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Greenhouse Gas Emissions and Economic Growth in Africa: Does Financial Development Play any Moderating Role?

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ABSTRACT

The study had two major objectives. Firstly, to investigate the influence of greenhouse gas emissions (GGE) on economic growth. Secondly, to find out if the interaction between GGE and financial development enhanced economic growth in Southern and Western African nations. Four econometric estimation methods, namely dynamic generalized methods of moments (GMM), pooled ordinary least squares (OLS), fixed and random effects were used with annual data ranging from 2001 to 2012. The impact of GGEs on economic growth was found to be non-significant positive (pooled OLS), non-significant negative (fixed and random effects) and significant positive (dynamic GMM). The interaction between GGEs and financial development was found to have had a significant positive effect on economic growth under the dynamic GMM, fixed and random effects. The non-significant positive influence of GGEs on economic growth is a finding produced by the pooled OLS regression approach.

Keywords: Greenhouse Gas Emissions, Economic Growth, Africa JEL Classificiations: F43, N27, Q5

1. INTRODUCTION

1.1. Background of the Study, Problem Statement and Research Gaps

Energy consumption alongside greenhouse gas emissions (GGEs) as determinants of economic growth have in the last two decades been of particular interest to researchers, academics and policymakers. The research work by these important stakeholders led to an international agreement known as the Kyoto Protocol signed in 1997. The latter was meant to reduce greenhouse gases and carbon gas emissions in order to enhance economic growth (Obradovic and Lojanica, 2017. p. 511). Of particular concern to the empirical researchers is whether the Kyoto Protocol signed in 1997 has so far produced the desired effect. This is the reason why there has recently been several empirical work done to explore the impact of greenhouse/carbon gas emissions

on economic growth, findings of which are varied, mixed and divergent.

In the theoretical literature, the impact of greenhouse/carbon gas emissions on economic growth has been found to be either positive or negative. Positive in the sense that more greenhouse or carbon gas emissions is a result of increased manufacturing activities which are necessary to spearhead economic growth. Negative in the sense that increased greenhouse or carbon gas emissions pushes up the global average surface temperatures, which according to Nordhaus (1991 causes floods, drought and excessively high temperatures. Empirical researchers on the subject matter found out results which can be classified into four main categories. (1) Greenhouse or carbon gas emissions and economic growth affect each other, (2) positive influence of greenhouse/carbon gas emissions on economic growth, (3) negligible impact of greenhouse/carbon gas emissions on

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economic growth and (4) negative effect of greenhouse/carbon gas emissions on economic growth. The mixed and varied findings is evidence that there is no consensus yet on the impact of GGEs on economic growth. Moreover, both theoretical and empirical literature on the influence of greenhouse/carbon gas emissions on economic growth assumes a linear relationship exists between the two variables, an assumption which is quite far from the truth. Majority of the empirical studies on the subject matter ignored not only the dynamic nature of economic growth data but possible endogeneity problem between greenhouse/carbon gas emissions and economic growth.

1.2. Contribution of the Study

The current study fills in the above-mentioned literature gaps in the following three ways: (1) By investigating the impact of the interaction between greenhouse/carbon gas emissions and financial development on economic growth, the current study acknowledges that the two variables are related in a non-linear manner. (2) It uses dynamic generalized methods of moment (GMM) estimation approach which takes into account the dynamic nature of the economic growth data and the possible endogeneity issues on the relationship between greenhouse/ carbon gas emissions and economic growth. (3) It focused on African countries, a bloc of countries which have so far to a large

Table 1:	Theory	intuition	and a	nriori	expectation
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extent been ignored by prior empirical studies on the similar subject matter.

