“Economic growth and conservation effort in the Congo Basin”

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ECONOMIC GROWTH AND CONSERVATION EFFORT IN THE CONGO BASIN

Abstract

In a world increasingly subject to climate change, protected areas are of particular importance for conserving biodiversity and human livelihoods. Therefore, they play an important role in helping many species, populations, and countries adapt to climate change. This paper analyzes the effects of economic growth on the evolution of the protected areas. The study examines this relation using a sample of nine countries of the Congo Basin from 1990 to 2010. The econometric results show that an increase in the Gross Domestic Product (GDP) per capita has a positive impact on the extent of the protected area in this region regardless of the model chosen. Therefore, economic growth is a means used for the preservation of biodiversity in the Congo Basin. Moreover, the population density is negative and statistically significant. This shows that the protected areas of the Congo Basin are particularly threatened in densely populated areas.

Keywords environment, protected areas, Africa, GMM random effect, GMM fixed effect

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INTRODUCTION

The empirical relation between economic growth and different indicators of the quality of the environment has been largely debated in the last years. The results on this relation enable to define the appropriate economic and environmental policies to improve the welfare of the population.

In literature, this debate is summarized in the factual discussion on an inverse U shaped relation called the "environmental Kuznets curve". It states that at the beginning of the growth process, pollution and environmental degradation will increase; then, beyond a certain level of per capita income, economic expansion is translated by improving the environment (Dietz & Adger, 2003; Nguyen Van & Azomahou, 2007).

Several authors have tested the hypothesis of the Kuznets curve for some environmental indicators such as carbon monoxide (CO), carbon dioxide (CO2), the concentration of sulfur dioxide (SO2), azote dioxide (NOx), deforestation (see, for example, Grossman and Krueger (1993, 1994), Selden and Song (1994), Shafik (1994), Suri and Chapman (1998), Nguyen Van and Azomahou (2007)). However, the analysis of the environmental Kuznets curve (EKC) is still embryonic for other types of environmental indicators. This problem is particularly acute in cases of destruction of biodiversity (Nourry, 2007; Kauano et al., 2020). This paper analyzes the impact of economic growth on the protected areas in the Congo Basin. The preservation of the forest is supposed to be one of the most efficient policies in assuring the conservation of biodiversity in the world (Rodrigues et al., 2004; Johnson et al., 2017). Recent studies have shown that when forest reserves are

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managed very well, it reduces the loss of habitat and species (Watson et al., 2014; Kauano et al., 2020). Forest reserves equally offer means of subsistence to millions of persons and play an important role in the storage of carbon and thus in the reduction of climate change (Bertzky et al., 2012).

At least two reasons explain the choice of the Congo Basin: on the one hand, the Congo Basin is the second-largest tropical forest in the world. It comprises about 70% of the African forest (Bakehe, 2018). This region is host to a large part of the biodiversity of the world and one of the most important world's natural heritage (Megevand et al., 2013). On the other hand, based on existing literature, this study is the first to examine the role of economic growth on the surface area of forest reserves in this region.

The econometric analysis results indicate a positive impact of economic growth on the surface area of forest reserves in the Congo Basin. The article is organized as follows: the first section presents the literature review on the relation between economic growth and the quality of the environment; the second section presents the econometric model retained and the empirical results; the third section discusses the results obtained, and the last section concludes and discusses the implications for public policy.

1. LITERATURE REVIEW

From the beginning of the 1990s, several authors have carried out studies on the relation between per capita income and different indicators of environmental degradation. These studies immediately had a vibrant success, especially due to their optimistic conclusions (Meunié, 2004).

The pioneer model on the growth-environment relation is an article of Grossman and Krueger published in 1994 in which they through more insight on their pioneer study of 1993. Their data are from the world surveillance program established by the Global Environmental Monitoring System (GEMS) on 19 to 42 countries (19 for dust concentration and 42 for those of SO_2) between 1977 and 1988 for air pollution; 58 countries for the period 1979–1990 for water pollution. Using generalized least squares, the authors find that the relationship between economic growth and environmental degradation seems to be inverse U shaped for dust concentration and SO2. The picks are at about USD 4,000 and USD 6,000, respectively. As for water pollution, they also find an EKC with a pick that is at about USD 8,000.

