The Determinants of Supply of Kenya's Major Agricultural Crop Exports from 1963 to 2012

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Abstract

Kenya has been experiencing low export growth rate in general and agricultural exports in particular and yet an increase in agricultural crop exports can contribute significantly to economic growth and improve the citizen's welfare. This study investigated the determinants of agricultural crop exports supply for Kenya over the period 1963-2012. Annual time series data were collected from Kenya's Statistical Abstracts and the IMF's International Financial Statistics (IFS). A disequilibrium model of agricultural crop export was used. The regression results showed that the real exchange rate was a significant determinant of tea, pyrethrum and horticulture exports but not of coffee export. Productive capacity as proxied by GDP was found to be a significant in determining coffee, tea and aggregate exports. El-Nino rainfall, as captured by a dummy, was significant for coffee exports, while trade liberalization, also captured by a dummy was only significant in determining pyrethrum exports.

Key words: Agricultural, Export, Real exchange rate, Kenya

Introduction

Like in many Sub Saharan African countries, agriculture has an important role in Kenya's overall economic development. Kenya's agricultural sector makes several specific contributions to the economy. First, agricultural exports contribute over 60 percent to total annual foreign exchange earnings (Republic of Kenya. 1996). This is important because as noted by Tom and Faick (1967), many less developed countries depend heavily upon agricultural exports for foreign exchange earnings to finance imports of capital goods.

Secondly the sector absorbs a large proportion of the labour force in rural areas that is, about 80 percent, and most of them depend on the agricultural sector for their livelihood (Republic of Kenya, 1992). Moreover, agriculture is the source of food for the country, with more than 80 percent of the food consumed coming from local production (Republic of Kenya, 1990). Finally, agriculture is a source of raw material for agro-based industries. Agricultural exports in Sub-Saharan Africa have declined significantly in the last two decades. The region's share of global agricultural exports has declined from 8.4% to 3.6% in 2004.

For the very poor countries both manufactured and agricultural exports have declined (Tonia and John, 2005). Like in many Sub Saharan countries, agricultural exports in Kenya have been declining. The annual volume of Kenya's agricultural exports for major crops is shown below for the year 1963-2012.

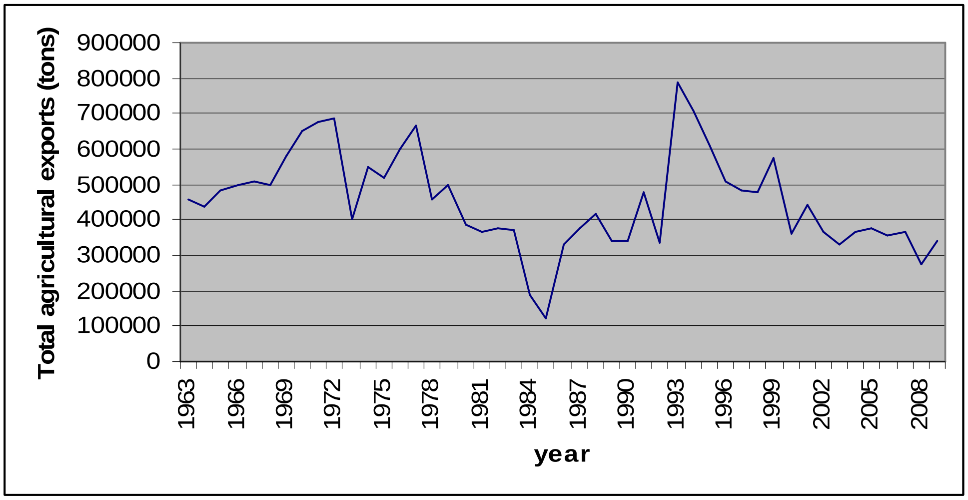

Fig 1.1 Graph of Kenya's agricultural exports for major crops, 1963-2012 (in tons).

In the first two decades after independence, agricultural exports were hit by both negative and positive external shocks in the form of two oil crises (1973 and 1978) and the 1976/77 coffee boom, respectively. Oil crises led to decline in GDP, which is one of the determinants of exports. In 1974, there was an increase in agricultural exports which coincided with the trade liberalization of 1974 (Republic of Kenya, 1980). The increase in 1976 was as a result of introduction of export promotion activities. For example, the Export Compensation Scheme (ECS) in 1976 and establishment of the Kenya External Trade Authority (KETA), which strengthened and reorganized export promotion.

