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Determinants of Coffee Export Supply in Ethiopia: Error Correction Modeling Approach

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Abstract
Coffee contributes an average of 65% to total export earning in Ethiopian economy and provides a source of livelihood for a substantial number of farmers. In this study, the determinant of coffee export supply in Ethiopia from the supply side is specified and estimated using error correction model. From the error correction model result, the coefficient of the co-integrating equation tells us that about 78.7 percent of disequilibrium corrected each year by change in export supply of coffee. Ethiopian coffee export supply in the short run is determined by real exchange rate, foreign capital inflow, real income and term of trade. In the long run it is determined by domestic price, real exchange rate, real income and term of trade. In the long run there is high price elasticity but in the short run it is low.
Keywords: Error correction model, Cointegration, Coffee Export Supply, Short and Long run.

1. INTRODUCTION

The major export commodity of Ethiopia, coffee, contributes an average of 65% to total export earning and provides a source of livelihood for a substantial number of farmers. Coffee contributes an average of 5.2 percent of GDP and 59.6 percent of total export for the period 1965-2005 in Ethiopia (See Figure 1 and 2). The volume of coffee export, prices and farm income are largely dependent on both national and international market and trade policies. Export performance cannot be only the good fortune to be producing goods in high demand. It is likely to be the outcome of the combination of various elements framing the production environment and export products' access to international markets.

Therefore foreign market access and supply side factors are important determinant of an export supply of a commodity. It is necessary to determine whether these affect export performance differently at different levels in order to draw up policy lessons. Much of the analysis about the export problems of primary commodities of under developed countries were concluding that it suffers from price problems (especially of overvaluation, marketing board intervention, etc.) (Alemayehu, 2002). Alemayehu (2002) had the first attempt to study the existence of other equally or more important factors which affect export of primary commodities. UNCTAD (2005) had relaxed the specification and used foreign market access and supply side factors in the determination of export supply of a given country. In this study, the determinant of coffee export supply in Ethiopia from the supply side is specified and estimated. The result shows that the determinants vary in the short and long run. The variables are cointegrated at a polynomial rank.

The rest of the paper is organized as follows. In section two the literature will briefly reviewed. Section three highlights the theoretical model of specifying export supply function. Section four deals with estimation results of coffee export supply functions. Section five concludes the results of the study.

