Electrification and Children Time-Use

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Abstract

Living in an electrified household has the potential to improve the opportunity set of children and youth by inducing time-use changes. Yet, the linkages between electrification and children's time-use have received little attention in the literature. We attempt to fill in this gap by offering empirical evidence from urban and rural Tanzania. Using a sample of 14,622 children aged 5 to 18 years old, we explore their educational outcomes and weekly time-use patterns for 4 types of activities, namely study time, time spent on household chores (including firewood collection), leisure time, and time spent working. We use the propensity score matching techniques as well as an instrumental variable approach to estimate the impact of household electrification on children's outcomes. Our analysis compares boys and girls as well as rural and urban locations.

Keywords

Energy; Electricity; Allocation of time; Education; Sub-Saharan Africa

JEL codes

Q40; O13; I25; O12; N57

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1. Introduction

The electricity gap is a salient feature of African economies. In 2016, only 42.80% of the population of Sub-Saharan Africa (SSA) had access to electricity, 24.80% in rural areas and 75.70% in urban areas (World Bank data).[2] Most households in the region still rely on traditional fuels, specifically charcoal and firewood, to meet their basic energy needs. Besides, the types of fuels they use have an important bearing on several factors influencing their well-being, such as economic welfare, education, health and safety, and aspects of individual and collective time-use.

Electrification in low-income economies can thus deliver a wide range of economic and noneconomic benefits to populations (see Bonan et al., 2017; Bos et al., 2018; Köhlin et al, 2015; Lee et al., 2017). In addition, the immediate linkages between energy use and time-use closely link to the risks and opportunities faced by children and adolescents.[3] For instance, the opportunity cost of firewood collection places a burden on households by limiting the time available for education or other productive activities. Using the UNICEF Multiple Indicator Cluster Surveys from 11 African countries, Webbink et al. (2012) have uncovered that girls spent on average 11 hours, and boys 8 hours in the past week in housework, i.e. collecting firewood, fetching water, shopping, cleaning, or caring for children. As such, the main goal of this paper is to develop an understanding of the relationship between electrification and time-use of children. This relationship should also not divorce from the broader research agenda on gender inequalities.

The stakes are high; the African under-18 population will increase from 547 million in 2015 to almost 1 billion by 2050.[4] By 2100, they will account for almost half of the under-18 world population. Needless to say, the future of the African continent lies with the capacity of policymakers to unlock opportunities to embracing these demographic and social transitions. Investing in children and youth will benefit their current well-being, their adult life and future generations of children, and will also generate significant economic and social returns (Sheehan et al., 2017).

Household electrification can, thus, play a key role in improving educational outcomes and pave the way for better opportunities. Living in a dwelling connected to electricity is expected to have impact on individual and collective time-use and can influence children's lives through 4 channels: (i) their study time and time spent in school, (ii) their leisure time and use of

[2] Source: World Bank, Sustainable Energy for All (SE4ALL) database from the SE4ALL Global Tracking Framework led jointly by the World Bank, International Energy Agency, and the Energy Sector Management Assistance Program.
[3] In the paper, we will use the term 'children' for the under-18 population.
[4] UNICEF data - Generation 2030 Africa 2.0 - https://data.unicef.org/wp-content/uploads/2015/12/Generation-2030-Africa-19Mar2015_e-version_173.pdf (consulted on 22/02/2019).

electronic appliances, (iii) their time spent on household chores, and (iv) their time spent working in formal and informal employment. Some studies have attempted to assess the impact of living in an electrified household on children's educational outcomes and time-use. Results suggest positive impacts on education and more mixed impacts on time-use. But as pointed out by Bos et al. (2018) in their thorough review of the literature, there is not enough evidence to draw general conclusions about the electrification–time-use relationship. In addition, most studies focus on rural locations.

In this respect our contribution is twofold. Firstly, children, notably girls, living in SSA face strong barriers to obtaining education and lack economic and social opportunities. Our article, therefore, aims at exploring if access to electricity is key to unlocking opportunities through a change in time-use patterns. Secondly, we analyse both rural and urban locations. A large body of the literature focuses on rural electrification where access rates are particularly low. However, the energy gap remains a challenge in urban locations where not all households are connected to the grid. It has notably been noted that there is a dearth of studies on the impacts of household electrification comparing rural and urban areas (Bos et al., 2018).

To address our research question, we use the case of Tanzania which provides useful insights for an understanding of the energy transitions taking place in SSA as it shares several salient features with many other SSA economies. The region is characterized by rapid population growth (in particular that of those under-18), a heavy reliance on traditional fuels for meeting households' everyday energy needs, coupled with the slow pace of mass electrification[5] and a lack of infrastructure to support economic growth and human development.

We use the 2016 Tanzania Energy Access Situation Survey (The United Republic of Tanzania, 2017). The survey covers all 26 regions of mainland Tanzania and took place with 10,140 households, containing 43,409 household members, of which14,622 are aged 5 to 18.

Since household electrification isn't random, we follow the approaches of Khandker et al. (2009a). The first approach consists of identifying electrified and non-electrified households that are similar with respect to their other observed characterises, using the propensity score matching (PSM) method. The second approach consists of estimating an outcome equation conditional on having electricity in the dwelling, using an instrumental variable (IV) approach.

[5] Despite ongoing efforts to bridge the energy gap, grid connection rates in SSA still lag behind the rest of the world (Bos et al., 2018; Bernard; 2012).

2. Literature Review

Given the importance of energy use in development outcomes, and in recognition of the various benefits associated with the adoption of modern fuels, the microeconomic literature on fuel transition in low-income economies has developed around two strands. The first one explores the determinants of household fuel choices in the context of the energy ladder and energy staking hypotheses (see Muller and Yan, 2018, for a literature review, and Choumert-Nkolo et al., 2019 for Tanzania). The second one investigates the economic and noneconomic benefits of household electrification (see Bos et al., 2018 for a literature review, and Chaplin et al., 2017 for Tanzania).

