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Economic Growth, Reduction of CO2 Emissions and Sustainable Development: Case of Madagascar

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Abstract: ***Madagascar is like all countries struggling to reduce CO2 emissions, degradation, and deforestation. This fight against CO2 emissions has appeared from the year 1970 to the present day. This fight against emissions is essential for reforestation and the protection of the existing forest to avoid environmental degradation according to the objectives of sustainable development within the framework of the Reduction of Emissions from Degradation and Deforestation or REDD. Thus the monetization of these emissions is known from the year 1990. Here the monetization is equivalent to that of net savings adjusted by including the damage caused by particular emissions or as a percentage of gross national income denoted RN, given from of the World Bank. Even if CO2 emissions are monetized or taxed, these emissions keep getting worse. Thus, to properly analyze the correlation between the environment and the economy, we have adopted the simple variance auto regression VAR model. This VAR model is adequate to the methodological response in question, as the a priori constraints of the model are reduced; it also allows knowing the causal effect and innovations through impulse shocks and forecasting errors. According to our results of analysis obtained and simulation, we found that economic growth can be improved from the monetization of CO2 emissions and the environment? Provided that our State respects the practice of environmental law. These results also present the short-term and medium-term relationships between variables, but in the long term the impulse shocks between variables remain stable. The variance forecast errors are corroborated with that of the simulation of the impulse shocks. Thus a one-way causal relationship from CO2 emissions to national income as an indicator of economic growth has been identified in the short and medium term.***

Keywords: monetization, development, VAR model, emission, degradation

1. Introduction

The world economic situation continues to grow after having passed from two great world wars of 1918 and 1945. This growth has hardly destroyed the world environment; it is world development in terms of population growth, bush fire, the exploitation of natural resources as raw materials, and especially technological evolution by major polluting industries that destroy the global environment. Therefore, from the year 1972, a new concept or paradigm was born: *sustainable development*[1]. It is the general realization of the need to change the system of production and consumption, preserve threatened natural resources throughout the world and make efforts to combat poverty.

This concept has become a driving force for investment action in both the private and public sectors. But poverty is every inevitable to carne in the world because of persistent inequality between individuals and between countries in the world. Indeed, this inequality is the source of economic externalities[2] related to the environment, in particular on the equity of pollution rights, Herfindahl and Kneese (1974), unfair properties as the source of the environmental problem Coase, (1960). Hence the consequences of the world through the release of CO2, the destruction of the ozone layer, climate change.

Least developed countries LDC are essential to the negative impact on environmental destruction such as Madagascar[3], will suffer the most significant effects (Adger et al., 2007; Adhikary and Taylor, 2012; Lepage et al. 2007; Smit et al., 2001). This is due to their geographical location in regions of concern and their lack of resources in general both at the human, institutional, economic, technical or financial (Smit et al., 2001)[4]. Economically, for example, these countries' high dependence on climate-sensitive activities, such as agriculture and fisheries, makes them vulnerable to climate change and extreme conditions such as floods, droughts, heat waves and cyclones (Bisaro, 2010; OECD, 2009).

2. Literature Review

Our literature review focuses on environmental monetary(monetarizetion ou monetization). Thus, human activities and their environment are now approached from the perspective of the concept of sustainable development (CMED, 1987).

[1] Martin Yelkouni, Cécile Duclaux-Monteil Ott, Michelle Mongo, Paul Ouédraogo, Flavien Tchapga, Louis-Édouard Pouget *: « Cours en ligne ouvert à tous pour favoriser l'analyse et les initiatives de développement durable : comprendre et analyser les enjeux du développement durable »*, Experte de l'IFDD, *2018, 104p*

[2] Jon Nicolaisen, Andrew Dean et Peter Hoeller « ÉCONOMIE ET ENVIRONNEMENT: PROBLÈMES ET ORIENTATIONS POSSIBLE », Revue économique de l'OCDE, no 16, printemps 1991, 41p