1.3. Structure of the Paper

The remaining portion of the paper is organised as follows: Section 2 discusses the greenhouse/carbon gas emissions and other factors' influence on economic growth from the theoretical angle whilst section 3 is the empirical literature on the impact of greenhouse/carbon gas emissions on economic growth. Section 4 discusses the greenhouse/carbon gas emissions and economic growth trends in Southern and Western Africa during the period ranging from 2001 to 2012. Section 5 is the research methodology estimation techniques, data analysis and interpretation whilst section 6 concludes.

2. GREENHOUSE/CARBON GAS EMISSIONS AND OTHER FACTORS' IMPACT ON GROWTH: THEORETICAL VIEW

Table 1 summarises the theoretical view on emission and other factors effects on economic growth.

Variable	Proxy used	Theory intuition	Expected sign
Economic	GDP per capita	-	Not applicable
growth (GROWTH)			
Carbon or GGE	Total GGE (kt of CO2	Increase in carbon/GGE pushes up the global average surface	±
	equivalent)	temperatures. This can lead to floods, drought or excessively high	
		temperatures which are not good for the health of human beings and the	
		economy (Nordhaus, 1991). On the other hand, the increase in carbon/	
		GGE is a direct result of increased economic or industrial expansion	
		activities.	
Foreign direct	Net FDI inflow (% of	Foreign direct investment flows alongside capital, technology, expertise,	±
investment (FDI)	GDP)	human capital development, all of which increases the productive	
		capacity of the host countries' economies (Kumar and Pradhan, 2002;	
		Romer, 1986; Lucas, 1988). The over-reliance on FDI creates an economy	
		that is predominantly monopolistic in structure hence leading to the	
		underutilisation of resources and negative economic growth (Bornschier	
		and Chase-Dunn (1985)	
Natural	Total natural resources	In line with the eclectic paradigm hypothesis advanced by	±
resources (NATURAL)	rents (% of GDP)	Dunning (1973), natural resources forms part of the locational advantages	
		in the host country thereby attracting FDI and enhancing economic	
		growth. The abundance of natural resources especially in African	
		countries has triggered civil conflict thus negatively influencing economic	
		growth	
Population	Population	Higher population growth rates increase the size of the market and the	±
growth (POP)	growth (annual %)	demand of goods and services. This does not only attract FDI but also	
		provides a fertile ground for the expansion of economic growth activities.	
		resources that could have been utilised for economic growth stimulation	
		initiatives are now used towards non-productive but essential services for	
		example health and education	
resources (NATURAL) Population growth (POP)	rents (% of GDP) Population growth (annual %)	Dunning (1973), natural resources forms part of the locational advantages in the host country thereby attracting FDI and enhancing economic growth. The abundance of natural resources especially in African countries has triggered civil conflict thus negatively influencing economic growth Higher population growth rates increase the size of the market and the demand of goods and services. This does not only attract FDI but also provides a fertile ground for the expansion of economic growth activities. On the other hand, increase in population size means that financial resources that could have been utilised for economic growth stimulation initiatives are now used towards non-productive but essential services for example health and education	±

(contd..)

