Human Capital Development as a Catalyst for Environment Sustainable Development in Nigeria: A VECM Approach

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Abstract

This study investigated the long-run relationship between HCD and environment sustainable development based on Lucas production function and the environment Kuznets framework. The econometric methodology employed was vector error correction model (VECM), which is used to estimate the short and long-run equilibrium convergence and the rate of speed of adjustments among cointegrating vectors, as well as the relationship between the included explanatory variables and dependent variable. The study covered the period 1977-2013, using an annual time series for eight variables, including the dependent variable, the ratio of total natural resources rent to gross domestic product was proxied by environment sustainable development. The results revealed that HCD was the strongest exogenous variable that speedily shocked other cointegrating variables to actualize stable environment sustainable development in the short-run for the study period in Nigeria. In the long run, the results found that HCD had a weak positive relationship and insignificant impact on environment sustainable development in Nigeria in the period 1977-2013. The study recommended that for reliable environment sustainable development in the long run, the government should intensify favourable policies on institutional quality and economic infrastructure; in the short run, government should intensify favourable policies on HCD, since it is a catalyst to affect other included variables within a short period to converge to long-run equilibrium.

Keywords: Human capital development, environment sustainable development
JEL Classification: E24, O13, O44

Introduction

For several decades, human capital had played a significant role in the economic growth and development of economies as an active agent which utilizes passive factors of production (i.e. natural resources and financial capital) to build

economic, social and political organization. Unfortunately, earlier endogenous growth economists, such as Arrow and Lucas (1988), perceived human capital development (HCD) in the narrow economic sense as labour size and labour productivity increase. Rather, the productivity of human capital should be judged in the broader perspective of social and economic infrastructure, which aid sustainable environmental development (Valeria and Salvatore, 2006). In spite of the recognition of human capital out of the four fixed capitals by Adam Smith in 1776, most classical economists gave prominence to natural resources and human–made capital as major determinants in their economic development theories. Appreciably, the neoclassical growth theories led by Solow (1957) introduced technological progress into the existing classical growth ideology, but also disregarded environmental resources importance.

Remarkably in the late 1950s and 1960s, prominent economists, such as Becker, Minzer and Schultz, and Harbison argued that investment in education and training builds up stock of skills and abilities in the population that can benefit national economies and accelerate economic growth, and ultimately foster the wealth of nations (Slaus and Jacobs, 2011). Subsequently, this insight gave birth to the new growth theories developed by Romer in 1990, which emphasizes the role of education, technical knowledge and economies of agglomeration and scale as determinants of economic growth. Nonetheless, the above growth studies did not consider the effects of human capital development on environment and sustainable development.

Following the neoclassical and endogenous growth theories, the role of human capital and human capital development (HCD) to accelerate economic growth cannot be overemphasized. Numerous studies, such as Dauda (2010), Ishola and Alani (2011), Mba, Mba, Ogbuabor and Ikpegbu (2013), and Eigbiremolen and Anaduaka (2014), found a positive impact of either human capital or human capital development on economic growth in Nigeria. Also, the Asian Tiger miracle's economic growth of South-Korea, Taiwan, Malaysia, and Singapore were accounted by human capital development (Ajibade, 2013). In spite of the laudable contributions of human capital or human capital development (HCD) to economic growth in growth theories and empirical studies, a few studies consider the role of human capital development (HCD) on environment sustainable development; this establishes the gap for this study.

In the context of this study, the term 'environment sustainable development' is attributed to the limits to growth report in 1972 and the Brundtland report in 1987. The limits to growth report by Meadows et al. (1972) identified that the earth's carrying capacity, known as environment, imposes strict limits to

sustainable growth. The Brundtland report (1987) considers not only environment sustainable development but also all three pillars of sustainable development: economic, social and environmental. According to Brundtland (1987), sustainable development (SD) is defined as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED, 1987).

Against this backdrop of a shift from economic growth to environment sustainable development, this study aims to provide answer to the questions: Does human capital development (HCD) serve as a catalyst for environment sustainable development in the short and long run in Nigeria? To what extent does the HCD cause weak or strong environment sustainable development for the future generations without affecting the present needs in Nigeria? Therefore, this study fills existing literature gap in the environment Kuznets curve (EKC) hypothesis by verifying the short and long-run relationship between economic growth and environment sustainable development; more importantly, it will broadly examine the long-run relationship between human capital development (HCD) and environment sustainable development in Nigeria within the period 1977–2013.

Literature Review

Dauda (2010), in her study on human capital formation and economic growth in Nigeria, used the endogenous growth model. In her study, human capital formation was proxied by the three levels of education – primary, secondary and tertiary. She found a long-run positive relationship between human capital formation and economic growth in Nigeria. Similarly, Ishola and Alani (2011) examined the contributions of different measures of human capital development to economic growth in Nigeria. They employed OLS and adapted the neoclassical growth model, which specifies that the growth of GDP is a function of labour and capital. They found that education, measured by adult literacy rate, and health, measured by life expectancy had positive relationship with economic growth in Nigeria for period 1980 –2005. Also, Slaus and Jacobs (2011) argued that all forms of capital (natural, social, technological, financial and human) constantly interact to influence sustainable economic growth. However, they considered that human capital is the central determinant of resource productivity and sustainability. More importantly, this study confirmed the role of human capital to economic growth and economic sustainability among nations of the world.

