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Article

Investigating the Effect of Trade Openness and Agriculture on Deforestation in Cameroon

Joel Sotamenou [1,*] and Glory Nehgwelah [2]

[1] Faculty of Economics and Management, University of Yaoundé II, Yaoundé P.O. Box 1365, Cameroon
[2] Faculty of Agriculture and Veterinary Medicine, University of Buea, Yaoundé P.O. Box 1365, Cameroon; nehgwelahglory@gmail.com
* Correspondence: sotamenou@yahoo.fr

Abstract: This study aimed to measure the effect of trade openness and agriculture on deforestation in Cameroon from 1980 to 2021 by using a fully modified ordinary least squares (FMOLS) approach. Data used are from the World Bank and FAO. The results obtained indicate that when trade openness increases, deforestation also increases, but when trade openness increases up to a certain threshold, deforestation decreases. This study also reveals that agriculture is one of the major causes of deforestation in Cameroon. Agricultural output and agricultural value-added both have a positive and significant impact on deforestation. There is an inverted curve relationship between economic growth and deforestation in Cameroon, this shows that the EKC is respected with deforestation as it is postulated that at higher levels of income, GDP turns to reduce deforestation meaning a unit change in GDP^2 leads to a reduction of deforestation. We recommend the implementation of concrete actions and strict environmental policies focused on a green economy, to control the exploitation of natural resources with particular attention to the sustainable exploitation of wood. Sustainable agricultural practices should also be implemented, as well as more suitable liberal trade policies.

Keywords: trade openness; agriculture; deforestation; CEK; Cameroon

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1. Introduction

It is believed that trade openness or trade liberalization has brought about unsustainable exploitation and consumption of natural resources (Udeagha & Ngepah, 2022; Wu, 2022). That is, the world benefits from trade openness at the cost of the environment (Shahbaz et al., 2013; Tsurumi & Managi, 2014). Deforestation occurs when forest land changes to non-forest use (Baccini et al., 2012). Deforestation is seen as one of the consequences of trade openness and is considered globally to be among the primary causes of climate change most especially in tropical regions. Deforestation brings about negative consequences on the environment such as soil degradation, soil erosion, desertification, loss of habitats for many animals and loss of plant species amongst others (Ajanaku & Collins, 2021; Van der Werf et al., 2009). Deforestation is of great concern as forests act as a good storage mechanism for carbon reason why they have been suggested as part of the climate change mitigation strategy (Cramer, 2004).

According to Food and Agriculture Organization of the United Nations (FAO, 2015) over the past 25 years, Cameroon has declined with a loss of about 1% forest cover annually. This shows an increasing rate of deforestation for Cameroon in the Congo basin. This increase in deforestation has been linked mainly to timber exports, agriculture, unsustainable and illegal exploitation of timber, infrastructure and fuelwood exploitation (Alemagi & Kozak, 2010; Ewane et al., 2015; Lescuyer et al., 2016; Ngome et al., 2019; Rudel et al., 2005).

According to Tazeen (2021), agriculture is a major cause of deforestation and its impact on deforestation is huge. Due to the large population, the demand of food is high and in order to fulfill the demand of food of society, deforestation takes place on large scale. The high demand of food promotes commercial farming that leads to the acquisition of lands on large scale. Forests are converting into farmlands for large scale farming. This causes adverse effects on environment, climate and health. It also damages natural ecosystems and biodiversity. When trade policies were liberalized in the early 90s in Cameroon, new forest laws were adopted and ever since timber trade and logging has increased in Cameroon and it emerged as one of the main export commodities after agriculture. Today Cameroon's legal timber production for exports has reached approximately 3 million m^3; as a result, Cameroon has become a leading exporter of timber in Africa.

Unfortunately, this affects deforestation as timber exploitation and logging are yet to be done sustainably in Cameroon (Alemagi & Kozak, 2010; Dixon et al., 1996; Lescuyer et al., 2016).

Agricultural production which is the country's second main export commodity has increased remarkably since the liberalization of trade policies in the early 90s. From 2005–2015 agriculture contributed over 28.47% to the country's Gross Domestic Product (GDP). Cameroon is more of an agrarian economy; it employs over 70% of the Cameroonian population and agriculture is often referred to as the backbone of the economy. As the trade for agricultural commodities increases and generates remarkable revenue, so too does the level of deforestation increase in the country as farmers strive for both small and large scale commercial agriculture and exports by increasing or expanding their lands for cultivation and this is done mostly through tropical deforestation (Bele et al., 2011; Cerutti & Lescuyer, 2011; Schmitz et al., 2015; Zapfack et al., 2013). Illegal timber exploitation and logging and fuelwood exploitation for domestic trade are a growing problem in Cameroon and all these exert pressure on deforestation (Alemagi & Kozak, 2010; Ewane et al., 2015).