There was a decline in the agricultural exports between 1980 and 1985, which was as a result of the removal of bonus rate of 15 percent to those exporters who had increased their exports the previous years and the impact of 1984 drought. Agricultural exports marked an increase in 1993, when they rose sharply to reach the highest peak. This coincided with the removal of foreign exchange controls, trade barriers and progressive implementation of reforms. The poor performance in 1996-98 was accompanied by significant reduction in quantities and prices of most exports items (Republic of Kenya, 1999). This perhaps was due to bad whether condition, that is, abnormal rain in 1997/98. The increase in 1999 was as a result of *El-Nino* rainfall.

The government of Kenya recognizes that increase in agricultural crop exports can contribute significantly to economic growth and welfare (Republic of Kenya, 1986). Indeed, some of the economic reforms pursued by the government were aimed at export promotion through export crops such as coffee, tea and horticulture and diversification of exports. However, Kenya has experienced low export growth rate in general, and agricultural exports in particular (Republic of Kenya, 2001). This is despite the measures taken by the government to boost exports such as exports promotion schemes. In their studies of exports in Kenya, Okore (1987) and Ng'eno (1991), focused on manufactured exports and aggregate exports respectively, on the basis of data running up to mid 1980s.

This study focused on agricultural exports supply. The sample period encompasses pre and post liberalization period to take into consideration the likely impact of trade liberalization on the supply of agricultural exports, which has not been done in Kenya. In addition the study employed recent advances in time series econometric modeling to boost its predictive power.

Materials and methods

Modeling agricultural export function

The supply of agricultural exports is assumed to be influenced by relative prices between traded and non traded goods i.e. real exchange rate, domestic capacity variables proxied by GDP, rainfall and trade liberalization, the two later ones being captured by dummies.

In this study the modeling of agricultural crop exports follows Khan (1974) and Goldstein and Khan (1985) procedures. Two versions of the basic model of the determinants of the volume of exports are considered. The first is an equilibrium model that assumes that there are no lags in the response of exports to changes in its determinants. This suggests that the adjustment of the actual level of exports to meet desired level of exports is instantaneous.

Given the profit function, $\pi(p)$, the net supply function can be derived from it using Hotelling's lemma (Varian, 1992). The profit function is differentiated with respect to price to give the supply function as shown below.
Let $y_i(p)$ be the firm's net supply function for good *i*. where p is the price.

Then
$y_i(p) = \partial л(p)/\partial p_i$ ……………………………………………….3.1
For *i*=1,………,n
Assuming that the derivative exists and that $p_i>0$

The first derivative of the profit function with respect to price at p^* must equal the maximizing factor supply at that price: y (p^*) = ∂л (p^*)/∂*p*

In the following model real exchange rate represents the price and the supply function for exports as specified by Goldstein and Khan (1985) is as follows;

$\ln X_t^s = \alpha_0 + \alpha_1 \ln RER_t + \alpha_2 \ln CAP_t + \alpha_3 DR + \alpha_4 DT + e_t$ ……………………………...3.2
Where;
$\ln X_t^s$: The log of volume of agricultural crop export supplied
$\ln RER_t$: The log of real exchange rate
$\ln CAP_t$: The log of productive capacity
DR: Dummy variable for rainfall
DT: Dummy variable for trade liberalization
$\alpha_1, \alpha_2, \alpha_3, \alpha_4$ are elasticities

The disequilibrium model is employed to account for the possibility that adjustment of actual equilibrium volumes may take place with some delay. This model assumes the existence of time lags in the response of exports supply to changes in its determinants. Goldstein and Khan suggested the partial adjustment mechanism given below.

$\ln X_t^s - \ln X_{t-1}^s = \beta(\ln X_t^{s*} - \ln X_{t-1})$
Where;
X_t^s : Actual levels of exports
X_t^{s*} : Desired level of exports
β : Coefficient of adjustment. It lies between 0 and 1

The adjustment function assumes that exports adjust only partially to the difference between export supply in period t and the actual exports in the previous period t-1. Substituting 3.2 into 3.1 yields the following equation:

$\ln X_t^{s*} = \alpha_0^* + \alpha_1^* \ln RER_t + \alpha_2^* \ln CAP_t + \alpha_3^* DR + \alpha_4^* DT + \alpha_5^* \ln X_{t-1} + e_t$
Where $\ln X_t$ is the log of volume of agricultural exports in year t and X_{t-1} is the log of lagged volume of agricultural exports. All the other variables are as defined earlier.
$\alpha_0^* = \beta\alpha_0$, $\alpha_1^* = \beta\alpha_1$, $\alpha_2^* = \beta\alpha_2$, $\alpha_3^* = \beta\alpha_3$, $\alpha_4^* = \beta\alpha_4$, $\alpha_5^* = 1 - \beta$

