

# Factors Affecting Sesame Seed Exports in Burkina Faso: The Vector Error Correction Approach

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*The research is financed by Academia Sinica, Taiwan. Grant No. AS-SS-107-02.*

## Abstract

Burkina Faso's (BFA) dependence on a single export crop, namely cotton, has so far threatened its economy since the fluctuating and uncontrollable drops in world cotton prices. The diversification of cash crops has become a national priority that is appropriated day by day by actors of rural development, and more particularly by farmers seeking to improve and secure their income. Thus, export crops, such as sesame, appear obvious and essential, not only for farmers' income security but also for the country by its ability to attract currencies. In the last decade, BFA's the sesame sector has recorded a tremendous growth both in quantity and value of exports to being the eighth world largest exporter of sesame seed. Considering its unequalled performance in the export of sesame seed, we deemed relevant to identify the key factors affecting that performance and to study their effects on sesame seed export earnings in order to draft appropriated policies aimed to enhance the country's earnings. This study uses the cointegration approach, and has purposely designed exports value as the independent variable to analyze the country exports performance using time series data for the period of 47 years (1970-2016). One cointegration vector is found between the variables employed; thereby the Vector Error Correction Model has been performed. The empirical results reveal that nominal exchange rate, producer price, world export volume of sesame seed as a proxy of world demand, and world price are key factors affecting significantly the country's exports performance in the short-run. Moreover, in the long-run nominal exchange rate, production, producer price, and world export price are factors determining significantly export earnings of sesame seed in Burkina Faso. For Burkina Faso to increase its market shares and export earnings, especially in the long-run, it is principally recommended to boost the production by increasing significantly yields and ensure an appropriate transmission of international prices increments to farmers.

**Keywords:** Agricultural Export, Determinants of Agricultural Exports, Sesame Seed, Cointegration, Burkina Faso.

**DOI:** 10.7176/DCS/10-4-03

**Publication date:** April 30<sup>th</sup> 2020

## 1. Introduction

Sesame seed represents an important export product for Sub-Saharan African countries (SSA). The seed is widely cultivated across the world; however, it constitutes a major cash crop for West and East African countries where the seed is produced in bulk (Food and Agriculture Organization (FAO), 2019). The major producers and exporters of sesame seed in SSA are Tanzania, Sudan, Ethiopia, Nigeria, and Burkina Faso (BFA) with their production representing 57% worldwide according to data from FAO. As for all SSA countries, agriculture remains the engine of BFA's economy and contributes to 35-40% of the GDP (Gross Domestic Product) through exports (Brüntrup and Zimmermann, 2009).

Sesame seed is considered as the second major cash crop for export in BFA and the country is one of the world-leading producer and exporter. The sesame sector is relatively young in BFA; however, recently the sector has been characterized by a tremendous growth in production and export. The growth is driven by the increasing world demand, which principally comes from the sesame-oil industry and the confectionary sector. This steady

increase in world demand of sesame seed induced significant variations in BFA's sesame sector.

According to FAO statistics, total export quantity increased from 20,600 tons in 2007 to 160,000 tons in 2016 (average growth of 22.75% per annual). In terms of value, sesame seed exports value maintained an average growth of 18.5% per year over the decade (2007-2016) and export earnings reached 170 million USD (103 billion FCFA in local currency). The buyers of BFA's sesame seed are quite concentrated in Asia such as Japan, Singapore, China and South Korea. With nearly 10% in world total export of sesame and with an unequalled performance in the production, BFA ranked eighth and fifth as world and Africa's largest exporter of sesame seed in 2016 respectively (FAO database).

Table 1 shows sesame exports quantities, values, and share during the period 2012-2016. Sesame exports in 2012-2016 accounted for about 21% of agricultural exports value and about 6% of total exports value of the country, on average. In addition, the logCEP for the sesame sector is greater than one, which highlights the competitiveness of the country in exporting sesame.

Table 1. Sesame export quantities and values in BFA (2012-2016)

Years	Quantity (ton)	Value (1000 USD)	Unit value (\$/Ton)	Share in agricultural exports value (%)	Share in total exports value (%)	Export performance logCEP
2012	98,754	89,469	906	20.64	4.00	4.80
2013	113,093	163,803	1,448	27.73	7.12	4.97
2014	94,889	132,379	1,395	19.00	5.10	4.56
2015	171,461	169,857	991	22.34	12.13	5.28
2016	159,837	113,363	709	16.35	4.72	4.87
Average	127,607	133,774	1,048	21.21	6.00	4.90

Note: CEP: Comparative Export Performance =  $\frac{X_{iB}/X_B}{X_{iA}/X_A}$ , where  $X_{iA}$ : value of world exports of sesame seed,  $X_{iB}$ :

value of sesame seed exports from BF,  $X_B$ : total value of agricultural exports from BFA,  $X_A$ : total value of world agricultural exports. When  $\log\text{CEP} > 1$  the country has competitiveness in the commodity being exported (Balassa, 1965).

In BFA, cotton industry is the principal engine of agricultural exports and a source of economic growth. This sector involves millions of farmers and contributes to 60% of the total agricultural exports value (FAOSTAT). However, the cotton sector is facing many serious difficulties caused by the downward pressure of world prices and internal problems, which partly led farmers to switch to other cash crops production such as the sesame. This situation has been threatening the country's economy, which depends on agricultural exports. For this reason, the government of BFA through its policies is promoting the diversification of agricultural exports in order to reduce the economy's dependency on cotton sector. Considering the tremendous growth mentioned above in the sesame sector, it turns out that the production and the exports of sesame seed are becoming a source of agricultural exports diversification, an emerging economic sector and another source of income for many farmers. Despite this study's attempt in determining the factors and their effects on seed sesame exports in BFA, there has been no econometrical study carried out on these exports in BFA. This present study turns out to be important in providing information on the factors affecting sesame seed exports in BFA, and to incite conducive actions that would aim to increase export earnings.

