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Environmental Quality and Health Expenditure in ECOWAS

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Abstract

Healthy environment and quality health status are increasingly becoming compromised by both the developed and developing economies for rapid output growth. This is particularly so as there is an established direct link between economic growth and growth in energy consumption.

This has invariably induced an increase in healthcare expenditure in order to ensure liveable and clean environment for continued human existence. The situation is particularly acute for most developing economies who do not have both technological and financial wherewithal to cope with the growing environmental menace. To this end, this study investigates the causal linkage between environmental quality and healthcare expenditure in fifteen (15) ECOWAS countries over the period 1995-2014.

The empirical evidence is based on three estimators viz: pooled OLS, fixed effects and system GMM respectively. For more specific policy targets, health care expenditure is further disaggregated into aggregate (national), public and private respectively. From the empirical findings, carbon emission is found to exert a positive statistically significant impact on both public and national healthcare expenditure on the one hand, while no relationship seems to exist between environmental pollution and private healthcare expenditure on the other hand.

On the policy front, we suggest that efforts should be intensified at reducing environmental degradation through introduction of carbon-free technology and other pollution abatement methods. The import of the preceding statement comes into a full glare as a positive income inelasticity of our results, which further reinforces the necessity of the nature of healthcare products.

Keywords: CO_2 emission, public/private sector, health expenditure, income, ECOWAS.

JEL Classification: F43, F64, H51, I18.

1.0 INTRODUCTION

The impact of poor environmental quality on health care expenditure has received much attention among researchers and policy makers. Majority of the existing studies (such as Narayan and Narayan, 2008; Zheng, Yu, Zhang and Zhang, 2010; Yahaya *et al*., 2016; Yadzi and Khanalizadeh, 2017, among others) claim that environmental degradation often leads to growth in health expenditure. Apparently from the studies, the findings and economic implications are found to be mixed and inconclusive owing to various reasons like variables measurement, data scope, stages of economic development, health and environmental policy employed in the respective countries investigated.

According to the United States Environmental Protection Agency (US EPA, 2017) report, carbon (CO_2) emissions from fossil fuel consumption, forestry, industrial processes and other land use account for about 76 per cent of the total global greenhouse gas emission. The report further revealed that China is the top carbon emitter with 30%, followed by United States (15%), European Union (9%), India (7%), Russia Federation (5%), and Japan (4%) while the remaining 30% are emitted by other countries. Despite the high level of carbon emitted by the developed countries, the World Health Organization (2012) noted that nearly 88% of the total 300.7 million deaths from outdoor air pollution occur in low- and middle- income countries. The reason is that the level of air pollution in these countries including the Economic Community of West African States (ECOWAS) has reached an alarming point as many urban dwellers living near industrial plants breathe in pollutants (like CO_2 dioxide, particulate matters, sulfur dioxide and nitrous oxide) emitted from cars and generating plants.

Carr (2015), for instance, emphasized that pollutants caused by human activity have been projected to double or quadruple by 2030 in Economic Community of West African States (ECOWAS). Knippertz *et al.* (2015) also noted that residents dwelling in the urban centres lack adequate knowledge on pollutants, and its impact on weather changes, crops, and public health. Although the region's contribution in terms of carbon emission from energy use to global climate change is presently negligible, but this might likely change if its output growth is linked to growth in fossil fuel consumption, which has high chances of increasing carbon emission (Gbatu *et al*., 2018). Available statistics have shown that carbon emissions from the region have increased from 3,862.57 kilotonne in 1995 to 10,129.72 kilotonne in 2014 (World Bank, 2018), representing an annual growth rate of 5.21%. However, the consequence of the pollutants on the people well-being in the region[1] is likely to be more devastating coupled with low expenditure on healthcare. Relative to the level of carbon emission within the period 1995-2014, the ratios of public and private health expenditure to GDP only grew at an annual rate of 1.55% and 0.41% respectively (World Bank, 2018). This shows that the amount government budgeted for healthcare is low, likewise the amount spent by majority of the people living in the region. A report of the World Health Organization (WHO, 2011) after ten years of the "Abuja Declaration" shows that only two countries (South Africa and Rwanda from Southern and Eastern Africa correspondingly) meet the 15% of national budget on health sector. In view of this, it is imperative to investigate the economic implications of poor environmental quality on healthcare expenditure. More importantly, the outcome of this research will provide a broader insight on the environmental impacts of healthcare demand not only to the region of study but to other emerging economies who share similar socio-environmental characteristics.

In health expenditure empirics, several factors have been advanced as driving healthcare spending, and these are closely categorised into two namely, income and non-income[2] factors. In the late 2000s, Narayan and Narayan (2008) note that the role of environmental quality on healthcare

[1]The average mortality rate of infants and under-5 per 1,000 live birth for the periods is 77.40 and 127.96 respectively while the mean modeled estimates of maternity mortality ratio is 734.93 per 100,000 live births.
[2]The non-income factors are demographic changes, social characteristics, medical progress, non-medical issues, time and technology and macroeconomic factors.

expenditure still lags in the literature. Several studies have been conducted after the work of Narayan *et al*. (2008) using different variable measurements of environmental degradation as well as different econometric approaches. This has possibly explained why their findings are mixed and inconclusive (Narayan *et al*., 2008; Yahaya *et al*., 2016; Yazdi and Khanalizadeh, 2017). This study employs a panel dataset to investigate the dynamic relationship between the measures of environmental quality and health expenditure for ECOWAS countries.

The study contributes to the extant literature in the following ways. First, the study augments the empirical model with salient variables used in environment-health literature: income, fertility rate, population age of 65 years and above, life expectancy, inflation rate and net official development assistance respectively. This is presented in a single model in order to determine their impacts on health expenditure. Second, unlike past studies which have only used either public or national health expenditure as a measure of health care spending, thus giving blanket policy implication, this study classifies the national health expenditure into public and private healthcare spending in order to avail room for more policy implications. Third, previous studies barely consider endogeneity issue in their empirical estimations. This study, therefore, takes into consideration this common econometric concern using the dynamic System Generalized Method of Moments (SGMM). Lastly, as the ECOWAS region strives to achieve both the third[3] and seventh[4] agenda of the Sustainable Development Goals (SDGs), this can be achieved if policy makers use the findings of this study to develop effective environmental and health regulatory frameworks without jeopardising the present level of economic growth in the region.

Apart from the introductory segment in one, section two reviews literature. The third section presents the methodology for analysing the relationship

[3] The goal target is healthy living and welfare promotion for everybody at all ages by reducing maternal mortality ratio to a ratio less than 70 per 100,000 live birth, neonatal mortality rate to less than 12 per 1,000 live births and infant mortality ratio to a value less than 25 per 1,000 live births among others by 2030.

[4] By 2030, the aim of the 7th SDGs is to ensure easy access to cheaper, reliable, modern and sustainable energy for everybody in the world.

between the variables of interest. Section four discusses the empirical findings while the last section concludes with policy recommendations.

2.0 LITERATURE REVIEW

The healthy state of individuals is derived from the consumption of health production inputs like health care services and time devoted to household members (Odusanya, Adegboyega, and Kuku, 2014). This kind of healthcare demand is considered as a derived demand. In specifying the factors determining healthcare expenditure, studies such as Hansen and King (1996), Muhlbacher *et al.* (2004), Dreger and Reimers (2005) among others have employed the demand function approach by hypothesizing per capita health expenditure as a function of real per capita income and a selection of non-income variables. The use of demand approach function was because aggregate data specifying the relationships lacks a theoretical basis in the econometric modelling of healthcare expenditure determinants (Murthy and Okunade, 2009).