[3] ANDRIAMBOLATINA Naly Haritiora : *« La croissance économique face aux défis de la protection de l'environnement à Madagascar »* Mémoire de fin d'études pour l'obtention du Diplôme de Maitrise es- Science économiques, Université d'Antananarivo, 2016, 57p

[4] JESSICA ONITSOA ANDRIAMASINORO : « ADAPTATION AUX CHANGEMENTS CLIMATIQUES.À MADAGASCAR: STRUCTURATION ET PROBLÉMA TISA Tl ON DE L'ACTION PUBLIQUE NATIONALE » thèse de doctorat, UNIVERSITÉ DU QUÉBEC À MONTRÉAL, service des bibliothèques, 2018, 191p

This sustainable or sustainable development leads to green growth, as a substitute source of technologist to be able to protect the environment and existing resources. Indeed, sustainable development represents their dimension by the three pillars; economic, social and ecological interact to lead society towards a path of sustainable growth in the long term. In the 1990s, empirical studies suggested that economic growth and respect for ecological constraints were compatible in the long term. Known as the Environmental Kuznets Curve (CEK), this analysis postulates that the environmental impact of human activities on the natural environment follows a differentiated dynamic according to the level of average income per capita. Formally, the relationship between pollutant emissions and the level of GDP per capita takes the form of an inverted U-curve[5].

In Madagascar, environmental monetarization is presented by the effect of deforestation, which is one of the most alarming in the tropical world[6]. In 1950, undergraded forest still occupied 15 million hectares. But according to Guichon, its surface area was only 12.5 million ha in 1990, compared to less than 10 million ha today. In general, thorny forests are the most affected compared to dense humid forests (USAID, April 2006). More recent studies based on satellite imagery analysis have shown that the annual rate of deforestation decreased from 0.83% between 1990-2000, to 0.53% between 2000-2005 (collaboration between Conservation International, FTM and the USAID-funded Ministry of Environment and Forestry). Despite this sharp decline in deforestation in some regions, the problem remains the same, especially since these figures do not take into account the effects of the socio-political crisis of 2009-2010. The causes of this severe deforestation stem from a combination of natural, socio-political and economic factors: the practice of clearing land for cash and food crops, bush fires started by pastoralists for the extension of grazing areas and logging to provide timber and construction needs as well as the production of energy wood.

To reduce this degradation, Madagascar, and Western and developed countries are cooperating to find solutions to reduced forestation. Thus, some associations in Europe are taking the initiative to help developing countries such as Madagascar to combat the illegal exploitation of forest products and store their forest carbon by improving governance according to the FLEGT[7] information note through the application of the REDD+ program. Therefore, climate change implies the United Nations Framework Convention on Climate Change (UNFCCC) in order to increase the carbon stock as a source of financing but it needs large-scale activities in the developing country.

3. Methods

To model our work, we will be inspired by the VAR model. This model will allow us to analyze the identification of shocks, to verify how the national income RN reacts in a short and long term way, in the face of reforestation RB, CO2 emission EMM, and deforestation DEF, as well as the existence of the correlation between ecology and economy. For this reason, we have adopted the following four main variables in this work: Let be the vector of dimensions (4 ×1), composed of stationary variables. The modeling of this vector in the form of an unrestricted VAR process can be represented for each of the variables as follows: is a constant vector of dimension (1x4)

$$\begin{pmatrix} LRN_t \\ LEMM_t \\ LDEF_t \\ LRB_t \end{pmatrix} = \begin{pmatrix} C_{10} \\ C_{20} \\ C_{30} \\ C_{40} \end{pmatrix} + \begin{pmatrix} a_{11}a_{12}a_{13}a_{14} \\ a_{21}a_{22}a_{23}a_{24} \\ a_{31}a_{32}a_{33}a_{34} \\ a_{41}a_{42}a_{43}a_{44} \end{pmatrix} \begin{pmatrix} LRN_{t-i} \\ LEMM_{t-i} \\ LDEF_{t-i} \\ LRB_{t-i} \end{pmatrix} + \begin{pmatrix} \varepsilon_t^1 \\ \varepsilon_t^2 \\ \varepsilon_t^3 \\ \varepsilon_t^4 \end{pmatrix}$$