Our research question belongs to the second axis. Indeed, recent global initiatives explicitly target access to modern energy services, such as Sustainable Development Goal 7 '*Ensure access to affordable, reliable, sustainable and modern energy for all*', '*The New Deal on Energy for Africa*' adopted by African Development Bank, and the '*Sustainable Energy for All*' initiative. It is expected that these initiatives, accompanied by significant investments in the energy sector, will have multiple dividends on several development goals.

The economic and noneconomic impacts of electrification on households and individuals are well described in the literature reviews conducted by Bonan et al. (2017), Bos et al. (2018), Lee et al. (2017), and Peters and Sievert (2016). This literature contains a wide range of discussions on individual and collective time-use changes induced by electrification. As far as children are concerned, living in an electrified household can influence their lives through four channels: Study time and time spent in school, leisure time and use of electronic appliances, time spent on household chores, and time spent at work.

Firstly, having more hours under light may allow children to study longer hours in the evening. The quality of the study time can also improve compared to children having to study under a kerosene lamp or candles. In addition, more hours under light may allow them to undertake household chores early morning or in the evening which may translate into higher school attendance rates. Secondly, the introduction of electricity in a dwelling can decrease the burden on some household chores such as firewood collection or chores for which the household can invest in electronic appliances. On the contrary, having longer days and being able to study at night may as well increase the time spent on household chores while adults spend more time at work. Thirdly, living in an electrified household may increase the time for leisure and use of TV, radios, mobile phone, and other devices. This may translate into more access to information and knowledge. Fourthly, having electricity in the household may influence labour supply decisions for the children of the household. Ultimately, all 4 channels can lead to improved human capital accumulation, better health, better opportunities, and higher streams of future income.

As such, some studies have explored the impact of living in an electrified household on children' s educational outcomes and time-use.[6] Results suggest positive impacts on education across different geographical contexts. Results are more mixed on time-use.

Chaplin et al. (2017) carried out an impact evaluation of a large-scale electrification programme in Tanzania using a difference-in-differences (DID) and a group randomized controlled trial approach. Using a sample of 8,897 households in rural and urban locations, they found that connecting to the grid led to an increase of 14 minutes in the total study time per day for children aged 5 to 14 (with 12 more minutes at night); and by 17 minutes for youth aged 15 to 24 (with 14 minutes at night). They also found reductions in time spent by children collecting water (9 minutes decrease) and fuel (21% decrease). In addition, children spend more time for leisure activities (1.27 hours more, that is 60% more), notably on watching TV, with children spending on average 1.45 hours watching TV per day (6 times more than children in non-electrified households). Last, the authors found that connection to the grid increased children school enrolment, with a 2 percentage points increase in the share of children age 5 to 14.

In India, using an instrumental variable approach with a sample of 24,000 rural households, Khandker et al. (2012) found that household electrification led to a 6% increase in school enrollment for boys and 7.4% for girls. They also found an increase in study time, by more than an hour and in average completed schooling year (0.3 for boys and 0.5 for girls). In the context of Vietnam, using a panel sample of 1,120 rural households, Khandker et al. (2013) uncovered that household electrification led to an increase in school attendance by 6.3 percentage points for boys and 9 percentage points for girls. In their sample of 4,000 rural households in Bangladesh, Samad et al. (2013) found that having a solar home system is associated with an increase of boys' study time by 8 minutes and girls' study time by 7 minutes during the evening. Using a randomized encouragement design in rural El Salvador, Barron and Torero (2014) explored time-use changes induced by electrification for 196 children. They found that electrification increases the probability of engaging in educational activities, i.e. home study, time in school and commute time (by 78 percentage points). In addition, the probability they participate in home chores increases by 96 percentage points. Using a DID approach with 974 rural households in Rwanda, Lenz et al. (2017) found that access to electricity leads to an increase in time awake for primary and secondary school children and in study time after school. For children between 6 and 11 years, study time increases by 19 minutes after nightfall, and by 44 minutes for children between 12 and 17 with similar effects for girls and boys. Nonetheless, total study time does not increase suggesting a shift from day to night study. Finally, they find no effect of electrification on school attendance. Using a DID and a PSM approach with a sample of 537 households in rural Rwanda, Bensch et al. (2011) obtained small positive effects of

[6] The studies presented below, as well as ESMPA (2002) in rural the Philippines and Grogan and Sadanand (2013) in rural Nicaragua, also present results for adults' time-use.

electrification on children study time at home (20 minutes more per day for primary school children) but the effect disappears when they account for regional differences. In their study in rural Ethiopia in which they asses a random allocation of vouchers as extra incentive to connect to the electrical grid, Bernard and Torero (2015) collected time-use information from a male adult, a female adult, and two children, but found no impact of electrification on time use over the 12 months of the study. Finally, in a study in Guatemala looking at 5,004 rural households, Grogan (2018) found no impact of household electrification on children's time spent studying, in leisure activities and looking after other children.

No clear-cut consensus emerges from this literature review. First, the time-use categories are not always the same and little information is provided on the production and quality of the time-use data although they are particularly challenging to collect in household surveys[7] (Frazis and Stewart, 2012; Grosh and Glewwe, 2000). Secondly, our literature review indicates that there is a dearth of evidence on the linkages between electrification and children time-use. Moreover, most papers concentrate on rural electrification. Although the energy gap is particularly striking in rural locations, it would be abusive to think that urban electrification is no longer at stake. It is expected that SSA's urban population will triple by 2050 (United Nations, 2018). Ensuring access to infrastructure and utilities to these additional 900 million urban dwellers will be crucial to the continent's growth and development. Yet in 2016, only 76% of SSA urban population had access to electricity, with great variations with for instance 49.7% in Burundi, 65.3% in Tanzania, and 92.5% in South Africa (World Bank data). Challenges thus remain and research should continue investigating how electrification impacts people's lives in both rural and urban locations which will be addressed in our analysis.

