Testing for Long-Run Relation between Economic Growth and Export Earnings of Cocoa in Ghana using Co-Integration Techniques*

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Abstract

In this study, we explore the causal influence of export earnings of cocoa towards economic growth (i.e., gross domestic product (GDP)). The augmented Dickey–Fuller (ADF) and the Phillips–Perron (PP) unit root tests indicate that the two series are integrated of order one, *I* (1). The results of the trace and the maxi-eigenvalue cointegration test based on Johansen's procedure indicate the existence of a cointegration between export earnings of cocoa and GDP. Thus, the two variables of the study have a long-run equilibrium relationship. The vector error correction model of order two, VECM (2), was considered as the "best" model after evaluating other competing models. It is observed that, in the long-run, previous year export earnings of cocoa is positively related to economic growth. In the short run, the results revealed that the previous GDP has positive effect on current GDP; and higher export earnings of cocoa have positive effect on GDP. Feedback causality is observed between economic growth (GDP) and export earnings of cocoa. This suggests a bi-directional causality from export earnings to economic growth (GDP).

Keywords: Cointegration, VECM, Johansen, ADF, Causality.

1 Introduction

Countries are concerned with improving the economic prosperity of their people. Therefore, it is known that increasing gross domestic product (GDP) will be able to achieve the goal of economic prosperity. One of the ways of increasing GDP is to promote exports, since it is a determinant of GDP. Export is often seen as an important catalyst for economic growth in developing economies. According to Ramos (2001), export growth is often considered to have a direct influence on production and employment growth of an economy.

In Ghana, cocoa is one of the most important crops in the economy. Ghana is reported to be the second largest producer in the world, accounting for about 21% of the total production (ICCO, 2006). Cocoa exports from Ghana are made up of five products, which are classified into: raw, semi-processed and processed products. Ghana exports cocoa beans, cocoa butter, cocoa powder, cocoa paste and cocoa husks (shells), with export of the latter commencing in the year 1986. Cocoa remains the country's most important agricultural export crop, accounting for approximately 23% of total export earnings (ICCO, 2012) and 11% of agricultural gross domestic product (GDP). In spite of Ghana's heavy dependence on the proceeds of cocoa export, no detail research has been conducted to review the role of cocoa export on economic growth in Ghana.

No detailed study could be found on the causal relationship between cocoa export earnings and economic growth in Ghana. However, there are detailed empirical studies on the relationship between economic growth and exports. There are contradicting evidences about the dynamic relationship between exports and economic growth. This has put many developing countries in dilemma whether to open up their economies to promote international trade.

Amavilah (2003) examined the role of exports in Nambia's economic growth. It was revealed that there was a general importance of exports, but the study finds no apparent sign of accelerated growth due to exports.

Thurayia (2004) studied the relationship between exports and economic growth in Saudi Arabia and Sudan. The cointegration and error correction models in the study showed that exports had a positive effect on GDP in the short- and long- run.

Dawson (2005) studied the contribution of agricultural exports to economic growth in less developed countries. The study concluded that the

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less developed countries provided evidence to support the theory of export led growth.

Aurangzeb (2006) studied the relationship between economic growth and exports in Pakistan. The study indicated that export oriented and outward looking approach was needed for high rates of economic growth in Pakistan.

Tang (2006) stated that there is no short- and long-run causality between export expansion and economic growth in China.

Jordaan (2007) examined the causality between exports and GDP of Namibia. The study revealed that exports Granger-cause GDP, and suggested that the export-led growth strategy through various incentives has a positive influence on growth.

Rangasamy (2008) examined the exports and economic growth relationship for South Africa. The study provided an evidence of unidirectional Granger causality runs from exports to economic growth.

Sanjuan-Lopez and Dawson (2010) assessed the contribution of agricultural exports to economic growth in developing countries. The results of the study indicated that there existed long run relationship and the agriculture export.

From the above literatures, it is obvious that a number of studies support the export-led economic growth while others do not. As indicated earlier, there are no studies on export earnings of cocoa and economic growth in Ghana. Thus, this paper is an attempt to investigate the export earnings of cocoa-economic growth nexus for Ghana. This study shall provide useful information which will be helpful to policy makers.

