Chapter 25

Environmental Quality and the Quality of Life in Sub-Saharan Africa: Measuring the Role of Economic Liberalisation

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Abstract

This study examines whether the nexus of environment and quality of life is contingent on the level of economic liberalization in SSA. The study employs the two-step system GMM estimation technique for the investigation. The study found a complementary interaction between environmental quality (ENVQ) and economic liberalization. It concludes that economic liberalization positively moderates the impact of ENVQ on the quality of life in SSA. Therefore, this study recommends that SSA countries pursue a guided liberalization policy that manages the process of industrialization in the region. This policy will involve mitigating environmental degradation and pollution in the industrial cities of the region.

Keywords: *Environmental Quality, Quality of Life, SSA, Economic Liberalization, System GMM*

1.1 Introduction

The quality of life (henceforth QoL) is a multidimensional concept with no well-developed theoretical background (Okunlola and Akinlo, 2021). The QoL has been viewed from both objective and subjective dimensions (WHO Group, 1995; Terhune, 1973; Felce and Perry, 1995; Rokicka, 2014). While Terhume (1973) viewed the QoL subjectively as personal satisfaction or as a prerequisite for happiness, Rokicka (2014) defined the QoL to mean a good life in terms of consumption, depending on the possession of particular material goods.

Many studies have investigated the various factors influencing the QoL (Martinez-Martin, Prieto-Flores, Forjaz, Fernandez-Mayoralas, Rojo-Perez, Rojo, and Ayala, 2012; Okunlola and Akinlo; Nikolaev, 2014; Graafland, 2020; Joshua, 2017; Scully, 2001; Easterlin and Angelescu, 2007). For example, Martinez-Martin et al. (2012) found health, family, and finances significant factors influencing QoL. Similarly, economic freedom, economic growth, and government consumption expenditure have been established to affect the QoL (Okunlola and Akinlo, 2021; Easterlin and Angelescu, 2007; Scully, 2001).

In addition to all these factors that have been demonstrated to influence the QoL, ENVQ has also been linked to the QoL (Streimikiene, 2015; Keles, 2011; Amuka, Asogwa, Ugwuanyi, Omeje and Onyechi, 2018; Borhan, Ahmed and Hitam, 2018; Milner, Hamilton, Woodcock, Williams, Davies, Wilkinson, and Haines, 2020; Nkalu and Edeme 2019; Azam, Khan, Abdullah and Qureshi, 2015; Deng, Alvarado, Toledo and Caraguay, 2020; Diener & Suh,1997; UNECE, 2009). It is a known fact that human life is greatly affected by the health of the physical

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environment. Pollutants and hazardous substances have enormous side effects on human health (Streimikiene, 2015). According to Brajsa-Zganec, Merkas, & Sverko (2011), the ENVQ matters intrinsically because human beings see very important the beauty and health of the place where they live and care about the depletion of its natural resources.

Furthermore, the ENVQ is a fundamental factor in well-being because the physical environment strongly affects the QoL (Holman & Coan, 2008; Kahn, 2002; Van Liere & Dunlap, 1980; Reto & Garcia-Vega, 2012). For instance, environmental events such as natural disasters and epidemics may lead to death, injury and disease. Similarly, Ahmad & Yamano (2011) claimed that severe environmental changes might damage human health through climate change. Also, the United Nations (2002) outlined the major health problems associated with environmental pollution as reduced IQ, anaemia, neurological damage, physical growth impairments, nerve disorders, pain and aching in muscles and bones, memory loss, kidney disorders, retardation, tiredness and headaches, lead colic, seizures, delirium, coma and, in some cases, death. Furthermore, the emissions of lead, mercury, chromium, and carbon dioxide (CO_2) have a dangerous impact by poisoning infants, pregnant women, and children between 5 and 14 (Blacksmith Institute 2011).

Aside from affecting human health, ENVQ is also a key factor influencing QoL through household consumption (Boyd & Uri, 1990; EEA, 2012; Narayan and Narayan, 2008; Odusanya et al., 2014; Boachie et al., 2014; Yahaya et al. 2016; Yazdi and Khanalizadeh 2017; Mujtaba and Shahzad, 2021; UNEP/MAP-Plan Bleu, 2009; Alimi, Ajide & Isola, 2020). In their work, Boyd & Uri (1990) demonstrated that irrespective of what type of strategy is employed to improve ENVQ, both output, and consumption decline, as does household utility. Furthermore, they noted that the aggregate loss in production and economic welfare (measured by consumption expenditures and utility) is less under a policy that stresses reliance on alternative fuels (brought about by taxation) than through one that requires the installation of pollution abatement devices (that is, regulation). Similarly, UNEP/MAP-Plan Bleu (2009) claimed that climate change causes the following: reduced yields in agriculture and fishing, reduced attractiveness of tourism (heatwaves, rarefied water resources), coastal zones and infrastructures (high exposure to waves, coastal storms, and other extreme climatic events, higher salination, depletion of underground freshwater resources, seawater penetration in aquifers), and negative impact on public health (heat waves). Also, Alimi et al. (2020) demonstrated that carbon emission exerts a positive and statistically significant impact on public and national healthcare expenditure, while no relationship exists between environmental pollution and private healthcare expenditure.

