Labor supply and welfare effects of electricity in Ghana: Does geography matter?

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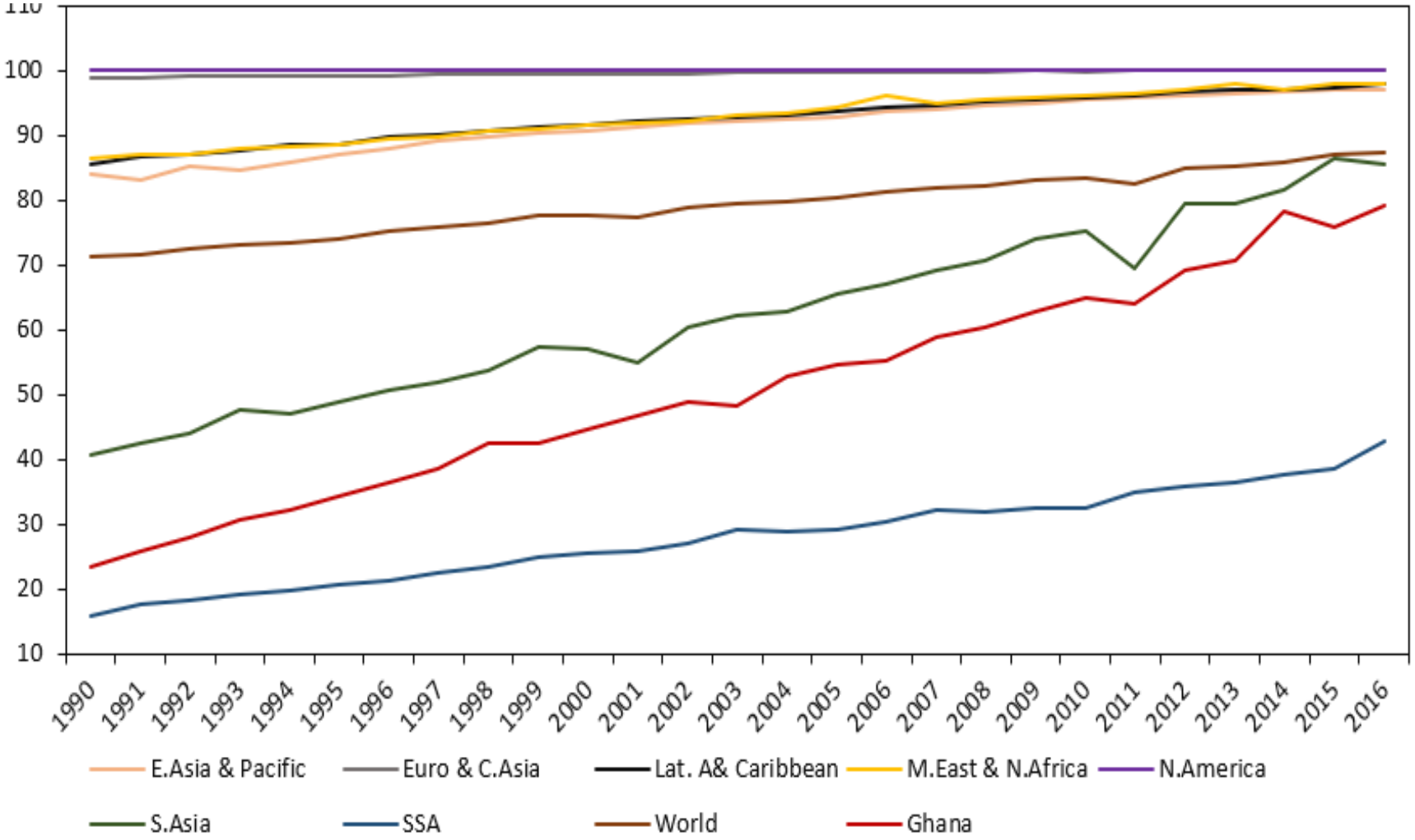
Outline

