Can Sub-Saharan Africa become Food Self-sufficient? Analyzing the Market Demand for Sunflower Edible Oil in Tanzania

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Abstract

Deficit in food supply, edible oil in particular is a common occurrence in Tanzania. The deficit in edible oil from the domestic supply is mainly due to use of poor production technology, that include use of unimproved seed coupled with dependent on rain fed agriculture leads to low productivity. However, the high rates of population growth and industrialization increase demand for edible oil both for home consumption and industrial use. Despite Tanzania having comparative advantage in the production of edible oil particularly from sunflower still this opportunity has not fully exploited. Currently, Tanzania, is revitalizing its edible oil sub-sector in order to reduce its dependency on imported edible oil. The sunflower sub-sector in Tanzania is deemed as key to industrialization, thus a potential contributor to economic growth and development, especially for smallholder farmers and small-to medium-size processors. This study aims at discerning the response of sunflower edible oil subsector to fulfill the edible oil demand in Tanzania. The study uses annual time series data from 1995 to 2019. A partial adjustment model is used to determine the relationship between edible oil demand, and its determinants, that are sunflower and palm oil prices, and per capita income. Findings from this study indicate that the demand for edible oil is inelastic for increase in palm oil price but elastic for the increase in domestic sunflower edible oil prices. This implies, as the price of sunflower edible oil increases per capita edible oil decreases. In contrast, increase in imported palm oil price per capita oil demand increases, implying the price for the imported palm oil are extremely low compared to the domestically produced sunflower edible oil. The current speed of adjustment in production of sunflower edible oil is low per year that indicate that it will take many years for Tanzania to be self-sufficient. This situation calls for the government and development agencies to intervene and improve the available technologies thus raise farmers productivity in terms of sunflower seed production as well as efficiency in processing. To improve the productivity of the agro processors, the Tanzania Government will need to reconsider the tax rates imposed on imported technologies and other materials required for processors, making sure they do not actually harm the country's goal of self-sufficiency in production of edible oils.

Keywords: Demand analysis; Sunflower edible oil; Partial Adjustment Model

Introduction

Edible oil deficit is a common phenomenon in Tanzania since the 1970s,this is mainly due low productivity caused by use of unimproved seeds, poor production, and processing technologies (FAO, 2017; Arouna, *et al.,* 2017). In addition, edible oil seed production and agro-processing in Tanzania is predominantly done by many smallholder farmers and small-scale processors, respectively. In addition, higher population growth rates coupled with high pace of industrialization in

Tanzania increase the demand for edible oil both for home consumption and industrial uses (Minot, 2014; Schoneveld, 2014; FAO, 2015; Ceballos, *et al.,* 2017). Despite, Tanzania being endowed with vast arable land and favorable agro ecological zones still such opportunities have not been fully exploited for agricultural production. Literature suggests that improving agricultural productivity could lead to food commodities self-sufficiency for countries that have comparative advantage on agriculture commodities` production like Tanzania (Arouna, *et al.,* 2017; Holden, 2018; ten Berge, *et al* 2019). Thus, improving productivity in edible oil production could revert the large edible oil deficit that resulted from the increasing demand and reduce importation of edible oil (Frisvold *et al.,* 1995; Diao *et al.,* 2008; Koroma *et al.,* 2009; FAO, 2015; May, 2017; Arouna, *et al.,* 2017).

Enhancing agricultural productivity could lead to increases in domestically produced edible oil in Tanzania. For instance, data show that Tanzania's domestic production of both factory and small-scale processor of edible oils fulfill about 40% of the national demand, with the remainder being from imports. Current annual demand for edible oil in Tanzania is more than 500,000 tons, which continues to increase at 3% annually, matching its population growth (RLDC, 2008; Kajimbwa *et al.,* 2010; BoT, 2018). Therefore, rapid expansion is crucial in the production of edible oil crops, including soybean, groundnuts, rapeseed, and sunflower seeds; all of which are largely used for domestic consumption (TEOSA, 2012; BoT, 2018). Among the edible oil crops, sunflower is the main source of edible oil in Tanzania, thus playing a central role supply of edible oil. The growing demand for sunflower oil reflects growing consumer awareness of its healthy nutritional values (RLDC, 2008; Kajimbwa *et al.,* 2010; Balchin *et al.,* 2018; Mgeni, *et al.,* 2018). In addition, the sunflower sub-sector is deemed as a key for industrialization and a potential contributor to economic growth and development, especially for smallholder farmers and small- and medium-size processors in Tanzania.