$$Y_t = \begin{pmatrix} LDF_t \\ LAT_t \\ LRT_t \\ LRB_t \end{pmatrix}, \quad \Gamma_0 = \begin{pmatrix} C_{10} \\ C_{20} \\ C_{30} \\ C_{40} \end{pmatrix}$$

is a constant vector of dimension (1x4)

$$\Gamma_1 = \begin{pmatrix} a_{11}a_{12}a_{13}a_{14} \\ a_{21}a_{22}a_{23}a_{24} \\ a_{31}a_{32}a_{33}a_{34} \\ a_{41}a_{42}a_{43}a_{44} \end{pmatrix}$$ is a matrix of dimension (ax4), i=1... 3

$E(\varepsilon_t) = 0$, $E(\varepsilon_t, \varepsilon_t^{"}) = \sum$

$\varepsilon_t = (\varepsilon_t^1, \varepsilon_t^2, \varepsilon_t^3, \varepsilon_t^4)$ the vector of structural shocks or disturbances of dimensions (4x1), le $\varepsilon_t \approx iidN(0, \sum)$ where $\sum$ is a diagonal matrix.

Our work is based on a VAR model, because its advantage will allow us to analyze the identification of shocks by the impulse function and variance decomposition, to check how a variable reacts to other variables in the short term.

4. Results and Discussions

4.1. Results

4.1.1. Total GES emissions: kt of CO2 equivalent

The first figure below shows us a strong oscillation in the direction of increasing the CO2 emission of Madagascar due

[5] Matthieu Clément, André Meunié : « Inégalité, développement et qualité de l'environnement : mécanisme et application », CAIRN INF 2010, 82

[6] Document de synthèse par la coopération entre Schweizerische Eidgenossenschaft Confédération suisse Confederazione Svizzera Confederaziun svizra et Coopération République de Madagascar République Fédérale d'Allemagne : « FOrêts engagées comme REservoirs de Carbone à Madagascar : REDD-FORECA » p6.

[7] Interaction FLEGT-RDD+ ; cette note d'information fait partie d'une série destinée à informer l'Union européenne et les représentants officiels des Etats membres de l'Union européenne, à la fois au sein de l'UE et dans les Délégations et Ambassades hors UE, au sujet de FLEGT et de REDD+ et des liens entre ces deux programmes, janvier 2011.

to the very strong degradation of the forest of twenty years past that is to say from the year 1990 to the year 2019.Thusfrom the year 1997, this oscillation continues to increase until today despite the effort of the Malagasy State each year in the context of reforestation, forest restoration and the creation of new national or private parks to reduce CO2 emissions.

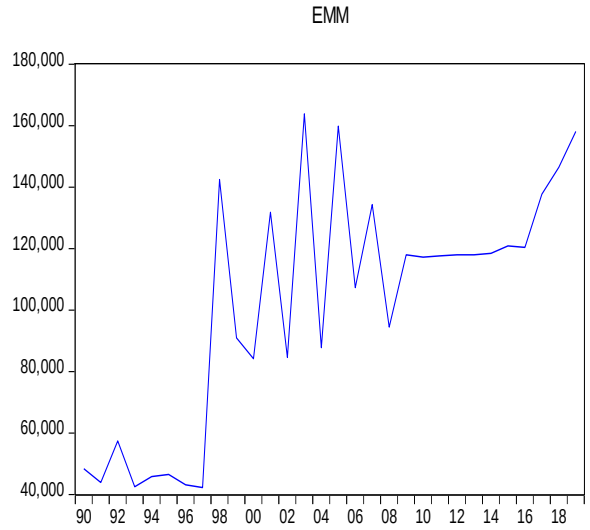

Figure 1: Total GES emissions: kt of CO2 equivalent
Source: author by World Bank figures, May 25, 2021

