CARBON ACCOUNTING AND ECONOMIC DEVELOPMENT IN SUB-SAHARAN AFRICA

Abstract

This study examined the impact of carbon accounting on economic development in Sub-Saharan Africa (SSA). This study made use of secondary data, which was analysed using Panel General Method of Means (GMM) as well as other econometric tests. The research findings show that carbon accounting had a significant impact of economic development in Sub-Saharan Africa. In addition, it was revealed that with the introduction of environmental tax on emissions, carbon emissions (CO_2) had a negative and significant impact of economic development in SSA. This study recommended that Governments should aid companies who are evidently reducing their carbon levels with environmental tax-free periods as long as they can maintain their reduction in emission levels. This would aid these companies to produce more, which would thereby lead to more economic development.

Key words: Carbon Accounting; Economic Development; Carbon Emissions; SSA; Gross Domestic Product

1.0 Introduction

According to Global Accountant Bodies, accounting professionals will play a major role in both climate change mitigation and adaptation at individual companies, enterprises, and the larger (national) economy (2020). At the beginning of the 1960s and 1970s, there was a desire to consider the natural environment in accounting choices that led to environmental accounting (Brandao, Levasseur, Kirschbaum, Weidema, Cowie, Jorgensen, Hauschild, Pennington & Chomkhamsri, 2013). Dating back to the late 1980s and 1990s, Brander (2017) contended for the inclusion of social and environmental elements of accounting, such as waste as well as energy management systems, compliance as well as ethical audits, social and environmental reporting, environmental accounting, as well as environmental assessment.

Throughout the last six decades, Sub-Saharan Africa's development experiences has been uneven, cyclical, but intermittent, but that has trailed behind the entire globe until lately (Olu & Afeikhena, 2015). This contrasts sharply with the developed world, where per capita income has more than doubled but also, in even the most productive developing nations, steadily increasing four times or even more (Olu & Afeikhena, 2015). Furthermore, Africa seems to be the only part in the globe wherein poverty has increased throughout the last 40 years, in sharp contrast to the enormous improvements made in the alleviation of poverty worldwide, notably in Asia (Olu & Afeikhena, 2015). With the emerging conflict amid economic development and sustainable environmental conservation, the subject of carbon emissions (CO_2) has drawn increasing debates from nations (Saidi & Hammami, 2015).

The use of fossil energy has a significant impact on climate change (Huxster, UribeZarain, & Kempton, 2015), owing to the carbon dioxide (CO_2) emissions linked with their usage accounting for around 75% of global emissions. Thus according to Simplice (2017), Africa is expected to bear the brunt of the harmful repercussions of climate change. Sub-Saharan

Africa has become the world's poorest area as a result of periods of economic instability and deteriorating standard of living. Notwithstanding the area's recovery since the late 1990s, with per capita income growth rates outperforming those of affluent nations for the very first time in several years, top development and policy watchers are proposing a "major push" to assist the continent overcome poverty and reclaim lost market share in comparison to the rest of Africa. These appeals suggest a wide range of corrective policy objectives.

Accounting-society researchers believe that accounting is essential not just to one organization, but also to social processes in general (Ben-Amar & McIlkenny, 2015). There has been some discussion on the necessity to develop accounting rules that address and acknowledge climate change, as well as account for greenhouse gases. As a consequence, empirical research on climate change accounting has not yielded clear-cut conclusions. When an empirical research ends with normative recommendations for practice, for example, or when a critical article uses empirical review (Feifei, Dai & Xiaohua, 2017). Nonetheless, their results may be helpful in the social and environmental accounting (SEA) field.

With the introduction of carbon accounting, the implementation of a carbon tax, which is a price placed on carbon emissions, has not been well researched and effectively managed, particularly in developing countries. In addition, an empirical study capturing the controlling effect of environmental tax on the impact of carbon emission on economic development has not been recorded yet in Sub-Saharan Africa which was adequately captured by Frank, Havlik, Valin, Wollenberg, Hasegawa and Obersteiner (2017). According to Corkery (2009), one best strategy to regulate carbon dioxide and other greenhouse atmospheric gases, which has a significant influence on economic development, is to impose a carbon price.

As a result, there is a need to investigate the effect of carbon accounting on economic development in Sub-Saharan Africa.

