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Cotton Export Performance and Constraints in Sudan

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Abstract

Purpose The paper analyzed the major factors that constrained cotton export earnings in Sudan.

Design A vector error correction model is applied to estimate short run and long run effects of the main factors constraining cotton exports. Data from 1970-2014 were used in the model estimation.

Findings The results showed that yield and exchange rate both affect cotton export earnings in the long run, but there is no strong relationship in the short run. A greater coefficient of the error-correcting term means that the variables in the model are adjusting faster from the short run to the long run equilibrium.

Practical implications Adopting policy that leads to improvement of yield and stabilization of exchange rate to restore cotton export earnings especially in the long run.

Value The model developed for cotton export value captured the dynamic between long run and short run equilibrium.

Keywords cotton export, low yield, unstable exchange rate, Sudan

Introduction

The commercial cotton industry in Sudan dates back to the colonial period, when cotton was grown to provide ginned cotton to the British textile industry. Cotton is grown in Sudan under various topographical and environmental conditions, utilizing various methods of irrigation and using different applications of chemical inputs. The average yield of cotton in Sudan has generally been low due to inadequate or inappropriate use of agricultural inputs like fertilizer. The low cotton yield, coupled with the high costs of production and low gross return, has detrimental effects on a farmer's decision to grow cotton and affects Sudan's competitiveness in international cotton markets.

In the past, cotton export earnings were the major source of Sudan's foreign exchange, but recently the share of cotton in agricultural exports has sharply declined from 15% in 2008 to only 1.5% in 2012. This is a result of a decrease in quantity exported from 139 thousand bales to only 13.4 thousand bales in 2012, despite an improvement in world prices (Table 1). In 2013, cotton exports slightly recovered, but only short and medium staple cotton is exported despite the fact that Sudan, in the past, was famous in the production and export of extra-long staple cotton. The sharp decline in exports is due mainly to a reduction in area and production of cotton, especially in the Gezira Scheme as a result of low yields. This is coupled with high costs of production that, therefore, lowers gross return.

Table 1. *Cotton export value and quantities: 2013-2008*

	Export quantity (1000 Bales)	Export value (million US $)	Export unit value (US $/ bale)	Share in agricultural exports (%)
2008	139.4	60.8	436	15.5
2009	35.1	42.1	1199	9.2
2010	34.1	40.4	1184	9.2
2011	37.6	27.0	718	3.5
2012	13.4	11.8	880	1.5
2013	47.8	102.7	2148	6.7

Source: *Central Bank of Sudan annual reports*

The limiting factors constraining the cotton exports in Sudan interchange around low productivity that is related mainly to the low use of agricultural inputs and use of uncertified seeds; high inflation rate and distorted exchange rate market; and low competitiveness because of high costs of production. Other factors, such as a shortage of finance, multiple taxes and fees, and non-conducive export policies are also considered constraints for cotton lint export.

This paper tries to analyze and quantify the effect of some of the major factors that constrained the export of cotton in Sudan, namely cotton yield and exchange rates, through the application of a vector-error-correction model. The average yield of cotton has generally been low due to inadequate or inappropriate use of agricultural inputs such as fertilizer, and the exchange rate policy in Sudan not being stable due to a shortage of foreign currency and use of multiple exchange rates. These two factors have a major influence on cotton exports as they affect its revenues and competitiveness in the world market.

Material and Method

The study employed the co-integration vector-error-correction model (VECM) to examine the determinants of cotton exports in Sudan. The co-integration technique is superior to other techniques, for example, panel and gravity modelling, because this technique is able to establish the short-run and long-run relationship amongst variables, and estimate a unit root and co-integration test. Granger (1986) pointed out that testing for co-integration of the regression residual is an imperative condition to avoid the possibility of producing spurious regression output.

In VECM, an equilibrium relationship exists when variables in the model are co-integrated. Two conditions must be satisfied for variables to be co integrated. First, the data series for each variable involved should exhibit similar statistical properties, that is, be integrated to the same order; and second, a stationary linear combination must exist (Malik, 2010). For a time series to be stationary, it means that variance and covariance at various lags stay the same over time.

Several studies have suggested a number of co-integration methodologies, including Hendry (1986), Engle and Granger (1987), Johansen (1988), Johansen and Juselius (1990), and Goodwin and Schroeder (1991). In this paper, Johansen's vector error correction model (VECM) has been used. VECM permits the testing of co-integration as a system of equations in one step and does not require the prior assumption of erogeneity of the variables.

