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TRADE OPENNESS, AGRICULTURAL SECTOR GROWTH AND ENVIRONMENTAL POLLUTION: EMPIRICAL EVIDENCE FROM CAMEROON

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Abstract

The paper examined the relationships among trade liberalisation, agricultural sector growth, and environmental air quality proxy by carbon dioxide (CO2) emissions using Johansen Cointegration, variance decomposition and impulse response functions approach. The main focus of the paper was to determine whether trade liberalisation, and agricultural sector growth affects environment air quality in Cameroon. Data was elicited from the World Development Indicators Book, 2016, spanning over the period 1970 -2010. The major findings reveal that, agricultural sector growth is negatively and insignificantly related to the level of Cameroon environmental air quality. However, trade liberalisation was found to be significant and negatively related to environmental air quality. This technically means that a 1% increase in trade liberalisation will result to 25% decrease in environmental air quality in the long-run. Based

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on these findings, we recommend that the government of Cameroon should put in place institutional, and trade policies that are environmental friendly and also inclusive in promoting agricultural sector growth.

Keywords: Trade liberalisation, Environmental Quality, Johansen cointegration, Impulse Response, Variance Decomposition

INTRODUCTION

Trade policy and agricultural sector reforms have been at the centre of policy debate in many developing countries for the past years, with the aim of fostering growth (Vaughan et al., 2007). The effect of trade liberalisation and agricultural sector growth on environmental air quality is still one of the most controversial issues in the field of international trade. As most developing countries reduce or limit trade barriers, with the aim to scale up economic activities, create jobs opportunities domestically, foreign industries with high cost abatement take advantage of weak environmental policies in these developing countries by relocating to these regions. These developing countries, who consider income and jobs to be more significant over environmental quality, easily opened their doors to these foreign industries. Though, the penetration of foreign firms through trade openness can bring enormous benefits in terms of efficiency, employment and economic growth, Thalut (2011) and Thalut & Kelese (2019) argued that increasing the scale of economic activities driven by liberalisation usually result to increase exploitation of natural resources, agricultural sector growth, increase pollution and waste. The argument of increase pollution and waste can only be true if it results to the growth of dirty industries as noted by Lucas et al., (1992) in their study of trade liberalisation and the toxic intensity of manufacturing industries in 80 countries between 1960 and 1988. Surveying on trade and environment, Esty and Gentry (1997) concluded that the foreign investors often set up operations with modern, less polluting, new technologies and management systems that are more advanced than those that exist locally.

Further, it is widely accepted that, trade liberalisation is considered as an engine of growth in most countries, and thus, the effect of trade liberalisation on growth is positive (Yanikkaya, 2003; Redding, 2002; Wacziarg, 2001; Greenaway, 2002; Sarkar, 2008; Shabaz, 2012). However other studies reports negative association between trade liberalisation and economic growth (Rodrik & Rodriguez, 2001). They argue that increase liberalisation without proper policies on the environment will greatly reduce the environmental performance in the long run. Their views are supported by the fact that liberalising trade gives room for

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uncontrollable exploitation of economic resources which may further reduce the quality and quantity of the available resources thereby reducing trade in the long run. Hence the proponents of this view postulate an inverse relationship between free trade and economic growth (Lankoski, 1997).

In another study, Gries and Redlin (2012) examines the short and long term effect of trade liberalisation on growth for a sample of 158 countries, spanning between the periods 1970 to 2009 using a panel co-integration test with GMM estimation. Their findings reveal that, in the long run, significant and positive correlation exists between trade liberalisation and economic growth. By contrast, they found a negative association in the short term, suggesting that trade liberalisation is purposive and helpful for growth improvement in long run, while it can be harmful during the short term adjustment. These results therefore mean that trade liberalisation may have a mixed effect on economic growth especially in developing countries (Hertel et al., 2003; World Bank, 2004). This is explained by a manifestation of the nature of investment undertaken by the foreign firms in these countries. However, for many developing countries, especially those in the Sub Saharan African region, where environmental policies towards pollution are friendly, and more openness may result to negative externality in production and consumption which may not be fully factor out in competitive market prices. Consequently, it may be difficult to succinctly explain the effect of trade liberalisation on the components of economic growth.

Empirical evidence from literature indicates that, the countries that actually benefits from trade are countries with diversified and high technology exports while those countries that export less complex products or services are at the disadvantage (Wacziary, 2004). In addition, countries that rely more on imports than exports suffer from deterioration in their trade balance. However, the effect of trade liberalisation on growth is not fixed or is not the same for all developing countries perhaps due to differences in trade and environmental policies reforms, competitiveness, technological differences and resources endowment gap (Thalut & Kelese, 2019). For instance, a study carried out by Dollar & Kraay (2003) investigating the effects of trade liberalisation and institutions on economic growth indicates that countries with well-developed institutions gain more from trade liberalisation and faster development than countries with poorly-developed institutions. Further, this conclusion corroborate the findings of Kim (2000), who argued that trade boost financial development, and productivity growth in high income countries.