2.0 Literature Review

2.1 Conceptual Review

2.1.1 Economic Development

Economic development is a policy intervention aimed at improving people's socioeconomic well-being (Salmon Valley Business Innovation Centre, 2014). It is indeed focused on enhancing people's lives, introducing innovative product and services utilizing contemporary technology, risk reduction, and innovation and entrepreneurial dynamics (Hadjimichael, Kemenyy & Lanahan, 2014). According to Bernard (2009), economic development may result in a rise in societal wellbeing as a consequence of the government's, private sector's, as well as society's coordinated and planned efforts. Economic development can be characterized as a long-term effort by a community to enhance the local economy and quality of life through increasing the area’s ability to adapt to economic change (Otekunrin, Kenechukwu, Eluyela, John & Ibrahim, 2022).

Statistical indicators such as GDP per capita (per person), health outcomes, literacy rate, and so on are used to assess a country's progress (Zehri & Abdelbaki, 2013). Depending on what type of economic system adopted, the degree and amount of income, the degree of government help and meddling, and the degree of export, economic development may indeed be achieved through a number of economic strategies. Each one of these variables might have a distinct influence on sustainable development.

Nevertheless, there is broad consensus that sustainable development aims to achieve economic, social, as well as environmental goals, and also that development should indeed be

promoted more sustainably in all three aspects (Munasinghe, 2001). The importance of sustainable development cannot be overemphasized because sustainability is involved with every aspect of business environment, including the economic, social and utilization of resources by the organizations (Adams, Thornton & Sepehri, 2012). Although sustainability has many faces, the main idea is that resources should be used in ways that will not reduce them. Resources such as wildlife should be conserved in a way that future generations will enjoy their lifestyles at least as happy and healthy as the present generations or perhaps better.

According to Ekanem, Nwachukwu and Etuk (2014), the primary aim of sustainable development is on human capital development, economic empowerment, basic services, healthy living as well as to leverage the resources organizations can give and empower the societies in taking the lead on issues for their development. Brundtland report of United Nations, opined that sustainable development is the 'development that enables the needs of the present generation without hindering the future generation in meeting their needs' (Mitchel, 2002). One of the major important questions in environmental studies is how we can ensure the improvements in human welfare within the limits of the earth natural resources.

2.1.2 Carbon Accounting

Carbon accounting is a term used in accounting firms to refer to the debate of incorporating elements of climate change mitigation into accounting (KPMG, 2008; Stechemesser & Guenther, 2012). Carbon accounting entails standardized methods for tracking emissions and assessing the efficacy of climate mitigation measures by describing their outcomes in terms of a common unit (Backstrand & Lovbrand, 2015). Accounting, in its most basic form, monitors the inventories and flows of a certain unit. All must be rendered equal in order for accounting to function by expressing them in standardized quantitative units (Backstrand & Lovbrand, 2015).

Carbon accounting is recognizing, monetary and non-monetary evaluation and monitoring of greenhouse gases at each level of the value chain and recognizing, evaluating and monitoring the impact of gas emission on the ecosystem of the carbon cycle (Stechemesser & Guenther, 2012). Accounting is often done in monetary terms, but it may also be done in other measures, such as carbon dioxide equivalents. Much of the criticism leveled at carbon markets is not so much about the idea of putting a monetary value on carbon as it is about whether it is better to control greenhouse gas emissions by setting emission standards (and then allowing trading, a process known as "cap and trade") or by charging the appropriate pollution taxes (Parry, Dirk, Shanjun & Eliza, 2014).

While accounting is most often linked with economics, families, or businesses, it is increasingly being used to nature and the environment. Ong, Kasbun, Teh, Muhammad and Javeed (2021) defines carbon accounting as "a system that uses accounting methods and procedures to collect, record, and analyze climate change–related information and account for

and report carbon-related assets, liabilities, expenses, and income to inform the decision-making processes of internal managers and external stakeholders" (Ong, Kasbun, Teh, Muhammad & Javeed, 2021)

Hespenheide et al. (2010) provide a wide definition of 'carbon accounting,' indicating the measurement of emissions and removals on the one hand and the financial consequences on the other. This definition includes both non-monetary and monetary elements from an organizational standpoint, and it also describes the internal and external applications of carbon accounting. Carbon accounting is a phrase that is often used by scientists across fields, and it is especially prevalent in debates about the incorporation of climate-related elements into accounting. However, there is no agreed-upon definition of carbon accounting. Carbon accounting is often demonstrated by accounting for emissions but not for "prevented" emissions (Gibassier & Schaltegger, 2015).

At the market level, carbon accounting literature has increasingly enlisted accounting as a method of resolving the market's CO_2 emissions issues (MacKenzie, 2009; Callon, 2009). Accounting is seen as a method for creating pricing, thus contributing to the development of a market for CO_2 emissions. This interest is reasonable given that markets are hotspots for a number of issues, including global warming (Mirowski, 2013). They are areas of worry; that is, they indicate things that must be questioned (Geiger et al., 2014).