Mba, Mba, Ogbuabor and Ikpegbu (2013) in their study, human capital development and economic growth in Nigeria employed OLS technique and exogenous growth model, which specifies that the real GDP is a function of labour and capital. The labour variable was proxied by primary school enrolment and public expenditure on education, while the public expenditure on health, life expectancy and stock of physical capital proxies the capital variable. They found that the primary school enrolments, life expectancy, total government expenditure on health and education was significant to economic growth in Nigeria. In same vein, Eigbiremolen and Anaduaka (2014) investigated the impact of human capital development on national output, using quarterly time series data from 1999 to 2012 in Nigeria. Their study used augmented Solow growth model and OLS technique. Human capital development was measured by the combination of capital and recurrent government expenditure, without considering health expenditure. They found a positive relationship among all the independent variables on economic growth in Nigeria.

A pioneered study of the relationship between economic growth and environmental quality by the Environmental Kuznets curve (EKC) in 1955 found an inverted U-shaped relationship. He found that at initial economic growth causes environmental degradation; and that increases in GDP per capita over a longer period leads to a reduction in environmental damage. Diaconu and Popescu (2016) in their study of human capital (a pillar of sustainable development), employed a bivariate correlation analysis from qualitative data derived from HDI, HSDI, and HCI rankings. They found that healthy and educated people increase productivity as well as guarantee sustainable development in EU states.

Recently, Ekperiware, Olatayo, and Egbetokun (2017) examined human capital and sustainable development in Nigeria, employing descriptive statistics and vector autoregressive (VAR) econometric technique. The study used all the three pillars of sustainable development (economic development, social development and environment protection) and found that increase in human capital development reduces environment degradation but increases economic growth in Nigeria within the period 1981-2014.

Prior to the neo-classical growth theory that dominated the economic philosophy for three decades (1955-1985), there was failure on the premise of constant returns and unexplained residual technological factors as sources of long-run growth among countries. By late 1980s, the dissatisfaction with neo-classical growth theory to explain long-run growth among nations, coupled with the publication of the Brundtland report in 1987 to define sustainable

development, gave birth to the new theory of growth, commonly called the endogenous growth model. The endogenous growth theory developed by Romer in 1990 as an extension of the neo-classical growth theory recognizes technological progress rate as endogenous factors, unlike exogenous in the Solow-Swan production function. The endogenous growth theory is expressed in the production function as:

$$Y_t = F(K_t, N_t, A_t) \quad (1)$$

Equation 1 shows that the level of aggregate output depends on the quantities of capital (K_t) and labour (N_t) used in the production, as well as in the technology (A_t), which is treated as endogenous factor. Further, Romer in 1990 characterized the endogenous growth model as increasing returns, while the technological progress represents investment as a source of long-run growth in the economy. Also, these external increasing returns are due to the technological improvements which result from (i) the rate of investment, (ii) size of the capital stock, and (iii) the stock of human capital.

Having recognized the importance of investment in human capital as assumed to be the source of technological progress under the endogenous growth model, each theory measures human capital investment differently. First, Arrow introduced the concept of learning by doing. According to this theory, the greater the level of labour input, the greater will be the scope of learning and acquiring of new skills. Second, Lucas in his work in 1988 laid emphasis on the accumulation of human capital in the endogenous growth model. According to this model, acquisition of new skills and knowledge will not only make a worker more productive but also increase the productivity of capital and that of other workers in the economy. In a nutshell, each new knowledge or skill makes the next idea possible and so the knowledge can grow indefinitely, implying sustainability not only for the present but also for future generations. The Lucas Cobb-Douglas production function is expressed as:

$$Y = Ak^{a} (HeL)^{1-a} \quad (2)$$

Where:

The technology coefficient A represents the external effect of human capital productivity (H) and labour productivity (eL).

The quantity of K represents the stock of physical capital in the economy, while human capital (H) is a function of labour input.

In the literature, sustainable development has three broad objectives: economic, social and environmental objectives. None of these objectives is neglected towards achieving a long-run growth for sustainable development. The objective on environmental sustainable development is the thrust of the current study. Similar studies include the environmental Kuznets curve (EKC) in 1955 that pioneered the inverted U-shape relationship between economic growth and environmental quality (Panayotou, 2000a, cited in Tim et al., 2010). This curve exhibits an increasing environmental degradation and economic growth at initial and lower income rates. However, after the turning point, increases in GDP per capita lead to a reduction in environmental damage. This is depicted in figure 1.

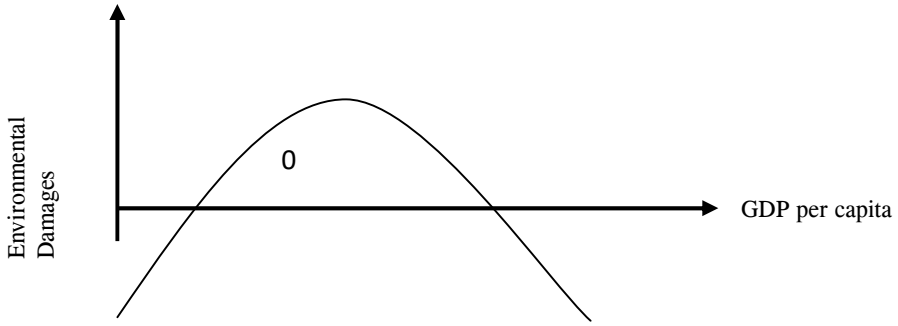

Figure 1: The environmental Kuznets curve

Aside the popular Kuznets inverted U-shaped economic growth and environment relationship, other theories like the limits theory, new toxics and Davidson, and the race to the bottom, suggest contrary shape relationship of backward curve, linear and net effect curve, respectively (Tim et al., 2010). These theories provide different drivers to the different shape-relationships between economic growth and environmental-scales composition and technical progress. Of all these, the technical effect provides the rational negative relationship between economic growth and the environment, which lies heavily on the assumption of the endogenous growth models— that is, technical progress on external factors affecting human capital plays a crucial role in the reduction of environmental damage, vis-à-vis sustained and long-run economic growth, as specified by the Lucas production function (2).

