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Effect of Institutional Quality on Environmental Quality in Waemu Countries

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Abstract
This paper analyzes the relationship between institutional quality and environmental quality. To do so, we use a new approach, the model of Cole et al (2007). This model allows for the simultaneous testing of two theoretical hypotheses, namely the Kuznets environmental equation and the endogenous growth equation. However, the institutional quality variable (government effectiveness) in each equation to understand the effect of this variable on both hypotheses, we estimate the Cole (2007) empirical model. The data used in this chapter are for the eight WAEMU countries and cover the period from 1996 to 2017. The results of this paper show that institutional quality has a significant and negative effect on the environmental Kuznets curve. In other words, as the quality of institutions decreases in the WAEMU, CO2 emissions increase. Regarding the endogenous growth equation, the results show that institutional quality has a positive and significant influence on the endogenous growth equation.

Key words*: quality of institutions, Kuznets environment curve, endogenous growth.*

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I. INTRODUCTION

In recent years, one of the concerns of the international community is the issue of global warming and other environmental difficulties, indeed environmental issues have received much attention. According to Kijima et al (2010), it is imperative for the government department in charge of environmental policy to capture and publish the evolution of environmental quality over time. To do this, it is essential to develop models to determine the relationship between environmental quality and economic growth.

In developing countries, the issue of the environment is approached from a double prism: namely, the imposed obligations to restrict food production and agriculture, due to numerous threats; for example, degradation of land, water, marine resources, and air pollution; and the loss of biodiversity, due to mass pollution, and emissions of other greenhouse gases that positively threaten the well-being of the ozone layer and contribute to the warming of the lower atmosphere, which is the physical consequence of climate change Many analyses have been conducted on environmental degradation and the factors that determine it. However, very little analysis has been done on the role of institutions in mitigating environmental stress. This analysis differs from the existing literature in two respects: first, most analyses in this area focus more on growth, financial expansion, and trade openness, and pay less attention to environmental policy aspects. Second, much attention has been paid to developed countries, ignoring developing countries where the difficulties are equally or more evident.

In general, the majority of African nations are characterized by weak institutions and poor governance (International Bank, 2010). Corruption data collected on WDI shows that almost all member nations of the WAEMU countries had a below average corruption perception index in 2017, indicating that corruption is considered "endemic" to the governance system. This finding is necessarily forced as it is indicative of the institutional failures that may be holding back economic growth and earnings levels in these economies (Lambsdorff, 2007).

In addition, WAEMU countries experienced strong economic growth of around 6.07% in 2017, which had little impact on poverty and people's happiness. In these WAEMU countries, corruption occurs frequently and takes the form of embezzlement of public funds, influence trafficking and fraud. The spread of corruption and its structural registration in all spheres of political, social and economic life is only possible because, thanks to the pervasive culture of zero tolerance, concessions and permissiveness, it has become an internal mode of operation by corruptors and swindlers, mainly institutionalized and systematized (Tamba, 1999). In addition, the quality of government institutions and systems directly or indirectly affects the quality of the environment.

Institutional quality helps to reduce pollution levels and improve the environment by facilitating a more equitable distribution of income and power (Hassan et al. 2020).

The objective of this paper is to analyze the effects of institutional quality on environmental quality: first to examine the indirect effect of institutional quality on environmental quality through economic growth; second to examine the direct effect of institutional quality on environmental quality. The rest of this paper is structured in four sections. Section 2 present literature reviews, section 3 presents the methodology and section 4 presents and comments on the results of the estimation of the model. Section 5 concludes.

II. LITERATURE REVIEWS

II.1 Theoretical review

The literature on the link between economic development and environmental degradation has two theoretical foundations. The first section discusses the traditional theory based on the CEK hypothesis, the assumption that the relationship between several indicators of environmental degradation and income has an inverted Kuznets U-shape. The second is more recent and is considered an alternative to CEK (Stern, 2014). It is based on the convergence assumption that countries will converge on emissions (Brock and Taylor, 2010). In other words, environmental degradation will first increase in poor countries with high economic growth before weakening as they catch up with rich countries.

II.1.1 The CEK hypothesis

The CEK hypothesis was first explained by the combination of three types of effects that occur during development: The production scale effect implies that an increase in production is accompanied by an increase in output. Composition effects taking into account the increasing levels of pollution of different industries and technological efficiency describe technological changes in the production process (Panayotou, 1993; Grossman and Krueger, 1993; 1995). After that, theoretical models began to develop. According to Bruyn and Heintz (2002) and Kijima et al. (2010), the theoretical mechanisms underlying these models are based on three factors: behavioral and preference change, institutional change, and technological and organizational change. These theoretical models can be classified into two groups: static models and dynamic models (Kijima et al. 2010). In a dynamic approach, John and Pecchenino (1994) use a nested generations model, in which each agent lives in two periods and divides his income between his consumption and waste disposal efforts. He shows that the pollution factors are inverted U-shaped adjusted for income levels. This can be shown by the fact that the economy has a low capital reserve at the outset, and therefore each first generation agent has a low income, so no one spends money on rehabilitation, which leads to a degradation of environmental quality. Then, over time, capital accumulates and income increases. Second generation dealers care about the environment and invest in remediation. As a result, the quality of the environment is improved.

