATSUURA, and Sadayuki TAKII	Does Trade Liberalization Boost Quality Upgrading?: Evidence from Indonesian Plant-Product-Level Data	2015
539	Hisatoshi HOKEN and Qun SU	Measuring the Effect of Agricultural Cooperatives on Household Income Using PSM-DID	2015
538	Byeongwoo KANG	What best transfers knowledge? Capital, goods, and innovative labor in East Asia	2015
537	Momoe MAKINO	Better than Nothing? Dowry in the Absence of the Legal Protection of Women's Inheritance Rights	2015
536	Takeshi KAWANAKA	The Stakes of Politics and Electoral Administration: A Comparative Study of Southeast Asian Democracies	2015
535	Tadashi ITO and Pierre-Louis VEZINA	Production fragmentation, Upstreamness, and Value-added: Evidence from Factory Asia 1990-2005	2015
534	Momoe MAKINO	Marriage, Dowry, and Women's Status in Rural Punjab, Pakistan	2015

No.	Author(s)	Title	
533	Kiyoyasu Tanaka	The Impact of Foreign Firms on Industrial Productivity: Evidence from Japan	2015
532	Koji KUBO	Impacts of Foreign Exchange Auctions on the Informal Market Rate in Myanmar	2015
531	Kiyoyasu TANAKA and Souknilanh KEOLA	Shedding Light on the Shadow Economy: A Nighttime Light Approach	2015
530	Ming YE, Bo MENG, Shang-jin WEI	Measuring Smile Curves in Global Value Chains	2015
529	David BULLÓN, Tayutic MENA, Bo MENG, Natalia SÁNCHEZ, Henry VARGAS, Satoshi INOMATA	Using the Input-Output Approach to Measure Participation in GVCs: The Case of Costa Rica	2015
528	Hongsheng ZHANG, Bo MENG and Shuzhong MA	Determinants of China's Bilateral Trade Balance in Global Value Chains	2015
527	Gianluca TARASCONI and Byeongwoo KANG	PATSTAT Revisited	2015
526	Tsunehiro OTSUKI, Keiichiro HONDA, Etsuyo MICHIDA, Kaoru NABESHIMA and Yasushi UEKI	Effects of RoHS and REACH regulations on firm-level production and export, and the role of global value chains: The cases of Malaysia and Vietnam	2015
525	Kazuhiko OYAMADA	Behavioral Characteristics of Applied General Equilibrium Models with an Armington-Krugman-Melitz Encompassing Module	2015
523	Abu S. Shonchoy and Kenmei TSUBOTA	Economic Impact of Political Protests (Strikes) on Firms: Evidence from Bangladesh	2015
522	Abu S. Shonchoy and Mehnaz RABBANI	The Bangladesh Gender Gap in Education: Biased Intra-household Educational Expenditures	2015
521	Tomoki FUJII and Abu S. SHONCHOY	Fertility and Rural Electrification in Bangladesh	2015
520	Chie KASHIWABARA	Changes in Source of Profits and Business Strategies?: Some Evidence from the Philippines' Universal Banks in the 2000s	2015
519	Yutaka ARIMOTO and Satomi KUROSU	Land and labor reallocation in pre-modern Japan: A case of a northeastern village in 1720–1870	2015
517	Kazuhiko OYAMADA and Yoko UCHIDA	Is FTA/EPA Effective for a Developing Country to Attract FDI? Simulation Analysis Based on an Extended Knowledge-Capital Model	2015
516	Yoko UCHIDA and Kazuhiko OYAMADA	Theory and Empirics of Markusen Type Multinationals	2015
515	Hikari ISHIDO	Establishing Global Value Chains through the Liberalization of Trade in Services	2015
514	Masaki MATSUO	Authoritarianism and Labor Market: Preference of Labor Policies in the Arab Gulf Countries	2015
