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Co-integration Analysis of the Determinants of Cotton Lint Exports from Mali

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Authors' contributions

This whole work was carried out in collaboration between all authors. Structured, guided and edited by the author DB. This work is the output of effective contributions from the authors DB, BOKL and JA. This article has been read and approved by all.

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ABSTRACT

Following recent declines in volume and value of cotton lint exports from Mali, we made use of the Johansen Full Information Maximum Likelihood test to identify the magnitude and effects of key drivers of cotton lint exports from the country. In this regard, we estimated two primary models using volume of exports as dependent variable in one and value of exports as dependent variable in the other. Results for the two primary models estimated show that exports are generally stimulated by production, improvement in competitiveness, openness to trade, increasing international trade and previous growth in exports. Growth in the country's exports of the commodity is however noted to be hindered by both domestic and international forces. In as much as distortionary induced downward pressure on world prices impacts negatively on exports from the country, inefficiencies and constraints in the domestic environment preclude the country from appropriately exploiting opportunities and adjusting to unexpected market developments in the short-run. To revitalize the gloomy export trade of Mali in cotton lint, policy makers and various stakeholders in the industry should put in place measures to address domestic inefficiencies (over which the country has some control compared to

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inefficiencies on the global market) to keep the country in a better position to exploit market opportunities and adjust to unexpected developments in the shortest possible time. In addition, measures should be put in place to revive the declining cotton production industry, promote trade openness, and improve on the quality of cotton lint exports. Increased production could be achieved through supporting of farmers in diverse ways, including provision of credits, input distribution, appropriate transmission of price increments to farmers, and creating of favorable marketing environment for their produce in terms of access and information. Minimization of trade restrictions and appropriate liberalization of internal and external marketing could further enhance the country's terms of trade index of exports. To improve the quality of exports, emphasis should be placed on improving the ginning process to ensure attainment of high quality lint for export.

Keywords: Co-integration; cotton lint; determinants; export growth; international trade; Mali.

1. INTRODUCTION

Just as cocoa has been and continues to be the basic foundation for economic development in Ghana, cotton has been and continues to be the most important cash crop in Mali (and the other members of the C-4 countries). The cotton sector supports the Malian economy not only through foreign exchange earnings, but also through production, processing and marketing serves as the only source of income for over a third of the population [1]. In addition, the sector has in diverse ways fueled development in both rural and urban areas. Through its' development potential, the sector continues to serve as the basic foundation for economic development by providing benefits to both small and large scale producers (who depend on it for sustenance), the rural communities on a broader perspective, private traders, cotton companies and the national government [2]. Cotton export (cotton seed and lint) is generally reported to have accounted for 92 to 97% of total agricultural exports for the country during the 1990s [3]. Besides, cotton represented 30% of total merchandise exports during the period 2001-2003 and more than 6% of the country's GDP [1]. Although the share of cotton in total agricultural exports is believed to have declined steadily since 2003 [3], cotton lint exports alone accounted for about 60.72% of agricultural export earnings for the period 2005-2011 (based on FAO estimates). These respective periodical contributions reflect a strong reliance of the Malian economy on cotton lint exports, which consequently makes the country vulnerable to unexpected developments on the global cotton lint market. The cotton sector, both in production and export dimensions has been subjected to various developments and instruments in internal and external policy environments over the past three decades. In as much as internal efforts have been towards strengthening the sector, external influences in the form of distortions (production and export subsidies levied by major players including the United States, India and China) have primarily induced downward pressure on world cotton prices and consequently prices faced by exporters, traders and producers in Mali. Changes in these policy environments, alongside pulls from other biophysical, structural, financial and quality constraints have led not only to a steady decline in national production of cotton lint, but as well a decline in volume and value of exports of the commodity since the year 2004. These conditions put not only the current stands of national production and exports at risk, but could as well trigger major food insecurity and poverty implications due to heavy reliance of majority of the populace on the cotton sector. As shown in Fig. 1, volume of cotton lint exports decreased from as high as 258,830tonnes in 2004 to 57,237tonnes in 2010 (increasing thereafter to 78,152tonnes in 2011). In value terms, exports decreased from $352,502 (thousand) in 2004 to $96,463(thousand) in 2010 (increasing thereafter to $206,734 (thousand) in 2011). Similar trends have been observed in Chad, Benin and Côte d'Ivoire. In the midst of these developments, the Malian Company of Textile Development (CMDP–a semi-public company that manages the cotton value chains at all levels) and various traders in the commodity are reported to be losing out in the system [3]. With the Malian cotton sector looking gloomier following developments in internal and external policy environments, there arises now a need for identification of key drivers of exports to guide informing of future agricultural and trade policy decisions on relevant political strategies needed for sectorial revitalization. Although several approaches have been employed in economic, business and trade literature for achieving this, in the present study, we make use of co-integration analysis technique (specifically, the Johansen Full Information Maximum Likelihood test) to identify the short- and long-run magnitudes and effects of such drivers for the period 1980-2011.