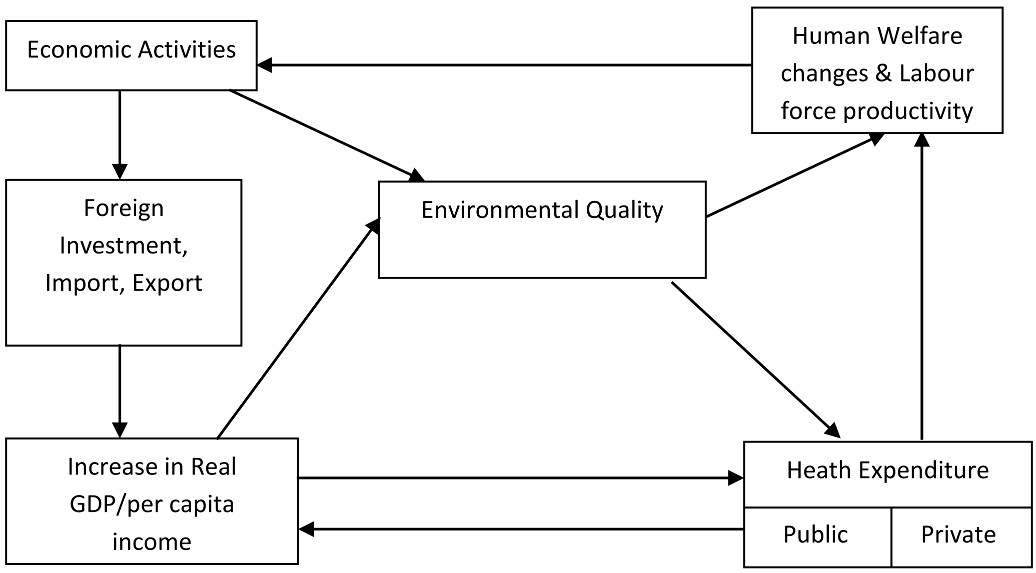

Figure 1: Environmental Quality and Health Care Expenditure Nexus

Figure 1 reveals a simple conceptual framework of environmental pollution and health expenditure nexus. The chart shows that an increase in healthcare expenditure results from rising environmental pollution. It further indicates that income increases as a result of improved economic activities geared by unrestricted flow of foreign investment and foreign earnings from exports over imports. One of the problems associated with the increase in income earnings is environmental degradation resulting from the manufacturing of toxic materials and chemicals and emission of greenhouse gas (GHG) from industrial plants. The effect of all these environmental pollutions on the health of the populace can be severe, acute and chronic. Above all, the problems caused by lead, mercury, chromium, and carbon monoxide ($C0_2$) emissions pollution are dangerous and poisoning for infant, pregnant women and children between the age of 5 and 14 (Blacksmith Institute, 2011). Also, the United Nations (2002) through her Environmental Programme outlined the major health problems associated with those 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".

Thus, all of the health challenges require huge spending to ensure healthy living. Also, there is the need for environmental quality control by the government to reduce health-related problems that could affect human capital development. As the number of population at risk of the health effect of environmental deterioration increases, more financial resources committed by the government, international donors, and private individuals to improve the population health status are necessary.

Empirically, numerous studies have investigated factor determinants of health care expenditure considering both income and non-income variables. From literature, we grouped the non-income factors into seven strands, which are: demographic such as age structure, trend in public spending, health care structure etc. (Clemente *et al.*, 2004; Di Matteo, 2005; Umoru and Yaqub, 2013); time and technology (Di Matteo, 2005; Mathias, Dickson and Bisong, 2013); non-medical heath factors like lifestyle, medicare pricing, practicing physicians, consumption of alcohol, tobacco etc. (Murthy and Ukpolo, 1996; Murthy and Okunade, 2000; Mathias, Dickson and Bisong, 2013); social characteristics like income distribution, distribution of skills etc. (Hitiris, 1999); health status and improvement or medical progress such as life expectancy, infant mortality etc. (Dreger and Reimers, 2005; Mathias *et al.*, 2013; Boachie *et al.*, 2014); environmental pollution (Narayan and Narayan, 2008; Odusanya, Adegboyega and Kuku, 2014; Boachie *et al.*, 2014; Yahaya *et al*., 2016; Yazdi and Khanalizadeh, 2017); and macroeconomic factors (Murthy and Okunade, 2000; Odusanya *et al.*, 2014). Nonetheless, few studies have investigated the impact of environmental quality on healthcare expenditure. The review of the few available studies is grouped based on panel, cross-sectional and time series data.

For panel studies, Narayan and Narayan (2008) examined the role of environmental pollution on per capita health expenditures in eight OECD countries from 1980 through 1999. The panel cointegration results show that there exists a long-run relationship between healthcare expenditure, income, nitrogen oxide emission, sulphur oxide emission and carbon emission. Employing panel Autoregressive Distributed Lag (ARDL), the short run estimates indicate that only income and carbon emission have a positive and significant impact on health expenditures, while the long-run estimates show that sulphur emission in addition to income and carbon emission have a direct and significant impact on health expenditures. Using panel fully modified OLS and error correction model for 31 pooled Chinese provinces, Zheng *et al*. (2010) reported that environmental quality and provinces' economy have a positive impact on public healthcare expenditure in both short run and long run.

While examining for 126 developing countries using a panel cointegration framework within the period of 1995 and 2012, Yahaya *et al*. (2016) found that the relationship between environmental pollution and health expenditure increases positively over time both in short-run and long-run periods. Yadzi and Khanalizadeh (2017) investigated the impact of air pollution and economic growth on healthcare spending in eleven Middle East and North Africa (MENA) countries for a period of twenty years (1995-

2014). The long-run relationship among the variables was confirmed using the Pedroni cointegartion test. They further confirmed that the countries' drive towards improving economic growth comes with a poor environmental condition which affects the quality of human health and results in high demand for healthcare expenditure.

Taking into consideration the cross-sectional data of 49 counties of Ontario in Canada; Jerrett *et al*. (2003) examined the relationship between environmental quality and health expenditures. Environmental pollution was measured by total pollution emission and total government expenses to ensure environmental quality. They employed the two-stage regression approach to establishing the link. Findings show that pollution and municipal environmental spending per capita have a significant effect on healthcare spending. They concluded that counties with higher pollution have higher per capita health expenditures while counties with a higher cost of ensuring environmental quality have lower expenditures on health care (Jerrett *et al.*, 2003).

For time series data, Boachie *et al.* (2014) analysed the determinants of health expenditure in Ghana using fully modified OLS (FMOLS) between 1970 and 2008. The result shows that carbon emission has a positive and insignificant impact on healthcare expenditure. Using autoregressive distributed lag (ARDL) model, Odusanya *et al.* (2014) examine the effects of environmental quality on health care spending in Nigeria within 1960 and 2011. The authors found that environmental pollution has a positive impact on health expenditure in both short-run and long-run. The result implies that deterioration of environmental quality drives health expenditure. Abdullah, Azan, and Zakariya (2016) also adapted the ARDL method for Malaysia and discovered that all the pollution measures per capita (carbon, nitrogen, and sulphur) increase health care spending per capita whereas carbon and sulphur have significant effects.

Besides, the findings of past studies on income-healthcare expenditure nexus were in two strands that is, whether health is a luxury or a necessity good.

Boachie *et al.* (2014) reported that health is a necessity goods that need public involvement in health care. A similar finding was reported by Dreger and Reimers (2005) as they found that health care expenditure is necessity goods after controlling for medical progress. Likewise, Di Matteo and Di Matteo (1998) found for five provinces (Atlantic, Quebec, Ontario, Prairies, and BC) in Canada between 1965 and 1991 that health care is not a luxury good. For 20 members of OECD within 1971 and 2004, Baltagi and Moscone (2010) established that health care is a necessity and not luxury.

On the other hand, the findings of Tang (2010) support the health care luxury hypothesis in Malaysia. The study conducted by Odusanya *et al.* (2014) reported that per capita income has a significant positive impact on health expenditure in long-run but not substantial in short-run and it is higher than one, i.e., health is luxury left for market forces to decide. The study of Murthy and Okunade (2000) revealed that the income coefficient to health care expenditure depicts that health is luxury. However, Zheng *et al*. (2010) found both strands within the two time periods. The scholars found health to be necessity goods in the short-run, and approximately necessity in long-run owing to techniques employed. Thus, Murthy and Ukpolo (1996) consider per capita income an essential determinant of health care spending in the United States.

We also report the results of other non-income factor determinants of health expenditure. Odusanya *et al*. (2014) found that inflation rate has a positive and significant association with health expenditure. They further discovered that foreign aid and total fertility have significant negative relation with health expenditure in long run as well as population proportion aged at 65 and over but insignificantly. Boachie *et al.* (2014) reported that crude birth and life expectancy have a positive impact on healthcare expenditure. Other indicators such as inflation rate and rural population have positive and insignificant effects on healthcare expenditure whereas; urbanization rate reports a negative and negligible relation. Dreger and Reimers (2005) concluded that medical progress like life expectancy and elderly shares of the population are the main factors of future health expenditure growth in OECD countries.

As well, Murthy and Ukpolo (1996) reported that the age structure of the population and the number of practising physicians are the primary determinants of aggregate healthcare expenditure. Conversely, factors such as the age of the population, number of practising physicians, and public financing of health care were considered necessary as determinants. Murthy and Okunade (2000) revealed that managed enrolment has a negative association with healthcare spending, whereas fiscal deficit has positive impact healthcare expenditure. Baltagi and Moscone (2010) said the non-income determinants of health expenditure show that percentage of young people explains health expenditure variations. The findings of Hitiris (1999) for G7 countries claimed that a person's demand for health depends on his health status, income, the price of healthcare, and sometimes health insurance.

