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Is the effect of access to electricity on employment greater for women with higher levels compared to lower levels of education?

The case of Sub-Saharan Africa

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Bachelor's thesis, 15.0 ECTS
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Spring Term 2016
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ABSTRACT

This paper aims to examine if the probability of being employed can be affected by having access to electricity and also a higher level of education. In line with previous research it focuses primarily on rural areas but observes to some extent also urban areas. The research question will be examined based on theory about reallocation of time, as an effect of electricity that could increase the probability of being employed, together with theory about higher levels of education positively influencing chances of employment. The overall results do not support the notion of a combined effect of having electricity and being more educated on the chances of being employed in rural areas. In urban areas, potential indications of secondary education that jointly with having access to electricity would make it more likely to be employed proved to only be due to regional differences.

Keywords: employment, electricity, education, Africa, Afrobarometer

ACKNOWLEDGMENT

We would like to express our gratitude towards our supervisor Pelle Ahlerup who helped us along the way with guidance and expertise for our thesis.

Contents

1. INTRODUCTION

Currently, 40 % of the African households either lack access to an electricity grid or do not have a connection to the existing and available electricity grid in the nearby area. Naturally, without connecting to a grid, having electricity in the household will simply not be a possibility. Although there is a 40 % lack of access to an electricity grid and connection in Africa as a whole, in Sub-Saharan Africa the percentage of households without access to a grid or connection is even higher, at 54.5 % (The Afrobarometer, 2016). Electricity is crucial in several aspects; to give children the light to study in, for families to take care of daily household activities, such as cooking, and for employers, where bringing a simple light bulb can be to provide decent working conditions for one's employees. Given all these benefits of electricity, it is strikingly sorrowful to observe that in, e.g., Burundi the connection rate is as low as 11 %, and although Nigeria has a connection rate of 96 % the rate of connection considered to 'work most- or all of the time' is only 18 % (The Afrobarometer, 2016).

Economic and social effects of electricity on an individual level is nowadays a well examined topic. Having electricity can reduce the workload within the household, and because of this, studies have found evidence for increased employment as an effect of electrification. In South Africa, evidence shows that the increase of employment due to electrification during 1995 to 2001 was between 9-9.5 % for female employment. For male employment the results were also significantly positive but not as high as for female employment (Dinkelman, 2011).

When observing household work, the within-household distribution of workload is one factor to look at since most of the household work is done by women. Supposing that electrification implies that the time spent on necessary household work can be reduced, as well as considering the notion that women do most of this household work, it could be likely to assume that the female labor supply in the formal sector will be the most affected when the households gain access to electricity. And increasing female labor in the formal sector is an important factor for society since it contributes to economic growth and development. Furthermore regarding women in particular, research has found that education is more important for female employment than for

male employment, although both effects are significantly positive (Grogan and Sadanand, 2012). Since there are indications of both electrification and education serving as important factors for female employment when observed separately it raises the question if it could be the case that the effect of access to electricity on female employment is conditional on female's level of education. Accordingly, there are also reasons to expect such a joint relationship. As an illustration, consider that the demand for more educated workers is higher than the demand for workers with lower levels of education. As the household then gain access to electricity and therefore can reduce time spent on household work, those women with higher levels of education might have more reasons to join the formal labor market, as there is a higher demand for well educated workers. Thus, the question this paper aims to answer is the following. *Is the effect of access to electricity on employment greater for women with higher levels compared to lower levels of education?* We examine this question by using data from the Afrobarometer consisting of responses from more than 20,000 women, where we primarily, in line with previous research, focus on rural areas. We back previous research with theory about alleviation of time constraints to analyze the obtained results, where the overall results did not support a combined effect of access to electricity and being more educated on one's chances of employment.

Much of previous research has focused on one specific country rather than a group of countries or a region, and has rarely primarily focused on the combined impacts from electricity and education on employment. Dinkelman (2011) finds that rural electrification has positive impacts on employment in South Africa, which primarily is for female labor. Similar to Dinkelman, Dasso and Fernandez (2015) find the effect of electrification on employment to be positive in rural areas of Peru. In contrast to other studies about the effect of electricity on employment, Salmon and Tanguy (2016) examine the effect of electricity on employment where they differentiate between spouses' and their joint decision of allocation of work hours. This differentiation is an aspect they find to be important when studying labor supply decisions.

The main contribution of this paper is that it considers access to electricity jointly with levels of education, and its combined effect on the probability of being employed. More specifically, we

examine if the relationship between access to electricity and female employment is conditional on the level of education. To the best of our knowledge it is the first study that does this with a clear focus on women and using data that covers over 30 countries in Sub-Saharan Africa.

The rest of the paper proceeds as follows. In Section 2 we present our theoretical framework. Then, we present our method together with information about data and variables in Section 3. In Section 4 the results are presented and analyzed, followed by a discussion of the insignificant results in section 5. Finally, a conclusion of our paper is presented in section 6.

2. THEORETICAL FRAMEWORK

In this section, we provide the theoretical framework for our analysis by presenting previous research and theory within the field.