Following the theoretical interactions between the endogenous growth theory and the environmental Kuznets hypothesis, it is important to empirically analyse the long run relationship between human capital development and the sustainable environmental development in Nigeria, unlike several previous studies (Ogunade,

2011; Omojimite, 2011; Ajibade, 2013; Kola-Olusanya, 2013) that considered the theoretical relationship between human capital development and sustainable development while only a few studies like (Valeria and Salvatore, 2006; Diaconu and Popescu, 2016; Ekperiware, Olutayo and Egbetokun, 2017) empirically examined the relationship between human capital development and sustainable environmental development.

Methodology

The model developed in this research is based on the empirical study of Ekperiware, Olutayo and Egbetokun (2017), the environment Kuznets curve (EKC) hypothesis and the Cobb-Douglas production function theoretical framework. The Cobb-Douglas production function is rooted in the endogenous growth theory that investment in human capital, innovation and knowledge are significant to sustainable environmental development. The environment Kuznets curve (EKC) establishes the technical effects of the relationship between economic growth and the environment. Following the EKC hypothesis of 1955, Ekperiware, Olutayo and Egbetokun (2017) and the Cobb-Douglas production function, the current study adapted model is specified in equations 3 and 4:

$$TNRRG = f(H_t, L_t, K_t, A_t) \quad (3)$$

$$A_t = f(GDPG_t, IQ_t, HCD_t) \quad (4)$$

Where *TNRRG* is the ratio of total natural resources rent to GDP, which proxies sustainable environmental development, as the dependent variable in this model. H_t is the human capital, measured as ratio of public expenditure on education to total public expenditure; L_t is labour quantity level, measured as the population growth rate; K_t is the physical capital, measured as the economic infrastructural investment with ratio of the sum of public housing and road construction expenditure to public expenditure; A is the endogenous technology progress investment, measured by the included control variables as specified in equation 4.

Further, the control variables in equation 4 include growth rate of GDP (GDPG), institutional quality (IQ), and human capital development (HCD). The HCD is the sum ratio of public expenditure on education to total public expenditure (PEER), public expenditure on health to total public expenditure (PHER), and public expenditure on information and technology to total public expenditure (PITER), which all form the endogenous technology progress

investment index, as direct and indirect determinants of ratio of total natural resources rents to GDP in resource-rich countries. These control variables have been justified in relevant previous studies (Gylfason, Herbertson and Zoega, 1999; Gylfason, 20001a; Bravo-Ortega and De-Gresorio, 2005; Sala-i-Martin and Subramanian, 2003; Levite and Weidmann, 1999; Akpan and Chuku, 2014; Valeria and Salvatore, 2006).

Incorporating equation 4 into equation 3 provided the econometric model for this study, which is an extension of Ekperiware, Olutayo and Egbetokun (2017) and EKC of 1955. It is noteworthy that both Eigbiremolen and Anaduaka (2014) and Mba, Mba, Ogbuabor and Ikpegbu (2013) measured human capital development separately from education expenditure and health expenditure. But the current study combined education expenditure, health expenditure and information and communication technology expenditure, proxied by human capital development (HCD). In this study, human capital in the Cobb-Douglas production is a vector of labour size, represented by L (arrow growth model); accumulation of human capital, represented by change in labour size (Lucas growth model), and sum of public expenditure on education, public expenditure on health and public expenditure on information and technology. Also, Gylfason (2001) and Auty (2001) justified the measures of TNRRG as the ratio of total natural resources rent to GDP that is proxied by sustainable environmental development, while EKC (1955) justified the inclusion of initial change in GDP and lagged period change in GDP and IQ to measure the relationship between growth and environmental quality. In addition, physical capital (K), proxied by the economic infrastructure investment, is ratio of the sum of public housing and road construction expenditure to public expenditure. Moreover, the total factor productivity (A) in the endogenous growth model is represented by economic growth, measured by the initial changes in GDP and lagged changes in GDP, institutional quality (IQ), and human capital development (HCD). Therefore, the econometric estimated equation is specified in equation 5:

$$Tnrry_t = \alpha_0 + \alpha_1 HCD_t + \alpha_2 L_t + \alpha_3 K_t + \alpha_4 dGDP_t + \alpha_5 IQ_t + \alpha_6 dL_t + \alpha_7 dGDP_{t-5} + \varepsilon_t \quad \text{_____(5)}$$

Where α_1 to α_7 are the elasticities, while α_0 is constant and ε_t is the white-noise error. All the expected signs of elasticities of these included explanatory variables are positive. All but IQ are dummy variables that are proxied by "0" for weak institutional quality and "1" for strong institutional quality.