Adjusted net saving, including damage caused by particulate matter emissions (% of Gross National Income, the second figure shows the percentage of RNB gross national income (% RN) by adjusted net saving, including damage caused by personal emissions. This figure varies, and oscillates, because the Malagasy State has a very low percentage of national income from individuals compared to environmental degradation by the exploitation of this natural resource, as well as pollution from individuals. This national income is very high from the year 1990 – 1993 and then there is a very sharp drop in the year 1993 -2020, it does not mean that there is a decrease in emissions but the respect and enforcement of the law in the context of the environment is weak. And there is an improvement in this gross national income from the year 2004-2010 and 2014 to the present day because the environmental law is dependent on the regime of the State and the leader.

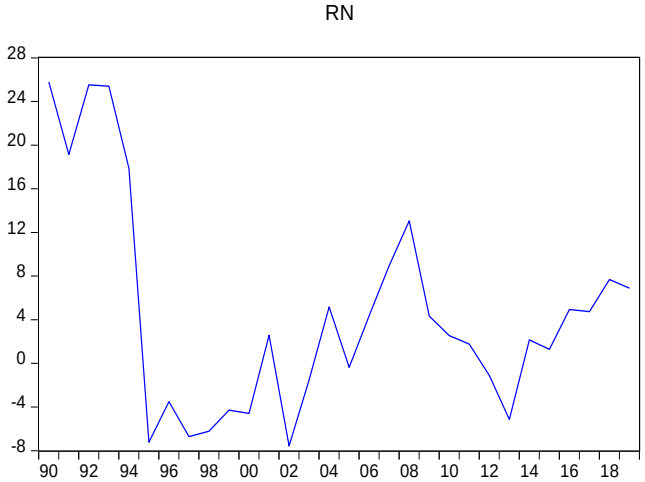

Figure 2: Adjusted net savings, including damage from particulate matter emissions (% of RNB)
Source: author by World Bank figures, May 25, 2021

4.1.2. Simulation results

Impulse shock simulation result of deforestation DEF, at the deforestation level, the response of impulse shocks over an interval of 10 periods represents the following three variations:

First in the short term of [1-3], deforestation decreases sharply and then it increases in the period of [3-4], and the rest stable. That is, variations in deforestation represent a variation of opposite directions with respect to the impulse reaction of others:

In the case of emissions, CO2 emissions vary in the opposite direction to that of environmental degradation, because the impact of environmental degradation is very low over the period but remains stable over the long term. In the case of reforestation, it is normal that reforestation always varies in the opposite direction to that of environmental degradation. But in the long term this variation always remains stable.

In the case of gross national income, this is the opposite way to that of environmental degradation, because it may be that the precaution in the context of State intervention on the environment, remains low, that is to say we would like to talk about the law of: "Polluter pay", all that pollute, he must pay.

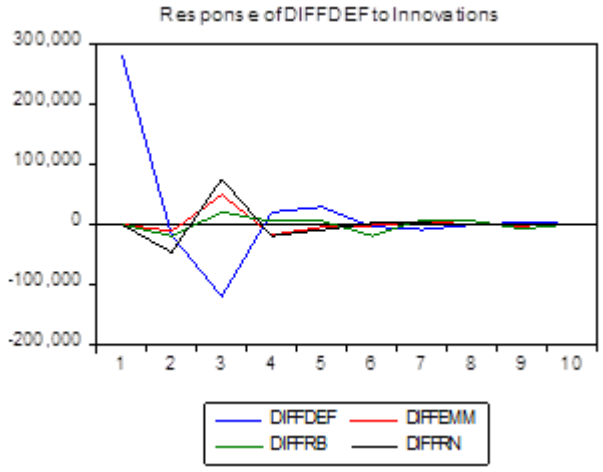

Figure 3: Impulse shock response function on deforestation

Pulse shock simulation result of CO2 emissions EMM, CO2 emissions vary in the form of oscillations, and its reactions relative to other variables, represent innovations of impulse shocks:

For deforestation DEF and gross national income RN represents the same sense of variations of impulse shock innovations to that of emissions. These variations are normal because CO2 emissions come from environmental degradation, particularly forest ecosystems. Thus, the increase in emissions, normally also increases the gross national income RN of damage caused by emissions.