Up to about a third or 30% of the world is covered by the forest. Forests provide environmental services and benefits such as conservation of biodiversity, soil conservation, climate change prevention, hydrological cycle regulation amongst other benefits. Forest resources are important for the long-term economic development of many countries (Chakravarty et al., 2012; Zeller & Pretzsch, 2019). Due to increasing dependence on forest resources, the world's rainforest is facing threats of extinction because of deforestation. Deforestation is an issue of primary concern for countries of the tropics such as Cameroon, as it leads to the rapid destruction of the tropical forests, with visible effects on biodiversity loss and greenhouse gas effects (Chakravarty et al., 2012). Trade liberalization, measured by trade openness has been identified in the literature as a determinant for deforestation.

Trade openness is measured as the ratio of total trade (imports + exports) to GDP and is an indicator of trade liberalization and globalization. This ratio is also interpreted as a measure of economic policies that either restrict or promote trade among countries. The higher the trade to GDP ratio, the more open a country is to trade and vice versa. Restrictive trade policies were the main feature of underdeveloped economies from 1980 to 1990 after which most economies were liberalized.

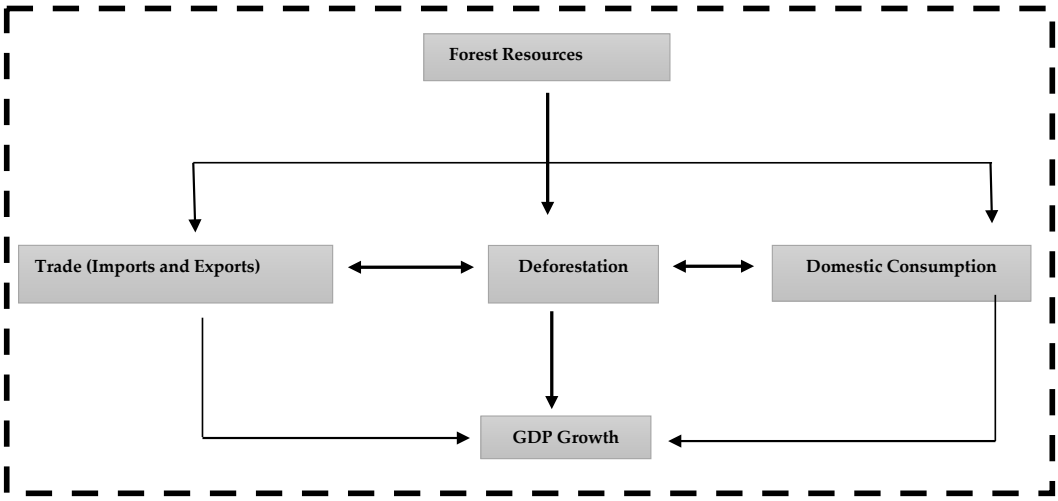

Figure 1. Conceptual link between trade openness and deforestation.
Source: Developed by Authors.

The conceptual framework linking trade liberalization to deforestation is presented in Figure 1. Forest resources are exploited for foreign and domestic consumption which all contribute to the country's GDP. An increase in both domestic and foreign demand for forest products leads to the permanent loss in forest cover. Deforestation reduces the number of forest products for trade and domestic consumption and hence GDP. Thus, it is seen that the more liberalized an economy is in terms of its openness, the more deforestation takes place, especially in countries where trade in natural resources constitutes a greater part of foreign trade. This has been confirmed in similar studies done across the world using different approaches.

