Electricity and Employment Diversification: Evidence from sub-Saharan Africa.

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Abstract

This study examines the impact of the electrification rate on employment based on three dependent variables: employment rate in agriculture, service, and manufacturing sectors. Due to the low electrification rate in SSA and its high agriculture employment rates, I wanted to investigate whether the electrification increase has a greater impact on employment change in SSA or countries with lower electrification rates. Using fixed effect models, I found that an increase in the electrification rate of a country translates into a decrease in employment in agriculture by 0.33 percentage points, whereas employment in other sectors increases. A separate analysis of SSA and non-SSA does not show significantly different results, except that electrification adversely affects manufacturing employment in SSA. This particular result is therefore not conclusive since other time-variant factors indicative of the quality of electricity provision are not considered in the model. I recommend that SSA emphasize investing in electricity to diversify employment and create more jobs as well as economic growth to catch up with the rest of the world.

Introduction

While developed countries are inventing and adopting cutting-edge technologies, like artificial intelligence, other parts of the world are still lagging to catch up with the basic technology of the Second Industrial Revolution, such as electricity. We are currently experiencing the 4th industrial revolution[1] (Groumpos, 2016); however, many countries in Sub-Saharan Africa have not yet fully embraced the first 3 industrial revolutions that formed the basis for the 4th. The electricity that revolutionized the economy throughout history is still scarce and unreliable in the SSA region. More than 573 million people, one in two people, in SSA, lack access to electricity, making it the region with the largest access deficit (International Energy Agency et al. 2019). In addition to this low electrification rate, SSA still has the highest employment rates in agriculture, as the agriculture sector is still manual and requires a great deal of labor. The agriculture sector employs more than 50% of the workforce in the region on average, indicating a low degree of employment diversification. I analyze the relationship between electricity and employment

[1] As Groumpos shows, the First Industrial Revolution, characterized by the use of water and steam to mechanize agriculture and production, led to the second industrial revolution during which the discovery of electricity revolutionized manufacturing.

diversification using 66 countries' data from different regions. I then conduct a separate analysis for 34 countries in sub-Saharan Africa. I hypothesize that for countries with low electrification rates and high agriculture employment rates, which include most of the SSA countries, an increase in electrification would lead to a greater change in employment rates than countries with already high electrification rates. Using fixed effect, I begin with a general analysis of electrification and employment relationships in 66 countries and then proceed with a more targeted analysis to prove my hypothesis. The importance of running regional or country-based analysis is to be able to give a personalized recommendation based on each country's situation. The models indicate that as electrification rates increase, agriculture employment declines while employment in service and manufacturing increases. The results I obtained from running two separate FE models on SSA and non-SSA groups do not support my hypothesis. However, more in-depth studies are necessary to find out what SSA should particularly do to diversify its employment while growing its economy.

The rest of the paper is organized as follows: Section 1: Review of some literature and employment and electrification across countries. Section 2. Data. Section 3: Model and empirical methods. Section 4: Results and discussion. Section 5: Conclusion.

I. Employment and electrification: A literature review

Since its invention during the Second Industrial Revolution, electricity has played a paramount role in society. Today, many high-income and middle-income countries have reached their 100% electrification rates. However, many low-income countries across Asia and sub-Saharan Africa remain among the least electrified countries in the world. Figure 1 illustrates, for example, the average electrification rate across countries used for this study from 2000 to 2019. In blue are countries that are not part of SSA, while in red are countries that are part of it. Average electrification rates are over 100% in countries like Australia, Belgium, the Netherlands, Switzerland, and so on, whereas they are less than 10% in countries like Mali, Chad, and Burundi. The electrification rate in SSA countries is generally lower than that in other countries, and most of them have a rate below 50%.