Variable	Proxy used	Theory intuition	Expected sign
Economic	GDP per capita	-	Not applicable
growth (GROWTH)			
Financial	Domestic credit to	Increased financial development enhances economic growth through	±
development (FIN)	private sector by	boosting savings mobilization and efficient allocation of resources	
	banks (% of GDP)	Townsend (1983), Shaw (1973), Goldsmith (1969) and McKinnon (1973).	
		On the other hand, high financial development discourages long term	
		foreign investment (FDI) while promoting speculative foreign portfolio	
		investment which destabilises the economy	
Trade	Total trade (% of	High levels of trade openness subject the country to external shocks,	±
openness (OPEN)	GDP)	a situation which might not be good for the local economy. On the	
		other hand, trade openness is advantageous to the economy as it allows	
		domestic companies to easily access more affordable and efficient raw	
		materials, technology and other inputs in global markets	
Exchange	Value of the local	A weak currency is good for the economy as it promotes the	±
rates (EXCH)	currency against	competitiveness of the country's exports thereby helping to generate more	
	the United States	foreign currency whilst the opposite is true in the case of a country having	
	Dollar (US\$)	a strong currency. On the other hand, the advantage of having a strong	
		currency is that it minimises imported inflation	
Unemployment	Total	Some foreign investors are attracted to set up their production facilities	±
rate (UNEMPL)	unemployment (% of	in countries which are characterised by high unemployment as this	
	total labour force)	guarantees them of cheaper labour force. High levels of unemployment	
		reduces the demand of goods and services hence stifling production in the	
		economy	
Infrastructure	Fixed telephone	High levels of infrastructural development not only enhances economic	±
development (INFR)	subscriptions (per 100	growth through attracting FDI but also acts as one of the inputs into the	
	people)	production process. Whilst infrastructural development boost long term	
		economic growth, it might have a negative effect on economic growth in	
		the short term as it takes away financial resources that could have been	
		used for projects that have a direct and immediate link with economic	
Tutono di un tonno	T-4-1 COF (14 - COO)	growth	
Interaction term	Iotal GGE (Kt of CO2	Frankel and Rose (2012) noted that financial markets contribute towards	+
	$equivalent) \times domestic$	resources to the domestic firms to enable them to purchase environment	
	by banks (% of GDP)	friendly technology. On the other hand, financial development boosts the	
	oy builds (/b of GDT)	scale of manufacturing activities through provision of financial assistance	
		to the domestic companies, thus increasing gas emissions, pollution and	
		environmental degradation Aye and Edoja (2017. p. 10). It is against this	
		backdrop that the current study expects the interaction term to have either	
		a positive or negative effect on economic growth	

 Table 1: (Continued)

Source: Author compilation

3. INFLUENCE OF CARBON OR GGE ON ECONOMIC GROWTH-EMPIRICAL VIEW

This section discusses prior empirical research on the impact of carbon or GGE on economic growth. Lu (2017) investigated the relationship between energy consumption, GGE and economic growth in 16 Asian countries using the fully modified ordinary least squares with data ranging from 1990 to 2012. Low GGE were found to have enhanced economic growth whilst higher levels of GGE were found to have had a deleterious effect on economic growth in the Asian countries studied. Lapinskiene et al. (2014) studied the relationship between economic growth and GGE in European Union countries using panel data analysis with data from 1995 to 2010. Among other findings, increased emissions of greenhouse gases were found to have had a negative influence on economic growth in the European

Union countries. On the contrary, Cifci and Oliver (2018) observed that the reduction in GGE was associated with a decline in economic growth, possibly because of the heavy financial burden involved. Nordhaus (1991) also consented that GGE cause global warming, whose negative consequences on economic growth could be dire. Table 2 summarises the empirical literature on the influence of GGE on economic growth.

The empirical research on the impact of carbon or GGE on economic growth produced mixed findings (Table 3). Firstly, carbon or GGE were found to have had a positive impact on economic growth. Secondly, economic growth was negatively affected by carbon or GGE. Thirdly, both carbon/GGE and economic growth affected each other. Fourthly, there is a negligible relationship between the two variables. Clearly, the