This study is conducted to principally investigate the key determinants affecting the sesame seed exports in BFA, to scrutinize their effects, and to analyze the causality between them through the application of the cointegration approach. Specific objectives of the study include the followings:

1. To identify key external and internal factor-drivers of sesame exports in BFA for the period 1970-2016,
2. To quantify the effects and analyze the magnitude of these factors on export performance, and
3. To inform relevant policy prescriptions and agricultural trade recommendations based on the findings.

The rest of the paper is organized as follow: Section 2 briefly presents agricultural and sesame sector in Burkina Faso, Section 3 reviews concisely the literature on the factors affecting agricultural exports in SSA, Section 4 describes econometric methodology used in this study and data descriptions, and Section 5 presents the empirical findings and discussion thereof. The final section presents conclusion remarks and recommendations.

## 2. Overview of Agricultural and Sesame Sector in Burkina Faso

Just like other SSA countries, trade liberalization policies were instituted in 1980s in BFA. The persistent decline in economic growth recorded in post mid-1960s led to the implementation of trade policy reforms to salvage the economy from collapse. Specifically, BFA implemented the Structural Adjustment Program (SAP) in 1983, which aimed to reposition the economy on the path of desired economic growth. The trade reform in 1983 and its fortification in 2000 by the Strategic Framework to Combat Poverty (SFCP), and the adoption of the Accelerated Growth and Sustainable Development Strategy (AGSDS) later in 2011 resulted principally in reducing poverty, sustaining the economic growth and diversifying the agricultural sector. Moreover, the

principal vision of the current economic program in BFA is still aiming to promote export-led growth through agriculture and to enhance the country's international competitiveness.

Yet, agriculture remains an important sector of BFA's economy and contributes between 35% and 40% of the GDP. The sector engages 80% of the population and is the backbone of economic growth, poverty reduction and sustainable development. Agricultural exports are cotton, livestock products, groundnuts, sesame seed, green beans, shea butter, and fruits among others. In 2016, total exports value of BFA was estimated at 2.4 billion-dollar USD (20% of GDP), with 37.5% attributed to total agricultural exports (World Bank Indicator data). Cotton industry, the first and the biggest industry, alone contributes to 60% to agricultural export earnings. However, the cotton sector is facing many serious difficulties caused by the downward pressure of world prices and internal problems, which partly led farmers to switch to other cash crops production.

After cotton, sesame is considered as the second major cash crop for export in BFA, and the country is one of the world's largest producer and exporter. Sesame in BFA is grown entirely under rainfed conditions with little or no use of machinery or modern inputs under the traditional farming system. The seed is cultivated throughout the country, but the major cultivation fields are in western, central and eastern regions. The total production of sesame seed stepped up from 18,802 metric tons in 2007 to 230,000 tons in 2016, corresponding an average growth of 28.45% per year (FAOSTAT). This is an outstanding performance relative to Africa's larger producers given that Nigeria, Ethiopia and Tanzania recorded an average growth of 14.63%, 6% and 19.70% per year respectively during the same period. In 2016, BFA was the second in West Africa, the fifth in Africa and the eighth largest producer in the world, with production representing respectively 28%, 7% and 4% (FAOSTAT). Nevertheless, BFA recorded a low yield in sesame production compared to other producing countries that was on average 603 kg/ha.

Three main groups of actors lead the sesame sector in BFA: producers, processors and traders/exporters. These actors, called direct actors, are supported by other sectors and actors such as the credit institutions (banks and microfinance structures), the State, non-governmental organizations (NGOs), associations, projects, programs and financial partners (TFP). All these sectors and partners provide financial assistance, training and technical services to the sector's direct actors. Analysis on exports data show that Singapore, China, and Japan are the top market destinations of BFA's sesame seed. Sesame sector in BFA possesses promising aspects including good prospects; land suitability for sesame production; abundant labor; a growing world demand; and amount of sesame seed research and development.

Table 2. Sesame seed production trend in BFA from 2007-2016

Crop year	Area (hectare)	Production (ton)	Yield (ton/hectare)
2007	55,058	18,802	0.3415
2008	91,997	51,924	0.5644
2009	93,384	56,252	0.6024
2010	125,471	90,649	0.7225
2011	120,750	84,759	0.7019
2012	165,575	100,488	0.6069
2013	203,449	137,347	0.6751
2014	506,095	321,837	0.6359
2015	400,000	235,000	0.5875
2016	390,000	230,000	0.5897
<b>Average</b>	215,178	132,706	0.6028
<b>AGR%</b>	21.62	28.45	-

Note: AGR: average growth rate per annual. Source: FAOSTAT, 2018

### 3. Review on the Factors Affecting Agricultural Exports in Sub-Saharan Africa

Determinants of agricultural exports in Sub-Saharan Africa (SSA) countries are still a controversial issue in economics, and studies on the determinants of agricultural exports in developing countries produced mixed results. In general, agricultural exports are affected by multiplicity of factors in low-income countries especially in SSA countries. Allaro (2011) and Fugazza (2004) classified determinants of agricultural exports into external and internal, where external factors are related to market access conditions and other factors affecting import demand. Apart from trade barriers and competition factors foreign market access is also determined by transportation costs, which include geography and physical infrastructures. On the other hand, internal or domestic factors refer to the supply side conditions or factors affecting supply capacity such as domestic policies.