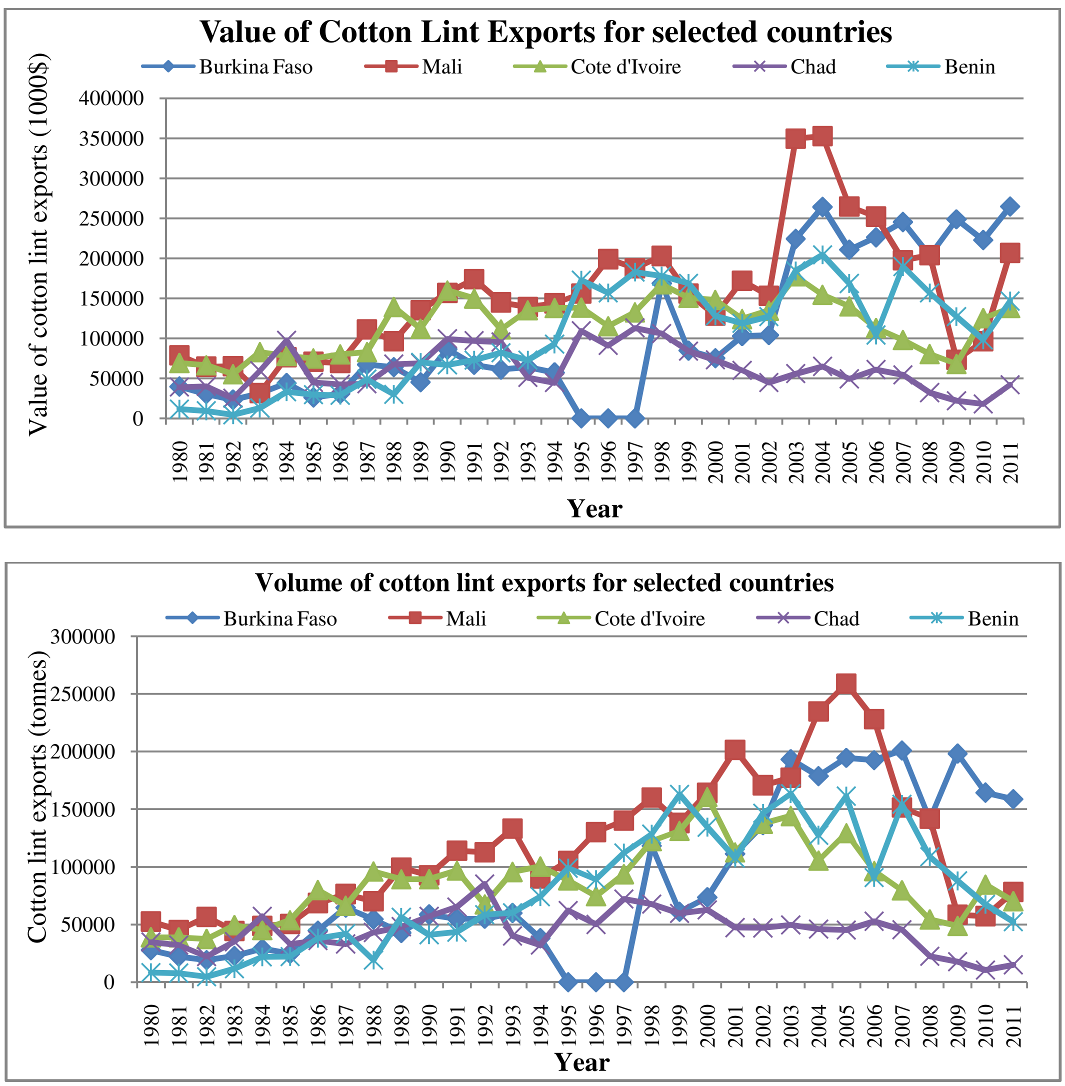

Fig. 1. Trends in value and volume of cotton lint exports from West and Central Africa
Data Source: Agricultural Trade Statistics of FAO (FAOSTAT)

Primarily, the study sources to achieve the following objectives:

1. To identify the magnitude and effects of key economic indicators on volume and value of exports of cotton lint from Mali for the period 1980-2011
2. To identify how exports from Mali have responded to dynamics in domestic and external policy environments (by assuming a linear deterministic trend in the long-run equations) and
3. To inform relevant agricultural trade policy prescriptions on the way forward

2. LITERATURE REVIEW

Following developments in world trade, several researches have been conducted in one way or another to help identify key drivers of exports and to inform appropriate trade policy prescriptions in various countries. In this wake, mixed findings have been noted in trade literature on the determinants of exports in both developing and developed economies. In assessing the impact of trade liberalization on export of cotton from Pakistan, [4] found that the key determinants of cotton exports are openness to agricultural trade (reflected by the terms of trade index), competitiveness and concentration of export and world demand. In assessing drivers of export growth for Uganda, [5] found terms of trade and previous growth to be the significant determinants of export growth. In a similar study, [6] found out that although terms of trade has a significant positive relationship with export growth, an increase in the index of trade openness marginally increases exports. In conformity with findings so far on terms of trade, [7] revealed that deterioration of terms of trade leads to contraction of export earnings. In a study by [8], export growth rate for Uganda was found to be significantly dependent on both internal and external drivers like gross domestic product, foreign prices, real exchange rate and terms of trade. In this study, [8] found export growth to be driven positively by gross domestic product of the country and terms of trade. Mixed signals (signs against a priori expectation) were however observed in the case of foreign price and real exchange rate in the long run. In a study on South Africa's international cost competitiveness and productivity in Manufacturing, [9] revealed that foreign prices have strong impact on export performance for the manufacturing sector of the country. Similarly, in their study on international trade and economic development in Tanzania,[10] discovered that foreign prices of primary commodities have a significant effect on export performance of countries involved in production of such commodities. In contrast to schools of thought that hold world price of a commodity as a key determinant of exports for that commodity, [11] found no significant effect of world price on rubber exports from Nigeria. In support of the discovery by [11,12] also found no significant effect of export price on India's exports of cucumber and gherkin. They however found a significant positive association between exports and volume of international trade in cucumber and gherkin. In this study, the effect of exchange rate was also found positive and significant. In assessing performance, competitiveness and determinants of tomato exports from India, [13] revealed that export demand for Indian tomato is driven positively by increasing volume of international trade in tomato and by the ratio of Indian and non-Indian International export prices. They however found a significant negative association between domestic production of tomato and export demand for it. In a study to assess the competitive and determinants of cocoa exports from Nigeria, [14] revealed that cocoa export from Nigeria is positively driven by increases in volume of world exports of the commodity and by increases in domestic production. They as well found a significant negative relationship between exports of the commodity and exchange rate (due to the weak currency of the country). Effect of export price on exports was however not significant. This supports earlier findings of [11] for rubber. Although it is believed that surplus production in a closed economy drives down prices, in an open economy, increased production is believed to be a key driver for export expansion. In assessing the relationship between United Kingdom's exports performance in Manufactures and the internal pressure of demand, [15] discovered that higher level of production remains the main cause of export expansion.