For the case of reforestation RB, oscillates in the same direction to that of CO2 emissions, but a little weak, because the effort of the State at the level of reforestation to fight against emissions and environmental degradation is still low. Indeed, the shock impulse reaction of reforestation remains weak.

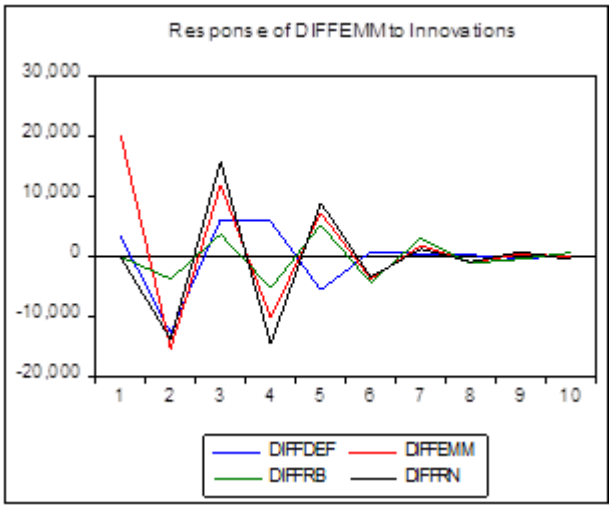

Figure 4: Impulse shock response function on CO2 emissions EMM

Impulse shock simulation result of reforestation RB, the impulse shock response of reforestation RB represents the form of short- and medium-term oscillations, and these variations are reacted by the reaction of the other variables:

The reaction of deforestation is of the form of opposite meanings to that of reforestation RB, but of the modest form. This variation is consistent with the goal of reducing deforestation and environmental degradation or REDD. Thus, for EMM CO2 emissions, its reaction to reforestation RB reacts weakly, but in the long term, it remains stable. On the other hand, for the GN gross national income oscillates in the opposite direction to that of impulse reaction of reforestation RB, but of the modest form and especially in the long term, which means that it is also on line with the objective of REDD+.

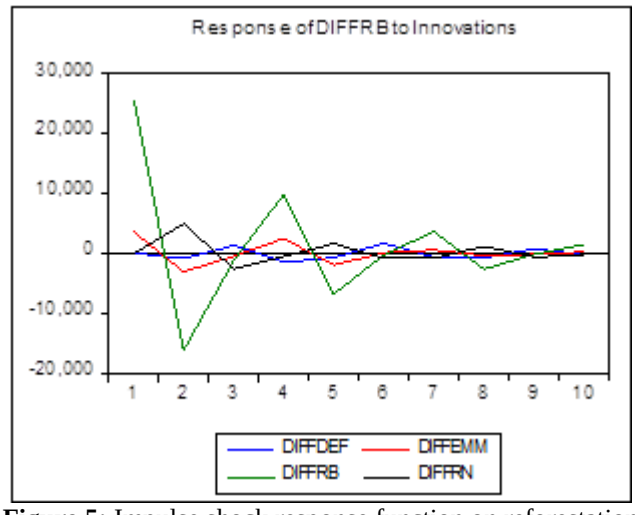

Figure 5: Impulse shock response function on reforestation RB

Impulse shock simulation result of RN gross national income, the impulse shock response of RN gross national income is governed by the opposite form of deforestation at the outset, but from the second period, these two variables react in the same direction of variation. As well as CO2 emissions automatically reacts with gross national income and deforestation as the increase in CO2 emissions by environmental degradation increases the net savings readjust caused by the damage of individuals. This damage feeds into gross national income.