II.1.2. Convergence Hypothesis

The convergence hypothesis is a new approach to understanding the relationship between the environment and economic growth. This hypothesis has been theoretically highlighted by the work of Brock and Taylor (2010) based on stylized facts. These authors start from Solow's (1956) growth model and argue that the forces that reduce profits and technical progress identified by Solow as fundamental to the growth process may also be fundamental to the growth-environment relationship. They therefore modified Solow's model by assuming that production generates pollution and that a constant portion of this production is allocated to clean-up activities through technical progress in reduction. The results of the model show that countries will converge on emission levels. In other words, emissions will initially increase in poor countries due to rapid growth but will then decrease as growth slows (due to converging forces for developed countries near a specified steady state). These results imply that the mechanism for managing emissions is the decline in output growth caused by converging forces accompanied by a steady rate of technical progress in reducing pollution. However, Stefanski (2010) points out that the emissions trajectories of developing countries can also be driven by changes in the growth rate of emissions intensity due to the structural transformation of these economies. In the literature, there are three types of convergence: first, beta convergence, which means that poor countries tend to grow faster (and therefore pollute more) than rich countries (SalaiMartin, 1996).Second, sigma convergence is defined as the convergence that occurs if the dispersion of the real level of GDP per capita in a group of countries tends to decrease over time (Salai Martin, 1996). This means that in the case of pollution, countries will have approximately equal average emissions or deforestation in the long run. Finally, random convergence states that a pair of countries converge at random if the difference in their emissions is fixed (Aldy, 2006).

II.2 EMPIRICAL REVIEW

II.2.1 Relationship between institutional quality (corruption) and economic growth

Corruption, a component of institutional quality that hinders economic growth (Kaufmann, 1997; Mauro, 1998; Tanzi and Davoodi, 1997), finds that it is not small.

According to much of the literature, corruption is seen as a brake on economic growth because of its impact on the mitigation of many aspects of the general economic environment such as the risk of expropriation, property rights, infrastructure quality, market functioning, bureaucratic efficiency, political and institutional stability, etc., and in terms of attracting foreign investment in particular. However, most economists agree that economic growth should be driven and sustained by the private sector.

Other, lesser authors argue that corruption should be seen as a means of stimulating the economies of developing countries, which are hampered by many institutional and bureaucratic pitfalls. They are proponents of "effective corruption". According to functionalist theory, corruption (like any other social arrangement) arises from an institutional vacuum and performs a social function that would otherwise not be fulfilled; therefore, it is not inherently reprehensible. Previous literature has mainly suggested that corruption will do the job in highly centralized economies and that it will be a means of reducing unnecessary bureaucratic burdens and avoiding delays for firms, thereby increasing their productivity. Under this assumption, the impact of corruption on economic growth would be positive. Lui (1985) argues that the work efforts of public officials can be made more efficient through corruption. In addition, it has also been argued that a system based on corruption would lead to an efficient process of awarding licenses and government contracts (bidding), as the most efficient firms would be able to pay the best bribes (Lui, 1985). The overall efficiency of the economy will be increased.

Moreover, recent theoretical and empirical literature suggests less optimistic growth scenarios for countries affected by corruption. BecherairOmrane (2016) studies the effect of corruption on economic growth in Algeria between 1995 and 2012, using an endogenous growth model that takes corruption into account. The main results of this empirical test show that there is a significant and negative association between corruption and investment on the one hand, corruption and public spending on the other, and the negative impact of corruption on economic growth.

2.2.2 The relationship between institutional quality (corruption) and the environment

Some authors point out that the solution to the problem of corruption would be less state involvement in the economy, including less regulation and less policy than in general (Lambsdorff, 2007). However, it is recognized that state intervention in economic activity is important when there are market imperfections (Acemoglu, 2000). In the literature, several authors point out that environmental goods (which are public goods) are characterized by externalities and well-defined property rights. Therefore, environmental problems cannot be solved by market forces alone, but state intervention is necessary to ensure optimal management and distribution of these problems. Empirical assessments of the effects of corruption on environmental quality are scarce, especially for African countries, and the findings are largely controversial; leading to uncertainty about the magnitude and consequences of such an impact (Welsch, 2004).

First, corruption has been shown to contribute to the negative impact of economic growth on environmental quality. Desai (1998) found that, in a database of ten developing countries, corruption contributes to increased environmental degradation. The idea is that corruption can affect the implementation of environmental regulations in general and, in general, will lead to the deterioration of environmental quality.

Second, authors like Cole (2007) argue that by reducing economic growth, corruption contributes to the preservation of environmental quality. It is intuitive that, on the one hand, economic growth is positively correlated with environmental degradation and, on the other, corruption is negatively related to economic growth. By slowing down the latter process, the indirect impact of corruption on environmental quality will be negative. Furthermore, Welsh (2004) found that any reduction in the level of corruption leads to economic growth and ultimately to an improvement in environmental quality. Given the above findings, there does not seem to be a clear consensus on the question of the impact of corruption on environmental quality. Yet the findings converge. There are two mechanisms through which corruption degrades environmental quality: (i) through environmental regulation (direct effects), (ii) through economic growth (indirect effects).