3. METHODOLOGY

3.1 Analytical Framework

Three primary techniques have been proposed in economic, business and trade literature for co-integration analysis. These are the Engle-Granger method [16], the Phillips-Ouliaris residual-based test [17] and the Johansen Full Information Maximum Likelihood test [18]. In as much as the Engle-Granger method is perceived to be intuitive and easy to perform, the approach is flawed by small-sample biases [19,20]. By its two-step estimation procedure, substantial errors introduced in the first stage (co-integrating regression) of the Engle-Granger approach are carried over into the second stage, rendering the results mostly unreliable. This in part is due to the fact that, in producing estimates for the first stage, the approach tends to ignore short-run dynamics, thereby producing short-run effects that are not guided by long-run estimates (hence inconsistency in estimates). Beside these flaws, the Engle-Granger approach tends to preclude the possibility of identifying more than a single co-integrating equation between two or more variables. In studying economic relationships however, there exists a high probability of identifying *n-1* co-integrating equations between *n* variables. In addition, the Engle-Granger two-step estimation procedure operates on the principle that, irrespective of which variable is chosen for normalization, there is almost a certain probability of witnessing the same results should the variables be interchanged [21]. In practice however, a regression that indicates existence of co-integration between some specified variables, may turn up against that same decision should the order be reversed (e.g. relationship between income and expenditure). These flaws render the Engle-Granger approach inappropriate for our work. The Phillips-Ouliaris residual-based test on the other hand is performed using either a variance ratio test or multivariate trace statistic. Although the multivariate trace statistic component of this method is believed to have advantage over the variance ratio test due to its nature of being invariant to normalization, just like the Engle-Granger method, the Phillips-Ouliaris approach is generally flawed due to its nature of assuming a single co-integrating equation between two or more variables. The flaws identified so far between the Engle-Granger and Phillips-Ouliaris approaches are appropriately addressed through the use of vector co-integration techniques, noted amongst which is the Johansen Full Information Maximum Likelihood test. In this regards, we make use of the Johansen technique for our analysis.

In contrast to the steps and principles held unto by the Engle-Granger and Phillips Ouliaris methods, the Johansen procedure builds co-integration variables directly from maximum likelihood estimation. The procedure relies on the relationship between the rank of a matrix and its characteristic roots. In spite of its ability to address flaws in the other approaches, the Johansen technique is heavily reliant on asymptotic properties and is sensitive to specification errors. In addition, this method has large-model problem, in that, including too many variables does not only complicate issues, but as well precludes appropriate capturing of dynamic, inter-temporal relocations between the variables considered [22]. By this, the Johansen technique and its associated vector auto-regression (VAR) process are suitable for describing data generation process (d.g.p) of a small to moderate set of time series variables. Under this approach, all variables are a priori assumed endogenous (unless one/some is/are stationary at level, in which case it/they is/are usually treated as exogenous). In contrast to the single co-integrating vector assumption held unto by the other two methods, the Johansen technique allows for all possible co-integrating relationships and permits empirical determination of the number of co-integrating vectors. Estimated short-run effects are appropriately guided by and consistent with long-run relationships.

By its nature, the Johansen Full Information Maximum Likelihood test begins with definition of a vector auto-regression. This is given as follows:

$$X_t = \Pi_1 X_{t-1} + \Pi_2 X_{t-2} + \ldots + \Pi_p X_{t-p} + \mu_t \qquad (1)$$

Where X_t is an *(n×1)* vector of *I*(1) variables, Π_1 through Π_p represents *(m×m)* matrix of coefficients, and μ_t is (n×1) vector of innovations (white noise errors). Following definition of the vector auto-regression as specified in equation (1), effort is made to select appropriate lag order for use in co-integration test. The co-integration test is primarily a test to identify the number of co-integrating equations in the system under study. In selecting appropriate lags, use is made of the Akaike Information Criterion (AIC), the Schwarz Criterion and the Hannan-Quinn Information Criterion. Following the lag selection process, the system under study is tested for number of co-integrating equations. In literature, this has so far been achieved using either the Trace test statistic or the Maximal-eigenvalue test. The trace test is a joint test of the null hypothesis of *r* co-integrating vectors against the alternative of more than *r* co-integrating vectors, and is expressed as follows:

$$Jtrace(r) = -T \sum_{i=r+1}^{p} \ln(1 - \lambda_i) \qquad (2)$$

The maximal-eigenvalue as an alternative, conducts separate tests on the individual eigenvalues for a null hypothesis that the number of co-integrating vectors is *r*, against an alternative of r+1. This test statistic is as well expressed as follows:

$$Jmax(r, r+1) = -T \ln(1 - \lambda_{r+1}) \qquad (3)$$

Due to the ability of the trace test statistic to show more robustness to both skewness and excess kurtosis in innovations than the maximal-eigenvalue test [23], the latter has been less used in co-integration studies. Due to this advantage of the trace test, we make use of it in this study as the choice approach for identifying the number of co-integrating equations. Confirmation of co-integrating equation(s) in a system of variables renders the VAR form (thus, eq. (1)) inappropriate or less convenient setup. In its stead, a special parameterization that supports analysis of the co-integrating structures is considered. The resulting model is known as the vector error correction model (VECM) or vector equilibrium correction model [22].