The dataset used in this study were secondary data, in the form of annual time series data, ranging from 1977 to 2013. All the data, except TNRRY and labour data, were sourced from the World Bank's World Development Indicators (WDI) database (2013) and Worldmeters.info, while other data were obtained from Central Bank of Nigeria's statistical bulletins (2014) and National Bureau of Statistics (NBS). The specified model was estimated using the ordinary least square (OLS) technique to achieve the broad objective of the study. Specifically, the vector error correction multivariate cointegration (VECM) model was used to estimate the long and short-run relationship between human capital development and sustainable environmental development in Nigeria for the covered period. To avoid spurious regression, the series were tested with the aid of appropriate unit root tests, as provided in the econometrics computer software packages of Eviews 7.0.

Results

Descriptive data

Table 1 shows the summary of the descriptive statistics of the included variables for this study. The result in table 1 reveals that a five-year lagged change in GDP was the highest variability (52.07), followed by Tnrry (11.06) and HCD (6.53). On the other hand, the least variability was DL. The Jarque-Bera test found that all variables, except L and Tnrry, rejected the null hypothesis of a normal distribution at 1% significant level. This implies that L and Tnrry were normally distributed in the study. Generally, the results reveal that each dataset was unreliable and thus inferred the econometric test to validate the data reliability for a valid inference in the study.

Table 1: Descriptive statistics for human capital development and sustainable environmental development in Nigeria

Variable	*Mean*	*Maximum*	*Minimum*	*Stand. dev.*	*Jarque-Bera*	*Observation*
Tnrry	37.74	67.69	12.30	11.06	0.57 (0.75)	36
L	11.29	17.7	7.00	3.11	2.52 (0.28)	37
DL	0.03	0.05	0.0000	0.011	11.36 (0.00)	36
K	2.80	8.19	0.28	2.36	7.02 (0.03)	35
HCD	14.33	36.17	4.39	6.53	13.58 (0.00)	35
DGDP	0.23	6.96	– 0.07	1.15	1633.06 (0.00)	36
$DGDP_{t-5}$	– 9.08	78.93	– 242.81	52.07	255.25 (0.00)	32
IQ	0.46	1.00	0.00	0.51	6.17 (0.05)	37

Source: Authors' computation from Eviews results

(b) P values are in parentheses

(c) D is change

Matrix correlation

Table 2 shows the degree of correlation between the dependent variable, Tnrry and the included explanatory variables. All included variables, except dL and $DGDP_{t-5}$, exhibited a negative relationship with the sustainable environmental development for the period 1977-2013 in Nigeria. However, the results were contrary to a priori positive expectation, except DL that upheld the Lucas growth theory (human capital accumulation) and the environmental Kuznets (lagged period change in GDP) on sustainable environmental development within the period in Nigeria. Moreover, the correlations results for the included variables were relatively low; thus, there was no presence of multicollinearity in table 2.

Table 2. Matrix correlations result of HCD and sustainable environmental development in Nigeria

Variable	*Tnrry*	*HCD*	*L*	*DL*	*DGDP*	*$DGDP_{t-5}$*	*IQ*	*K*
Tnrry	1.00							
HCD	– 0.35	1.00						
L	– 0.39	0.17	1.00					
DL	0.02	0.03	0.08	1.00				
DGDP	– 0.13	– 0.26	0.49	0.36	1.00			
$DGDP_{t-5}$	0.008	0.13	– 0.03	– 0.005	– 0.21	1.00		
IQ	– 0.40	0.21	0.86	0.06	0.37	– 0.009	1.00	
K	– 0.45	0.35	0.42	– 0.17	– 0.03	0.03	0.28	1.00

Source: Authors' computation from Eviews results

Time Series Econometric Results

Unit root test

Following the non-reliability of the variables in the descriptive statistics, the unit root test in time series econometric became relevant in confirming whether each variable was stationary or not. The study used three unit root tests out of the provided six in the Eview 7.0 package for robustness. The three unit root tests used were Augumented Dickey-Fuller (ADF) test, the Dickey-Fuller Generalized Least Square (DF-GLS) test, and Phillip-Perron (PP) test.

First, the ADF test was preferred over the two alternative tests because it is used for a large sample, of which the study covered 36 years. However, the ADF test could be misleading due to the inclusion of regressors that are sometimes irrelevant and make the residual underestimated. Second, DF-GLS is a modified ADF test which helps reduce the misleading result from ADF test by detrending the included regressors; thus, DF-GLS is more reliable, for it considers only the stationary test of a variable without the included regressors. Unfortunately, DF-

GLS fails to account for the serial correlation problems in a variable (Elliot, Rothenberg and Stock, 1996, cited in Eviews 7 User's Guide II 2010). The third unit root test is Phillip-Perron (PP) which is superior to ADF and DF-GLS as it accounts for serial correlations adjustment and the endogeneity of regressors. It is also used for non-parametric variables like IQ in this study. Nonetheless, the three tests used ignored the structural breaks in time series and thus, gave a misleading result, but beyond the scope of this study (Zivot and Andrews, 1992).