Traditionally, trade theories emphasizes that free trade based on allocative efficiency, improves social welfare of the society on the assumption of the existence of perfect competition more specifically in advance countries (Verter, 2015). The theory further implies that free trade

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policies improve welfare of any economy by reducing dead weight loss associated with the characteristics of monopoly or oligopoly practices. Even though they state that free trade increases welfare, the welfare effects of free trade policy is still a subject of debate among economists, and policies makers (Robichaud, & Decaluwe, 2010). These notwithstanding, trade policy reforms encourage and motivate trade openness which tends to ultimately increase welfare derive from an efficient allocation of domestic resources in the agricultural sector. Efficient allocation of domestic resources reduces the production of import substitutes and increases the production of exportable products which finally increases total output of the agricultural sector. This argument has been supported by the studies of Andersen & Babula, (2008) and Akanni, et al. (2008).

In another aspect, improvement in agricultural production as a result of trade openness can therefore be detrimental to environmental degradation. On the one hand, improved output in the agricultural sector is related to biophysical phenomena that lead farmers to contribute items that have broad environmental consequences. For example, high use of pesticides for controlling fungal and insect diseases of crops, may lead to high levels of toxic residues entering the non-agricultural environment (Lankoski, 1997) depending on the nature of the compounds and their transformation in the environment, which may variously be dangerous to our environment. He further concluded that the increase in agricultural output may also be beneficial to the environment if it is achieved through intensification of production, or by bringing additional land into cultivation, using appropriate environmental friendly techniques.

In Cameroon, the structural adjustment and trade liberalisation programmes that Cameroon embarked on in the late 1980s and early 1990s were intended to revamp trade and productivity in the various sectors of the economy. These policies achieved some positive results in the agricultural sector, although, fiscal revenue did not meet up with the target expectations (Bamou, 1999). Based on the gap above, this paper is aim at examining the relationship between trade openness, agricultural sector growth and environmental air quality in Cameroon. Specifically the study intends to achieve the following: Examine the existence of a long run relationship between trade liberalisation, agricultural sector growth and environment quality.

LITERATURE REVIEW

From a theoretical perspective, the nexus between environmental quality, trade openness and agricultural sector growth can be incorporated in the neo-classical growth theories. The basis of these theories is the comparative cost advantage theory of David Ricardo. According to this theory, trade is still beneficial to both countries even when a country have absolute advantage in

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the production of a given range of commodities (David, 1817). Economists have some arguments in support of trade in agricultural commodities base on the idea that trade brings varieties of food that increase choices for the population; trade maintains stable demand and supply for food that allows efficient exchanges (Stiglitz & Charlton, 2007; Erokhin & Ivolga, 2013). This therefore is imperative for each country to practice specialisation where she can produce at a lower domestic opportunity cost relative to other countries. David Ricardo postulated that trade liberalisation could enhance productivity, and hence growth in each sector of specialisation. Therefore it can be infer that trade is essential in growing the agricultural sector.

Further, the factor endowment model known as the Hecksher-Ohlin theory of trade assumed that trade arises because of the differences in labour productivity, which is assumed to be fixed for different commodities in different countries. According to this theory, the basis for trade arises not because of inherent technological differences in labour productivity for different commodities between different countries but because countries are endowed with different factor supplies or inputs (Heckscher, 1919).Given relative factor endowments, factor prices will differ (for instance, labour will be relatively cheap in labour- abundant countries) and so too will domestic commodity price ratios and factor combinations. The above theory therefore explains why resource- abundant (for instance, labour-abundant) less developed Countries are into the production and export of labour-intensive commodities in return for imports of capital-intensive goods because of their relative cost and price advantage enhanced by international specialisation (Blaug, 1992).

Many studies have examined the linkage between trade liberalisation, environmental quality and growth in recent years. Most of these studies rely on the environmental Kuznets Curve (EKC) hypothesis. Copeland and Taylor (1994), Grossman and Krueger (1991), explain the changes in growth potentials of a country in the E.K.C analysis and how it affects the environment. Cole (2004) examines how the economy achieves higher growth caused by increase market access or free trade. These studies explain the channel through which growth can be achieved such as the scale effect and the technique effects. The scale effect explains dramatic increases in environmental pollution caused by a higher desire for agricultural growth drives. On the other hand, the techniques effect indicates the methods of production that occurs because of trade liberalisation (Thalut & Kelese, 2019). The reason behind the techniques effect is explained by Cole (2004), Suri & Chapman (1998), Beckman (1992), Stem (1998) as income induced demand. This effect caused by greater environmental regulations and access to improved environmental beneficial technologies. It can be argued that trade liberalisation and agricultural sector growth affects the quality of the environment. However, the Neo classical theories bring out the elements of benefits showing that the gains from liberalisation may be more than the drawbacks. This is explained in the work of H.O theory and E.K.C as we have mentioned supra (Nicola, Borre & guard (2004), Josh, Arik & Jenny, 2004, Richard D. et al, 2000).