For instance, since the early 1990s, Tanzania has implemented import liberalization strategy, both for agricultural commodities and technologies (Lall, 1999; URT, 2016). This strategy is part of a broader policy reform strategy and structural adjustment, with the goal of improving productivity in its agriculturally based economy. In addition to its 3% population growth, GDP per capita has been growing at a rate of 6.7% annually inevitably result in increasing prices for food commodities particularly edible oils (BoT, 2017). Policymakers are keen on keeping edible oil at affordable prices for all consumers, while also increasing domestic production. The Tanzania government has been implementing various strategies to achieve the envisioned increase in domestic production, among the strategies is the gradual increase in import tariff for edible oils. For example, a 10% import tariff was imposed in 2016 and increased to 25% in 2018, and since 2019 is 35% both for crude and refined imported edible oils, aimed at fostering local production. Regardless of the government's intentions and aforementioned plans, it is not known how Tanzania's edible oil sector, especially the sunflower sub-sector, has responded to the growing demand.

This study, therefore, aims at discerning the response of sunflower edible oil demand and supply in Tanzania using annual time series data from 1995 through 2019. Specifically, the study focuses on estimating the relationship between demand for sunflower edible oil and the world price of palm oil. Palm oil is considered to be a substitute for sunflower edible oil. Other factors considered are sunflower oil prices, the price of substitutes, and per capita income. Thus, the guiding research question is, is there a long-run relationship between the demand for local sunflower edible oil and its major supply determinants? To answer this, we examine causal and dynamic relationships in order to identify interdependence among the variables in the short- and long-run. The resulting analytical estimates provide important insights to researchers and policymakers on how market demand of sunflower edible oil responds to its price level and to per capita income in Tanzania. This helps in identifying appropriate interventions that could be used to improve the edible oil sub-sector, thus curbing the edible oil supply deficit, and increasing its contribution to the Tanzania economy in the long run.

The remaining sections of this paper are structured as follows: Section 2 provides an overview of production and demand for edible oil in Tanzania, section 3 presents data and the analytical framework applied in this study. The empirical results and discussion are presented in Section 4, while section 5 concludes.

Overview of production and demand for edible oil in Tanzania

Tanzania's share of edible oil production in Africa

In Africa, according to FAO statistics (2015), sunflower oil production is estimated to be 650,000 tons, with South Africa the largest producer. South Africa also supplement domestic production by importing seeds for crushing, making up 46% of all African sunflower oil production. Tanzania is the second in sunflower production, with 23% share. Uganda is third with 15% sunflower production share. Despite being second in sunflower production in Africa, Tanzania is among the edible oil deficit countries with its oil production going mostly for domestic consumption and limited exports. Other countries are Egypt and Morocco, both importing seeds for crushing, and producing 4% and 6% of African sunflower oil, respectively. (Figure 1).

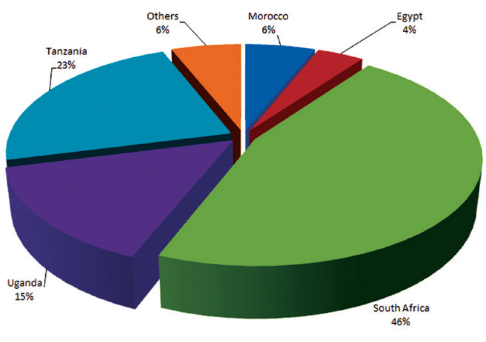

Figure 1: Sunflower Oil production in Africa
Source: Food and Agriculture Organization of the United Nations (2015)

Production of oilseeds in Tanzania

Oilseed production in Tanzania is dominated by sunflower (35%), groundnut (25%), sesame (13%), and cotton (19%) (Figure 2). The area under oil crop cultivation is continually expanding, along with increasing productivity and yields. For example, yields were seven times higher in 2014 than those in 2007. Sunflower oil production in Tanzania increased from 52,000 tons in 2002 to over 163,000 tons in 2012. Such an increase in production, along with government efforts to promote the edible oils sub-sector, could lead to a reduction of edible oil import dependency.