The two unit root equations specified in equations 6 and 7 depended on the nature of the variables, which were constant with trends and constant without trends, respectively:

$$\Delta Y_t = \alpha + \beta Y_{t-1} + \phi T + \sum_{i=1}^{k} \lambda_i \Delta Y_{t-1} + U_i \text{ - - - - - - - - - - - - - - - - - (6)}$$

$$\Delta Y_t = \alpha + \beta Y_{t-1} + \phi T + U_i \text{ - (7)}$$

The study used the constant with trends because all the included variables exhibited trends and the Mackinnon critical values were computed based on constant and trends (Eviews 7 User's Guide II, 2010).

Table 3: Unit root tests for human capital development and sustainable environmental development

Variable	*ADF*	*DF-GLS*	*PP*	*Integrate order*
Tnrry level	– 3.21*	–3.16*	–3.23*	
1st Diff	– 7.58***(0.00)	–7.86***	–15.86***(0.00)	I(1)
L level	1.91	–0.42	–1.58	—
1st Diff	– 6.11***(0.00)	–5.80**	–6.08***(0.00)	I(1)
DL level	– 7.45***(0.00)	–7.28***	–7.55***(0.00)	
1st Diff	– 6.02***(0.00)	–8.27***	–14.62***(0.00)	I(1)
DGDP level	–4.81***(0.00)	–1.89	–6.35***(0.00)	
1st Diff	–3.12	– 1.68	–32.02***(0.00)	I(1)
$DGDP_{t-5}$ level	–5.44***(0.00)	– 5.62***	–5.47***(0.00)	
1st Diff	–9.05***(0.00)	–9.38***	–27.21***(0.00)	I(1)
IQ level	–2.07	–2.01	–2.12	
1st Diff	–5.83***(0.00)	–6.00***	–5.83***(0.00)	I(1)
K level	–2.74	–2.88	–2.67	
1st Diff	–7.46***(0.00)	–7.67***	–10.54***(0.00)	I(1)
HCD level	–3.46*(0.06)	–3.53**	–3.43*(0.06)	
1st Diff	–10.77***(0.00)	–10.57***	–11.64***(0.00)	I(1)

Source: Authors' compilation from Eviews results

Note (a): *** significant at the 1% level;** at 5% level and * at the 10% level.

(b): P values are in parenthesis.

Table 3 reveals that all the included variables were stationery at integrate order of one, I(1), at 1% significant level under the Phillip-Perron unit root test. The test concluded that all the included variables were not stationary at level except at 1st differencing order, which validated the descriptive statistics in the study.

Multivariate cointegration test

The establishment of uniform order of integration of one I(1) for each individual series in table 3 confirmed the use of Johansen (1998) and Johansen and Juselius (1990) maximum likelihood cointegration techniques (VAR) to test the existence of long-run relationship and the number of cointegration vectors. Against previous studies, the purpose of the study is to establish long-run multivariate relationship between human capital development and sustainable environmental development. This multivariate cointegration test can be expressed as:

$$X_t = K_0 + K_1\Delta X_{t-1} + K_2\Delta X_{t-2} + ... + K_{p-1}\Delta X_{t-p} + \Pi X_{t-p} + U_t \quad (8)$$

Where X_t includes n variables in the model, which are *I(1); K* and $\prod$ are parameter matrices to be estimated; U_t is a vector of normally and independently distributed error term. The Johansen test for cointegration evaluates the rank (r) of the matrix $\prod$. If $r = 0$, all variables are *I(1)* but not cointegrated. In the case of $0 < r < N$, there exist r cointegrating vectors. In another case, if $r = N$, all the variables are *I(0)* , implying stationary at level and n cointegrating vectors. $\prod$ represents the long response matrix and is defined as the product of two matrices: $\propto$ and β of dimension ($g \times r$) and ($r \times g$) respectively. The β matrix contains the long-run coefficients of the cointegrating vectors; $\propto$ is known as the adjustment parameter matrix and is similar to an error correction term. According to the Granger representation theorem (Engle and Granger, 1987), when $K > 0$ and rank of $\prod (r) < K$, these are r cointegrating vectors or r stationary linear combinations of the variables. Therefore, to determine the number of cointegrating vectors, Johansen developed two likelihood ratio tests: trace test (λ_{trace}) and maximum eigenvalue test ($\lambda_{\max}$). If there is any divergence of results between these two tests, it is advisable to rely on the evidence based on the $\lambda_{\max}$ test because it is more reliable in small samples (Mukhtar and Rasheed, 2010).

The two tests are expressed as:

$$\lambda_{trace} = -T\sum_{i=r+1}^{n} 1n(1-\lambda_i^2) - (9)$$

$$\lambda_{\max}(r, r+1) = -T1n(1-\lambda_{r+1}) - - - - - - - - - - - - - - - - - (10)$$

Where, λ_i is the estimated values of the ordered eigenvalues obtained from the estimated matrix and T is the number of observations after the lag adjustment. The trace statistics test the hypothesis that the number of district cointegrating vectors (r) is less than or equal to r against a general alternative. The maximal eigenvalue test the hypothesis that the number of cointegrating vectors is r against the alternative of $r+1$ cointegrating vectors.