Since β is positive and given that $\alpha_1, \alpha_2, \alpha_3, \alpha_4, and \alpha_5$ are positive, it follows that $\alpha_1^*, \alpha_2^*, \alpha_3^*, \alpha_4^*, and \alpha_5^*$ are positive

Estimation techniques

Time series data for the sample period 1963-2012 were used. For Ordinary Least Square (OLS) method to be used to estimate the model specified, stationarity test for variables was performed. This is because if the data were non stationary the results would have been spurious, that is, with a large R-squared and significant t-statistics being obtained yet would have no economic meaning (Gujarati, 1995).

a) Graphical inspection method-The trends of all variables included in the models were inspected for stationarity, but basing a decision on whether or not a series is non-stationary by causal inspection may be misleading. Therefore, Augmented Dickey Fuller (ADF) and Philip Perron (PP) test for stationarity were conducted.

b) Test of the unit root hypothesis-The presence of unit root was performed using the Augmented Dickey Fuller (ADF) and Phillip Perron (PP) tests based on the following models (Gujarati, 1995).

$\Delta y_t = a_0 + \rho y_{t-1} + e_1$ Random walk with a drift…………………………………….…....3.4

$\Delta y_t = a_0 + \rho y_{t-1} + a_2 t + e_1$ Random walk with a drift and a trend …………………….…....3.5

The ADF test assumed that the data generating process was autogressive of the first order. This was done so that autocorrelation in the error terms does not bias the test. The ADF includes first-difference lags in such a way that the error term is distributed as a white noise. The test is based on the regression model of the form;

$$\Delta y_t = a_0 + \sigma T + \rho y_{t-1} + \sum_{j=1} \gamma_j \Delta y_{t-j} + e_1 \quad \ldots\ldots 3.6$$

Where y_t is the variable tested for unit root, j is lag length and T is time trend.

Unit root test implied testing the null hypothesis that ρ =1 (non stationary).The absolute value of conventionally computed statistics known as τ (tau) compared with the critical values. If the absolute value of tau statistics exceeded the critical values of ADF, the null hypothesis that the given series was non stationary was rejected. It was concluded that the variable was stationary. The number of times the original series was differenced before it became stationary was the order of integration.

The distribution theory governing the ADF tests assumes that the error terms are statistically independent and have a constant variance. The PP test is an improvement of ADF that allows the mild assumptions concerning the distribution of errors. The PP test on its part addresses the problem of the unknown structure of data generating process under the null hypothesis by adjusting the t-statistic for the potential omitted variable bias results (Gujarati, 1995). The PP test is based on the regression;

$$\Delta y = \beta + \rho y_{t-1} + \mu_{t1} \ldots\ldots 3.7$$

To test for a unit root, equation 3.7 was estimated by OLS and the t-statistics of ρ was corrected for serial correlation. If the results of the unit root tests showed that the variables were not stationary in their levels, then a cointegration analysis was performed.

Data

To achieve the objectives of the study, annual time series data for period 1963 to 2009 were collected. Data was gathered from various secondary sources namely; International Financial Statistics (IFS) and Kenya Statistical Abstracts.

Results and Discussion

a) Graph inspection method-An inspection of graphs for the variables showed that fluctuations and volatility characterized their behaviour. This suggests that all the variables exhibit non- constant means and variance. However basing a decision on whether or not a series is non-stationary by causal inspection may be misleading. Appropriate methods of testing for stationarity is Augmented Dickey Fuller (ADF) and Phillip Perron (PP) test.

b) Unit root tests -Unit root tests indicated that the series for the volume of exports of coffee, tea, pyrethrum, horticulture and real exchange rates are integrated of order zero, that is, *I(0),* meaning that they are stationary at levels.

Productive capacity is integrated of order one, that is, I(1) meaning that it is stationary at its first difference. These findings indicate that the left hand side of the model is an I(0) which implies that the regression using Ordinary Least Square (OLS) is meaningful, hence no valuable long-term information was to be lost if they were to be differenced. Since all variables apart from productive capacity in the model were found to be stationary, cointegration test was not necessary.