Holding unto the assumption that the vector of *(n×1)* variables (X_t) from equation (1) is non-stationary, the VECM obtained from parameterization (subtraction of X_{t-1} on both sides) of equation (1) yields:

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \Gamma_2 \Delta X_{t-2} + \ldots + \Gamma_{p-1} \Delta X_{t-p+1} - \Pi X_{t-p} + \mu_t \qquad (4)$$

Where $\Gamma_1 = \Pi_1 - I$, $\Gamma_2 = \Pi_2 - \Gamma_1$, $\Gamma_3 = \Pi_3 - \Gamma_2$, and $\Pi = I - \Pi_1 - \Pi_2 - \ldots - \Pi_p$

In contrast to the *I*(1) (non-stationary) status of X_t in equation (1), ΔX_t in equation (4) is *I* (0) (stationary) due to the parameterization. By this, j=1, 2, p-1 are all *I*(0), andμ_t is assumed to be *I*(0). For a meaningful equation, ΠX_{t-p} is expected to (and must) be stationary. The matrix Π determines the extent to which a given system is co-integrated and is called the impact matrix [21]. By this, information on the number of co-integrating relationships among the variables in X_t is given by the rank of the matrix Π. Should the rank of Π matrix r be 0<*r* >n, this implies that there are *r* linear combination of the variables in X_t that are stationary. The matrix Π can further be decomposed into two sub matrices α and β, where α measures the speed of adjustment of the system(represented mostly as the error correction for a system) and β contains *r* co-integrating vectors. From equation (4) Γ_i gives the short-run estimates, whiles Π contains the long-run estimates. In performing co-integration analysis however, for variable to be co-integrated, they are primarily expected to be integrated of the same order (usually *I* (1)). Should there however be variables that are found stationary at level (i.e. *I*(0)), are significant in the long-run co-integrating space and affect the short-run model, equation (4) can be re-written as follows [24]:

$$\Delta \boldsymbol{X_t} = \boldsymbol{\Gamma_1} \Delta \boldsymbol{X_{t-1}} + \boldsymbol{\Gamma_2} \Delta \boldsymbol{X_{t-2}} + \ldots + \boldsymbol{\Gamma_{p-1}} \Delta \boldsymbol{X_{t-p+1}} - \boldsymbol{\Pi X_{t-p}} + \boldsymbol{v D_t} + \boldsymbol{\mu_t} \tag{5}$$

Where D_t stands for the stationary (*I*(0)) variable(s), and all other variables hold their earlier representations. Appropriate specification and estimation of both the VAR and VECM (in case of co-integrating equations) involves use of fewer but relevant variables and setting of appropriate lag length(s). Fewer but relevant signifies variables that have a greater probability of affecting the short-run behavior of the model [25].

3.2Variable Selection and Model Specification

Glancing critically through the literature review in this document and other researches in trade literature, several indicators have been proposed as key determinants of export growth. In this study however we stick to the use of few variables we deem relevant and primarily unique to Mali. In estimating response of export growth in this study however, we specify two separate models. In Model 1, we set volume of cotton lint exports as the dependent variable, while in Model 2 we set value of cotton lint exports as the dependent variable. This is to help identify the respective responses of volume and value of exports to key indicators as specified below. The respective models are expressed as follows:

$$\mathbf{ln}(\boldsymbol{EXPVol}) = \boldsymbol{f}(\mathbf{ln}(\boldsymbol{EXPPRICE}), \mathbf{ln}(\boldsymbol{PROD}), \mathbf{ln}(\boldsymbol{ToT}), \mathbf{ln}(\boldsymbol{CEP}), \mathbf{ln}(\boldsymbol{EXPVolW})) \tag{6}$$

$$\mathbf{ln}(\boldsymbol{EXPVal}) = \boldsymbol{f}(\mathbf{ln}(\boldsymbol{EXPPRICE}), \mathbf{ln}(\boldsymbol{PROD}), \mathbf{ln}(\boldsymbol{ToT}), \mathbf{ln}(\boldsymbol{CEP}), \mathbf{ln}(\boldsymbol{EXPVolW})) \tag{7}$$

Where

$ln\ (EXPVol)$ -log of volume of cotton lint exports from Mali
$ln\ (EXPVal)$ -log of value of cotton lint exports from Mali
$ln\ (EXPPRICE)$-log of cotton lint export price for Mali
$ln\ (PROD)$ -log of cotton lint production (output) for Mali
$ln\ (ToT)$ -log of terms of trade index of exports for Mali
$ln\ (CEP)$ -log of the comparative export performance index for Mali in cotton Lint
$ln\ (EXPVolW)$-log of world volume of cotton lint exports

In contrast to the use of world price as noted in several articles in trade literature as proxy for export price, we make use of actual export price faced by Mali for exports of cotton lint. In spite of the average price(s) quoted on various trade websites as export price for cotton lint, countries involved in export of the commodity do face different prices for the commodity based on quality of the product they export, their respective performances and on their primary destinations. Export price as employed in this study is defined as follows:

$$\boldsymbol{EXPPRICE} = \frac{\boldsymbol{EXPVal}}{\boldsymbol{EXPVol}} \times \mathbf{1000} \tag{8}$$

The result for equation (8) represents the export price of cotton lint in $/tonne. Multiplication of the primary fraction by 1000 is due to the fact that value of exports reportedin the agricultural trade database of the FAO is expressed in $1000, while the volume of exports is in tonnes. The index of competitiveness (as reflected by the comparative export performance index (CEP)) was computed using the following formula:

$$\boldsymbol{CEP} = \frac{(\boldsymbol{X_{iB}}/\boldsymbol{X_B})}{(\boldsymbol{X_{iA}}/\boldsymbol{X_A})} \tag{9}$$

Where

X_{iB} - value of cotton lint exports from Mali
X_B - total value of agricultural exports from Mali
X_{iA} - value of world exports of cotton lint
XA - total value of world agricultural exports.

