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Determination of import demand of wheat in Kenya; A time series analysis from 2000 to 2019

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Trade influences economic growth and entails imports and exports. In Kenya, wheat imports have been expanding with no sign of slowing down and this has become a matter of great concern because the country is losing over 30 billion Kenyan shillings in importing wheat on a yearly basis. This motivated the need to estimate wheat import demand model, which was conducted using secondary time series data from 2000 to 2019. The findings of the study show that there is cointegration in the estimated wheat import demand which captures 98.2% of wheat imports. Therefore, the model can be used to predict the amount of wheat imports in Kenya at any given time to achieve the optimal wheat importation. It was also found that yields, relative prices, ending stock and lagged wheat imports explained wheat expansion in Kenya in the last two decades. Therefore, the study recommends that Kenya wheat imports should be monitored to avoid over importation because, it has adverse effects on the domestic wheat sector.

Key words: Trade, economic growth, food imports, time series, generalized least squares.

INTRODUCTION

Trade is known to promote economic growth in literature. According to Krugman and Obstfeld (2008), trade gains emerge from the specialization and exchange of products and services. Recently, it has been reported that agricultural trade has increased, led by demand in emerging economies (Clapp, 2015). Since there is a strong connection between food security and food trade (import and export). Economists in support of liberalization argue that trade is a transmission belt of food from surplus regions to deficit areas (Clapp, 2015). The opponents, on the other hand, point out that due to differences in competition capacities, trade liberalization harms domestic producers by suppressing their revenues (Clapp, 2015). This has led to great debate by policymakers, generating price dilemmas on producers and consumers as both parties try to maximize their utility. Thus, trade growth is expected to continue in bringing both positive and negative consequences in low-income food-insecure countries (Sharma et al., 2005).

The trade liberalization strategies were expected to foster growth and ensure food is always available to all people. However, the intended result was not attained because the state of liberalization was rapid, broad and far-reaching, poorly aligned and not synchronized with other policies in place (Sharma et al., 2005). Observers and experts have related the rise in imports to the World Trade Organization (WTO) agreement on trade liberalization. The Agreement of the WTO specifies that

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when a commodity is imported into a country in such an increased quantity, absolute or relative to domestic production under such conditions, it may trigger or threaten the domestic industry which produces the same competitive goods (Iloh et al., 2020; Sharma et al., 2005). Import surges and their associated effects on domestic producers and consumers is a sensitive matter that needs to be relooked especially in developing countries such as Kenya.

Transforming agriculture in Kenya helps to strengthen the economic growth by the provision of a mechanism to solve price volatility, ensuring sustainable private investments and developing country's approaches to lower dependency on food imports (ASTGS, 2019). In Kenya, there is a need to provide a long-lasting solution to the structural deficit and have a focused wheat importation. This can be achieved by targeting efficient farmers (large scale producers) to produce wheat, as the inefficient farmers produce other crops that they are efficient in (Gitau et al., 2011). However, the unique situation of Kenya in wheat production shows that most of our farmers despite producing do not produce enough for their consumption and have to rely on the market for wheat grain and its products. Therefore, low food prices are beneficial to smallholder farmers in the short run but disadvantageous in the long run.

Estimation of import demand helps to address important policies such as the sensitivity of import demand to factors such as relative prices and income. Which are key to policymakers when they are planning and evaluating the feasibility of an economic strategy? Due to adverse influence that may arise from excess imports on the economic growth of a developing nation, it is worth estimating the elasticity of import demand. Because import management is very important in developing economies as it influences economic growth (Tellaeche and Aliphat, 2019).

In Kenya, the foremost challenge of free trade in wheat is competition with low priced and high-quality imports. Therefore, there is a need to reconsider and reshape the planning model and policy-making of agricultural development and food security strategies (Gitu, 2012) Looking at previous studies, they have approached wheat production with a focus on technical issues such as increasing wheat yields leaving out the effect of wheat which is being imported yearly.

Therefore, the study sort to determine wheat import demand in Kenya defines the reasons driving wheat import spikes and possible effects.

LITERATURE REVIEW

In literature, import surges are generally associated with varying effects in importing countries which are linked to unfair trade practices for example export subsidies. According to Sharma et al. (2005), the Food and Agriculture Organization of the United Nations (FAO) analysis to measure import surges showed that the impacts differ depending on products.

Although the negative effect of Senegal's broiler industry was apparent, import spikes in dairy goods were not a major issue due to the gradual rise in dairy imports in Tanzania. Again the study revealed that government and other stakeholders are necessarily not open-minded about resolving import surges and strong import trends. Hence a large degree of resource reallocation across firms within an industry due to trade liberalization to the sector of more growth. This in future will create Dutch disease in the economy (Kasahara and Lapham, 2013). This will contribute to policy uncertainty by reducing investor confidence, as well as poor harmonization and coordination in the implementation of the other policies.

According to Sukati (2016), the idea of competitive advantage is used to describe the ability of countries to produce goods more effectively compared to their trading partners. This implies that countries will tend to export those commodities that they produce at the lowest cost and import what they do not possess competitiveness. If this concept is followed, it can be beneficial because it can allow countries to specialize, resulting in the more effective use of limited resources. It is also believed that farmers are willing to grow crops that bring more income, therefore choosing to plant a higher-yielding crop (Shavanov and Shigapov, 2020). Therefore, the use of competitiveness to inform producers and agro-processors is good to ensure they operate at a low cost of production (Sukati, 2016).