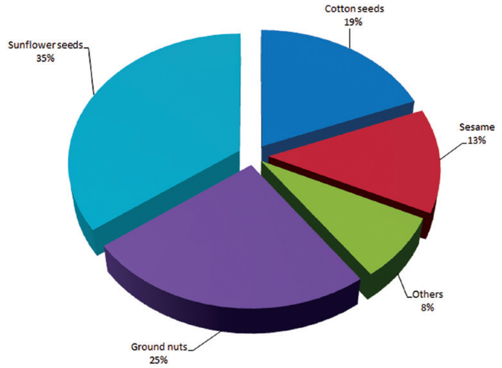

Figure 2: 2014 Oilseed production in Tanzania
Source: Food and Agriculture Organization of the United Nations (2015)

Demand for edible oil and seed cakes

Apart from growing consumer awareness of the healthy nutritious values of sunflower edible oil, its demand is increasing due to the expanded use of sunflower by-products (Kajimbwa, 2010; BoT, 2017). These by-products include seed cake, seed meal, and sludge, which are exported to neighboring countries and the Far East. The important sunflower export product in value is seedcake, which increased from the US $25 million in 2013 to US $65 million in 2014. Around 95% of these exports are destined for India and Pakistan, followed by Kenya and other neighboring East and Central African countries. According to BoT, (2018), Tanzania, which is endowed with good agricultural arable land, could tap lucrative markets within the region and beyond if it improves its agricultural productivity, particularly in sunflower production.

Methodology

Data Sources,

This study used price and production data of sunflower oil sub-sector to estimate price and income elasticities of oil demand in Tanzania using annual time series data from 1995 through 2019. The data used are per capita sunflower oil consumption (in metric tons), international oil prices converted in local currency[1], and per capita real GDP (in US dollar). Data on yield, traded quantity, and prices of sunflower were retrieved from Food and Agricultural Organizations database (FAO, 2020). Sunflower edible oil consumption and price data were collected from the National Bureau of Statistics, the Ministry of Agriculture, Food Security and Cooperatives, as well as the Ministry of Industry and Trade, while real GDP per capita was computed from an economic survey report [2] published by the Tanzanian Ministry of Finance and Planning.

Diagnostic check for Stationarity and Parameter Stability

As noted earlier, this study used time series data, in order to infer a logical conclusion from the resulting analysis, the time series has to be stationary. This implies that the dependent variable over time has a constant mean, variance, and covariance between different observations that do not depend on time (t) but depend only on the distance or lag between them. However, most time series data have a non-stationary problem. This implies that the mean, variance, and auto-covariance are time-varying. Therefore, undertaking empirical work based on time series data without accounting for stationarity of the dependent variable could lead to spurious regression estimates and, hence, misleading conclusions (Granger, 1981; Gujarat and Porter, 2010; Dougherty, 2011; Chung and Tan, 2015; Mills, 2019). Thus, in order to obtain true regression estimates, it is important to check whether the time series data is non-stationary or stationary. Therefore, the analysis started by conducting a unit root test on all the variables to identify their order of integration. The unit root test is used to ascertain the number of times that the data need to be differenced in order to achieve stationarity. Dickey and Fuller (1979), who introduced the unit root test for non-stationarity, recommend testing whether the coefficient of a lagged value of the dependent variable (D) in an Auto Regressive of order one AR(1) or not. If it is one, then there is a unit root, and the time series data is non-stationary. Moreover, when there are higher-order lags, the alternative method for testing the non-stationarity of a time series is the Augmented Dickey-Fuller (ADF) (Abdulnasser and Manuchehr, 2002; Gujarati and Porter, 2009).

Therefore, whenever the unit root test shows non-stationarity, the common method used to achieve stationarity is transforming the time series data. The transformation is done by taking the first difference of the edible oil per capita demand (dD_t). That is, $dD_t = (D_t - D_{t-1}) = \varepsilon_t$; this assumes that the random disturbance, ε_t, is a white noise term (Granger,1981; Chung and Tan, 2015). This is commonly referred to as the integrated order of degree one and is denoted as I(1). Moreover, when a series is differenced twice to become stationary is denoted as I(2), while if the time series variable is stationary before differencing, by default it is denoted as I(0) (Dougherty, 2011; Mills, 2019). In addition, a parameter stability test was conducted by hypothesizing that the parameter is constant. The parameter stability was tested using a Cumulative Sum (CUSUM) assuming the lag of the sunflower edible oil consumption data. The CUSUM boundaries are constructed based on the cumulative sum of the recursive residuals, which are plotted with 5% critical lines (Brown et al., 1975; Stambuli, 2013). This means that, if the cumulative sum goes outside the region between two boundary lines, the test indicates parameter instability.