Model specification

The study uses real exchange rate (RER) and yield (Y) as main determinant factors that affect cotton export value in Sudan. The RER is a key determinant of agricultural exports of any country. It is expected that, as the domestic currency depreciates, agricultural exports will increase and vice versa: it is a measure of competitiveness. The inclusion of cotton yield is essential to determine the contribution of agricultural production capacity and technology use in Sudan to cotton export earnings. The cotton export value can be expressed in the following form:

$$LnX=f(LnY,LnRER) \qquad (1)$$

Where Ln is a natural logarithm, X is

Where Ln is a natural logarithm, X is the export value of cotton, RER is real exchange rate, and Y is yield. The real exchange rate is calculated by using the following equation (see Kingu, 2014):

$$RER = CPI_{sud} / CPI_{us} * NER \qquad (2)$$

Where CPIsud is the consumer price index of Sudan, CPIus is consumer price index of the United States of America (US), and NER is the nominal exchange rate in the local currency. To estimate the long-term relationship and short-term dynamics among variables in equation (1), VECM is estimated. To estimate the VECM model the following steps are followed: first, a test of stationary for the variables included in the model is conducted using an Augmented Dickey-Fuller test (ADF) at level and first difference. If the variables are found to be non-stationary at level then the output of regression is spurious. Also, Engle and Granger (1987) and Gujarati (2004) pointed out that if the regression residuals of an equation are stationary, this indicates the existence of a long-run relationship amongst the variables. Thereafter, a first difference of the variables has been taken in order to obtain stationary variables. Second, a co-integration test for selected variables is conducted using the Johansen co-integration test. Third, the VECM model is specified and estimated.

Data sources

Time series data for 44 years (1970-2014) was used in the analysis. Data was compiled from different sources: cotton export value, nominal exchange rate, consumer price index for Sudan and cotton yield were collected from annual reports of the Bank of Sudan (different issues), while the consumer price index of the US was collected from the US Department of Labor Bureau of Labor Statistics.

Stationary test

To check the stationarity of the data, an Augmented Dickey-Fuller (ADF) unit root test was applied. The ADF test was preferred over the DF test, as it allows for more dynamics, and considers the problem of the correlation between the error terms and includes the lagged value of dependent variables in the regression (Anwar et al., 2010). For this test, intercept terms are included in the regression. Table 2 shows the results of the ADF unit root test for the model variables both at level and first difference. For all variables in levels, the null hypothesis that each series has a unit root test cannot be rejected as the ADF statistics are below the critical value at 5% level of significance. These results indicate that the regression output of the model for the variables at level is spurious. However, the regression residual of equation (1) for the variable at level is stationary; this indicates the existence of a long-run relationship amongst the variables. Table 2 shows that all variables become stationary and have no unit root after taking first difference, therefore, we can go to the next step and conduct a co-integration test.

Co-integration test

After checking the hypothesis of non-stationary, the time series were examined for the co-integration. Co-integration analyzes the relationship between integrated series and explores a linear combination of integrated time series that was itself stationary. For co-integration, the Johansen (1995) maximum likelihood procedure was used. Johansson's procedure for co-integration utilizes two statistics tests for deciding the number of co-integrating vectors:

Table 2. *Results of unit root test*

Variables	Augmented Dickey-Fuller Test			
	Variables in Level	P value	Variables in 1st Difference	P value
LnX	-2.3	0.16	7.6	0..00
LnRER	1.45-	0.54	6.01	0.00
LnY	-2.6	0.09	6.6	0.00

Source: *Calculated in EViews 6*

• Trace test: the null hypothesis (H0) is that the number of co-integrating vectors is less than or equal to r, and alternative hypothesis (H1) is that the number of co-integrating vectors is more than r; and

• Maximum eigenvalue: in the maximum Eigenvalue test, the null hypothesis (H0) is that the number of co-integrating vectors is r, and the alternative hypothesis (H1) is that the number of co-integrating vectors is r+1.

The results of the co-integration test are given in Table 3, together with the critical values of trace statistics and max-eigenvalue with lag length of 3 (k=3). The first row in the upper table tests the hypothesis of nil co-integration, the second row tests the hypothesis of one co-integration relation, the third row tests the hypotheses of two co-integrating relations, and so on, all against alternative hypotheses that there are more than r co-integrating vectors (r = 0,1,…,4) .

Both the trace test and max-eigenvalue test indicate 3 co-integrating equations at the 5% level of significance (Table 3). Based on this result, we may conclude that the model variables have a long-run equilibrium relationship. When there is more than one co-integrating vector, the first eigenvector, which is based on the largest eigenvalue, is considered the most useful (Anwar et al., 2010). The study conducts the analysis assuming at least one co-integration equation.