Figure 1. The relationship b/n the value of real GDP and coffee export

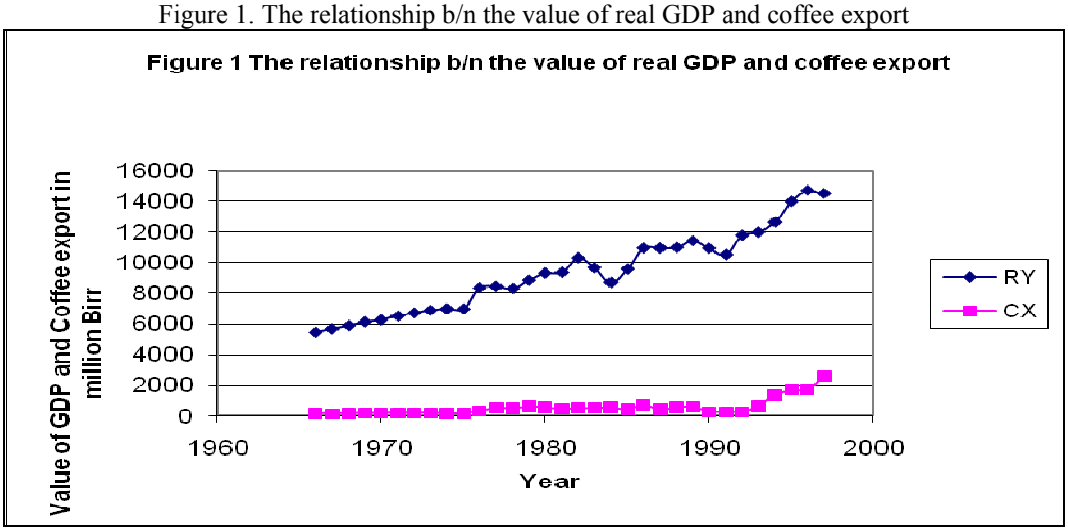
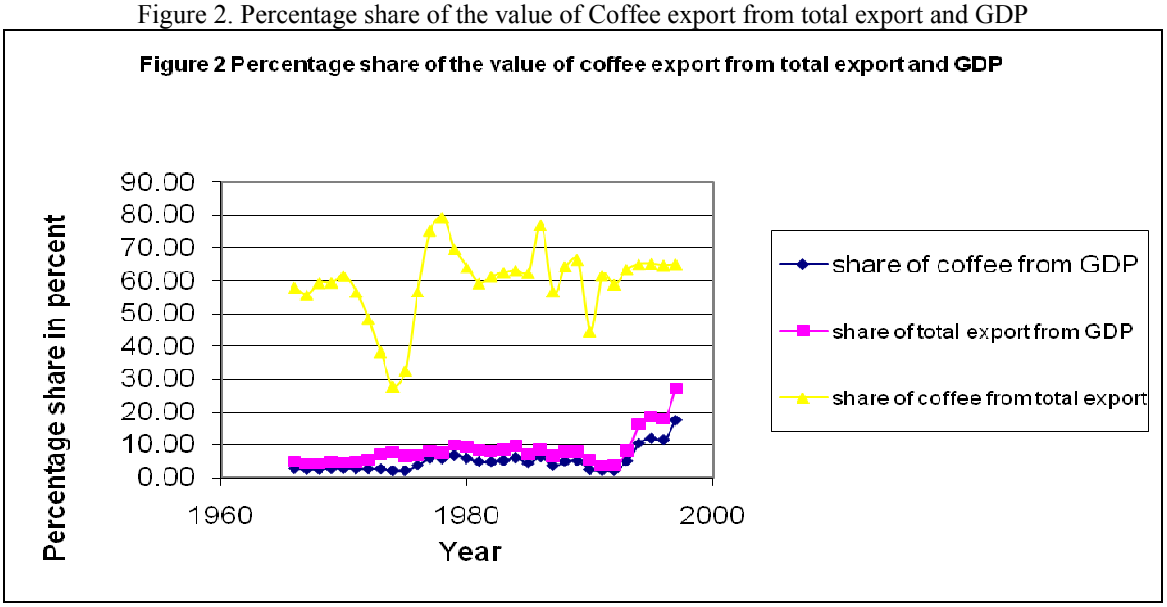


Figure 2. Percentage share of the value of Coffee export from total export and GDP



2. EMPIRICAL REVIEW OF LITERATURE

The literature on supply of primary commodities attempts to answer the question, 'what determine the supply of primary commodity exports?' Broadly, these supply determining factors include: cost and accessibility of consumer goods, farm subsidies and taxes, research and extension, road infrastructure (including its quality) and services such as marketing or credit (Binswanger, 1992).

Infrastructure might include the indirect impact of services, too. Services like credit (number of commercial banks or total credit) might affect the accessibility to fertilizer. Agro-climatic condition and human capital (e.g. rural population density and literacy) are also important factors. Further, these studies show that the short run elasticities are generally low simply because the factors of production (i.e. land, labour and capital) are fixed in the short run and these constitute 70-85% of cost of agricultural production (Binswanger, 1992).

At aggregate level studies on determining primary commodity export supply can be categorized under two themes: (a) Price focused Models which use prices of different complexities as explanatory factors and (b) Mixed (heterodox) factors based Model which uses additional explanatory variables. Price focused supply models began from the simple 'cobweb theorem' of Ezekiel (1938) which states that output is determined by the level of price in the previous period. All price focused models specified supply as function of current and lagged prices, exchange rate and a supply shock indicator (Alemayehu, 2002).

Heterodox model, on the other hand, specify supply function as a function of farmer's income and price. The mixed (heterodox) factor based model provides insight into some important points in specifying export functions of primary commodities. Firstly, factors other than price are found to be important determinants of commodity supply. Secondly, a distinction across commodities, especially between annual and perennial crops, is essential in specifying supply functions. A third and relatively neglected point is the need to place the commodity market within a macro framework where the role of stockholding and the impact of macroeconomic variables are likely to be important (Alemayehu, 2002).

Alemayehu (2002) specified export supply as a function of lagged and current price (which is relative price of south multiplied by exchange rate and divided by relative domestic price), supply of domestic credit, government investment and foreign capital inflow. He used error correction model to estimate the elasticities of the independent variables. His results indicate that long run price elasticities are larger than the short-run one.

