Human Capital and Environmental Quality in Cameroon

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Abstract

The aim of this paper is to analyze the impact of human capital, notably education, on environmental quality in Cameroon. Used is made of ARDL bound testing techniques to analyze annual data spanning the period 1971-2019. The data was obtained from the World Development Indicators published by the World Bank website. The results show a positive impact of human capital development on environmental quality. Also, evidence was found to support the existence of the environmental Kuznets curve in the context of Cameroon. These results indicate that the government of Cameroon can improve on its environmental quality by developing the human capital of its citizens. This can be done by enhancing environmental education in the country.

Keywords: *Environmental Quality; Human Capital; ARDL*
JEL Classification: H5; H6; Q01; Q52

INTRODUCTION

The cry of alarm against the negative impact of human activities in the environment dates from the publication of the Club of Rome report in the early 1970s. The solution recommended to remedy the multiple pollution and overexploitation of natural resources was to stop economic growth (Meadows et al., 1972). The Rio Summit in 1972 on sustainable development placed great importance on the protection of the environment, the causes of which are multiple. For the United Nations Development Program (UNDP), this degradation is caused by the overexploitation of natural resources (UNDP, 2009). For the World Trade Organization (WTO), this is explained as much by the increase in human population as by the growth of consumption (WTO, 2009).

Thus, human actions are responsible for the greenhouse gas emissions considered as the main cause of environmental degradation, due to the increasing CO_2 emissions since the industrial revolution (Stern, 2007).

However, the scale of environmental problems is not the same everywhere, and this requires a diagnosis specific to each country. In Cameroon, the main GHGs are Carbon dioxide (CO_2) which represented 54% of total emissions in 2013; Methane (CH_4) represented 24.36%, Nitrous oxide (N_2O), 18.05%, and Carbon Monoxide (CO) representing only 3.3%. The other GHGs represent less than 1%

(Nkengfack, Kaffo & Kamajou, 2014). Therefore, CO2 emissions account most for environmental degradation in Cameroon. Policies geared towards improving the quality of the environment should therefore take this factor into consideration.

Cameroon regularly takes part in international conferences on environmental protection and has also ratified several treaties aimed at preserving the environment and biodiversity. The Paris Climate Agreement of 15 December 2015, ratified by Cameroon on 29 July 2016, is just one example. At the local level, Cameroon has had a National Environmental Management Plan since 1996, drawn up by the Ministry of the Environment and Forests (MINEF) in collaboration with the United Nations Development Programme (UNDP). Despite this political will, in practice, there is a lot of negligence in the management of environmental problems in Cameroon. Mutation (2005), quoted by Ndame (2010), denounces in the city of Douala many polluting industrial enterprises that do not have any anti-pollution equipment to internalise their externalities.

Without internalising externalities, each economic activity has a cost, which includes not only the private cost borne by the agent responsible for the activity, but also a social cost related to environmental externalities (Barde, 1992; Crétois, 1999). As we can see, human activities have a negative effect on the environment, and it is necessary to show the extent of this situation and take appropriate measures.

Since the degradation of the environment is linked to human action, and as the behaviour of humans is determined by their level of human capital (health status and education), this study proposes to investigate how the level of human capital in a developing country affects environmental quality. This exercise is important as there are not many studies that have studied the effect of human capital on the quality of the environment and furthermore, no such study exists for Africa in general and Cameroon in particular. This study will fill this gap in the literature by analysing the case of Cameroon.

METHOD
Theoretical Model

Goetz et *al*. (1998) analyze the effects of human capital on environmental quality. Their model assumed the following utility function for individuals, which is maximized subject to income and time constraints:

$$Max U(x) + V(E, H, t_e) \tag{1}$$

$$\text{With } V_E \succ 0, V_{EH} \succ 0, V_{Ht_e} \geq 0$$

$$s.t. \quad \pi x + \omega(t_l + t_e) \leq \omega t_w + y_0 = y + y_0$$

$$T = t_w + t_e + t_l$$

x are non-environmental goods and π is the prices of these goods, E represents local environmental quality, H *is* environmental human capital, t_w is time allocated to work at wage w, t_e is time used by the individual to improve on the environment, t_l *is* time devoted to leisure, T *is* total time available. Furthermore, $y = \omega t_w$ and y_0 are earned and unearned income respectively, and $Y = y + y_0$ is total income.

The concept of environmental human capital incorporates, among other things, past choices regarding consumption of environmental services, environmental sensitivity, and education. In general, the level of education, used as an indicator of human capital, can be positively correlated with environmental sensitivity. For example, Goetz et al (1998) have approximated environmental human capital by education level.

The living environment also has an impact on environmental capital, and the level of investment devoted to settling in a particular environment influences the level of environmental human capital in one way or another.