2.1 Previous research

There is a considerable amount of evidence showing that electricity has a positive impact on the probability of employment. Dinkelman (2011) finds, by analyzing a major project of electrification in South Africa, that rural electrification has a positive impact on employment growth. More specifically, female employment rates started to increase within a five years period after the electrification project had been implemented in the examined area. It is conceivable that this is the result of a reallocation of workload in the household, enabling women to substitute some of their household work to outside of the household.

Most research examining the effects of electrification on employment and working time allocation treats the labor supply decisions of spouses as independent within the household. In a study of rural Nigerian households, Salmon and Tanguy (2016) question this approach by differentiating between the husband's, the wife's and the couple's joint decisions on time allocation of working hours, when studying effects of electrification on employment and household labor supply. Their results show an increase of working time from electrification for both spouses when studying them separately, whereas the combined analysis only supports an

increase of working time in male employment. This finding is in contrast to most other studies treating the same topic as most evidence is found for an increase of female labor supply as an effect of electrification (Salmon and Tanguy, 2016). The authors point out that this finding reflects the labor supply approach as one's decision about hours worked is highly related to the other spouse's working hours. Therefore, according to their analysis, the joint decision regarding the household's labor supply is crucial and should be highlighted as an aspect to take into account when examining the effects of electricity on employment. The main insight from this literature is, nevertheless, that having electricity can positively impact the probability of being employed.

Access to electricity has a positive effect also when it comes to education. With access to electricity at home, the conditions for studying improve significantly by making it possible to use more hours of the day for studying. One can more or less extend the day by using hours after sunset more efficiently. Kanagawa and Nakata (2008) find strong support for positive impacts of electricity on education, where they argue that the extension of the day is explicitly a key factor. They furthermore find that increased education also has a positive effect on employment, where more education improves the possibilities to get a job. Although they find that electricity has a positive impact on education and that education then a positive impact on employment, they do not study whether there is a joint effect between the level of education and access to electricity on employment.

In a study that among other things observes the effect of electricity and education on employment, Kooijman-van Dijk and Clancy (2010) argues that the effect of electricity and education on employment is an indirect way of reducing poverty. An effect that improves quality of life in more general terms than just the financial benefits from electricity. Where electricity, as light to study in, specifically increases job opportunities for especially young people. There is also evidence in, e.g., India, where results show that increased government spending on infrastructure such as electricity and education increases job opportunities for farmers outside of the agricultural sector (Fan et al, 2000).

Dasso and Fernandez (2015) study the effects of electrification on employment in rural Peru by examining an electrification program, similar to the one by the South African government presented by Dinkelman (2011). The results are similar to those in the South African case in the sense that electrification increases female employment and wages, as well as augmenting the probability of working outside the agricultural field. In a study that considers both Peru and India, Cabraal et al. (2005) find that in both countries the joint combination of electricity and education have a stronger positive effect on household incomes in compared to only education's effects on employment.

2.2 Reallocation of time

A theoretical foundation to build upon in this paper is the theory developed by Gronau (1977), a trichotomy of time allocation assuming that every household can allocate their time to either (1) household work, (2) work in the market, or (3) leisure. According to the trichotomy, the marginal productivity of household work is diminishing and can be substituted for work in the market. If household work is reduced, more time can be reallocated to a wage-paying job. In the model, an increase in the market wage would result in a decrease in time spent on household work, while the expected result on leisure and work in the market is unknown. With a potential increase in income, this would result in a substitution effect where leisure would increase, work in the market decrease while work at home will remain unchanged. In line with the reasoning in this model, we expect that having access to electricity should reduce the amount of time spent on household work and enable more time to spend on wage paying work.

From studies of household work we furthermore know women to be doing the majority of the household work, especially in developing economies. For instance, ILO (2012: http://www.ilo.org) concludes that "[…] *although there are important regional variations, women around the world spend more time on housework than men."* Therefore, the notion of women spending more time on household work is an important component to bear in mind for this analysis.

2.3 Electricity, education and employment

Electricity as an infrastructural improvement can have many positive outcomes besides reducing the household workload. Focusing on purely the light aspects it can, for instance, enable more time to spend on studying, by extending the hours per day for studying or working. Many studies are supporting the evidence for electricity significantly impacting time spent on studying, that in turn leads to a positive result in education (Kanagawa and Nakata, 2008). Likewise, there is evidence for education as a factor positively affecting one's chances for employment. People with higher levels of education have better job prospects, with more developed skills making them more attractive for employers (OECD, 2012). In for instance Malawi, the estimated wage increase from an upper secondary education, compared to a lower level of education, is over 100 %. This positive effect of education on employment has not only been found in Malawi but throughout the entire world, where indications suggest an even stronger effect for women (OECD, 2012). Evidence is also found for further definitions of employment as it can have different meanings depending on the context. Work can sometimes be categorized by self-employed, yet wage earning, and formal work, where the employee gets hired by a company. Although there are several definitions for employment Glick and Sahn (1997) for instance, find also when using this differentiation that education increases the amount of self-employed workers.

To sum up, this section has presented theory about alleviation of time constraints as well as notions about potential effects that electricity and education can have on employment. This will together with previous research make up a theoretical framework for the analysis of this paper.

3. METHOD

In this section we present information about the dataset, the specific variables and the econometric model used to examine the research question.