Shafik and Bandayopadhyay (1992) analyze a sample of 149 countries for the period 1960–1990, and their results show an environmental Kuznets curve between USD 3,000 and 4,000. Selden and Song (1994) carried out a study on emissions instead of on concentrations analyzed by their predecessor. The data were based on 30 countries for the periods 1973–1981 and 1982–1984. Using a panel model with fixed effect, they find an environmental Kuznets curve with a pick higher than those obtained by Grossman and Krueger (1991) (who use concentration measures): USD 8,700 for SO2, USD 11,200 for the NOx, and USD 10,300 for particles.

If the first studies on the EKC found an inverse U relation between economic growth and the quality of the environment, several methodological limits are highlighted by different studies throwing doubts on the validity of the results obtained.

Harbaug et al. (2000) retook the database on air pollution used by Grossman and Krueger (1994) and indicated doubts on the validity of the results obtained by the latter. In fact, Harbaug et al. (2000) use an improved database of GEMS (missing data are added, three countries and 25 towns are incorporated in the list, and the observation period is on 10 additional years). The results of this study put into evidence an inverse N shaped curve, which is contradictory to the results of the studies of Grossman and Krueger (1994).

Stern and Common (2001) indicate that the empirical analyses of the 1990s in which countries of the OCDE are over-represented largely underestimate the breakeven income per capita as from which economic growth would be synonymous to an improvement in the state of the environment. According to these authors, when developing countries are better represented, the empirical

existence of an EKC is questionable, the point of reversal being largely beyond the maxima. This study confirms the results of the studies of Holtz-Eakin and Selden (1995) who show that when the EKC is put into evidence, the pick is generally found at extravagant levels (USD 8 million per capita).

A first conclusion can henceforth be made. The lack of empirical consensus on the existence of an environmental Kuznets curve is in opposition to the affirmations of Beckerman on the concert possibility "to grow out of" environmental problems. Only observations of some pollutants support the idea that as from a certain level of income, economic growth positively impacts the quality of the environment. In no circumstances can there be generalization (Meunié, 2004). Therefore, it is important to continue the analysis by using other indicators of the quality of the environment, such as the surface area of forest reserves.

2. METHODS

The sample retained is made up of 9 from 10 countries of the inter-ministerial commission of the Forests of Central Africa (COMIFAC)[1] and covers a period from 1990 to 2010.

The indicator of coverage of protected areas is calculated using all the national protected areas registered in the World Database of Protected Areas (WDPA) and whose surface area is known. The WDPA is all the most complete world spatial data available on protected maritime and land protected areas. The data of WDPA are obtained from national and regional authorities, as well as from non-governmental organizations.

Just as in the studies of Dietz and Adger (2003), the explanatory variables retained here are GDP per capita, population density, population growth rate, and quality of institutions.

The GDP per capita (Y) is expressed in constant dollars (USD), with 2000 as the reference year. The data relative data are extracted from the database of the World Bank indicators (World Bank, 2018), which is often used in the literature on the subject matter.

The population density and the population growth rate are included to consider the probability that in countries with a high density or high population growth, governments may not be able to protect large areas of the ecosystem. These data are extracted from the World Bank development indicators (World Bank, 2018). The paper will also analyze the effects of the quality of institutions since, for some studies, the conservation can be difficult in countries where democracy is weak and political institutions are of poor quality (Deacon, 1994; Didia, 1997). To capture this variable, this study uses two well-known indicators of democracy (FreeHouse and Polity IV) because of their historical background and their wide use in empirical studies and the robustness of the results. Just as Nguyen Van and Azomahou (2007), the author constructs an indicator of the quality of institutions (FreeHouse) from two variables, respectively, based on political rights and civil liberty. The Polity IV democracy indicator (named polity 2) measures competition and openness in recruiting the executive branch of government, regulation, and competition in participation in political life.

This paper tries to estimate the parameters of the following econometric specifications:

$$PA_{it} = \alpha_i + \beta_1 Y_{it} + \beta_2 Popd_{it} + \\ + \beta_3 Popg_{it} + \beta_4 I_{it} + \beta_5 T_{it} + \varepsilon_{it}, \quad (1)$$

where PA_{it} designates the surface area of protected land as a percentage of the total surface area of the country i at period t. Y represents the income per capita, $Popd$ and $Popg$, respectively, represent the density and growth rate of the population. I designates the indicator of the quality of institutions (FreeHouse or polity 2) and T is the temporal trend.