Thus, the purpose of this study is to examine the causal relationship, if any, between the export earnings of cocoa and economic growth (GDP) using a vector error correction model (VECM), and to ascertain the economic implications of such a causal relationship.

2 Resources and Methods Used

2.1 Data Source

The export earnings (US$) data were obtained from the Ghana Cocoa Board and GDP (per capita) from the World Bank Development Indicator website. All data span from 1980 to 2011.

2.2 Unit Root Test

In order to find an appropriate model for a series, we must check the series for stationarity. A non-stationary time series will have a time-varying mean or a time-varying variance or both. Thus, it is always proper to transform a non-stationary time series to a stationary series before doing any meaningful analysis. The unit root test is a formal way of testing for stationarity.

Among the various methods of unit root test, the test developed by Dickey and Fuller, known as the augmented Dickey-Fuller (ADF) test, is commonly used. The hypothesis of the test is:

H_0: series has a unit root or not stationary

H_1: series does not have a unit root or stationary

The ADF test consists of estimating the following regression model:

$$\Delta Y_t = \beta_1 + \beta_1 t + \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-1} + \varepsilon_t \quad (1)$$

where ε_t is a pure white noise error term and the ADF test follows an asymptotic distribution.

2.3 Error Correction Model

The error correction model is used when the time series are not stationary and are cointegrated.

Tests for Cointegration

Two *I (1)* time series $y_{1,t}$ and $y_{2,t}$ are said to be cointegrated if there exists a linear relationship of the form $Z_t = \beta_1 y_{1,t} + \beta_2 y_{2,t}$ such that Z_t is *I(0)*. If we define the vectors

$$\beta = \begin{pmatrix} \beta_1 \\ \beta_2 \end{pmatrix}, \quad y_t = \begin{pmatrix} y_{1,t} \\ y_{2,t} \end{pmatrix} \quad (2)$$

so that the cointegrating relationship is written $Z_t = \beta' y_t$, then β is called the cointegrating vector. The cointegration relationship is often interpreted as being a long run or equilibrium relationship between the variables. The number of linearly independent cointegrating vectors is called the cointegrating rank. The two common tests to determine the cointegrating rank are the trace and the maximum eigenvalues tests. The hypothesis of the test is:

H_0: *the number of cointegrating vectors is r,*

H_1: *the number of cointegrating vectors is* $(r+1)$

The two statistics are:

$$\lambda_{Trace}(r) = -T\sum_{i=r+1}^{g}\ln(1-\hat{\lambda}_i)$$
$$\lambda_{Max}(r, r+1) = -T\ln(1-\hat{\lambda}_{r+1}) \quad (3)$$

where $\hat{\lambda}_i$ is the estimated value for the i^{th} ordered eigenvalue.

Vector Error Correction Model

The appropriate model for cointegrated time series is called a Vector Error Correction Model (VECM) and is a rearranged restricted form of a VAR. In general, the VECM is of the form:

$$\Delta y_t = \alpha\beta' y_{t-1} + \Gamma_1\Delta y_{t-1} + \ldots + \Gamma_{p-1}\Delta y_{t-p+1} + \varepsilon_t \quad (4)$$

A VECM thus consists of a mixture of variables in levels and first difference form. If we applied the univariate modeling strategy of taking first differences of any *I*(*1*) time series, and hence fitting a VAR in first differences, the resulting model would be mis-specified because of the omitted error correction term. Conversely we cannot use a VAR in levels to model cointegrated time series because the resulting inference in the presence of the non-stationarity would not be valid. In the presence of cointegration, a VECM is required.

2.4 Model Selection Criteria

The information criteria used in this study are the following:
Akaike information criterion (AIC):

$$AIC = -2\ln L\left(\hat{q}_k\right) + 2k \quad (5)$$

Baysian information criterion (SIC) :

$$SIC = -2\ln L + k\ln(n) \quad (6)$$

where

$L\left(\hat{\theta}_k\right)$ is the likelihood of the fitted model,
$k = p + 1$ (which is the model size),
p = number of parameters and
n = number of observation.

