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Short- and Long-Run Analysis of Factors Affecting Electricity Consumption in Sub-Saharan Africa

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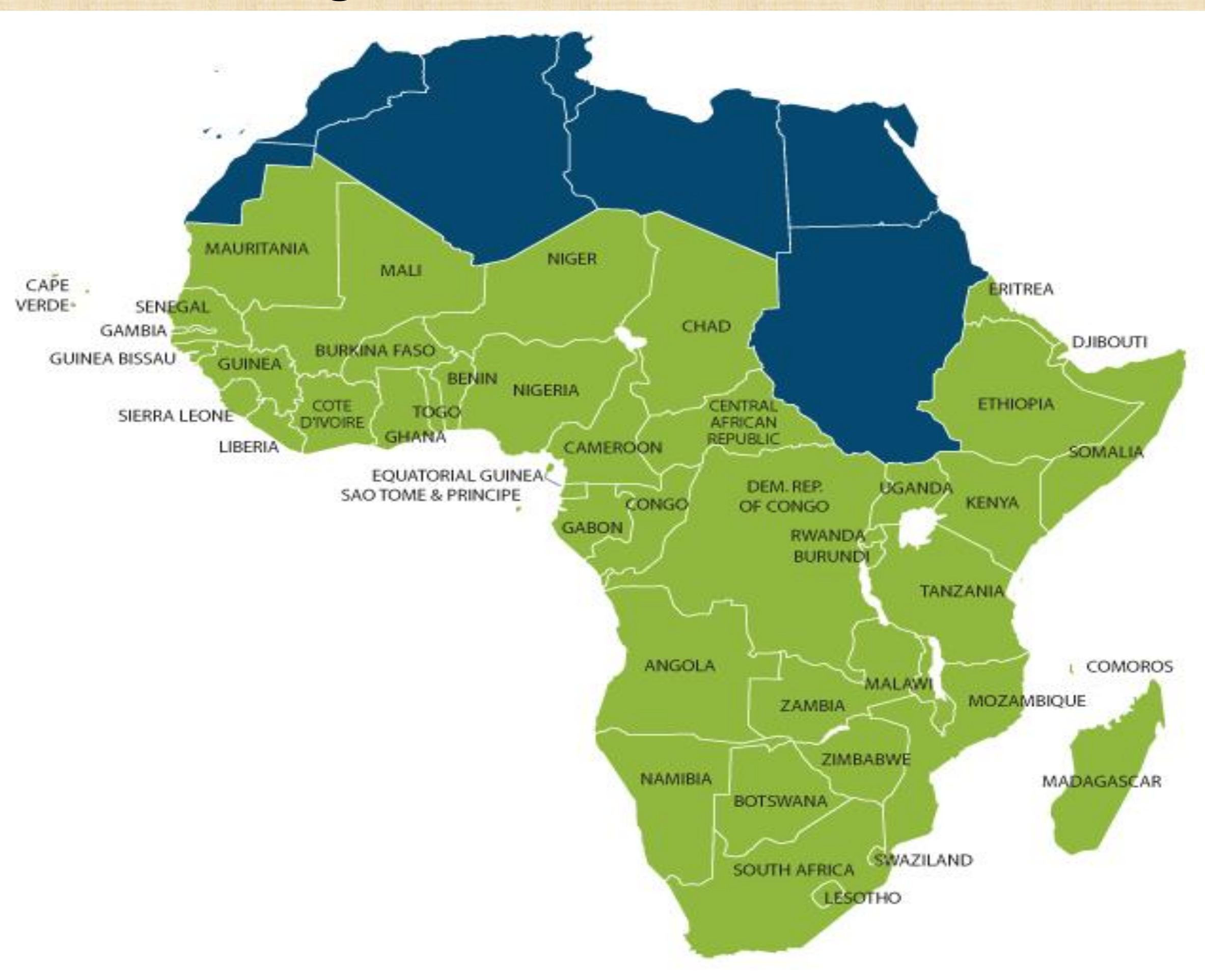### California State University, Bakersfield CA, 93311

Introduction

- Electricity is a vital contributor to the economy

- It stimulates improvements in many aspects of society including employment, health, food preservation, farming, medical technology and education (Tucker et al. 2014)

- The World Bank reported that in 2012, 621 million people lacked access to electricity in Sub-Saharan Africa

Literature

Energy Cons.	to	Econ. Growth	Reducing energy cons. affects growth (conservation policies have effect)
Energy Cons.	None	Econ. Growth	Neutrality hypothesis
Econ. Growth	to	Energy Cons.	Conservation policies have little effect
Energy Cons.	either	Econ. Growth	Complement each other
Energy Cons.	To(-)	Econ. Growth	Energy use constrained by infrastructural, political obstacles – put pressure on poverty
Econ. Growth	To (-)	Energy Cons.	Increased economic growth; people use less energy; walk, mass transit

Objective

This study seeks to analyze causality between electric power consumption, GDP, trade openness, financial development and industry in Sub-Saharan Africa

Motivation

- Contributes to studies that look at causality between electricity consumption & macroeconomic variables in Sub-Saharan Africa