Following the above reviewed studies, the findings on the relationship between poor environmental quality and health care expenditure are mixed, inconclusive and questionable. The studies have shown that carbon emission and income are important determinants of health expenditure. However, majority of these studies have neglected the effects of fertility rate, population age of 65 years and above, life expectancy, inflation rate and net official development assistance variables, which equally drive healthcare spending. Additionally, the literature review reveals that only a few studies have been conducted for African countries and most of the excluded variables have been omitted in the modelling framework. Moreover, only a few studies consider the dynamic nature of healthcare expenditure, whereas, virtually all these studies do not consider the high persistence of the healthcare indicator(s). This therefore suggests that the sophisticated estimators like difference generalized method of moments (GMM) or system GMM for dynamic analyses, that are useful for a dependent variable with high persistence, have not been widely engaged. The two estimators designed for small time, large objects or panels, are set to fit a linear model with a lag of dependent variable, control variables with possible lagged values and deeper lags of dependent variables, and orthogonal component terms (Roodman, 2009b). Bond (2002) submitted that the estimation of a System GMM outperforms the difference GMM most especially when the dependent variable is highly persistent as in the case of healthcare expenditure. Therefore, this study aims to employ the system GMM estimation approach and use the additional variables in modelling the healthcare spending of ECOWAS for gaining better insights into health and environmental policy framework. It is believed that the findings from this study will provide a broader insight for other emerging and developing countries.

3.0 Methodology and Data

3.1 Analytical Framework, Model Specification and Theoretical Expectation

The analytical framework of this study is the demand function approach, which states that households' resources and relative prices are the driving forces of healthcare expenditure (Dreger and Reimers, 2005). Although, the earliest work of Newhouse (1977) was the most commonly adapted model in literature stating that income has a direct relationship with health demand. Robert (1999) also concluded that healthcare expenditure specifications are largely ad hoc. The non-negativity of healthcare demand is considered to be a Giffen good. Dreger and Reimers (2005) provided evidence about the growing share of healthcare expenditure to GDP as one of the leading features of industrial economies. The authors also suggested that medical progress might be behind the evolution. Sauerland (2002) included a linear time trend into his model to control for medical progress. Muhlbacher *et al.* (2004) later consider life expectancy, infant mortality and the share of the elderly in the population as appropriate factors to be more affected by medical progress. Infant mortality will fall relative to medical advancement whereas life expectancy and the share of the elderly in the population are going to rise. We therefore model health expenditure (*HEXP*) as a function of real per capita income (*PCI*) and measures of medical progress (*MP*) in a panel form as:

$$HEP_{i,t} = \alpha_0 + \alpha_1 PCI_{i,t} + \alpha_2 MP_{i,t} + \mu_{i,t} \tag{1}$$

Where *HEP* denotes health expenditure, *PCI* denotes real per capita income, *MP* denotes measures of medical progress, μ is the stochastic term, *i* represents country and *t* denotes time. If income coefficient is higher than one (1), health expenditure is a luxury good, and if otherwise, it is a necessity good.

The model is extended by incorporating environmental quality factors and other non-income factors as determinants of healthcare expenditure. For this study, we incorporate carbon emission per capita (*CEM*) as measure of environment pollution; non-income factors like fertility rate (*FR*), population age of 65 years and above (*PP65*) and life expectancy (*LE*) as measures of medical progress; and inflation rate that is the general price level (*INF*) and net official development assistance per capita (*ODA*) to capture the impact of macroeconomic stability in the economy. The model becomes:

$$HEP_{i,t} = \alpha_0 + \alpha_1 PCI_{i,t} + \alpha_2 CEM_{i,t} + \alpha_3 FR_{i,t} + \alpha_4 PP65_{i,t} + \alpha_5 LE_{i,t} + \alpha_6 INF_{i,t} + \alpha_7 ODA_{i,t} + \varepsilon_{i,t} \tag{2}$$

Where: *HEP* is a vector of national, public and private healthcare expenditure per capita in international dollar PPP terms; *CEM* is carbon emission per capita in metric tonnes; *FR* is total fertility rate birth per woman; *PP65* is population age of 65 years and above; *LE* is total life expectancy at birth in years; *INF* is inflation rate denoting the general price level and *ODA* is net official development assistance received per capita; α_0 is constant; α_{1-7} are slope; ε is the error term bounded by the statistical properties of the classical school; *i* represents country; and t is time.

Theoretically, an increase in income per capita and deterioration in environmental quality proxy by carbon emission per capita are expected to have a positive impact on health expenditure. It is expected that countries tend to spend more on healthcare as they experience high income growth and poor environmental quality through high emission of poisonous gas into the atmosphere. Thus, countries tend to spend more on healthcare services as the level of income increases. On the other hand, poor environmental quality affects human health which requires more healthcare expenditure. Empirically, studies that have laid facts on the relationships are Narayan and Narayan (2008), Yahaya *et al*. (2016), Yazdi *et al*. (2017) among others.

Also, healthcare expenditure is expected to rise as fertility rate increases. It implies that the average number of children that a woman within the childbearing age of 15 and 44 will bear increases, investment in healthcare services is also expected to increase. Likewise, life expectancy measuring the average number of years an average person is expected to live after birth increases as more investment is expended in the healthcare sector. Similarly, a direct relationship is expected between the population of the old people above 65 years and healthcare expenditure as they require more investment on healthcare services to stay healthy. In addition, the coefficients of official development assistance (ODA) and macroeconomic factors measured by price instability are expected to be positive. For instance, many developing countries including West African countries are not only recipients of ODA from international organizations and developed countries, but they also depend on these funds to carter for health-related problems. As for price instability, the unstable nature of price makes the cost of healthcare services to increase.

3.2 Data Source and Description

This study makes use of all the 15 West African Monetary Zones (WAMZ), namely Benin, Burkina Faso, Cabo Verde, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo. The data were sourced from the database (World Development Indicators) of the World Bank (2018). Due to data availability, the scope of the study spans the period 1995 through 2014. The reason is that the data on healthcare expenditure starts from 1995 and ends in 2014, whereas the series of other variables begin as far as 1960 to 2016. Also, two countries, Guinea and Liberia have missing values in their inflation data. The missing years of inflation rate data for Guinea (1995-2004) and Liberia (1995-2001) were sourced from the database of Knoema[5] (2017) and Index Mundi[6] (2017) respectively. There is no healthcare data for Liberia between 1995 and 1997.

The average value of national health expenditure per capita is US$94.70 with maximum and minimum values ranging between US$321.65 and US$13.68 respectively. It is however interesting to note that health expenditure per capita for the private surpasses that of the public, thus suggesting that private spends more on healthcare facilities. Statistically speaking, while private averaged US$54.35, that of the public stands at US$40.35. For granular exposure, table two presents both the means and standard deviations of each country in the regional bloc. From the table, the average value of Cabo Verde with respect to health expenditure per capita is US$198.70, being the highest value, directly followed by Nigeria with US$182.6 and the Guinea has the least value of US$39.63. In terms of variability, the healthcare spending in Nigeria is largely dispersed over the period indicating high level of inequality among her citizens. On environmental ground, the metric tons of per capita carbon emission averaged 0.291 and both the maximum and minimum standing at 1.213 and 0.049, respectively. Of the countries on the regional bloc, Cape Verde takes a lead with 0.75 metric tons while Mali and

[5] https://knoema.com/atlas/Guinea/Inflation-rate
[6] https://www.indexmundi.com/liberia/inflation_rate_(consumer_prices).html

Niger are at par with each having 0.07 metric tons of per capita carbon emission. In sum, the top three emitters of carbon (Cabo Verde, Nigeria and Cot d'Ivoire with 0.75, 0.57 and 0.41 metric tons per capita respectively) and the set of countries also spend more on healthcare delivery.