Model Specification

Economic theory suggests that the main determinant of the demand for a product is its own price; that is, the higher the price, the lower the quantity demanded of that commodity. On the other hand, the increase in price motivates producers to supply more. Therefore, this study argues that an increase in domestic sunflower edible oil prices will motivate domestic producers to increase supply. In addition, other

1 *The annual exchange rates of standard local currency units TZS per UDS were retrieved from www.fao.org/faostat/en/#data/PE*

2 *www.mof.go.tz/mofdocs/Micro/2012/ECONOMIC%20SURVEY%20BOOK%202012.pdf*

factors thought to determine the supply and demand for sunflower edible oil are the prices of substitute commodities and consumer income. For this case, the imported palm oil is considered to be the major substitute for sunflower edible oil in Tanzania.

Therefore, in order to determine the relationship between sunflower edible oil demand, sunflower and palm oil prices, and per capita income, a multiple log-linear regression model is used. Specifically, Nerlove's Partial Adjustment model, introduced by Nerlove (1956), is adopted for this study. The model is adopted because it is widely used by other researchers to analyze producers' responses to price changes (see. McKay *et al.,* 1999; Wasin 2005; Mythili, 2008; Dougherty, 2011; Shoko, 2014; Magrini *et al.,* 2016). Moreover, the model can be used to obtain short-run and long-run price and income elasticities.

Therefore, the partial adjustment model assumes a behavioral function that determines the target output value of D_t* of the dependent variable rather than the actual value, D_t:

$$D_t^* = \alpha + \beta_i X_{ti} + \varepsilon_t \quad \text{................................(1)}$$

The model assumes that: D_t-D_{t-1} is the actual increase in the dependent variable and is proportional to the discrepancy between the target output value and the previous value D_t*-D_{t-1}

$$D_t - D_{t-1} = \delta\left(D_t^* - D_{t-1}\right) \text{.............................(2)}$$

Where δ is the adjustment coefficinet: 0≤δ≤1
Rearranging equation two above, we obtain:

$$dD_t = \delta D_t^* + \left(1-\delta\right) D_{t-1} \quad \text{.......................(3)}$$

Therefore, it can be observed that D_t represents the weighted average of the target value and the previous value. Implying that the higher the value of δ, the longer is the adjustment process. When δ is one, D_t is equal to D_t* and full adjustment is achieved in one period. However, if δ is equal to zero, then there is no adjustment. Moreover, substituting the value of D_t* from equation one into equation three above and rearranging we obtain:

$$D_t = \delta\left(\alpha + \beta_i X_{ti} + \varepsilon_t\right) D_t^* + \left(1-\delta\right) dD_{t-1} \text{.........(4)}$$
$$= \alpha\delta + \beta_i \delta X_{ti} + \left(1-\delta\right) dD_{t-1} + \varepsilon_t a$$

Where α, β_i, and δ are the parameters of the partial adjustment model that are estimated by regressing D_t on the X_t and the lagged value of itself. Thus, the coefficient of $D_{(t-1)}$ gives the estimate of (1-δ) and, ultimately, the speed of adjustment δ. In addition, the short-run effect of X on D is given by the coefficient of X_t, while the long-run effect is obtained by dividing the coefficient of X_t on the estimate of δ.

Therefore, the partial adjustment model is used for this study to capture the short- and long-run price and income elasticities of demand for sunflower edible oil in Tanzania. The specified partial adjustment equation for the short run has the following form:

$$LnD_{ts} = Ln\alpha + \beta_1 LnPs_t + \beta_2 LnG_t + \beta_3 LnPp_t + \delta LndD_{t-1} + \varepsilon_t \text{..(1)}$$

Where:
Dts = Per capita sunflower oil demand in year t
dD_{t-1} = Lagged per capita sunflower oil demand
P_{st} = Real price of sunflower edible oil in year t
Ppt = Price of palm oil in year t
Gt = Real GDP per capita in year t
εt = Assumed random error term
Ln = Natural logarithm
α, β_1,β_2,β_3, δ are the coefficients to be estimated

Assuming that Tanzania wants to reduce the amount of edible oil imported from one year to the next, which also targets a long-run reduction of edible oil importation. This reduction cannot be achieved within a single period due to low productivity, which reflects the poor infrastructure and technologies of domestic edible oil producers. Only a partial adjustment can be spread over many years so as to achieve the new long-run desired amounts. Hence, Nerlove's partial adjustment model allows us to capture the partial adjustment situation and, at the same time, to estimate long-run prices and income elasticities from existing short-run data (Nerlove, 1956; Nerlove and Bachman, 1960; McKay *et al.,* 1999; Thiele, 2000; Seay *et al.,* 2004; Kennedy, 2008; Ocran and Biekpe, 2008; Gujarati and Porter, 2009; Stambuli, 2013; Chung and Tan, 2015).