Inclusion of the volume of world exports in the specified equations (6 and 7) is to help capture implications of changes in international trade and demand on exports from Mali. This inclusion is in line with specifications by [12,13,26,27]. In addition to these, we excluded nominal exchange rate (as a surrogate measure of incentive for exports) from our specification. This exclusion is based on the grounds that, with the exception of Ghana, Nigeria and possibly other few countries, all other countries in West and Central Africa use the CFA franc and have the same nominal exchange rate. Developments in exports under such condition could possibly be enhanced by external factors and internal factors that are unique to Mali as a competing country within and outside the West and Central Africa region. Beside the computations for equations (8) and (9), and terms of trade index of exports (ToT), data for all the other variables were gathered from the agricultural production and trade database of FAO (FAOSTAT) for the period 1980 -2011. Data for terms of trade index of exports were gathered from the United Nations Conference on Trade and Development statistics (UNCTAD STAT) for the period 1980-2011.

3.3 Unit Root Test

For variables to be co-integrated, they are expected to be integrated of the same order. This has been the basic rationale behind performing of unit root test in co-integration studies, as it guides the assumptions made and the entire data generation process. To ascertain the order of integration of variables in co-integration analysis, several methods have been proposed in literature. These include Dickey-Fuller (DF) test, Augmented Dickey-Fuller (ADF) test, Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test, Ng-Perron modified unit root tests, and Phillips-Perron (PP) unit root test. In this study however, we employ the Phillips-Perron unit root test for data verification. The PP unit root test is primarily a Dickey-Fuller statistic that has been made robust to serial correlation using the Newey-West heteroskedasticity-and-autocorrelation consistent matrix estimator. In the data verification process, we hold unto the assumption of linear trends in data at level by including an intercept and trend at level, and intercept alone on first difference. As presented in Table 1, the results show that, with the exception of the log of world volume of cotton lint exports, all the other variables (expressed in log) are non-stationary (*I*(1)) at level but become stationary (*I*(0)) on first difference at the 1% significance level. The log of world volume of cotton lint exports was however found stationary (*I*(0)) on level at the 5% significance level. Accordingly, it is treated as exogenous variable in the VAR specification (in conformity with eq. (5)).

Table 1. Trend+intercept at level, intercept at first difference

	PP-stat level	N-W Bandwidth	PP-stat 1st Diff	N-W Bandwidth
$ln\ (EXPVol)$	-1.043260	1	-5.644778***	1
$ln\ (EXPVal)$	-2.813120	1	-6.592364***	3
$ln\ (EXPPRICE)$	-3.428186	1	-7.608338***	14
$ln\ (PROD)$	-1.823726	0	-6.263015***	0
$ln\ (ToT)$	-0.231015	0	-4.571951***	1
$ln\ (CEP)$	-2.518715	2	-7.718185***	6
$ln\ (EXPVolW)$	-3.665094**	1	-8.473463***	6
Critical Value, 5%	-3.562882		-2.963975	

****1%, **5%*

3.4 Lag Selection and Co-integration Test

As shown in Appendices 'A' and 'B', all the three primary information criteria (AIC, SC and HQ) and the two secondary criteria (LR and FPE) selected lag order one for either model. Accordingly, we select lag order one for the VAR models. A test for number of co-integrating equation(s) among the variables in the respective models confirmed the existence of one co-integrating equation for each of the models. In this regard, the VAR setup is deemed inappropriate. We therefore make use of a vector equilibrium correction model (VECM). The vector equilibrium correction model is basically made up of a co-integrating (long-run) equation and a short-run (VAR) equation. Under this model specification, analysts have a choice of assuming no deterministic trend in data, allowing for linear deterministic trend in data or allowing for quadratic deterministic trend in data. The first alternative has two subsections, and so does the second one. Following recent developments in internal and external policy environments and their implications for cotton lint exports however, we assume a linear deterministic trend (intercept and trend in co-integrating equation, no trend in VAR) to help capture the response of exports to changing policy environments. Results from the respective specifications for Model 1 and 2 are presented in the results and discussion section.