3. Data Description

3.1. Electrification in Tanzania

Despite a high and stable growth rate in recent years (averaging 6–7% a year over the last decade[8]), poverty remains a serious problem in Tanzania; the country is currently 154th in the Human Development Index.[9] With respect to access to electricity, few Tanzanian households are connected to the electric grid. At the national level in 2016, only 16.9% (65.3%) of rural (urban)

[7] The quality of time-use data (and associated measurement errors) depends on several aspects: Is the information self-reported or reported by the main survey respondent? Do activities overlap? Does total time-use exceed 24 hours for one day? What is the recall period, last day, a typical day? last week, a typical week?

[8] https://www.worldbank.org/en/country/tanzania/overview

[9] http://hdr.undp.org/en/countries/profiles/TZA

households of mainland Tanzania were connected to electricity (The United Republic of Tanzania, 2017).

To address the energy gap, the Tanzanian government plans to increase electrification rates to 75% by 2035 (IED, 2014).[10] Recognizing the need for wider electrification to accompany the structural transformation of the economy, Tanzania formulated several strategies, with more recently the 2015 Tanzania National Energy Policy, and other reforms[11] aimed at improving access but also the quality of energy services. The Rural Energy Agency (REA) was notably established to tackle the rural considerable energy gap. Presently, Tanzania's electricity is mostly generated by hydroelectricity, natural gas, and oil (Power Africa, 2015). The sector is currently operated by the public utility TANESCO (Tanzania Electric Supply Company Limited) under the regulation of the Ministry of Energy and Minerals.

3.2. Presentation to the data

3.2.1. Sampling procedure

We use the Energy Access Situation Survey (2016) produced by the Rural Energy Agency (REA) and the National Bureau of Statistics (NBS) (The United Republic of Tanzania, 2017). The survey covers all 26 regions of mainland Tanzania. A two-Stage sampling design was used, primary sampling units being the enumeration areas (EAs), and secondary sampling units being the households. EAs were selected using the 2012 Census and using a probability proportional to size procedure. A listing exercise was conducted to list all households in the selected EAs. Then, within each EA, 15 households were selected using an equal probability selection procedure. In total the survey took place in 676 EAs with 10,140 households, containing 43,409 household members.

The survey mainly asked about household demographics, economic activities for household members aged 5 years or above, housing/water/sanitation conditions, electricity consumption, and energy use, asset ownership, sources of income, household expenditures, and time-use of each household member aged 5 years old and above.

The survey respondent could change depending on the questionnaire module. For generic household level questions, the household head or another adult representative was the

[10] Detailed information about electrification programmes in the country can also be found in Chaplin et al. (2017), Peng and Poudineh (2016), and The United Republic of Tanzania (2017).

[11] Petroleum Act, 2015; Oil and Gas Revenues Management Act, 2015; Natural Gas Utilisation Master Plan 2016 – 2045, 2016; other cross-cutting policies and strategies, such as the Integrated Industrial Development Strategy 2025.

respondent. For some questions, the respondent could be all household members or any household member. For time-use data, the respondent could be any household member.[12]

3.2.2. Electrification and energy data

Electrification and energy variables are presented in **Error! Reference source not found.**. Among the 10,140 households of our sample, although 54.22% live in a village/mtaa[13] that has electricity, only 28.47% have electricity in their dwelling with significant rural/urban disparities (see Figure 1a.). A large share of households thus lives 'under grid' in reference to the work of Lee et al. (2016).

The household energy landscape is characterised by a very high prevalence of traditional and transitions fuel use for cooking (See Figure 1b.) and lighting (See Figure 1c.), as well as energy stacking behaviour of households: 31.65% and 22.1% of electrified households report using at least two energy sources for cooking and lighting, respectively (versus 10.18% and 3.73% of unelectrified households); urban households using a more diverse range of fuels. This is referred to as "stacking-up the energy ladder".[14] Interestingly, many electrified households still use firewood, charcoal, and kerosene for cooking. The pattern differs for lighting energy sources. Among electrified household, 66.1% of rural households use solar lamps and 35.05% electricity, while 90.32% of Dar es Salaam households and 93.57 other urban households use electricity.

The source of electricity varies by region: 68.94% of rural households are connected through solar electricity, while 99.3% of Dar es Salaam households and 77.05% of other urban households are connected to the national grid. Electricity being indispensable to use certain appliances, differences in asset ownership reflect differences in wealth status, in urban/rural location, but also in connection to electricity. For example, in Dar es Salaam, 47.78% own a refrigerator, 89.76% a TV, 68.26% an electric iron, and 11.60% a computer versus almost none for non-electrified households (see Annex 1 for summary statistics of electric and energy assets). Those differences in electric and energy assets ownership are expected to reflect in time-use patterns.

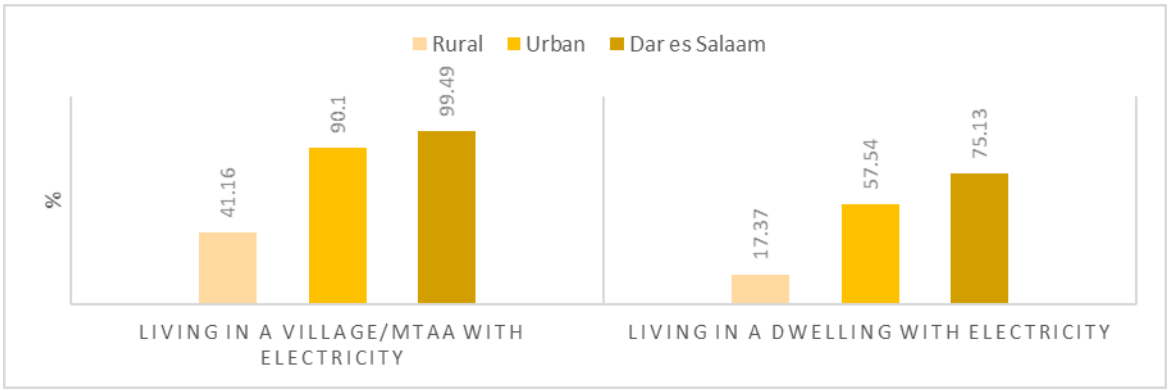
[12] According to the data, 1.64% of households changed of respondents during this module, however, there is no indication as to whether other household members were present or not.