Table 4: Johansen cointegration test for human capital development and environment sustainable development

Null hypothesis	*Trace (λ) statistic*	*Critical value*	*Prob.*	*Null hypothesis*	*Max-Eigen statistic*	*Critical values*	*Prob.*
H_0 : r = 0*	254.28	150.56	0.00	H_0 : r = 0*	80.16	50.60	0.00
H_0 : r = 1*	174.12	117.71	0.00	H_0 : r ≤ 1*	53.74	44.50	0.00
H_0 : r = 2*	120.38	88.80	0.00	H_0 : r ≤ 2*	39.71	38.33	0.03
H_0 : r = 3*	80.67	63.88	0.00	H_0 : r ≤ 3	30.81	32.11	0.07
H_0 : r = 4*	49.85	42.92	0.01	H_0 : r ≤ 4	25.01	25.82	0.06
H_0 : r = 5	24.85	25.87	0.07	H_0 : r ≤ 5	16.45	19.39	0.13
H_0 : r = 6	8.41	12.52	0.22	H_0 : r ≤ 6	8.41	12.52	0.22

Source: Authors' compilation from Eviews result

Note (a) * denotes rejection of the null hypothesis at 0.05 significant level.

** denotes Mackinnon-Haug-Michelis (1999) P-values

(b) Trace test indicates 5 cointegrating eqn(s) at the 0.05 level

(c) Maxi-eigen value test indicates 3 cointegrating eqn(s) at the 0.05 level.

Table 4 established the cointegration relationship among the included explanatory variables and the dependent variable under the Johansen maximum likelihood method. The two statistics trace (λ_{trace}) and maximal eigen value (λ_{max}) statistics indicated that there were five and three cointegrating vectors respectively in this study. Therefore, the results rejected the null hypothesis of no cointegrating vectors in favour of the superior three cointegrating vectors at 5% level of significance. This implies that a long-run relationship exists among

environment sustainable development (Tnrry), labour size (L), human capital accumulation (DL), initial economic growth (dGDP), consistent economic growth ($dGDP_{t-5}$), institutional quality (IQ), economic infrastructure (K), and human capital development (HCD) in Nigeria. This finding is consistent with those of Kuznets (1955), Lucas (1988) and Arrow (1962).

Table 5. Summary of Long-run and Short-run VECM estimates.

Regressor	Long run estimates
D (Tnrry (– 1))	1.000
D (L (– 1))	– 47.08 (–1.11)
D (DL (– 1))	–2532.33 (–3.56)***
D (DGDP (– 1))	–20.15 (–10.28)***
D (HCD (– 1))	0.64 (1.35)
D (IQ (– 1))	28.91 (2.95)***
D (K (– 1))	4.47 (4.22)***
@trend (77)	0.37 (0.97)
C	6.51

Short-run estimates

D(L, 2)	D(DL, 2)	D(DGDP, 2)	D(HCD, 2)	D(IQ, 2)	D(K, 2)
0.02118	0.0022	– 0.3409	0.7494	0.0096	0.0957
0.00[0.0024]	–0.00005[– 0.0002]	0.06[0.003]	–0.09[0.036]	–0.003 [–0.002]	–0.07[– 0.006]
0.65	0.90	0.89	0.72	0.38	0.74
0.53	0.86	0.86	0.61	0.16	0.64
0.10	0.008	1.18	5.58	0.24	2.09
5.164	24.60	23.15	6.98	1.71	7.81

Error Correction	D(Tnnry, 2)
Constant	0.8177
ECT (–1)	–0.09 [–0.2226]
R^2	0.25
Adjusted R^2	– 0.02
S.E. of Regression	13.92
F – Stat	0.923

Having established that all included variables in the model were *I(1)* and cointegrated, the vector error correction model (VECM) was used to estimate each endogenous variable speed of adjustments to the long-run equilibrium path within the short-run through the vector error correction term (ECT) coefficient and also estimate the long run relationship of the included explanatory variable with the dependent variable in the system. The data in table 5 show the long and short-run VECM estimate in this study. The long-run estimates revealed that all but a lag first difference in human capital accumulation, initial GDP, institutional quality and economic infrastructure, were not statistically significant at 1%. This implies that a lag first difference in human capital accumulation, initial GDP, institutional quality and economic infrastructure had long-run significant impact on environment sustainable development in Nigeria within the study.

Furthermore, the analysis showed that a lag first difference in institutional quality and economic infrastructure had positive significant impact on environment sustainable development in Nigeria. That is, a 1% change in *IQ* and *K* caused 28.91% and 4.47% in error sustainable development, respectively. But the lag first difference in human capital accumulation and initial GDP had negative significant impact on environment sustainable development in Nigeria, which implies that 1% of human capital accumulation and initial economic growth led to a decrease in environment sustainable development by 2532.33% and 20.15% respectively.

The results also show that both labour size and human capital development were not statistically significant at 1%, 5% or 10%. Also labour size had high negative impact on environment sustainable development in the long run, while

human capital development (HCD) had low positive impact on environment sustainable development in the long run. Thus, a 1% increase in labour size and human capital development caused a decrease and increase in environment sustainable development by 47.08% and 0.64% respectively in the long run.

On the other hand, the short-run VECM estimate revealed that all the endogenous or vector variables had a long speed of adjustment to the long-run equilibrium path within the short run. Also, none of the endogenous variables were statistically significant at 1%. This implies that all the endogenous variables were not reliable within the short run to either converge to or diverge from the long-run equilibrium path in the study. Furthermore, the data in table 5 reveal that four out of seven vector variables had the expected negative sign of ECT. This implies that the four vector variables converged to the long-run equilibrium position, but that their low coefficients indicated a very slow convergence rate of adjustment within the short run. Also, the two positive ECT values in table 5 indicated a low divergence speed rate from the long-run equilibrium position within the short run. Finally, the F-statistics value indicated the relevance of each endogenous variable to achieve long run; and that all but environment sustainable development and institutional quality had significant potentials to achieve long-run equilibrium (stability) in the shorter period of this study.