Just as Koop and Tole (1999), this study estimates the fixed and random effect model. The underlying hypothesis of the random effect model is that the explanatory factor is not correlated with the terms α_i for each country. However, there may be unique characteristics to each country that has not

1 Gabon, the Republic of Congo, the Democratic Republic of Congo, Equatorial Guinea, the Republic of Cameroon, the Central African Republic, Burundi, Rwanda, and Chad. Sao Tome and Principe is excluded because of the lack of data.

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been considered in the regression, correlated with the retained explanatory variables. In this case, the appropriate model is the fixed effect model. Classically the study has put in place the Breusch-Pagan test (1980) and Hausman test (1978) to know which specification is most appropriate for the data used. An inverse U shape does not have to be observed since the surface area of protected space has to increase with the economic development of the country. Thus, only the linear model will be examined, and a positive relationship between economic growth and an increase in protected territories are expected.

3. RESULTS

The descriptive statistics for each of the variables are presented in Table 1. The complete sample is made up of 189 observations corresponding to 09 countries. According to the data, the extent of the protected territories of the Congo Basin is 10.08% of the total surface area of land (see Table 1). Equatorial Guinea registers the maximal value (19.16%), and Burundi registers the lowest value (3.84%). The GDP per capita for all the countries is on average equal to USD 1192.81. Equatorial Guinea has the highest level of GDP, certainly due to the exportation of raw materials (USD 8,750.18 in 2009). As for demographic variables, the population density is 75 persons per hectare for the entire sample, and the growth rate of the population is 2.53% per year for all the sample. Finally, the quality of institutions of all the sub-region is at 11.19 for FreeHouse and –2.26 for polity 2.

The Hausman test refutes the hypothesis of the absence of correlation between the random term and the explanatory variables of the model (p-value = 0.000% < 5%). The Chi-squared test is at 7 degrees of freedom since there are 7 restrictions relative to the equality of coefficients of the two models for factors that are variable over time. The estimators of the model with composed errors are biased. It is preferable to retain those of the model with fixed effects that are not biased.

The results show that the relation between economic growth and the protected areas (which is an important tool for preserving species and ecosystems in the Congo Basin) is positive and very significant. This result confirms those of Dietz and Adger (2003), which show that economic growth positively impacts the number of protected spaces. Even though natural resources represent an important weight of the economies of countries of the Congo Basin in terms of contribution to GDP or employment, economic growth seems to be an essential factor for maintaining the biodiversity and viability of all the ecosystems.

Moreover, the positive and very significant coefficient of the temporal variable shows that the coverage of protected areas increases with time. On the contrary, the results relative to the quality of institutions are not significant.

The coefficient associated with population density variable is negative and statistically significant. This shows that the protected areas of the Congo Basin are particularly threatened in densely populated areas. However, the variable of population growth is statistically not significant. This implies that demographic growth has no impact on the safeguard of natural resources and areas of cultural importance on which the local communities and indigenous peoples of the Congo Basin depend.

Table 1. Description of the sample

Source: Author (from the data of WDPA, the World Bank, the Penn World Table 4.0, and the Polity IV).

Variables	Observations	Mean	Standard errors	Min	Max
Protected area	189	10.08	4.39	3.84	19.16
Popd	189	75.890	119.04	3.605	430.6
Popg	189	2.52523	1.6596	–7.533	9.770
FreeHouse	189	11.1904	1.86961	6	14
Polity 2	189	–2.2592	3.80250	–8	6

Table 2. Relation between economic growth and protected areas in the Congo Basin

Source: Author (from the data of WDPA, the World Bank, the Penn World Table 4.0, and the Polity IV).