According to Sen (1999), human development is a process through which people expand their freedom. Progress in human development promotes communities educational level, and people with higher educational levels not only pursue material wealth, but also require a better living environment. Brasington and Hite (2003) used time series techniques to analyze data for the United States. They found complementarity between education and environmental quality. When the accumulation of wealth came at the expense of the environment and resources, improvement in education caused people to restraints from excessive resource demand. Jalan, Somanathan, and Chaudhuri (2009) showed that when the educational level increases, the willingness to pay for higher water quality increased significantly in India. Furthermore, Costantini and Monni (2008) analyzed 179 countries with cross-sectional data, then found that achieving sustainable economic growth by investing in human capital did not harm the environment.

In the same line, Serkan (2009) used data from 15 countries in the Mediterranean region for 1970–2006 that showed that human development reduced regional pollution emissions. Jing Lan and Munro (2012) used cross-sectional dataset of Chinese industrial firms, to identify the internal and external effects of human capital on firms' environmental performance. Their results show that firms have better environmental compliance because they are urged to make compliance decisions by the internal driver of human capital and pulled to environmentally friendly by the external force of social human capital stock. Also, evidence from that study suggests that the weak implementation of environmental supervision and evasion of environmental monitoring could be reconciled by external and internal effects of human capital.

Li and Xu (2021) identify the relationship between environmental quality and human capital development in China. Using provincial panel data in (2004-2017), they constructed an Environment Degradation Index and Human Development Index in measuring the environmental pollution and human development, respectively. The simultaneous equations model was then employed to assess the relationship between environment degradation and human development. Li and Xu (2021) found an inverted U-shape relationship supporting the environmental Kuznets curve hypothesis. The studies above corroborate the hypothesis of the Goetz et al. (1998) model that environmental human capital development has a positive impact on environmental quality. This study tests this hypothesis for the case of a small developing Sub-Saharan country-Cameroon.

Estimation Technique

The bound testing approach for cointegration analysis is employed in this study to analyse the relationship between environmental quality and human capital development. This section presents the technique and defines the variables and the data sources.

Bound testing modelling of the relationship between Environmental Quality(EQ) and Human Capital (HC)

In this paper, we estimate the relationship between environmental quality and human capital using an ARDL (Autoregressive Distributed Lag) cointegration model. The choice of this method is justified by the advantages it offers for our study. In particular, it allows the estimation of level relationships (Pesaran et al., 2001). In addition, ARDL models have the advantage of capturing the dynamics of both the long-term and short-term effects of one or more exogenous variables on a dependent variable. This modeling is also adapted to small samples.

Following Pesaran *et al*. (2001), we assemble the vector autoregression (VAR) of order *p,* denoted VAR (*p*), for the following environmental quality function:

$$Z_t = \mu + \sum_{i=1}^{p} \beta_i z_{t-i} + \varepsilon_t \tag{2}$$

Dependent variable defined as Environmental Quality (EQ), x_t is the vector-matrix which represents a set of explanatory variables i.e., Human Capital (HC), per Capita Income (IC), Energy Consumption (EC), and Manufacturing (MN). The endogenous variable is then integrated of order 1 while the exogenous variable can be either stationary or integrated of order 1. The following vector error correction model is also used:

$$\Delta z_t = \mu + \alpha t + \lambda z_{t-1} + \sum_{i=1}^{p-i} \gamma_t \Delta y_{t-i} + \sum_{i=1}^{p-1} \gamma_t \Delta x_{t-i} + \varepsilon_t \tag{3}$$

Δ is then the difference operator and the long-run multiplier matrix is as follows:

$$\lambda = \begin{bmatrix} \lambda_{YY} \lambda_{YX} \\ \lambda_{XY} \lambda_{XX} \end{bmatrix}$$

The variable Y is then stationary if $\lambda_{yy} < 0$, and integrated of order 1 if $\lambda_{yy} = 0$

Assuming $\lambda_{yy} = 0$, $\mu \neq 0$ and $\alpha = 0$, the following unrestricted error correction model is then used:

$$\Delta(EQ) = \beta_0 + \beta_1 (HC)_{t-1} + \beta_2 (IC)_{t-1} + \beta_3 (EC)_{t-1} + \beta_4 (MN)_{t-1} + \sum_{i=0}^{p} \delta_1 \Delta(EQ)_{t-i}$$
$$+ \sum_{i=0}^{q} \delta_2 \Delta(HC)_{t-i} + \sum_{i=0}^{r} \delta_3 \Delta(EC)_{t-i} + \sum_{i=0}^{s} \delta_4 \Delta(IC)_{t-i} + \sum_{i=0}^{t} \delta_5 \Delta(MN)_{t-i} + \mu^t \tag{4}$$

Where u is white noise.