Several studies have been conducted to determine drivers of exports for various agricultural commodities in SSA and have yielded quite interesting findings in economics, business and trade literature. As a key supply side determinant, higher level of production has been found as an important factor for stimulating exports in many studies on export and trade (Bertil, 1968). In an open economy, increased production offers an opportunity for export development through surpluses, which consequently earn foreign exchange, revenue and taxes for the

exporting country. The rich and cultivable land availability (factor endowment) enables Burkina Faso (BFA) to specialize in the exportation of tropical products (e.g. sesame seed) in which it has comparative advantage in the production. BFA having adopted a more liberal trading environment (open economy), increased production of sesame seed is a priori expected to yield beneficial implications for exports supply (Ngeno, 1966; Boansi, 2014). In the same vein, Boansi et al. (2014) conducted a study on Chad cotton exports by using the Vector Error Correction Model (VECM). The authors used external and supply side factors for a period of 31 years and discovered that, world export volume (proxy of world demand) of the commodity under study and the export competitiveness (measured by comparative export performance index) of the product significantly determine cotton lint exports from Chad and Mali. Anwar et al. (2010) using the VECM on cotton lint exports in Pakistan including similar variables as Boansi et al. (2014), revealed that the export of cotton lint is positively driven by increasing world demand for cotton and export competitiveness of the country. Similarly, Kumar et al. (2007) in a study using the same variables as Anwar et al. (2010) concluded that an increase in the volume of world demand of commodities studied leads to an increase in demand for exports from India.

As stated by Dercon (1993), prices generally serve as the basis with which relevant economic policies may affect agricultural variables such as production, exports supply and income. In investigating the determinants of agricultural export growth in Uganda for the period 1987-2006 using the co-integration analysis, Agasha (2009) found that foreign export prices are important determinants of export performance. Edward et al. (2004) studied on the determinants of agricultural exports using the gravity model in South Africa. The authors found a significant effect of foreign export prices on export supply in South Africa. In addition, Allaro (2011) conducted a study on oilseed exports performance in Ethiopia using the VECM and the author found a significant effect of foreign export prices on oilseed. Ndulu et al. (1990) revealed that foreign prices of primary commodities significantly affect the export performance of countries involved in their production.

Moreover, a good producer price matching with foreign export price has a reinforcing effect on agricultural exports performance. Tijani et al. (1999) conducted a study on export supply in Nigeria using the co-integration approach. The empirical finding revealed that producer price has a long-run equilibrium relationship with the cocoa exports in Nigeria, and high producer price leads to accumulation of ample revenue to producers. The author concluded that high price induces producers to increase production of the given product and thus assures the supply and availability of products to export.

Likewise, various studies have also shown that domestic exchange rate depreciation (foreign exchange rate appreciation) makes export products cheaper in the international market resulting in their increased demand. Fang et al. (2006) analyzed the impact of exchange rate depreciation on exports for eight Asian economies and they found that depreciation contributes to exports performance for most countries. In addition, the study of Edward et al. (2004) on the determinants of agricultural exports using the gravity model in South Africa found a significant association between nominal exchange rate and agricultural exports. The study conducted by Allaro (2011) using the VECM in Ethiopia found a positive effect of nominal exchange rate on oilseed exports in the short and long-run. On the contrary, Amoro et al. (2012) in a study on the determinants of agricultural exports in Cote d'Ivoire using the Ordinary Least Square, found a significant and negative effect of nominal exchange rate on cocoa and rubber exports in Cote d'Ivoire. Thus, the devaluation of the nominal exchange rate of a country produces the same effects as the depreciation and enables an increase of its export products. For this reason, WAEMU<sup>1</sup> in 1994 devaluated the Union's currency, which aimed to stimulate the exports and competitiveness of the member states.

So far, in the literature, various variables have been identified as factors affecting agricultural exports in developing countries. In as much as some of the findings conforming with economics and trade theories, others either are mixed signals or tend to disprove existing theories. However, in either case, knowing the factors that affect agricultural exports is key to drafting and implementing appropriate policy measures to further stimulate exports and boost social and economic development in SSA and particularly in BFA.

## 4. Research Methodology

### 4.1. Model Specification

In this section, we shall recap some essential aspects of the effective use of analytical tools employed in this study. To begin, the export supply models for the various crops are modelled from Goldstein et al. (1978), which was adopted and used in numerous studies such as Islam et al. (1989); Lukonga (1994); Anagaw et al. (2001); Alloro (2001) and Kingu (2014). To identify and analyze the factors affecting sesame seed exports in BFA, the following function is considered:

$$Xvalue = f(Exchrates, Prod, Pdprice, Wexprice, Wexpol) \quad (1)$$

where Xvalue is exports value or export earnings of sesame seed, Exchrates is the nominal exchange rate

<sup>1</sup> West African Economic and Monetary Union (Benin, Bissau Guinea, Burkina Faso, Ivory Coast, Mali, Niger, Senegal and Togo are member States)



(between USD and local currency, FCFA), Prod is the production of sesame seed, Pdprice is producer price or farm gate price of sesame seed, Wexprice is world export price or international price of sesame seed and Wexpvol is world export volume as a proxy for world demand of sesame seed.

In this study, the co-integration approach is applied to study the factors that affect sesame seed exports in BFA. This technique, however, is conditional on the stationarity of the times series variables employed. Again, this technique requires the variables to be integrated (stationary) of the same order; and second, a stationary linear combination must exist (C. J. Granger, 1986; Malik, 2010). These requirements must be satisfied because most economic time series contain unit roots dominated by stochastic trends; and any regression on these series may produce spurious, meaningless and irrelevant results (C. W. Granger & Newbold, 1974). A stochastic trend is determined by testing the presence of unit roots in the time series data (Elliott, Rothenberg, and James, 1996). The Augmented Dickey Fuller (ADF) test (D. A. Dickey and Fuller, 1981) is used to test for detecting unit roots. The equation for performing the ADF is expressed as follow:

$$\Delta Z_t = \alpha_1 + \alpha_2 t + \alpha_3 Z_{t-1} + \sum_{i=1}^p \beta_i \Delta Z_{t-i} + \varepsilon_t \quad (2)$$

where ADF regression tests for existence of unit root of  $Z_t$ , the logarithm values of all model variables at time t. The null (and alternative) hypothesis that tests the presence of unit root in the variable  $Z_t$  is  $H_0: \alpha_3 = 0$  against  $H_1: \alpha_3 \neq 0$ .