3 Results and Discussion

A correlation analysis on export earnings of cocoa and GDP is performed, the Pearson's correlation coefficient between the two variables is calculated over the sample period, and its significance is tested by the p-value. The value of Pearson's correlation coefficient (r) is 0.86 with p-value of 0.00. This shows that export earnings of cocoa and GDP are positively related in Ghana and this relationship is statistically significant. Correlation, however, does not say anything about long-run relationship, and that does not help us to settle the debate concerning the long-run relationship between export earnings of cocoa and economic growth (GDP).

Stationarity Test

The results of the *ADF* and *PP unit root tests* are reported in Table 1. These two unit root tests are performed on both the level and first differences of GDP and export earnings. The variables GDP and Export earnings of cocoa are *I*(1) processes according to *ADF* and *PP*. However, it is evident that these variables became stationary after first difference.

Table 1 Test of Unit Root Test Hypothesis with Intercept

Variables	ADF Test			PP Test			Conclusions
		Test Statistic	P-value		Test Statistic	P-value	
Export Earnings	Level	-0.07	0.94	Level	0.16	0.96	Export earnings is not stationary at level
	First Difference	-4.76	0.00	First Difference	-5.36	0.00	First difference of export earnings is stationary
Log GDP	Level	0.75	0.99	Level	0.53	0.98	GDP is not stationary at level
	First Difference	-4.22	0.00	First Difference	-4.21	0.00	First difference of GDP is stationary

Cointegration Test

In Table 2, we give the results of the Johansen Cointegration Test. According to the results of the *ADF and PP in Table 2*,the variables have the same order of integration, i.e., I(1) and the Johansen Cointegration Test was used to find out the cointegration rank and the number of cointegrating vectors. The null hypothesis of $r = 0$ (i.e., there is no cointegration) is rejected against the alternative hypothesis of $r = 1$ at the 5% level of significance in case of the Max-Eigen value statistic. Similarly, going by the result of the Trace statistic, the null hypothesis of $r = 0$ is rejected against the alternative hypothesis of $r \geq 1$.

In Table 2, both trace statistic and maximum eigenvalue statistic show that there is one cointegration equation at 0.05 level of significant. We fit VECM because the two conditions for using the vector error correction model are met.

Table 2 Unrestricted Cointegration Rank Test for GDP and Export Earnings

Ho: No. of CE(s)	Trace Statistics	P-value	Max-Eigen Statistics	P-value
None	27.71	0.00	24.21	0.00
At most 1*	3.49	0.06	3.49	0.06

Model Selection

In order to capture the impact of variables observed in the past time period in explaining the future performance, the ideal lag length p (which determines the appropriate model) is chosen. Firstly, the information criteria in Table 3 is use to select the "best" model for the data. The lag length with the minimum information criterion is selected as the "best" model. Thus, according to Table 3, the three information criteria are not consistent in selecting a unique model as the "best" model. In specific, AIC selects lag length 8 as the "best" model, SIC selects order 6 and HQ selects order 7. For proper assessment, we fitted eight models with lag length from 1 to 8, and standard diagnostics checking are conducted on these fitted models.

Table 3 Lag Order Selection [GDP, Export Earnings]

Lag	AIC	SIC	HQ
0	56.4	56.5	56.4
1	53.6	53.9	53.7
2	53.6	54.1	53.7
3	53.3	54.0	53.5
4	53.2	54.0	53.4
5	52.7	53.8	53.0
6	52.5	53.7*	52.8
7	52.4	53.9	52.7*
8	52.3*	54.0	52.8

** indicates lag order selected by the criterion*

Models VECM (1), VECM (3), VECM (4), VECM (5), VECM (6), VECM (7) and VECM (8) violated the white noise test (inverse roots of AR characteristic polynomial, serial correlation and normality test).Therefore, VECM(2) which passed the white noise test was considered as the "best" model for our data.

In Table 4, the cointegration equations are given along with the equation for changes in GDP [*first* column, D(GDP)] and changes in Export earnings (*second* column). In this study, our interest is the first column (GDP as the endogenous variable). The coefficients of the cointegrating equation contain information about whether the past values affect the current values of the variable under study in the long run. In the cointegrating equation in Table 4, the previous year export earnings variable [EXE(-1)] is positive and statistically significant. This means that, in the long-run, previous year export earnings is positively related to economic growth. For the vector error correction model, a significant lagged co-efficient implies that past equilibrium errors has a role in determining the current outcomes in the short run.