In the above equation, the demand for sunflower edible oil for a given year is assumed to be determined by its own selling price in the previous year, real GDP per capita, and the price of the principal substitute – in this case, palm oil. Therefore, the estimated demand is determined using observable parameters, as presented by the partial adjustment in equation one. Hence, we hypothesize that the actual demand in a given year is a function of both the demand and weight of divergence between the estimated demand in the previous year (Gujarat and Porter 2010; Chung and Tan 2015, Mills, 2019). The adjustment coefficient, as indicated in equation two, is assumed to take a value between zero and one; if it takes the value of one, then the hypothesis is violated (breaks down) because estimated edible oil demand becomes indeterminate. On the other hand, a value of zero implies supply is equal to the estimated demand year by year and all previous observations are irrelevant (random walk phenomenon) (Harvey, 1990; Gujarat and Porter, 2010; Dougherty, 2011; Paollella, 2019). In addition, a log-linear form of the partial adjustment model is used to determine the short-run and long-run price and income elasticity of demand. An advantage of using the partial adjustment model in a log-linear form is on the interpretation of the resulted coefficients β and $\beta/(1–\delta)$. The coefficient β can be directly interpreted as the short-run price elasticity of demand while $\beta/(1–\delta)$ is interpreted as the long-run elasticities of demand for price and income.

Results and discussion

Diagnostic check results of the time series data

First, a trend analysis was done using a random walk model to plot the graph for each variable. The trend analysis was intended to identify if there are historical changes in the data. These historical changes could be used to predict the future behavior of the variables. In this case, it could be seen if there was an increase of sunflower productions overtime for the analyzed period. After plotting the individual time series data employed in this study in their natural logarithms, it is evident that the real GDP per capita ($\ln G_t$), the real price of sunflower edible oil ($\ln P_{st}$), and the price of imported palm oil ($\ln Pp_t$) have an upward trend over the study period and do not show any specific trend (Figure 3). The observed upward trend indicates an increase in the production of sunflower edible oil in Tanzania. However, since the study uses yearly data points, the observed trend movement is an approximate annual average of demand of edible oils. Moreover, McLaren

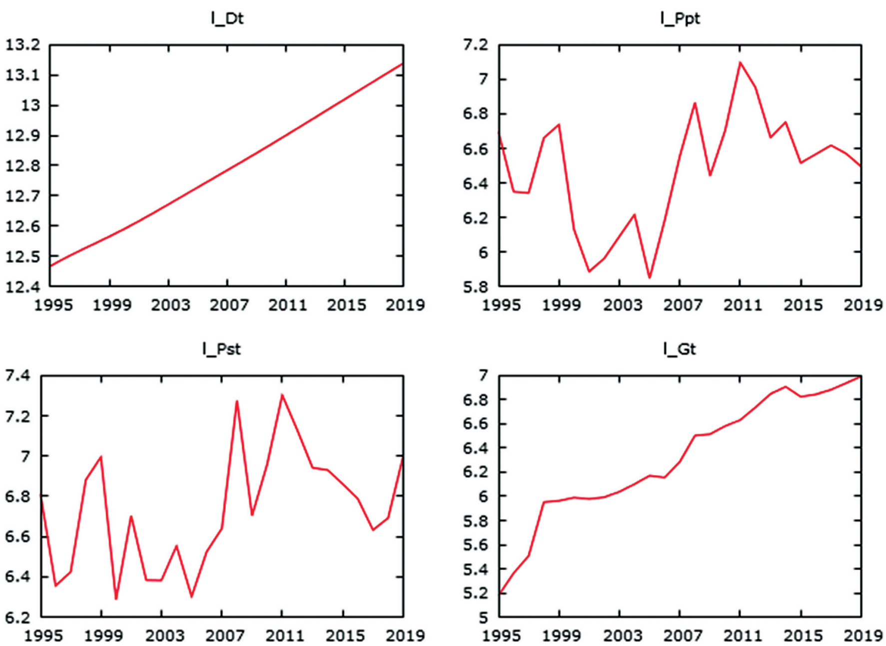

Figure 3: Plot of series in natural logarithms

and Zhang (2010) contend that such observed average trend movements do not reflect monthly behavior as the observed turning points in yearly data are picked with lags.