There are enormous studies on the linkage between trade liberalization and environmental air quality. It is argued that trade openness has a robust positive impact on growth because trade expansion leads to the increase in the agricultural sector growth as a result of increased exports, capacity utilization and positive externalities on the non-exports (Edwards, 1993). Surveying on trade and environment, Dasgupta (1999) found that, trade liberalization does not have a positive effect on environmental quality in developing countries meanwhile finding of Thalut & Kelese, (2019) indicated a contrary view on this speculation in which they concluded that most significant environmental problems are linked to emission of greenhouse gases of which CO_2 is a key contributor.

In a similar manner, Brandao & Martin (1993) investigating on the structure of agricultural protection in developed and developing countries and reviewed estimations of trade implications on trade liberalisation. They employed the 10 RUNS model. The results of their study indicate that agricultural prices of OECD countries will have significant impact on world prices whereas developing countries in aggregate could expect to achieve smaller welfare gains if these policies are implemented by developed countries alone. In addition, the study also showed that food exporters of developing countries are likely to be the main beneficiaries of trade liberalisation. Moreover, this analysis concluded that large potential gains from a comprehensive move to agricultural trade liberalisation will be achieved in the future even though there is a small gain from the initial liberalization and the effects on the environmental pollution.

Contrary to the above views, Weeks (1990) examined trade liberalisation, market deregulation and agricultural performance in Central America. The study indicates that liberalisation of foreign trade and deregulation of domestic markets has not been linked with improved agricultural performance as explained by Brandao & Martin. This suggests that, the failure of agriculture to respond positively to the changes in policy is partly due to the unfavourable movements in the world prices of the Central American Countries major tradable commodities. Even though, they indicated that liberalisation and deregulation hypothesis is the best strategy for agricultural growth. This reflects a shift from import substitution towards a substantially less interventionist strategy which favours the development of agriculture. Munasinghe (1999) equally arrived at the same conclusion after studying the consequences of environmental degradation on economic growth. The experiences of these developed nations

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are a lesson to learn by developing countries. This involves seeking for a win - win policies that will enhance growth and environmental sustainability (Thalut, 2011). In addition, Torreas & Boyee (1996) examined the environmental pollution and growth relationship and found a U-shaped relation-ship as explained by the Kuznets Curve hypothesis.

METHODOLOGY

Model Specification

Based on the empirical literature reviewed and the objective, the study adopts a log- log model specification, following the works of Sanusi (2008), Grossman & Helpman, 1991). Assuming a neo classical production function with constant return to scale of the form

(1) $$EAQ_t = \alpha_0 Tlib_t^{\alpha_1}.GCF_t^{\alpha_2}.ASG_t^{\alpha_3}$$

Where, EAQ represent environmental air quality proxy by $C0_2$ emissions, Tlib is trade liberalisation, GCF is Gross Capital Formation and AGS is agricultural sector growth. By taking the natural logarithm of equation 1, assuming that other factors apart from the one mentioned can as well contribute in explaining variation in the dependent variable are held constant. It is capture using the disturbance term (ε_t). We have;

(2) $$LEAQ_t = \alpha_0 + \alpha_1 LTlib_t + \alpha_2 LGCF_t + \alpha_3 LASG_t + \varepsilon_t$$

Where, L is the natural logarithm, $\alpha_i = (i = 0,\ 1,\ 2,\ 3)$ are the parameters to be estimated, ε_t is the disturbance term and t is the time period. The a priori expectation signs are as follows;

$\alpha_1 > 0,\ \alpha_1 < 0,\ \alpha_2 < 0,\ \alpha_3 < 0,\ \alpha_3 > 0$

Estimation Technique

A. Unit Root Test

One of the fundamental assumptions when dealing with time series variables is to ensure that the variables are stationary. Stationarity means that the variable exhibits mean reversion. That is, it fluctuates around a constant long run mean. In other words it means it is stable over time (Seiler, 2004). If a variable is not stationary it means is a random walk. The variables were tested to see whether it is stationary at level or at first different, since the outcome of unit root testing is important indicator in selecting which model to be estimated. This paper relies on Augmented Dickey-Fuller (ADF) unit root testing procedure. We proceed to present the test equation for

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B. ADF Test Equation

$$\Delta Z_t = \alpha + \theta t + (\phi - 1)Z_{t-1} + \sum_{i=1}^{k} \varphi_i \Delta Z_{t-i} + u_t$$ (3)

The reduced form of equation (4) is given as

$$\Delta Z_t = \alpha + \theta t + \lambda Z_{t-1} + \sum_{i=1}^{k} \varphi_i \Delta Z_{t-i} + u_t$$ (4)