3.1 The econometric model

The econometric model is a binary dependent model. We will estimate it with ordinary least squares (OLS), because of its versatility and robustness which in turn also makes the model a linear probability model (LPM). In a binary regression one uses a dependent variable that takes on values of 1 or 0 representing "success" and "failure", where the probability of a success, here being employed, is related to the explanatory variables. The following model will be the simplest specification and further on be developed by including several control variables.

$$Y_i = \beta_0 + \beta_1 \textit{access to electricity grid}_i + \beta_2 \textit{level of education}_i + \beta_3 \textit{access to electricity grid}_i * \textit{level of education}_i + \beta_4 * X_i + \varepsilon_i$$

This regression presents the outcome of the explanatory variables *access to electricity grid* together with *level of education* on the dependent variable *employment*,Y_i, in Sub-Saharan Africa. The parameter β_0 is a constant term of the econometric model and the interaction term β_3 will give the difference in employment of having both access to electricity and being educated compared to only having the one or the other. Accordingly, this interaction term will be a key in order to analyze and answer the research question. The interpretation of a positive β_3 suggests that women with a higher level of education could gain even more from having access to electricity, while a negative β_3 suggests that less educated women have more to gain. Furthermore, $\beta_4 * X_i$ stands for the respondent's age (including a squared term) and different enumeration area/primary sampling unit (EA/PSU) control variables. The EA/PSU variables present data on different characteristics about the primary sampling unit from the Afrobarometer, explained more specific below, which is information about the local area that the respondent live in. Regional fixed effects will be added in the fourth specification to control for regional differences. Finally there is the error term ε_i, which captures the unobserved variations such as family background and moral character of the respondents, but also factors concerning the local area that we could not control for. We have done our best given the restrictions from the dataset by including possibly relevant control variables, but since it is not possible to take stand for all

other factors that can be correlated with both the dependent variable and main explanatory variables, the error term is necessary (Wooldridge, 2009).

3.2 Data description

The data used in this analysis is from The Afrobarometer, an independent research network conducting public attitude surveys in more than 35 African countries covering topics such as of democracy, governance, and economic conditions. We use data from the latest round that includes answers from all the surveyed countries, round 5, which was conducted in 2011-2013 (The Afrobarometer, 2016).

Our sample consists of respondents' answers to questionnaires from households in 30 different Sub-Saharan African countries, with a list of the countries in the Appendix. Since we focus on women we exclude men from our sample, and end up with a total number of observations of 23,418. All respondents in the dataset are at the age of 18 or older and, as mentioned, only female respondents are included in our sample. The respondents are from both rural and urban areas, as coded by the enumerators, and this information is used to split the sample into a rural as well as an urban sample in order for us to study women in those areas separately. We primarily focus on rural areas, which is in line with previous research such as Dasso and Fernandez (2015) and Dinkelman (2011), with 14,401 observations making up approximately two-thirds of the full sample of women. Although the main sample examines rural areas, the urban sample will also be studied but more briefly to see if there are any major differences between the two groups, which could be useful to bear in mind for this analysis. The urban sample consists of 8,527 observations. In table 1 below, the definitions of the variables are presented.

Table 1

Variable description

Dependent variable	**Definition**
Employed	If an individual has a cash income
Explanatory variables	
Access to electricity	If there is electricity grid in the area that most houses could access
Primary education	If the respondent has pursued primary education
Secondary education	If the respondent has pursued secondary education
Post-secondary education	If the respondent has pursued post-secondary education
Control variables	
Piped water	If there is water system in the respondents nearest area that most houses could access
Sewage system	If there is sewage system in the respondents nearest area that most houses could access
Cell phone	If there is cell phone service in the respondents nearest area
Post office	If there is a post office within the respondents nearest area
Police station	If there is a police station within the respondents nearest area
School	If there is a school within the respondents nearest area
Health clinic	If there is an health clinic within the respondents nearest area
Market stalls	If there is market stalls within the respondents nearest area
Policemen	If policemen have been seen in the respondents nearest area
Soldiers	If soldiers have been seen in the respondents nearest area
Paved roads	If the road at start point in the area was concrete
Age	Age of the respondent
Age^2	Square of age

Table 2 below presents descriptive statistics, with the number of observations and further information about the different variables used in our analysis.

Table 2
Data description

	Observations	Mean	Std. Dev.	Min	Max
Dependent variable					
Employed	23,314	0.27	0.44	0	1
Explanatory variable					
Access to electricity	23,418	0.59	0.49	0	1
Primary education	23,362	0.33	0.47	0	1
Secondary education	23,362	0.34	0.47	0	1
Post-secondary education	23,362	0.09	0.28	0	1
Control variables					
Piped water	23,378	0.52	0.50	0	1
Sewage	23,229	0.24	0.43	0	1
Cell phone	23,398	0.92	0.27	0	1
Post office	23,359	0.22	0.41	0	1
School	23,355	0.88	0.23	0	1
Health clinic	23,312	0.59	0.49	0	1
Market stalls	23,361	0.65	0.48	0	1
Policemen	23,418	0.28	0.45	0	1
Police station	23,318	0.36	0.48	0	1
Soldiers	23,418	0.10	0.30	0	1
Paved roads	23,418	0.43	0.50	0	1
Age	23,136	35.49	13.77	18	105