Figure 1

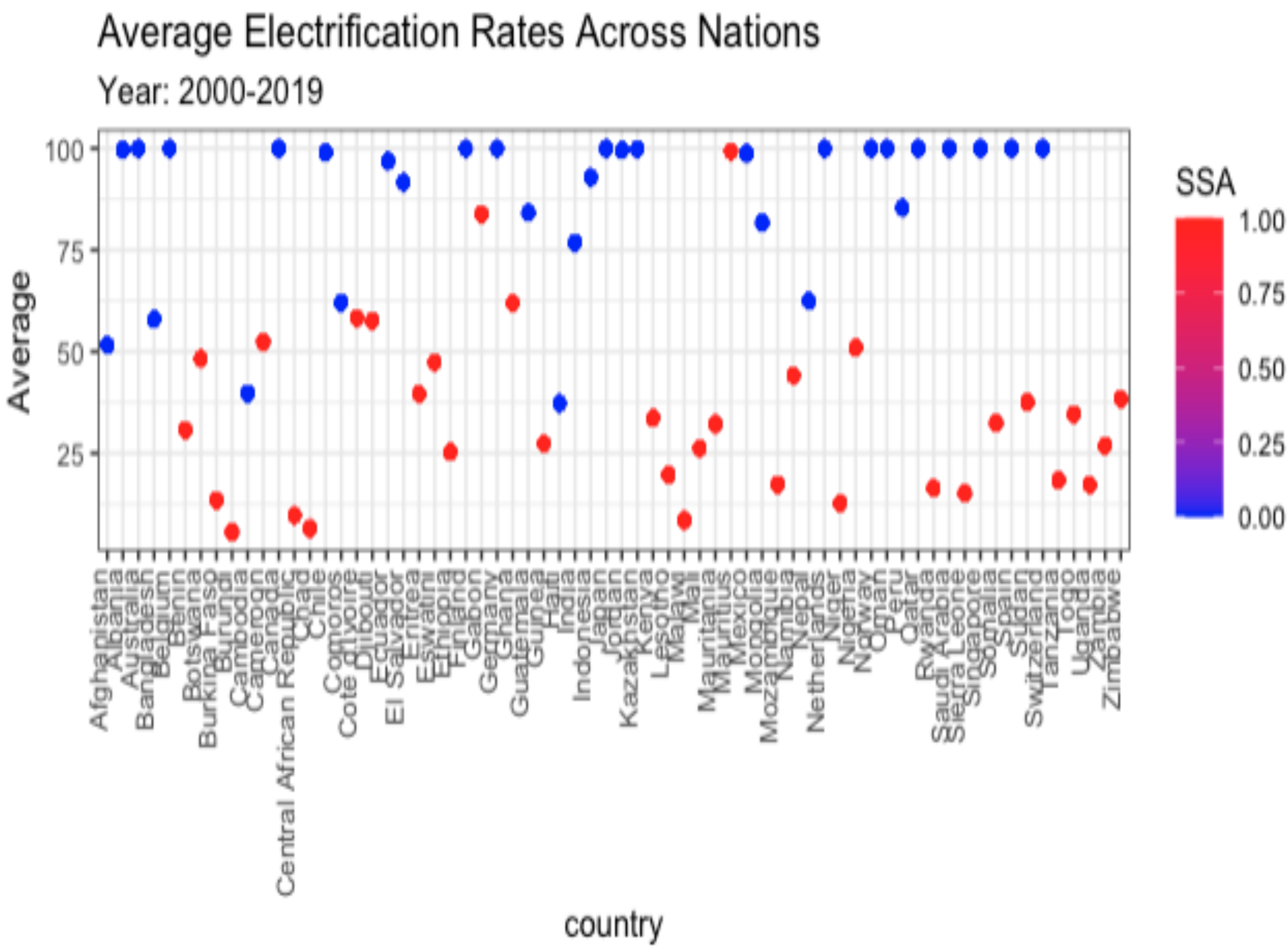