Discussion

The descriptive statistics shown in table 1 revealed that all the included variables were not normally distributed, except environment sustainable development (Tnrry) and labour size (L) in the period 1977–2013. Further, the matrix correlation results in table 2 justified the fact that there was no presence of multicollinearity among the included variables. However, the non-normality of most variables in the model provided the reasons for the unit root test for each included variables in the study. For robustness of the stationarity test, ADF, DF-GLS and PP unit root tests were used. The PP unit root test found that all the included variables were stationary at first difference at 1% significant level. In addition, the unit root test confirmed the Jarque-bera test that the included variables were not stationary at level but at first difference order, except environment sustainable development and labour size. Thus, the PP unit root test validated that the OLS estimates were reliable if the included variables were at *I(1)* and dismissed fears of spurious OLS outcomes in the study.

Aside the reliability of the individual variables through the unit root test, the study employed the Johansen maximum likelihood cointegration test to verify the long run relationship among the co-movement variables in the model. The trace

and maximal eigen-value statistics in table 4 found a strong relationship among the endogenous variables, as the greater the number of cointegrating vectors, the more stable the specified relationship (Huq, Arshad and Islam, 2013). Also, the pre-estimation tests (unit root and cointegration) outcome and the main objective of the study justified the vector error correction model (VECM) technique employed in the study.

The data in table 5 represented the long and short-run VECM estimates. The long-run estimates found that only a one-year lagged change in institutional quality and economic infrastructure had high positive significant impact on environment sustainable development in Nigeria. These results suggest that for a reliable long-run positive environment sustainable development, the government should increase institutional quality and economic infrastructure. The result is in line with those of Tim et al. (2010) and Valeria and Salvatore (2006) that IQ and economic infrastructure are important to sustainable development path.

Also, both a one-year lagged change in human capital accumulation and initial economic growth had high negative impact on environment sustainable development in the long run. The result supports the environmental Kuznets hypothesis (1955) and Ekperiware, Olatayo and Egbetokun (2017) that initial economic growth causes environment degradation and human capital development reduces environment degradation, respectively. Thus, the VECM long-run estimates found low positive and insignificant impact of human capital development on environment sustainable development in the period 1997–2013 in Nigeria.

On the other hand, the short-run VECM estimates found that all, except 2nd difference in labour size and initial economic growth had the expected negative sign of ECM. This implies that the endogenous variables had the tendency to converge into the long-run equilibrium path within the short period in the study. Unfortunately, the negative low ECM coefficient indicated that the speed of adjustment to long-run equilibrium took a longer period in the study. However, none of this ECM coefficient values was statistically significant at either 1% or 5%; thus, their convergence into long-run equilibrium path was not reliable in the short-run.

In addition, the high F-statistics value for each endogenous variable indicated that they played significant roles in affecting each endogenous variable in the system to attain long-run equilibrium within the short period in the study. On the contrary, the positive ECM coefficients of 2nd difference in labour size and initial economic growth indicated a divergence from the long-run equilibrium position within the short period. Also, the F-statistics value of 23.15 for initial

economic growth indicated that 2nd difference initial economic growth contributed largely or significantly to the divergence from the long-run equilibrium path than the 2nd difference labour size. This result supports that of Kuznets environment of 1955 that initial economic growth causes environmental degradation.

Conclusion and Recommendations

This study employed the vector error correction model (VECM) technique to empirically examine the long-run relationship between human capital development and environment sustainable development in Nigeria within the period 197 –2013. The long-run VECM estimates showed that human capital development caused low positive weak environment sustainable development within the period in Nigeria. Furthermore, the analysis revealed that human capital development was not a catalyst to environment sustainable development at the long run; rather, institutional quality and economic infrastructure positively and significantly impacted on environment sustainable development at the long run in the period 1977–2013 in Nigeria. on the other hand, the short-run VECM estimates showed that human capital development (HCD) was the strongest endogenous variable, followed by economic infrastructure and institutional quality that speedily shocked other cointegrating variables or restored the long-run equilibrium (stability) within the short-run period. The study thus concludes that HCD took a long period to restore long-run equilibrium within the short-run in Nigeria in the study period.

The policy implication of this study is in twofold: first, human capital development (HCD) should be a priority of government or decision-makers to effect relevant variables that will guarantee environment sustainable development within the short period, as established in the short-run VECM estimates in the study. Second, to achieve long-run environment sustainable development in Nigeria, the government or policymakers should intensify favourable policies on institutional quality and economic infrastructure than others, as found in the long-run VECM estimates in this study.

References

Ajibade, A.P. (2013). Building human capital for sustainable development: Role of the university. A paper delivered at the University of Ibadan Registry discourse.

Akpan, G.E. and Chuku, C. (2014). Natural resources, human capital and economic development in Nigeria: Tracing the linkage. *Journal of Economics and Sustainable Development*, 5(21): 44-50.

Alam, S. (na). Environmental degradation affects human development and sustainable economic development. Case of Pakistan. Applied Economics Research Centre, University of Karachi, Pakistan, 83-96.