Introduction

Background

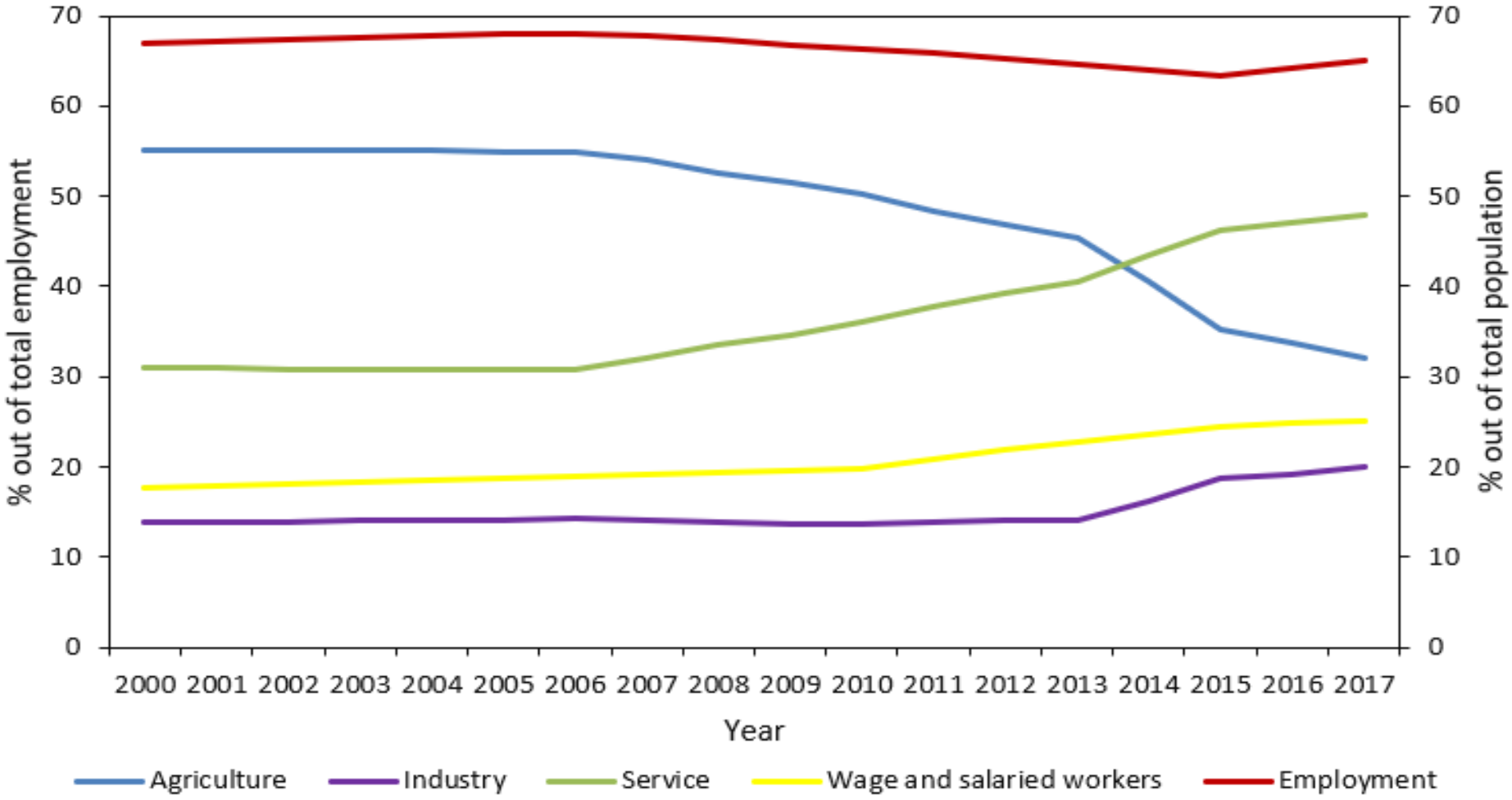
Figure: Access to electricity across regions (World Banks' WDI, 2017)



Introduction

Background

Figure: Employment in Ghana (2000 – 2017)



Introduction

Motivation

- Difficult to imagine economic activities without public infrastructures such as access to
  - Electricity
  - Public transport
  - Water e.t.c
- Empirical evidence on effects of public infrastructures on labour force participation and welfare in recent years is still lacking in Ghana.
- Even so there has been methodological challenges in existing works in the country.