The nature of stationarity indicates the existence of co-integration and causality, based on the Vector Autoregression (VAR) and the Vector Error Correction Model (VECM) representations. Cointegration test is meant to reveal the presence of long-run equilibrium relationship between the variables. However, a lack of cointegration implies that such variables have no long-run equilibrium relationship and in principle, might wander arbitrarily far away from each other (D. Dickey, Jansen, and Thornton, 1991). The hypothesis that tests this is the null of non-cointegration against an alternative that cointegration exists. This study uses the Johansen (1988) maximum likelihood ratio test and considers two test statistics (Johansen & Juselius, 1990), that are, the trace statistics and the maximum eigenvalue statistics. They are expressed as follow:

$$\lambda_{trace} = -T \sum_{i=r+1}^n \log(1 - \hat{\lambda}_i) \quad (3)$$

$$\lambda_{max} = -T \log(1 - \hat{\lambda}_{r+1}) \quad (4)$$

where  $\hat{\lambda}_{r+1}, \dots, \hat{\lambda}_n$  are (n-r) smallest estimated eigenvalue. The null hypothesis of r cointegrating vectors is tested here against the alternative hypothesis of r+1 cointegrating vectors. The cointegration would determine the types of model, either VAR or VECM that the study may use to analyze the factors affecting sesame seed exports in BFA. First, if the variables employed in this study are stationary and not cointegrated, the following VAR model must be used:

$$Xvalue_t = \beta_0 + \sum_{i=1}^p \beta_{1i} Xvalue_{t-i} + \sum_{j=1}^p \beta_{2j} Exchrae_{t-j} + \sum_{k=1}^p \beta_{3k} Prod_{t-k} + \sum_{r=1}^p \beta_{4r} Pdprice_{t-r} + \sum_{n=1}^p \beta_{5n} Wexprice_{t-n} + \sum_{m=1}^p \beta_{6m} Wexpvol_{t-m} + \mu_{1t} \quad (5)$$

$$Exchrates_t = \alpha_0 + \sum_{i=1}^p \alpha_{1i} Exchrates_{t-i} + \sum_{j=1}^p \alpha_{2j} Xvalue_{t-j} + \sum_{k=1}^p \alpha_{3k} Prod_{t-k} + \sum_{r=1}^p \alpha_{4r} Pdprice_{t-r} + \sum_{n=1}^p \alpha_{5n} Wexprice_{t-n} + \sum_{m=1}^p \alpha_{6m} Wexpvol_{t-m} + \mu_{2t} \quad (6)$$

$$Prod_t = \gamma_0 + \sum_{i=1}^p \gamma_{1i} Prod_{t-i} + \sum_{j=1}^p \gamma_{2j} Exchrates_{t-j} + \sum_{k=1}^p \gamma_{3k} Prod_{t-k} + \sum_{r=1}^p \gamma_{4r} Pdprice_{t-r} + \sum_{n=1}^p \gamma_{5n} Wexprice_{t-n} + \sum_{m=1}^p \gamma_{6m} Wexpvol_{t-m} + \mu_{3t} \quad (7)$$

$$Pdprice_t = \eta_0 + \sum_{i=1}^p \eta_{1i} Pdprice_{t-i} + \sum_{j=1}^p \eta_{2j} Exchrae_{t-j} + \sum_{k=1}^p \eta_{3k} Prod_{t-k} + \sum_{r=1}^p \eta_{4r} Xvalue_{t-r} + \sum_{n=1}^p \eta_{5n} Wexprice_{t-n} + \sum_{m=1}^p \eta_{6m} Wexpvol_{t-m} + \mu_{4t} \quad (8)$$

$$Wexprice_t = \delta_0 + \sum_{i=1}^p \delta_{1i} Wexprice_{t-i} + \sum_{j=1}^p \delta_{2j} Exchrae_{t-j} + \sum_{k=1}^p \delta_{3k} Prod_{t-k} + \sum_{r=1}^p \delta_{4r} Pdprice_{t-r} + \sum_{n=1}^p \delta_{5n} Xvalue_{t-n} + \sum_{m=1}^p \delta_{6m} Wexpvol_{t-m} + \mu_{5t} \quad (9)$$

$$Wexpvol_t = \lambda_0 + \sum_{i=1}^p \lambda_{1i} Wexpvol_{t-i} + \sum_{j=1}^p \lambda_{2j} Exchrae_{t-j} + \sum_{k=1}^p \lambda_{3k} Prod_{t-k} + \sum_{r=1}^p \lambda_{4r} Pdprice_{t-r} + \sum_{n=1}^p \lambda_{5n} Wexprice_{t-n} + \sum_{m=1}^p \lambda_{6m} Xvalue_{t-m} + \mu_{6t} \quad (10)$$

here  $\beta, \alpha, \gamma, \eta, \delta$  and  $\lambda$  are parameters.