A stationary series is characterized by a time-invariant mean and a time-invariant variance. In this study, we use the Dickey-Fuller (DF) test to examine the unit root properties of the data. The results reveal that the null hypothesis of unit root is not rejected at the 5% level of significance for all variables but is rejected in first differences for all variables. Table 1 presents the DF unit root test results. The unit root test results show that all the variables are integrated of order one, I(1). Thus, as the DF test shows that the original variable is not stationary, then the differenced variable is used to see whether the series will be stationary. It is observed that after differencing the original variable once, the differenced variable show stationarity. This implies that the variable is an integrated order of degree one I(1). Dougherty, (2011), Chung and Tan, (2015), and Mills, (2019) contend that non-stationary variables in time series analysis must be differenced until they become stationary before they are used in the model. Consequently, a differenced variable I(1), is used for analysis in the model.

Table 1: Dickey-Fuller Test

	Original Variable	Differenced variable
Constant	6584.933	16661.87
L1.d or Dt-1	0.2087	
LD.y or ΔDt-1		-0.4854*
Test stat	2.61	-2.28
p-Value	0.9908	0.0183
Conclusion	Variable is not stationary	The differenced variable is stationary

To complement the DF test, correlograms for Autocorrelation Function (ACF) and Partial Autocorrelation (PACF) are drawn to determine the maximum number of differencing the original variable needs to become stationary. The Autocorrelation Function (ACF) tails off and Partial Autocorrelation (PACF) cuts off after lag 1 (Figure 4); this supports using AR (1). In addition, a CUSUM test for parameter stability indicates that the parameters are stable during the sample period since the cumulative sum lies within the 95% critical bounds, as observed in Figure 5.

Regression analysis results

Results in Table 2 show the parameter estimates of the short-run behavior of Tanzanian sunflower edible oil demand. From the estimated model, the Adjusted R-square indicates the goodness of fit of the model. Generally, the Adjusted R-square shows that about 95% of the total variation in sunflower edible oil demand is explained by sunflower prices, palm oil prices, per capita real GDP, and the lagged value of sunflower edible oil consumption. This implies that the model fits the data very well.

In addition, the F-statistic indicates the joint significance of all independent variables in the model. This indicates that at least one independent variable is not zero in explaining the dependent variable. Generally, the model seems to be statistically significant. Moreover, the estimated demand equation indicates that all variables have the correct sign, as anticipated by demand theory. In the short run, the results indicate that the demand for sunflower edible oil is price inelastic against palm oil. On the other hand, demand for sunflower edible oil seems to be income elastic in the short run. Per capita income has a significantly positive impact on oil consumption since a 1% increase in per capita real GDP leads to about 0.46 tons increase in per capita sunflower edible oil consumption.

The speed of adjustment of per capita sunflower edible oil consumption toward its desired level in the long-run is given by $(1–\delta)=1-0.0462= 0.538$. This implies that 0.538 of the difference between the desired and the