Beckman et al. (2017) researched on international trade and deforestation in the United States of America and other six major exporting countries. They analyzed the patterns of deforestation and those commodities that contribute greatly to tropical deforestation. Using historic data with economic models, they found evidence that trade liberalization results to increase in deforestation; the prohibition of the exportation of illegally logged wood will reduce deforestation. Joshi and Beck

(2016) did a study on deforestation in different countries, their result showed that greater trade openness and agricultural lands impacted deforestation differently in different countries and regions. Oktavilia & Firmansyah (2016) did a similar study in Indonesia; they measured the impact of trade liberalization on environmental degradation and economic development. They used pollution as a proxy for environmental degradation. Using the econometric model and the Engel granger procedure of the error correlation model, it was statistically proven that trade liberalization indeed leads to environmental degradation and deforestation; trade liberalization partially increases pollution in the environment. Eskander et al. (2016) did a similar study on trade openness, domestic and foreign investment and the environment in Africa, Asia and other member countries of OECD. They found evidence of mixed effects of trade openness on the environment; it has positive effects in some countries and negative effects in others. Schmitz et al. (2015) researched on agricultural trade and tropical deforestation to investigate the impact trade, agriculture and trade policies have on tropical deforestation in future. They found out that trade liberalization leads to an increase in deforestation, and extensive clearing of tropical forests is partly assigned for agriculture. Tchatchou et al. (2015) carried out a study in the Congo basin (Cameroon, the Democratic Republic of Congo [DRC], Central Africa Republic, Equatorial Guinea and Gabon). Using ordinary least square method (OLS) they analyzed the causes of deforestation and its effects on carbon emissions and land degradation. From their findings, agriculture, fuelwood collection and infrastructure constructions are the principal causes of deforestation which leads to land degradation. This result is similar to the findings of Ewane et al. (2015) in a study conducted in Cameroon and Faria and Almeida (2016) who did a study on the relationship between trade openness and deforestation in the Brazilian Amazon. Tsurumi & Managi (2014) measured the environmental consequences of trade openness and economic development, using the Antweiler et al. (2001) model of decomposing environmental effects; he found evidence that the effects of trade openness are more in the long term than in the short term. Many papers underline the negative impact of agriculture on deforestation (Abman & Carney, 2020; Ajanaku & Collins, 2021; Angelsen & Kaimowitz,1999; Leite-Filho et al., 2021).

The main objective of this paper is, therefore, to measure the effect of trade openness and agriculture on deforestation in Cameroon over 42 years; from a period of pre-liberalization (1980–1994) to a period of post-liberalization from (1995–2021). This study is presented in 4 sections, section 1 is the introductory section followed by section 2 which is the materials and methods of the study, section 3, the results and discussion of the study, and section 4, conclusion.

2. Materials and Methods

2.1. The Model

In this study, we employ the Fully Modified Ordinary Regression Least Squares (FMOLS) regression with an econometric specification similar to the model used by Bhattarai and Hammig (2001) and Ogundari et al. (2017).

Following Bhattarai and Hammig (2001) the model in its general form can be given as:

$$E = f(Y, Y^2, Z), \tag{1}$$

Z is a vector of control variables that may contribute to environmental degradation

$$E = f(trade\ openness, Agriculture), \tag{2}$$

The following specification holds for deforestation.

$$Deforestation = f(trade\ openness, Agriculture), \tag{3}$$

Thus, the following functional relationship will be used:

$$Deforestation = f(economic\ growth + trade\ openness + Agriculture), \tag{4}$$

The indicator for deforestation was obtained from the variable forest cover, it was obtained by calculating the difference between forest cover for period t-1 and t expressed in terms of t-1, thus the following equation was used to obtain deforestation. This relationship can be specified as:

$$Deforestation_t = \frac{forest\ cover_{t-1} - forest\ cover_t}{forest\ cover_{t-1}} \tag{5}$$

$$\begin{aligned} Deforestation_t = {} & \alpha + \beta_1 gross\ domestic\ product_t + \\ & \beta_2 gross\ domestic\ product_t^2 + \beta_3 trade\ openness_t + \beta_4 trade\ openness_t^2 + \\ & \beta_5 agric\ capital\ formation_t + \beta_6 agric\ gross\ production_t + \\ & \beta_7 agric\ value\ added_t + \beta_8 permanent\ cropland_t + \end{aligned} \tag{6}$$

$$\beta_9 forest\ area\ of\ land_t + \beta_{10} foreign\ direct\ investment_t + \beta_{11} real\ effective\ exchange\ rate_t + \varepsilon_t,$$

α is a constant and β_1 to β_{11} are regression coefficients.