Table 1: Descriptive Statistics

Variables	Measurements	Mean	Std. Dev.	Skewness	Kurtosis	Max.	Min.	Obs.
HEP	Health expenditure per capita (national, constant 2010 US$)	94.70	59.56	1.513	2.297	321.65	13.68	297
PBHEP	Health expenditure per capita (public, constant 2010 US$)	40.35	38.69	2.547	7.333	231.78	3.861	297
PVHEP	Health expenditure per capita (private, constant 2010 US$)	54.35	36.85	1.914	3.789	221.04	8.947	297
CEM	Carbon emission (metric tons per capita)	0.291	0.218	1.489	2.497	1.213	0.049	300
PCI	GDP per capita (constant 2010 US$)	844.7	665.4	2.174	4.920	3494.6	115.44	300
ODA	Net ODA received per capita (current US$)	72.31	90.55	3.437	13.30	666.8	1.268	300
FR	Fertility rate, total (births per woman)	5.625	1.042	-0.584	1.577	7.749	2.303	300
LE	Life expectancy at birth, total (years)	54.82	6.711	0.370	1.158	73.15	35.72	300
PP65	Population ages 65 and above (% of total)	3.069	0.661	2.542	6.825	5.751	2.336	300
INF	Annual rate of consumer prices (%)	7.285	10.04	2.475	11.88	72.84	-35.84	300

Note: Std. Dev. denotes standard deviation; Max. is maximum; Min. represents minimum; Obs. is observation; Official development assistance.
Source: Authors' computation (2019).

This aside, in terms of other covariates, the mean of per capita GDP in the ECOWAS region leaves much to be desired as it is less than US$1000. This notwithstanding, the maximum in the region is US$3494.56 while the minimum being US$115.44. Also, the average net per capita ODA received equals US$72.31. The averages of other explanatory like fertility rate, life expectancy, population ages 65 and above and annual rate of consumer prices are 5.625, 54.82, 3.069 and 7.285 respectively. Among the member countries that made up ECOWAS, Cabo Verde has the least average fertility rate coupled with the highest life expectancy of over 70 years. The country also has the highest percentage of population above 65 years to the total population amounting to 5.25%. However, the average of other member states ranges within 2.49%–3.28%. Conversely, Sierra Leone has the least average years of life expectancy indicating the impact of civil war and the recent outbreak of Ebola disease in the life of average Sierra Leoneans.

Table 2: Mean and Standard Deviation of Individual Countries Data Series

	HEP	PBHEP	PVHEP	CEM	PCI	ODA	FR	LE	PP65	INF
Benin	64.97	31.47	33.50	0.38	708.7	49.27	5.58	56.92	2.90	3.71
	[13.48]	[8.24]	[5.78]	[0.16]	[47.95]	[14.41]	[0.51]	[1.74]	[0.08]	[3.40]
Burkina Faso	64.73	33.48	31.25	0.11	502.3	50.84	6.26	53.51	2.65	2.81
	[23.26]	[16.20]	[7.77]	[0.03]	[82.71]	[15.95]	[0.42]	[3.36]	[0.20]	[3.17]
Cabo Verde	198.7	149.2	49.45	0.75	2621.3	357.1	3.15	70.97	5.25	3.10
	[70.61]	[50.56]	[20.77]	[0.30]	[759.0]	[121.12]	[0.74]	[1.75]	[0.40]	[3.07]
Cote d'Ivoire	150.5	40.85	109.7	0.41	1293.8	45.82	5.58	48.66	2.91	3.34
	[24.40]	[7.78]	[18.10]	[0.07]	[80.11]	[37.12]	[0.38]	[1.62]	[0.08]	[3.01]
Gambia, The	68.09	36.87	31.23	0.22	524.5	51.38	5.86	57.28	2.58	5.40
	[27.09]	[22.22]	[5.33]	[0.03]	[19.45]	[15.54]	[0.09]	[2.21]	[0.13]	[4.03]
Ghana	122.2	76.67	45.51	0.39	1162.5	49.23	4.50	58.82	3.28	20.07
	[36.45]	[31.63]	[7.71]	[0.07]	[251.4]	[14.62]	[0.27]	[1.64]	[0.22]	[13.29]
Guinea	39.63	13.62	26.01	0.20	425.3	31.30	5.74	53.67	3.28	12.48
	[14.37]	[8.53]	[6.62]	[0.02]	[18.50]	[11.71]	[0.43]	[2.64]	[0.16]	[9.52]
Guinea-Bissau	76.82	18.08	58.74	0.15	527.5	72.97	5.50	52.52	3.27	9.59
	[21.02]	[8.41]	[14.02]	[0.01]	[61.95]	[27.25]	[0.45]	[1.41]	[0.18]	[17.12]
Liberia	51.94	14.44	37.49	0.18	304.6	109.0	5.48	55.43	3.05	11.29
	[29.28]	[9.62]	[20.33]	[0.03]	[78.38]	[100.3]	[0.47]	[3.63]	[0.03]	[4.08]
Mali	80.37	32.11	48.26	0.07	628.1	55.10	6.74	52.37	3.03	2.92
	[18.36]	[10.21]	[14.89]	[0.01]	[69.38]	[17.83]	[0.24]	[3.69]	[0.34]	[4.06]
Niger	45.06	15.49	29.57	0.07	344.7	34.55	7.70	54.02	2.49	2.73
	[7.14]	[6.32]	[3.07]	[0.02]	[16.32]	[9.67]	[0.04]	[4.47]	[0.04]	[3.73]
Nigeria	182.6	53.74	128.89	0.57	1779.0	12.08	5.98	48.85	2.78	15.14
	[75.39]	[27.56]	[49.37]	[0.15]	[492.0]	[18.88]	[0.17]	[2.38]	[0.05]	[14.61]
Senegal	84.96	39.23	45.73	0.46	924.9	65.81	5.40	60.78	3.13	1.99
	[19.71]	[14.64]	[7.21]	[0.09]	[71.03]	[16.41]	[0.30]	[3.22]	[0.07]	[2.38]
Sierra Leone	128.3	25.70	102.6	0.12	413.7	68.50	5.74	43.10	2.59	11.17
	[42.06]	[6.31]	[37.04]	[0.03]	[89.25]	[27.63]	[0.62]	[5.18]	[0.08]	[14.94]
Togo	55.24	20.38	34.86	0.29	509.6	31.68	5.18	55.45	2.81	3.53
	[13.28]	[7.43]	[6.89]	[0.07]	[25.03]	[22.69]	[0.34]	[2.04]	[0.08]	[4.01]

Note: The values in square brackets are standard deviation and the figures on top are the mean values. HEP is national healthcare expenditure; PBHEP is public healthcare expenditure; PVHEP is private healthcare expenditure; CEM is carbon emission per capita; PCI is per capita income; ODA is net official development assistance per capita; FR is fertility rate; LE is life expectancy; PP65 is population ages above 65 years to total; and INF is inflation rate.
Source: Authors' computation (2019).

In regards to unstable nature of price, the mean value of countries like Ghana (20.07%), Nigeria (15.14%), Guinea (12.48%), Liberia (11.29%), and Sierra Leone (11.17%) recorded a two-digit value while others have values below 5.5% except Guinea-Bissau with 9.59%.Even though the data series are not normally distributed, the variations between the data sets including fertility rate, life expectancy rate and people above the age of 65 are low as indicated in the table.