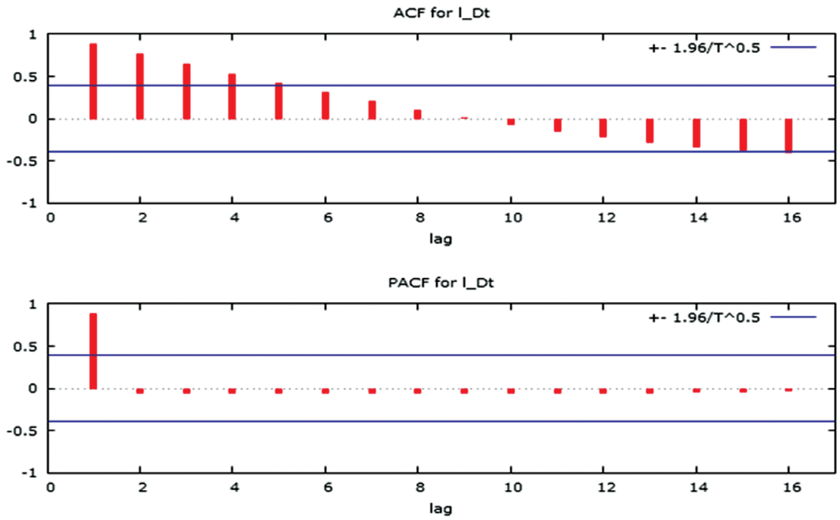

Figure 4: Correlogram, ACF, and PACF

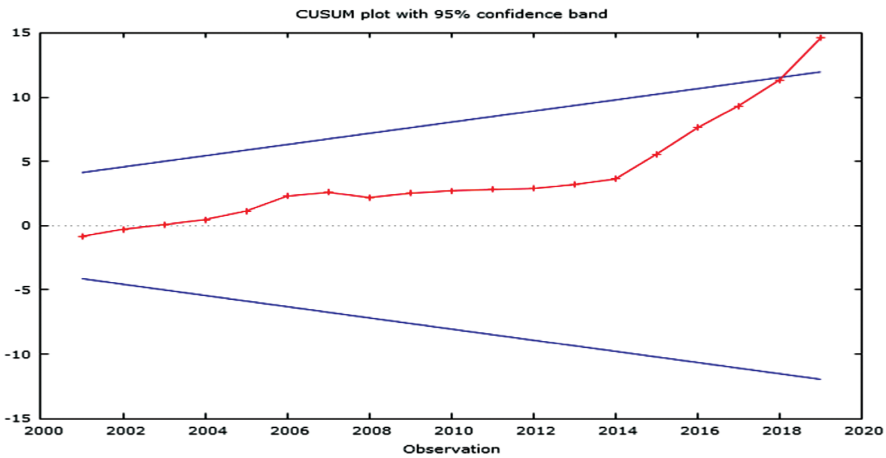

Figure 5: CUSUM and CUSUM squares tests of parameter stability of the estimated demand

actual per capita sunflower edible oil demand is reduced in a year. In other words, the adjustment model results show a high implicit adjustment rate for the lagged sunflower edible oil demand, meaning that demand does change quickly in response to changes in price and income. Nmadu, (2010), Doughety, (2011), Chung *et al.* (2015), and Mills, (2019) also recommend that the coefficient of adjustment is used to determine the long-run elasticities from the short-run elasticities. Therefore, using the relationship the long-run sunflower oil price, palm oil price, and income elasticities, respectively. Therefore, the long-run price elasticities of sunflower oil and palm oil are 0.109and -0.141, respectively, while the long-run income elasticity is 0.291. This implies that, one percent increase in income leads to an increase in per capita sunflower edible oil consumption by 29.1%.

In addition, the model results indicate a lower short-run income elasticity than the long-run income elasticity. Furthermore, short-run price elasticities are also lower than the long-run price elasticities (in absolute values) for both sunflower edible oil and palm oil. This implies that the country is more sensitive in the long-run than in the short-run. Thus, the results show that, in the long run, demand is income and price elastic. Since the results indicated a higher level of price elasticity, the country will

Table 2: Estimated coefficients for edible oil consumption in Tanzania, (1995-2019)

	Coefficient	Std. Error	t-ratio	p-value	
Const	7.67346	0.384781	19.94	<0.0001	***
ln_Ppt	0.0597686	0.0261711	2.284	0.0348	**
ln_Pst	−0.0765235	0.0328095	−2.332	0.0315	**
ln_Gt	0.157010	0.0365363	4.297	0.0004	***
ln_d_Dt_1	0.462247	0.0573946	8.054	<0.0001	***

Mean dependent var	12.78951	S.D. dependent var	0.191666
Sum squared resid	0.007720	S.E. of regression	0.020710
R-squared	0.990448	Adjusted R-squared	0.988325
F(4, 19)	466.5974	P-value (F)	6.56e-18
Log-likelihood	59.35800	Akaike criterion	−108.7160
Schwarz criterion	−103.0385	Hannan-Quinn	−107.2881

Dependent variables: lnDt (sunflower edible oil demand)
Note: All variables are in logarithm form

find it difficult to abandon the importation of edible oil from alternative sources. This is due to the fact that there is increase in demand of edible oil while in the short run the domestic supply of sunflower edible cannot suffice the increase in demand caused by the increase in the per capita income and population. Moreover, findings from this study indicate that the speed of adjustment required to reach required supply of edible oil is about 54% of the previous year production. A study by Thurlow, *et al* (2018) report that the sunflower production growth rate is 3.9%, this implies it will take a long period for Tanzania to suffice the edible oil demand based on domestic production that currently covers about 40%. Moreover, the increase of world price for the substitute edible oil does not affect the demand for because from the findings (table 2) as the price of imported palm oil increases by a unit, still the per capita demand increase by 5% tons. This indicates that the price of imported palm oil is extremely low compared to the price of domestically produced sunflower oil. In contrast, results indicate the increase in sunflower edible oil price by on unit decrease per capita demand by about 7 tons per year. This concurs with the find findings by Thurlow, *et al,* (2018) and Mgeni *et al* (2018) and URT, (2015) reported that the costs domestic produced edible oils are higher which render them to be sold at higher in market compared to the imported edible oil.