3.3 Variable description

3.3.1 Dependent variable

In this paper, the variable *employed* is the dependent variable and we construct it as a binary dependent variable. Since the data is based on household questionnaires the definition for being employed is dependent on the survey questions, where in the survey, the question posed is whether or not the respondent has a cash income, which thus will be the definition for employment. Obtained answers in the survey were divided into different categories being ‘having no employment’, for which employment takes the value 0, and then combining all types of

employment such as ‘part-time’ or ‘full time employment’ to a ‘being employed’ category, for which employment takes the value 1. Accordingly, this is throughout the paper what we refer to when categorizing between whether the respondent has a job or not. By this definition we will not be able to study household work directly, both in the sense of including those who currently work in the household as well as when examining the results in employment as an effect of electricity. Yet, due to lack of data on household work this will not be possible to account for.

3.3.2 Explanatory variables

In our empirical model, we use two main explanatory factors, one being *access to an electricity grid*, which in this analysis is used to observe the impact of electricity grid on employment. As whether or not one has electricity at home can depend on what area one lives in, if it is rural or urban and whether it is a richer area or not, the choice of defining the electricity term as whether or not the respondent has access to an electricity grid in the nearby area, aims to overcome the potential endogeneity problem of having electricity only because one already has a job and therefore can afford to install electricity at home. This is known as reversed causality (Wooldridge, 2009). We will also account for this by controlling for the EA/PSU variables.

The second explanatory factor is the *level of education*, which here will observe the impact of higher education on employment. We divide the level of education into different subcategories based on the categories used in the survey; ‘no formal education’, ‘primary education’, ‘secondary education’ and ‘post-secondary education’. Each of the level categories consists both of those who have started and those who have completed the specific level of education. The variables we include in our regressions are *primary education*, *secondary education*, and *post-secondary education*.

Considering that the variables ‘access to electricity’ and ‘level of education’ alone cannot answer the research question, interaction terms will be included. These interaction terms will be created with ‘access to electricity grid’ and each level of education resulting in the different interaction

terms; access to *electricity*primary education*, access to *electricity*secondary education* and access to *electricity*post-secondary education.*

3.3.3 Control variables

We include control variables in our model to reduce omitted variable bias. The aim of including these control variables, considering other things than our explanatory variables, is to avoid omitted variable bias on estimates for our main explanatory variables. This since, when estimating the implied impact on employment from the explanatory variables, it is likely that not all factors that are correlated with employment can be included in the model.

As we specified earlier the term $\beta_4 * X$ consists of the respondent's age and our EA/PSU control variables. Based on the data sample, the control variables included are *piped water, sewage system, cell phone service, post-office, police station, school, health clinic, market stalls, policemen, soldiers, paved roads* and *age*. These were coded when the enumeration took place for each area by the enumerator and represents whether or not the item/service in question was present in the EA/PSU at the time. The above factors are controlled for by applying dummy variables for each one of the above stated. The intention here is to decrease the risk for biased estimators on the explanatory variables. Although there are other characteristics about the individual that one would like to hold constant, the dataset does not have this information and therefore the EA/PSU variables are an attempt to control for as much as possible.

Depending on what area one lives in, it is highly possible that richer areas have more access to electricity, or the other way around that richer families have greater possibilities to choose to live in an area with more services as sewage systems, market stalls etc. In line with this, our intention with including the EA/PSU variables is control for the type of area the respondents live in. This to reduce the possibility of infrastructural services due to wealth, as there could be more infrastructural services in richer areas, and by this endogeneity problems are taken into consideration. Further, to capture systematically the differences between regions within countries, we include region fixed effects, i.e., a dummy variable for each region in the regression.

Naturally, this also means that any systematic differences that could be between the countries in our Sub-Saharan African sample are removed.

Moreover, only respondents at the age of 18 years or above are present in the dataset. Since age is known to influence how much education and work experience one has, we control for age, which is a continuous variable. The variable is also included in squared form, to capture possible nonlinear effects on employment. Knowing that older respondents naturally have a lower probability of being employed, this factor we partly address by including this age variable and its square. We also find that we get the same qualitative results if we exclude all respondents older than 65. Furthermore, there are many other potential control variables in the dataset from the Afrobarometer but as they are likely to depend on education and/or employment they are not suitable as control variables.

4. EMPIRICAL RESULTS & ANALYSIS

In this section, we present the results from our regressions and analyze the outcomes. We use four different specifications, where we start with the most simple specification and then add on more control variables for each specification. All four specifications are first estimated using our rural sample, and then using our urban sample.

4.1 Rural sample

Table 3 below presents the obtained results for women in rural areas.