2.2 Theoretical Review

Epistemic Communities

Haas (1992) developed the concept of an epistemic community, which refers to a knowledge-based international community of experts, specifically a "... network of professionals with recognized expertise and competence in a particular domain and an authoritative claim to policy-relevant knowledge within that domain or issue area" (Haas, 1992). According to Peter Haas, epistemic communities (EC) have the following characteristics: shared sets of causal and principled beliefs, a consensual knowledge base, and a shared policy enterprise (Haas, 2015).

This knowledge is often the consequence of complicated technological problems and the necessity for cohesive answers to political concerns that are frequently beyond of politicians' intellectual reach. What may be effectively applied to the situation of carbon accounting is the concept of shared ideas and values that unite a group of specialists on a specific policy problem, as stated by Haas and others (Gough & Shackley 2001). As a result, an epistemic community approach focuses our attention to accountants' professional culture and training, as well as the connections between this culture and competence and their views about how to mitigate climate change, which are then reflected in specific policy recommendations. Furthermore, accountants have framed climate change in such a way that their own expertise and knowledge (in calculation, measurement, and so on) are highly relevant to policy solutions, contributing to a broader framing of the issue as a matter of reshaping and extending market processes and existing corporate reporting procedures (and not radically altering or disrupting those processes and procedures).'

2.3 Empirical Review of Literature

Rajeshwar (2021) study tries to analyze the association between GDP per capita, FDI, population, trade openness and CO_2 emissions in India. Using ARDL, the results show that in

the long run, GDP per capita and FDI has a positive impact on CO_2 emissions; whereas in the short run, FDI, GDP per capita and trade openness appears to have a positive and significant impact on CO_2 emissions.

Wahyu, et al (2021) study aimed to determine the effect of CO_2 emissions, energy consumption, and coal use on per capita economic growth in Indonesia. Secondary data used are time series sourced from the World Bank, the Central Bureau of Statistics, and related agencies during the period 1985 to 2019. The analytical tool used in this study is multiple linear regression based on Ordinary Least Square (OLS) along with statistical tests and Classical Assumption Test. The estimation results conducted show that the CO_2 emission variable has a significant effect and has a positive relationship to Gross Domestic Product (GDP) per capita in Indonesia

Svetlana and Boidurjo (2021) research examined the relationship between economic growth and CO_2 emissions in 17 West African countries and whether economic growth and pollution have a linear or U-inverted relationship between 2010-2019. The research uses a two-step GMM estimation method for empirical estimation of regression CO_2 emissions on the variable of interest economic growth defined as GDP per capita and other macroeconomic variables. From the empirical estimation, it was found that there is a positive linear relationship between them in West Africa between 2010-2019.

Mahmoud, Walid, and Damien (2020) investigated the connection between environmental levies and the pace of economic growth. The study also looks at whether this connection varies across countries that have adopted environmental tax reforms (ETRs) and those that have not. The paper finds that when we allow environmentally related tax revenues to interact with an initial level of real GDP per capita, the overall revenues of these taxes are negatively associated with the economic growth rate in the short and long term, using panel data from 31 OECD countries from 1994 to 2013. Furthermore, we demonstrate that the higher the starting level of GDP per capita, the more environmentally linked tax revenues may boost the pace of economic development

Cederborg and Snöbohm (2016) examined the relationship between per capita GDP and per capita emissions of the greenhouse gas carbon dioxide ($CO2$) in order to observe the possible influence of economic growth on environmental degradation. The study was conducted on 69 industrial countries as well as 45 poor countries using cross-sectional data. The empirical result of the cross-sectional study implies there is in fact a relationship between per capita GDP and per capita carbon dioxide emissions. The correlation is positive, which suggests growing per capita GDP leads to increasing carbon dioxide emissions.

3.0 Methodology

This study examined the impact of carbon accounting on economic development in SSA. It adopted the Ex-post facto research design which examines data from past events and they cannot be easily manipulated. The study made use of secondary data which was sourced from the world development indicator (WDI) database. Pearson's product moment correlation was employed to examine the degree of association amid carbon emissions and per capita gross domestic product as well as to determine the existence of multicollinearity problem among the explanatory variables.

The General Method of Moments (GMM) estimate method was adopted for this study. The Ordinary Least Squares (OLS) estimating method has a significant difficulty in that it fails to address the endogeneity problem of the independent variables caused by correlation between the delayed dependent component and the residuals. The Least Square Dummy Variable

(LSDV) model combined with the lagged dependent variable offers response from past or current shocks to the present dependent variable. This requirement is handled in Arellano and Bond's (1991) and Arellano and Bover's (1992) Generalized Method of Moments (GMM) approach (1995).