III. METHODOLOGY

This section presents the methods used to analyze the relationship between environment and income. We first specify the econometric model and then discuss the problems associated with parameter identification.

III.1 Econometric model

Our model is based on the new approach developed by Cole et al (2007). This approach establishes a simultaneous equation that takes into account both the conceptual framework of endogenous growth theory and the EKC hypothesis on the one hand, but also takes into account unobserved country specificities due to the fact that it is a panel specification.

The advantage of this model is that it captures both the direct and indirect effects of corruption on environmental quality. The equation in Cole (2007) is as follows:

$$\begin{cases} \ln E_{it} = \alpha_1 \ln Corr_{it} + \alpha_2 \ln Y_{it} + \alpha_3 (\ln Y_{it})^2 + \alpha_4 Z_{it} + \gamma_i + \sigma_t + \mu_{it} & (1) \\ \ln Y_{it} = \beta_1 X_{it} + \beta_2 \ln Corr_{it} + \lambda_i + \eta_t + \varepsilon_{it} & (2) \end{cases}$$

The subscripts i and t represent the country and year, respectively. The variable E represents the per capita emissions of pollutants. The variable Corr represents corruption, Y represents per capita income (GDPhab), Z represents a vector of control variables and X represents a vector of additional explanatory variables, generally used in the endogenous growth literature. The purpose of the Kuznets environmental curve equation (1) is to show that the transition to better environmental quality occurs as income increases; whereas the purpose of the endogenous growth equation (our production function) is to explain economic growth from a microeconomic process and decisions. Specifically, it bases economic growth as measured by per capita GDP on the per capita stock of physical capital, the per capita stock of human capital, and the growth rate of the labor force over the total population, primarily. By adding the corruption variable, it would thus be possible to capture the direct effect of corruption on economic growth and to better understand the indirect effect of corruption on the environment through economic growth.
Empirically, these different effects can be calculated as follows.

Table 1: Decomposition of the different effects of corruption on the environment

Nature of the effect	**Assessment of the effect**
Directeffect	$\frac{\partial \ln E}{\partial \ln Corr}$
Indirect effect	$\frac{\partial \ln E}{\partial \ln Y} x \frac{\partial \ln Y}{\partial \ln Corr}$
Net effect	$\frac{\partial \ln E}{\partial \ln Corr} + \frac{\partial \ln E}{\partial \ln Y} x \frac{\partial \ln Y}{\partial \ln Corr}$

Source : COLE 2007

We also add, separately, the Ide and Trade variables to test the impact of foreign direct investment on environmental quality on the one hand, and the effect of trade openness on the other, in order to provide more robust inferences on the relevance or not of the pollution haven hypothesis.

We will consider a panel specification following Cole (2007) in order to take into account unobserved specificities across countries. However, the lack of data on relevant instruments for the countries in the sample did not allow us to instrument for corruption in the same sense, (Cole et al. 2006; Wei, 2001) attest that accounting for the impact of corruption on the relationship between foreign direct investment and environmental quality would improve the relevance of the pollution haven hypothesis. Specifically, we will replace the corruption variable (Corr) with IQ (Institutional Quality) in the augmented Cole (2007) equation, and becomes as follows:

$$\begin{cases} \ln CO_{it} = \alpha_1 \ln PIBhab_{it} + \alpha_2 (\ln PIBhab_{it})^2 + \alpha_3 \ln QI_{it} + \alpha_4 \ln Z_{it} + \gamma_i + \sigma_t \mu_{it} & (3) \\ \ln PIBhab_{it} = \beta_1 \ln X_{it} + \beta_2 \ln QI_{it} + \beta_3 \ln TRADE_{it} + \lambda_i + \eta_t + \varepsilon_{it} & (4) \end{cases}$$

Equation (3) corresponds to a modified CEK equation. It expresses polluting emissions per capita as a function of real GDP per capita (Y). This indicator is used here as a proxy for environmental quality mainly because of the availability of data for our sample. Specifically, it refers to carbon dioxide emissions per capita (CO2). The inclusion of real GDP per capita squared allows for the reversal of the CEK. In addition, the traditional form of the CEK is augmented by including the corruption indicator.

The institutional quality perception index is used to capture the level of institutional quality. However, we will reverse the initial scale of this indicator, so that the index still ranges from 0 to 10, but with values near 0 reflecting rather low levels of institutional quality, and values near 10 reflecting high levels of institutional quality.

Where Z is a vector of control variables as before; in view of the literature, we add foreign direct investment (Ide), industrialization (Ind), literacy rate (Edu), labor force growth rate (Pop) and trade openness

(Trade). The Trade variable is added to the endogenous growth equation because the economic performance of WAEMU countries is for the most part highly dependent on international commodity prices.