[13] A mtaa (plural mitaa) is a division/street under the jurisdiction of an urban authority.

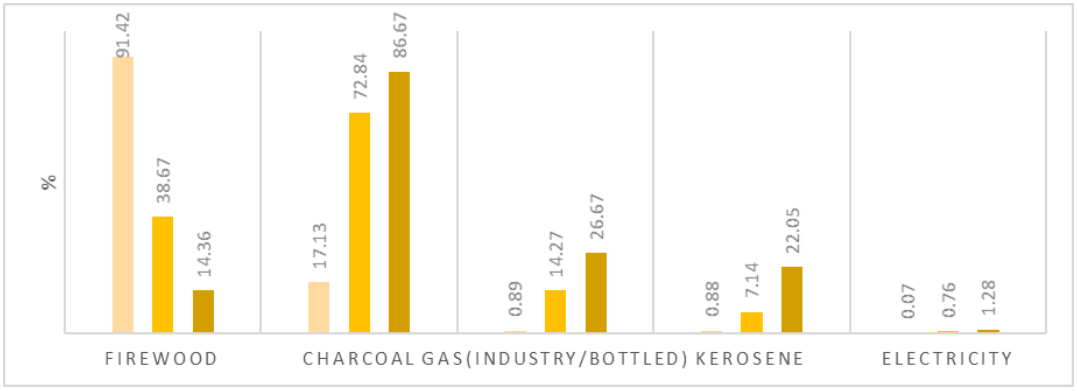
[14] See Choumert-Nkolo et al. (2018) for a discussion on fuel stacking behaviours and analysis on Tanzanian households.

Figure 1. Energy variables

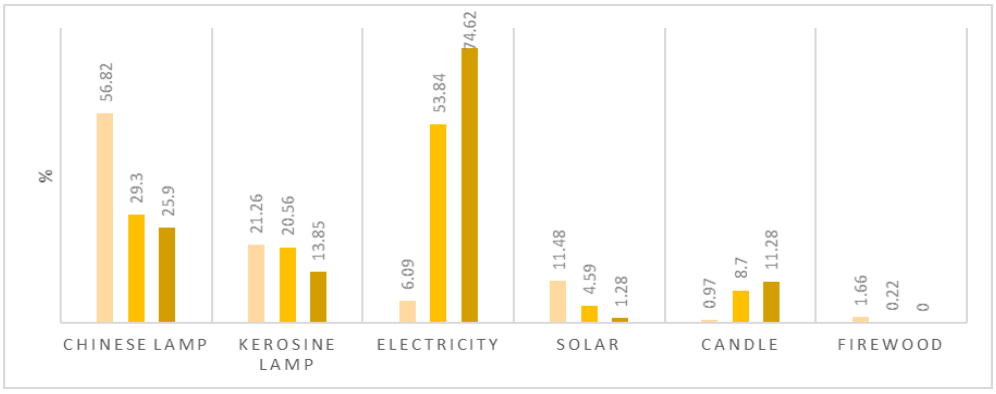
a. Household electrification



b. Households energy sources for cooking



c. Households energy sources for lighting



Note: N_{HH}=10,140 (Rural=7,508; Urban=2,242; Dar es Salaam=390)

3.2.3. Time-use and education data

There are three main levels of education in Tanzania, namely, primary level, secondary level and tertiary level of education. In our sample of 14,622 children aged 5 to 18, only 66.45% are currently attending school, only 10.1% have completed more than primary level education and 28.72% can't read or write. Obviously, figures improve when we restrict the sample to an older age category (e.g. 10 to 18).

Respondents were asked about time-use for each household member above 5. The questions that were asked are presented in Table 1. Three measures of time-use can be constructed, (i) the total mean, i.e. the average time spent in each activity over the past 7 days of the whole 5-18 population, (ii) the participation rate, i.e. the proportion of the 5-18 population who undertook the activity, (iii) and, the participation mean, i.e. the average time spent in each activity over the past 7 days by those individuals aged 5-18 who undertook the activity.

An overview of total study time indicates some interesting features (see Figure 3). Total study time is much higher in urban locations and in Dar es Salaam, as well as the participation rate. However, the participation mean, i.e. only accounting for those who do homework, is only higher for Dar es Salaam. We also provide the participation rate for household chores, labour activities and leisure activities, disaggregated by gender, rural/urban location and access to electricity in the dwelling (Figure 4, Figure 5, Figure 6).

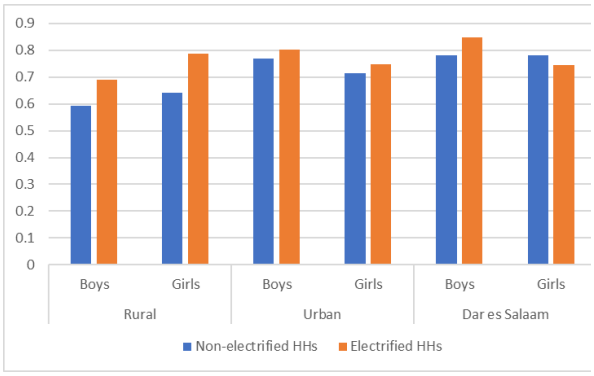
Table 1. Education and time-use questions

Education	Is (Name) currently attending school?	School_att
	Can (Name) read and write a short sentence? In Swahili, in English, both Swahili and English, another language, none	Read_write
	What is the highest level/grade of school that (Name) attended?	School_level
Activity	Question asked: In the past 7 days,	
Study time	If (name) is a pupil/student ask: how many hours did (name) spend on self-reading or doing homework? (minutes) (if less than 60 minutes '00') day time, night time	Time_stud_day Time_stud_night
Household chores	How many hours did (name) spend collecting firewood for the household including travel time? (minutes) (less than 60 minutes write '00')	Time_wood