Also, Narayan and Narayan (2008), Yazdi and Khanalizadeh (2017), Mujtaba and Shahzad (2021), Alimi et al. (2020), and Yahaya et al. (2016) demonstrated a positive impact of ENVQ on consumption expenditure in the health sector. However, Boachie et al. (2014) found no statistically significant effects of ENVQ on consumption expenditure.

Furthermore, another aspect of QoL that has been linked with ENVQ is the economic well-being measured by per capita income or growth. Some viewed that the link runs from economic well-being to ENVQ (Kasman & Duman, 2015; Uddin, Salahuddin, Alam, & Gow, 2017). For instance, the environmental Kuznets curve views the ENVQ-economic well-being nexus as one running from economic growth to ENVQ. Environmental Kuznets curve argues that as the economy develops, it has more impact on the environment (Jeffords & Thompson, 2019).

Many country-specific studies have demonstrated an inverted U-shaped curve in the ENVQ and per capita income relationship (Hamit-Haggar, 2012; Du et al., 2012; Yavuz, 2014; Ratanavaraha and Jomnonkwao, 2015; Onafowora and Owoye, 2014; Ahmed and Long, 2012). Other results from the cross-national and panel studies are mixed and are not conclusive (see Shafik & Bandyopadhyay, 1992; Panayotou, 1993; Grossman & Krueger, 1995; Unruh & Moomaw, 1998; Unruh & Moomaw, 1998; List & Gallet, 1999; Stern & Common, 2001; Apergis and Payne, 2009; Cole & Neumayer, 2004; Chen, 2009; Lean & Smyth, 2010). While many of these studies found support for inverted U-shaped relationships or the environmental Kuznets curve hypothesis, others found an N-shaped (Friedl & Getzner, 2003) and monotonically increasing (Akbostanci et al., 2009) relationship between income and CO_2 emission.

However, in looking at the links between ENVQ and the QoL, many studies did not consider the role of economic liberalization, which can stimulate industrial growth. For example, growing effluent pollution associated with industrialization may reduce dissolved oxygen in higher-income countries (Shafik. 1994). Also, Halicioglu (2009), Machado (2000), Ang (2009), and Jalil and Mahmud (2009) have demonstrated the existence of a positive relationship between liberalization and carbon dioxide emissions. Given these established linkages, it will be instructive to show the role economic liberalization plays in the ENVQ-QoL relationship.

Sub-Saharan Africa (henceforth SSA) suffers from serious environmental problems, including deforestation, soil erosion, desertification, wetland degradation, and insect infestation (Mabogunje, 2010). Despite the low QoL in the region, SSA has enormous natural resources in its rural areas, including forests and grasslands, wetlands, cultivable soils, and other biological resources (World Bank, 1989). These natural resources extracted contributed to environmental degradation in the region. For instance, in the ranking of global greenhouse emissions, only three countries in the SSA region (i.e., South Africa, Zaire, and Nigeria) ranked among the top 50 countries in terms of their 1991 contributions to global greenhouse emissions (World Resources Institute, 1994). In 2018 however, no African country was among the first 10 on this list, but the Democratic Republic of Congo, South Africa, and Nigeria have moved to the 12th, 16th, and 26th position, respectively (Climate Watch, 2020). This study will depart from other empirical studies to investigate the role economic liberalisation plays in the relationship between the ENVQ and QoL.