Table 3

OLS Estimates using the rural sample

	(I)	(II)	(III)	(IV)
Dependent variable: Employed				
Access to electricity	0.060***	0.071***	0.050**	-0.000
	(0.013)	(0.013)	(0.015)	(0.016)
Primary education	0.103***	0.113***	0.104***	0.040***
	(0.009)	(0.009)	(0.010)	(0.011)
Secondary education	0.150***	0.169***	0.161***	0.116***
	(0.013)	(0.013)	(0.013)	(0.015)
Post-secondary education	0.387***	0.396***	0.393***	0.347***
	(0.043)	(0.042)	(0.042)	(0.042)
Primary*electricity	0.010	-0.004	-0.002	0.005
	(0.019)	(0.019)	(0.019)	(0.018)
Secondary*electricity	-0.007	-0.019	-0.024	-0.030
	(0.201)	(0.020)	(0.021)	(0.021)
Post-secondary*electricity	-0.059	-0.066	-0.094*	-0.112*
	(0.052)	(0.050)	(0.052)	(0.052)
Age and age-squared		Yes	Yes	Yes
EA/PSU controls			Yes	Yes
Region fixed effects				Yes
Observations	14,401	14,176	13,947	13,947

Robust standard errors in parentheses. Level of significance: *** p<0.01, ** p<0.05, * p<0.1

Constants included in all specifications but omitted from the table.

In specification (I) only the main explanatory variables together with the interaction terms are included. Specification (II) consists of the variables from (I) as well as control variables for the individual characteristics *age* and age^2. (III) Includes further control variables about the area, i.e., the EA/PSU control variables. In the final specification (IV), all previous variables together with regional fixed effects are included.

The results from the first specification of the rural sample shows the relationship between being employed whether one has primary education, secondary education, post-secondary education

and access to an electricity grid. It also measures the joint impact on being employed from having access to an electricity grid by level of education. We use terms such as "impact" to simplify, but are indeed aware of the fact that the possible relationships do not need to represent causal effects. Whereas all educational variables and access to electricity grid are significant and show a positive relationship with employed, none of the interaction terms are statistically significant. The *primary education*electricity* has a positive, yet insignificant correlation with employed, while *secondary education*electricity* and *post-secondary education*electricity*, also being insignificant, have negative values.

In specification (II) control variables for the individual respondent, *age* and age^2 are included, besides the variables in (I). Both age variables are highly statistically significant (not shown in table 3) where a positive estimate on *age* together with a negative on age^2 reveal that age has a positive but diminishing impact on *employed*. The effect from including these control variables does not have any impact on the level of significance of the interaction terms, where all three still are insignificant and cannot establish a potential impact.

The third specification (III) shows the results on the outcomes from adding EA/PSU control variables, which consists of information about the area where the respondent lives. What we found here was that *cell phone, police station, post office, market and paved roads* were significant, while remaining *piped water, sewage, police, soldiers, health clinic and school area* were insignificant. All of the significant variables implied a positive effect on employment with the exception of *cell phone*. Adding these control variables changes *post-secondary education*electricity* to being significant at a 10 % level, while the level of significance for the remaining variables did not change for neither the interaction terms nor the main explanatory variables.

The results from the specification (IV) are including region dummies to show if which region the respondent lives in has any impact on the outcome. Out of 343 region dummies the majority of them are insignificant, although some of them are significant. The impact of including these

dummy variables also changes electricity grid to give an insignificant value while the interaction term *post-secondary education*electricity* here is significant at a 10 % level with a negative value. With the implied effect of having post-secondary education on the probability of being employed, added to the negative value for having both post-secondary education and electricity the obtained value is still positive only not as strongly as with only post-secondary education. We can therefore draw the conclusion that the more educated women still have a higher chance of being employed, but for these rural women with post-secondary education the situation is rather the opposite if they also have access to electricity as the probability actually is lower in this case, but still higher than compared to if they had not had post-secondary education.

One scenario that could explain the non-correlations between having *access to electricity*higher level of education* and being employed concerns the issue of the joint decision-making of the spouses in a household. According to Gronau (1977) a potential increase in income would result in a substitution effect where leisure would increase, household work be unchanged and work/being employed decrease. That is to say that if a woman is more well educated so might also her husband be, as many couples are formed in the same segment of the social structure. This in turn could mean that the husband instead works more, since his higher level of education itself increases the possibility for him to have a job and higher wage. Although they do have electricity to facilitate household work, mainly for the woman in this case, the household work may be unchanged while work in the market reduces as it is substituted for leisure, which thus might be because the woman works less. Like this, a reallocation of time spent on household work for women to work more in the market, due to having access to electricity and being more educated, would not happen.

Also as discussed in previous research by Salmon and Tanguy (2016) the results of electricity on employment can be dependent on household labor supply decisions and approaches. What might be the case is that we are showing exactly the situation that Salmon and Tanguy (2016) argues for is misleading, where labor supply decisions are treated as independent although as they in fact often are, as suggested above, a joint decision for the household. Therefore, it could be the case

that although there is access to electricity and the woman is more or less well educated, so might the husband be and the joint decision about the household labor supply is that the husband should work while the woman takes care of the household. Then there would not be any real changes from having access to electricity or not. Access to electricity together with a higher level of education could also represent higher social status, and that the norm for women in certain social segments is to stay at home while their husbands work. Although we have controlled for other aspects of physical and social infrastructure in the area, one thing that we cannot control for directly are the social and cultural preferences or the social norms of the women in our sample. Some of the differences between various regions should however, be captured by the regional fixed effects. Yet, in order to treat household labor supply decisions as joint for the spouses of the household, we would have to have a sample that includes answers from both husbands and wives in each household. This would require a sample where both spouses would need to take part in the survey, which unfortunately our dataset lacks information about. That is, although we would estimate our specifications on only the men in the Afrobarometer sample it could indeed provide some insights, but it is beyond the scope of the present paper, and would still not give us conclusive evidence in this matter, since we still would not know the level of education of wives of these men.