Where, Δ is the first difference operator, u_t is a white noise disturbance term with means zero and variance σ^2 that is time invariant and t= 1, . . . , T, represents the index of time. The term Δz_{t-i} is the lag value of the dependent variable, which allowed for serial correlation between the independent variable and ensured that the disturbance term is a white noise. The null hypothesis of the test assumed that there is non-stationarity, while the alternative assumed stationarity. The variable is stationary if the λ<0, since $\lambda = \varphi_i - 1$. However, if λ=0, it implies that $\varphi_i = 1$, meaning the characteristic root of the equation is equal to unit root. By examining the probability value of the output test, we conclude for stationarity or non-stationarity. For p-value less than 0.05, we reject the null hypothesis. If the null hypothesis is not stationary at level, we proceeded to first difference stationary. If it becomes stationary after first difference, then it is said to be integrated of the order one (I (1)). The lag length set using information criterion such as Akaike information criterion (AIC) is utilised. The test was conducted with drift or without drift depending on the graphically presentation of the variables over time. The significance of unit root testing is to avoid spurious regression and also to improve on the precisions of the forecast of the estimates. When the variables are integrated of the order one, and there are no co-integration, the vector autoregressive technique of estimation could have been appropriate in establishing short run relationship between the variables. Since the interest in this paper is to examine both short and long run relationship, vector error correction mechanism becomes inevitable. We perform the Johansen (1988), and Johansen and Juselius (1990) test for Cointegration. The JJ test for cointegration is based on the rank of the coefficent matrix of changes in the vector of variables on its own lags and lags of other variables in the model. The test equations developed by and Johansen and Juselius (1990) are given as seen below.

$$\xi_{Trace} = -T \sum_{i=r+1}^{t} \ln(1 - \xi_i)$$ (5)

$$\xi_{Max} = -T \ln(1 - \xi_{r+1})$$ (6)

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These two test a statistic equation that is equation (5) and (6) depends on the rank of the matrix. If the characteristic root or eigenvalue of the rank matrix is difference from zero, there is strong evidence of long run relationships among the variable. The number at which the rank of the matrix of coefficient is linearly dependent gives us the number of cointegration equation(s). Equation (5) is the trace statistic test. The null hypothesis of the test assumed that there are at most r cointegration vectors against a general alternative. Meanwhile equation (6), the maximal eigenvalue test the null hypothesis that the number of cointegration vectors is r against the alternative hypothesis of r+1. We proceeded in presenting the model specification of vector error correction. From equation **(**2) we derived a model of error correction mechanism;

$$\begin{bmatrix} \Delta LEAQ_t \\ \Delta LGCF_t \\ \Delta LTlib_t \\ \Delta LASG_t \end{bmatrix} = \begin{vmatrix} \alpha_0 \\ \beta_0 \\ \phi_0 \\ \delta_0 \end{vmatrix} + \sum_{i=1}^{p} \begin{bmatrix} \alpha_{1i} & \alpha_{2i} & \alpha_{3i} & \alpha_{4i} \\ \beta_{1i} & \beta_{2i} & \beta_{3i} & \beta_{4i} \\ \phi_{1i} & \phi_{2i} & \phi_{3i} & \phi_{4i} \\ \delta_{1i} & \delta_{2i} & \delta_{3i} & \delta_{4i} \end{bmatrix} \begin{bmatrix} \Delta LEAQ_{t-1} \\ \Delta LGCF_{t-1} \\ \Delta LTlib_{t-1} \\ \Delta LASG_{t-1} \end{bmatrix} + \begin{vmatrix} \alpha_1 \\ \beta_2 \\ \phi_3 \\ \delta_4 \end{vmatrix} ECT_{t-1} + \begin{vmatrix} \varepsilon_t \\ v_t \\ \omega_t \\ \kappa_t \end{vmatrix} \quad (10)$$

Where, ε_t, v_t, ω_t, κ_t are residuals in period t. These residuals are assumed to follow a normal distribution with zero-mean and constant variance. Δ Is the first difference operator, where α_i, β_i, ϕ_i, δ_i (i = 1,2, 3, 4) are the short-run elasticity coefficients which measure how the dependent variable responses to a one percent change in the respective explanatory variable. The lag lengths are m1, m2, m3 and m4 chosen on the basis of minimizing Akaike information criterion. ECTs are the error-correction terms, which are the stationary residuals, generated from the long-run co-integrating regression of Johansen multivariate process representing disequilibrium position in period t. In other words, the error-correction terms represent the adjustment of variables towards a long-run equilibrium path. The coefficients are expected to be negative, indicating short-run adjustment towards the long-run equilibrium value**.** This model is chosen based on its dynamism in capturing both short run and long run adjustment among the measure of environmental air quality, trade liberalisation, stock of capital proxy by gross capital formation and agricultural sector growth.

Source of Data and Definition of Variables

The data used in the study was obtained from World Development Indicators Book, 2016. The data spanned from 1970 to 2010. The justification of the time frame is that this period correspondence to the period of major economic reforms in trade policy and agricultural sector. Trade liberalisation is defined as the removal or reduction of restrictions or barriers on the free exchange of goods between nations. This includes the removal or reduction of both tariff (duties and surcharges) and non-tariff obstacles (like licensing rules, quotas and other requirements. Trade liberalisation or openness is captured in the study by the summing values of exports and imports per GDP over the years. Agricultural sector growth is measured using agricultural value added per worker. It measures agricultural productivity, output of the agricultural sector as well as the value of intermediate inputs. It comprises value added from hunting, fishing, and forestry, cultivation of crops and livestock production as indicated by world development indicator, 2016. The data on agricultural sector growth was also collected from world development indicator, 2016.