Here, trade openness is used as a proxy for trade liberalization (Antweiler et al., 2001) calculated as:

$$Trade\ openness_t = {(export_t - import_t)}/{gross\ domestic\ product_t}, \quad (7)$$

The sign β_1 is expected to be positive, this depicts the Environmental Kuznets Curve (EKC) at the early stage of economic growth, the sign of β_2 is expected to be negative; GDP^2 is GDP per capital squared which depicts the curvature nature of the EKC (Wang et al., 2012). This same effect is expected for trade openness, β_3 is expected to be positive, when trade policies lead to increase trade, resources will be exploited in an unsustainable manner leading to increase deforestation, with increasing advocacy for environmental protection, actions will be taken to reduce deforestation thus leading to a negative impact, this is reflected by a negative value for β_4.

2.2. The Data

All the data used in this study is obtained from World Development Indicators (WDI) and Food and Agricultural Organization (FAO). The period of study is from 1980 to 1994 (a period of pre-liberalization) and from 1995 to 2021 (a period of post-liberalization).

Table 1. Summary statistics of variables.

Variables	Observation	Mean	Std. Dev	Min	Max
Deforestation	42	0.349	0.05	0.26	0.41
Gross domestic product	42	23.73	0.34	23.13	24.38
Trade openness	42	45.19	8.79	26.15	65.02
Agriculture capital Formation	42	213.70	176.47	21.73	580.92
Agriculture gross production	42	58.34	27.08	28.07	104.23
Agriculture value added	42	19.62	3.65	15.62	28.67
Permanent crop land	42	2.76	0.34	2.15	3.27
Forest area of land	42	214720.36	6907.82	202844.80	225000
Foreign direct investment	42	1.24	1.18	−0.91	4.06
Real effective exchange rate	42	113.89	23.12	90.28	169.20

Source: Authors using Eviews.

3. Results

3.1. The Trends in Trade Openness, Agriculture and Deforestation

Figure 2 shows that the trend displayed by trade openness is stochastic, with many fluctuations throughout the period. It represents a random walk process without drift since it does not have an intercept term. The implication is that its mean and variance is likely to be constant indicating that the first difference of this variable would be stationary. Though stochastic, it can be realized that the trend of trade openness was downward from 1980 to 1990 reflecting the restrictive trade policies that characterized that period. Economic policy in Cameroon was internally managed up to the early 90s when the economy of Cameroon was liberalized. From the early 90s, though fluctuations in trade openness continued, the trend displayed has been upward.

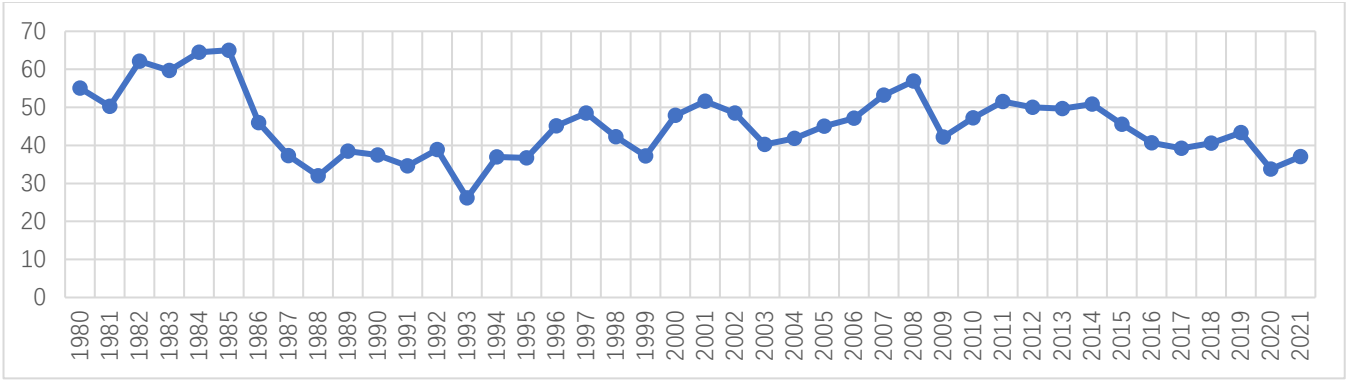

Figure 2. Trends in trade openness from 1980 to 2021.
Source: Authors compilation