Another aspect of why the implied effect of the interaction term is not stronger is the type of jobs that are available within the specific area. What possibly could be a result from having access to an electricity grid in some areas is that it attracts those firms that are specifically dependent of having access to electricity, e.g. factories. This goes without saying that is does not only apply to industry jobs but all low skilled jobs that are mainly labor and power demanding, usually not requiring that high level of education to get hired. It is conceivable that most factory jobs in this geographical region are low skilled work and not requiring a higher education, only low educated people might be suitable for the jobs that are available there. This would mean that the more educated one is, the smaller probability that one has a job in that local area, unless one decides to move. Another possibility is that there are more high skilled jobs available in a nearby village or if where one lives is close to a city where there might be more suitable jobs for someone well

educated. Although observing a rural sample only, which is in line with previous research where most studies are carried out in rural areas specifically, we get insignificant values for the remaining interaction terms. As *primary education*electricity* and *secondary education*electricity* both are lower levels of education that could make one more suitable for the above described types of jobs, they are insignificant and therefore we cannot to draw any conclusions from this either.

4.2 Urban sample

Table 4 below presents the obtained results for women in urban areas.

Table 4

OLS Estimates using the urban sample

	(I)	(II)	(III)	(IV)
Dependent variable: Employed				
Access to electricity	0.019	0.031	0.025	0.015
	(0.025)	(0.024)	(0.028)	(0.037)
Primary education	0.123**	0.163***	0.124**	0.065
	(0.038)	(0.038)	(0.039)	(0.042)
Secondary education	0.105**	0.165***	0.128**	0.082*
	(0.037)	(0.037)	(0.039)	(0.043)
Post-secondary education	0.390***	0.433***	0.360***	0.325***
	(0.081)	(0.082)	(0.087)	(0.089)
Primary*electricity	0.036	0.009	0.032	0.024
	(0.041)	(0.041)	(0.042)	(0.045)
Secondary*electricity	0.083*	0.066*	0.077*	0.052
	(0.039)	(0.039)	(0.041)	(0.044)
Post-secondary*electricity	0.014	-0.000	0.045	0.013
	(0.083)	(0.084)	(0.088)	(0.091)
Age and age-squared		Yes	Yes	Yes
EA/PSU controls			Yes	Yes
Region fixed effects				Yes
Observations	8,527	8,477	8,245	8,245

Robust standard errors in parentheses. Level of significance: *** p<0.01, ** p<0.05, * p<0.1

Constants included in all specifications but omitted from the table.

Regarding the urban sample presented in table 4, the outcomes in specification (I) gave only significant values for the different levels of education as well as the interaction term of having both secondary education and access to electricity. As the interaction term is positively significant at 10 % level, this would imply that having access to electricity and having secondary education does increase one's possibility of being employed compared to only having secondary education. This implied effect would be 0.207 for having access to electricity grid and being educated at a secondary level, as compared to having less than primary education and not having access to electricity. That is, a woman with secondary education is about 11 %-points more likely to be employed as compared to if she had less than primary education, if she did not have access to electricity, but if she also had access to electricity, the chance would increase with about 10 % points. Since, the other interaction terms have non-significant estimates, we cannot draw strong conclusions regarding these.

The second specification (II) shows similar results to (I), access to an electricity grid is insignificant whereas all levels of education are significantly positive and so is *secondary education*electricity* with an implied impact on being employed of 0.262. Regarding the other interaction terms, they are positive but statistically non-significant.

The same goes for the third (III) specification, where the level of significance for the explanatory variables remained unchanged. In this specification, the significant EA/PSU variables were *piped water, sewage, police station, police, soldiers, paved roads, health clinic and school area,* whereas *cell phone, post office and market* were insignificant. Once again *secondary education* electricity* is significantly implying an impact on being employed with 0.230 compared to a woman with less than primary education and lack of access to electricity. *Primary education*electricity* and *post-secondary education*electricity* were both non-significant.

In the fourth (IV) specification where we add regional fixed effects, of the education variables only *secondary education* and *post-secondary education* are significant. This could be because the majority in an urban area already has primary education, which therefore would not imply an

effect to the same extent as in rural areas. This in turn could explain why also the interaction terms are non-significant. Additionally, out of 330 regions the majority is likewise to the rural example insignificant.

What we found in this section is in line with previous literature about access to electricity and higher levels of education positively impacting the probability of being employed in rural areas. However, we were not able to find evidence for those two explanatory variables, access to electricity grid and level of education, together implying a further impact on being employed. In the urban sample, access to electricity was non-significant as were the interaction terms, with the exception of secondary education together with access to electricity in some specifications. In the last specification secondary education together with access to electricity was however not significant, implying that the effects we could see in previous specifications only were due to regional differences. Some of the EA/PSU control variables were significantly positive and some were negative, and the same goes for the regional fixed effects variables for both rural and urban samples, but these results were not reported in the tables as they mainly served as control variables to ensure that we were not capturing other factors with our main explanatory variables of interest.