Contribution

This paper

- Uses household (hh) survey data across Ghana from 2005 to 2017.
- Investigates effect of electricity on labor outcomes such as
  - Employment
  - Employment in agricultural sector
  - Employment in service sector
  - Wages
- Examines effect of electricity on hh demand for durable goods.
- Explores complementarities between electricity, water and public transport using PCA to redo the above analysis .
- Attempts to address endogeneity in infrastructure using slope of land.

Related Literature

- **Data**
  Infrastructure services on welfare (Mensah et al., 2014) using GLSS 3–4; Income and Welfare (Adu et. al. 2018) using GLSS 5–6.

- **Treatment**
  Electrification by Akpandjar and Kitchen, (2017), Adu et. al. (2018) and Public transport by Mensah et al., 2014.

- **Empirical strategy**
  Land gradient as IV elsewhere (Dinkelman, 2011; Grogan and Sadanand, 2013).

Model and Empirical Strategy

- Consider individual, i in community, c at period t.
- The system of equations to be estimated in an IV approach are:

$$Y_{ict} = \alpha_0 + \alpha_1 \hat{E}_{ict} + X'_{ict}.\lambda + \rho_r + \rho_t + (\mu_i + \epsilon_{ict}) \quad (1)$$

$$E_{ict} = \pi_0 + \pi_1 Z_c + X'_{ict}.\lambda + \rho_r + \rho_t + e_{ict} \quad (2)$$

- Y is outcome of interest (employment, wages, assets) and E is access to electricity.
- X is set of controls, and Z is slope of land which is the IV.
- ρ_r and ρ_t are region and year dummies.
- $(\mu_i + \epsilon_{ic})$ and e_{ic} are clustered unobserved errors at the ind. level.