Gross capital formation refers to increase net physical investment within the measurement period. Statistically, it measures the value of acquisitions of new or existing fixed assets by the business sector, governments and pure households less dispersible of fixed assets. It was use as a control variable to proxy for capital, since is a fundamental variable in the neo classical production function. Gross capital formation was collected from world development indicator, 2016. Most significant environmental problems as pointed out from the literature are related to emission of Greenhouse gases of which Carbon dioxide (CO_2) is the dominant contributor. It is used in this study to proxy for environmental air quality. It is measure in Kg per tons. It was also collected from world development indicator, 2016.

RESULTS AND DISCUSSION

Before testing for Johansen co-integration and Granger causality test, we first established the degree of integration of the variables by carrying out an Augmented Dickey- Fuller (ADF) unit root tests on the agricultural sector growth proxy by agricultural value added, environmental air quality proxy by carbon dioxide (CO2) emission, gross capital formation and trade liberation series in their log-levels and log differenced forms. ADF test statistic checks the stationarity of the series. The result presented in Table 1 reveals that all variables are non-stationary in their level data. However, the stationarity property is found in the first difference of the variables. This permit we to reject the null hypothesis of a unit root in the ADF tests at 1% significance level for all series. Thus the four variables are integrated of order one, I (1).

Table 1: ADF Unit Root Test (Eviews 8 Output)

Variables	Level	First Differences	Decision
LEAQ	-2.647294	-7.555350*	I(1)
LASEG	-1.975175	-3.350255***	I(1)
LGCF	-2.093095	-4.997440*	I(1)
LTLib	-1.044399	-6.622344*	I(1)

Note: The optimal lags for conducting the ADF tests were determined by AIC (Akaike information criteria). *, **, *** indicate significance at the 1%, 5% and 10% levels

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Since all variables are I (1) processes, the necessary condition for the Johansen co-integration test has been verified. However, before conducting the Johansen test, a lag exclusion Wald test was carried out to determine the optimal lag-length that is to be used, since this test is sensitive to the number of lags. Table 2 present the co – integration test result.

Table 2: Test Results of Unrestricted Cointegration Rank Test (Trace)

Cointegration Test – Basic System

Null Hypothesis	Eigenvalue	Test Statistics		Critical Value 0.05	Critical Value (0.05)
		Trace	Max-Eigen	Trace	Max-Eigen
r = 0 *	0.505869	44.85604	28.90316	42.91525	25.82321
r≤ 1	0.226647	15.95287	10.53780	25.87211	19.38704
r≤2	0.123725	5.415069	5.415069	12.51798	12.51798

Note: *Denotes rejection of the hypothesis at the 0.05 level of Significance

**Mackinnon-Haug-Michelis(1999) p-values

The result of cointegration test is given in Table 2. The maximum Eigen value and the trace statistics reveal that the variables included in the model are co-integrated at 5% significance level and there exist one cointegration vector. Therefore, the null hypothesis of no long run relationship between EAQ, AGSEG and TLIB is not accepted. In other words, the trace and maximum Eigen value statistics suggest that there is one long run relationship among the variables as the null hypothesis r = 0 is rejected at 5% level. By implication, a long run relationship exists between the variables agricultural sector growth and trade liberalization and environmental air quality in the long run. The variable gross capital formation was treated as a true exogenous variable in the model. Since the model contains cointegration relationship among the variables we proceed with the test of vector error correction mechanism. We present the result of the long run equation.

$$LEAQ_{t-1} = -8.98 - 2.55LTRADELIB(-1) - 0.76LAGSG(-1)$$

S.E	**(1.28)**	**(1.16)**
t-stat	**[1.98]**	**[0.66]**

Agricultural sector growth is negatively and though not significantly related to the level of environmental air quality proxy by carbon dioxide emission measure in Kg per ton. The reason

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why agricultural sector growth in Cameroon does not have significant long-run effect on measure of environmental air quality, may be explained by the fact that growth in the sector have not yet reach a threshold where its effect can felt. Another reason could be because data on agricultural value added is under reported. If this was significant, it would technically mean that a one percent increase in agricultural sector growth in Cameroon will lead to 76% reduction in Carbon dioxide emission in the long-run. This makes intuitive sense, since growth in agricultural sector will mean more income, thereby making it easy and affordable to clean the environment through use of modern technology. Trade liberalization has a negative significant long run relationship with measure of environmental air quality in Cameroon. A one percent increase in level of trade liberalization, the environmental quality of Cameroon can actually be improved by 255% in the long run. These findings corroborated the finding of Grossman and Krueger (1991).