The lagged coefficients of change in GDP are positive but only the second lag is statistically significant at 0.05. This indicates that higher second lag of GDP has positive effect on current GDP in the short run. However, this study revealed that previous GDP has positive effect on current GDP. The lagged coefficients of change in export earnings are positive but only the second lag is statistically significant at 0.05. This suggests that higher export earnings have positive effect on GDP in the short run

Table 4 Vector Error Correction Model Estimates [VECM (2)]

Cointegrating Equation:	Coint. Eq1	
GDP(-1)	1.000000	
EXE(-1)	8.55E-07	
	(9.2E-08)	
	[9.28113]	
C	39.26913	
Error Correction:	D(GDP)	D(EXE)
CointEq1	-0.620903	11662.02
	(0.12659)	(335654.)
	[-4.90497]	[0.03474]
D(GDP(-1))	0.301401	702665.7
	(0.16184)	(429128.)
	[1.86235]	[-1.63743]
D(GDP(-2))	0.493851	1088332.
	(0.17256)	(457544.)
	[2.86199]	[2.37864]
D(EXE(-1))	1.88E-07	0.223392
	(1.2E-07)	(0.32251)
	[1.54279]	[0.69266]
D(EXE(-2))	5.20E-07	-0.188332
	(1.4E-07)	(0.36267)
	[3.79992]	[-0.51929]
C	55.52461	57158720
	(17.5248)	(4.6E+07)
	[3.16834]	[1.23005]
Log likelihood		-754.9236
Akaike information criterion		53.02922
Schwarz criterion		53.68929

(a) Standard errors in ( ) and t-statistics in [ ]
EXE denotes export earnings of cocoa

Causality Test with VECM

The causality test with VECM (2) is presented in Table 5**.** The null hypothesis that export earnings does not Granger cause GDP is tested using changes in GDP (D(GDP), and changes in export earnings (D(export earnings). These variables are stationary in their first difference form in standard Granger causality regression. The null hypothesis is accepted or rejected based on the "F- test" to determine the joint significance of the restrictions under the null hypothesis.

In this study, our interest is to establish the direction of influence between economic growth (GDP) and export earnings and if there is a feedback influence. In Table 5, all the *p* values of the variables are less than 0.05; this indicates that the coefficient of Export earnings is not zero in the equation for GDP. Thus, the null hypothesis that export earnings does not granger cause economic growth (GDP) can be rejected and a bi-directional causality is observed from export earnings to economic growth (GDP).

Table 5 Results of Granger causality test

Null Hypothesis:	F-Statistic	P-value	Conclusion
EXPORT Earnings does not Granger Cause *GDP*	15.05	0.00	Reject Ho
GDP does not Granger Cause *EXPORT* Earnings	7.55	0.00	Reject Ho

EXPORT Earnings ⟶ GDP

GDP ⟶ EXPORT Earnings

It is observed that there is existence of a long-run relationship between economic (GDP) and export earnings, since there is presence of bi-directional causality between the two variables.

Impulse Response

Here, we want to know how economic growth will react or behave as a result of one standard deviation shock or impulse or innovation in export earnings and itself. We present the graphical results in Figure 1. The first graph is the response of economic growth to itself as a result of one standard deviation shock. The graph shows that when there is one standard deviation shock, the influence of economic growth on itself decreases but its positive until the fourth year. At the fifth year, its influence is negative but begins to increase until it becomes positive at the seventh year and continue to rise.

The second graph (horizontally) is the response of economic growth (GDP) as results of one standard deviation shock or innovation to export earnings of cocoa. The response of GDP on export earnings increases rapidly and becomes constant at the fifth and sixth year but still rising.

In the third graph, the response of export earnings to GDP initially decreases and it is negative but starts rising before the second year (and becomes positive at the second year). Its influence starts to decrease negatively at the sixth year and never becomes positive up to the tenth year.