Table 2. The relationsh	ip between carbon o		economic growth - e	
Author	Country/	Period	Methodology	Results
	Countries of study			
Hamit-Haggar (2012)	Canada	1990–2007	Panel data analysis	In line with the environmental Kuznets curve,
				a non-linear relationship was found to have
				characterised the relationship between GGE and
				economic growth. Economic growth was found to
				have been Granger caused by GGE in the short run
				only. In the long run, a weak causality running from
				economic growth and energy consumption towards
				GGE was detected.
Azam et al (2016)	United States of	1971-2013	FMOLS	Carbon emissions and energy usage were observed to
	America, India,			have had a deleterious impact on economic growth in
	China and Japan			the countries studied.
Narayan et al (2016)	181 countries	1960-2008	Panel data analysis	To a larger extent, economic growth led to a decline
				in the amount of carbon emissions. The finding is
				consistent with the environmental Kuznets curve.
Mapapu and Phiri (2017)	South Africa	1970-2014	Quantile regression	Economic growth went up in response to low levels of
			approach	carbon gas emissions.
Albiman et al (2015)	Tanzania	1975-2013	Toda and Yamamoto	Economic growth was found to have increased the
			non-causality	quantity of carbon emissions in Tanzania.
			test (1995)	
Lin et al (2018)	China and India	1969-2015	Bootstrap	Carbon gas emissions and economic growth were
			Autoregressive	found to have affected each other.
			Distributive Lag	
Obradovic and	Greece and	1980–2010	Vector Error	Economic growth was found to have been positively
Lojanica (2017)	Bulgaria		Correction	influenced by carbon emissions and energy
	C1	1070 0016	Model (VECM)	consumption in the long run in Bulgaria and Greece.
Appiah et al (2017)	Ghana	1970-2016	OLS	Carbon emissions went up in direct response to
$\mathbf{P}_{\mathbf{a}}$	India	1070 2012	VECM	Increased levels of economic growth.
Falalialai et al. (2013)	IIIula	1970-2012	V ECIVI	the level of economic growth activities in India
Iouini (2017)	Tunisia	1970_2010	VECM	Increased carbon emissions enhanced economic
Journ (2017)	Tumsia	1770 2010	VLCIVI	growth in Tunisia
Issaoui et al (2016)	Middle East and	1990-2010	FMOLS	Economic growth had a positive effect on carbon
	North African			emissions in the short run. The same study observed
	countries			that lower carbon gas emissions enhanced economic
	• • • • • • • • • • • • • • • • • • •			growth in the long run
Kumar (2011)	India	1971-2007	VECM	Carbon emissions had a negative influence on
· · · ·				economic growth in India.
Ejuvbekpokpo (2014)	Nigeria	1980-2010	OLS	Economic growth was negatively affected by carbon
				emissions in Nigeria.
Nnaji et al (2013)	Nigeria	1971-2009	ARDL	Among other findings, economic growth was found
				to have been Granger caused by carbon emissions in
				Nigeria.
Alam (2013)	Developing and	1993–2010	Panel data analysis	Economic growth was found to have been positively
	developed countries			influenced by carbon emissions in the short run.

Table 2. The relationship between carbon of OOE and contonne growth - empirical research	Table 2	2: Tł	he relation	ship	between	carbon	or GGE	and	economic	growth -	- empirical	research
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Source: Author compilation, FMOLS: Fully modified ordinary least squares, OLS: Ordinary least squares

relationship between carbon/GGE and economic growth is far from being a settled matter in the field of green economics and finance.

4. GGE AND ECONOMIC GROWTH TRENDS IN SOUTHERN AND WESTERN AFRICA

Table 3 shows the GGE and economic growth trends in Southern and Western African countries during the period ranging from 2001 to 2012.

South Africa, Mozambique, Tanzania, Zambia and Nigeria were the only countries which recorded the highest mean GGE above the overall mean of 127,333.59 kt of CO₂ equivalent. The same countries (Mozambique, South Africa, Tanzania, Zambia, Nigeria) are outliers because their mean total GGE are well above the overall mean of 127,333.59 kt of CO₂ equivalent. Botswana, Namibia, Burkina Faso, Ivory Coast, Guinea-Bissau, Liberia, Niger, Senegal, Sierra Leone and Togo are also outliers because their mean total GGE are well below the overall mean of 127,333.59 kt of CO₂ equivalent.