1.2 Materials and Methods

This study adopts the panel data analysis to examine the role economic liberalization play in the relationship between ENVQ and QoL. This chapter uses the dynamic generalized method of moment (GMM) to estimate the phenomena under consideration. To achieve this, a framework dynamic panel regression model to capture the role of economic liberalization in the relationship between ENVQ and QoL in SSA is specified as follows:

$$Qol_{it} = a + \gamma QoL_{it-1} + \beta ENVQ_{it} + \sum_{j=1}^{k} \delta_j X_{jit} + \varepsilon_{it};\ j = 1, \ldots, k; i = 1, \ldots, n; t = 1, \ldots, T \quad (1)$$

In equation (1), Qol_{it} represents the quality of life for country i over period t; QoL_{it-1} entails the lagged value of the quality of life for a nation's i over time t; $ENVQ_{it}$ stands for environmental quality (ENVQ) for a nation's i over time t; X_{jit} represents the remaining regressors in the model, including the moderating variable (economic liberalization measured by economic freedom) and control variables for country i over time t, and j is the number of control and moderating variables included. A country-specific fixed effect1 is assumed for the disturbance term as follows:

$$\varepsilon_{it} = e_i + u_{it} \tag{2}$$

Where ε_{it} represents error term; which entails e_i, the country-specific fixed effects that are time-invariant, while u_{it} is assumed to be independent and normally distributed and has zero (0) mean and constant variance σ_u^2 overtime and across countries, that is, $u_{it} \approx n(0, u_{it})$. To empirically analyze economic liberalization's role in the relationship between quality of life and ENVQ, this paper uses a dynamic panel approach with the system-GMM estimator. In a dynamic panel, including a lagged dependent variable as an independent variable violates the orthogonality assumption. This is because the lagged value of the dependent variable (QoL_{it-1}) depends on ε_{it-1}, which is a function of ε_{it}. Because $\varepsilon_{it} = e_i + u_{it}$, absolutely the expected value of the lagged dependent variable and error term $E(QoL_{it-1}\varepsilon_{it}) \neq 0$. From this correlation, dynamic panel data estimation suffers from bias which disappears as t tends to infinity. To get rid of this country-specific effect, we differenced equation (1) as follows:

$$\Delta lnQol_{it} = \beta \Delta ENVQ_{it} a + \gamma \Delta lnQoL_{it-1} + \sum_{j=1}^{k} \delta_j \, \Delta lnX_{jit} + \Delta u_{it} \tag{3}$$

But, the converted error term Δu_{it} is correlated with $\Delta lnQoL_{it-1}$ as they both contain Δu_{it-1}. Compared to the astatic model, ordinary least square on the first differenced data in a dynamic model generates inconsistent parameter estimates since $E(QoL_{it-1}\varepsilon_{it}) \neq 0$. We must take note that $E\left(QoL_{it-g}u_{it}\right) = 0$ where $g \geq 2, t = 3, \ldots T$. Then, the chances of using instrumental variable IV estimations, using the lagged variables as instruments. Going by this, Anderson and Hsiao (1982) proposed IV estimation using $lnQoL_{it-2}$ as instrument for $\Delta lnQoL_{it-1}$since $E(QoL_{it-2}\Delta u_{it}) = 0$.

Blundell and Bond (1998) argued that if the explained variable is close to the random walk, this will execute the difference-GMM poorly because the past levels convey little information about the future changes. In this case, untransformed lags are weak instruments for transformed variables. Therefore, to increase the efficiency, we assume that orthogonality moment condition $E(\varphi_{it}\varepsilon_{it}) = 0$ for all i and t. Arellano and Bover (1995) first employed this method, in which to make the instruments exogenous to the fixed effects, they transformed difference. Therefore, this assumption is only valid if the variations in instrumental variables are linked to the fixed effect. Going by this assumption, $\Delta\varphi_{it}$ is valid for all variables in levels since $E(\varphi_{it-1}\varepsilon_{it}) = 0$.

If N>T, the GMM estimators are suitable. The bias in the GMM model will vanish in the large T panel. This shows that the changes to the economy's fixed effect indicated by the error term reduce with time, and the link between the lagged explained variable and error term would not be significant (Judson & Owen, 1997; Roodman, 2009). For the dynamic GMM, the problem of endogeneity is being resolved than when we use static and OLS models, which excludes internally generated instruments. Similarly, according to Arellano (2003), Han, Phillips, & Sul (2013), and Horváth, Hušková, Rice, & Wang (2015), the variables from the regression model are not associated with the error factor are valid as instruments. It allows a condition where N>T helps manage dynamic panel bias (Baum, Schaffer, & Stillman, 2007).