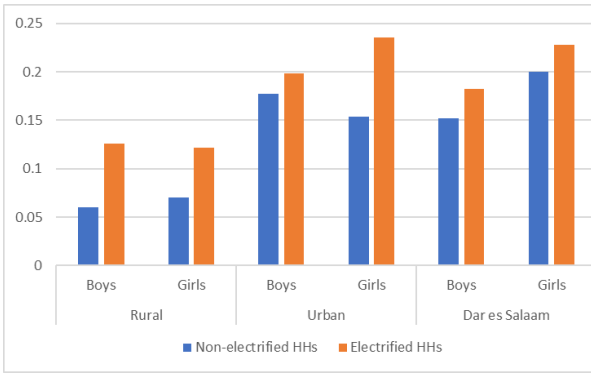
	How many hours did (name) spend preparing food at the household for immediate consumption? (less than 60 minutes write '00') day time, night time	Time_food_day Time_food_night
	How many hours did (name) spend washing clothes, ironing and cleaning households' dwelling? (less than 60 minutes write '00') day time, night time	Time_wash_day Time_wash_night
	How many hours did (name) spend taking care of children/elders/ sick of household members? (less than 60 minutes write '00') day time, night time	Time_care_day Time_care_night
	How many hours did (name) spend on milling and other food processing for the household? (less than 60 minutes write '00') day time, night time	Time_mill_day Time_mill_night
Labour	How many hours did (name) involved in an economic activity (employed/self-employed)? (less than 60 minutes write '00') day time, night time	Time_work_day Time_work_night
	How many hours did (name) spend going/returning from work? (less than 60 minutes write '00')	Time_travel_day Time_travel_night
Leisure	How many hours did (name) spend on self-reading books/newspapers/any? (less than 60 minutes '00') day time, night time	Time_read_day Time_read_night
	How many hours did (name) spend on watching tv or listening to the radio?. time in minutes day time, night time	Time_tv_day Time_tv_night

Figure 2. Education variables

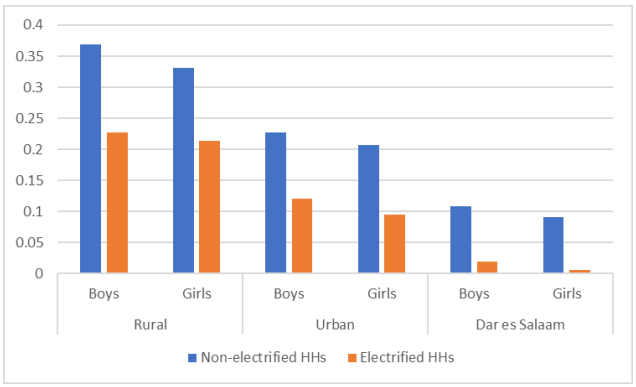
a. Currently attending school



b. Have at least (>) completed primary school education



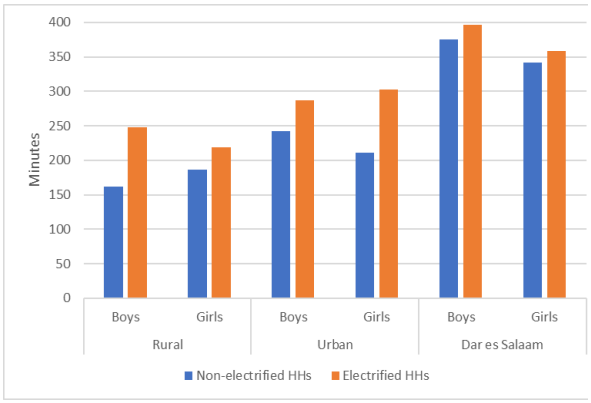
c. Can't read and write



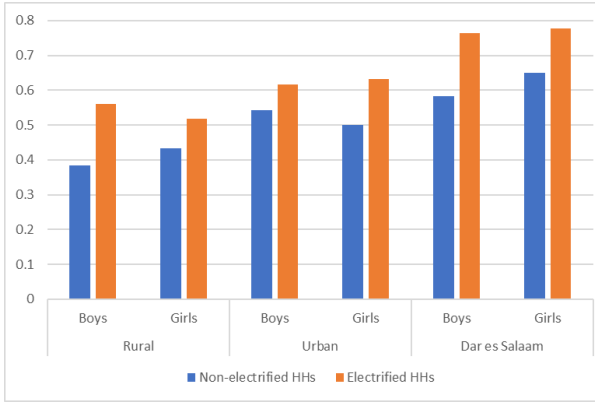
Sample of 14,622 children aged 5-18. The category "Urban" does not include Dar es Salaam.