This last equation shows that domestic savings are also influenced by their own past values. As Bardsen (1989) points out, the estimation of unrestricted error correction models shows that long-run elasticities are given by the ratio of the

coefficient of a lagged endogenous variable to the coefficient of a lagged dependent variable, with short-run effects given by the coefficients of the first difference variables.

The following test (Wald test) was then used to understand the long term relationship between the different variables:

$$H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0 \quad \text{(No co-integration)}$$

Against the alternative hypothesis

$$H_1 : \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0 \quad \text{(Co-integration)}$$

At the end of this test, the non-rejection of the null hypothesis implies that there is no cointegrating relationship between the variables in presence, and in the contrary case, the rejection of this hypothesis means that there is indeed a cointegrating relationship between the variables considered.

Variable and Data Source

In this sub-section, the variables used for the analysis are presented together with data sources.

- Environmental Quality (EQ)

  In order to measure in environmental quality in Cameroon, we consider the fact that the highest type of greenhouse gas emitted in the country is CO2. As such, CO2 emissions are used as a proxy of environmental quality. Less emission would therefore indicate better environmental quality. The data for this variable is from the World Bank's World Development Indicators, online version.

- Human Capital (HC)

  Human capital here is captured by level of education. The proxy for educational performance is measured by secondary school enrolment ratio. This proxy has been used by previous authors such as Nkengfack *et al.* (2014) and we expect education to positively impact environmental quality, therefore a negative sign for its coefficient. The data is from the online version of the World Development Indicators published by the World Bank.

- Per Capita Income (IC)

  Per capita income (IC) captures the impact of the level of development on the environment. Theoretically, going from the assumptions of the Environmental Kuznets Curve (EKC), environmental pollution is high in developing countries, while the opposite effect is observed when these countries reach a certain level of income. Considering the weak economic performance of Cameroon due to its low technological development, it is expected that an increase in GDP per capita would be associated to an increase in total carbon dioxide emissions. Therefore, a positive sign of the coefficient of this variable would indicate support to the environmental Kuznets curve hypothesis. Data for this variable is retrieved from the World Development Indicators published online by the World Bank.

- Energy Consumption

  Power consumption refers to the use of fuel, coal, and natural gases as source of energy. Power consumption constitutes the second most important source of emissions of greenhouse effect gases at the global level. If the improve in the consumption of fossil energy is due to the good performance in the productive sector, the expected sign for its coefficient is positive. This variable is measured

in kg of oil equivalent per capita, and the data obtained from the World Development Indicators of the World Bank.

- Manufacturing (MN)
  The value added of the industrial sector captures the effects of industrial activities on CO2 emissions. Given the poor and obsolete nature of industrial facilities in the majority of developing countries, the sign of the coefficient is expected to be positive. The data for this variable is also obtained from the World Development Indicators by the World Bank.

RESULTS AND DISCUSSION

The results are discussed in three steps: the unit root test results, bound testing test results, the long run coefficients and the error correction model results.

Unit Root Test Results

The purpose of these tests is to check the order of integration of the variables in presence and to make sure that none of them is integrated of order higher than 1. The unit root test of Augmented Dickey-Fuller (ADF) is thus applied to all the series considered. The results obtained are in the following table:

Table 1. ADF unit root test results

Variables	ADF Test Statistics		
	Level	First Difference	Decision
LEQ	-1.651137	-4.495516***	I(1)
LHC	-4.131554**	----------------	I(0)
LIC	-2.165479	-6.939356***	I(1)
LEC	-0.247434	-5.408048***	I(1)
LMN	-1.332386	-5.137758***	I(1)

Note: (*), (**), (***) indicates significance at 10%, 5%, and 1% respectively

The unit root test results presented in Table 1 reach the conclusion that the variables are integrated of different orders but are all less than 2. Also, the dependent variable is I(1) as required. This not only validates the use of the bound testing approach to cointegration but imposes it as it is the only appropriate method when variables are integrated of mixed order (Pesaran *et al.,* 2001).

Cointegration Test Results

The first step of the bound test is to test the equation (4) given above. We can then perform different tests (error normality test, ARCH test, etc.). In this article, all the tests performed confirm that the model respects all the econometric assumptions: independent residuals, normally distributed and constant variance. The results of the different tests are presented in the appendices.

Table 2 presents the results of the restriction test (Wald test) performed on the estimation results of equation (4).

Table 2. Bounds Test for Cointegration Analysis

Wald F- Statistics	Critical value	Lower Bound Value	Upper Bound Value
	1%	3.74	5.06
10.55844	5%	2.86	4.01
	10%	2.45	3.52

Note**:** Computed F-statistic: 10.55844 (Significant at 0.01 marginal values). Critical Values are cited from Pesaran et al. (2001), Table CI (iii), Case III: Unrestricted intercept and no trend.