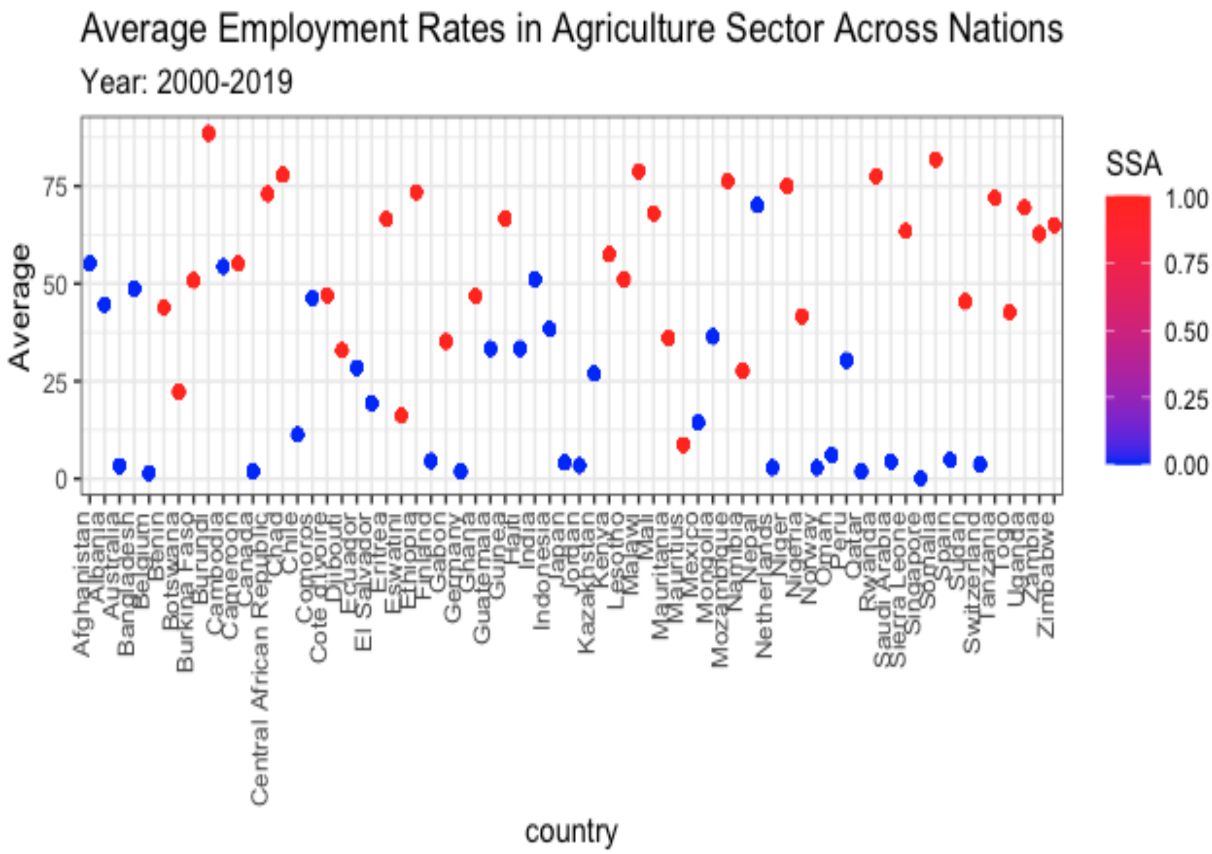