513	Andrew M. GARDNER	Migration, Labor and Business in the Worlding Cities of the Arabian Peninsula	2015
512	Takayuki HIGASHIKATA Koichi KAWAMURA	Voting Behavior in Indonesia from 1999 to 2014: Religious Cleavage or Economic Performance?	2015
511	Koji KUBO	Transition from Black to Official Markets for Foreign Exchange in Myanmar	2015
510	Tadashi ITO	On the Variety of Mexico's Export Goods	2015

No.	Author(s)	Title	
509	Byeongwoo KANG, Kaoru NABESHIMA, and Fang-Ting CHENG	Avoiding the middle income trap: Indigenous innovative effort vs foreign innovative effort	2015
508	Mami YAMAGUCHI	The Voices and Protests of China's Labour NGOs and Their Effort to Promote Migrant Worker Rights	2015
507	Kaoru NABESHIMA, Etsuyo MICHIDA, VU Hoang Nam, Aya SUZUKI	Emergence of Asian GAPs and its relationship to Global G.A.P.	2015
506	Mila KASHCHEEVA, Kaoru NABESHIMA	Innovation in Eastern Europe: A case study of Czech Republic	2015
505	Yutaka Arimoto, Hisaki Kono, Tsilavo Ralandison, Takeshi Sakurai, Kazushi Takahashi	Understanding traders' regional arbitrage: The case of rice traders in Antananarivo, Madagascar	2015
504	Takeshi Sakurai, Tsilavo Ralandison, Kazushi Takahashi, Yutaka Arimoto, Hisaki Kono	Is There Any Premium for Unobservable Quality? A Hedonic Price Analysis of the Malagasy Rice Market	2015
503	Tsilavo Ralandison, Yutaka Arimoto, Hisaki Kono, Takeshi Sakurai, Kazushi Takahashi	Rice flows across regions in Madagascar	2015
502	Yuya Kudo, Abu Shonchoy, Kazushi Takahashi	Impacts of Solar Lanterns in Geographically Challenged Locations: Experimental Evidence from Bangladesh	2015
501	Lei LEI	A Closer Look at the Diffusion of ChinaGAP	2015
500	Kaoru NABSEHIMA, Tadashi ITO, Kiyoyasu TANAKA, Mila Kashcheeva, David BULLÓN, Natalia SÁNCHEZ	The Source of Sustainable Growth in Costa Rica	2015
499	Satoru KUMAGAI, Yasushi UEKI, David BULLÓN, and Natalia SÁNCHEZ	Industrial Agglomeration in Costa Rica: A Descriptive Analysis	2015
497	Hakaru IGUCHI, Toshi H. ARIMURA and Etsuyo MICHIDA	Adoption of ISO9001 through Supply Chain in Vietnam: Impacts of FDI and Product-related Environmental Regulation	2015
496	Saumik PAUL, Abu SHONCHOY and Andrew DABALEN	Food Crop Diversification as a Risk Mitigating Strategy During Conflict: Evidence from Cote d'Ivoire	2015
495	Kiyoyasu TANAKA and Yoshihiro HASHIGUCHI	Agglomeration Effects of Informal Sector: Evidence from Cambodia	2015
494	Kazunobu HAYAKAWA, Han-Sung KIM, Taiyo YOSHIMI	FTA in International Finance: Impacts of Exchange Rates on FTA Utilization	2015
493	Jiansuo PEI, Bo MENG, Fei WANG and Jinjun XUE	Production Sharing, Demand Spillovers and CO2 Emissions: The Case of Chinese Regions in Global Value Chains	2015
492	Taeko Hoshino	Boundaries of Firms and Catching Up by Latecomers in Global Production Networks: The Case of a Mexican Auto-Parts Manufacturer	2015
491	Mila KASHCHEEVA, Kevin TSUI	Political influence in commercial and financial oil trading: the evidence from US firms	2015
490	Yuning GAO, Yunfeng ZHENG, Angang HU, Bo MENG	Input–Output-Based Genuine Value Added and Genuine Productivity in China's Industrial Sectors (1995-2010)	2015
489	Ikuo KUROIWA	Industrial Deepening in East Asia	2015