Model selection criteria

Before estimating the model, a decision was made regarding the number of lags to be included. The Akaike Information Criterion (AIC) and the Schwarz Bayesian Criterion (SBC) were used for this purpose. From the results AIC and SBC pointed to one (1) as the appropriate lag length for tea export and the aggregate model (volume of tea, coffee, horticulture and pyrethrum). For coffee and horticulture exports models, AIC was minimal when the number of lags equals one, while SBC when number of lags equals two. For both models, the appropriate number of lags chosen was two since SBC is a superior criteria than AIC. For pyrethrum exports model, the best lag length was two since it was the lowest value of the information criteria.

Diagnostic tests for regression residuals

Before reporting the regression results for the models estimated, diagnostic tests results were presented and discussed first. The J-B normality test was applied to test whether the series is normally distributed or not. The null hypothesis states that the regression residuals are normally distributed. A small probability value (p-value) for J-B coefficient leads to the rejection of this hypothesis. The results as shown by the table below show that the aggregate of the selected crops, individual crops; tea, horticulture, pyrethrum and coffee exports models gives J-B test statistic of 2.5, 4.14, 3.45, 2.07 and 2.46 with probability values of 0.57, 0.67, 0.55, 0.66 and 0.56 respectively.

The null hypotheses were accepted since probabilities are greater than 0.05, which indicates that the residuals are normally distributed. To test whether residuals were serially correlated LM test was applied. The null hypothesis of the LM test is that there is no serial correlation up to lag order p, where p is a pre-specified integer (Godfrey, 1988). A small probability value of less than 0.05 leads to the rejection of this hypothesis. The results are shown in the table1 below. These results show that the probability values are 0.014, 0.35, 0.27, 0.32 and 0.43 for tea, horticulture, pyrethrum and coffee exports models respectively. This leads to acceptance of the null hypothesis. Hence the residuals were not serially correlated.

Further, to test whether there is Autoregressive Conditional Heteroskedasticity (ARCH) in the residuals the ARCH test was applied. The null hypothesis is that there is no autoregressive conditional heteroskedasticity in the residuals. To accept the null hypothesis, the probability must be greater than 0.05. The test results presented in the table below show that the probabilities of all the exports models are greater than 0.05 hence there are no ARCH present in the residuals of the models.

White Heteroskedasticity test was applied to test for heteroskedasticity in the residuals from a least squares regression. White's test is a test of the null hypothesis of no heteroskedasticity against heteroskedasticity of some unknown general form (White, 1980). As shown in the table1 below the probabilities of this test for aggregate of selected crops, tea, pyrethrum, horticulture and coffee exports model are 0.58, 0.55, 0.84, 0.72 and 0.56 respectively. The results show that there is no heteroskedasticity present in the residuals since the probabilities of this test for all exports models are more than 0.05.

Reset which stands for Regression Specification Error Test was to test for omitted variables, incorrect functional form of a model and correlation between the independent variables and the error term.

The null hypothesis states that there is no misspecification in the model. A small probability of this test leads to rejection of the null hypothesis. The results of all models rejected the null hypothesis since they all had probability values greater than 0.05. Therefore, all the models were well specified and parameters were not omitted. Chow forecast test was used to test for structural changes. The null hypothesis of this test is that there is no structural change. In all models the null hypotheses are accepted at 5% since they have probabilities greater than 0.05. Hence there were no structural change in the series and the models could safely be used for forecasting and prediction.

Table 1: Diagnostic test results

Test type		Aggregate	Tea	Pyrethrum	Horticulture	Coffee
Jarque-Bera normality test	Test statistic	2.5	4.14	2.07	3.45	2.46
	probability	0.57	0.67	0.55	0.66	0.56
White Heteroskedasticity test	Test statistic	0.23	1.45	2.11	2.14	1.56
	probability	0.58	0.55	0.84	0.72	0.56
Serial correlation LM test	Test statistic	4.12	1.45	3.57	3.22	2.11
	probability	0.014	0.35	0.27	0.32	0.43
Ramsey RESET test	Test statistic	1.14	2.14	4.16	5.45	2.34
	probability	0.88	0.45	0.82	0.14	0.42
ARCH LM test	Test statistic	0.48	1.25	3.67	2.11	2.01
	probability	0.68	0.54	0.82	0.73	0.69
Chow forecast test	Test statistic	2.46	3.45	3.11	2.09	2.17
	probability	0.67	0.78	0.74	0.53	0.64

Estimated models and results

The regression results for the coffee for the coffee exports are presented in the table below.