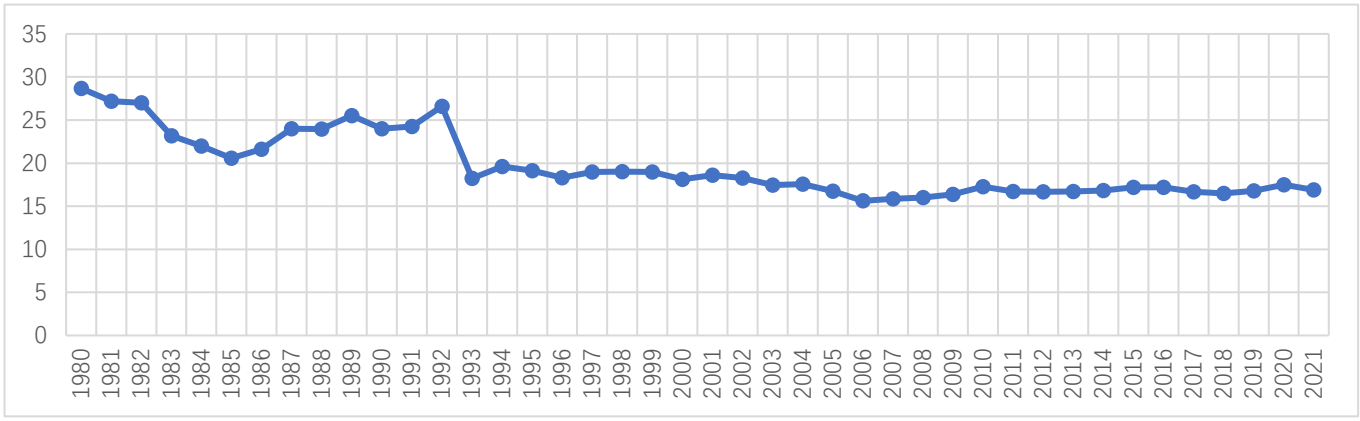

Figure 3. Trends in agricultural value added from 1980 to 2021.
Source: Authors compilation.

Figure 3 is a graphical presentation of trends in the key agricultural indicators over the years (1980–2021); a period of pre-liberalization (1980–1990) and post-liberalization (1991–2021). The agricultural value added evolves in the same direction with trade openness all over time after 1995; it illustrates how much agricultural value added took an ever-increasing turn with the implementation of trade policies after the 1990s.

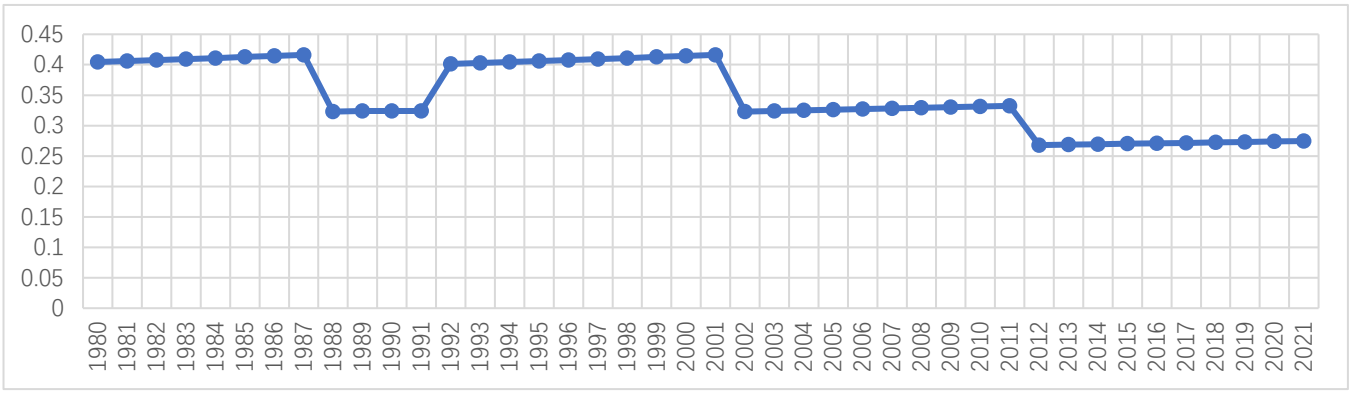

Figure 4. Trends in deforestation from 1980 to 2021.
Source: Authors compilation.