UNCTAD (2005) specified export supply within a country as a function of access to foreign market and supply side factors. Access to foreign markets relates directly to the characteristics of the trading partner countries, such as the size of their market and transport facilities, and inversely to their own internal transport costs. It also depends positively on the size of the export basket and the number of differentiated items and their prices, which in turn are affected by market entry conditions. Trans-border costs, which also include tariff and non-tariff barriers, have the expected negative impact on foreign market access. On the other hand, the key determinants of supply factors on their model are (i) Domestic transport infrastructure which include the availability of physical infrastructure, ranging from roads and ports to energy and telecommunications (ii) Macroeconomic environment which include the real exchange rate, which reflects the underlying relative movement of prices at home and abroad, proves to have a significant effect on the export performance of a country (iii) Foreign direct investment (FDI) which includes foreign capital inflow and knowledge-based

industries (iv) Institutions. They used Tobit model to estimate the elasticities. They found that the elasticity of exchange rate increase over time.

In this study, the coffee export supply function of Ethiopian economy is specified to identify its inducing determinants using error correction model.

3. DATA SOURCE AND METHODOLOGY

3.1. Source of Data

The main source of data for this study is the national income accounts of Ethiopia as prepared and compiled by the Ministry of Finance and Economic Development (MOFED), Department of National Accounts. Some data used which are not available for the whole period are adjusted by using its growth rate. In addition World Bank Africa database is used. The data is used for the period 1965-2005.

3.2. Analytical Procedure

This study uses annual data to examine the determinants of coffee export supply in Ethiopia. The co-integration procedure requires time series in the system to be non-stationary in their levels. Moreover, it is imperative that all time series in the co-integrating equation have the same order of integration. Thus, the study first ascertains the time series properties of coffee export and other explanatory variables by using the augmented Dickey-Fuller (ADF) and Philips-Perron test for stationarity (Dickey and Fuller, 1979 and 1981). The equation estimated for the ADF test is stated as follows:

$$DX_t = \phi_0 + \beta_1 X_{t-1} + \delta t + \sum_{i=1}^{n} \theta_i DX_{t-1} + \varepsilon_t \qquad (1)$$

Where, for example X_t=LCX is the coffee export supply in natural logarithmic, D is the first difference operator, t is the time trend, β, δ and θ are parameters, ε is the stationary random error and n is the maximum lag length. The null hypothesis is that the series contains a unit root which implies that $\beta_1 = 0.$ The null hypothesis is rejected if β_1 is negative and statistically significant. To determine the long run relationship between coffee export supply and explanatory variables, the Johansen co-integration procedure is used (Johansen and Juselius, 1990 and Johansen, 1991). The procedure involves the estimation of a VECM. The VECM used in the study is as follows:

$$DY_t = X_t`\beta + \gamma DZ_t + \lambda (Y_{t-1} - \theta Z_{t-1}) + \varepsilon_t. \qquad (2)$$

Where, Y_t is the dependent variable, Z_t is the explanatory variables, X_t is exogenous variable, $Y_{t-1} - \theta Z_{t-1}$ is the error correction and D is represents the difference operator. Furthermore, ε represents the vector of white noise process. The VECM allows causality to emerge even if the coefficients of the lagged differences of the explanatory variable are not jointly significant (Granger, 1983; Engle and Granger, 1987; Miller and Russek, 1990; Miller, 1991; Dawit, 2003).

In this study, an attempt is made to specify the coffee export supply function of Ethiopia following Alemayehu (2002) and UNCTAD (2005). The hypothesized variables in this study are rainfall, relative domestic price, labour employed in agriculture, real exchange rate, domestic interest rate, foreign capital inflow, capacity utilization rate, real income, and term of trade. All variables are in natural logarithmic forms and β's are parameters to be estimated which are elasticities. The variables considered in the model are defined as follows.