Figure 2.



As shown in Figure 2, the countries that had low electrification rates in Figure 1 now have the highest employment rates in agriculture. The average employment rate in agriculture in Belgium, Australia, the Netherlands, Singapore, etc., is currently below 5%, while it is above 75% in Burundi, Mali, and Chad. The sub-Saharan African region has the highest employment rate in agriculture, and most of these countries have average employment rates exceeding 50%. Many of the countries with a high concentration of labor in the agriculture sector still practice labor-intensive agriculture, which explains why the First Industrial Revolution has yet to fully take hold.

Besides having the highest employment rates in agriculture, Sub-Saharan Africa also has the highest unemployment rates among young people. According to the African Development Bank report in 2020, unemployment rates among people with intermediate or advanced levels of education in Africa are the highest globally because of the mismatch between skills and jobs.

Africa needs to create 12M new jobs every year to keep the current unemployment rate constant (AFDB, 2020). Increasing the electrification rate in the region is necessary to create these jobs.

Several studies have shown that electricity stimulates investments and innovation, which leads to the creation of more jobs. According to Dinkleman(2011), rural electrification stimulated home businesses while increasing employment for women in South Africa. In 2004, the World Bank reported that electricity had allowed people in India to acquire electric stoves and other electric cooking appliances, which allowed them to spend less time looking for wood and more time on other economic pursuits. According to Grogan & Sadanand (2013), electricity increases the likelihood of rural Nicaraguan women working outside the home by about 23%. A study conducted by Falcone et al. (2020) in Nigeria shows a shift out of agricultural employment by approximately 7% and into non-agricultural employment by approximately 15%, with some evidence of a positive effect on overall labor participation. They suggest that increasing the electrification rate in Nigeria could help shift the economy from the agriculture sector. This paper contributes to the literature by studying the impacts of electrification on employment diversification in sub-Saharan Africa and comparing it to other countries in other regions.