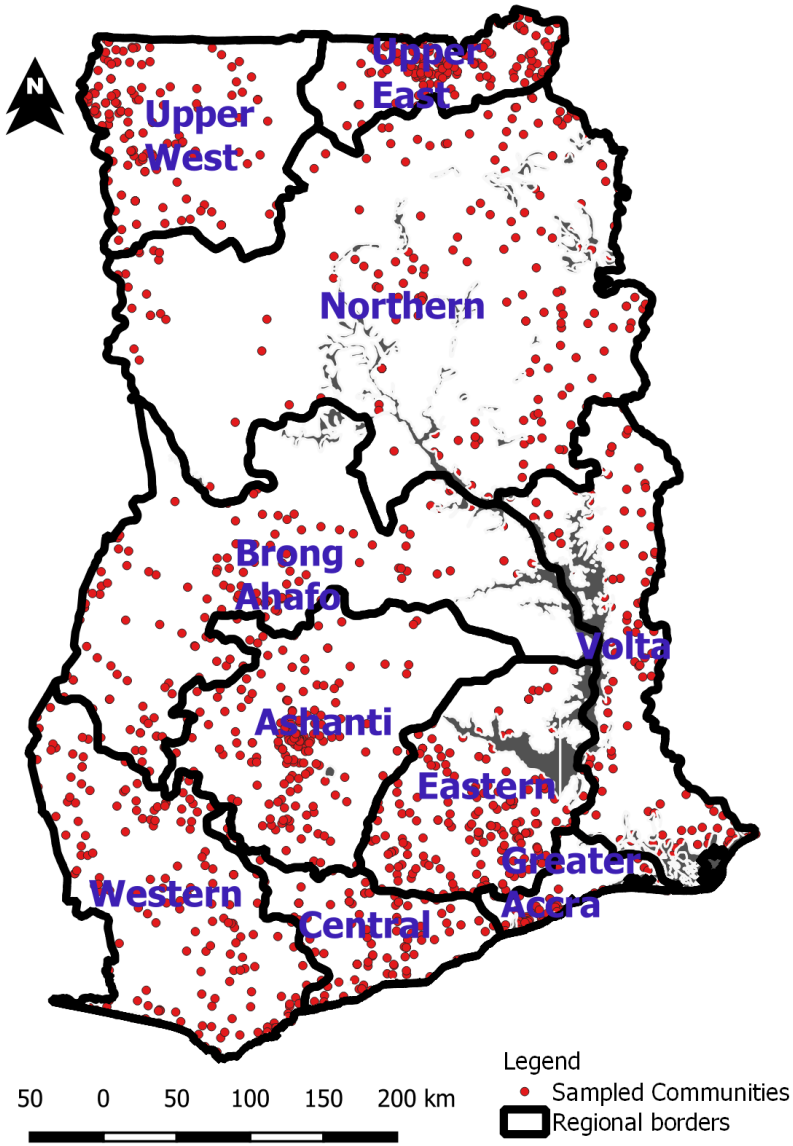
IV Validity

Identification Assumptions

- Conditional on individual and hh characteristics, region and year fixed effects, the estimates from the IV are consistent if
  1. $\mathbb{E}(Z_c \ \epsilon_{ic}) = 0$
  2. $\mathbb{E}(Z_c \ E_{ic}) \neq 0$
  1. assumes slope of land does not affect any of the outcome variables except through access to electricity.
  2. assumes slope of land is highly correlated with access to electricity.
- I will replace E by WEP (infrastructural index) in all alternative analyses.

Data

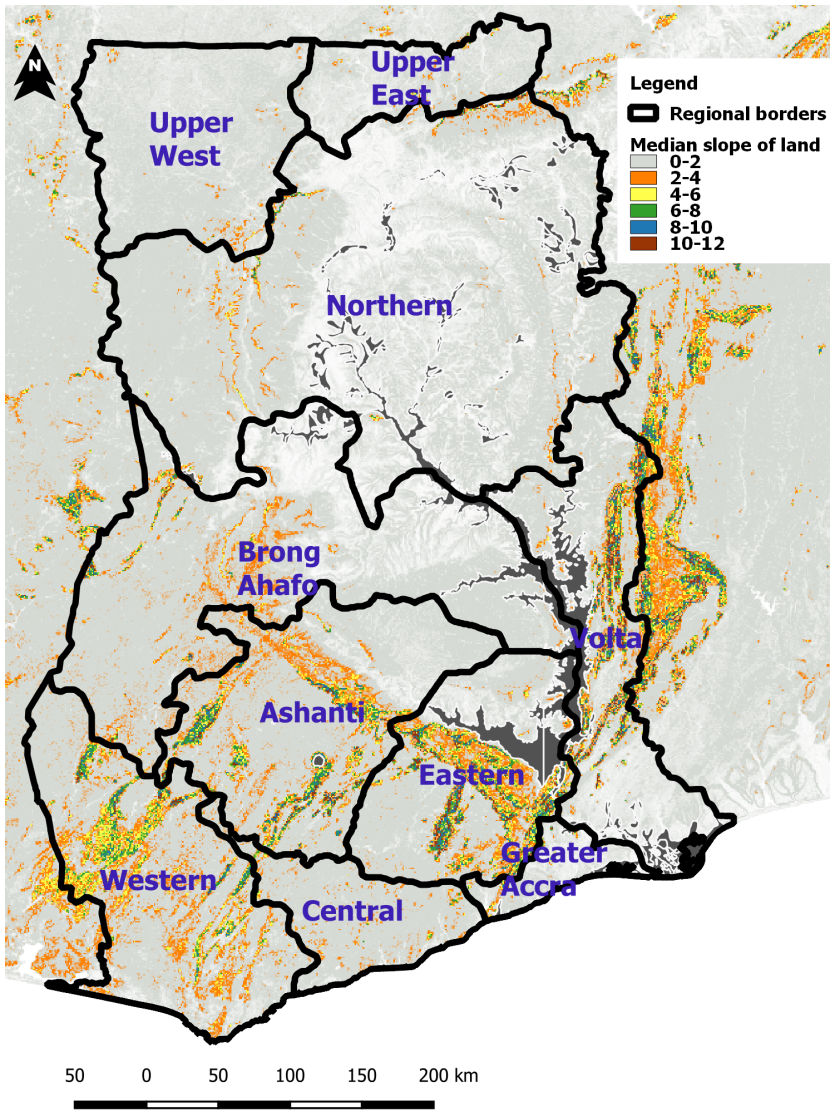
- Household geocoded survey from Ghana Statistical Services' (GSS) Ghana Living Standard Surveys (GLSS) 2005/6, 2012/13, 2016/17.
- In all, there are 50,961 (aged 15+) individuals from 19,430 households coming from 1,441 communities in 200 districts across 10 administrative regions of Ghana
- Others