Second, if the variables used in this study are cointegrated, then the VECM shown below would be applied:

$$\Delta Xvalue_t = \beta_1 + \sum_{i=1}^p \alpha_{11,i} \Delta Xvalue_{t-i} + \sum_{i=1}^p \gamma_{12,i} \Delta Exchrates_{t-i} + \sum_{i=1}^p \eta_{13,i} \Delta Prod_{t-i} + \sum_{i=1}^p \delta_{14,i} \Delta Pdprice_{t-i} + \sum_{i=1}^p \lambda_{15,i} \Delta Wexprice_{t-i} + \sum_{i=1}^p \phi_{16} \Delta Wexpvol_{t-i} + \rho_1 ECT_{t-1} + \pi_t \quad (11)$$

$$\Delta Exchrates_t = \beta_2 + \sum_{i=1}^p \alpha_{21,i} \Delta Exchrates_{t-i} + \sum_{i=1}^p \gamma_{22,i} \Delta Xvalue_{t-i} + \sum_{i=1}^p \eta_{23,i} \Delta Prod_{t-i} + \sum_{i=1}^p \delta_{24,i} \Delta Pdprice_{t-i} + \sum_{i=1}^p \lambda_{25,i} \Delta Wexprice_{t-i} + \sum_{i=1}^p \phi_{26} \Delta Wexpvol_{t-i} + \rho_2 ECT_{t-1} + \pi_t \quad (12)$$

$$\Delta Prod_t = \beta_3 + \sum_{i=1}^p \alpha_{31} \Delta Prod_{t-i} + \sum_{i=1}^p \gamma_{32,i} \Delta Exchrates_{t-i} + \sum_{i=1}^p \eta_{33,i} \Delta Xvalue_{t-i} + \sum_{i=1}^p \delta_{34,i} \Delta Pdprice_{t-i} + \sum_{i=1}^p \lambda_{35,i} \Delta Wexprice_{t-i} + \sum_{i=1}^p \phi_{36} \Delta Wexpvol_{t-i} + \rho_3 ECT_{t-1} + \pi_t \quad (13)$$

$$\Delta Pdprice_t = \beta_4 + \sum_{i=1}^p \alpha_{41} \Delta Pdprice_{t-i} + \sum_{i=1}^p \gamma_{42,i} \Delta Exchrates_{t-i} + \sum_{i=1}^p \eta_{43,i} \Delta Prod_{t-i} +$$

$$\sum_{i=1}^p \delta_{44,i} \Delta Xvalue_{t-i} + \sum_{i=1}^p \lambda_{45,i} \Delta Wexprice_{t-i} + \sum_{i=1}^p \phi_{46} \Delta Wexpvol_{t-i} + \rho_4 ECT_{t-1} + \pi_t \quad (14)$$

$$\Delta Wexprice_t = \beta_5 + \sum_{i=1}^p \alpha_{51} \Delta Wexprice_{t-i} + \sum_{i=1}^p \gamma_{52,i} \Delta Exchrates_{t-i} + \sum_{i=1}^p \eta_{53,i} \Delta Prod_{t-i} + \sum_{i=1}^p \delta_{54} \Delta Pdprice_{t-i} + \sum_{i=1}^p \lambda_{55,i} \Delta Xvalue_{t-i} + \sum_{i=1}^p \phi_{56} \Delta Wexpvol_{t-i} + \rho_5 ECT_{t-1} + \pi_t \quad (15)$$

$$\Delta Wexpvol_t = \beta_6 + \sum_{i=1}^p \alpha_{61} \Delta Wexpvol_{t-i} + \sum_{i=1}^p \gamma_{62,i} \Delta Exchrates_{t-i} + \sum_{i=1}^p \eta_{63,i} \Delta Prod_{t-i} + \sum_{i=1}^p \delta_{64} \Delta Pdprice_{t-i} + \sum_{i=1}^p \lambda_{65,i} \Delta Wexprice_{t-i} + \sum_{i=1}^p \lambda_{66,i} \Delta Xvalue_{t-i} + \rho_6 ECT_{t-1} + \pi_t \quad (16)$$

where, ECT is the error correction term; the estimated residual from the co-integration regression. A negative and significant coefficient implies that the past equilibrium errors play a role in determining the current outcomes. The short-run dynamics are captured through the individual coefficient of the difference terms.

One of the difficulties that researchers may face in estimating a VAR model is the appropriate specification of lag order. In this study we consider the Schwarz (Schwarz, 1978) and the Hannan-Quinn (Hannan and Quinn, 1979) criteria for selecting the optimal lag order. In this study also performs the Granger Causality test (C. W. Granger, 1988) to analyze the nexus between variables. We also perform certain diagnostic tests on the residuals of the model. We used the Lagrange test (LM) for the possible existence of autocorrelation, the White heteroskedasticity and the Ramsey test.

#### 4.2. Data Source and Description

The data employed for this research are annual and cover the period 1970 to 2016 obtained from FAOSTAT, World Bank Indicators and INSD (Institute of National Statistics and Demography, INSD BFA) database. Both producer price and world export price were measured in USD dollar per ton, while exports value was measured in USD dollar. In addition, production and world demand of sesame seed were measured in ton. In the analysis, all data were expressed logarithmically in order to include the proliferative effect of time series. Table 3 provides the summary statistics for all variables employed in this study.

Table 3. Summary statistics

	Xearnings	Exchrates	Prod	Pdprice	Wexprice	Wexpvol
Mean	20,270,021	416,09	35895,32	538,04	825,94	663393,85
Max	169,857,000	733,03	321837,00	2451,15	2059,36	1895582,00
Min	31,8000	211,27	1676,00	108,53	232,60	183008,00
Std. Dev	42,464,717	152,65	67013,62	588,83	361,71	473696,02
Skewness	2,50	0,24	2,87	2,06	1,60	1,10
Kurtosis	7,85	1,87	10,83	6,37	4,85	3,21

Note: FCFA: currency of Burkina Faso

## 5. Empirical Results and Discussion

### 5.1. Stationarity

The empirical analysis begins with checking stationarity of the time series variables as a prime condition for cointegration and using either VAR or VECM. The ADF unit root test has been applied to examine the stationarity of the time series data. The estimated results of unit root test are reported in Table 4.