The study employs a dynamic panel model adopting the system-GMM in this study because it has an advantage over difference-GMM in a variable that is‘ random walk’ or close to being a random walk variable (Arellano, 2003; Baltagi, 2008; Baum, Schaffer, & Stillman, 2007; Han, Phillips, & Sul, 2013). Since this study’s model includes primarily macroeconomic variables characterized by random o difference- GMM by improving precision and reducing the finite sample bias (Baltagi, 2008). In conducting the tests of over-identifying restrictions, whether the instruments, as a group, are exogenous or not; either Sargan or Hansen J statistics or both are used. Sargan statistic is reported for a one-step non-robust estimation which minimized the value of the one-step GMM criterion function. Further, Sargan is reported for all two-step estimations and minimized the value of the two-step GMM criterion function, and it is robust. This study uses the Sargan test to account for the over-identifying restrictions based on this criterion.

As mentioned, the main goal of this study is to find out if the level of economic liberalization positively/negatively moderates the impact of ENVQ on the QoL. Then, an interactive term and other variables are incorporated in Eq. 1. Eq. 1 then becomes:

$$QoL_{i,t} = \beta_1 QoL_{i,t-1} + \alpha_1 ENVQ_{i,t} + \alpha_2 EFW_{i,t} + \alpha_3 (ENVQ * EFW_{i,t}) + \alpha_4 POPG_{i,t} + \alpha_5 FAID_{i,t} + \alpha_6 GS_{i,t} + \mu_i + \varepsilon_{i,t} \quad (2)$$

Where $ENVQ * EFW_{i,t}$ is the interactive term of ENVQ and economic liberalization, $POPG_{i,t}$ represents population growth rate, $FAID_{i,t}$ measures the foreign aid inflow into country i at the period t, and $GS_{i,t}$ indicates government size measured by government size as a percentage of GDP. The definition of other variables can be seen in Eq. 1; ENVQ is measured by CO_2 emissions (metric tons per capita). The carbon dioxide emissions stem from burning fossil fuels and cement manufacture. They include carbon dioxide produced during the consumption of solid, liquid, and gas fuels and gas flaring. Also, for validation purposes, fossil fuel energy consumption (% of total) was used to measure ENVQ. Fossil fuel comprises coal, oil, petroleum, and natural gas products. Both CO_2 emissions and fossil fuel energy consumption are the commonly used indicators in the literature.

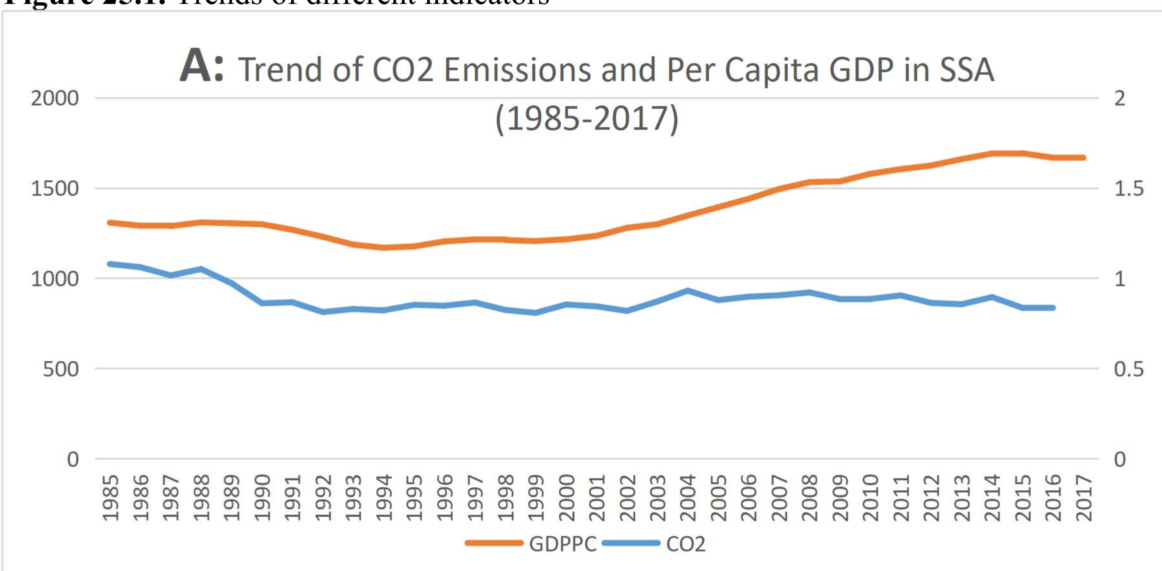
The study used three indicators of the QoL. Per capita income was used to measure economic well-being, consumption per capita was used to capture the standard of living, while life expectancy measures the health component of the QoL (Okunlola and Akinlo, 2021; Okunlola and Ayetigbo, 2021). This study hypothesized that the coefficient of the interactive term α_3 may have a negative value but is not significant. Economic liberalization improves industrialization, which worsens ENVQ. Also, economic liberalization improves the QoL; economic liberalization has a positive effect on QoL but a negative effect on ENVQ. The impact of the interactive term depends on where the impact of economic liberalization is higher--on the environment or QoL. Data of per capita GDP, consumption per capita, life expectancy, CO_2 emissions (metric tons per capita), fossil fuel energy consumption (% of total), foreign aid, population growth rate, and government expenditure (%GDP) were sourced from World Development Indicators of the World Bank. Economic freedom data was sourced from the Economic Freedom of the World (EFW) report published by the Fraser Institute.