In terms of economic growth, only Botswana, Namibia and South Africa had their mean GDP per capita above the overall mean GDP per capita of 1,351.92 whilst the remaining African countries studied had their mean GDP per capita below the total overall mean. Madagascar, Mozambique, Tanzania, Guinea-Bissau, Liberia, Niger, Sierra Leone and Togo are outliers because their mean GDP per capita is well below the overall mean GDP per capita of 1,351.92. South Africa, Botswana and Namibia are also outliers because their mean GDP per capita. In order to curtail the detrimental effects of outliers on the quality of the overall results, the study converted all the data into natural logarithms, following Hair et al.'s (2014) argument.

5. RESEARCH METHODOLOGY

5.1. Data, Data Description and its Sources

The study used annual panel data ranging from 2001 to 2012 for 17 Southern and Western African countries. They include Botswana, Namibia, South Africa, Madagascar, Mozambique, Tanzania, Zambia, Burkina Faso, Ivory Coast, Ghana, Guinea-Bissau, Liberia, Niger, Nigeria, Senegal, Sierra Leone and Togo. The study only included Southern and Western African countries whose data for the variables of interest could be found. Table 1 shows the proxies that were used to represent the dependent, independent and control variables. International Monetary Fund, African Development Bank, World Bank Indicators and International Financial Statistics Agency were the four sources of data from which the data used in the study was extracted.

5.2. Econometric Model

Equation 1 is the general econometric format, explaining the relationship between GGE and economic growth.

$$\text{GROWTH}_{i,t} = \beta_0 + \beta_1 \text{GGE}_{i,t} + \beta_2 X_{it} + \mu + \varepsilon_{it}$$
(1)

Where GGE stands for GGE and X are the control variables (FDI, natural resources, population growth, financial development, exchange rates, trade openness, infrastructure development and unemployment). Unlike equation 1, equation 2 shows all the variables is an econometric format that describes the impact of GGE on economic growth.

 $\begin{aligned} & \text{GROWTH}_{i,t} = \beta_0 + \beta_1 \text{GROWTH}_{i,t-1} + \beta_2 \text{GGE}_{i,t} + \beta_3 \text{FIN}_{i,t} + \beta_4 (\text{GGE}_{i,t} \text{ FI} \\ & \text{N}_{i,t} + \beta_5 \text{FDI}_{i,t} + \beta_6 \text{NATURAL}_{i,t} + \beta_7 \text{POPUL}_{i,t} + \beta_8 \text{OPEN}_{i,t} + \beta_9 \text{EXCH}_{i,t} \\ & \beta_{10} \text{UNEMPLOY}_{i,t} + \beta_{11} \text{INFR}_{i,t} + \mu + \epsilon \end{aligned}$

 $GROWTH_{i,t} = \beta_0 + \beta_1 GGE_{i,t} + \beta_2 FIN_{i,t} + \beta_3 (GGE_{i,t}, FIN_{i,t}) + \beta_4 FDI_{i,t} + \beta_5$ NATURAL_{i,t} + $\beta_6 POPUL_{i,t} + \beta_7 OPEN_{i,t} + \beta_8 EXCH_{i,t} + \beta_9 UNEMPLO$ $Y_{i,t} + \beta_9 INFR_{i,t} + \mu + \epsilon$ (3)

Arellano and Bond's (1991) dynamic GMM was used to estimate equation 2 whilst equation 3 was estimated using pooled ordinary least squares (OLS), fixed and random effects estimation techniques.

5.3. Data Analysis, Reporting of Results and Interpretation

All the data was found to be integrated of order 1 (Table 4). A long run relationship between and among all the variables used

Table 3: Mean GGE	and economic	growth trends in
Southern and Wester	rn Africa (2001	l-2012)

Country	Total GGE	GDP per
	(kt of CO2 equivalent)	capita
Southern Africa		
Botswana	48,547.63	5,292.74
Namibia	32,245.22	3,808.28
South Africa	482,467.27	5,378.39
Madagascar	119,543.00	353.80
Mozambique	331,618.01	399.62
Tanzania	219,820.65	523.97
Zambia	326,868.89	990.99
Western Africa		
Burkina faso	43,854.14	461.94
Ivory coast	28,617.29	1,021.68
Ghana	104,269.27	893.33
Guinea-Bissau	7,321.91	473.11
Liberia	2,487.05	237.47
Niger	10,460.03	283.62
Nigeria	310,395.07	1,252.44
Senegal	51,199.30	845.75
Sierra leone	21,096.31	348.87
Togo	21,859.98	416.59
Overall mean	127,333.59	1,351.92