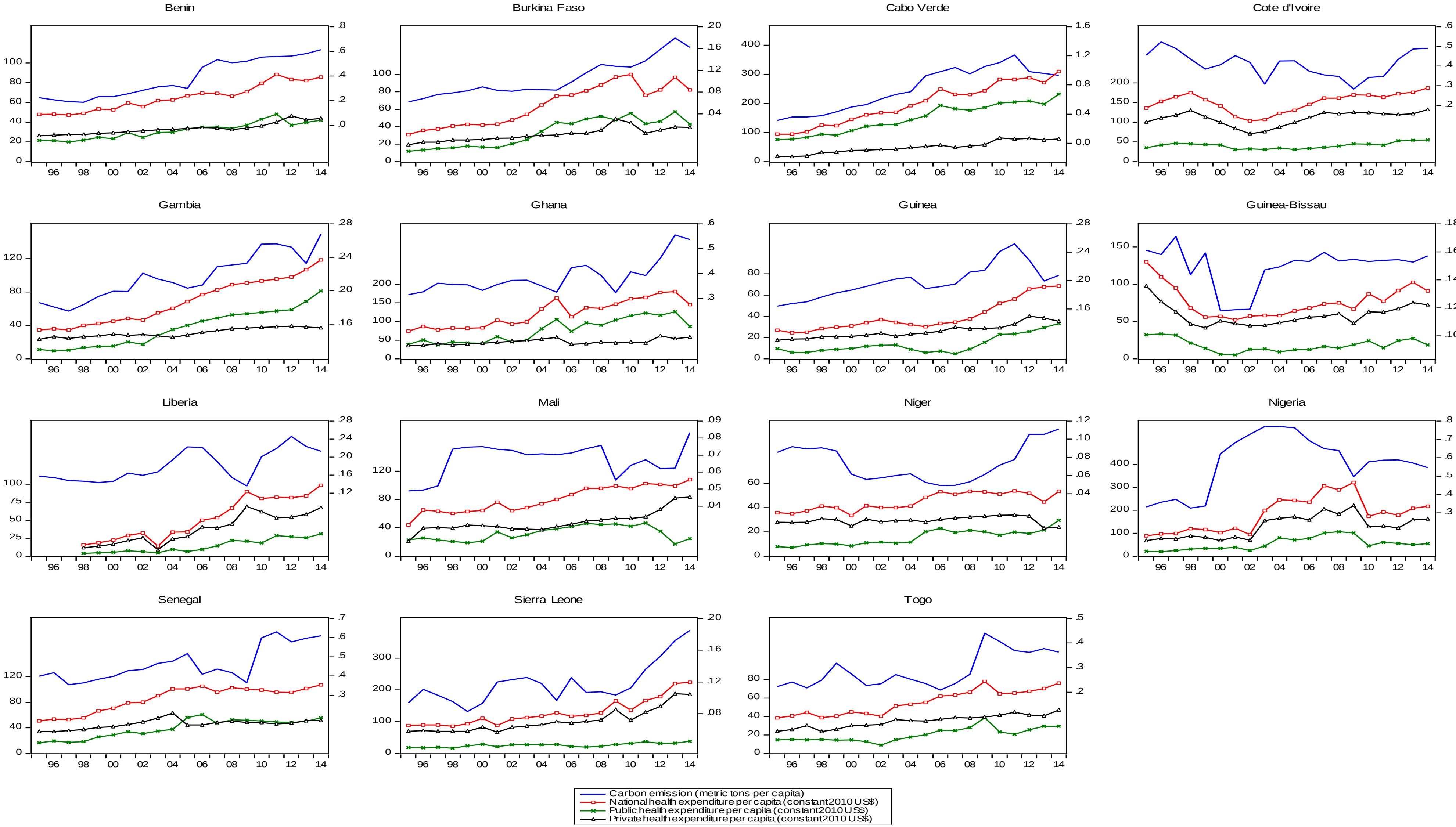

Figure 2: Member States' Plot of Healthcare Expenditure (Private, Public and National) and Carbon Emission of ECOWAS

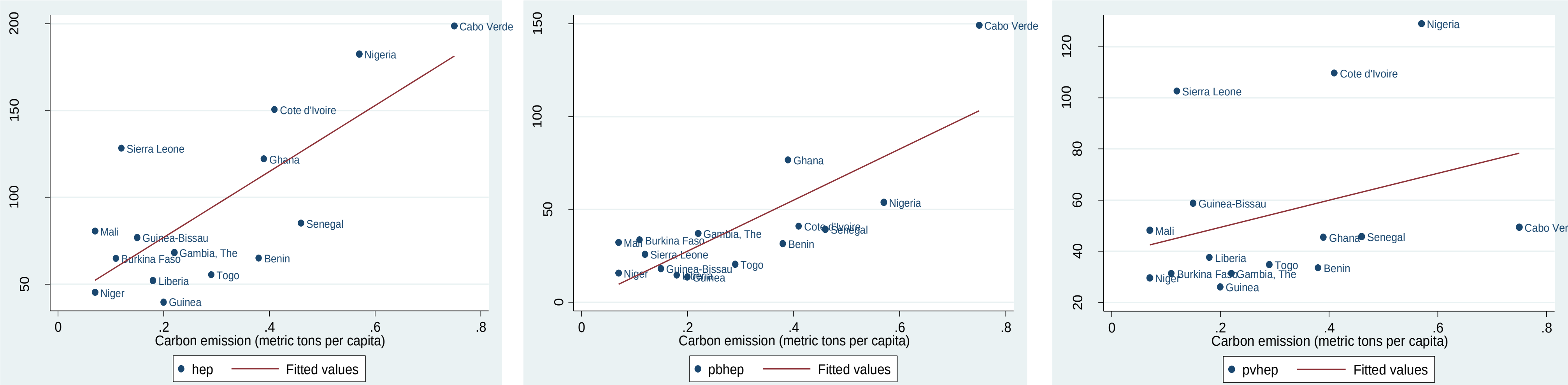

Figure 3a: Carbon emission and national healthcare expenditure
Figure 3b: Carbon emission and public healthcare expenditure
Figure 3c: Carbon emission and private healthcare expenditure

Figure 3(a-c): Carbon emission and healthcare expenditure (national, public and private) in ECOWAS

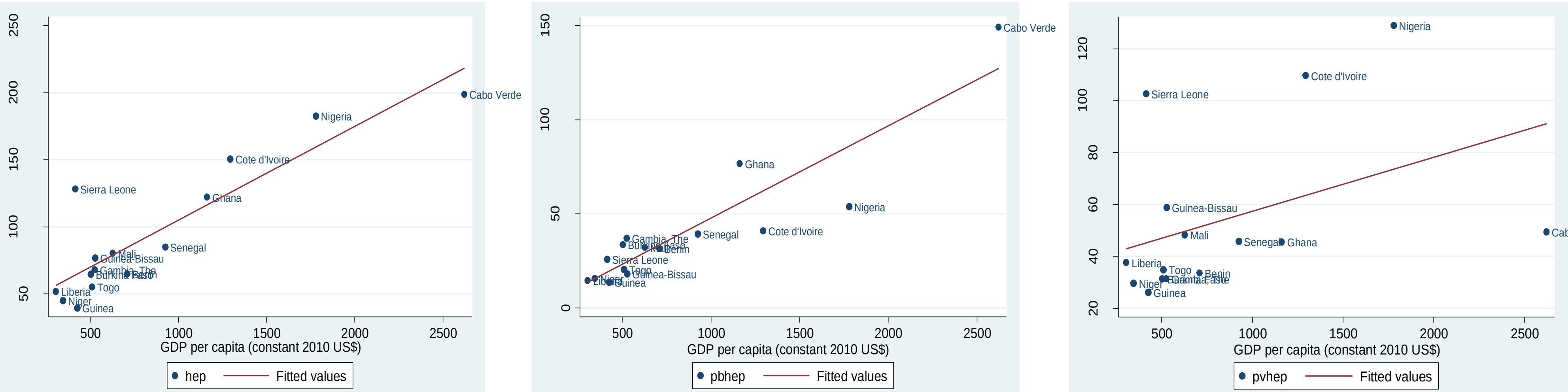

Figure 4a: Income per capita and national healthcare expenditure
Figure 4b: Income per capita and public healthcare expenditure
Figure 4c: Income per capita and private healthcare expenditure

Figure 4(a-c): Income per capita and healthcare expenditure (national, public and private) in ECOWAS

Figure 2 shows the time series plots of healthcare per capita and carbon emission per capita of ECOWAS. The time series plots of Benin, Burkina Faso, Cabo Verde, Gambia, Mali and Senegal depict upward trends thus implying that healthcare spending of these countries increases as environmental quality deteriorates. Also, the private healthcare spending per capita of ECOWAS countries like Cote d'Ivoire, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, and Sierra Leone were higher than the public healthcare spending over the periods. However, the healthcare expenditures of Ghana and Cabo Verde report contrary while, for countries like Benin, Burkina Faso, Gambia, Senegal, and Togo alternate within the period. The direction of the remaining eight countries is not clear enough as the trends indicate positive and negative movements. The scatter plots of the two main variables, environment pollution and healthcare expenditure of ECOWAS member states, were presented in Figures 3(a-c). Likewise, the scatter graphs of income per capita and healthcare expenditure per capita were depicted in Figures 4(a-c). The scatter plots all reported positive relationships.

Table 3: Correlation Matrix

	PBHEP	**PVHEP**	**CEM**	**PCI**	**ODA**	**FR**	**LE**	**PP65**	**INF**
HEP	0.860	0.834	0.543	0.772	0.242	-0.543	0.168	0.316	0.023
PBHEP	1	0.459	0.582	0.793	0.378	-0.631	0.493	0.453	-0.036
PVHEP		1	0.330	0.495	-0.047	-0.198	-0.265	-0.042	0.071
CEM			1	0.763	0.068	-0.700	0.450	0.456	0.047
PCI				1	0.110	-0.628	0.399	0.567	-0.008
ODA					1	-0.522	0.549	0.516	-0.184
FR						1	-0.641	-0.773	0.020
LE							1	0.570	-0.201
PP65								1	-0.009

Note: HEP is national healthcare expenditure; PBHEP is public healthcare expenditure; PVHEP is private healthcare expenditure; CEM is carbon emission per capita; PCI is per capita income; ODA is net official development assistance per capita; FR is fertility rate; LE is life expectancy; PP65 is population ages above 65 years to total; and INF is inflation rate.
Source: Authors' computation (2019).