Table 4. Unit root test results

Variables	Level data		Conclusion
	Constant	Constant with trend	
logXvalue	1.12	-1.47	Non-stationary
logExchrte	0.23	-2.20	Non-stationary
logProd	1.12	-0.54	Non-stationary
logPdprice	-1.28	-2.07	Non-stationary
logWexprice	-2.49	-2.90	Non-stationary
logWexpvol	-1.03	-3.55	Non-stationary
First difference			
logXvalue	-9.95	-10.08***	Stationary
logExchrte	-5.96	-5.90***	Stationary
logProd	-7.29	-7.73***	Stationary
logPdprice	-6.37	-6.30***	Stationary
logWexprice	-6.18	-6.24***	Stationary
logWexpvol	-6.43	-5.78***	Stationary

Note: Xvalue: exports value; Exchrte: nominal exchange rate; Prod: production; Pdprice: producer price; Wexprice: world export price; Wexpvol: world demand; log: natural logarithm; and \*\*\* indicates statically significant at 1%.

The results indicate that no time series variables appear to be stationary in variable level, since computed test statistics could not reject the null hypothesis of non-stationarity. This signifies that the variables are non-stationary in their level data. It suggests that the stationarity must be checked at a higher order of differencing. In this present study, it is found that when the first differences of the variables are considered, the null hypothesis of unit root is rejected at 1% significance level. Hence, the differences become stationary and as a result the related variables are integrated of order one, I (1). The optimal lag selection is considered by using the Schwarz (SC) and the Hannan-Quinn (HQ). The result the VAR lag order selection is reported in Table 5.

Table 5. VAR lag order selection

Lag order	LR	FPE	AIC	SC	HQ
0	NA	1.33E-05	5.8	6.04	5.89
1	293.82*	2.48e-08*	-0.5*	1.2*	0.12*
2	48.96	2.88E-08	-0.44	2.71	0.72
3	40.86	3.72E-08	-0.43	4.17	1.27

Note: LR: sequential modified test statistic; FPE: final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion; and \* indicates optimal lag criteria.

### 5.2. Cointegration

Following that, the series are integrated of order one, the cointegration relationship between them are established by using Johansen's maximum likelihood (ML) test. The results of cointegration test ( $\lambda_{trace}$  and  $\lambda_{max}$ ) indicate that the time series variables (exports value, exchange rate, production, producer price, world export price and world demand) are cointegrated (see Table 6) and hence, long-run equilibrium relationship may exist among them.

Table 6. Cointegration test results

Null hypothesis	Trace statistic	5% critical value	Max Eigenvalue	5% critical value
H <sub>0</sub> : r = 0	92.84	83.93	39.52	36.63
H <sub>0</sub> : r ≤ 1	53.32**	60.06	22.83**	30.43
H <sub>0</sub> : r ≤ 2	30.49	40.17	12.07	24.15
H <sub>0</sub> : r ≤ 3	18.41	24.27	10.74	17.79
H <sub>0</sub> : r ≤ 4	7.66	12.32	7.39	11.22
H <sub>0</sub> : r ≤ 5	0.275	4.12	0.27	4.12

Note: r denotes the number of cointegrating vectors; and \*\* indicates statistically significant at 5%.

The existence of cointegration leads us toward the use of the VECM (expressed by equations (11) – (16)). The VECM is applied to analyze the factors affecting sesame seed exports in BFA and to know the causality between the factors. This model gives us the short-run dynamics and long-run estimates. The short-run results indicate that the nominal exchange rate, producer price, international price, and world demand of sesame seed are factors affecting sesame seed exports in BFA (with export value-Xvalue being our target dependent variable).

The estimated results of the VECM are reported in Table 7. D1-D4 are dummy variables included to control for short-run structural break. The study used the Zivot-Andrews unit roots test with structural break to define

the dummy variables. These dummy variables take one at the break point and zero otherwise. The break points are represented by D1-D4, and concern the nominal exchange rate, exports value, production and world export price, respectively.

A 1% depreciation of the nominal exchange rate (or 1% increase in the value of the USD) will increase export earnings or value by 2.30% in the short-run. This is in line with Allaro (2011) results, which found positive and significant short-run effect of nominal exchange rate on oilseed exports in Ethiopia. Similarly, it is expected that a 1% increase in farm gate price or producer will affect exports performance by 0.58% in the short-run. This finding supports the result of Okoruwa et al. (2003) who reported that an increase in producer's price of rubber is associated with an increase in exports of rubber in Nigeria. A 1% increase in world market price of sesame increases exports value for BFA by 1.30%. Boansi et al. (2014) also found that, in short-run; world price causes cotton exports performance in Mali.

Table 7. Estimation results of the VECM

Short-run dynamics (one lag included)						
Dependent variables	$\Delta \log X_{value}$	$\Delta \log Exchrat$	$\Delta \log Prod$	$\Delta \log Pdprice$	$\Delta \log Wexprice$	$\Delta \log wexpvol$
$\Delta \log X_{value}$	-0.16 (-1.04)	-0.08 *** (-2.88)	-0.03 (-0.20)	0.06 (-0.65)	0.06 (-1.11)	-0.06 (-1.62)
$\Delta \log Exchrat$	2.30 *** (4.00)	0.08 (0.76)	0.48 (0.86)	-0.23 (-0.67)	-0.03 (-0.15)	-0.18 (1.24)
$\Delta \log Prod$	0.01 (0.09)	0.11 *** (3.87)	-0.24 (-1.62)	-0.17 * (-1.79)	-0.18 *** (-3.17)	0.06 (1.56)
$\Delta \log Pdprice$	0.58 * (1.87)	-0.03 (-0.57)	0.12 (0.41)	0.01 (0.09)	0.14 (1.27)	0.06 (0.84)
$\Delta \log Wexprice$	1.30 ** (2.46)	-0.17 * (-1.73)	0.00 (-0.01)	0.18 (0.58)	0.22 (1.14)	-0.05 (-0.37)
$\Delta \log wexpvol$	2.11 *** (3.66)	-0.08 (-0.75)	0.53 (0.94)	0.26 (0.73)	0.17 (0.83)	-0.04 (-0.27)
D1	-0.17 (-0.36)	0.70 *** (7.77)	-1.50 *** (-3.18)	0.00 (0.02)	0.15 (0.87)	0.15 (1.27)
D2	-0.44 (-0.90)	-0.35 *** (3.86)	0.22 (0.46)	-0.02 (-0.08)	-0.15 (-0.84)	0.07 (0.61)
D3	0.37 (1.12)	-0.07 (-1.20)	0.17 (0.53)	0.45 ** (2.21)	0.22 ** (1.79)	-0.08 (-0.95)
D4	-0.12 (-0.24)	-0.07 (-0.81)	-0.22 (-0.45)	0.20 (0.65)	0.07 (0.40)	-0.25 * (-1.91)
ECT	-0.36 ** (-2.44)	0.10 * (3.81)	0.35 ** (2.40)	-0.03 (-0.38)	-0.06 (-1.22)	0.09 ** (2.39)
Long-run equilibrium						
logXvalue	logExchrat	logProd	logPdprice	logWexprice	logWexpvol	
	1.13 *** (3.71)	1.43 *** (10.11)	0.20 (0.90)	-1.14 *** (-4.06)	0.05 (0.25)	