Variables	GMM fixed effect	GMM random effect	GMM fixed effect	GMM random effect
GDP/1000	0.001*** (0.00)	0.001*** (0.00)	1.193*** (0.15)	1.170*** (0.14)
Popd	–0.016** (0.01)	–0.014** (0.01)	–0.017** (0.01)	–0.015** (0.01)
Popg	–0.088 (0.10)	–0.102 (0.09)	–0.084 (0.09)	–0.097 (0.09)
FreeHouse	0.077 (0.13)	0.091 (0.12)	–	–
Polity 2	–	–	–0.044 (0.05)	–0.045 (0.05)
Trend	0.195*** (0.03)	0.191*** (0.03)	0.205*** (0.03)	0.202*** (0.03)
Constant	–380.127*** (57.75)	–373.481*** (55.38)	–399.310*** (58.35)	–393.675*** (57.00)
Breusch-Pagan test Chi-2; d.l; prob.	906.18; 01; 0.0000		902.97; 01; 0.0000	
Hausman test Chi^2; d.l; prob.	1.60; 05; 0.9018		1.40; 05; 0.9240	
Observations	189		189	
Number of countries	09		09	

Note: The dependent variable is the protected area. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are in brackets.

4. DISCUSSION

Using the best data available and taking into account the principal variables of control, the paper has demonstrated that economic growth positively impacts the protected areas. Using the data of the list of national parks and protected areas of the United Nations of 1990, Lightfoot (1994) found a positive correlation between development and the surface of protected areas. Dietz and Adger (2003) equally found a positive relationship between economic development and the protection of biodiversity and efforts of conservation of protected areas. Economic growth improves the ability of governments to take measures to increase the surface of protected areas and conserve biodiversity and carry out action aimed at conserving existing protected areas. As economic growth improves, society accumulates enough capital to orientate part of its investments towards environmental protection. Moreover, economic growth transforms rural economies into urban and industrial societies, increasing the protected surface area.

The population density has a positive and significant effect on the protected areas. The population can negatively affect the protected surface area via an increase in the number of rural families that use the forest in search of farmlands, firewood, and shelter. According to Megevand et al. (2013), the expansion of subsistence activities (agriculture and the fetching of firewood) because of demographic pressure is one of the principal causes of reducing biodiversity in the Congo Basin.

Finally, this study noticed that the coefficient associated with the quality of institutions is not significant. Good governance may encourage investments in the Congo Basin countries, including agriculture and forest exploitation. In this case, additional investment in terms of improvement in the quality of institutions may not lead to an increase in the protected areas. According to Dietz and Adger (2003), an improvement in the quality of institutions that leads to the conservation of the forest by the state necessarily represents the best means to conserve protected areas and protect biodiversity.

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CONCLUSION

This study attempted to study the effects of economic growth on the protected areas of the Congo Basin. Henceforth, if it is proven that economic growth has major consequences in terms of human well-being, its possible consequences to the environment are still being debated today. With the help of data on 9 countries of the COMIFAC, some principal results have been put into evidence.

First, the results show that the coverage of protected areas increases over time. On the contrary, the results relative to the quality of institutions are not significant. The paper then shows that protected areas of the Congo Basin are particularly threatened in densely populated areas. Finally, the results show that the relation between economic growth and protected areas is positively significant. This indicates that although natural resources are the engine of the economy of the Congo Basin in terms of formal contribution to GDP, the economic growth of these countries is accompanied by the maintenance of biodiversity and the viability of the entire ecosystems.

It is important to highlight some limits to this study. First, even though this study considers countries with similar economic structures, the number of countries in the sample is low (9 countries), which can raise doubts about the results and, consequently, they cannot be generalized. Secondly, the period chosen for the study from 1990 to 2010 does not consider long-term elements in the analysis. More recent data could enable to improve the quality of the analysis in future studies.

AUTHOR CONTRIBUTIONS

Conceptualization: Novice Patrick Bakehe, Roukiya Hassan.
Data curation: Novice Patrick Bakehe, Roukiya Hassan.
Formal analysis: Novice Patrick Bakehe.
Funding acquisition: Novice Patrick Bakehe.
Investigation: Novice Patrick Bakehe, Roukiya Hassan.
Methodology: Novice Patrick Bakehe, Roukiya Hassan.
Project administration: Novice Patrick Bakehe.
Resources: Novice Patrick Bakehe.
Software: Novice Patrick Bakehe.
Supervision: Novice Patrick Bakehe.
Validation: Novice Patrick Bakehe.
Visualization: Novice Patrick Bakehe.
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