Furthermore, the partial correlation coefficients of the series are presented in Table 3. It further confirms that there exists a direct relationship between environmental pollution, income and healthcare expenditure. This implies that people spend more on healthcare as the economic activities of these countries grow which also come with environmental cost. Likewise, income has a positive level of association with carbon emission. All other indicators have positive correlation coefficients with healthcare expenditure except fertility rate. However, private healthcare spending has a negative relationship with life expectancy and population of people above 65 years, while inflation rate has inverse relationship with public healthcare expenditure. The correlation matrix table also shows the correlation coefficients among the non-income determinants of healthcare expenditure at different magnitudes and degrees. The values of our coefficients revealed the absence of multicollinearity problem. However, the results are just preliminary analyses subject to confirmation in Section four after considering other determinants of healthcare expenditure.

Table 4: Correlation Coefficients of Dependent Variables and their first Lag

	HEP (-1)	PBHEP (-1)	PVHEP (-1)
National Healthcare Expenditure (HEP)	0.962		
Public Healthcare Expenditure (PBHEP)		0.975	
Private Healthcare Expenditure (PVHEP)			0.951

Source: Authors' computation (2019).

4.0 Estimation Techniques

This study employed the system generalized method of moments (GMM) developed by Arellano and Bond (1991) and Blundell and Bond (1998) to resolve the severe problem of a weak instrument of difference-GMM when the dependent variable is persistence. The correlation coefficients of per capita healthcare expenditure and their lagged variables are higher than the value of the rule of thumb (0.800). The correlation matrix results are presented in Table 4.The problem of weak instrument which characterize difference-GMM estimator renders its point estimates and hypothesis tests unreliable (Stock and Wright, 2000; Stock, Wright and Yogo, 2002; Che, Lu, Tao, and Wang, 2013). Studies such as Heid, Langer and Larch (2012), Che *et al.* (2013), and a host of others have confirmed the concern raised by Bond (2002) that system-GMM estimation always outperforms the difference GMM estimation. We confirm the validity of system GMM following Roodman (2009a) recommendation that the number of instruments should not be greater than the number of cross-sections. One of the requirements for employing the system GMM is that the number of observation (N) must be greater than the time (T). This condition is not meant in the case of this study. This we resolve by making a recourse to using two non-overlapping intervals.

For the diagnostic test, we test for the presence of first-order and second-order serial correlation of the error terms, whereas Hansen test is also used to check for orthogonality condition. Prior to estimating system GMM, we evaluate the parameter estimates of our variables using both the pooled ordinary least square (OLS) and panel fixed effects approaches as baseline models. We estimate the Hausman test to determine the suitability of either fixed or random effects models.

Table 5: Baseline Pooled Regression Results (Environmental Quality and Healthcare Expenditure)

Variables	**Dependent Variable:** Healthcare Expenditure											
	National Healthcare Expenditure				**Public Healthcare Expenditure**				**Private Healthcare Expenditure**			
CEM	-0.124***	0.006	-0.100***	-0.012	-0.098*	-0.109**	-0.065	-0.131***	-0.051	0.109**	-0.099**	0.087**
	(0.043)	(0.035)	(0.028)	(0.028)	(0.055)	(0.045)	(0.042)	(0.046)	(0.059)	(0.051)	(0.038)	(0.040)
PCI	0.836***	0.854***	1.067***	1.040***	1.064***	1.069***	1.278***	1.298***	0.604***	0.605***	0.880***	0.825***
	(0.055)	(0.051)	(0.048)	(0.050)	(0.064)	(0.062)	(0.075)	(0.074)	(0.075)	(0.067)	(0.060)	(0.061)
ODA	0.084***	0.203***	0.219***	0.284***	0.214***	0.196***	0.345***	0.295***	-0.017	0.152***	0.110***	0.248***
	(0.025)	(0.022)	(0.025)	(0.027)	(0.028)	(0.026)	(0.029)	(0.033)	(0.036)	(0.027)	(0.031)	(0.028)
FR	-0.095				-0.155				0.391			
	(0.171)				(0.198)				(0.248)			
INF	0.003	0.000	0.005**	0.002	0.001	0.002	0.003	0.004**	0.003	-0.002	0.005	0.000
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)
LE		-1.787***		-1.385***		0.551*		1.043***		-3.404***		-2.931***
		(0.192)		(0.192)		(0.285)		(0.329)		(0.239)		(0.200)
PP65			-0.403***	-0.339***			-0.368***	-0.416***			-0.536***	-0.401***
			(0.038)	(0.037)			(0.058)	(0.056)			(0.049)	(0.040)
Constant	-1.452**	5.169***	-2.377***	3.035***	-4.290***	-6.745***	-5.288***	-9.362***	-0.825	13.075***	-0.893**	10.556***
	(0.577)	(0.780)	(0.316)	(0.755)	(0.659)	(1.159)	(0.473)	(1.383)	(0.832)	(1.065)	(0.404)	(0.859)
Adj. R-squared	0.623	0.695	0.717	0.758	0.708	0.711	0.751	0.762	0.260	0.542	0.437	0.637
F-Stat	121.5***	178.1***	189.9***	164.2***	222.8***	216.8***	222.6***	192.2***	20.48***	77.85***	62.48***	89.92***
Observations	297	297	297	297	297	297	297	297	297	297	297	297

Note: HEP is national healthcare expenditure; PBHEP is public healthcare expenditure; PVHEP is private healthcare expenditure; CEM is carbon emission per capita; PCI is per capita income; ODA is net official development assistance per capita; FR is fertility rate; LE is life expectancy; PP65 is population ages above 65 years to total; and INF is inflation rate. Standard errors in parentheses; *, **, & *** signify significance level at 10%, 5% & 1% respectively. The significance of estimated coefficients and the Fisher statistics are in bold forms.
Source: Authors' computation (2019).

Table 6: Baseline Panel Fixed Effects Regression Results (Environmental Quality and Healthcare Expenditure)

Variables	**Dependent Variable:** Healthcare Expenditure											
	National Healthcare Expenditure				**Public Healthcare Expenditure**				**Private Healthcare Expenditure**			
CEM	0.084	**0.220*** **	**0.283*** **	**0.220*** **	**0.254** **	**0.326*** **	**0.414*** **	**0.326*** **	-0.024	**0.173*** **	**0.214*** **	**0.173*** **
	(0.068)	**(0.060)**	**(0.065)**	**(0.060)**	**(0.116)**	**(0.099)**	**(0.105)**	**(0.099)**	(0.061)	**(0.060)**	**(0.062)**	**(0.060)**
PCI	**0.507*** **	**0.538*** **	**0.904*** **	**0.563*** **	**0.524*** **	**0.389** **	**0.876*** **	**0.404** **	**0.438*** **	**0.626*** **	**0.872*** **	**0.651*** **
	(0.114)	**(0.105)**	**(0.110)**	**(0.110)**	**(0.193)**	**(0.174)**	**(0.178)**	**(0.182)**	**(0.102)**	**(0.106)**	**(0.105)**	**(0.110)**
ODA	**0.194*** **	**0.124*** **	**0.186*** **	**0.125*** **	**0.285*** **	**0.189*** **	**0.274*** **	**0.190*** **	**0.141*** **	**0.095*** **	**0.136*** **	**0.096*** **
	(0.023)	**(0.023)**	**(0.024)**	**(0.023)**	**(0.038)**	**(0.038)**	**(0.039)**	**(0.038)**	**(0.020)**	**(0.023)**	**(0.023)**	**(0.023)**
FR	**-1.490*** **				**-1.234*** **				**-1.724*** **			
	(0.209)				**(0.356)**				**(0.188)**			
INF	0.001	0.001	-0.0004	0.001	0.002	0.003	0.0005	0.003	0.002	0.001	-0.0002	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
LE		**2.395*** **		**2.296*** **		**3.235*** **		**3.175*** **		**1.586*** **		**1.487*** **
		(0.273)		**(0.299)**		**(0.452)**		**(0.496)**		**(0.274)**		**(0.300)**
PP65			**-0.278*** **	-0.057			**-0.340*** **	-0.035			**-0.201*** **	-0.058
			(0.071)	(0.070)			**(0.114)**	(0.117)			**(0.067)**	(0.071)
Constant	**2.973*** **	**-8.868*** **	**-0.964**	**-8.464*** **	1.330	**-12.359*** **	-1.742	**-12.113*** **	**3.308*** **	**-6.723*** **	**-1.459** **	**-6.314*** **
	(0.946)	**(1.089)**	**(0.765)**	**(1.199)**	(1.608)	**(1.806)**	(1.235)	**(1.990)**	**(0.847)**	**(1.095)**	**(0.728)**	**(1.205)**
Within R-squared	0.654	0.680	0.612	0.681	0.486	0.547	0.480	0.548	0.647	0.589	0.553	0.590
Hausman Test	**25.03*** **	**100.6*** **	**14.97** **	**82.42*** **	**16.08*** **	**25.30*** **	**12.44** **	**27.80*** **	**20.48*** **	**105.6*** **	**11.94** **	**77.23*** **
F-Stat	**104.73*** **	**117.7*** **	**87.5*** **	**98.04*** **	**52.41*** **	**67.01*** **	**51.22*** **	**55.67*** **	**101.4*** **	**79.27*** **	**68.59*** **	**66.09*** **
Number of country	15	15	15	15	15	15	15	15	15	15	15	15
Observations	297	297	297	297	297	297	297	297	297	297	297	297