As a conclusion of the Johansen co-integration procedure, there are non-spurious long-run relationships between the model variables, and hence the VECM is a valid representation of the relationships between the dependent variable (cotton export value) and independent variables (real exchange rate and yield).

Table 3. *Johansen co-integration test*

Trace Test				
Number of co-integration	Eigenvalue	Trace statistics	Critical	P value
Value (5%)	Prob.	0.16	7.6	0..00
None *	0.54	55.7	29.7	0.000
At most 1*	0.38	24.0	15.4	0.002
At most 2*	0.11	4.7	3.8	0.028
Trace Test				
Number of co-integration	Eigenvalue	Trace statistics	Critical	P value
None *	0.54	31.7	21.1	0.001
At most 1*	0.38	19.2	14.2	0.007
At most 2*	0.11	4.7	3.8	0.028

VECM specification

The VECM model provides a long-term relationship and short-term dynamics of the endogenous variables. This model shows the achievement of long-term equilibrium and the rate of change in the short term to achieve equilibrium.

Depending on the results of the Johansen co-integration analysis, we assumed there is only one co-integrating vector that affects only one equation. To capture both the short-run dynamics between time series and their long-run equilibrium relationship, the following VECM model with 3 lags was estimated (see Jaupllari and Zoto, 2013; Zulfiqar and Kausar, 2012):

$$D(LnX)=\gamma LnX(-1)+b1LnRER(-1)+b2LnY(-1)+\propto+C(1)DLnX(-1)+C(2)DLnX(-2)+C(3)DLnX(-3)+C(4)DLnRER(-1)+C(5)DLnRER(-2)+C(6)DLnRER(-3)+C(7)DLnY(-1)+C(8)DLnY(-2)+C(9)DLnY(-3)+C(10) \quad (3)$$

Where D denote first difference
The first part of equation (3) represented by ($\gamma LnX(-1)+b1LnRER(-1)+b2LnY(-1)+\propto$) is long term co-integration vector that captured the long-run equilibrium relationships between the model variables. The second part of equation (C1-C10) captured the short-run dynamic equilibrium relationships between model variables. γ is the error correction coefficient that shows the speed of adjustment of disequilibrium. If γ has a negative sign and is statistically significant, this indicates the existence of a long-run equilibrium relationship between the model variables.

Variance Decomposition

To illustrate the implication of the relationships among model variables (cotton lint export value, real exchange rate and yield), variance decomposition was employed.

Empirical Results

Using the variables included in equation (3), a VECM model is estimated as follows:

$$D(LnX)=-1.02LnX(-1)+0.175LnRER(-1)+0.37LnY(-1)+6.5+0.54DLnX(-1)+0.32DLnX(-2)+0.31DLnX(-3)+0.27DLnRER(-1)-0.017DLnRER(-2)+0.05DLnRER(-3)+0.04DLnY(-1)-0.122DLnY(-2)+0.42DLnY(-3)-0.048 \quad (4)$$

To test the significance of the coefficients in equation (4), a Wald test has been conducted and the results are presented in Table (4). The results of the Wald test showed that γ is significant and has a negative sign, which is an indication of the presence of a long-run equilibrium relationship between model variables. On the other hand, the coefficients from C(2)-C(10) are not significant except for C(10), and this indicates that there is no clear short run equilibrium relationship between the model variables.

Table 4. *Wald test results*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
γ	-1.02	0.38	-2.62	0.01
C(1)	0.54	0.32	1.67	0.10
C(2)	0.32	0.31	1.04	0.30
C(3)	0.31	0.28	1.08	0.28
C(4)	0.27	0.40	0.67	0.50
C(5)	0.02-	0.45	0.03-	0.97
C(6)	0.04	0.43	0.10	0.91
C(7)	0.04	0.19	0.21	0.83
C(8)	-0.12	0.19	-0.62	0.53
C(9)	0.42	0.20	2.09	0.04
C(10)	-0.04	0.09	-0.49	0.62

Source: *Calculated in EViews 6*

For statistical accuracy of the residuals in the estimated VECM, a number of diagnostic tests are performed. As indicated by the results in Table 5, the residuals of estimated VECM have no trace of autocorrelation or heteroskedasticity (ARCH effect) and are normally distributed.

Therefore, we can consider the residual of VAR components of the VECM model as a white noise (stationary and unrelated).