Source: Author's compilation

Table 4:	Panel	root	tests -	individual	intercept
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Level				
Variable	LLC	IPS	ADF	РР
L (GROWTH)	-6.5959***	-0.3218	41.4123	58.4894***
L (GGE)	-3.1950***	-1.6917**	47.6081*	123.002***
L (FDI)	-3.7535***	-3.0708***	64.7289***	96.3956***
L(NATURAL)	-4.4268***	-1.6494**	55.1409**	61.6619***
L (POPUL)	-7.2378***	-2.7222***	70.2650***	41.0566
L (FIN)	-4.2733***	0.0177	35.5957	35.7181
L (OPEN)	-3.9710***	-0.3554	39.9668	29.7394
L (EXCH)	-6.5431***	-2.7970***	70.8353***	90.5300***
L (UNEMPL)	1.2874	2.0352	27.4278	12.5829
L (INFR)	-1.7981**	-0.7922	44.5595	35.8463
First difference				
L (GROWTH)	-9.0902***	-5.0363***	90.3578***	122.807***
L (GGE)	-11.4905***	-7.7695***	124.271***	271.656***
L (FDI)	-8.8333***	-5.8513***	102.998***	200.562***
L(NATURAL)	-9.9108***	-4.8616***	87.4703***	123.888***
L (POPUL)	-9.9050***	-4.3168***	86.5816***	85.8917***
L (FIN)	-4.5614***	-3.4899***	69.5578***	156.053***
L (OPEN)	-5.8959***	-3.6308***	75.4320***	116.437***
L (EXCH)	-7.9772***	-4.3582***	80.1325***	90.4147***
L (UNEMPL)	-1.6124*	-0.8926*	46.6980**	78.3466***
L (INFR)	-5.6019***	-3.3593***	70.7877***	148.782***

LLC, IPS, ADF and PP stands for Levin et al. (2002); Im et al. (2013); ADF fisher Chi-square and PP fisher Chi-square tests respectively. *, ** and **** denote 1%, 5% and 10% levels of significance, respectively. Source: Author's compilation from E-views

was detected (Table 5), thus paving way for main data analysis (Table 6).

Under pooled OLS approach, GGE had a non-significant positive effect on economic growth in Southern and Western African countries, consistent with Cifci and Oliver (2018) whose study observed that an increase in GGE enhanced economic growth. Following authors such as Goldsmith (1969) Townsend (1983), McKinnon (1973) and Shaw (1973), the pooled OLS approach found out that financial development had a significant positive influence on economic growth. The interaction between GGE and financial development produced a non-significant positive effect on economic growth, in line with theoretical expectation (Table 1).

Both GGE and financial development had a non-significant negative impact on economic growth under both the fixed and random effects framework, results which are theoretically backed (Table 1). Under both fixed and random effects, the interaction between GGE and financial development was found to have had a significant positive effect on economic growth, a finding which confirms theoretical predictions.

Following Nor et al. (2015), the dynamic GMM approach shows that the lag of economic growth had a significant positive influence on economic growth in the Southern and Western African countries studied. Consistent with not only the fixed and random effects results but theoretical literature in Table 1, the interaction between GGE and financial development had a significant positive impact on economic growth under the dynamic GMM framework.