Note:HEP is national healthcare expenditure; PBHEP is public healthcare expenditure; PVHEP is private healthcare expenditure; CEM is carbon emission per capita; PCI is per capita income; ODA is net official development assistance per capita; FR is fertility rate; LE is life expectancy; PP65 is population ages above 65 years to total; and INF is inflation rate. Standard errors in parentheses; *, **, & *** signify significance level at 10%, 5% & 1% respectively. The significance of the estimated coefficients, Fisher statistics and Hausman test are in bold forms.
Source: Authors' computation (2019).

5.0 Empirical Results and Discussion

5.1 Baseline Regression Results[7]

This section presents the baseline regression results using both pooled ordinary least square (OLS) and panel fixed effects that controlled for unobserved individual characteristics to examine the role of environmental quality on healthcare expenditure in ECOWAS. The results of the two estimation approaches are reported in Tables 5 and 6 respectively. We estimate three main sets of equations pertaining to each healthcare expenditure measure (national, public and private) in the table with each having four different specifications. This is done in order to avoid the spurious estimates since each healthcare expenditure measure seems to be highly correlated as indicated in Table 3. As a result, each table has twelve columns in total indicating twelve main specifications. It is equally worth stating that the Hausmann test results validate the appropriateness of the panel fixed effect over random effects model as depicted in Table 6. Based on values of the calculated Chi-square, the outcomes do not reject the alternative hypotheses for all the models at 5% significant level.

The results of our parameter estimates, from the two baseline estimators, are inconsistent in terms of directions, magnitudes as well as in their levels of statistical significance. The results of our pooled OLS revealed that: (a) on the average, environmental quality has an inverse relationship with healthcare expenditure. (b) per capita income and official development assistance are significant predictors of healthcare; and (c) life expectancy and population ages 65 and above are negatively related with healthcare spending. Owing to the inherent weaknesses associated with the pooled OLS, we particularly tend to focus on interpreting panel fixed effects' results as thus: (a) a direct relationship exists between environmental quality and healthcare expenses; (b) income and official development assistance equally enhance healthcare spending positively; (c) healthcare expenses are positively influenced by the average number of years' people in the region are expected to live, while

[7] Time was not spent much in discussing the results because of the inherent problems of the methods.

negatively influenced by population whose age bracket lies between 65 and above. Just like the pooled OLS, we equally rely on discussing the results of the system GMM due to inherent limitation of the fixed effects model. We therefor deploy a system of generalized method of moments to deal with the potential endogeneity issues by: (a) taking into account the time invariant omitted variables by accounting for the unobserved heterogeneity and cross sectional dependence; and (b) ensuring reverse causation or simultaneity through the instrumentation process. The result of the system GMM is discussed in the succeeding sub-section.

Table 7: System Generalized Method of Moments Results (Environmental Quality and Healthcare Expenditure)

	Dependent Variable: Healthcare Expenditure											
Variables	**National Healthcare Expenditure**				**Public Healthcare Expenditure**				**Private Healthcare Expenditure**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
HEP(-1)	**0.743*****	**0.777*****	**0.719*****	**0.760*****								
	(0.017)	**(0.019)**	**(0.015)**	**(0.024)**								
PBHEP(-1)					**0.734*****	**0.704*****	**0.858*****	**0.799*****				
					(0.052)	**(0.034)**	**(0.058)**	**(0.076)**				
PVHEP(-1)									**0.812*****	**0.887*****	**0.800*****	**0.806*****
									(0.028)	**(0.022)**	**(0.061)**	**(0.023)**
CEM	**-0.204****	**0.162***	**0.438****	**0.333****	**0.371*****	**0.314*****	**0.528*****	**0.367***	**-0.262*****	-0.055	0.0501	2.856
	(0.104)	**(0.982)**	**(0.208)**	**(0.161)**	**(0.098)**	**(0.089)**	**(0.152)**	**(0.178)**	**(0.0394)**	(0.095)	(0.184)	(11.137)
PCI	**0.246*****	**0.248****	**0.114*****	**0.109***	**0.088*****	**0.128***	-0.111	-0.094	**0.177****	**0.392*****	**0.410*****	**0.389*****
	(0.094)	**(0.105)**	**(0.054)**	**(0.057)**	**(0.024)**	**(0.074)**	(0.097)	(0.079)	**(0.078)**	**(0.115)**	**(0.102)**	**(0.123)**
ODA	0.007	**0.047*****	**0.056*****	**0.059*****	**0.045*****	**0.022****	**0.032****	**0.028***	-0.004	**0.037*****	**0.032*****	**0.038*****
	(0.010)	**(0.011)**	**(0.007)**	**(0.017)**	**(0.009)**	**(0.011)**	**(0.015)**	**(0.015)**	(0.009)	**(0.003)**	**(0.008)**	**(0.005)**
FR	**-0.122*****				0.480				**-0.078*****			
	(0.039)				(2.124)				**(0.023)**			
INF	-0.174	**-0.414****	**-0.421****	**-0.429****	-0.177	-0.237	-0.267	-0.228	-0.121	**-0.382*****	**-0.187****	**-0.405****
	(0.099)	**(0.153)**	**(0.183)**	**(0.171)**	(0.106)	(0.157)	(0.161)	(0.165)	(0.082)	**(0.124)**	**(0.066)**	**(0.183)**
LE		**0.699****		0.208		**0.713*****		**0.428***		-0.184		-0.070
		(0.301)		(0.336)		**(0.181)**		**(0.229)**		(0.146)		(0.215)
PP65			**-0.072****	-0.0405			**0.0933*****	0.0579			**-0.1088****	**-0.0857*****
			(0.026)	(0.0487)			**(0.0259)**	(0.0333)			**(0.0488)**	**(0.0197)**
Constant	**9.009*****	-2.348	**2.605*****	0.944	-0.503	**-3.665*****	**-2.379*****	**-3.582*****	**5.933*****	**1.703****	**3.475****	**3.436*****
	(2.450)	(1.404)	**(0.558)**	(2.191)	(1.345)	**(0.888)**	**(0.708)**	**(0.776)**	**(1.512)**	**(0.708)**	**(1.351)**	**(0.069)**
AR(1)	(0.007)	(0.006)	(0.005)	(0.012)	(0.0001)	(0.001)	(0.002)	(0.001)	(0.006)	(0.005)	(0.009)	(0.008)
AR(2)	**(0.433)**	**(0.380)**	**(0.373)**	**(0.376)**	**(0.136)**	**(0.142)**	**(0.224)**	**(0.166)**	**(0.591)**	**(0.723)**	**(0.836)**	**(0.746)**
Sargan OIR	**(0.264)**	**(0.273)**	**(0.278)**	**(0.273)**	**(0.153)**	**(0.152)**	**(0.160)**	**(0.147)**	**(0.277)**	**(0.274)**	**(0.294)**	**(0.287)**
Hansen OIR	**(0.975)**	**(0.940)**	**(0.977)**	**(0.996)**	**(0.903)**	**(0.941)**	**(0.977)**	**(0.998)**	**(0.962)**	**(0.902)**	**(0.948)**	**(0.998)**
DHT for instruments												
(a) Instruments in levels												