Data

The Instrumental variable

- Slope of land data is taken from the GMTED2010 and near-global 90m SRTM4.dev dataset (Amatulli et al., 2017)
- Within 30 arcsecond (approx. 1km resolution) digital elevation model.
- Matched to community geo-coded data from GLSS to extract the slope of land.



▸ Global Slope

Data

Construction of Infrastructure Index using PCA

- To explore complementarities between electricity, water and public transport, we create an index (WEP) for public infrastructure.

- Correlation Matrix:

Table: Correlation Matrix

	Water	**Electricity**	**Public transport**
Water	1		
Electricity	0.412***	1	
	(0.000)		
Public transport	0.318***	0.387***	1
	(0.000)	(0.000)	

Note: P-value in brackets and statistical significance at $^{***}p < 0.01$

Data

Construction of Infrastructure Index using PCA

Table: Principal Component Analysis

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	1.746	1.063	0.582	0.582
Comp2	0.683	0.113	0.228	0.809
Comp3	0.571	.	0.190	1
Maintained component	1			
N	50961			

- We maintain the *first* component (C1) which explains 0.582 of the variation following the eigenvalue-greater-than-one criterion.
- Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is 0.644.
- This means the composite can be use as an infrastructural index.

Data

Table: Summary Statistics

Variable	Mean	Std. dev.	Variable	Mean	Std. dev.
Employment	0.720	[0.449]	Gender(=1 if male)	0.472	[0.499]
Wage	8.391	[1.840]	Age	36.802	[17.901]
Agriculture	0.508	[0.500]	Age squared	1674.813	[1628.073]
Services	0.233	[0.423]	Marital status(=1 if married)	0.670	[0.470]
Sewing machine	0.156	[0.363]	Household size	6.120	[3.652]
Refrigerator	0.147	[0.354]	Household size squared	50.783	[69.890]
Television	0.339	[0.473]	Basic education	0.276	[0.447]
Mobile phone	0.668	[0.471]	secondary education	0.084	[0.277]
Flush toilet	0.051	[0.220]	Higher education	0.032	[0.177]
Car	0.029	[0.168]	Mudfloor	0.165	[0.372]
Motor cycle	0.130	[0.336]	Roof material	0.181	[0.385]
Shares	0.005	[0.070]	Local mini grid	0.001	[0.034]
Electricity Main grid	0.480	[0.500]	Solar	0.013	[0.112]
Rechargeable battery	0.004	[0.067]	Self generator	0.002	[0.042]
N			50961^{+}		

Note: (1) $^{+}$ total sample is 50961 except Wage which is 19477. (2) Standard deviation in parentheses [ ]. Source: Author's construct from GSS –GLSS 5, 6. & 7.