From the estimated VECM we simulate the variance decompositions and the impulse response functions. The optimal lag at which the residual of the series was serially uncorrelated was 4. We equally adopt Sim (1980) and Ibrahim (2003) empirical strategy to identify various shocks using the generalised cholesky. The variables was ordered as follows; LEAQ LAGRSG LTRADELIB assuming that environmental quality is sluggish to adjust to shocks in agricultural sector growth and trade liberalization. Table 3 present the result of variance decomposition (see appendix 1) over 30 years' time horizon for each variable. Figure 1 show the graphs of the impulse response function of environmental air quality to other variables, trade liberalization to other variables and agricultural sector growth to other variables (see appendix 2). We examined the interaction between environmental air quality and other variables. In this paper we focus more on trade liberalization and agricultural sector growth. More than 14% of LEAQ forecast error variance is attributed to innovation in trade liberalization in the 4^{th} years from 1970, followed by declined in 1975-76, then a steady rise from 1987 to 2000. This finding suggests that shocks in trade liberalization have effect on environmental quality in the short run while in the long run the effect tends to zero as presented in figure 1 showing the impulse response of LEAQ to Trade liberalization. The shocks produce two waves of effects. The first wave of effects last for five years while the second wave of effects last for only three years, before hitting a neutral effects for over the rest of the years.

CONCLUSION

The paper addressed empirically the debate that trade liberalisation is the major source of environmental deterioration in developing countries. The findings indicate that trade liberalisation can instead improve environmental air quality in the long run though its impact

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may be split into two waves spanning over the periods of eight years, as observed from the impulse responses function. Based on this finding we recommend the government of Cameroon to put in place institutional and trade policies that are environmental friendly and also inclusive in promoting agricultural sector growth in Cameroon.

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APPENDICES

Appendix 1

TABLE 4: Result of Decomposition Test

Variance Decomposition LEAQ

Period	S.E.	LEAQ	LAGRSG	LTRADELIB
1	0.387134	100.0000	0.000000	0.000000
2	0.528009	91.12426	0.080808	8.794928
3	0.538068	91.08938	0.132771	8.777848
4	0.588339	81.51068	4.341253	14.14807
5	0.636778	80.64779	6.202176	13.15003
6	0.650504	80.90056	6.424659	12.67478
7	0.664024	77.64010	6.477062	15.88284
8	0.681344	73.81404	6.325009	19.86095
9	0.693702	72.66831	6.486206	20.84548
10	0.700473	72.02164	6.400546	21.57781
11	0.703520	71.55480	6.345490	22.09971
12	0.715639	69.90287	6.215191	23.88193
13	0.731242	70.13261	6.121956	23.74543
14	0.747164	70.53301	5.935139	23.53185
15	0.758130	70.20959	5.776180	24.01423
16	0.771835	69.71588	5.818239	24.46588
17	0.789532	69.69496	5.801505	24.50354
18	0.802002	69.70490	5.749956	24.54515
19	0.811521	69.24495	5.674857	25.08020
20	0.822051	68.42400	5.647177	25.92882
21	0.832515	68.05297	5.666960	26.28007
22	0.841824	67.69092	5.618290	26.69079
23	0.849304	67.24509	5.565298	27.18961
24	0.858227	66.72752	5.534640	27.73784
25	0.868094	66.43744	5.498251	28.06431
26	0.877393	66.28634	5.453977	28.25968
27	0.886440	66.02565	5.395277	28.57908
28	0.896011	65.75412	5.363576	28.88230
29	0.906400	65.60954	5.338183	29.05228
30	0.916217	65.47429	5.299655	29.22605

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Variance Decomposition LAGRSEG

Period	S.E.	LEAQ	LAGRSG	LTRADELIB
1	0.064432	4.501298	95.49870	0.000000
2	0.083318	5.574792	93.54150	0.883710
3	0.108349	8.632930	87.61988	3.747195
4	0.117012	9.101596	87.19370	3.704706
5	0.130065	22.01021	74.32825	3.661532
6	0.141390	28.80946	68.08869	3.101844
7	0.151441	31.64814	63.99423	4.357632
8	0.159830	31.98505	63.27725	4.737699
9	0.164923	31.52442	64.01281	4.462761
10	0.169197	31.53516	64.21786	4.246980
11	0.174089	30.10812	65.77381	4.118068
12	0.177656	29.02514	66.99645	3.978402
13	0.182362	27.91610	68.19898	3.884924
14	0.186807	26.95748	69.34024	3.702277
15	0.191513	26.32241	70.15040	3.527190
16	0.196281	25.67004	70.94270	3.387260
17	0.200712	25.62462	71.10546	3.269928
18	0.205632	25.86362	71.01954	3.116847
19	0.210321	25.90750	71.10400	2.988501
20	0.214704	26.03501	71.09718	2.867806
21	0.219012	26.06258	71.17411	2.763311
22	0.222945	26.09979	71.23137	2.668848
23	0.226897	25.97658	71.44313	2.580291
24	0.230542	25.72089	71.77847	2.500640
25	0.234124	25.52431	72.04994	2.425746
26	0.237754	25.28928	72.35475	2.355976
27	0.241294	25.06144	72.65111	2.287450
28	0.244854	24.85121	72.92501	2.223775
29	0.248364	24.68926	73.14922	2.161520
30	0.251885	24.60390	73.29459	2.101519