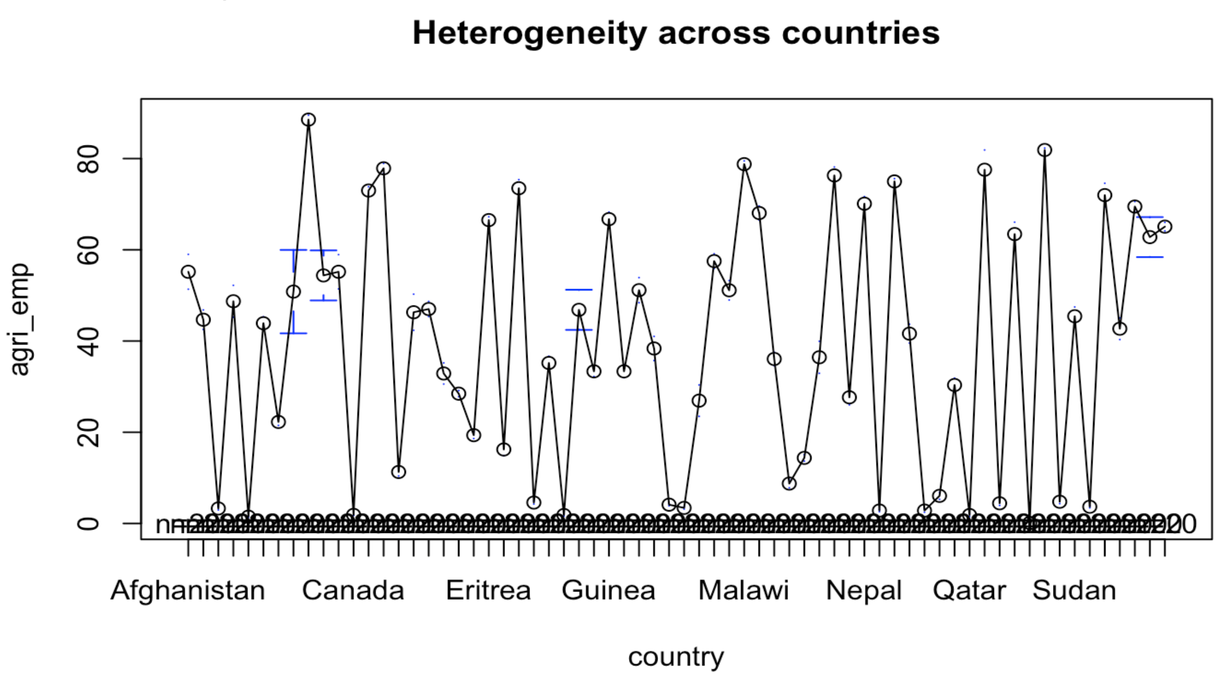
II. Data

I use panel data downloaded from the World Bank and GapMinder open sources. I use two main data sets: employment and country electrification rates from 2000 to 2019. In each dataset, country and year are the units of observation. Based on data availability, I use 34 sub-Saharan African countries and 32 non-SSA countries. These non-SSA countries include countries from different continents, low-, middle -, and high-income countries are all included. This paper seeks to understand how electricity impacts employment diversification in different regions and how these impacts differ. The question I am trying to answer is whether the impact is greater or smaller in SSA, or whether it does not matter at all. I use three dependent variables, such as the rate of employment in agriculture, which is the percentage of the workforce employed in the agriculture sector in a country; a country's employment in the service sector, which is the percentage of its workforce in this sector; and employment in manufacturing, which is the number of workers employed in the manufacturing sector in a country. A regressor or time-variant independent variable is a country's rate of electrification, which is a country's percentage of the population with access to electricity in a particular year.

III. Methodology and Empirical Model

A simple OLS model can be used to estimate the relationship between electrification rates and employment rates, expressed as: $Y_{it} = \beta_0 + \beta_1 electricity_{it} + \varepsilon_{it}$ (1); Y: dependent variable such as a country's percentage employment in the agriculture sector, service sector, and manufacturing sector. This approach, however, may not help understand that relationship. In panel data, linear relationships assume that the dependent variable has the same mean across countries (see Dinkelman, 2011).

Figure 3



Nevertheless, as shown in Figure 3, heterogeneity varies across countries, resulting in different means. There is a variation in the parameters among the countries, and it is possible that the independent variable, electricity, is correlated with the unobserved heterogeneity. The simple OLS model would not be able to provide us with accurate predictions, resulting in biased results. To avoid running into omitted variable bias, I use a fixed effects model to obtain accurate estimates of employment diversification by controlling for unobservable time and country invariants. The fixed effect model is expressed as follows: $Y_{it} = \beta_1 X_{it} + \alpha Z_i + \lambda T_t + \varepsilon_{it}$ (2)

Where αZ_i is country-fixed effects, factors that remain invariant across time but vary across countries (time invariants). λT_t is time-fixed effects, factors that vary across time but remain invariant across countries (Country invariant);ε_{it}: the error term. To estimate this fixed effect model, I use within-group estimation by demeaning the values. The second model becomes:

$$Y_{it} - \overline{Y_i} = \beta_1(X_{it} - \overline{X_i}) + \alpha(Z_i - \overline{Z_i}) + \lambda(T_t - \overline{T_t}) + (\varepsilon_{it} - \overline{\varepsilon_i}) \quad (3)$$

The purpose of this technique is to avoid reporting each country's coefficients individually; otherwise, I would have to create a table for 66 countries, which would take up a significant amount of space.

In addition to analyzing the impact of changes in electricity on employment in general, I also perform the same analysis for specific sub-Saharan African countries and compare the results with those of non-sub-Saharan African countries. According to the Solow growth model, economies grow faster at lower levels of capital until they reach a steady state. Based on this analogy, countries with lower levels of electrification should experience a greater change in employment diversification when a unit increase in electrification rate is made than countries that have already reached a steady state. The coefficient should be higher in SSA than in other countries with 100% electrification rates, for instance. To study this potential difference in impact, I create an indicator variable that is equal to 1 if a country is in sub-Saharan Africa and zero if it is not.

$$Y_{it} = \beta_1 X_{it} + \alpha Z_i + \lambda T_t + SSA + \varepsilon_{it} \ (4)$$

I use model 4 to estimate, analyze, and compare the effect of electricity on employment across those two groups. I run two separate regressions, one for countries within the sub-Saharan African region and one for countries outside the region.

IV. Results and Discussion

A simple OLS linear model is presented in Table 1 columns 1 to 3, and a fixed effect model is shown in columns 4 to 6. The FE coefficients are generally smaller than the OLS coefficients, implying a positive bias. Because of this bias in the OLS estimates, I will not pay particular attention to the linear OLS results.