- Analyzes causality in individual countries

- The inclusion of Industry, trade openness & financial development

Figure 1: Sub-Saharan Africa

Methodological Approach (VECM)

$$\Delta elec_t = \alpha_1 + \sum_{i=1}^{l} \beta_{1i} \Delta elec_{t-i} + \sum_{i=1}^{m} \gamma_{1i} \Delta fd_{t-i} + \sum_{i=1}^{n} \alpha_{1i} \Delta gdp_{t-i} + \sum_{i=1}^{o} \delta_{1i} \Delta ind_{t-i} + \sum_{i=1}^{p} \mu_{1i} \Delta trade_{t-i} + \xi_{1i} ECT_{t-1} + u_{1t}$$

$$\Delta fd_t = \alpha_2 + \sum_{i=1}^{l} \beta_{2i} \Delta elec_{t-i} + \sum_{i=1}^{m} \gamma_{2i} \Delta fd_{t-i} + \sum_{i=1}^{n} \alpha_{2i} \Delta gdp_{t-i} + \sum_{i=1}^{o} \delta_{2i} \Delta ind_{t-i} + \sum_{i=1}^{p} \mu_{2i} \Delta trade_{t-i} + \xi_{2i} ECT_{t-1} + u_{2t}$$

$$\Delta gdp_t = \alpha_3 + \sum_{i=1}^{l} \beta_{3i} \Delta elec_{t-i} + \sum_{i=1}^{m} \gamma_{3i} \Delta fd_{t-i} + \sum_{i=1}^{n} \alpha_{3i} \Delta gdp_{t-i} + \sum_{i=1}^{o} \delta_{3i} \Delta ind_{t-i} + \sum_{i=1}^{p} \mu_{3i} \Delta trade_{t-i} + \xi_{3i} ECT_{t-1} + u_{3t}$$

$$\Delta ind_t = \alpha_4 + \sum_{i=1}^{l} \beta_{4i} \Delta elec_{t-i} + \sum_{i=1}^{m} \gamma_{4i} \Delta fd_{t-i} + \sum_{i=1}^{n} \alpha_{4i} \Delta gdp_{t-i} + \sum_{i=1}^{o} \delta_{4i} \Delta ind_{t-i} + \sum_{i=1}^{p} \mu_{4i} \Delta trade_{t-i} + \xi_{4i} ECT_{t-1} + u_{4t}$$

$$\Delta trade_t = \alpha_5 + \sum_{i=1}^{l} \beta_{5i} \Delta elec_{t-i} + \sum_{i=1}^{m} \gamma_{5i} \Delta fd_{t-i} + \sum_{i=1}^{n} \alpha_{5i} \Delta gdp_{t-i} + \sum_{i=1}^{o} \delta_{5i} \Delta ind_{t-i} + \sum_{i=1}^{p} \mu_{5i} \Delta trade_{t-i} + \xi_{5i} ECT_{t-1} + u_{5t}$$

	Cote d'Ivoire	Congo Republic	Kenya	Gabon	South Africa	Zambia
Independence	1960	1960	1963	1960	1994*	1964
Pop. (millions)	20.40	4.45	44.35	1.67	52.98	14.54
GDP (current US$) in billions	31.10	14.09	55.24	19.34	350.63	26.82
GDP growth (annual %)	9%	3%	6%	6%	2%	7%
Electricity prod. In 2011 billions (kWh)	6.10	1.23	7.85	1.77	259.60	11.45

Results

Short Run Causality Running from

GDP	→	Elec. Consumption
Cote d'Ivoire, Gabon, S. Africa and Zambia		

Financial Development	→	Elec. Consumption
Cote d'Ivoire, Gabon & S. Africa		

Industrial growth & trade openness	→	Elec. Consumption
Gabon		

Long Run Causality Running from

GDP, trade openness, financial development and industry *to* electricity consumption in Congo, Cote d'Ivoire, South Africa and Zambia

Average Growth Rates(%) between 1971 to 2011

	Cote d'Ivoire	Congo Rep.	Kenya	Gabon	S. Africa	Zambia
Electricity Consumption	5.72	7.28	5.11	7.00	4.01	1.67
Export	4.77	5.28	3.79	3.30	2.50	4.41
Imports	4.38	8.16	4.85	5.90	3.63	4.67
GPD	2.76	4.30	4.13	3.70	2.57	2.41
Industry	0.78	4.27	-0.26	1.50	-0.46	-0.39
Urban	4.78	4.05	5.35	4.88	2.77	3.55
Financial Development	-0.42	1.12	2.34	0.64	1.53	2.05

Figure 2: Granger Causality Results

Null Hypothesis:	F-Stat	Prob.
EXPORTS_GROWTH does not Granger Cause ELEC_GROWTH	0.4735	0.7924
ELEC_GROWTH does not Granger Cause EXPORTS_GROWTH	1.5076	0.2232
IMPORTS_GROWTH does not Granger Cause ELEC_GROWTH	1.5801	0.2021
ELEC_GROWTH does not Granger Cause IMPORTS_GROWTH	0.8965	0.4986
GDP_GROWTH does not Granger Cause ELEC_GROWTH	0.4590	0.8028
ELEC_GROWTH does not Granger Cause GDP_GROWTH	1.5474	0.2113
INDUSTRY_GROWTH does not Granger Cause ELEC_GROWTH	1.5921	0.1988
ELEC_GROWTH does not Granger Cause INDUSTRY_GROWTH	0.4644	0.7990
URBAN_GROWTH does not Granger Cause ELEC_GROWTH	0.2090	0.9556
ELEC_GROWTH does not Granger Cause URBAN_GROWTH	0.2780	0.9208
FD_GROWTH does not Granger Cause ELEC_GROWTH	0.7538	0.5913
ELEC_GROWTH does not Granger Cause FD_GROWTH	0.9112	0.4897

Summary of Key Findings

- GDP & financial development play an important role in predicting future values of electricity consumption in Cote D' Ivoire, Zambia, and South Africa

- Energy demand projections in these economies that exclude GDP and financial development might provide inaccurate forecasts

- In Gabon, industrial growth & trade openness play a role in predicting future values of electricity consumption

- In Kenya, there are forces outside our model which Granger cause electricity consumption

Weakness of the Study

- Interpretations ought to be treated with caution due to the small sample size

- Non-grid electric power consumption from small and medium sized were not considered

- The use of generators (non-inclusion in official statistics)

Further Information