Table 1 Definition of variables

Variable	Definition
LCX (Dependent)	Export supply of coffee in metric tone per year
LRF (Explanatory)	Amount of rainfall in millimeter
LP(Explanatory)	Relative domestic price of commodities in Birr
LLAG(Explanatory)	Agricultural labour employed in man days
LRER(Explanatory)	Real exchange rate (Birr/US dollar)
LRd(Explanatory)	Domestic interest rate in percentage
LFCF(Explanatory)	Foreign capital inflow in million Birr
LCUR(Explanatory)	Capacity utilization rate in percentage
LRY(Explanatory)	Real income in Birr
LTOT(Explanatory)	Term of trade

L indicate natural logarithmic

4. ESTIMATION AND RESULTS

Based on recent innovations in time series econometrics, the estimation is, in fact, carried out by formulating an

Error Correction Model. The first step in dynamic modeling is to test for stationarity for the variables of interest. All variables considered are nonstationary at 1% significance level. Augmented Dickey Fuller (ADF) (Dickey and Fuller, 1981) and Phillips (1987) and Phillips and Perron (1988) test statistics suggest that the levels are nonstationary except rainfall data (Table 2 and 3). Whereas the first differences of each variable are stationary.

Table 2. Unit root results of variables using Augmented Dickey Fuller test statistics

Variable	ADF Test Statistic	Variable	ADF Test Statistic	*MacKinnon critical values 1%	5%	10%
LCX	-1.4382	DLCX	-4.41992	-3.6067	-2.9378	-2.6069
LRF	-3.021954	DLRF	-6.80297	-3.6067	-2.9378	-2.6069
LP	-0.558246	DLP	-3.96222	-3.6067	-2.9378	-2.6069
LLAG	2.45776	DLLAG	-3.68889	-3.6067	-2.9378	-2.6069
LRER	-0.91242	DRER	-4.67801	-3.6067	-2.9378	-2.6069
LRd	-2.230322	DLRd	-3.84008	-3.6067	-2.9378	-2.6069
LFCF	-0.470855	DLFCF	-5.88312	-3.6067	-2.9378	-2.6069
LCUR	-2.282706	DLCUR	-3.2289	-3.6067	-2.9378	-2.6069
LRY	1.097677	DLRY	-4.86399	-3.6067	-2.9378	-2.6069
LTOT	-1.74269	DLTOT	-6.27539	-3.6067	-2.9378	-2.6069

*MacKinnon critical values for rejection of hypothesis of a unit root

Table 3. Unit root results of variables using Phillips-Perron (PP) test statistics

Variable	PP Test Statistic	*MacKinnon critical values 1%	5%	10%
LCX	-1.779271	-3.6019	-2.9358	-2.6059
LRF	-4.323264	-3.6019	-2.9358	-2.6059
LP	-0.402356	-3.6019	-2.9358	-2.6059
LLAG	3.308162	-3.6019	-2.9358	-2.6059
LRER	-0.653909	-3.6019	-2.9358	-2.6059
LRd	-1.927067	-3.6019	-2.9358	-2.6059
LFCF	-0.382984	-3.6019	-2.9358	-2.6059
LCUR	-2.211826	-3.6019	-2.9358	-2.6059
LRY	1.467032	-3.6019	-2.9358	-2.6059
LTOT	-1.864195	-3.6019	-2.9358	-2.6059

*MacKinnon critical values for rejection of hypothesis of a unit root

After determining the stationarity of the variables, attempt is made to undertake unrestricted VAR. Based on the unrestricted VAR result, the appropriate lag length using Johansen approach is determined (Johansen, and Juselius, 1990 and Johansen, 1991). Based on Swartz (SC), Hanan Quin (HQ) and Akaike information (AIC) criteria, the appropriate lag length is determined as one. After determining the lag length, the next step is to determine cointegrating equations. The result suggests that zero cointegration is rejected at 1% significant level. Hence the variables are at least cointegrated at one cointegrating equation and at most 10 cointegrating equations (See Table 4).

Table 4 Johansen cointegation test

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.924691	440.3621	233.13	247.18	None **
0.867837	339.502	192.89	204.95	At most 1 **
0.836952	260.577	156	168.36	At most 2 **
0.736629	189.8424	124.24	133.57	At most 3 **
0.643089	137.8089	94.15	103.18	At most 4 **
0.609075	97.62834	68.52	76.07	At most 5 **
0.463028	60.99799	47.21	54.46	At most 6 **
0.402355	36.74741	29.68	35.65	At most 7 **
0.277444	16.67183	15.41	20.04	At most 8 *
0.097442	3.998376	3.76	6.65	At most 9 *

*(**) denotes rejection of the hypothesis at 5% (1%) significance level

L.R. test indicates 10 cointegrating equation(s) at 5% significance level

The next step is to undertake hypothesis testing on the significance of coefficients of the variables in the long run structural equation. This helps to identify the long run determinant variables in the model. However, likelihood ratio (LR) statistics is wedded to the normal distribution and limits its generality (Greene, 2003).