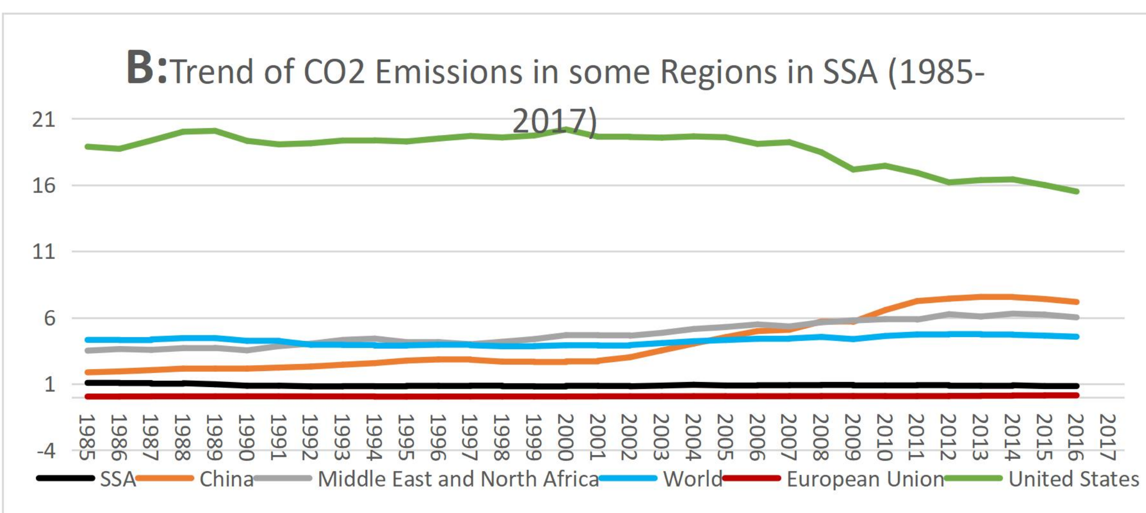
1.3 Results and Discussion

Although there are claims that SSA countries are not meticulous with their environmental issues (Mabojuje, 1995), the region is still a meager contribution to global greenhouse emissions (Climate Watch, 2020). For instance, Panel A of Figure 25.1 shows the trend of CO_2 emissions and per capita income in SSA between 1985 and 2017. Chart B in Figure 25.1 compares the trend of CO_2 in SSA and other regions. Chart B shows that despite the claim that SSA possesses a nonchalant attitude towards her environment, the region still has low average CO_2 emissions compared with other regions. For instance, aside from the European Union with a lower average CO2 emission, the United States and China have average CO2 emissions higher than SSA (see chart B in Figure 25.1). Chart A in Figure 25.1 shows the trend of average CO_2 emissions and GDP per capita in SSA within the study period. Chart A shows that average CO_2 emissions and GDP per capita exhibit almost a similar trend.

Also, spatial mapping of the average CO_2 emissions in SSA shows that most countries with a higher value are in the southern part of Africa (Figure 25.2). It is not a coincidence that those with high average CO_2 emissions are among the region's countries with the highest economic freedom level. This may validate the relationship that has been hypothesized between economic liberalization and CO_2 emissions. The countries with the highest average CO_2 emissions are represented in deeper green colour, while the countries represented with lighter green colour have lower average CO_2 emissions. And white represents an absence of data.