Table 5. *Residual diagnostic tests of the estimated VECM*

Autocorrelation Test	
LM(5)	**10.08**
p-value	**0.343**
Normality Test	
Jarque-Bera x2 (2)	**3.19**
p-value	**0.20**
ARCH Test	
F value	**1.236**
p-value	**0.311**

Source: *Calculated in EViews 6*

Long run relationship

The long run equilibrium relationship between cotton export value, yield and real exchange rate is shown by equation (5):

$$D(LnX)=0.175LnRER(-1)+0.374LnY(-1)-1.02LnX(-1)-6.5 \qquad (5)$$

The coefficients of the real exchange rate and yield have the expected sign and are statistically significant (see Table 4). Thus, the real exchange rate and cotton yield has a positive impact on the cotton export value. In terms of magnitude, the effect of yield is higher than that of the real exchange rate.

When the yield of cotton increases by 1%, cotton lint export earnings will increase by 0.37%. Meanwhile, when the real exchange rate depreciated by 1% the export value will increase by only 0.17% (note that the coefficients of the equation are long-run elasticity). This result is in the line of a dominant problem facing the agricultural sector of Sudan, which is low yield. A lower yield has detrimental effects on farmer's decisions and exporter's competitiveness. As the error correction term was significant with a negative sign, the results of the vector error correction model depicted that the adjustment in LnX is due to the error correction term (γ). The empirical findings found a greater coefficient of the error-correcting term

(-1.02); this signifies that the variables in the model are adjusting faster from the short run to the long run equilibrium. LnX adjusted almost in one year to the long run equilibrium meaning that it took under one year to eliminate the disequilibrium.

Short run relationship

The short run equilibrium relationship between cotton export value, yield and real exchange rate is depicted in equation (6):

$$D(LnX)=-0.048+0.54DLnX(-1)+0.32DLnX(-2)+0.31DLnX(-3)+0.27DLnRER(-1)-0.07DLnRER(-2)+0.046DLnRER(-3)+0.041DLnY(-1)-0.122DLnY(-2)+0.428DLnY(-3) \qquad (6)$$

As shown in Table 4 above, most of the variables included in equation (6) are statistically insignificant, which means that there is no clear short-run equilibrium relationship between cotton export value and real exchange rate and yield. This finding is in line with Kingu’s (2014) and Diakosavvas and Kirkpatrick’s (1990) results, which were found in some Sub Saharan African countries. However, it should be clear that real exchange rate and yield are also still important determinants of cotton export earnings in the short-run, since they have a positive influence. Cotton yield in lag three (LnY(-3)) is statistically significant and has a positive sign. This implies that a 1% increase in cotton productivity increases cotton export earnings in the short run by 0.42%. This indicates that cotton productivity is a vital determinant of cotton lint export earnings in Sudan, not only in long-run but also in the short-run.

Variance decomposition of cotton export value

Table 6 shows the results of variance decomposition of the dependent variable during 10 periods. Impulse or innovation or shock in the short-run in cotton lint export value accounts for 85% of the fluctuation in export value (owned shocked), while real exchange rate shock in the short-run accounts for a 1.86% fluctuation in cotton lint export value, while in the long-run it accounts for 11.7%. Yield shock in the short-run accounts for 12.8% of fluctuation or variation in export value of cotton lint, while in the long-run it accounts for 15.48%. These results support the findings of the VECM model that there is a strong long-run relationship between the model variables compared to the short-run.

Table 6. *Variance decomposition of cotton export value*

Period	S.E.	X	RER	Y
1	0.457	100.00	0.00	0.00
2	0.549	95.44	0.23	4.31
3	0.597	86.58	0.32	13.08
4	0.608	85.26	1.86	12.87
5	0.616	83.50	3.02	13.46
6	0.633	80.29	4.23	15.46
7	0.652	77.77	6.78	15.43
8	0.680	74.54	8.72	16.73
9	0.720	73.79	10.24	15.95
10	0.756	72.81	11.70	15.48

Source: *Calculated in EViews 6*

Conclusions

This paper has analyzed the main determinants of cotton exports in Sudan through applying a vector error correction model. The results showed that yield and exchange rate both affect foreign exchange earnings of cotton exports in the long run, but apparently there is no strong relationship between them in the short run. The results confirm that low yield and unstable fluctuating exchange rates are the main factors affecting cotton exports earnings and competitiveness in Sudan Therefore, to improve competitiveness of cotton exports in specific, and the agricultural trade as a whole, the government should adopt a concrete policy that leads to an improvement of yield of agricultural products, and establish stable, unified exchange rate in the medium to long run. Changes in trade and the exchange rate regime would need to be accompanied by new technologies, improved seeds, development and expansion of rural infrastructure, and other productivity raising investments in order to significantly boost long-term performance of cotton export.

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