Equation (4) expresses real GDP per capita as a function of the level of institutional quality QI and a vector of control variables X. The vector X encompasses a number of control variables commonly found in the economic growth literature, the per capita physical capital stock proxy for gross fixed capital formation (Inv), the human capital stock, the literacy rate (Edu), industrialization (Ind), and the population growth rate (Pop) (Mankiw et al. 1992).

Also, the error terms are of the form , so we take into account the country fixed effects in our estimates.

III.1.1 Stationarity test

To check the stationarity of the data series, we will use two (2) types of unit root tests: Levin, Lin and Chu test (LLC, 2002) and Im, Pesaran, Shin test (IPS, 2003).

- Levin, Lin and Chu test (LLC, 2002)

The test proposed by these authors is based on the ADF test (Augmented Dickey - Fuller test) which assumes homogeneity in the dynamics of the autoregressive coefficients for all the units of the cross-sectionally independent panel. They consider the following equation:

$$\Delta y_{it} = \alpha_1 + \beta_1 y_{i,t-1} + \delta_i t + \sum_{j=1}^{k} \gamma_{ij} \Delta y_{i,t-j} + \varepsilon_{it} \qquad \textbf{(3)}$$

Where is the first difference, is the independent variable, is a white noise disturbance with a variance of , i is country index and t indicates time.

$$\begin{cases} H_0 : \beta_i = 0 & \forall_i \\ H_1 : \beta_i \prec 1 \qquad H_1 : \beta_i \prec 1 & \forall_i \end{cases}$$

- Im,Pesaran, Shin test (IPS, 2003)

Contrary to Levin, these authors proposed a non-restrictive test, the coefficients being heterogeneous. The hypothesis test becomes:

$$H_0 : \beta_i = 0 \qquad H_1 : \beta_i \prec 1$$

$$\begin{cases} \text{Pour } i=1,2,\ldots\ldots, M & \beta_i \prec 0 \\ \text{Pour } i= M+1 \ldots\ldots N & \beta_i = 0 \end{cases}$$

Clearly, under the null hypothesis, all individuals have unit roots, while the alternative hypothesis allows some individuals to have unit roots. In practice, the average of the individual unit roots are used to perform this test

Table 2 is the results of the unit root tests which show that all variables are stationary at level for the variables (LQI, IDE, IND, POP) and in first difference for the variables (LCO2,LPIBhab,LINV,LTRADE, EDU).

Table 2: Stationarity test

Variables	**LLC**		**IPS**	
	niveau	différence 1ère	Niveau	différence 1ère
LCO2	-0,3583 (0,3600)	-6,8029*** (0,0000)	0 ,5101 (0,6950)	-6,7260*** (0,0000)
LQI	-9,4510*** (0,0000)	-3,9431*** (0,0000)	-6,5769*** (0,0000)	-4,2564*** (0,0000)
LPIBhab	-1,0197 (0,1539)	-5,4564*** (0,0000)	3,2411 (0,9994)	-5,3512*** (0,0000)
INV	-1,6370 (0,0508)	-5,8401*** (0,0000)	-0,7919 (0,2142)	-6,6959*** (0,0000)
LTRADE	0,2213 (0,5876)	-3,6589*** (0,0001)	0,8715 (0,8083)	-4,3965*** (0,0000)
IDE	-2,8580*** (0,0021)	-5,0154*** (0,0000)	-2,2620* (0,0118)	-7,1802*** (0,0000)
IND	-2,1681* (0,0151)	-6 ,3165*** (0,0000)	-2,4958* (0,0063)	-6,7260*** (0,0000)
POP	-9,8862*** (0,0000)	-10,1204*** (0,0000)	-8,4669* (0,0000)	-10,9119*** (0,0000)
EDU	-2,8757*** (0,0020)	-3,6802*** (0,0001)	-0,4786 (0,3161)	-3,2153*** (0,0007)

Note: *** and ** indicate statistical significance at the 1% and 5% level, respectively. The null hypothesis is the non-stationarity hypothesis. Shift selection (Automatic) based on Schwarz information criteria (SIC).

III.1.2. Verification of the identification criteria

There are several methods for estimating a simultaneous equation model, the choice of method depends on the identification conditions.

We distinguish between the estimation methods known as limited information methods (among which we have the indirect least squares method (ILS), the double least squares method (DLS) and the limited information maximum likelihood methods) and the complete information methods (among which we have the triple least squares (TLS) and the complete information maximum likelihood method).

The full information methods turn out to be potentially more efficient than the limited information methods. To this effect, if the triple least squares method (TLS) allows a gain in efficiency compared to the double least squares (DLS), it should be noted that this method is weakened in the presence of specification errors.

These conditions are determined equation by equation. We distinguish three cases of identification:

Table 3: Model identification conditions

Identification Cases	Conditions	Estimation methods
The under identification	g-1 > (g-g') + (k-k')	Estimation impossible
The right identification	g-1 = (g-g') + (k-k')	MCI ou DMC
Over-identification	g-1 < (g-g') + (k-k')	DMC ou TMC

Source: by the author from the literature review

g : is the number of endogenous variables in the model, or the number of equations in the model. g' : is the number of endogenous variables in an equation. k : is the number of exogenous variables in the model.

k' : is the number of exogenous variables in an equation.