Figure 3. Total study time

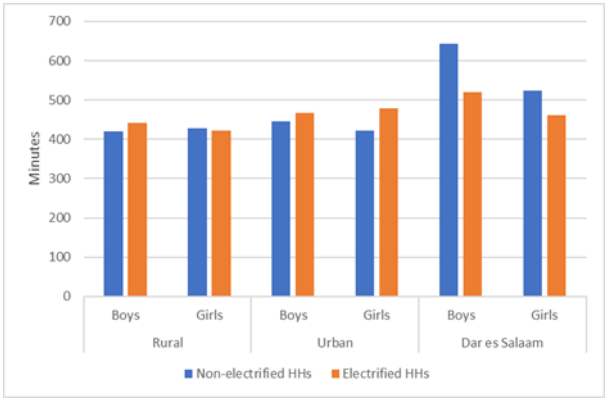
a. Average total study time



b. Participation rate



c. Participation mean

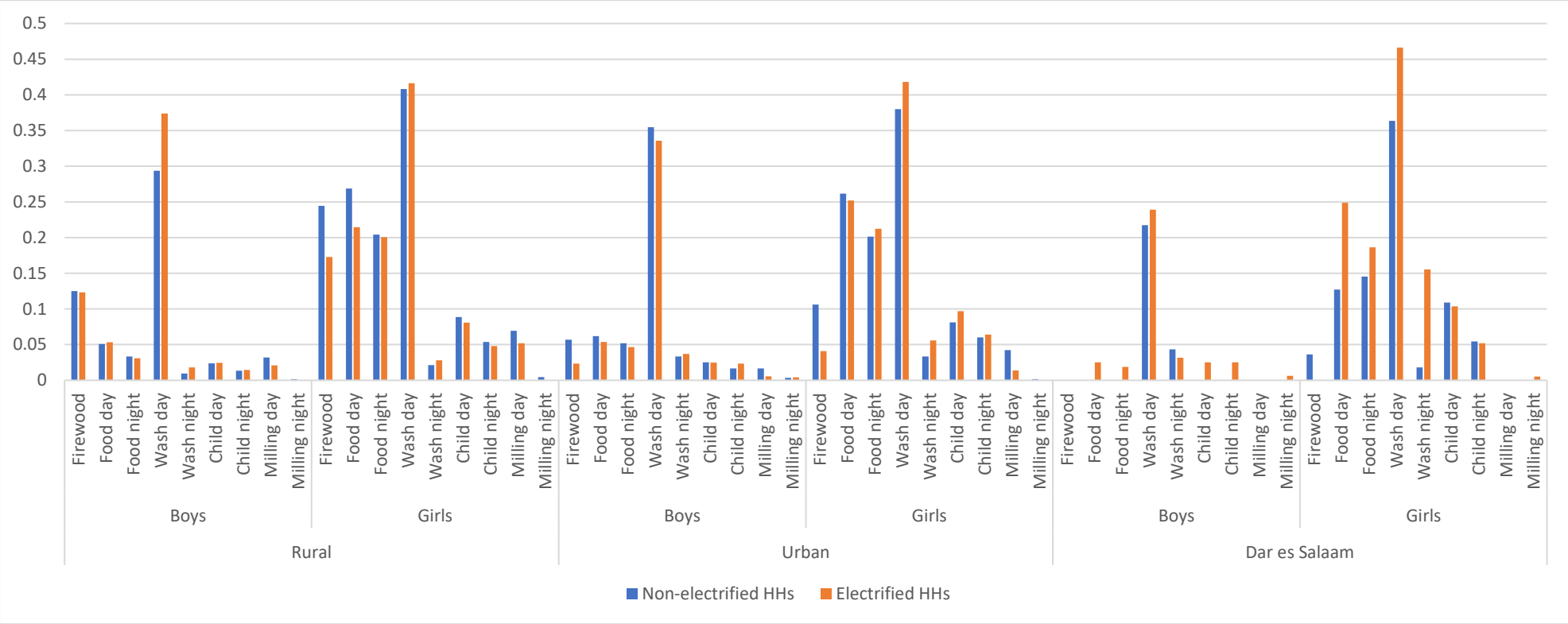


Sample of 9,716 children aged 5-18 who attend school. Sample size for the participation mean only include those 4,637 children aged 5-18 who attend school and who engaged in home studying activities.

The category "Urban" does not include Dar es Salaam.

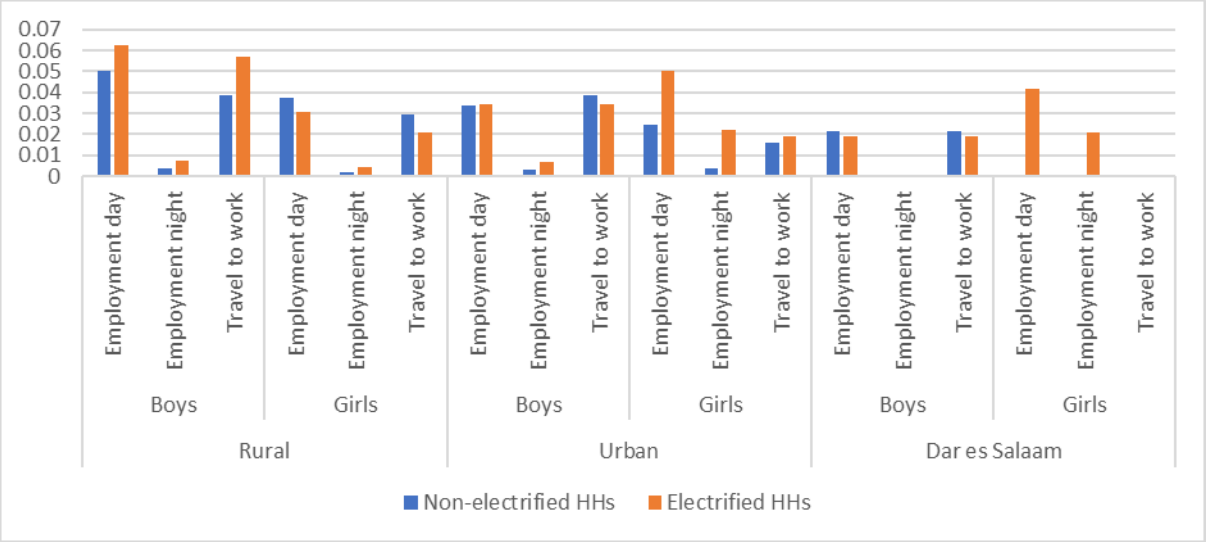
The question asked is the following "If (name) is a pupil/student ask: in the past 7 days, how many hours did (name) spend on self-reading or doing homework? (minutes) (if less than 60 minutes '00')".