Preliminary Results

Table: Estimates of access to electricity & WEP on employment outcomes

	(I)				(II)			
	(1) **Employment**	(2) **Wage**	(3) **Agric.**	(4) **Services**	(5) **Employment**	(6) **Wage**	(7) **Agric.**	(8) **Services**
Electricity	-0.041***	0.285***	-0.167***	0.103***				
	(0.010)	(0.018)	(0.016)	(0.016)				
WEP					-0.031***	0.139***	-0.117***	0.073***
					(0.008)	(0.006)	(0.007)	(0.008)
Slope of land	-0.001	-0.002	0.007	-0.004	-0.001	-0.001	0.006	-0.004
	(0.002)	(0.003)	(0.005)	(0.003)	(0.002)	(0.003)	(0.005)	(0.003)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year & Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.204	0.580	0.210	0.156	0.206	0.580	0.229	0.167
N	50961	19475	50961	50961	50961	19475	50961	50961

Note: Control variables include gender (=1 if male), age and quadratic, marital status(=1 if married), household size and a quadratic, education, household wealth (i.e floor and roofing materials) Robust standard errors clustered at individual level in parentheses and * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ shows the level of significance.

Main Results

Table: Baseline 2SLS estimates of electricity & WEP on labor outcomes

	(I)				(II)			
	(1) **Employment**	(2) **Wage**	(3) **Agric.**	(4) **Services**	(5) **Employment**	(6) **Wage**	(7) **Agric.**	(8) **Services**
(A) Baseline Results								
Electricity	0.050	0.429*	-0.646**	0.411**				
	(0.132)	(0.244)	(0.292)	(0.177)				
WEP					0.029	0.169*	-0.372**	0.236**
					(0.077)	(0.095)	(0.150)	(0.104)
(B) First Stage								
Slope of land	-0.014***	-0.013***	-0.014***	-0.014***	-0.025***	-0.033***	-0.025***	-0.025***
	(0.002)	(0.001)	(0.002)	(0.002)	(0.004)	(0.002)	(0.004)	(0.004)
F-statistic	39.218	18.743	39.218	39.218	19.402	15.588	19.402	19.402
R-squared	0.303	0.303	0.303	0.303	0.300	0.264	0.300	0.300
N	50961	19475	50961	50961	50961	19475	50961	50961
AIC	55543.96	21021.39	55543.96	55543.96	126775.6	48401.65	126775.6	126775.6
BIC	55791.45	21226.18	55791.45	55791.45	127023.1	48606.44	127023.1	127023.1

Note: Estimates include the set of control variables, year and regional dummies. Robust standard errors clustered at individual level in parentheses. F-statistic is the Kleibergen-Paap rk Wald F statistic and * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ shows the level of significance. Also see notes under Table **??**.

▸ Sub-sectoral Results

Main Results: Alternative Outcomes

Table: 2SLS estimates of electricity & WEP on demand for durable goods

(1) **Television**	(2) **Refrigerator**	(3) **Mobile Phone**	(4) **Sewing Machine**	(5) **Flush toilet**	(6) **Car**	(7) **Motor Cycle**	(8) **Shares**
			(I) Estimates from electricity				
0.750***	0.352***	0.369***	-0.200*	0.223***	0.104***	0.170***	-0.020
(0.064)	(0.045)	(0.042)	(0.105)	(0.029)	(0.035)	(0.027)	(0.021)
			(II) Estimates from the WEP index				
0.442***	0.208***	0.218***	-0.116*	0.129***	0.060***	0.099***	-0.012
(0.041)	(0.030)	(0.022)	(0.066)	(0.015)	(0.022)	(0.017)	(0.012)

Note: Estimates in Panels (I) and (II) is using electricity and WEP to investigate the demand for various durable goods listed in columns (1) – (8). Sample includes the full set of observations of 50961. Also refer to notes under Table **??**.