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Variance Decomposition LTRADELIB

Period	S.E.	LEAQ	LAGRSG	LTRADELIB
1	0.110522	9.636644	0.578844	89.78451
2	0.135591	16.77286	7.925538	75.30160
3	0.148503	15.04999	13.95646	70.99355
4	0.152456	16.04150	14.27874	69.67976
5	0.153712	15.83211	14.51045	69.65744
6	0.161997	15.74508	13.06911	71.18581
7	0.170424	21.39825	12.52101	66.08074
8	0.184922	29.99052	11.63416	58.37532
9	0.195960	34.54687	11.59446	53.85867
10	0.209144	39.11841	12.51033	48.37126
11	0.222020	41.99746	12.47311	45.52943
12	0.229572	43.15329	12.80744	44.03927
13	0.236249	42.65971	12.98734	44.35294
14	0.241670	41.58068	13.28761	45.13171
15	0.246229	40.88915	13.84511	45.26573
16	0.250390	40.10724	13.95667	45.93609
17	0.253628	39.47199	14.13017	46.39784
18	0.257707	38.95367	14.20943	46.83689
19	0.261929	38.77476	14.26177	46.96347
20	0.266260	38.97645	14.35280	46.67076
21	0.271061	39.15190	14.34056	46.50754
22	0.276001	39.47435	14.43078	46.09487
23	0.281478	39.91019	14.48772	45.60210
24	0.286543	40.21611	14.52996	45.25393
25	0.291287	40.36856	14.62632	45.00512
26	0.295994	40.36046	14.70396	44.93558
27	0.300343	40.33342	14.82409	44.84249
28	0.304484	40.25440	14.91228	44.83333
29	0.308355	40.09995	14.98401	44.91603
30	0.312169	39.96711	15.06959	44.96329

Cholesky Ordering: LEAQ LAGRSG LTRADELIB

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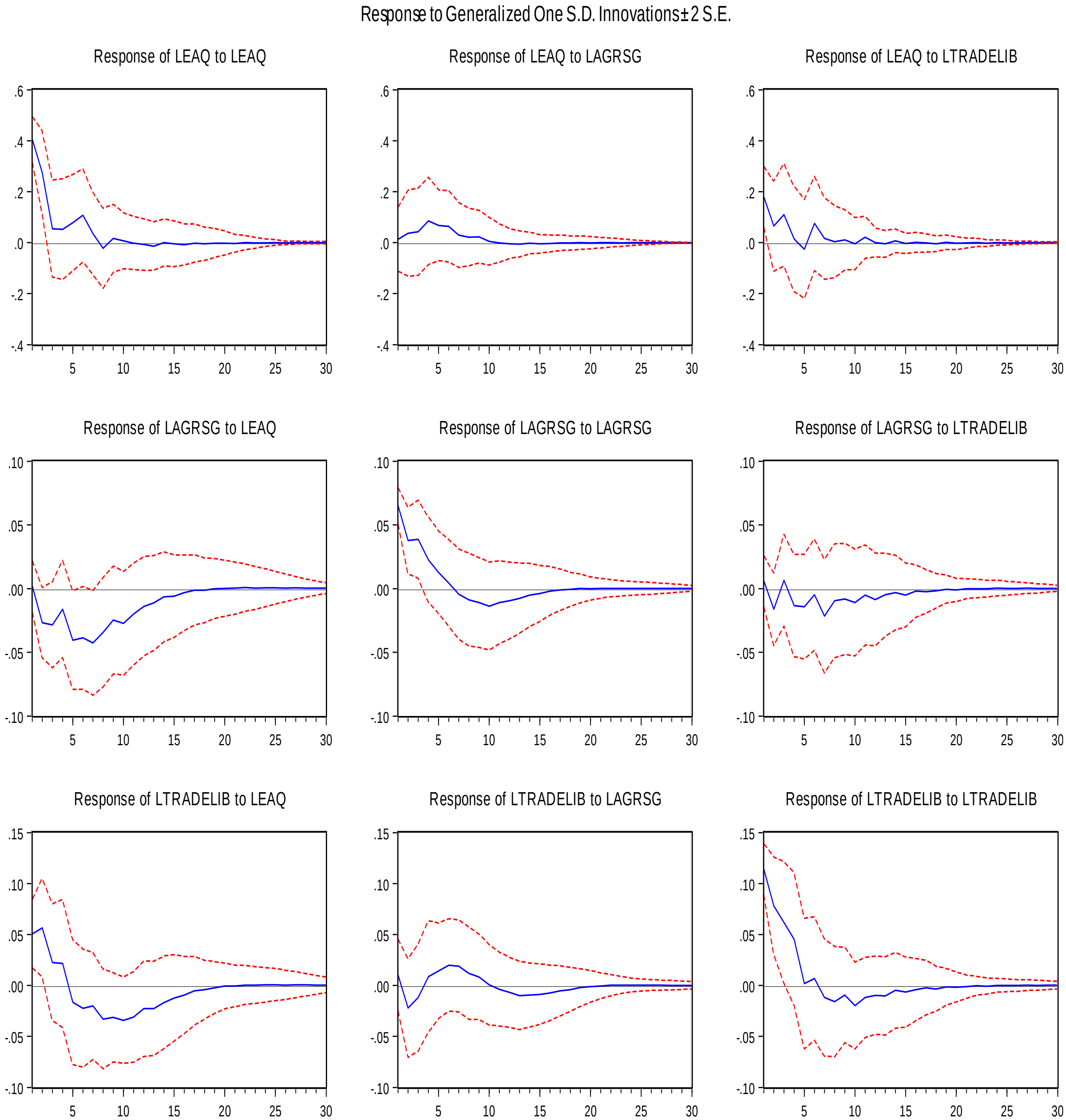
Appendix 2