Therefore an alternative to LR statistics is to use alternative estimator using Granger causality test which uses F test statistics. Based on Granger causality test (Engle and Granger, 1987), domestic price, agricultural labour, real exchange rate, and real income are the significant variables that Granger causes the dependent variable in our case the export supply of coffee (see Table 5). Hence in the long-run structural equations domestic price, domestic real interest rate, foreign capital inflow, capacity utilization rate, agricultural labour, real exchange rate and real income are the most important variables spanning the relationships. Whereas the variables, rainfall and term of trade, are not the structural long run variables.

Table 5 Pairwise Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Probability
LRF does not Granger Cause LCX	39	0.85987	0.43221
LCX does not Granger Cause LRF		0.56784	0.57203
LP does not Granger Cause LCX	39	3.22693	0.0521
LCX does not Granger Cause LP		0.31859	0.72932
LLAG does not Granger Cause LCX	39	3.53561	0.04027
LCX does not Granger Cause LLAG		0.94465	0.39878
LRER does not Granger Cause LCX	39	3.0925	0.05835
LCX does not Granger Cause LRER		0.69716	0.50498
LRD does not Granger Cause LCX	39	0.20015	0.81957
LCX does not Granger Cause LRD		2.3533	0.11036
LFCF does not Granger Cause LCX	39	2.14178	0.13303
LCX does not Granger Cause LFCF		1.39638	0.26133
LCUR does not Granger Cause LCX	39	0.57286	0.56926
LCX does not Granger Cause LCUR		2.18433	0.1281
LRY does not Granger Cause LCX	39	3.07265	0.05934
LCX does not Granger Cause LRY		0.88553	0.42179
LTOT does not Granger Cause LCX	39	0.08261	0.9209
LCX does not Granger Cause LTOT		0.66088	0.5229

Our model is valid for one cointegrating equation by specifying the export supply as dependent variable and the rest as explanatory variables. Based on individual basis, the long run (levels) determinants of coffee export supply in Ethiopia include all variables considered. Whereas the short run (differenced) determinants include price, real exchange rate, domestic interest rate, foreign capital inflow, capacity utilization rate and real income.

Table 6 Estimation result for short run: Dependent variable (DLCX)

Explanatory variable	Short run coefficient (elasticities)	t-value
DLP_2	0.826851	1.71***
DLRER	1.57897	4.20*
DLRd	-0.590136	-1.67
DLFCF	-0.322675	-2.60**
DLCUR_2	-1.20421	-1.97***
DLRY_2	2.38057	2.81*
Diagnostic test		
AR 1-2 test: F(2,31) = 0.97621 [0.3880]		
ARCH 1-1 test: F(1,31) = 0.10523 [0.7478]		
Normality test: Chi^2(2) = 3.0625 [0.2163]		
hetero test: F(10,22) = 0.60557 [0.7926]		
hetero-X test: F(20,12) = 0.31830 [0.9885]		
RESET test: F(1,32) = 0.11562 [0.7361]		

* Significant at 1% significant level , ** significant at 5% significant level, *** significant at 10% significant level

However, when we use the levels for regression analysis (long run determinants), our regression is spurious. On the other hand, if we use the differenced, we will loss the long run determinants of the model. Once there exists a cointegrating vector that ties the variables in the regression equation. That is the variables are cointegrated, vector error correction model is estimated for the significant variables which combined the short run (differenced) and the long run variables spanning the relationship which explain the major determinant of coffee export supply in Ethiopia.