Figure 4 on the trend of deforestation in Cameroon displays two trends from 1980–2021: a downward trend from 1980–1990 and an upward trend from 1990–2021. From the graphical illustration, it is observed that in the years before liberalization, Cameroon depended mostly on agricultural production (excluding forestry) and petroleum for economic growth until the late 1980s when the world was hit by a drop in market prices of many products including agricultural commodities and oil. Again, huge fiscal deficits plunged the country into serious economic crises. Within the framework of the structural adjustment program (SAP) measures imposed on

developing countries including Cameroon in the late 1980s and early 1990s was the liberalization of trade and investments. Since the adoption of liberalized trade policies in Cameroon in the early 90s, the rate of deforestation per year has been increasing steadily, showing that Cameroon is slowly becoming less of a forest dominant country over time. Also, with a fall in the world market prices of agricultural commodities, attention was shifted toward the forest sector; the reason why up to date, the rate of deforestation is on the rise. In econometric terms, the trend displayed by the graph on deforestation can be described as deterministic.

3.2. The Unit Root and Johansen Co-integration Tests

Table 2 shows that eight of the ten variables of study are integrated of the order 1. The other two notably forest area of land and foreign direct investment, are integrated at level. This result shows a long-run relationship might exist between trade openness and deforestation in Cameroon.

Table 2. Unit root test.

	Augmented Dickey-Fuller test				
	Level		**First Difference**		
Variables	**trend & inter**	**Probability**	**trend & inter**	**Probability**	**Decision**
Deforestation	−2.549152	0.3044	−6.288337	0.0000	I(1)
Gross domestic product	−2.098204	0.5310	−3.826330	0.0253	I(1)
Trade openness	−2.669977	0.2537	−6.866277	0.0000	I(1)
Agriculture capital Formation	−2.4044002	0.3722	−6.645736	0.0000	I(1)
Agricultural gross production	−1.781555	0.6954	−5.564408	0.0002	I(1)
Agriculture value added (% of GDP)	−3.152213	0.1083	−8.169255	0.0000	I(1)
Permanent cropland (% of land area)	−2.254916	0.4477	−7.694852	0.0000	I(1)
Forest Area of land	−20.06878	0.0000	−44.20255	0.0000	I(0)
Foreign direct investment	−5.57848	0.0002	−13.44724	0.0000	I(0)
Real effective exchange rate	−1.8227123	0.6732	−5.548626	0.0003	I(1)

Source: Authors compilation using E-views 9.

Table 3 shows the presence of co-integration between deforestation and trade openness. The trace statistic shows that there are six co-integrating variables significant at 5% and the maximum Eigenvalue statistic shows that there are four co-integrating variables. This shows that a linear combination of these variables gives a stationary series (I (0)), thus confirming the presence of a long-run relationship between the variables of the study.

Table 3. Johansen Co-integration test on deforestation.

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.939270	384.7455	197.3709	0.0000
At most 1 *	0.855820	272.6927	159.5297	0.0000
At most 2 *	0.815141	195.2248	125.6154	0.0000
At most 3 *	0.671400	127.6983	95.75366	0.0001
At most 4 *	0.560488	83.18172	69.81889	0.0030
At most 5 *	0.480931	50.29813	47.85613	0.0289
At most 6	0.359663	24.06940	29.79707	0.1975
At most 7	0.143223	6.238965	15.49471	0.6673
At most 8	0.001396	0.055877	3.841466	0.8131

Trace test indicates 6 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.939270	112.0529	58.43354	0.0000
At most 1 *	0.855820	77.46784	52.36261	0.0000
At most 2 *	0.815141	67.52647	46.23142	0.0001
At most 3 *	0.671400	44.51662	40.07757	0.0148
At most 4	0.560488	32.88360	33.87687	0.0653
At most 5	0.480931	26.22872	27.58434	0.0737
At most 6	0.359663	17.83044	21.13162	0.1363
At most 7	0.143223	6.183088	14.26460	0.5898
At most 8	0.001396	0.055877	3.841466	0.8131

Max-eigenvalue test indicates 4 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

3.3. The Effect of Trade Openness and Agriculture on Deforestation

Table 4 shows a summary of the regression analysis. The adjusted R^2 shows that 67.1% of the variance of deforestation is affected by the variables under study, thus the variables are explicative enough. It also shows that the model is globally significant at 1%.

Table 4. Regression analysis.