This dynamic approach handles temporal auto-correlation in the error term, preventing false regression. The GMM approach, which, when compared to the OLS method, would address endogeneity and heteroskedasticity issues and enhance estimator performance in a panel model (Headey, 2013). Furthermore, the robust version of the System-GMM (SYS-GMM) estimating model modified by Blundell and Bond (1998) was used in this research, which is an improvement on the GMM method due to the inclusion of the instrumental variables (IV), which is why we chose the model. The population of this study is the 48 countries in Sub-Sahara Africa. However, the convenient sampling technique was adopted based on data availability. Using the convenient sampling technique, a total of 22 countries in SSA where selected.

3.1 Model Specifications

The econometric model used to analyse the impact of carbon accounting on economic development in SSA is as follows:

In order to analyze the research objective of this study, the model of Oguntegbe, Okoruwa, Obi-Egbedi and Olagunju (2018) is adapted and expressed below:

$$EDEVT = \beta_{oit} + \Omega EDEVT_{it-1} + \beta_1 C0_{2it} + \beta_2 ENVTAX_{it} + Uit \ldots\ldots\ldots\ldots\ldots (1)$$

Where

EDEVT= Economic Development

ENVTAX= Environmental Tax

CO_2 = Carbon emission

Ω is the coefficient of the first-lag of the dependent variables in equation

Ut = Error term

3.2 Description and Measurement of Variables

Dependent Variable (Economic Development)

This is measured based on **Gross Domestic product per Capita** calculate by using gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products.

Independent Variable

Carbon Emission (CO_2)

CO_2 emissions in Metric tons (WDI 2021)

Environmental taxes

International organizations define environmental tax as “a tax whose tax base is a physical unit (or a proxy of it) that has a proven specific negative impact on the environment” (United Nations, 2003). The measurement of environmental tax used in this study is established by the United Nations description, which is recognised by the major international organizations, including the OECD as well as the European Union's Statistical Office (Eurostat). The OECD figures on environmental tax revenue include taxes on energy items such as fossil fuels, electricity, including transportation fuel (petrol and diesel). Most CO2-related taxes are included.

4.0 Data Analysis and Interpretations

Table 1: Descriptive Statistics

	GDPPC	CO_2	ENVTAX
Mean	5410.089	31.52057	1.071212
Median	3539.450	4.042850	0.760000
Maximum	22989.30	481.8847	12.39000
Minimum	1017.500	0.487310	0.000000
Std. Dev.	5108.102	98.62829	1.561095
Skewness	1.636765	3.965152	4.243839
Kurtosis	4.893564	17.51889	27.89833
Jarque-Bera	117.9880	2257.924	5708.730
Probability	0.000000	0.000000	0.000000
Sum	1071198.	6241.073	212.1000
Sum Sq. Dev.	5.14E+09	1916325.	480.0923
Observations	198	198	198

***Source**: Authors Computation (2022)*

From table 4.1 above, GDPPC has a mean value of 5410.089, with a maximum and minimum value of 22989.30 and 1017.500 respectively. The standard deviation of GDPPC is 5108.102. Furthermore, the mean value for carbon emission (CO_2) is 31.52057, with a maximum and minimum value of 481.8847 and 0.487310 respectively. The standard deviation of 8.272899

which is high indicates that CO_2 has been relatively unstable over the period in view i.e. 2011 to 2019 in SSA.

Also, ENVTAX has a mean value of 1.071212, with a maximum and minimum value of 12.39000 and 0.000000 respectively. The standard deviation of ENVTAX is 1.561095.

Skewness is a statistical analysis that is employed to measure the departure from symmetry. A distribution or data set is said to be symmetric if it is spread out evenly to the left and right of the center point; in such an instance, skewness is zero. Positive values for skewness indicate data that are skewed right or positively skewed, while negative values indicate data that are skewed left or negatively skewed (Gujarati, 2003). From the table above however, GDPPC, CO_2 (3.965152) and ENVTAX (4.243839) are positively skewed.

Finally, the Jarque-Bera statistics rejected the null hypothesis of normal distribution for all variables at 5% critical value. This depicts that most of our variables are not normally distributed.

Table 2 Correlation Analysis

	GDPPC	CO_2	ENVTAX
GDPPC	1.000000	0.339787	0.130078
CO2	0.339787	1.000000	0.075519
ENVTAX	0.130078	0.075519	1.000000

Source: *Author's Computations (2021)*

Table 2 above shows the result of the correlation analysis. The reason for the correlation analysis is to check for multicollinearity between the independent variables. There is no problem of multicollinearity since the correlation coefficients of all the variables are lower than the recommended threshold of more than 0.8. As a rule of thumb, Gujarati (2004) suggested that if the correlation > 0.8 then severe multicollinearity may be present.