H Excluding group	**(0.240)**	**(0.104)**	**(0.348)**	**(0.224)**	**(0.610)**	**(0.349)**	**(0.550)**	**(0.321)**	**(0.589)**	**(0.375)**	**(0.460)**	**(0.300)**
Diff(null, H=exogenous)	**(1.000)**	**(1.000)**	**(1.000)**	**(1.000)**	**(0.904)**	**(0.997)**	**(0.996)**	**(1.000)**	**(0.981)**	**(0.981)**	**(0.990)**	**(1.000)**
(b) IV(years, eq (diff))												
H Excluding group	**(0.953)**	**(0.952)**	**(0.958)**	**(0.994)**	**(0.928)**	**(0.928)**	**(0.964)**	**(0.993)**	**(0.948)**	**(0.848)**	**(0.924)**	**(0.981)**
Diff(null, H=exogenous)	**(1.000)**	**(1.000)**	**(1.000)**	**(0.770)**	**(0.240)**	**(0.559)**	**(1.000)**	**(1.000)**	**(0.659)**	**(1.000)**	**(1.000)**	**(1.000)**
Fishers test	**2389.8*** **	**734.3*** **	**1284.8*** **	**360.4*** **	**1758.6*** **	**3502.4*** **	**1858.6*** **	**2512.2*** **	**295.3*** **	**3119.2*** **	**433.9*** **	**2264.8*** **
Instruments	11	11	11	13	11	11	11	13	11	11	11	13
Countries	15	15	15	15	15	15	15	15	15	15	15	15
Observations	134	134	134	134	134	134	134	134	134	134	134	134

Note: HEP is national healthcare expenditure; PBHEP is public healthcare expenditure; PVHEP is private healthcare expenditure; CEM is carbon emission per capita; PCI is per capita income; ODA is net official development assistance per capita; FR is fertility rate; LE is life expectancy; PP65 is population ages above 65 years to total; and INF is inflation rate. The bolded values signify significance of (a) estimated parameters and F-statistics and (b) failure to reject the null hypotheses of: (i) no autocorrelation in the AR(1) & AR(2) tests and; (ii) the validity of the instruments in the Sargan OIR test.

Source: Authors' computation (2019).

5.2 Empirical Discussion of the System GMM Results

In this sub-section, the results of the parameter estimates using system generalized method of moments are reported in Table 7. Our findings are discussed as follows. First, the positive values on the coefficient of carbon emission are significant at 5% conventional level for healthcare spending measures except for the private sector. These are consistent with Narayan and Narayan (2008), Yahaya *et al*. (2016), and Yazdi and Khanalizadeh (2017) for 8 OECD countries, 125 developing countries, and 11 MENA countries respectively. This intuitively suggests that poor environmental quality has capacity of inducing an increase in healthcare spending. That is, environmental degradation tends to increase expenditure on healthcare services. Also, the magnitude of impacts, given the values on the coefficients of the carbon emissions, appears to be higher for public healthcare expenditure as compared to the national healthcare spending. The values ranging between 0.16%–0.33% and 0.31%–0.53% in both national and public healthcare expenditure. However, the coefficients on carbon emission under private healthcare expenditure model are not significant and inconsistently signed. The implication is that the people are not likely to increase their expenditure on healthcare as a result of an increase in carbon emission. This can possibly be associated with low level of income which most often require to cater for other pressing basic needs. Overall, it implies that the economic cost of ensuring sustainable development and quality healthy living come at the instance of government than the private individuals. Summarily, healthcare facilities need public sector involvement for citizens to enjoy better services.

Second, the coefficients on income per capita variable are found to be positive, significant and consistent with theoretical expectation. The economic implication is that as economy continues to grow with resultant increase in income for the people, there is a high likelihood that healthcare spending by both public and private sectors will increase. It thus simply means that as the economy grows, healthcare expenditure also increases. This is finding aligns with such studies like Narayan and Narayan (2008), Zheng *et al*. (2010), Boachie *et al.* (2014), Odusanya *et al.* (2014), Yahaya *et al*. (2016) and Yazdi and Khanalizadeh (2017) that are able to establish direct relationship between income and healthcare expenses. The positive evidence between per capita income and healthcare expenditure per capita shows that healthcare spending is a necessity good, and not a luxury commodity. For example, the results show that a 1% increase in per capita income growth will lead to about 0.047% – 0.059%, 0.022%–0.032%, and 0.18%–0.41% increase in national, public and private healthcare expenditure respectively. However, in a situation where the coefficients on healthcare spending are found to be inferior particularly under the public sector, the level of statistical irrelevance becomes notable. The magnitude of the parameter estimates indicating a necessity good goes contrary to the findings of Narayan and Narayan (2008) and Odusanya *et al.* (2014). However, the result supports the empirical submission of Boachie *et al.* (2014), Yahaya *et al*. (2016) and Yazdi and Khanalizadeh (2017). Being a necessity commodity, thus suggesting that the crave for government involvement in healthcare delivery services regardless of socio-cultural beliefs, status, race, and ethnic society.

Third, the per capita official development assistance (ODA) exerts a positive and statistically significant impact on healthcare spending per capita except for columns 1 and 9 that are statistically insignificant. It implies that funds obtained from international donors go a long way in providing healthcare services in the region. Also, the active commitment of international donors to make funds available plays a vital role in per capita health spending and making healthcare services accessible. In terms of statistical magnitude, a 1% change in ODA per capita leads to 0.049%–0.059%, 0.22%–0.45% and 0.032%–0.038%increase in per capita national, public and private healthcare expenditures, respectively.

Fourth, the result equally establishes that fertility rate has a negative and statistically significant impact on national and private healthcare expenditure, whereas, the positive relationship between fertility rate and public healthcare spending are statistically insignificant. The economic implication is that as fertility rate increases, per capita private and national healthcare spending decreases. It can thus be interpreted for the former that households have lesser money to spend on health as birth rate increases thus indicating that the family budgets may be used for other domestic expenses like food, clothing, and shelter, etc. For the public healthcare spending, the healthcare facilities seem inadequate. Hence are seen to be inadequate for fertility issue. This outcome may possibly explain why the national healthcare expenditure is insufficient.

Fifth, the coefficients on life expectancy carry positive signs for both national and public healthcare spending while showing a negative and mixed sign for private healthcare spending. The positive signs of life expectancy corroborate the findings of Boachie *et al.* (2014). This further buttress the importance of public resources most especially on healthcare services toward improving human longevity. Also, the parameter estimates of the population percentage of people above 65 years are negative and significant for private healthcare expenses but positive for public healthcare spending. It implies that private healthcare expenditure does not increase with the population growth of old people above 65 years. This might be as a result of low life expectancy of people in the region which lies below 65 years of age. The coefficients of inflation rate are negative across board but found to be significant at 5% level for private and national healthcare expenditures. The implication is that high inflation rate in the region has a sizeable impact on healthcare spending as it reduces the purchasing power of the people's income.

Finally, all the diagnostic results are satisfactory, implying that the system generalized method (GMM) of moments approach is appropriate and the empirical models are well specified. Specifically, the p-value of AR(2) indicates that there is no problem of second-order serial correlation and the validity of the instruments is confirmed as the number is lesser than the cross-sections. Nonetheless, the highly persistence rate of healthcare expenditure are confirmed as its parameter estimates of lagged one are significant at the conventional level.

6.0 Conclusion and Policy Options

This study investigates the impact of environmental quality on healthcare expenditure for 15 ECOWAS countries for a period of 20 years (1995-2014). The ECOWAS countries considered include are Benin, Burkina Faso, Cabo Verde, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo respectively. The novelty of our study stems from adoption of three surrogates for measuring healthcare spending namely national, public and private. This aside the study equally employs both income and non-income factors drivers of healthcare spending. The carbon (CO_2) emission is used to proxy environmental quality, while income measure is real per capita income and other non-income factors are fertility rate, life expectancy, people with ages 65 and above, foreign aids and inflation rate, respectively

The findings suggest that carbon emission only had an inelastic and statistically significant positive impact on both public and national healthcare expenditure. This suggests that environmental damages caused by pollution are responsible for the increasing share of public and national healthcare spending in GDP in the region. It means that if the situation should continue, funding of other key sectors like education and to maintain environmental quality might be a challenge to the government. Hence, efforts should be intensified at reducing environmental degradation by introducing carbon-free technology equipment, healthcare spending of those affected by deteriorating environmental quality and future pressure on government budgets. The positive inelasticity of income suggests that health is a necessity commodity that requires public involvement for quality and affordable healthcare services. It further implies that the countries achieved economic growth at the expense of environmental degradation, thereby increasing pollution-induced health diseases including early death. Therefore, the policies that aim at ensuring healthy environment in the ECOWAS region would be very beneficial to human welfare and government investment in the health sector.

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