Since the calculated statistic (10.55844) is higher than the upper bound (4.01) in the table above, the null hypothesis of the Wald test given above must be rejected. Therefore, there is indeed a long-run relationship between environmental quality and its determinants in Cameroon.

Let us now proceed in turn to the estimation of the long-run and short-run coefficients.

Long-Run Relationship

The coefficients of the long run relationship between environmental quality and its determinants are presented in Table 3.

Table 3. Long-run coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LHC	-1.9301**	0.934923	-2.064448	0.0499
LEC	5.3807*	3.069594	1.752928	0.0924
LIC	1.6871***	0.515410	3.273434	0.0026
LMN	1.8675*	1.073087	1.740390	0.0946
C	-12.9587	11.253260	-1.151557	0.2608

Note: (*), (**), (***) indicates significance at 10%, 5%, and 1% respectively

The long run coefficients presented in Table 3 shows that human capital development improves on the quality of the environment by reducing the emission of greenhouse effect gases. Furthermore, the coefficient of per capita income (IC) is found to have a significant and positive impact on the emission of greenhouse gases. This implies degradation of environmental quality with increase in economic growth in accordance with the environmental Kuznets curve hypothesis. Also, energy consumption and manufacturing activities are found to degrade environmental quality at the 10% level of significance.

Short-Run Relationship

Table 4 presents the estimate of the short-term parameters. From this table we deduce the existence of an error correction mechanism, through the error correction variable, which absorbs more than 92% of the shock of the previous period. This table also shows that the past values of environmental quality, manufacturing sector and per capita income are significantly and positively correlated with environmental degradation.

Table 4. Short-run coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LEQ(-1))	0.5313**	0.179977	2.952543	0.0069
D(LHC)	-0.5583	1.621245	-0.344384	0.7336
D(LHC(-1))	-2.3934	1.545395	-1.548759	0.1345
D(LEC)	-3.8656	4.628912	-0.835113	0.4119
D(LEC(-1))	-2.4211	7.722632	-0.313511	0.7566
D(LEC(-2))	-0.2772	7.112947	-0.038984	0.9692
D(LEC(-3))	-10.4615*	5.148331	-2.032030	0.0534
D(LIC)	3.5983	2.882649	1.248281	0.2240
D(LIC(-1))	1.4578	3.651149	0.399292	0.6932
D(LIC(-2))	-2.4034	3.769356	-0.637625	0.5298
D(LIC(-3))	8.3062**	2.672512	3.108033	0.0048
D(LMN)	-0.2470	1.774710	-0.139185	0.8905
D(LMN(-1))	1.9374	2.359680	0.821066	0.4197
D(LMN(-2))	-0.8807	2.297923	-0.383276	0.7049
D(LMN(-3))	3.8041**	1.743378	2.182044	0.0391
ECT(-1)	-0.9285***	0.231078	-4.018449	0.0000

Note: (*), (**), (***) indicates significance at 10%, 5%, and 1% respectively

If we stick to the long-run analysis, where all the calculated coefficients (except the constant) are significant at the 1%, 5% or 10% level, we find that the quality of human capital and the quality of the environment move in the same direction. This result is identical to those of previously cited works, including Brasington and Hite (2003), Jalan, Somanathan and Chaudhuri (2009), Serkan (2009), Jing Lan and Munro (2012). It is also consistent with the U-shaped curve obtained by Li and Xu (2021) between environmental quality and human capital development, showing that environmental degradation would be reduced with human capital development. This also answers the purpose of this study, which was to examine how the level of human capital in a developing country affects environmental quality.

The sign of the coefficients of the variables (income per capita, energy consumption, manufacturing) shows that these variables significantly contribute to environmental degradation. Their common positive sign is easily interpreted: the higher the income, the more energy and manufacturing goods are consumed, and the more polluting waste is released into the environment. One might then ask whether it is not the best educated individuals who also have the highest incomes. One possible answer is that the best educated individuals might also be the most sensitive to environmental concerns. However, these results must be put into perspective, given the small sample size.

CONCLUSION

The aim of this paper was to analyse the impact of human capital development, notably education, on environmental quality. To achieve this objective, the study employed the ARDL bound testing cointegration approach to analyse time series data obtained from the online version of the World Development

Indicators of the World Bank. The theoretical hypotheses of the model of Goetz et al. (1998) were tested together with that of the environmental Kuznets curve.

The results obtained show that human capital development improves on environmental quality by reducing the emission of greenhouse gases. Furthermore, support is found for the existence of the environmental Kuznets curve in Cameroon. These results have far reached theoretical and policy implications.

First, it adds evidence of the effect of human capital and specifically environmental education on improving the quality of the environment. Secondly, it provides support to the existence of the environmental Kuznets curve for the case of Cameroon. Finally, it provides a means of improving environmental quality in Cameroon through environmental human capital development.

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