Table 3: Carbon Emissions, Environment Tax and GDPPC in sub-Saharan Africa

	(1)
GDPPC (-1)	1.034***
	(0.0195)
CO_2	-0.000203***
	(4.88e-05)
Environment Tax	-0.00134**
	(0.000523)
Constant	-0.107
	(0.0698)
AR(1)_P-value	0.258
AR(2)_P-value	0.0966
Sargan Prob	0.000263
Hansen Prob	0.0821

DHT for Instruments	
(a) Instruments in levels	
H excluding group	0.396
Dif (null, H=exogenous)	0.056
(b) IV (years, eq(diff))	
H excluding group	--
Dif(null, H=exogenous)	0.082
No. of Instruments	18
Countries	22
Observations	176

****, **, *: significance levels at 1%, 5% and 10% respectively. The difference in Hansen Test for Exogeneity of Instruments Subsets. Dif: Difference. OIR: Over-identifying Restrictions Test. The significance of bold values is twofold. 1) The significance of estimated coefficients and the Wald statistics. 2) The failure to reject the null hypotheses of: a) no autocorrelation in the AR(1) & AR(2) tests and; b) the validity of the instruments in the Sargan and Hansen tests. Constants are included in all regressions. ( ) for standard errors of estimated coefficients and [ ] for p-values of all other tests.*

From table, when controlled by environmental tax, the coefficient of $C0_2$ is **-0.000203***** with p-value < 5% significance level. This indicates that there exists a negative and significant relationship between Carbon emission ($C0_2$) and per capita gross domestic product (economic development) in sub-Saharan Africa. The value of the coefficient implies that a percentage increase in Carbon emission ($C0_2$) will cause the dependent variable (economic development) to decrease by 0.02% in the short-run ceteris paribus and vice-versa.

From the Sargan test, it can be seen that the probability value was greater than 5%, so we accept the H_0 that all instruments are valid (Goodman, 2009). Further, the null hypothesis of the first order autocorrelation test is rejected which is not the case for the null hypothesis of the second order autocorrelation test of residuals. This implies that the errors are not correlated over time and hence the consistency of the dynamic GMM estimator. However, according to Roodman (2006), it is recommended that the Sargan P-value should be greater than 0.25. Also, the Hansen test shows P-value greater than 5% meaning that endogeneity is not a significant issue in this regression. Furthermore, the AR(2) P-value are all greater than 5% which means there is absence of second order autocorrelation of errors.

From the Two Step System GMM Result presented in table above, it is evidenced that there exists negative and significant relationship between carbon emissions (CO_2) and economic development (per capita GDP) in sub-Saharan Africa. The value of the coefficient implies that a percentage increase in CO_2 when controlled by environmental tax will cause the dependent variable (economic development) to decrease by 0.02% in the short-run ceteris paribus and vice-versa. From the P-value greater less than 1% level of significance, we accept the alternative hypothesis and reject the null hypothesis which says there is a significant effect of carbon emissions on economic development in sub-Saharan Africa. This mean that with the adoption of environmental tax (carbon tax) in Sub-Saharan Africa, there would be a negative impact of carbon emissions on per capita gross domestic product.

That is, when organizations are taxed due to consequences of their interaction with the environment, it would bring about a decrease in economic development in an economy within Africa. Also, proper tax justice should be ensured, so that tax revenue are judiciously utilized.

This finding is in line with that of Wu and Thomassin (2018) study, which indicated a negative effect between carbon tax and development.

5.0 Summary, Conclusion and Recommendation

From the analysis and interpretation above, it was evidenced that there exists negative and significant relationship between carbon emissions (CO_2) and economic development in sub-Saharan Africa. This means that the environmental tax system serves as a control system on companies to ensure that they carry out their production activities efficiently. Due to this system, there would be a reduction in production activities as companies who cannot adopt low carbon technologies would be unable to operate consistently. This invariably means that, the lower the production activities that leads to emissions, the lower the development of a country as productivity drives development. While this may seem to produce negative results, it actually promotes environmental consciousness of firms who would remain in operation and be carbon solvent while striving to maintain carbon neutrality or meet the carbon zero goal. This study recommends that:

i. Governments should aid companies who are evidently reducing their carbon levels with environmental tax-free periods as long as they can maintain their reduction in emission levels. This would aid this companies to produce more which would thereby lead to more economic development
ii. Companies should seek low carbon technologies in their production activities, as this would go a long way in reducing their carbon levels while they are still in production.

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