Note: D1-D4 are dummy variables included as exogenous variables in the VECM to control for structural break. This concerns Xvalue, Exchrat, Prod and Wexprice variables. Numbers in the brackets (...) are t statistics, \*\*\* indicates statistically significant at 1%, \*\* statistically significant at 5% and \* statistically significant at 10%.

According to the principles of trade theory, an inverse association is usually expected between prices and world exports volume or world demand. This is because whenever prices in the international market increase, international consumers are expected to demand less, while exporting countries on the other hand are expected to export more. However, in this study a 1% increase in world demand of sesame seed will increase exports value by 2.11%. The positive effect of world demand and world market price of sesame seed on BFA's exports performance reflects a good standing of the commodity involved in the international market as pointed out by Kumar et al. (2007).

Furthermore, none of the dummy variable has a significant effect on exports value; however, D1 has a significant effect on exchange rate and production. BFA has devaluated its currency in 1994, which is represented by D1. This has depreciated the currency, stimulated the sesame seed exports and affected significantly sesame production. The effect of D3 on producer price and world export price is negative and significant. D3 is included to control for structural break and concern production variable. It implies that the



structural change happened in 2008 (financial crisis) had a negative impact on world price of sesame seed. The ECT coefficient (-0.36) is negative and statistically significant. This implies that the past equilibrium errors play a role in determining the current outcomes or suggests an existence of a high speed of convergence to long-run relationship (equilibrium) amongst the variables.

The long-run estimates point out that nominal exchange rate, production and world export price of sesame seed are factors determining sesame seed exports in BFA. Like in the short-run, nominal exchange rate remains a major factor in determining exports for the long-run. In the long-run, a 1% depreciation of the nominal exchange rate (or 1% increase in the value of the USD) will increase exports value by 1.13% for BFA. This result again confirms the finding of Allaro (2011), which, in the long-run, reveals that the nominal exchange rate is a key determinant of oilseed exports in Ethiopia.

The variable production was not a significant factor in determining sesame seed exports in the short-run. However, the production of sesame seed has an elastic long-run effect on export performance. It is projected that a 1% increase in the production is associated with 1.43% increase in the exports value of sesame seed for BFA. This finding is in line with Ball et al. (1966) and Bertil (1968) who reported that production is a key supply side determinant of exports, thus increased production stimulates exports expansion and performance.

Unlike the short-run, the world export price of sesame seed has a negative sign and is significant. A 1% increase in world export price decreases exports value by 1.14%. In fact, exporters are motivated to export more and to expect higher gains when there is a positive response in price increments. However, in equilibrium they are hindered in doing so by the downward pressure of world prices, which makes sesame seed in the international market and other sources cheaper than the one offered by BFA.

To complement this study, we report also the diagnostic tests for serial correlation (LM test), heteroskedasticity (White test) and stability test (Ramsey test). These diagnostic tests aim to test the absence of residuals serial correlation, the robustness and the stability of the coefficients. These are provided in Table 8.

Table 8. Short-run diagnostic tests

Test	LM	White	Ramsey
Value	1.05**	15.27**	1.78**

Note: LM: Serial correlation; Ramsey: Ramsey test; White: White heteroskedasticity test; \* indicates that the test statistics is significant at 5%.

### 5.3. Causality

The findings of the variables' stationarity, co-integration between variables employed and significance of the ECT immediately implies that there is causality between the variables in the short and long-run. Therefore, it would be useful and relevant to test for causality in order to note the causal relationship between the variables. Thus, the test results can help to find out key pathways and key factors that affect exports value. The short-run null hypothesis is stated as: there is no short-run causality going from variable X to variable Y and the long-run causality null hypothesis is similarly stated as the short-run. The null hypothesis is rejected (accepting a causality) if the chi-square is statistically significant. The short-run causality is tested by using the Granger short-run causality test. However, the long-run causality test is conducted by using Wald test based on the ECT's coefficient. Short-run and long-run causality tests are displayed in Table 9.

The results of causality presented above show unidirectional causality in the short-run going from producer price to exports value. Unidirectional causality is also noted from world export price and world demand to exports value. It simply means that a rise in any of these factors causes a rise in exports value for BFA. The analysis also finds unidirectional causality in the short-run going from production and world export price to exchange rate. This suggests that a rise in production or world export price causes a rise in nominal exchange rate. A short-run unidirectional causality also exists between production and producer price, and between production and world export price.