Table 7 Estimation result for long run: dependent variable (LCX)

Explanatory variable	coefficient (elasticities)	t-value
LRF	2.15084	3.77*
LRF_2	3.26909	6.83*
LP_2	3.45559	5.83*
LP_3	-0.806753	-2.28**
LLAG	2.35037	5.43*
LLAG_2	1.46708	2.62**
LRER	3.20816	7.54*
LRER_1	-2.08846	-5.69*
LRER_3	-2.72724	-7.33*
LRd	-5.85754	-7.30*
LFCF	0.614826	3.79*
LFCF_1	-0.513155	-4.80*
LFCF_2	-0.245279	-2.37**
LFCF_3	-0.671037	-4.90*
LCUR_1	2.07786	3.50*
LRY_1	-3.09930	-4.42*
LTOT	1.33364	5.22*
Diagnostic test		
AR 1-2 test: F(2,16) = 1.0737 [0.3651]		
ARCH 1-1 test: F(1,16) = 0.32361 [0.5773]		
Normality test: Chi^2(2) = 0.41712 [0.8118]		
RESET test: F(1,17) = 1.7147 [0.2078]		

* Significant at 1% significant level , ** significant at 5% significant level, *** significant at 10% significant

Error correction model is estimated for the significant variables which combined the short run (differenced) and the long run variables spanning the relationship which explain the major determinant of coffee export supply in Ethiopia. In doing so several attempts were made to get the congruent error correction model. The final model is selected using information criteria, coefficient of determination and significant of the cointegrating equation coefficient.

Table 8. Cointegrating Equation and Vector error correction model: Dependent variable (DLCX)

Variable	Coefficient	Standard error	t-value
LCX(-1)	1		
LP(-1)	0.743998	-0.12221	-6.08807*
LRER(-1)	0.314641	-0.09261	-3.39748*
LFCF(-1)	0.076302	-0.06968	-1.095
LRY(-1)	-2.05246	-0.16212	-12.6599*
LTOT(-1)	0.820909	-0.18441	-4.45158*
CE1	-0.78686	-0.2276	-3.45724*
D(LCX(-3))	1.054548	-0.25859	-4.07807*
D(LP(-2))	0.183776	-0.5322	-0.34531
D(LRER(-2))	-1.45804	-0.47742	-3.05399*
D(LFCF(-2))	0.619705	-0.14835	-4.17745*
D(LRY(-3))	.825981	-0.94577	-1.93068**
D(LTOT(-2))	0.732308	-0.22402	-3.26896*
Diagnostic test			
R-squared	0.679273		
Adj. R-squared	0.358547		
F-statistic	2.11		
Akaike AIC	-0.11544		
Schwarz SC	0.711785		
Log likelihood	21.1357		

* Significant at 1% , ** significant at 5%

From the error correction model result, the coefficient of the co-integrating equation tells us that about 78.7 percent of disequilibrium corrected each year by change in export supply of coffee. As we see from the results, in the short run export supply of coffee in Ethiopia is determined by real exchange rate, foreign capital inflow, real income and term of trade. In the short run, elasticity of domestic price is the smallest although it has positive elasticity and insignificant. In the short run the income elasticity with respect to coffee export supply is high as compared to other elasticities. Term of trade has positive and significant elasticity. This implied that improvement of term of trade had a positive impact on the volume of coffee export. Real exchange rate has

negative and significant elasticity. This implied that continuous depreciation of real exchange rate have a negative impact on volume of export of coffee.

In the long run, relative domestic price, real exchange rate and term of trade have negative and significant elasticities. Foreign capital inflow has negative but insignificant elasticities. Real income in the long run has positive and significant elasticities. Price elasticity is higher in the long run than in the short run. Hence in this empirical study, the result show high price elasticity in the long run and low price elasticity in the short run which is similar with the previous studies. But low income elasticity in the long run and high income elasticity in the short run. Elasticity of exchange rate with respect to coffee export supply is low in the short run and high in the long run.

5. CONCLUSION AND RECOMMENDATION

In this empirical work, an attempt is made to specify and estimate the determinants of coffee export supply in Ethiopia using error correction model. From the error correction model result, the coefficient of the co-integrating equation tells us that about 78.7 percent of disequilibrium corrected each year by change in export supply of coffee. Ethiopian coffee export supply in the short run is determined by real exchange rate, foreign capital inflow, real income and term of trade. In the long run it is determined by domestic price, real exchange rate, real income and term of trade. Continuous depreciation of the exchange rate had a negative effect on the export supply of coffee. In the long run there is high price elasticity but in the short run it is low. The implication of low price elasticity is related to the fixed nature of factors of production in the short-run. It is recommended that Ethiopia should have to improve its terms of trade to increase the value of coffee at the international market. It is also suggested that Ethiopia should have to increase its real gross domestic product to improve the volume and value of coffee export.

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