Alexeev, M. and Conrad, R.F. (2009). The natural resource curse and economic transition. Centre for Applied Economics and Policy Research (CAEPR) working paper AL 018-2009.

Auty, R.M. (2007). Natural resources capital accumulation and resource curse. *Ecological Economics*, 61: 627-634.

Becker G. (1975). *Human Capital: A theoretical and empirical analysis with special reference to education*. New York: Colombia University Press.

Bravo-Ortega, C. and de Gregorio, J. (2005). The relative richness of the poor. Natural resources, human capital and economic growth: Available at www.wds.worldbank.org.

Brundtland Commission (1987). *Our Common Future: Report of the World Commission on Environment and Development.* Oxford University Press: London UK.

Brunnschweiler, C.N. and Bultle, E.H. (2008). Natural resources, human capital and economic growth. The World Bank Policy.

Dauda, R.O.S. (2010). Role of human capital in economic development: An empirical study of Nigeria. Paper presented at Oxford Boomers and Economic conference, June 28-29, UK.

Diaconu, L. and Popescu, C. (2016). Human capital: A pillar of sustainable development. Empirical evidences from the EU states. *European Journal of Sustainable Development*, 5(3): 103-112.

Eigbiremolen, G.O. and Anaduaka, U.S. (2014). Human capital development and economic growth: The Nigeria experience. *International Journal of Academic Research in Business and Social Sciences*, 4(4): 25-35.

Ekperiware, M.C., Olatayo, T.O. and Egbetokun, A.A. (2017). Human capital and sustainable development in Nigeria: How can economic growth suffice environmental degradation. Economic Discussion Paper No. 2017-29. *Open Access e-Journal.*

Gylfason, T. (2001). Natural resources, education and economic development. *European Economic Review,* 45: 847-859

Gylfason, T., Herbertsson, T. and Zoega, G. (1999). A mixed blessing: Natural resources and economic growth. *Macroeconomic Dynamics*, 3: 204-225.

Huq, A.S., Arshad, F.M. and Islam, G.N. (2013). Supply response of wheat in Bangladesh: co-integration and vector error correction analysis. *Academic Journal*, 8(44): 5440-5446.

Ibok, E.E. and Ibanga, S.E. (2014). The impact of human capital development and economic empowerment on the socioeconomic development of Akwa Ibom State, Nigeria. *Global Journal of Human Resource Management,* 2(3) 37- 44.

Ishola, W.A. and Alani, R.A. (2011). Human capital development and economic growth: Empirical evidence from Nigeria. *Asian Economic and Financial Review,* 2(7): 813-827.

Johansen, S. (1991). Estimation and hypothesis-testing of cointegration vectors in Gaussian vector autoregressive models. *Econometrical,* 59(6): 1551-1580.

Johansen, S. and Juselius, K. (1990). Maximum-likelihood estimation and inference in cointegration with applications to the demand for money. *Oxford Bulletin of Economic and Statistics*, 52 (2): 169-210.

Kola-Olusanya, A. (2013). Embedding environmental sustainability competencies in human capital training and development. *Mediterranean Journal of Social Science*, 4: 65-71.

Kuznets, S. (1955). Economic growth and income inequality. *American Economic Review*, 49: 1-28.

Levite, C. and Weidmann, J. (1999). *Does Mother Nature Corrupt? Natural Resources, Corruption and Economic Fund*. World Bank; Washington DC.

Lucas, R. (1988). On the mechanics of economic development. *Journal of Monetary Economic*, 22 (July): 3-42.

Mba, I.C., Mba E.I., Ogbuabor J.E. and Ikpegbu C.H. (2013). Human capital development and economic growth in Nigeria. *Journal of Economics and Sustainable Development*, 4(18): 48-52.

Meadows, D.H., Meadows D.L., Randers J. and Behrens W.W. (1972). *The Limits to Growth*. New York: Potomae.

Murthy, V. and Okunade, A. (2009). The core determinants of health expenditure in the Africa context: Econometric evidence for policy. *Health Policy*, 91(1): 57-62.

Ogunade, A.S. (2011). *Human Capital Investment in the Developing World: An analysis of praxis.* University of Rhodes Island.

Omojimite, B.U. (2011). Building human capital for sustainable economic development in Nigeria. *Journal of Sustainable Development*, 4: 183-189.

Panayatou, T. (1993). Empirical tests and policy analysis of environmental degradation at different stages of economic development. World Employment Research Programme Working Paper. Geneva: International Labour Force.

Romer, P.M. (1990). Are nonconvexities important for understanding growth? *American Economics Review*, 80, 27-34.

Sala-i-Martin, X. and Subramarrian, A. (2003). Addressing the natural resource curse: An illustration from Nigeria. ??INCOMPLETE REF???.

Slaus, I. and Jacobs, G. (2011). Human capital and sustainability. *Sustainability*, 3:97-154.

Solow, R.M. (1957). Technical change and the aggregate production function. *Review of Economics and Statistics*, 39: 312-320.

Tim, E., Mallika I., Gian P.A. and Alex R. (2010). Economic growth and the environment. Department for Environment, Food and Rural Affairs (DEFRA) Working Paper No.2.

Tisdell, C. (na). Sustainable development of human resources. Principles of Sustainable Development, Vol. 1. Encyclopedia of Life Support Systems (EOLSS).

Valeria, C. and Salvatore, M. (2006). Environment, human development and economic growth. *International Energy Markets,* 1-37.