3.5 Normalized and Short-Run Equations

Having observed the estimates in Table 1 for the unit root test, and confirmed the existence of one co-integrating equation, the respective normalized and error correction (short-run) equations are expressed finally as follows:

3.5.1 Normalized equations

Assumption: Linear deterministic Trend

Model 1

$$\ln(EXPVol) = f(\ln(EXPPRICE), \ln(PROD), \ln(ToT), \ln(CEP)) \quad (10)$$

Model 2

$$\ln(EXPVal) = f(\ln(EXPPRICE), \ln(PROD), \ln(ToT), \ln(CEP)) \quad (11)$$

Exclusion of *ln (EXPVolW)* from the normalized equations is to reflect the fact that it is treated exogenous at level due to its stationary status, but included in the short-run equation in line eq. (5). The respective short-run equations are expressed as follows:

3.5.2 Short-run equations

Model 1

$$\Delta \ln(EXPVol_t) = \Gamma_0 + \sum_{i=0}^{n} \Gamma_{1i} \Delta ln(EXPVol_{t-1}) + \sum_{i=0}^{n} \Gamma_{2i} \Delta \ln(EXPPRICE_t) + \sum_{i=0}^{n} \Gamma_{3i} \Delta \ln(PROD_t) + \sum_{i=0}^{n} \Gamma_{4i} \Delta \ln(ToT_t) + \sum_{i=0}^{n} \Gamma_{5i} \Delta \ln(CEP_t) + \Gamma_{6I} \ln(EXPVolW_t) - \propto (RESIDUAL_{t-1}) \quad (12)$$

Model 2

$$\Delta \ln(EXPVal_t) = \Gamma_0 + \sum_{i=0}^{n} \Gamma_{1i} \Delta ln(EXPVal_{t-1}) + \sum_{i=0}^{n} \Gamma_{2i} \Delta \ln(EXPPRICE_t) + \sum_{i=0}^{n} \Gamma_{3i} \Delta \ln(PROD_t) + \sum_{i=0}^{n} \Gamma_{4i} \Delta \ln(ToT_t) + \sum_{i=0}^{n} \Gamma_{5i} \Delta \ln(CEP_t) + \Gamma_{6I} \ln(EXPVolW_t) - \propto (RESIDUAL_{t-1}) \quad (13)$$

Where, Γ's reflect short run effect of changes in the explanatory variables on the explained variables and α represents the speed of adjustment in the system. Accordingly, 'RESIDUAL' in equations (12) and (13) represents the error correction term. A negative and significant value of α in these two equations validates the existence of co-integration relationships in either model. In addition, the negative sign of α indicates that adjustments made in response to deviations from the long-run equilibrium are made towards restoring such equilibrium.

In selecting the best ECM estimates however, in accordance with theory and common sense, we modified the lags to avoid double counting of export volume in the short-run. This was achieved by using current (but differenced) values of all the other variables (except the exogenous variable which was not differenced) and the lag of the dependent variable. This modification was justified by the three primary information criteria of being more appropriate than the original short-run specification used by the software package (E Views). Results for the respective long- and short-run equations are presented in Tables 3 and 4 respectively.

4. RESULTS AND DISCUSSION

This section is primary structured into two parts. The first part is briefly on descriptive statistics for the variables considered in the primary models of this study. The second (and final) section is on presentation and discussion of results for the respective long- and short-run models.

4.1 Descriptive Statistics

We note a wide variation between the minimum and maximum values for all the variables considered in this study. The greatest variations are however with value of exports, comparative export performance index, production and volume of exports. Another unique observation is that, the mean and median values for all the variables are quite close in magnitude. Over the period 1980-2011, as shown in Table 2, the maximum and minimum volumes of cotton lint exported from Mali are 258,830tonnes and 44,358tonnes respectively. The corresponding values are $352,502 (thousand) and $31,844 (thousand). The mean volume and value of exports are however 117,184.40tonnes and $153,490.40 (thousand) respectively. The country faced maximum, minimum and mean export prices of $2,645.28/tonne, $717.89/tonne, and $1,354.99/tonne respectively. On the production side, maximum, minimum, and mean outputs of 259,655tonnes, 38,065tonnes, and 124,803.50tonnes were respectively recorded. The country's terms of trade index for exports ranged between a maximum value of 177.31 and a minimum value of 95.45, recording a mean of 117.86 for the period 1980-2011. Reflecting competitive advantage in exports, Mali's comparative export performance index ranged between a maximum of 63.63 and a minimum of 6.02. This signifies a strong competitive advantage in exports of cotton lint over the entire period. The country recorded a mean value of 31.53.Serving as a proxy for developments in international trade and demand for cotton lint, world volume of exports increased from a minimum of 4,136,978tonnes to a maximum of 9,094,328tonnes. A mean of 5,913,448tonnes of cotton lint was exported worldwide over the period 1980-2011.

Table 2. Descriptivestatistics

	Mean	Median	Maximum	Minimum	Std. Dev.
EXPVol	117,184.40	108,806.00	258,830.00	44,358.00	59,859.87
EXPVal	153,490.40	149,101.50	352,502.00	31,844.00	77,398.70
EXPPRICE	1,354.99	1,370.36	2,645.28	717.89	368.71
PROD	124,803.50	107,606.50	259,655.00	38,065.00	65,267.61
ToT	117.86	113,47	177.31	95.45	17.07
CEP	31.53	32.16	63.63	6.02	15.01
EXPVolW	5,913,448.00	5,712,990.00	9,094,328.00	4,136,978.00	1,395,108.00

4.2 Results and Discussion of Export Responses

In interpreting the respective outputs as shown in Tables 3 and 4, the variables employed in this study are noted to explain about 59.1% and 79.1% respectively of the variations in volume and value of exports, and their joint effect is highly significant in either model. A total of 55.8% and 52.9% respectively of deviations in volume and value of exports from the long-run equilibrium are corrected for in the current period. The relatively lower rate of adjustment for value of exports to volume of exports indicates that the country has better control over volume that value of exports. Appropriate diagnostic tests performed confirmed that the model is valid, coefficients are stable and the errors are normally distributed and non-serially correlated (at the 5% level). In the long-run, both volume and value of exports are noted to decrease significantly by 0.044 units. This indicates that, changes in both internal and external policy environments have had generally adverse impact on cotton lint exports from

Mali. In as much as volume of exports decreases significantly by 0.95% for a 1% increase in export price faced by exporters in the country, the 0.05% increase in value observed is not significant. These effects present an unprofitable condition for the Malian cotton lint export industry. In as much as exporters hope for better prices and may be willing to export more in response to price increments, they are precluded from doing so, by the downward pressure on world prices which makes cotton on the world market and other sources cheaper than is offered by Mali. In as much as countries that induce downward pressure on prices on the world market initiative distortionary measures to protect their domestic industries, implications of these are largely felt by poor and lower market share holders like Mali. In the short-run, a 1% increase in export price faced by exporters from the country leads to a significant 0.55% decrease in volume of exports, and a relatively smaller but significant 0.448% increase in value of exports.