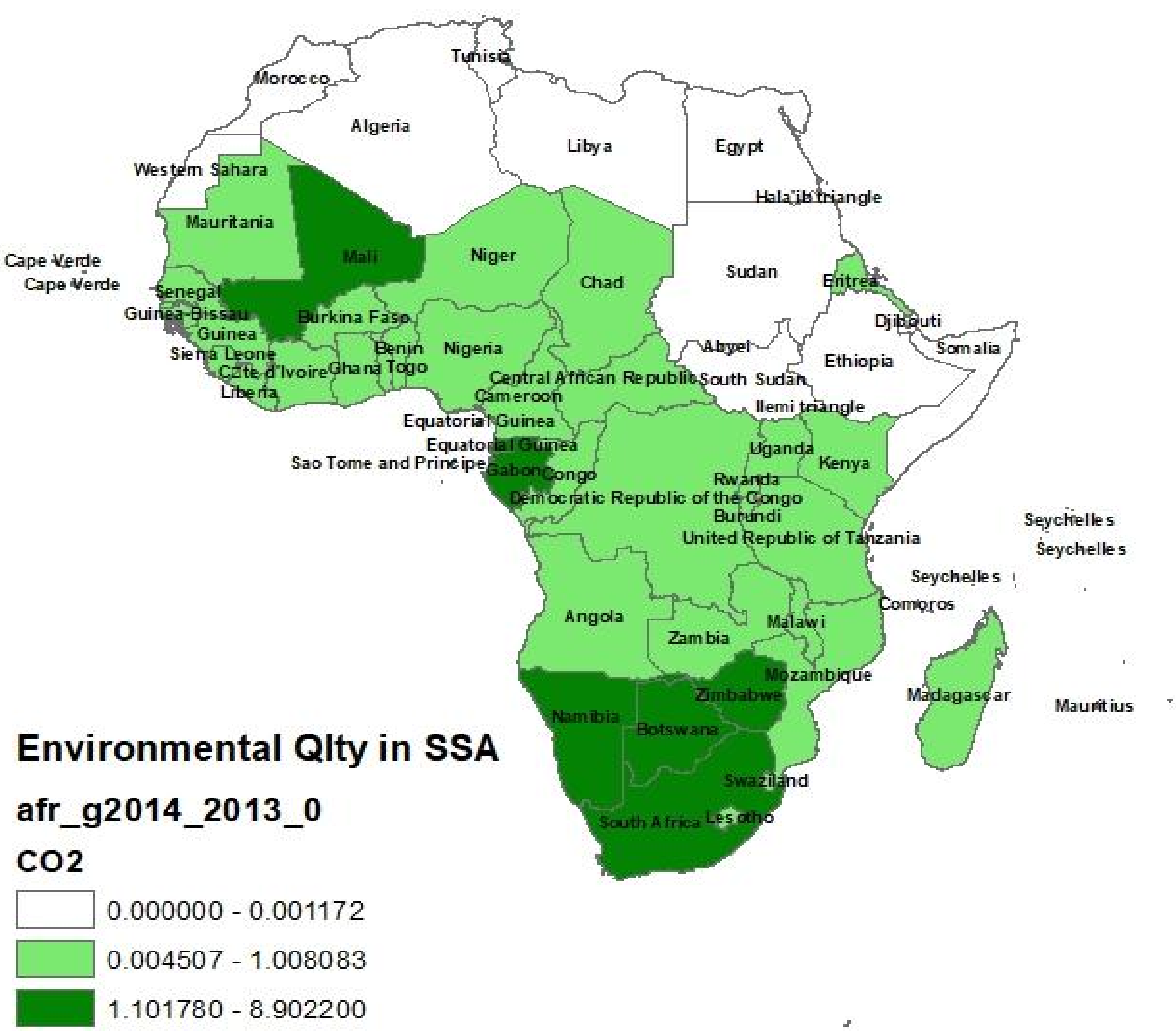
Figure 25.1. Trends of different indicators





Source: Data sourced from WDI, World Bank.

Figure 25.2: Spatial Analysis of the Average carbon dioxide emissions (metric tons per capita) in SSA between 1985 and 2017.



Source: Data sourced from WDI, World Bank.

Table 25.1: Empirical dynamics of system GMM dynamic panel (two-step estimate)