Figure 1: Response to Shocks



Appendix 3

Vector Error Correction Estimates
Date: 09/16/18 Time: 12:16
Sample (adjusted): 1970 2010
Included observations: 41 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1		
LEAQ(-1)	1.000000		
LAGRSG(-1)	0.758395		
	(1.15763)		
	[0.65513]		
LTRADELIB(-1)	2.546292		
	(1.28272)		
	[1.98506]		
C	-8.979887		
Error Correction:	**D(LEAQ)**	**D(LAGRSG)**	**D(LTRADELIB)**
CointEq1	-0.322164	-0.037640	-0.143514
	(0.18070)	(0.03007)	(0.05159)
	[-1.78289]	[-1.25155]	[-2.78199]
D(LEAQ(-1))	0.289768	-0.020828	0.234208
	(0.24714)	(0.04113)	(0.07055)
	[1.17249]	[-0.50637]	[3.31953]
D(LEAQ(-2))	-0.228088	-0.024971	0.089520
	(0.23644)	(0.03935)	(0.06750)
	[-0.96467]	[-0.63456]	[1.32621]
D(LEAQ(-3))	0.202809	0.031603	0.145626
	(0.22175)	(0.03691)	(0.06331)
	[0.91457]	[0.85627]	[2.30028]

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D(LEAQ(-4))	0.385332	-0.048304	0.110288
	(0.19410)	(0.03230)	(0.05541)
	[1.98522]	[-1.49525]	[1.99029]
D(LAGRSG(-1))	0.205630	-0.162809	-0.550904
	(1.01017)	(0.16813)	(0.28839)
	[0.20356]	[-0.96836]	[-1.91026]
D(LAGRSG(-2))	-0.874312	0.084936	-0.369639
	(1.07170)	(0.17837)	(0.30596)
	[-0.81581]	[0.47618]	[-1.20814]
D(LAGRSG(-3))	2.522644	-0.161711	0.352957
	(1.04111)	(0.17328)	(0.29722)
	[2.42302]	[-0.93325]	[1.18751]
D(LAGRSG(-4))	-0.275234	-0.273746	-0.175210
	(0.98793)	(0.16443)	(0.28204)
	[-0.27860]	[-1.66485]	[-0.62122]
D(LTRADELIB(-1))	-0.674909	0.021051	-0.122392
	(0.67867)	(0.11295)	(0.19375)
	[-0.99446]	[0.18637]	[-0.63169]
D(LTRADELIB(-2))	1.249351	0.218201	0.108028
	(0.72947)	(0.12141)	(0.20825)
	[1.71268]	[1.79724]	[0.51873]
D(LTRADELIB(-3))	-1.165763	-0.085322	-0.050760
	(0.80423)	(0.13385)	(0.22960)
	[-1.44954]	[-0.63744]	[-0.22108]
D(LTRADELIB(-4))	1.357168	-0.097955	0.122314
	(0.79582)	(0.13245)	(0.22719)
	[1.70538]	[-0.73956]	[0.53836]
C	-1.544531	-0.203336	-0.734196
	(1.40940)	(0.23457)	(0.40237)
	[-1.09588]	[-0.86684]	[-1.82470]

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LGCF	0.529507	0.065113	0.241464
	(0.47416)	(0.07892)	(0.13537)
	[1.11674]	[0.82509]	[1.78380]
R-squared	0.520294	0.564971	0.444415
Adj. R-squared	0.261991	0.330724	0.145254
Sum sq. resids	3.896687	0.107940	0.317591
S.E. equation	0.387134	0.064432	0.110522
F-statistic	2.014280	2.411863	1.485538
Log likelihood	-9.930850	63.58843	41.46505
Akaike AIC	1.216139	-2.370167	-1.290978
Schwarz SC	1.843056	-1.743251	-0.664061
Mean dependent	0.026511	-0.006647	0.000164
S.D. dependent	0.450641	0.078759	0.119544
Determinant resid covariance (dof adj.)		6.52E-06	
Determinant resid covariance		1.66E-06	
Log likelihood		98.27584	
Akaike information criterion		-2.452480	
Schwarz criterion		-0.446347	