Table 3. Assumption: linear trend in data (intercept and trend in CE–no trend in VAR)

Variables	Model 1–Ln (EXPVol)	Model 2–Ln (EXPVal)
C	2.435	-4.473
$\ln(EXPPRICE)$	-0.951*** (0.219)	0.049 (0.219)
$\ln(PROD)$	0.873*** (0.106)	0.873*** (0.106)
$\ln(ToT)$	1.057** (0.462)	1.057** (0.462)
$\ln(CEP)$	0.449** (0.212)	0.449** (0.212)
$@TREND(80)$	-0.044*** (0.013)	-0.044*** (0.013)

****1%, **5%*

The corresponding short-run output observed is presented in Table 4 below:

The positive coefficient for the intercept term in Model 1 of the long-run equations shows that in spite of the gloomy nature of export trade in the commodity, Mali would continue to export cotton. This confirms strong reliance of the country on exports of the commodity. Value of cotton lint exports is however expected to decrease significantly should all other things be held in their current states. Interestingly, both volume and value of exports decrease significantly in the short-run. Besides distortions in world export trade of cotton, the coefficients of the intercept term for the short-run equations indicates that cotton exporters and traders in Mali face other domestic constraints that hinder them from appropriately responding to sudden developments in export trade for cotton lint. By this, it is perceived that growth of the cotton lint export industry for the country is hindered by both external forces and internal constraints.

Both volume and value of exports are observed to increase with increasing production, terms of trade index of exports and comparative performance index of exports. In contrast to a close economy where increasing production is deemed bad due to the price-decreasing implications thereof, in an open economy, increasing production is regarded an opportunity for export expansion [15]. A 1% increase in production leads to a 0.87% increase in both volume and value of exports in the long-run, significant at the 1% level. In the short-run however, production leads to 0.35% increase in volume and 0.34% increase in value of exports. Effect for the former is found significant at the 1% level, whiles that for the latter is significant at the 5% level. Mali is observed to have quite an elastic response to improvements in the country's terms of trade index for exports in the long-run. In the long-run where Mali stands adjusting to short-run constraints, a 1% increase in the index of trade openness leads to a 1.06% increase in both volume and value of exports. Increase in trade openness presents the country with diverse and greater market opportunities and at the same time promotes efficiency in operations by exposing Mali to competition. Mali is however noted to have a poor exploitation power towards opportunities in the short-run due to potentially existing domestic constraints in production, processing and marketing of the commodity. This claim is made in response to the insignificant coefficient for terms of trade index of exports in the short run. Reflecting competitive advantage of Mali in export of cotton lint, comparative export performance index for cotton lint is observed to stimulate both volume and value of exports in the short and long run. This index reflects success of the country in exports of the commodity relative to world norms [28]. This is enhanced mostly through the use of surrogate measures of incentives like exchange rate, through improvements in quality of products exported, through addressing of existing inefficiencies in the domestic and international market and through the initiation and implementation of appropriate trade policies. A 1% increase in this index leads to a significant 0.449% increase in both volume and value of exports in the long-run. Although significant, this relatively inelastic response to improvements in the index, once again confirms the impact of existing inefficiencies on the world market on Malian exports. Although with a high competitive advantage in exports, being a price taker and a relatively smaller-market share holder, developments in exports from Mali are mostly dictated by policy initiatives instilled in the economies of major players like the USA, India and China (the primary destination of majority of world cotton lint exports). In the short-run however, a 1% increase in CEP leads to a 0.55% increase in volume of exports and 0.56% increase in value of exports. The short-run effects for CEP and cotton lint production present interesting insights. In as much as the effect of production is relatively higher on volume than value, the opposite is observed for CEP.

Table 4.Regression Results for the Short-run Equations

Variables	Dependent variableLn (EXPVol)	Dependent variableLn (EXPVal)
C	-11.507*** (3.217)	-11.317*** (3.488)
$\Delta ln\ (EXPVal(-1))$		-0.065 (0.099)
$\Delta ln\ (EXPVol(-1))$	0.284** (0.136)	
$\Delta ln\ (EXPPRICE)$	-0.551*** (0.157)	0.448** (0.172)
$\Delta ln\ (PROD)$	0.345*** (0.117)	0.342** (0.129)
$\Delta ln\ (ToT)$	0.074 (0.524)	0.357 (0.547)
$\Delta ln\ (CEP)$	0.549*** (0.155)	0.558*** (0.168)
$Ln\ (EXPVolW)$	0.738*** (0.206)	0.725*** (0.224)
$RESIDUAL\ (-1)$	-0.558*** (0.105)	-0.529*** (0.113)
R-Squared	0.689	0.841
Adjusted R-squared	0.591	0.791
Log Likelihood	15.987	13.561
F-statistic	6.979	16.677
Prob. (F-statistic)	0.000	0.000
Durbin Watson Stat	2.378	2.594
Akaike Info Criterion	-0.532	-0.371
Schwarz criterion	-0.159	0.003
Hannan-Quinn criter.	-0.413	-0.251
Jarque-Bera [Probability]	0.407 [0.82]	0.057 [0.97]
Q-stat [Probability]	1.885 [0.17]	3.967 [0.05]