5. DISCUSSION

In this section we discuss in more detail potential explanations to why some of the outcomes were insignificant.

What we can see from the results is that, in line with previous research, having access to electricity is positively correlated with being employed in rural areas, but also that it is no guarantee that the effect remains when we include more control variables. In the last specification of the rural sample, having access to an electricity grid in the area is not statistically significant. Also in line with previous literature we see that higher level of education increases the possibility of being employed. When observing the obtained estimates for having an electricity grid, we see that although it is positively correlated with being employed, when significant, the value is very

close to zero, which implies a very low correlation and thus that it cannot have much of an influence of the likelihood of being employed. One reason to why we do not find strong evidence for a correlation between having access to an electricity grid and being employed might lie in the definition of our variable for electricity. Most of the literature examines correlations between electrification specifically of the household, which is in contrast to our study as our electricity variable measures whether or not the respondent has access to an electricity grid in the nearby area. However, using this variable was an attempt to overcome possible reversed causality, which could be done by observing a potential relationship where those respondents who already have jobs, are those who therefore also might have had the possibility to move to a more developed area, where there is electricity. Although this was a choice made in order to make the relationship cleaner, it may have affected our outcomes in such a way that we no longer can capture the correlation. Moreover, the confidence interval shows that the estimates remain close to zero and there is not that much of a wide spread, the obtained estimate is relatively precisely. We could however not find any support for a potential reallocation of time from household work to work in the market that would increase possibilities of being employed from a labor supply side.

Even though we do see that the result from the rural sample is in line with previous research, in the sense of access to electricity and increasing levels of education implying a positive effect on being employed, this is not the case for the combined effects on being employed. When it comes to access to electricity and levels of education separately, we were as mentioned not able to find evidence for a combined effect between electricity and primary education as well as secondary education. That is, we have a hard time finding support for the idea that the probability of employment would be higher if one has both access to electricity and is more educated. There could be several reasons for this, from both a statistical and economical point of view. It might be the case that the variables are highly related to each other and it therefore is not possible to tell what the pure separate contribution to being employed is from having both access to electricity and being well educated. One possible scenario is that those who have a higher level of education are those who already have access to electricity. Previous studies such as Kanagawa and Nakata (2008), have found strong support for electricity positively impacting higher levels of education.

Therefore it could be that having electricity is so crucial for studying that it becomes very rare to be well educated, or at least having secondary education, without having electricity. This would be as it more or less becomes too hard to pursue higher studies without light and therefore those who do not have it at home might have moved to a relative or family friend who lives in another area where they happen to have access to electricity instead. There could be multicollinearity between the variables, which makes it very hard to separate the specific impact from each of them. Also, as primary education can be less demanding compared to more advanced studies, the need for light could be less necessary, which would also support that primary education together with electricity is not as negative as higher levels of education together with access to electricity. But we are, as mentioned, not able to prove anything based on our results. Although we did not obtain significant estimates in this paper the question is still highly relevant and important to examine. Firstly, since both higher levels of education and having electricity, separately show evidence for a positive impact on the probability of being employed, but also secondly as there are reasons to assume that theory would imply this. This is, since women primarily spend the most of the time in a household to take care of the household work, and therefore when they gain access to electricity would have more time on their hands. This enabled time together with more education, could indicate that these factors together could be positively impacting a women's chance of employment, since there is a higher demand for well educated workers.

Furthermore, on the topic of different job categories, when observing the different EA/PSU control variables we found that *police*, *markets* and *paved road*s were positive at 5 % significance level. Since they all are positively correlated with being employed it could be another aspect as they obviously are related to the labor market. One way of looking at it is that some of EA/PSU variables capture the amount of potential employers. If there is a police station in the area where the individual lives, this could give job opportunities. This does, however, not necessarily mean that everyone who lives in an area where there are policemen works as a police themselves since there could be need for administrative workers, cleaners or similar facilitating work tasks. This in turn might be another example of jobs available in the area that do not really require highly developed skills or a diploma and therefore be in line with a non-correlation with being

employed. Likewise, having markets close to where you live provides another category of job opportunities. Having a market stall at a market in developing countries would mostly be for self-produced goods such as weaving and crops for instance, which would not reflect job opportunities for those individuals who are well educated. Being a farmer and selling your crops at the local market in a village where there is access to an electricity grid will also qualify as being employed, i.e. having a cash income, but still this will assumingly not have that much to do with what your highest level of education is. Worth noting is also that such a scenario could still be in line with theory about reallocation of time, as it does not distinguish between the different educational requirements per jobs. It only treats work as work regardless of entrance requirements for different occupations and could therefore, if such a scenario were to exist and to be found evidence for yet not the case here, reallocation of time for household work might be more applicable to low skilled labor.

Reasons to why the electricity variable was not significant in any of the specifications in the urban sample could be due to that assumingly many of the urban areas do have access to electricity, since it is a city. Therefore, this does point out the difference between rural and urban areas, and the fact they surely are two different groups and should be examined thereafter. Because of this, it is hard to analyze the outcome of the significant interaction term of secondary education and access to electricity even though it is significant as it is a completely different sample group to our main sample of rural areas.