Dependent Variable: Deforestation **Method: Fully Modified Least Squares (FMOLS)** **Sample (adjusted): 1981 2021** **Included observations: 41 after adjustments** **Cointegrating equation deterministic: C** **Long-run covariance estimate (Bartlett kernel, Newey-West fixed bandwidth** **Effect on deforestation**				
	Coefficient	Std. Error	t-Statistic	Prob.
Gross domestic product	11.19764	3.075430	−3.640999	0.0011
Gross domestic product^2	−0.234945	0.064100	3.665283	0.0010
Trade openness	0.812403	0.634121	1.281148	0.0003
Trade openness^2	−0.098439	0.082271	−1.196524	0.0012
Agriculture capital Formation	0.000251	0.000103	−2.427701	0.0216
Agricultural gross production	0.002299	0.000751	−3.061976	0.0047
Agriculture value added (% of GDP)	0.007358	0.002698	−2.727367	0.0107
Permanent cropland (% of land area)	0.036562	0.029729	1.229832	0.2286
Forest Area of land	−3.30E-06	2.88E-06	−1.143048	0.2624
Foreign direct investment	−0.001645	0.003097	−0.531125	0.5994
Real effective exchange rate	0.000348	0.000486	−0.715123	0.4803
C	133.0599	36.46359	3.649115	0.0010
R-squared	0.825810	Mean dependent var		0.347417
Adjusted R-squared	0.759739	S.D. dependent var		0.057108
S.E. of regression	0.027992	Sum squared resid		0.022723
Long-run variance	0.000317			

Source: Authors using E-views 8.

From the results, trade openness has a nonlinear relation and a significant effect on deforestation. When trade openness increases, deforestation also increases, but when trade openness increases to the threshold of 8, 25% (turning point), deforestation decreases. With increasing trade and demand for timber, harvesting of forests and related products for exports, illegal logging and fuelwood exploitation; deforestation is on an increasing trend as affirmed by Ewane et al. (2015) and Faria and Almeida (2016). We also investigated if agricultural production affects deforestation in Cameroon that is if increasing agricultural production comes with increasing deforestation. The results reveal that agricultural output and agricultural value-added have a positive and significant impact on deforestation. A 1% increase in agricultural value-added will lead to a 0.007 % increase in deforestation all things being equal. This result is significant at 5%. This result is similar to research of Tchatchou et al. (2015) and Ordway et al. (2017) where agriculture is an overwhelming direct cause of deforestation in Cameroon. This is due to the felling down of trees by farmers to expand farmlands as they seek to increase agricultural production for consumption and trade (domestic and export trade). The regression results also show that agricultural capital formation has a positive and significant effect on deforestation. Precisely, a slight increase in agricultural capital formation will bring about a change of 0.0002 units increase in deforestation. Increasing investments in agricultural capital without taking adequate sustainable measures to ensure sustainable farming systems and resource exploitation will lead to deforestation. The regression result equally shows that the EKC is respected with deforestation as affirmed by Bhattarai and Hammig (2001) and Martínez et al. (2009), at higher levels of income, deforestation reduces. It can be seen from the regression table that a slight increase in GDP leads to a 11.197 unit increase in deforestation, but at higher levels of income (with GDP doubled) the effect on deforestation becomes negative. Thus, a slight increase in GDP^2 leads to a 0.234 unit decrease in deforestation. This result is statistically significant at 5%. This means that countries with higher levels of income turn to invest in environmental protection and deforestation measures, thus for Cameroon, increasing control of natural resource management will enhance the sustainable management of natural resources and less deforestation.

4. Conclusion

This study aimed to measure the effect of trade openness and agriculture on deforestation in Cameroon from 1980 to 2021. Trade openness influences deforestation. When trade openness increases, deforestation also increases, but when trade openness increases to the threshold of 8, 25% (turning point), deforestation decreases. This study also reveals that agriculture is one of the major causes of deforestation in Cameroon. Agricultural output and agricultural value-added both have a positive and significant impact on deforestation. A unit change in agricultural value-added will lead

to 0.0002 units increase in deforestation. There is an inverted curve relationship between economic growth and deforestation in Cameroon, this shows that the EKC is respected with deforestation as it is postulated that at higher levels of income, GDP turns to reduce deforestation meaning a unit change in GDP^2 leads to a reduction of deforestation by 0.234 units. Forest area is also affected by deforestation; thus, forest cover is reducing. We recommend that to reduce the rate of deforestation in Cameroon concrete actions and stringent environmental policies with a focus on a green economy should be taken to control the exploitation of natural resources with special attention on sustainable exploitation of timber and sustainable logging activities. Sustainable agricultural practices should be implemented, and more suitable liberalized trade policies should be adopted and implemented in the country. We also recommend strict implementation of adopted forest laws and control of legal logging and prohibition of illegal logging. Reforestation should be encouraged in the country**.**

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