	SGMM	R-Effect	SGMM	F-Effect	SGMM	F-Effect
Lag(DEP)	1.0026*		0.981*		0.962*	
	(0.000)		(0.000)		(0.000)	
CO2	-0.030*	-0.015	-0.034*	-0.210*	-3.253***	2.412**
	(0.000)	(0.790)	(0.000)	(0.000)	(0.076)	(0.048)
EFW	-0.007*	0.089*	0.046*	0.098*	-0.505	3.082
	(0.005)	(0.000)	(0.000)	(0.000)	(0.235)	(0.000)
EFW*CO2	0.004*	0.026*	0.006*	0.056*	0.527**	-0.370***
	(0.000)	(0.007)	(0.000)	(0.000)	(0.043)	(0.060)
POPG	-0.003	-0.014	0.014*	(0.709)	-0.032	1.748*
	(0.207)	(0.233)	(0.000)	(0.000)	(0.937)	(0.000)
LNFAID	-0.001**	0.047*	-0.007*	0.060*	0.634*	2.099*
	(0.030)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GEGDP	0.001*	-0.001	-0.005*	-0.003	-0.025	0.086***
	(0.000)	(0.763)	(0.000)	(0.159)	(0.408)	(0.083)
C	0.058*	5.383*	0.051*	4.765*	-6.703**	-9.561**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.032)	(0.022)
AR(1)	-2.51		2.56		-1.67	
	(0.012)		(0.010)		(0.095)	
AR(2)	-0.97		1.83		-1.25	
	(0.334)		(0.167)		(-0.210)	
Hausman Test		9.57		14.83		55.05
		(0.144)		(0.022)		(0.000)
Sargan Test	13.76		8.32		3.83	
	(0.787)		(0.999)		(0.922)	
F-Test		273.23		239.44		33.64
		(0.000)		(0.000)		(0.000)
OBS	535	582	535	558	612	558

	SGMM	F-Effect	SGMM	F-Effect	SGMM	F-Effect
Lag(DEP)	0.974*		0.987*		0.971*	
	(0.000)		(0.000)		(0.000)	
FOSSIL	-0.008	-0.013*	-0.009*	-0.016*	0.036	0.303*
	(0.001)	(0.001)	(0.002)	(0.000)	(0.802)	(0.000)
EFW	-0.026	-0.009	-0.011	-0.002	0.127	1.428*
	(0.324)	(0.647)	(0.626)	(0.928)	(0.848)	(0.001)
EFW*Fossil	0.002*	0.004*	0.001*	0.004*	-0.003	-0.024**
	(0.000)	(0.000)	(0.001)	(0.000)	(0.808)	(0.030)
POPG	0.101*	0.012	0.034*	-0.059***	0.371	1.777*
	(0.000)	(0.594)	(0.001)	(0.057)	(0.753)	(0.001)
LNFAID	-0.035*	0.036*	0.010*	0.066*	0.410*	1.623*
	(0.000)	(0.000)	(0.004)	(0.000)	(0.004)	(0.000)
GEGDP	-0.001	0.011*	-0.002	0.006***	0.014	0.016
	(0.268)	(0.000)	0.226)	(0.078)	(0.714)	(0.806)
C	0.732*	6.089*	0.308***	5.387*	-8.336**	6.197
	(0.000)	(0.000)	(0.064)	(0.000)	(0.020)	(0.110)
AR(1)	-2.61		-1.69		-0.24	
	(0.009)		(0.091)		(0.812)	
AR(2)	0.37		1.36		-0.18	
	(0.713)		(0.173)		(0.857)	
Hausman Test		16.31		68.07		23.64
		(0.012)		(0.000)		(0.001)
Sargan Test	8.6		1.31		2.22	
	(0.659)		(1.000)		(0.946)	
F-Test		51.31		163.08		46.6
		(0.000)		(0.000)		(0.000)
	286	307	288	301	313	325

Note: The probability values for the fixed-effects and system GMM estimates are in parenthesis. *, ** and *** denote the significance of the individual coefficients at 1%, 5%, and 10% levels, respectively. The Sargan test is for over-identifying restrictions. AR(1) and AR(2) represent the Arellano–Bond test of first-order and second-order autocorrelation, respectively. The F-test examines if the panel has an individual-specific effect. Hausman's test determines if the difference in coefficient is systematic. Dependent variable: CO_2 and Fossil emissions.

Source: Authors' Computation

This study carried out all the pre-estimation tests, such as the stationarity and cointegration tests. In addition, it examined the characteristics of the data used. However, due to the limited number of tables/figures/graphs allowable, I will present the results of the tests by request.

Then, this study moves to the primary analysis of this work. Table 25.1 presents the analysis results of the impact of economic liberalization on the nexus between ENVQ and the QoL in SSA. The two-step system GMM results are shown in Table 25.1. First, the study used final household consumption, per capita GDP, and life expectancy as proxies for QoL. Also, this study used CO_2 emission per capita and fossil fuel energy consumption (% of total) as the proxies for ENVQ.