On the other hand, reforestation reduces deforestation, CO2 emissions, and national income, but in the long term this reforestation replenishes the national coffers of the State by the carbon market which is stored by the new forest.

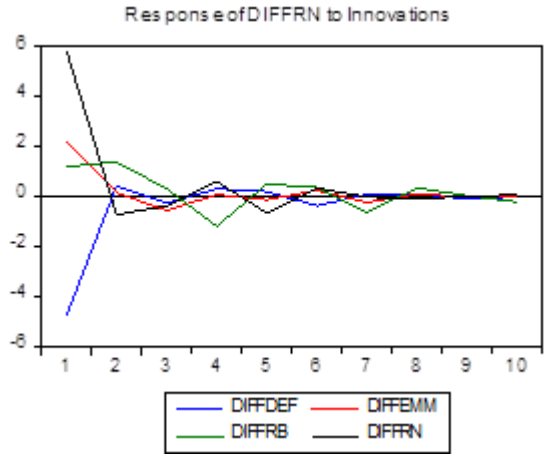

Figure 6: Impulse shock response function on RN gross national income

4.2. Discussions

The variance of the RN national income forecast error is due 51.47% to its own innovations, 7.58% to RB reforestation innovations, 7.69% to EMM emissions innovations, and 33.39% to DEF deforestation innovations. This result shows the shock of national income; it is obviously that it has more impact on reforestation compared to other variables. This means that these two variables are closely correlated with the short, medium and long term. The result of the error in forecasting the variance of national income is very significant to reforestation by different parameters between this two variable, improves the revenue of the State through the carbon market, agriculture, improves the environment ...On the other hand, the reaction of national income to emissions and deforestation does not mean economic growth by different parameters. Because deforestation destroys the environment, increases CO2 emissions, ultimately disrupts and changes the environment.

So in relation to these variance prediction errors humans have done great harm to the Earth. Forests have disappeared, biological flora has been erased to make way for rural lands, cities and metropolitan areas, and industrialization has polluted seas, rivers and the atmosphere. Governments and environmentalists like have been looking for ways to reduce the damage humans have caused. Although backtracking time would never be possible, alternative ways to resolve the troubles that human beings caused can be very promising. Knowing the pros and cons of deforestation could give us the right values to help feed the earth rather than deplete it of the natural resources.

DIFFRN:					
Period	S.E.	DIFFDEF	DIFFEMM	DIFFRB	DIFFRN
1	7.952371	35.88300	7.862265	2.27805	53.97667
2	8.118379	34.71623	7.580718	5.12704	52.57601
3	8.155259	34.49490	7.965853	5.23245	52.30678
4	8.269872	33.68419	7.756762	7.14704	51.41200
5	8.313437	33.39342	7.696166	7.43730	51.47311
6	8.340599	33.36177	7.737159	7.58901	51.31206
7	8.367753	33.15681	7.755801	8.10753	50.97985
8	8.376680	33.10481	7.753204	8.25842	50.88356
9	8.377292	33.11124	7.752153	8.26015	50.87645
10	8.380302	33.08752	7.747435	8.31853	50.84651
Cholesky Ordering: DIFFDEF DIFFEMM DIFFRB DIFFRN					

5. Conclusion

To conclude we have seen that deforestation, deforestation varies in the opposite direction of the other variables, and these impacts lead to adverse effects on the other short-term and long-term variables. This effect is exogenous because deforestation is widely practiced in Madagascar for different reasons such as the use of charcoal, the practice of tavy on agriculture, cattle grazing .... So the intervention of environmental actors to protect existing resources or develop green areas, especially through reforestation or afforestation, must improve the ecological environment of the same economy including agriculture even if there is oscillation of shocks between variables. . So the state must restructure its environmental policy to reduce CO2 emissions, automatically improves the economic growth through the carbon market, increased production in agriculture... hence the Malagasy monetary situation.

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