Table 9. Results of causality tests

Short-run causality (in first difference)						
Dependent variable	logXvalue	logExchrte	logProd	logPdprice	logWexprice	logWexpvol
logXvalue	-	(8.30)***	(0.04)	(0.42)	(1.24)	(2.65)
logExchrte	(16.06)***	-	(0.74)	(0.45)	(0.02)	(1.55)
logProd	(0.00)	(14.80)***	-	(3.22)*	(10.06)***	(2.46)
logPdprice	(3.52)*	(0.26)	(0.17)	-	(1.63)	(0.70)
logWexprice	(6.07)**	(3.19)*	0.00	(0.33)	-	(0.13)
logWexpvol	(13.40)***	(0.56)	(0.89)	(0.53)	(0.70)	-
Long-run causality						
Dependent variable	logXvalue	logExchrte	logProd	logPdprice	logWexprice	logWexpvol
logXvalue	-	(14.99)***	(8.51)**	(0.42)	(1.70)	(5.77)*
logExchrte	(19.31)***	-	(7.41)**	(0.70)	(1.62)	(6.48)**
logProd	(7.77)**	(20.23)***	-	(3.45)	(10.11)***	(6.04)**
logPdprice	(10.51)***	(15.40)***	(5.80)*	-	(3.47)	(6.11)**
logWexprice	(8.43)**	(14.60)***	(7.04)**	(0.37)	-	(6.27)**
logWexpvol	(17.27)***	(14.64)***	(7.41)**	(0.61)	(1.95)	-

Note: numbers between the brackets (...) are Chi-square statistics, \*\*\* indicates statistically significant at 1%, \*\* statistically significant at 5% and \* statistically significant at 10%.

In addition, this study finds bidirectional causality in the short-run between nominal exchange rate and exports value. A point needs to be made here regarding bidirectional causality. If the rise in one variable causes the rise of another, and is also true when the variables are switched, the variables would reinforce each other and be self-reinforcing. This situation, therefore, would be easy to handle by policy maker (Chontanawat, 2019).

In the long-run, this work discovered bidirectional causality from nominal exchange rate to exports value, from production to exports value, and from world demand of sesame seed to exports value for BFA. The same type of causality is verified also between exports value and world demand of sesame seed. A bidirectional causality is also observed between nominal exchange rate and production, and between nominal exchange rate and world demand. The long-run bidirectional causality is again noticed between production and world demand. In the long-run, unidirectional causality is going only from world export price to exports value, from producer price to exports value, and from producer price to production.

## 6. Concluding Remarks and Policy Implications

### 6.1. Summary of Findings

This study has examined the factors affecting sesame seed exports in BFA using the VECM with time series data for the 1970-2016 period. It has also analyzed the causality between these determinants using the Granger causality test. The short-run empirical evidence from our study suggests that nominal exchange rate, producer price, world price and demand significantly determine the sesame seed earnings in BFA. For the long run, nominal exchange rate, production and world price have a significant burnt on sesame seed earnings in BFA. Thus, BFA's exports of sesame seed are determined by both internal factors such as producer price, production, nominal exchange rate and by external factors such as world demand and price, in the short and long-run.

The findings reveal that after the currency's devaluation sesame seed export earnings showed improvement. The error correction term in the model is found to be statistically significant, and this suggests a high speed of convergence to equilibrium. The coefficient estimate of the error correction term in our model is (-0.3686) and this implies that variables adjust to long-run equilibrium at the speed of 36 percent per annum as such confirming the validity of the long-run relationship (equilibrium) amongst the variables. This indicates a high speed of adjustment of variables to equilibrium.

### 6.2. Conclusions and Recommendations

With a continuous increase in world demand of sesame seed, the study is deemed to be vital in the effective design and implementation of policies aimed to increase BFA's export earnings of sesame seed. The study concludes with the following:

First, production is a factor that determines sesame seed exports value and there is bidirectional causality between production and export earnings. It means that production causes export earnings and vice versa. Sesame seed is a cash crop for farmers in BFA; therefore, a higher revenue from sesame exports is an incentive to produce more. The potentiality to expand produced quantities is a factor that will increase sesame seed export earnings, ceteris paribus. Hence, it is important to boost the production, and this could be achieved through increasing significantly yields; by supporting farmers in diverse ways, including provision of adapted financial credits, input distribution (modern technologies, fertilizers, pesticides, and improved seed) as well as improving

the quality of the sesame being exported.

Second, bidirectional causality between exports value and world demand of sesame seed was found in this study. This implies that when world demand steps up, exports value is expected to increase through the increase of world price. The increase in world demand raises world price, which will significantly affect export earnings, all things being equal. In addition, producer price has significant effect on the export earnings and production. The implication is that an increase in the producer price of sesame seed to match export price will encourage farmers to increase the output. However, a huge gap between export price and farm gate price discourage farmers from fully participating in sesame seed production. Hence, ensuring an appropriate transmission of export prices increments to farmers could contribute to incentivize them, thereby increasing production and exports earnings.

Finally, we also found bidirectional causality between nominal exchange rate and exports value; and between nominal exchange rate and world demand of sesame seeds. As pointed out by trade and economics literature, exchange rate is an important factor that determines the exports of any country. A policy aimed to depreciate local currency could have an impact on exports performance of sesame seed. In other words, the appreciation of the USD would have a positive effect on exports value. The unidirectional causality from producer price to exports value is important to highlight. Farmers' earnings are determined mainly by gate price, therefore, ensuring that an acceptable margin between the producer prices and export price of sesame seed would be beneficial to farmers in boosting their revenues and economic fallouts.

Our study, so far, has scrutinized the factors affecting the sesame seed exports in Burkina Faso. However, the trade between countries, a country's competitiveness and its international market share could be influenced by numerous factors. Thus, it may be prospectively important to study the determinants of trade flows and trade structure of sesame seed between BFA and its major buyers (Japan and China). This will not only complete the present study in terms of recommendations, but also will end up with trade policies aimed to increase the competitiveness and market share of BFA in the international market.

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