Calculation

g = 2 g'=2 , k=6 and k'=1 so g-1 < (g-g') + (k-k') means that 1<5

The results of the identification calculations show that our model is over identified. For its estimation, the appropriate method is the one of the Triple Least Squares (TLS).

3.1.3. Strategy of the identification of the method

The estimation method used is that of the triple OLS. This estimation technique makes it possible to estimate a system of structural equations, where the explained variables of certain equations are found to be the explanatory variables of other equations. Recall, however, that the technique used estimates a simultaneous equation model to allow for the presence of dynamic effects between institutional quality, income growth and CO_2 emissions (in this case, environmental quality). This estimation technique shares the following advantages:

- It allows for the possible problem of endogeneity between the explanatory variables of the model and the error term.
- It uses all the information available on the model variables.
- It can also estimate the systems of equations by a seemingly independent regression estimate, a multivariate regression and by ordinary least squares (OLS) or even double ordinary least squares (2OLS).

We then use the Hausman test to choose between the fixed effect and the random effect, which one is appropriate for our study.

Our approach in this work is to assess the effect of institutional quality on environmental quality, here represented by the level of CO_2 emissions. This approach will allow us to capture both the direct and indirect effect of institutional quality on the environment. Moreover, the choice of this approach is motivated by the availability of data on environmental quality, such as the CO_2 emission rate, for the countries in our sample.

3.2 Data

In this section we describe the dependent variable and other variables that may be determinants of CO_2. Then we present the descriptive statistics of these variables.

3.2.1. Description of the variables

The sample used in this study consists of eight African countries, members of the WAEMU zone. Our study covers the period from 1996 to 2017, mainly because of the availability of data.

3.2.2. CO_2 emissions per capita

The use of CO_2 emissions as a proxy for environmental quality often poses a problem of relevance according to the authors. The use of this variable as a proxy for air pollution could be justified on at least two levels:

First, CO_2 is the main greenhouse gas responsible for climate change. Its regulation would therefore be an issue of paramount importance. Second, databases on CO_2 emissions are available, unlike the other indicators for which very little data exists, especially for the countries included in the study.

3.2.3 Explanatory variables
Several factors are at the origin of environmental degradation. In this research, we use the macroeconomic and institutional variables that are relevant from the literature and available data.
3.2.3.1 The quality of institutions
Institutions play an important role in environmental protection: either by financing cleanup activities or by clearly defining property rights. Thus, the quality of the environment is only the result of the interaction between pollution and cleanup, which is ensured by the regulatory authorities (Panayotou, 1997). In our study, institutional quality includes six (6) institutional indicators in the political domain according to the World Bank; which are political stability and violence, democratic expression and accountability, effectiveness of public governance, quality of administrative regulation, quality of legal procedures, and control of corruption.
3.2.3.2 GDP per capita
GDP captures the impact of increasing income levels on environmental quality. Theoretically, the EKC hypothesis posits that environmental degradation is accelerated in developing countries, while the opposite effect could be observed if they reach a certain level of income. Given the low economic performance associated with the low level of technological development of the countries in our sample, we can expect that any unit increase in GDPH is associated with an increase in the quantities emitted of CO2. Thus, the expected sign is positive.
3.2.3.3. The population growth rate
The population is also an important variable of the environmental degradation. Indeed, the increase of the active population induces the increase of food needs, which results in the overexploitation of resources on the one hand and thus a reduction of the available stock and an increase of polluting emissions on the other. This analysis is shared by several authors (Malthus, 1894; Azomahou et al. 2007, etc.). In this way, we hope to obtain a positive sign between the working population and greenhouse gas emissions and a negative sign between the working population and economic growth.
3.2.3.4. The value added of the industrial sector
It captures the effects of industrial activities on CO2 emissions. Given the dilapidated state of industrial facilities in most developing countries, we expect a positive sign.
3.2.3.5. Foreign trade
This variable captures the effects of international trade (or trade openness) on environmental quality. International trade theory indicates that trade openness leads to an increase in economic growth in the various participating countries. In developed countries (DC), the imposition of strong environmental regulations generally results in the relocation of polluting industries to countries with weak environmental regulations. In developed countries (DC), the pollution haven hypothesis reduces environmental degradation, while the opposite effect is observed in developing countries. In this way, we can expect a positive relationship between the latter and CO2 emissions.
3.2.3.6. Gross domestic investment
Gross domestic investments are used here to capture not only the contribution of their increase on environmental degradation, but also on economic growth. We postulate that gross domestic investment is positively related to economic growth, and since we have previously postulated that economic growth is positively related to environmental degradation, we can expect gross domestic investment as a % of GDP to be positively related to environmental degradation.
3.2.3.7. Foreign Direct Investment
The use of this variable will serve as evidence on the validity of the pollution haven hypothesis. Assuming that environmental regulations in the countries in our sample are flexible or lax, investors will be encouraged to relocate their polluting production to countries with more flexible regulations. All of this leads us to postulate a positive relationship between foreign direct investment and the deterioration of environmental quality in the countries of the WAEMU zone.
3.2.3.8 Literacy rate
Education is a key factor in environmental protection. It makes it possible to modify the environmental preferences of economic agents and increase demand for environmental quality. Indeed, education allows agents to have more access to information about the harmful effects of environmental degradation and can therefore change their behavior (Bimonte, 2002). Furthermore, according to Farzin and Bond (2006), an educated population is more receptive to environmental protection measures implemented by regulatory authorities to improve environmental quality. These authors have shown that there is a negative correlation between the literacy rate and environmental policy measures.
3.2.4. Descriptive Analysis
This analysis focuses on the descriptive statistics and correlation pairs of the different variables. Tables 1.6, 1.7 and 1.8 present the descriptive statistics and correlation pairs (of the environmental Kuznets curve model and the endogenous growth model, respectively).