Figure 4. Participation rate for household chores



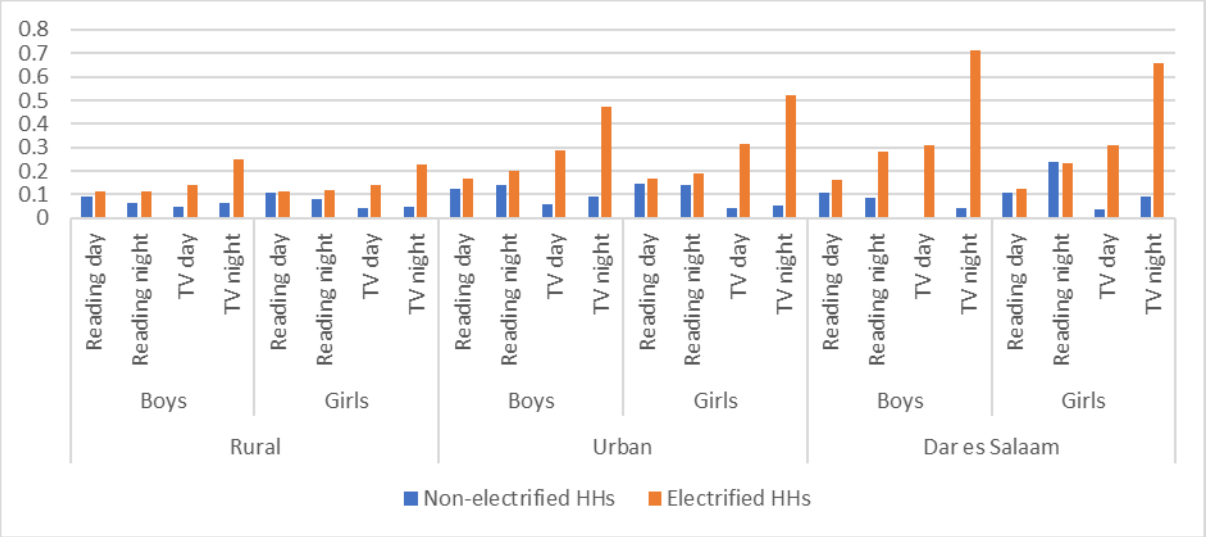
Sample of 14,622 children aged 5-18. The category "Urban" does not include Dar es Salaam.

Figure 5. Participation rate for labour activities



Sample of 14,622 children aged 5-18. The category "Urban" does not include Dar es Salaam.

Figure 6. Participation rate for leisure activities



Sample of 14,622 children aged 5-18. The category "Urban" does not include Dar es Salaam.

3.2.4. Socio-demographic characteristics

To be completed

Table 2. Socio-demographic characteristics

	Non-electrified HHs	Electrified HHs	Whole sample
Age	11.07	11.49	11.18
Sex of child (female=1)	0.48	0.49	0.48
Age of HHH	47.26	46.48	47.05
Sex of HHH (female=1)	0.20	0.18	0.20
Education level of HHH	1.75	2.70	2.00
Highest male education level	2.39	3.37	2.65
Highest female education level	2.19	2.95	2.39
Household size			
Share of female HH members			

Note: Education levels: Never gone to school (0), nursery education (1), primary education (2), course after primary (3), secondary O level (4), course after secondary (5), secondary A level (6), training after high school education (7), other certified training (8), high learning (9), adult education (10).

4. Empirical models

In order to estimate the impact of household electrification on a set of education and time-use outcomes for the 5-18 population of our sample. Since household electrification isn't random, we need to create a counterfactual situation in order to compare similar children living in electrified and non-electrified households. Indeed, simply comparing children's outcomes in electrified and non-electrified would lead to biased findings by omitting that changes can be attributed to household or village characteristics.

We follow the approaches of Khandker et al. (2009a). The first approach consists of identifying electrified and non-electrified households that are similar with respect to their other observed characterises, using the propensity score matching (PSM) method (see Khandker et al., 2009b and Rosenbaum and Rubin, 1983). The second approach consists of estimating an outcome equation conditional on having electricity in the dwelling, using an instrumental variable (IV) approach.

4.1. Propensity score matching

The PSM technique will allow us to calculate for both electrified (treated) and non-electrified (untreated) households, the probability of electrification (treatment) as a function of household and village characteristics from a probit/logit model. The propensity score is the probability of adopting electricity, which is calculated for both electrified and non-electrified households. The outcomes of children living in electrified households (treated children) are then compared with those of children living in non-electrified households (untreated children). The PSM approach relies on the assumption that differences in adoption of electricity are based on differences in observed characteristics. Since it would be challenging to identify two households exactly similar to each other, but electrification, the PSM method consists of matching them over a single propensity score. More formally, the propensity score $P(X) = \Pr(T = 1|X)$ is the probability of adopting electricity (treatment T), conditional on observed characteristics X. Two assumptions are necessary to estimate the effect of electrification, namely conditional independence (or unconfoundedness) and common support (or overlap condition) (see Khandker et al., 2009b).

Conditional independence means that the adoption of electricity is based on observed characteristics. Put differently, $(Y_i^T, Y_i^C) \perp T_i|X_i$, meaning that given observed characteristics X that are not affected by adoption of electricity T, outcomes Y are independent of T, with Y_i^T outcomes of electrified households and Y_i^C outcomes of non-electrified households.

Common support can be expressed as follows: $0 < P(T_i = 1|X_i)<1$. It means that electrified households have comparison households which are close in the propensity score distribution. Having a large sample of comparison observations facilitates finding a common support. Common support can be written as $P(T_i = 1|X_i)<1$ if the impact evaluation consists in estimating a treatment effect on the treated. Electrified households will, therefore, be similar to non-electrified households in terms of characteristics. As a consequence, some electrified households may have to be dropped should we not find comparable non-electrified households. We will thus examine their characteristics to assess the existence of a bias in estimating the effect of electrification.

4.2. Endogenous electrification

The IV technique allows us to deal with the endogeneity of village/mtaa electrification (programme placement) and household electrification (participation). Indeed, it is very likely that those selected for electrification programmes are different from the others and that is not random. We thus use village/mtaa characteristics to control for this endogeneity bias.