Table1. Electricity on Employment: OLS and FE

	Dependent variable:					
	agri_emp	service_emp	manuf_emp	agri_emp	service_emp	manuf_emp
	OLS	*OLS*	*OLS*	*panel*	*panel*	*panel*
	(1)	(2)	(3)	(4)	(5)	(6)
electricity	-0.656^{***}	0.473^{***}	0.087^{***}	-0.331^{***}	0.247^{***}	0.022^{***}
	(0.011)	(0.009)	(0.003)	(0.011)	(0.010)	(0.005)
Constant	78.665^{***}	16.331^{***}	3.788^{***}			
	(0.769)	(0.653)	(0.229)			
Observation	1,320	1,320	1,320	1,320	1,320	1,320
R^2	0.728	0.659	0.347	0.410	0.337	0.019
Adjusted R^2	0.728	0.658	0.347	0.379	0.302	-0.033
Note:	$^{*}p^{<0.1; >**}p^{<0.05; >***}p<0.01$					

Based on FE results, a one percentage point increase in electrification in a particular country within a particular year leads to a 0.33%-point decrease in agriculture employment, a 0.022%-point increase in manufacturing, and a 0.25%-point increase in service employment, all else equal. All the coefficients on electricity are statistically significant at a 1% significance level. These results are consistent with Falcone et al.(2020) study in Nigeria, where they show that an increase in electrification rates reduces agricultural employment by 7% while increasing employment in other sectors by 15%.

Since I was interested in determining whether electrification has a greater effect on employment diversification in SSA than in other countries, I ran an FE model on these two groups (SSA and non-SSA) separately. The results are presented in Table 2 where columns 1 to 3 are for the SSA group and the last 3 columns are for the other group. Except for employment in the manufacturing sector, there is no significant difference between the groups. The increase in electrification in SSA countries will result in a decline in manufacturing employment, whereas the opposite is true in non-SSA countries.

Table 2. Sub-Saharan Africa vs. Non-Sub-Saharan Africa

	Dependent variable:					
	agri_emp	manuf_emp	service_emp	agri_emp	manuf_emp	service_emp
	(1)	(2)	(3)	(4)	(5)	(6)
electricity	-0.315***	-0.015**	0.285***	-0.347***	0.059***	0.209***
	(0.019)	(0.006)	(0.014)	(0.011)	(0.007)	(0.013)
SSA	Y	Y	Y	N	N	N
Non-SSA	N	N	N	Y	Y	Y
Observation	680	680	680	640	640	640
R^2	0.290	0.010	0.385	0.628	0.113	0.289
Adjusted R^2	0.252	-0.043	0.353	0.608	0.067	0.252
Note:	$^{*}p^{<0.1; >**}p^{<0.05; >***}p<0.01$					

A comparison of electrification rates and average employment in agriculture at a country level can provide more insight.

Table 3: Averages across sample countries.

country	mean_elect	mean_agri	mean_manuf	mean_service
Afghanistan	70.050000	50.90	6.320	33.550
Bangladesh	50.289106	54.10	10.615	31.050
Benin	30.150000	45.45	16.000	35.400
Burundi	5.980000	88.10	1.700	8.840
Chad	5.927836	78.70	1.155	19.300
Ethiopia	21.325755	74.20	5.175	18.150
Guatemala	87.442631	32.35	14.300	46.850
India	85.002216	48.05	11.700	29.200
Indonesia	92.032129	39.65	13.350	40.500
Mexico	98.521068	15.25	17.250	59.600
Rwanda	8.500000	83.35	1.845	12.245