Table 2: Regression results for the coffee export model

Independent Variable	Coefficient	t-Statistic
Constant	9.02	2.44
First difference of log GDP	0.08	3.20
Log real exchange rate	-0.99	-1.00
First lag of log coffee exports	2.35	-1.00
First lag of log GDP	0.05	2.13
First lag of log real exchange rate	0.69	0.98
Second lag of log coffee exports	-0.08	-1.45
El-Nino 1998 D=1,0 otherwise	0.48	1.91
Coffee boom 1977 D=1, 0 otherwise	0.71	2.66
Adjusted R-squared	-0.63	
S.E of regression	0.02	
Durbin-Watson stat	1.33	
F-statistic	0.87	
Prob (F-statistic)	0.01	

The Durbin Watson statistic (1.33) shows the presence of serial correlation between the variables in the coffee exports model. However, basing a decision on whether or not the variables are serially correlated using D-W statistic may be misleading, because the D-W statistics test for Autoregressive (1) errors. The appropriate test is LM test for correlation, which test for higher order ARMA errors as discussed earlier. The value of adjusted R-squared is 0.63 indicating that the overall fit of the regression is 63 percent, that is, 63 percent of the variation in coffee exports is explained by the variables that were included in the model. This leaves 37% of the variation in coffee exports to be explained by exogenous variables.

The probability of the F-statistic is 0.01 therefore the null hypothesis that the coefficients are equal to zero is rejected.The results for the coffee exports model show that coffee exports supply elasticity with respect to productive capacity and first lag of productive capacity was positive and statistically significant.

The response of coffee to real exchange rate was fairly elastic, negative and insignificant. However, coffee exports were affected positively by lagged real exchange rate but it was also a insignificant determinant of agricultural crop exports. The lagged coffee export coefficient was also found to be insignificant but very elastic. To capture the extreme weather conditions, a dummy variable was introduced to capture the *El-Nino* rainfall in 1998 and was found significant. That is, *El-Nino* rainfall shifted the coffee export supply curve upward. Coffee boom in 1977 had significant impact on coffee exports; by shifting the supply curve upwards.

Hence all the variables as a group explain the coffee export model. For tea export supply model, the results are presented in the table 3 below.

Table 3: Regression results for tea export model

Independent Variable	Coefficient	t-Statistic
Constant	0.79	0.79
First difference of log GDP	1.27	2.67
Log real exchange rate	0.03	2.14
First lag of log tea exports	0.63	3.54
First lag of log GDP	-0.09	-0.78
First lag of log real exchange rate	-0.01	-0.07
Second lag of log tea exports	0.31	1.86
Adjusted R-squared	0.95	
S.E of regression	0.001	
Durbin-Watson stat	1.60	
F-statistic	1.51	
Prob (F-statistic)	0.000	

The model is well fitted because the R-squared is very large, that is, 95% of the variations in tea exports are caused by changes in the variables included in the model. The probability of the F-statistics is 0.000, which leads to rejection of the null hypothesis that the coefficients are not jointly equal to zero.The results show that first difference of log GDP, log real exchange rate, first and second lag of tea exports had significant impact on supply of tea export. This is consistent with the results presented by Yang (1978). Berlow and Senses (1995) also found similar results.

The authors concluded that real exchange rate was the single most important factor explaining growth in the volume of agricultural exports. On the other hand first lag of GDP and first lag of real exchange rate were statistically insignificant and their elasticities were very low. Thus, changes in these two determinants would not cause substantial changes in tea exports. The model that follows is for horticulture export supply. Its results are given in the table 4 below.

Table 4: Regression results for horticulture exports model

Independent Variable	Coefficient	t-Statistic
Constant	-1.43	-0.49
First difference of log GDP	0.11	1.34
Log real exchange rate	1.04	2.07
First lag of log horticulture exports	1.11	5.48
First lag of log GDP	0.30	0.94
First lag of log real exchange rate	0.11	-0.21
Second lag of log horticulture exports	0.07	-0.39
Trade liberalization of 1973 D=1, 0 otherwise	0.71	0.66
Adjusted R-squared	0.88	
S.E of regression	0.005	
Durbin-Watson stat	1.65	
F-statistic	46.98	
Prob (F-statistic)	0.00	

The model was well fitted with R-squared of 0.88. Moreover, there was serial correlation between the variables in horticulture exports model. This is evidenced by the DW statistic of 1.65. However, LM test was used. The probability of F-statistic is 0.000 hence the coefficients are not equal to zero and the relationship between dependent and independent variables is meaningful. From the regression results presented in the table 4, supply elasticities of horticulture export with respect to log real exchange rate and its first lagged exports volume were high and statistically significant. All the variables had expected signs. Other studies for example, Ng'eno (1991) found similar results.