In Figure 25.1, CO_2 emission per capita coefficients have a negative and significant sign for all the models. This result suggests that CO_2 emission harms economic well-being (measured by GDP per capita), the standard of living (measured by consumption per capita), and health (measured by life expectancy), which are all proxies used for QoL. These findings are consistent with a priori expectations and results in the literature. For example, Ahmad & Yamano (2011), Reto & Garcia-Vega (2012), United Nations (2002), and Blacksmith Institute (2011) all demonstrated how ENVQ negatively impacts human health. Furthermore, environmental degradation negatively impacts consumption and per capita income (Boyd & Uri, 1990; UNEP/MAP-Plan Bleu, 2009; Alimi et al., 2020; Hamit-Haggar, 2012; Du et al., 2012; Grossman & Krueger, 1995; Moomaw & Unruh, 1997). Similarly, in the second estimation, where fossil fuel consumption is the indicator for QoL, the result shows that fossil fuel consumption has a negative and significant impact on economic well-being and standard of living only (Table 25.1).

As found in Okunlola and Akinlo (2021), Nikolaev (2014), and Graafland (2020), this study also found a positive effect of economic freedom on QoL. Here, an increase in economic freedom improves the QoL of people. But in the second estimation in the table, there is no significant effect of economic freedom on QoL.

The table shows that the interactive term of economic liberalization and ENVQ has a positive sign for all the models using the system GMM. For instance, the interaction of the economic freedom variable and CO_2 emission positively impacts GDP per capita, consumption per capita, and life expectancy. While in the second estimation, the result shows a positive and significant impact on GDP per capita and consumption per capita only. This result suggests a complementary interaction between economic freedom and QoL. By complementary interaction, an increase in the value of the moderator (in this case, economic freedom) will increase the impact of the explanatory variable on the explained variable (Cartwright et al., 2018). This implies that a unit increase in economic freedom will increase the effect of CO_2 on QoL indicators and vice versa.

Given the harmful impact, CO_2 has on QoL, an increase in economic freedom should reinforce this negative impact on QoL. However, this is not the case as the interactive terms positively impact QoL. Earlier in this paper, we hypothesized that economic freedom also stimulates QoL (which has been established by the result of this study). The impact of the interactive term depends on which variable----ENVQ or QoL, economic freedom has more impact. From this result, however, it is evident that the effect of economic freedom on QoL outweighs the effects of economic freedom on ENVQ. Therefore, this explains why the interactive terms of economic freedom and ENVQ have positive signs.

Next, the study looks at the economic interpretation of the marginal effect of the interactive terms. For instance, in *case 1*: the conditional marginal impact of CO2 on GDP per capita when there is economic freedom is presented as $\frac{d\Delta GDPPC_{it}}{dCO2_{it}} = \frac{-0.030}{(0.000)}$ - [$\frac{0.004}{(0.000)} * EFW_{it}$]. Thus, the study calculates the statistical significance of this impact for a realistic value of economic freedom. This implies that when the economic freedom index is at its mean value (such that the economic freedom index = 0), the marginal effect of CO_2 emission is - 0.030. Given the complementary interaction term, a rise in the value of the economic freedom index will reduce the impact of CO_2 on GDP per capita and vice versa. In other words, improvement in the level of economic freedom in SSA increases the effects of CO_2 on GDP per capita. This also applies in the case of consumption per capita and life expectancy models.

For *case 2*: the conditional marginal effect of economic freedom on the GDP per capita when there is CO_2 emission in Table 25:1 is given by $\frac{d\Delta GDPPC_{it}}{dEFW_{it}} = \frac{0.007}{(0.000)}$ - [$\frac{0.004}{(0.000)} * CO2_{it}$]. This implies that when the mean value of CO_2 emission is being reached (i.e., CO_2 emission = 0), the marginal effect of economic freedom is 0.007. In this case, with a complimentary interactive term, an increase in CO_2 emissions will reduce economic freedom's impact on human development and vice versa. This also applies to the consumption per capita and life expectancy models. From these findings, we can conclude that the interaction of ENVQ and economic liberalization is favourable for the improvement in QoL in SSA.

1.4 Conclusion

This study examined whether the ENVQ-QoL nexus is contingent on the level of economic liberalization in SSA. The study employs the two-step system GMM estimation technique to investigate the role of economic liberalization in the ENVQ-QoL relationship.

The study concludes that economic liberalization positively moderates the impact of ENVQ on QoL in SSA. It also found that the direct effects of economic freedom on the QoL offset its indirect effect on QoL through ENVQ. Therefore, this study will recommend that SSA countries pursue a guided liberalization policy that would manage the process of industrialization in SSA to mitigate environmental degradation and pollution in the industrial cities of the region. Given a complementary interaction between ENVQ and economic liberalization in the region, a guided liberalization policy that will take environmental preservation as its hallmark will improve the people's QoL.

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