Economic growth was positively and significantly influenced by FDI under the fixed effects whereas FDI was found to have had a non-significant positive influence on economic growth under both pooled OLS and random effects. The findings resonate with Romer (1986) and Lucas (1988) whose study noted that FDI flows into the host country alongside technology, expertise, capital, human capital, all of which are necessary ingredients for economic growth. The negative effect of FDI on economic growth, a finding under dynamic GMM was supported by Bornschier and Chase-Dunn (1985) whose study argued that FDI promotes a predominantly monopolistic economic structure which underutilises resources. Natural resources were found to have had a significant positive

Table 5: Kao residual co-integration test - individual intercept

Estimation technique	T-statistic	Probability
Augmented Dickey-Fuller (ADF)	-2.4156	0.0079

Source: Author's compilation from E-views

Table 6: Main data analysis - results

effect on economic growth under pooled OLS, fixed and random effects yet dynamic GMM approach observed that economic growth was positively but non-significantly affected by natural resources in the Southern and Western African nations studied. The findings to a larger extent resonate with Dunning's (1973) eclectic paradigm hypothesis which argued that natural resources enhance economic growth through its ability to attract FDI.

Under the pooled OLS, population growth was found to have had a significant negative effect on economic growth whereas economic growth was negatively but non-significantly influenced by population growth under both random effects and dynamic GMM approach. According to the fixed effects framework, population growth positively but non-significantly affected economic growth. Under all four estimation approaches used, trade openness had a significant negative effect on economic growth. Consistent with theoretical predictions, the depreciation of the local currency led to a significant negative impact on economic growth under pooled OLS, random effects and the dynamic GMM estimation approaches. On the other hand, the depreciation of the local currency nonsignificantly had a positive influence on economic growth. All these results are supported by theoretical literature (Table 1).

An increase in unemployment had a significant positive effect on economic growth under pooled OLS and a non-significant positive impact on economic growth under the random effects. The results resonate with a theoretical argument which says that high unemployment is synonymous with cheap labour thereby attracting foreign investment. The fixed effects show that unemployment had a non-significant positive influence on economic growth. Under pooled OLS and random effects approaches, infrastructural development had a significant positive causal effect on economic growth whereas under dynamic GMM framework, infrastructural development had a non-significant positive impact on economic growth. Last but not least, infrastructural development had a nonsignificant influence on economic growth in Southern and Western African nations studied, a finding which is inconsistent with most theoretical predictions.

Variable	Pooled	Fixed	Random	Dynamic GMM
	OLS	effects	effects	
GROWTH ₂₂	-	-	-	0.9746***
GGE	0.0934	-0.0822	-0.1147	0.0512**
FIN	0.8499**	-0.4641	-0.1614	0.1733*
GGE.FIN	0.0465	0.0819**	0.0705**	0.0172**
FDI	0.0450	0.0519*	0.0319	-0.0140
NATURAL	0.1281*	0.3093***	0.1799***	0.0186
POPUL	-1.1492***	0.2752	-0.1367	-0.0576
OPEN	-0.4436***	-0.3027***	-0.2638**	-0.0193*
EXCH	-0.0399*	0.1950	-0.0763*	-0.0117**
UNEMPL	0.1474**	-0.1262	0.0186	-0.0099
INFR	0.2483***	-0.0026	0.1424***	0.0077
Number of countries	17	17	17	17
Number of observations	204	204	204	204
Adjusted R-squared	0.7675	0.9179	0.4482	0.9846
F-statistic	68.02	88.24	17.49	J-statistic 192.00
Prob (F-statistic)	0.00	0.00	0.00	Prob (J-statistic) 0.00

***, ** and * denote 1%, 5% and 10% levels of significance, respectively. Source: Author's compilation from E-views, OLS: Ordinary least squares, GMM: Generalized methods of momen

5.4. Robustness Tests

Equation 4 shows a lagged variable econometric model which was used to test for robustness.