For instance, real exchange rate was found being significant in most of the studies. The coefficients of first difference of log GDP, first lag of log GDP, first lag of log real exchange rate and second lag of log horticulture exports were inelastic and insignificant, but they had correct signs. Therefore changes in these variables would not cause substantial changes in export of horticulture. Trade liberalization in 1973 had insignificant impact on horticulture exports. Table 5 shows the regression results of pyrethrum export supply.

Table 5: Regression results for pyrethrum export supply model

Independent Variable	Coefficient	t-Statistic
Constant	6.08	1.76
First difference of log GDP	1.01	0.05
Log real exchange rate	-1.84	-2.50
First lag of log pyrethrum exports	0.05	3.23
First lag of log GDP	-1.07	-0.27
First lag of log real exchange rate	0.06	0.11
Second lag of log pyrethrum exports	0.21	2.96
Second lag of log GDP	0.13	-0.49
Second lag of log real exchange rate	0.04	0.09
Third lag of log pyrethrum exports	0.76	1.89
Trade liberalization of 1973 D=1, 0 otherwise	0.03	2.25
Adjusted R-squared	0.55	
S.E of regression	0.001	
Durbin-Watson stat	1.67	
F-statistic	1.77	
Prob (F-statistic)	0.00	

The results for the pyrethrum exports model show that exports supply elasticities with respect to first difference of log GDP, log real exchange rate and first lag of log GDP were high, but only log real exchange rate was elastic and statistically significant. Thus, pyrethrum exports responded substantially to changes in real exchange rate. In contrast to findings by Amin (1996), real exchange rate had negative sign contrary to expectation. The first, second and third lag of log pyrethrum exports was found significant determinant but they were fairly inelastic. This means that, supply of pyrethrum export depended on exports of previous years. All the other variables had expected signs apart from the first lag of GDP. Trade liberalization in 1993 had significant impact on pyrethrum exports, by shifting the supply curve upwards. The table 6 shows the regression results of the aggregate model.

Table 6: Regression results of aggregate of coffee, tea, horticulture and pyrethrum

Independent Variable	Coefficient	t-Statistic
Constant	1.10	2.44
First difference of log GDP	1.07	2.20
Log real exchange rate	-1.75	-4.00
First lag of log aggregate exports	2.35	0.50
First lag of log GDP	0.05	0.13
First lag of log real exchange rate	0.69	0.97
Second lag of log aggregate exports	0.08	-0.44
Adjusted R-squared	-0.53	
S.E of regression	0.00	
Durbin-Watson stat	1.39	
F-statistic	0.87	
Prob (F-statistic)	0.00	

From the results, all variables had the expected signs apart from log real exchange rate. However, real exchange rate is the most significant variable influencing agricultural export supply and is fairly elastic. This confirms the results found by Amin (1996) that a small change in exchange rate will cause exports to change significantly. First difference of log GDP is also statistically significant variable and fairly elastic. Thus, change in GDP would cause substantial export change. Ng'eno (1991) also found similar results. On the overall, the lagged export variable coefficients were not statistically significant at 5% level, although they had the expected signs. Therefore, as Amin (1996) noted, the volume of exports supply was not affected by past exports.

The Durbin Watson statistic (1.39) shows the presence of serial correlation between the variables in the model. However, LM test for serial correlation was used due to reasons given earlier. The value of the adjusted R-squared is 0.53 indicating that the overall fit of the regression is 53%, that is, 53% of the variation in total agricultural crop exports is explained by the variables that were included in the model.

Conclusion and recommendations

Since real exchange rate was found significant in determination of volume of exports for most of the crops, the Government of Kenya should consider an examination of the question of depreciation of the real exchange rate. The Central Bank of Kenya should only intervene in foreign market to limit undesirable fluctuations caused by mismatches between the supply and demand of foreign currencies. This will help to increase the volume of agricultural exports. Also, flexible exchange rate will have expansionary effect by switching demand away from imports and making exports more competitive.

The government should develop policies that focus on how to improve on the productive capacity of this country in the short term since, a small change in GDP cause export to change significantly. It should put measures that will increase rainfall for instance, emphasis on planting of more trees to attract rain and strengthen the policy that no unauthorized cutting of trees.

Acknowledgement

We are grateful to the following institutions for all the support: Chuka University, Kenyatta University and University of Nairobi. We are also grateful to African Economic Research Consortium (AERC) for their support.

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