Table 4. Country-based Analysis

	Dependent variable:										
	Employment rate in Agriculture										
	Afghanistan	Bangladesh	Benin	Burundi	Chad	Ethiopia	Guatemala	India	Indonesia	Mexico	Rwanda
electricity	-0.252***	-0.377***	0.456***	0.791***	0.885***	0.322***	-0.316***	0.503***	-1.143***	1.629***	0.704***
	(0.014)	(0.040)	(0.055)	(0.066)	(0.087)	(0.026)	(0.045)	(0.020)	(0.095)	(0.261)	(0.072)
Observations	20	20	20	20	20	20	20	20	20	20	20
R^2	0.951	0.831	0.791	0.888	0.853	0.894	0.735	0.972	0.889	0.683	0.841
Adjusted R^2	0.948	0.821	0.780	0.882	0.845	0.888	0.721	0.970	0.883	0.666	0.832
Note:	$^{*}\text{p}^{<0.1;\ >**}\text{p}^{<0.05;\ >***}\text{p}<0.01$										

Based on their variable means, I represent a small sample of countries for this 4th model. Table 3 presents the averages for each country. Table 4 presents the results of the country-based analysis model. Regression of individual countries is carried out based on their level of average employment and electrification rate. My objective is to determine whether an increase in electrification in a country with a low electrification rate would result in a greater change in employment than in a country with a high electrification rate. Based on the results of this analysis, my assumption is not 100% supported. One percentage point increase in electrification for a country like Mexico whose average electrification rate is 98.5% with 15% employment in agriculture would result in a reduction of 1.3 percentage points in agriculture employment. An increase in the electrification rate in Burundi, a country with an average electrification rate of 6% and an average agricultural employment rate of 88%, would result in an approximately 0.8 percentage point reduction in agricultural employment.

These results may, however, be influenced by other factors not addressed in this paper. Electrification may have a lesser impact on employment diversification than I expected due to the unreliability of power in sub-Saharan Africa, which is explained by the rates of power outages. According to Zhang et al. (2018), the greatest barrier to business development in developing countries is the lack of reliable energy infrastructure, which directly impedes industrial production. An increase in outage frequency can hinder both domestic and foreign investment as well as the creation of other small businesses that rely on power, which can hinder the growth of employment in other fields. According to Osei-Gyebi and Dramani (2003), in their study of firms in sub-Saharan Africa, outage frequency and outage duration combined to reduce yearly sales of firms by \$114.9, making them uncompetitive. Poczter (2016) concluded that unreliability negatively impacts productivity both initially and over time, with the effect being greater for smaller firms. Despite an increase in electricity, these frequent outages can discourage more innovation and growth of manufacturing companies, which can explain why we see a negative relation between electricity increase and employment in manufacturing. As many firms in SSA are still small and lack sufficient capital to grow quickly, increased electrification may not be benefiting them as it should be. This might impede their ability to grow and employ many people in comparison to countries that have reliable and cheaper electricity. It may be possible to address my initial hypothesis by controlling for outages and reliability of electricity in sub-Saharan Africa; however, this is beyond the scope of this paper and might be an appropriate topic for future research.

V. Conclusion

I use a fixed effect model to analyze the impact of electrification on employment diversification. The fixed effect results across 66 countries, show that a country's increase in electrification rate reduces employment in agriculture and increases employment in other sectors such as services and manufacturing. These results suggest that SSA should prioritize investments in the energy sector to raise electrification rates and reliable electricity provision. This can help SSA catch up to the rest of the world through the adoption of new technologies to increase production and labor productivity while creating more jobs. Because SSA countries have the lowest electrification rates and the highest employment in agriculture, I was interested in understanding whether the effects of electrification on employment might be greater in SSA countries. Coefficients for SSA countries don't greatly differ from the rest of the countries and individual country analysis results don't align with my hypothesis. Rather, an increase in electrification is negatively associated with employment in the manufacturing sector in SSA. I do not assume a causal relationship between electrification and employment in manufacturing in SSA; I believe the model does not adequately capture other underlying factors, such as the reliability of electricity in the region. Even if I used a fixed effect model, factors capturing the quality of electricity provision in SSA are time-variant and should be included in the model as regressors. This limitation opens doors for future research to deeply examine the impact of electrification on employment by controlling for the frequency and duration of power outages and other factors affecting electricity reliability in SSA.

Citation:

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