 $\begin{aligned} & \mathsf{GROWTH}_{i,t} = \beta_0 + \beta_1 \mathsf{GGE}_{i,t-1} + \beta_2 \mathsf{FIN}_{i,t-1} + \beta_3 (\mathsf{GGE}_{i,t-1}, \mathsf{FIN}_{i,t-1}) + \beta_4 \mathsf{FDI}_{i,t-1} \\ & + \beta_5 \mathsf{NATURAL}_{i,t-1} + \beta_6 \mathsf{POPUL}_{i,t-1} + \beta_7 \mathsf{OPEN}_{i,t-1} + \beta_8 \mathsf{EXCH}_{i,t-1} \\ & + \beta_9 \mathsf{UNEMPLOY}_{i,t-1} + \beta_{10} \mathsf{INFR}_{i,t-1} + \mu + \varepsilon \end{aligned}$

The use of the alternative approach was found to be necessary consistent with Matthew and Johnson's (2014) argument that it takes a long time for macro-economic variables to have an effect on each other.

Whilst GGE had a non-significant positive influence on economic growth, the impact of financial development on economic growth was positive and significant under the pooled OLS approach. The combination of both GGE and financial development had a non-significant positive causal effect on economic growth under the pooled OLS framework. Both GGE and financial development had a non-significant negative influence on economic growth under fixed and random effects. Yet the interaction between GGE and financial development had a significant positive causal impact on economic growth under both fixed and random effects. This shows that whilst GGE and financial development might separately have a negative influence on economic growth, the growth of the economy is enhanced if both variables are interacted in the same economy (Table 7).

6. CONCLUSION

The study had two major objectives. Firstly, to investigate the influence of GGE on economic growth. Secondly, to find out if the interaction between GGE and financial development enhanced economic growth in Southern and Western African nations. Four econometric estimation methods, namely dynamic GMM, pooled OLS, fixed and random effects were used with annual data ranging from 2001 to 2012. Theoretically, the positive and negative influence of GGE on economic growth is quite compelling. On the empirical front, four views have been emerged, (1) the positive

Table 7: The lagged independent variable approach (t-1)

00	1	11	
Variable	Pooled	Fixed	Random
	OLS	effects	effects
GGE	0.0791	-0.0064	-0.0881
FIN	0.7919**	-0.1617	-0.0942
GGE.FIN	0.0398	0.0513*	0.0602*
FDI	0.0673*	0.0564*	0.0559*
NATURAL	0.1059	0.3057***	0.1566***
POPUL	-1.3218***	0.1529	-0.4301***
OPEN	-0.4344***	-0.2369**	-0.2461**
EXCH	-0.0401*	0.2789**	-0.0647*
UNEMPL	0.1270*	-0.1216	0.0606
INFR	0.1744***	0.0066	0.0739***
Number of countries	17	17	17
Number of observations	204	204	204
Adjusted R-squared	0.7696	0.9109	0.4357
F-statistic	68.80	80.78	16.67
Prob (F-statistic)	0.00	0.00	0.00

***, ** and * denote 1%, 5% and 10% levels of significance, respectively. Source: Author's compilation from E-views, OLS: Ordinary least squares influence of GGE on economic growth, (2) the negative effect of GGE on economic growth, (3) a bi-directional causality and (4) a negligible relationship between the two variables.

Currently, there exists some gaps in the literature. For example, no study that the author is aware of has so far explored the impact of the interaction between GGE and financial development on economic growth. Evidently, the existing theoretical and empirical literature shows a lack of consensus when it comes to the relationship between GGE and economic growth. The impact of GGE on economic growth was found to be positive but non-significant (pooled OLS), negative but non-significant (fixed and random effects) and positive and significant (dynamic GMM). The interaction between GGE and financial development was found to have had a significant positive effect on economic growth under the dynamic GMM, fixed and random effects.

The non-significant positive influence of the interaction between GGE and financial development on economic growth is a finding produced by the pooled OLS regression approach. Southern and Western African countries are therefore urged to implement policies aimed at deepening the levels of financial development in order to delete the negative effects of GGE on economic growth.

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