To summarize, we have not been able to find evidence for having access to electricity together with higher levels of education would imply a positive effect of being employed. This might be due to education and access to electricity being highly correlated and hard to distinguish from each other. It might also be a consequence of our definition of the variable for electricity, although it was a well thought through decision in order to overcome endogeneity problems. The question remains, however, highly relevant to further examine due to theory and previous research about electricity and higher education separately impacting the probability of being employed.

6. CONCLUSION

The purpose of this paper was to examine whether or not there could be an implied effect of both having access to electricity and being more educated in especially rural areas of Sub-Saharan Africa, compared to only having electricity, a higher level of education or none one of them. In line with previous research we were able to draw conclusions about having access to electricity and higher levels of education implying a positive effect on especially rural areas. However, determining a combined effect proved to be much harder where the only significant interaction term was *post-secondary education* and *access to electricity* that resulted in a slightly negative effect on the probability of being employed, anyway. Derived from theory about electricity positively affecting the probability of being employed, as well as higher levels of education also positively affecting, our assumed result would be to accordingly find positive implied effects of these two variables together. This was however not accomplished in this paper for the main sample of rural areas. Still the question remains truly relevant to further examine because of theory and previous research about electricity and higher education separately impacting the probability of being employed. Secondary education together with access to electricity proved to be significantly positive in urban areas for the first specifications, but disappeared when adding regional fixed effects and thus only being due to regional differences. Even though we did not find evidence for it, it could be that a reallocation of time as a result of having access to electricity is more suitable for low skilled work. Also potential explanations for the statistical non-significance or the interaction terms for higher education is that household labor supply decisions are treated as independent, although they could very much be dependent on the other spouse. Therefore this is an aspect for future research that should be bared in mind, since without treating them as dependent on the other spouse in the household, one could ignore important factors of the impacts. Furthermore for future research, is to primarily examine electrification in order to decrease the risk of not being able to observe the impacts on household level. Yet as the theory does seem to imply possibilities of further effects on being employed from both electricity and higher level of education, the topic needs more time to thoroughly be examined.

7. REFERENCES

Afrobarometer Network. (2011). Round 5 Survey Manual, Afrobarometer

Afrobarometer Network. (2016). Retrieved 2016-05-18, from http://afrobarometer.org/publications/ad75-unreliable-electricity-supply-still-plague-majority-of-africans

Cabraal, R. A, Douglas F.B & Agarwal, G.S. (2005). *Productive uses of energy for rural development.* Annual Review of Environment and Resources, 30, 117–144.

Dasso & Fernandez. (2015). *The effects of electrification on employment in rural Peru.* IZA Journal of Labor & Development.

Dinkelman, T. (2011). The Effects of Rural Electrification on Employment: New Evidence from South Africa. The American Economic Review, vol. 101, pp. 3078-3108

Fan, S. Hazell, P.B.R & Thorat, S. (2000). *Government Spending, Growth and Poverty in Rural India.* American Journal of Agricultural Economics, Vol. 82, No. 4, pp. 1038- 1051

Glick, P & Sahn, P. E. (1997). *Gender and Education Impacts on Employment and Earnings in West Africa: Evidence from Guinea.* Chicago Journals.

Grogan, L & Sadanand, A. (2012). *Rural Electrification and Employment in Poor Countries: Evidence from Nicaragua.*

Gronau. R. (1977). *Leisure, Home Production, and Work-The Theory of the Allocation of Time Revisited.* Journal of Political Economy, vol. 85, pp. 1099-1123.

ILO (2012). Global Employment Trends for Women, International Labor Office 2012, Geneva: International Labor Organization. Retrieved 2016-05-18, from

http://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/documents/publication/wcms_195447.pdf

Kanagawa, M & Nakata, T. (2008). *Assessment of access to electricity and the socio-economic impacts in rural areas of developing countries.* Tohoku University.

Kooijman-van Dijk, A & Clancy, J. (2010). *Impacts of Electricity Access to Rural Enterprises in Bolivia, Tanzania and Vietnam.* International Energy Initiative.

OECD. (2012). *Education at a Glance 2012.* Retrieved 2016-05-18, from http://www.oecd-ilibrary.org/docserver/download/9612041e.pdf?expires=1460022667&id=id&accname=guest&checksum=46FFA425961AC4677C04B1CA548D97E1

Salmon, C & Tanguy, J. (2016) *Rural Electrification and Household Labor Supply: Evidence from Nigeria.* World Development Vol. 82, pp. 48–68, 2016.

Wooldridge, M. J. (2009). *Introductory Econometrics, A Modern Approach*. Fourth Edition. South-Western Cengage Learning.

8. APPENDIX

Countries
Benin
Botswana
Burkina Faso
Burundi
Cameroon
Cape Verde
Cote d'Ivoire
Ghana
Guinea
Kenya
Lesotho
Liberia
Madagascar
Malawi
Mali
Mauritius
Mozambique
Namibia
Niger
Nigeria
Senegal
Sierra Leone
South Africa
Sudan
Swaziland
Tanzania
Togo
Uganda
Zambia
Zimbabwe