Table 4: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
LCO2	176	-.7103224	.3440273	-1.30103	-.1307683
LQI	176	.8885705	.18663	.39794	1.146128
LTrade	176	1.781593	.1252657	1.487563	2.097014
LPOP	176	.4434236	.0759073	.2296221	.5847
LIND	176	1.279631	.0912566	1.037825	1.473049
IDE	176	2.386399	2.739551	-1.054363	19.37574
LINV	176	1.261794	.1726934	.6724418	1.602577
LPIBhab	176	5.451142	.2131383	4.976186	5.98574
LEDU	176	1.904338	.1554763	1.447313	2.208388

Source: Author's calculation

Table 2.1 shows that the sign of CO2 is negative (increases by 0.71%), which is indicative of the degradation of environmental quality (CO2 emissions). The maximum value is negative (-0.13), which proves that the WAEMU countries must implement processes to reduce CO2 emissions.

The logarithm of the quality of institutions is positive (0.88%) with a positive maximum value (1.14), which implies that a good quality of institutions could increase the rigor of environmental regulations resulting in a decrease in corruption and CO2 emissions (Damania et al, 2003).

The log Trade is positive (1.78%) with a positive maximum value (2.09), implying that trade openness would indicate a likely level of corruption (Hall and Janes, 1999). This could aptly increase CO2 emissions.

On the other hand, the log GDPhab is positive (5.45%) with a positive maximum value (5.98), implying that economic growth has a causal impact on environmental degradation. CO2 can affect GDP per capita (Apergis and Payne, 2009).

Similarly, the log POP is positive (0.44%) with a positive maximum value (0.58), which implies that an increase in urban population induces the increase of food needs, which translates into the overexploitation and reduction of natural resources and the increase of polluting emissions. This analysis is shared by several authors (Malthus, 1894; Azomahou et al. 2007)

The logarithm of industrialization is positive (1.27%) with a positive maximum value (1.47), which implies that the industrial sector captures the effects of industrial activities on CO2 emissions. Given the age of industrial facilities in most developing countries. The logarithm of gross capital formation (Inv) is positive (1.27%) with a positive maximum value (1.60), in fact gross capital formation is one of the determinants of economic growth which implies that it could have a causal impact on environmental degradation. Finally, the logarithm of the literacy rate (EDU) is positive (1.90%) with a positive maximum value (2.20), which implies that a well-educated population could enforce good environmental regulations resulting in a reduction of CO2 emissions.

Table 5: Analysis of the correlation between the different variables of the environmental Kuznets curve model.

	LCO2	LPIBhab	LQI	LTrade	LIND	IDE	LINV	LEDU	LPOP
LCO2	1.0000								
LPIBhab	0.6819*	1.0000							
	(0.0000)								
LQI	0.2502*	0.6024*	1.0000						
	(0.0008)	(0.0000)							
LTrade	0.5720*	0.4567*	0.3086*	1.0000					
	(0.0000)	(0.0000)	(0.0000)						
LIND	0.3868*	0.5150*	0.2753*	0.2099*	1.0000				
	(0.0000)	(0.0000)	(0.0002)	(0.0052)					
IDE	-0.0464	-0.0287	0.2725*	0.3258*	-0.0816	1.0000			
	(0.5410)	(0.7052)	(0.0003)	(0.0000)	(0.2817)				

LINV	0.0185	0.0295	0.4019*	0.0474	0.2452*	0.3525*	1.0000		
	(0.8079)	(0.6978)	(0.0000)	(0.5319)	(0.0010)	(0.0000)			
LEDU	0.5297*	0.4866*	0.3344*	0.4625*	-0.0121	0.1100	-0.0370	1.0000	
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.8730)	(0.1461)	(0.6261)		
LPOP	3924*	0.1664*	-0.2929*	-0.2563*	0.0573	0.2689*	0.4968*	-0.2893	1.0000
	(0.0000)	(0.0273)	(0.0001)	(0.0006)	(0.4498)	(0.0003)	(0.0000)	(0.0001)	

Sources: Author from stata, values in parentheses represent standard deviations. (* 1% level of significance)

The above table provides information on the correlation between the different explanatory variables and the explained variable of the EKC equation. Income per capita and CO2 emissions are positive for the WAEMU zone, this link between these two variables is very important and also significant at the 1% level. The correlation between institutional quality and CO2 emissions is positive and significant at 1%, which would imply that a good level of institutional quality would lead to an improvement in environmental quality for the countries in our study. The correlation between GDP and CO2 emissions is also positive and significant at the 1% level, which would imply that an increase in GDP will lead to an increase in CO2 emissions for the countries in our study.