5. Results

To be completed

5.1. Preliminary results

VARIABLES	Total study time	Total study time Village FE	Total study time (for only those who studied)	Total study time (for only those who studied) Village FE
Food exp Q1	-13.07	-45.13***	-31.39**	-57.22***
	(9.781)	(10.07)	(14.69)	(16.76)
Food exp Q2		-34.02***	-20.68	-50.18***
		(10.80)	(16.65)	(17.64)
Food exp Q3	23.16**	-18.14*		-42.93***
	(10.34)	(9.954)		(15.84)
Food exp Q4	39.61***	-6.417	20.27	-13.33
	(10.22)	(9.534)	(14.46)	(14.62)
Food exp Q5	49.03***	-	31.65**	-
	(10.41)		(14.38)	
elec_dwelling	38.15***	8.101	1.567	-23.05*
	(7.075)	(7.931)	(10.56)	(12.50)
age	29.38***	29.88***	20.43***	21.76***
	(0.888)	(0.866)	(1.411)	(1.443)
female_hhm	10.47*	7.977	1.928	-0.393
	(5.873)	(5.677)	(9.207)	(9.245)
age_HHH	0.432*	0.182	0.724*	0.481
	(0.236)	(0.245)	(0.370)	(0.407)
female_hhh	33.14***	-3.452	19.50*	-5.196
	(7.686)	(7.947)	(11.75)	(12.75)
edu_HHH	16.82***	10.45***	8.406***	5.695*
	(2.022)	(2.127)	(2.920)	(3.210)
Rural		369.2***	-52.61**	
		(100.4)	(21.55)	
Urban	25.04***		-46.21**	

	(7.952)		(21.77)	
Dar	113.4***			
	(16.59)			
Constant	-211.6***	-505.8***	183.6***	421.3***
	(16.36)	(118.4)	(34.43)	(123.4)
Observations	9,716	9,716	4,637	4,637
R-squared	0.144	0.306	0.058	0.297

OLS estimation.

5.2. Robustness checks

We conduct several robustness checks. In previous sections, household electrification was considered as a binary outcome. We now consider three alternatives to measure household electrification:

- *Elec_2* = {0 = non-electrified; 1 = solar electricity; 2 = grid connection};
- *Elec_3* = time connected to electricity (years)
- *Elec_4* = amount spent per month for electricity (in Tanzanian Schillings).

In addition, since we expect differentiated behaviours between young children and teenagers, we conduct sub-sample analysis for three age categories, namely young children, young teenagers, and young adults.

To be completed

5.3. Distributional impacts

We assess time-use spent studying against household socio-economic status and education levels of both adult male and female household members.

To be completed

6. Discussion and conclusion

The effects of household electrification on children time-use are theoretically ambiguous and there is a dearth on empirical literature on the topic. In this paper, we investigated the role of

electrification on various time-use patterns of 14,622 children aged 5-18 in Tanzania. We explore the effects of household electrification on school attendance, study time, time spent on household chores, time spent watching TV/listening to the radio and time spent working. We explore additional questions such as: Is a child more prone to engage in household chores or work if he/she lives in a non-electrified household? Do children living in poorer households with low parental education benefit from household electrification?

Using a propensity score matching approach and an instrumental variable estimator, we explore time-use patterns of children aged 5-18 comparing electrified and non-electrified households. We then zoom in on households with low economic status and low parental education since time-use patterns depend on parental inputs.

The private benefits of household electrification thus go beyond economic and health benefits and complement well school electrification to improve education outcomes of children (Sovacool, 2014).

The relationships between household electrification and children considered could be expanded. For instance, further research could explore how household electrification impacts children's nutrition and health. Last, the long-term dynamics of household electrification should be examined to understand if it actually increases the set of opportunities of children in their adult life.

To be completed

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Annex 1. Ownership of electric appliances (%)

	Electrified households			Non-electrified households			Difference between electrified and non-electrified		
Assets	Rural	Urban	Dar es Salaam	Rural	Urban	Dar es Salaam	Rural	Urban	Dar es Salaam
Mobile phone	91.03	96.98	97.61	66.89	79.83	88.66	24.14	17.14	8.95
Charcoal/firewood cooker/stove	82.44	85.66	83.62	73.18	77.73	65.98	9.26	7.93	17.64
Radio/Radio casset	71.70	72.71	76.79	46.70	49.37	64.95	25.01	23.34	11.84
Solar panel PV system	63.57	7.60	1.37	8.59	8.09	4.12	54.98	-0.49	-2.76
TV(Coloured or Black and White)	35.74	77.29	89.76	2.16	4.73	3.09	33.58	72.56	86.67
CD/DVD/Decoder/Video casset	25.15	54.73	82.25	1.06	1.89	3.09	24.09	52.84	79.16
Kerosine lamp	13.42	15.89	30.03	27.10	37.82	30.93	-13.68	-21.92	-0.89
Electric iron	7.52	38.60	68.26	0.24	0.95	0.00	7.27	37.66	68.26
Refrigerator	4.06	24.26	47.78	0.13	0.53	1.03	3.94	23.74	46.75
Generator	2.76	0.93	0.68	0.45	0.42	0.00	2.31	0.51	0.68
Music system	2.22	5.19	0.34	0.29	0.53	0.00	1.93	4.67	0.34
Fan	1.92	13.41	57.34	0.15	0.53	0.00	1.77	12.89	57.34
Computer	1.69	7.91	11.60	0.19	0.42	0.00	1.49	7.49	11.60
Water heater	1.61	4.96	9.90	0.08	0.32	0.00	1.53	4.65	9.90
Frezer	0.61	2.56	3.07	0.02	0.11	0.00	0.60	2.45	3.07
Electric cooker/stove	0.61	2.25	5.12	0.10	0.42	0.00	0.52	1.83	5.12
Land line telephone	0.00	0.62	0.34	0.06	0.00	0.00	-0.06	0.62	0.34
Washing machine	0.00	0.31	0.34	0.03	0.00	0.00	-0.03	0.31	0.34

Air conditioner	0.00	0.08	1.71	0.06	0.00	0.00	-0.06	0.08	1.71
N_{HH}	1304	1290	293	6204	952	97			