Heterogeneous Results: IV

Table: 2SLS estimates of electricity & WEP on labor outcomes by gender

	(A) **Females**				(B) **Males**			
	(1) **Employment**	(2) **Wage**	(3) **Agric.**	(4) **Services**	(5) **Employment**	(6) **Wage**	(7) **Agric.**	(8) **Services**
				(I) Estimates from electricity				
Electricity	0.145	0.872	-0.928**	0.671***	0.000	0.229	-0.392	0.190
	(0.265)	(1.099)	(0.423)	(0.172)	(0.320)	(0.326)	(0.050)	(0.186)
F-statistic	12.185	3.306	12.185	12.185	18.902	11.403	18.902	18.902
				(II) Estimates from the WEP index				
WEP	0.079	0.279	-0.505***	0.365***	0.000	0.100	-0.234	0.114
	(0.150)	(0.145)	(0.163)	(0.089)	(0.030)	(0.284)	(0.184)	(0.108)
F-statistic	6.944	4.474	6.944	6.944	8.163	7.544	8.163	8.163
N	26896	9691	26896	26896	24065	9781	24065	24065

Note: Estimates in Panels (I) and (II) is investigating the effect of access to electricity and an increase in the WEP index for females and males in columns (A) and (B) respectively.

Alternative Treatment

Table: Effect of Dumsor (power outages) on labor outcomes

	(1) **Employment**	(2) **Wage**	(3) **Agriculture**	(4) **Service**
$Dumsor_{6-12hours}$	0.148***	-0.094***	0.343***	-0.143***
	(0.050)	(0.022)	(0.037)	(0.051)
$Dumsor_{12-18hours}$	0.027	-0.244**	0.181***	-0.101**
	(0.031)	(0.093)	(0.068)	(0.041)
$Dumsor_{18-24hour}$	-0.046	-0.130***	0.073	-0.001
	(0.111)	(0.039)	(0.064)	(0.073)
N	15312	5685	15312	15312

Note: Sample of households with electricity access. $Dumsor_{6-12hours}$, $Dumsor_{12-18hours}$, & $Dumsor_{18-24hours}$ is the average hours of power outages recorded between 6 - 12, 12 - 18, and 18 - 24 hours over a week with reference group being between 0 - 6 hours. Estimates include all the control variables. Robust standard errors clustered at individual level in parentheses and * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ represent level of significance.

Possible Explanations

Table: Possible mechanisms

	(I)			(II)		
	(1) **Self – employment**	(2) **Hourly work**	(3) **Underground Economy**	(4) **Self – employment**	(5) **Hourly work**	(6) **Underground Economy**
Electricity	0.011	4.700***	0.275***			
	(0.161)	(1.110)	(0.1049)			
WEP				0.006	2.645***	0.302***
				(0.095)	(0.691)	(0.107)
F-Statistic	72.702	25.702	53.616	34.534	25.496	3.159
N	50961	38097	27807	50961	38097	27807

Note: Columns I (models 1 - 3) and II (models 4 - 6) provide estimates in investigating the effect of access to electricity and an increase in the WEP index, respectively.

Conclusion

- Employment shift from the agricultural sector to the other sectors because of access to electricity (water and public transport).
- Sectoral shift is only significant among women in Ghana.
- There has been an increase in the demand for certain durable goods and a reduction in others.
- Also, the quality of power supply measured as hours of electricity availability was seen to be important.
- The possible explanations behind the results included self-employment, the underground economy, and hours of work.
- Several policies discussed.

THANK YOU

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Alternative outcomes: sub-sectors