The correlation between trade openness and CO2 emissions is positive and significant at the 1% level, which would imply that trade openness contributes to CO2 emissions. The correlation between industrialization and CO2 emissions is positive and significant at the 1% level, which would imply that industrialization leads to environmental degradation in WAEMU countries. The labor force growth rate is negatively and significantly correlated at 5% and 1% with CO2 emissions. The correlation between the literacy rate and CO2 emissions is positive and significant at 5% and 1%, which would imply that when a population is well educated it could practice good environmental regulation.

Table 6: Analysis of the correlation between the different variables of the endogenous growth model

	LPIBhab	**LCorr**	**LINV**	**LTrade**	**LEDU**	**IDE**	**LPOP**
LPIBhab	1.0000						
LQI	0.6024*	1.0000					
	(0.0000)						
LINV	0.0295	0.4019	1.0000				
	(0.6978)	(0.0000)					
LTrade	0.4567*	0.3086	0.0474	1.0000			
	(0.0000)	(0.0000)	0.5319				
LEDU	0.4866*	0.3344	-0.0370	0.4625	1.0000		
	(0.0000)	(0.0000)	(0.6261)	(0.0000)			
IDE	-0.0287	0.2725	0.3525	0.3258	0.1100	1.0000	
	(0.7052)	(0.0003)	(0.0000)	(0.0000)	(0.1461)		
LPOP	-0.2929*	0.1664	0.4968	-0.2563	-0.2893	0.2689	1.0000
	(0.0001)	(0.0273)	(0.0000)	(0.0006)	(0.0001)	(0.0003)	

Sources: Author from stata, values in parentheses represent standard deviations. (* 1% level of significance)

In this table, the correlation between the explanatory variables and the explained variable of the endogenous growth equation is highlighted. The quality of institutions is positively and significantly related to per capita income at the 5% and 1% level, which implies that good quality institutions should lead to an increase in the level of per capita income. Trade openness and literacy rate are positively correlated with per capita income. However, the population growth rate is negative and significant at 5% and 1% of per capita income. This implies a drag on economic growth.

III. RESULTS AND DISCUSSIONS

Table 7: Estimation of the environmental Kuznets curve model and the endogenous growth model.

Equation I dependent variable logCO2/tête	**Coefficients** P-value	**Equation II** dependent variable log PIBhab/tête	**Coefficients** P-value
LQI	-0,6486473***	**LQI**	0,5257589***

	(0,000)		(0,000)
LPIBhab	17,80105***	**LTrade**	0,1829654**
	(0,007)		(0,032)
LPIBhabsq	-1,5190087**	**LIND**	1,001878***
	(0,013)		(0,000)
LTrade	0,7718741***	**LEDU**	0,3823702***
	(0,000)		(0,000)
IDE	-0.030783 *	**LINV**	-0,3152991***
	(0,090)		(0,000)
LPOP	-0,7432274 ***	**constant**	3,044468***
	(0,014)		(0,000)
LINV	0,4348949***		
	(0,001)		
constant	-53,5249***		
	(0,003)		
Observations	**176**	**Observations**	**176**
Number of country	**8**	**Number of country**	**8**
Fisher/Wald chi^2	**288,42**	**Fisher/Wald chi^2**	**368,50**
(p-value)	**(0,000)**	**(p-value)**	**(0,000)**
R^2	**0,5394**	**R^2**	**0,6767**

Note: Authorship from Stata 14.0. Values in parentheses represent p-value. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 8: Effect sizes of institutional quality on environmental quality.

Nature of the effect	Evaluation of the effect	Algebraic value
Direct effect	$\frac{\partial \log E}{\partial \log QI} = \alpha_3$	**-0,64**
Indirect effect	$\frac{\partial \log E}{\partial \log Y} x \frac{\partial \log Y}{\partial \log QI} = \beta_2(\alpha_1 + 2\alpha_2 \log Y)$	**0,39**
Net effect	$\frac{\partial \log E}{\partial \log QI} + \frac{\partial \log E}{\partial \log Y} x \frac{\partial \log Y}{\partial \log QI}$	**-0,25**

Note: Authors' calculations based on estimation results.

Table 1.9 presents the estimation results for the environmental Kuznets curve model and the endogenous growth model, respectively.

The post-estimation tests were Fisher and Wald chi tests. These tests are statistically significant at the 5% level for both equations. The estimation results indicate:

- Environmental Kuznets curve model.