Conclusion and Policy Recommendations

Conclusion

The main objective of this study is to determine whether sunflower edible oil production in Tanzania responds to sunflower oil prices, palm oil prices, and increases in per capita income. The results show that sunflower edible oil demand in Tanzania is elastic to variations in prices. From the results, it is clear that increasing price levels have not improved sunflower edible oil supply since producers have not responded positively to price changes. At the same time, the elasticity estimate of palm oil price is less than unitary and, in absolute value, it was higher than that of sunflower oil prices, an indication that palm oil supply is inelastic, such that consumers will resort to buying palm oil when sunflower oil prices increase. Per capita income has a significant positive impact on oil consumption, since a 1% increase in per capita real GDP leads to about a 5% increase in per capita sunflower edible oil consumption. The speed of adjustment of per capita sunflower edible oil consumption toward its desired level, in the long run, is 0.538. These results imply that actual per capita sunflower edible oil consumption adjusts toward its long-run desired level by 0.54 in each year. It is also worth noting that even if sunflower edible oil producers would respond positively to price increases, they can only produce 0.46of the desired level of output or supply in a year. This slow rate of adjustment is attributable to the fact that both processors and farmers do not use modern technology, including improved seeds with fast growth and high returns. Moreover, in the long run, demand is income elastic and price elastic. Since the results indicate a higher level of price elasticity, the country will find it difficult to completely stop importing edible oil from alternative sources unless costs for domestic producers are reduced and their productivity enhanced.

Policy recommendations

This situation calls for the government and development agencies to improve the available technologies raise farmers productivity in terms of sunflower seed production as well as efficiency in processing.

The government also needs to strengthen its extension services, thereby educating sunflower farmers about the advantages of the new improved seeds and technology. Moreover, government support is needed for the research institutions to improve genetic potential of the local sunflower seeds as their mostly used by farmers.

To improve the productivity of the agro-processors, the Tanzania Government will need to reconsider the tax rates imposed on imported technologies and other materials required for processors, making sure they do not actually harm the country's goal of self-sufficiency in production of edible oils.

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Appendix

Table 3: Data series for the natural logarithm plots

Year	lnD_t	$lnPs_t$	$lnPp_t$	lnG_t	lnD_{t-1}
1995	12.46738	6.810356	6.695589843	5.205993	8.84903
1996	12.49386	6.355721	6.349137246	5.391581	8.84903
1997	12.51814	6.424317	6.341462344	5.535269	8.788041
1998	12.54132	6.881741	6.660241838	5.980233	8.765073
1999	12.56478	6.995403	6.73755006	5.992124	8.800936
2000	12.58947	6.286165	6.129176263	6.018477	8.875763
2001	12.6156	6.703161	5.885516801	6.007679	8.957676
2002	12.64282	6.383507	5.961372851	6.020956	9.025533
2003	12.67081	6.382115	6.08942462	6.066757	9.080941
2004	12.69908	6.553308	6.215343445	6.129615	9.119079
2005	12.72732	6.30252	5.847132973	6.199761	9.146127
2006	12.75548	6.525008	6.18258754	6.185174	9.171754
2007	12.78372	6.640395	6.555410238	6.315068	9.2026
2008	12.81214	7.2758	6.865575697	6.532902	9.237115
2009	12.84087	6.703862	6.439896004	6.544224	9.276712
2010	12.86999	6.959248	6.704325384	6.611239	9.319085
2011	12.89947	7.302675	7.097207489	6.661135	9.360862
2012	12.92923	7.126941	6.953167523	6.766039	9.399685
2013	12.95917	6.941865	6.663159437	6.877726	9.435695
2014	12.98919	6.931004	6.752160278	6.937404	9.468257
2015	13.0192	6.861252	6.515556502	6.854284	9.498024
2016	13.04917	6.787503	6.566362705	6.873655	9.526857
2017	13.07909	6.632368	6.617122321	6.912585	9.554874
2018	13.10888	6.691842	6.569860985	6.966962	9.580603
2019	13.13849	6.999022	6.494320774	7.022977	9.603877