Table: 2SLS estimates of electricity & WEP on employment in sub-sectors

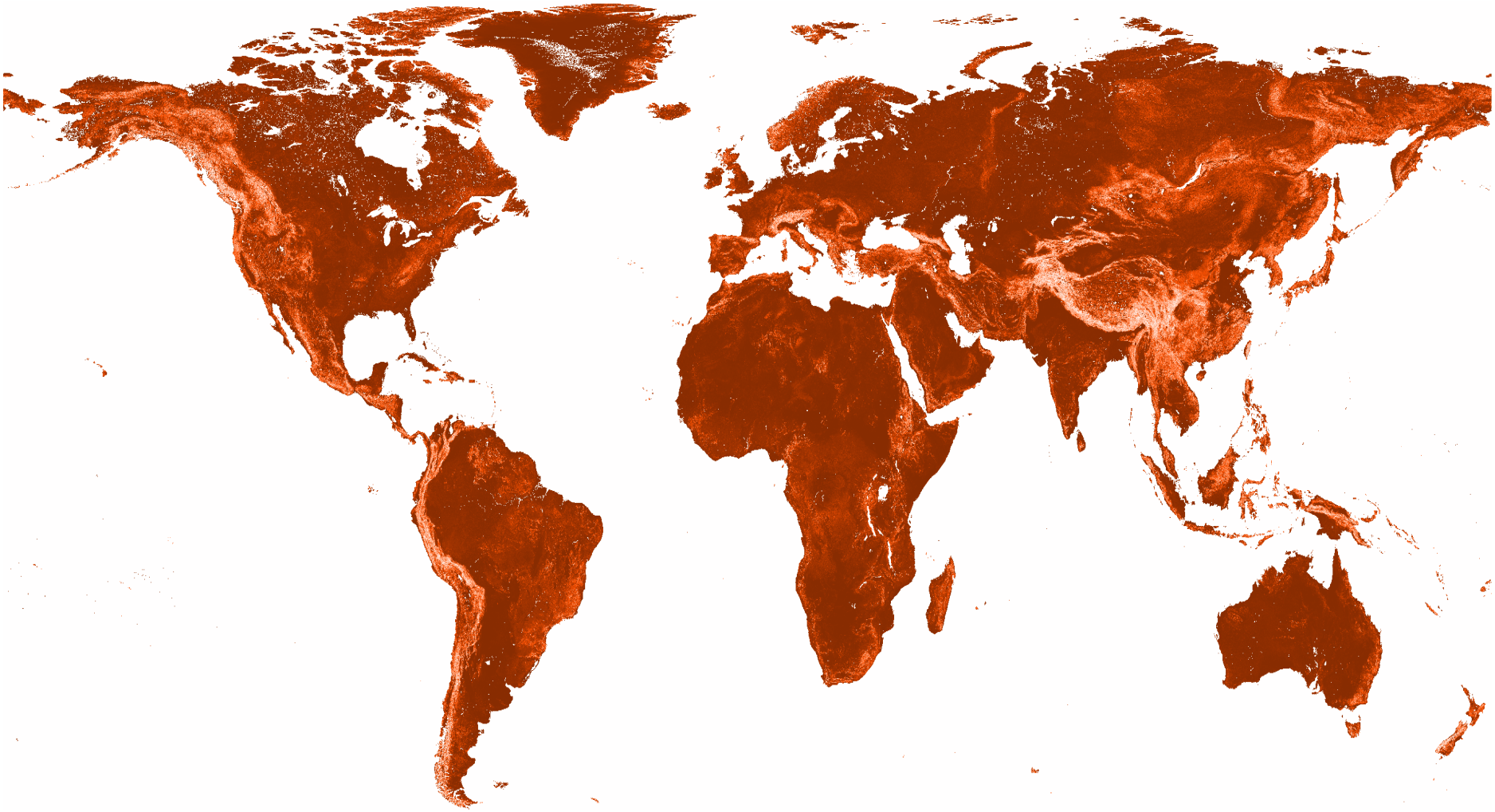
	(I)				(II)			
	(1) **Construction**	(2) **Transport & Storage**	(3) **Accommodation & Food**	(4) **Finance & Insurance**	(5) **Construction**	(6) **Transport & Storage**	(7) **Accommodation & Food**	(8) **Finance & Insurance**
Electricity	0.047	0.104***	-0.040***	0.008				
	(0.044)	(0.034)	(0.012)	(0.010)				
WEP					0.028	0.060***	-0.023***	0.005
					(0.024)	(0.016)	(0.006)	(0.006)

Columns I and II are estimates when the main explanatory variables are electricity access (models 1 – 4) and the infrastructural index (models 5 - 8) on labor force participation in sub-sectors such as Construction (models 1 & 5), Transport & Storage (models 2 & 6), Accommodation & Food (models 3 & 7), Finance & Insurance (models 4 & 8). Estimates are done using the full sample of 500961 individuals.

◂ Main Estimates

Slope of Land from Amatulli et al. (2017)

Figure: Global slope of 1km spatial grain from satellite view



◂ Ghana Slope