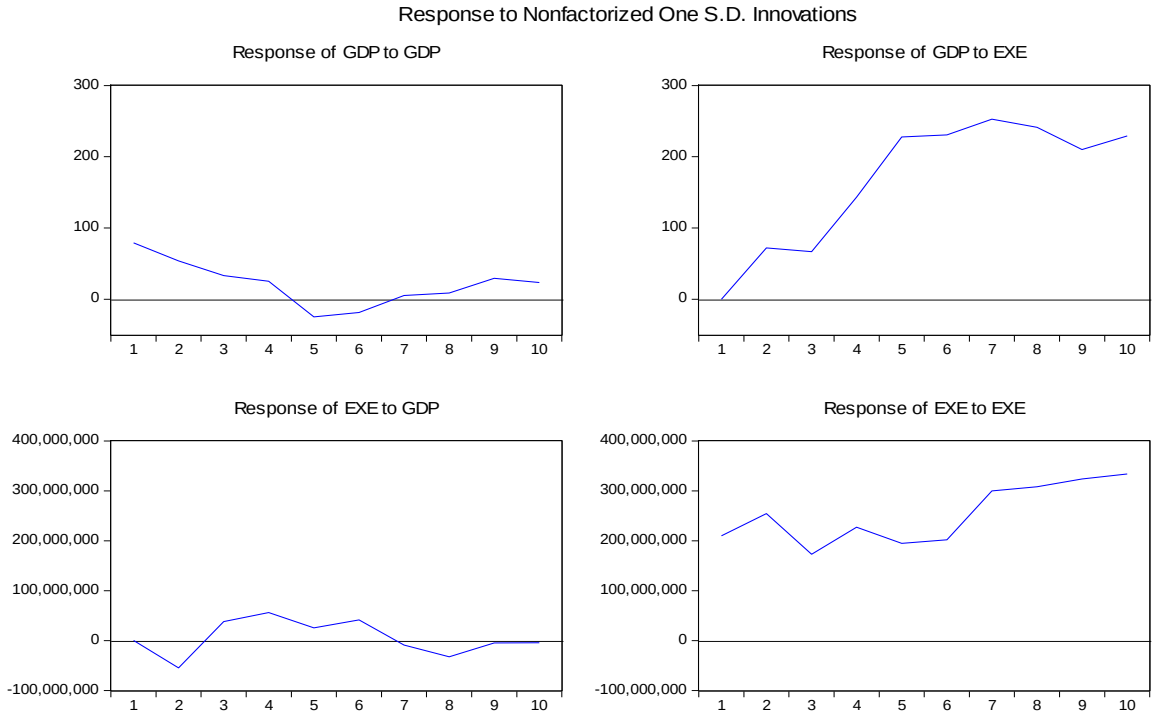

Fig 1 Impulse Response graph for GDP and Export Earnings

4 Conclusions

In this study, we explore the causal influence of export earnings of cocoa towards economic growth (GDP). Here, the ADF and the PP unit root tests indicate that the two series are *I*(1). The results of the trace and the maxi-eigenvalue cointegration tests based on Johansen's procedure indicate the existence of a cointegration between export earnings of cocoa and GDP. Thus, there is a long-run equilibrium relationship between the two variables in this study.

The vector error correction model of order two, VECM (2) was considered as the "best" model. We observed that, in the long-run, previous year export earnings of cocoa is positively related to economic growth. In the short run, the results revealed that the previous GDP has positive effect on current GDP. Again, it was observed that higher export earnings of cocoa have positive effect on GDP in the short run.

Feedback causality between economic growth (GDP) and export earnings of cocoa is observed. This suggests that a bi-directional causality is observed from export earnings of cocoa to economic growth (GDP).

The policy implication of such empirical evidence may be that policies aimed at increasing the productivity and quality of cocoa should be implemented. For instance, most of the producers lack the material and financial means to increase the production of cocoa. Thus, as a policy, the government should encourage farmers to form cooperatives so that they could be open to loan schemes, which will go a long way to increase productivity. Also additional value should be added to cocoa before exporting. When this is done, it will lead to a higher rate of economic growth in Ghana.

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