Institutional quality is negatively related to environmental degradation because its effect on the institutional quality variable is negative and significant at the 5% level. This implies that poor institutional quality would lead to significant degradation of environmental quality. The quality of institutions has a direct negative and significant effect on the rate of CO_2 emissions in the WAEMU economies. This implies that poor institutional quality would contribute directly to the increase in CO_2 emissions. This is consistent with theoretical predictions of the main transmission mechanism of the direct effect of corruption on the environment via the weakening of environmental regulations (Cole, 2007; Pellegrini and Gerlagh, 2006; Welsch, 2004). By weakening environmental regulations in WAEMU economies, corruption contributes directly to the degradation of environmental quality.

The results of the model indicate the presence of an EKC curve for WAEMU countries. This would imply that these countries have reached a level of income such that any increase would be followed by an improvement in environmental quality. This is shown by the signs associated with the GDP and GDP2 variables in the table.

Moreover, trade openness is positively and significantly related at 5% to the rate of CO_2 emissions. This means that the pollution haven hypothesis would hold true in the WAEMU countries. Foreign direct investment is negatively and significantly related to the CO_2 rate at 1%. This could be justified by the fact that FDI over this period in non-polluting sectors such as health, education, infrastructure etc.

The rate of growth of the active population is negatively and significantly linked at 5% to the CO_2 rate, while investment in GFCF is positively and significantly linked at 5% to the CO_2 rate.

- Endogenous growth model

Institutional quality is positively related to GDP because its effect on the institutional quality variable is positive and significant at the 5% level. This implies that good institutional quality would help preserve environmental quality.

The coefficients linked to the variables measuring foreign trade and the industrial sector are positive and significant at the 5% level. The increasing industrialization of African economies is therefore also accompanied by a progressive degradation of the environment. This seems all the more true given that the prevailing corruption in African countries can enable industrial sector operators not only to circumvent existing environmental regulations, but also to influence the adoption of new, more accommodating regulations in their interests.

Investment in GFCF is significantly negatively related to the CO_2 rate at 5%.

From the analysis of the two equations in the table above, the net effect of institutional quality on environmental quality is negative in African countries. This result is consistent with that obtained by Cole (2007) for developing countries in general. Thus, as in many other developing countries, corruption would affect environmental quality in Africa more through changes in GDP per capita than through the weakening of environmental regulations. The net effect of institutional quality on environmental quality is therefore positive. This paradoxical result can be explained by the fact that most African economies are in the early stages of development. At this stage, growth has a strong impact on the quality of the environment. Activities that play a major role in wealth creation, such as the exploitation of natural resources and manufacturing industries, generate strong pressures on the environment. Production techniques are still very polluting at this stage. For this reason, growth strongly determines the quality of the environment. It is therefore understandable that corruption, which negatively affects growth, will lead to an equally important reduction of polluting emissions and consequently to an improvement of the quality of the environment. Corruption affects the environment more at this stage through its effects on growth than through its effects on environmental policies.

This result simply shows that the relative effect of growth on environmental quality is higher. Thus, as Perkins (2003) indicates, developing countries should appropriate the environmental experience acquired from developed countries through the transfer of "clean" technologies. The adoption of cleaner production processes now would prevent African countries from undergoing the phase of intensive environmental degradation as indicated by the CEK. Moreover, distinguishing between direct and indirect effects, it is clear that by fighting corruption, the authorities can improve the quality of environmental regulations (direct effect). Improved environmental regulations should promote environmentally friendly growth (indirect effect). By reducing the level of corruption, African authorities could force existing and potential firms to operate in a more environmentally friendly manner.

IV. CONCLUSION

The objective of this paper was to analyze the relationship between institutional quality, economic growth and environmental quality in WAEMU countries. From a theoretical point of view, two main effects can be distinguished. A direct effect through environmental regulations and an indirect effect through economic growth. The study covered 8 countries over the period 1996-2017. The results obtained show that the direct effect of the quality of institutions on the quality of the environment is negative.An increase in the quality level of institutions by 1% directly leads to a decrease in the per capita CO_2 emission rate by 0.65%. The indirect effect of institutional quality on environmental quality is positive. An increase in the quality level of the institutions by 1% indirectly leads to a reduction of the CO_2 emission rate per capita by 0.52%. There is a net negative effect of institutional quality on environmental quality in the WAEMU economies. Every 1% reduction in the quality of institutions leads to a 0.13% increase in the per capita CO_2 emission rate. Thus, the authorities in WAEMU countries should take advantage of the experiences of developed countries and adopt low-pollution production techniques from the early stages of their development. The fight for good quality institutions should also be strengthened so that regulations can contribute effectively to improving environmental quality in WAEMU.

6. APPENDIX
Appendix 1
Description of variables

Variables	Descriptions	Source
Emission of CO2/hbt	in tonsper capita	WDI
gross domestic product/gross domestic product	in ppp (US 2005)	WDI
Quality of Institutions	GovernmentEffectiveness	WDI
Trade	in % GDI	WDI
Industrialization	in % GDI	WDI
Foreign direct investment (FDI)	in % GDI	WDI
Investment	in % GDI	WDI
Literacy rate	primaryenrollment	WDI
Population growth rate	working population	WDI

Appendix 2: List of countries

Benin, Burkina Faso, Côte d'Ivoire, Guinée Bissau, Mali, Niger, Sénégal, Togo

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