****1%, **5% ( ) - standard errors*

Increase in world trade is observed to enhance both volume and value of exports. World trade in this contest reflects increasing volumes of export triggered by increasing demand as against overproduction and subsidy induced increases. Increasing world demand for cotton linttriggers a competition among exporters from all corners of the earth, and such competition helps in shaping and restructuring economies that are dependent on the commodity for sustenance. Countries with a competitive edge are able to respond to and benefit from such demands. Significant positive coefficients observed for volume of world exports in each of the two models confirm that Mali has a competitive edge in cotton lint exports, and that should current domestic and international market inefficiencies be addressed, the country stands benefiting from increasing global demand for cotton lint. In the short-run, 1% increase in volume of world exports of cotton lint leads to significant increases of 0.74% and 0.73% respectively in volume and value of exports. Previous growth in export by volume is observed to increase current volume of exports by 0.28%, significant at the 5% level. This indicates that Mali is a relatively small player on the global market. By this, exports from Mali have no significant adding-up effect on global exports of the commodity. This presents a greater opportunity for exporters in the country to work towards increasing the share of Mali in export trade for the commodity. Although negative, the effect for previous value of export on current value is found insignificant. Findings from this study generally for all the explanatory variables are in conformity with previous findings by [4, 5, 8, 12, 13 and 14]

5. CONCLUSION

Following recent declines in volume and value of cotton lint exports from Mali, we deemed it necessary to through a co-integration analysis identify the magnitude and effects of key determinants for exports of the commodity. Results for the two primary models estimated show that exports are generally stimulated by production, improvements in competitiveness, openness to trade, increasing international trade and previous growth in exports. Growth in the country's exports of the commodity is however noted to be hindered by both domestic and international forces. In as much as distortionary induced downward pressure on world prices impacts negatively on exports from the country, inefficiencies and constraints in the domestic environment preclude the country from appropriately exploiting opportunities and adjusting to unexpected market developments in the short-run. Revitalizing the gloomy export trade for Mali in cotton lint requires addressing of domestic inefficiencies (over which the country has some control compared to inefficiencies on the global market) to keep the country in a better position to exploit market opportunities and adjust to unexpected developments in the shortest possible time. In addition, policy makers and various stakeholders in the industry should put in place measures to revive the declining cotton production industry, promote trade openness, and improve on the quality of cotton lint exports. Increased production could be achieved through supporting of farmers in diverse ways, including provision of credits, input distribution, appropriate transmission of price increments to farmers, and creating of favorable marketing environment for their produce in terms of access and information. Minimization of trade restrictions and appropriate liberalization of internal and external marketing could further enhance the country's terms of trade index of exports. To improve the quality of exports, emphasis should be placed on improving the ginning process to ensure attainment of high quality lint for exports.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDICES

APPENDIX A: Lag selection and co-integration test for Model 1

VAR Lag Order Selection Criteria
Endogenous variables: LNEXPVOL LNEXPPRICE LNPROD LNTOT LNCEPMALI
Exogenous variables: C LNEXPVOLWORLD
Date: 05/08/14 Time: 02:28
Sample: 1980 2011
Included observations: 30

Lag	LogL	LR	FPE	AIC	SC	HQ
0	14.73901	NA	5.02e-07	-0.315934	0.151132	-0.166515
1	75.23121	92.75471*	4.92e-08*	-2.682080*	-1.047350*	-2.159116*
2	98.42577	27.83348	6.73e-08	-2.561718	0.240676	-1.665208

** indicates lag order selected by the criterion*

LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion
Date: 05/08/14 Time: 02:28
Sample: 1980 2011
Included observations: 30
Series: LNEXPVOL LNEXPPRICE LNPROD LNTOT LNCEPMALI
Exogenous series: LNEXPVOLWORLD
Warning: Rank Test critical values derived assuming no exogenous series
Lags interval: 1 to 1

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend: Test Type	**None No intercept No trend**	**None intercept No trend**	**Linear Intercept No trend**	**Linear Intercept Trend**	**Quadratic Intercept Trend**
Trace	2	1	1	1	2
Max-Eig	1	1	1	1	1

**Critical values based on MacKinnon-Haug-Michelis (1999)*

APPENDIX B: Lag selection and co-integration test for Model 2

VAR Lag Order Selection Criteria
Endogenous variables: LNEXPVAL LNEXPPRICE LNPROD LNTOT LNCEPMALI
Exogenous variables: C LNEXPVOLWORLD
Date: 05/10/14 Time: 01:44
Sample: 1980 2011
Included observations: 30

Lag	LogL	LR	FPE	AIC	SC	HQ
0	14.73901	NA	5.02e-07	-0.315934	0.151132	-0.166515
1	75.23121	92.75471*	4.92e-08*	-2.682080*	-1.047350*	-2.159116*
2	98.42577	27.83348	6.73e-08	-2.561718	0.240676	-1.665208

** indicates lag order selected by the criterion*

LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion
Date: 05/10/14 Time: 01:46
Sample: 1980 2011
Included observations: 29
Series: LNEXPVAL LNEXPPRICE LNPROD LNTOT LNCEPMALI
Exogenous series: LNEXPVOLWORLD
Warning: Rank Test critical values derived assuming no exogenous series
Lags interval: 1 to 2

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend: Test Type	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Trace	1	2	1	1	3
Max-Eig	1	1	1	1	1

**Critical values based on MacKinnon-Haug-Michelis 1999)*

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