Russia and the USA are among the major countries in the world producing wheat amounting to 72100 MT and 51300 MT respectively in 2018. Over the last two decades, Russia has managed to switch from a net importer of wheat to a net exporter, displacing the EU to become the biggest exporter in the 2016/2017 marketing season. The high level of wheat output and low production costs, as well as quality, has helped propel Russia to the top position among wheat exporters. However, the average yearly production of the USA from 1992 to 2018 is higher, a total of 59000 MT, while the Russian average for the same duration is just 48500 MT (Shavanov and Shigapov, 2020). This shows that the comparative advantage of agriculture evolves depending on circumstances and policies put in place.

The reliance on food imports is viewed differently by different countries. This is according to the way they pay for the food import bills. For example, in certain oil or mineral-rich countries, importing specific food products tend to be more beneficial than producing them at home because they have enough foreign currency reserves to pay for the food import bills. However, for cash-strapped countries, persistent food imports is an issue, as large and growing food import bills suck resources away from other development agendas without addressing long-term food insecurity (Iloh et al., 2020).

Conventionally, low domestic production and low competitiveness have been known as the main reasons

for wheat importation. Imports now have to do with economic factors and non-economic factors[1] (Safoulanitou and Ndinga, 2010).

This leads to key dilemmas in SSA on the growing dependence on imports of staple foodstuffs. The first one is occurring when world prices for these goods are rising as well as the availability of these products is likely to be more unpredictable because of climate change. The Second is that SSA consumption of wheat is generally greater in urban than in rural areas, with wheat imports and domestic production on large-scale commercial farms meeting currently most of its urban demand for wheat. Apart from Ethiopia, very little wheat from small-scale farmers is produced in SSA. Hence, growing wheat demand entails limited urban-rural synergies and negligible expectations for the structural changes to contribute to broad-based economic growth (Mason et al., 2012). Hence, a policy dilemma to resolve the issues surrounding food imports.

Kenya has total imports of 17.4 billion United States of America dollars (US$) and total export of US$ 6.05 billion that is partially used to pay for the imports as per the statistics of 2020. This leads to a deficit balance of trade of US$ 11.3 billion. Kenya imports of goods and services as a percentage of GDP is 23% in 2020 (WITS, 2020). Statistics depict that Kenya dependence on international markets to feed the citizens has increased more than $4^{1}/_{2}$ times in the last decade as food imports were valued at KES 15.09 billion in 2008 to KES 68.63 billion in 2018 (Africa, 2020). However, food imports and aid at times serve to fulfil temporary food security needs but in return, it generates the following consequences; it reduces domestic food prices, suppresses domestic food production and reduces food production in importing countries when they are over imported (Mason et al., 2012).

Market access for imports in Kenya has improved since reforms of trade liberalization, thus a tremendous growth in imports (Nyangito et al., 2004). The most significant quantities of food imports come from developed countries[2]. These are nations where food production is highly subsidized, thus posing a threat to the domestic production of food commodities in developing countries (Gitu, 2012). The bulkiness of Kenya wheat imports is from Russia, Ukraine, Canada, Argentina and Latvia. United States of America (USA) wheat export to Kenya is hampered by Kenya's long-standing restriction from lack of certification protocol for flag smut between USA and Kenya. Recently Kenyan government granted USA tender to import wheat in Kenya this is according to the smart farm report February 2020. Research done by Monroy et al. (2013) found that imports of wheat in Kenya appear pro-cyclical with the highest level occurring in the same years with the highest production. As he noted that, there is a positive correlation of 0.29 between imports and domestic production over the period 1960 – 2010. This however should not be the case, as it is known for domestic production to reduce imports. Therefore, fluctuations in domestic production reflect changes in import levels (Gitu, 2012; Nyangito et al., 2004).

The country's national and county governments provide enabling environment for the private sector development. However, poor performance in the agricultural industry discourages private sector investment and value chain development for certain crops, for instance, Kenyan wheat production. Because of low agricultural productivity in wheat, Kenya relies on wheat imports, limiting the scope for agribusiness development for the wheat value chain (Babu and Shishodia, 2017). In Kenya, wheat production inefficiencies occur from high input costs (fertilizers, chemicals, seeds and high cost of machinery operation) and low yields. Transporters face inefficiencies through high maintenance costs, high fuel prices, poor infrastructure (feeder roads connecting production areas and the markets) and roadblocks. Wheat traders face multiple layers of taxation (cess) levied by local authorities, especially when wheat crosses several municipalities (Gitau et al., 2011). All these make Kenya wheat production uncompetitive when compared to other nations.

In a study on SSA wheat consumption, the results show that the key drivers of rising wheat imports and consumption are; rise in the household incomes, growing populations, increasing opportunity costs of women's participation in the labour force, a change in dietary patterns and preferences, low yields and productivity, limited access to essential inputs and infrastructure, oil shocks, low fertilizer uses and difficulty in controlling pests and diseases (Agriculture in Sub-Saharan Africa," 2016; Mason et al., 2012; Rakotoarisoa et al., 2011). Additionally, wheat products are known to save time because bread and other wheat products can be prepared in one place and distributed in a form that is easily consumed with little additional preparation (D'Alessandro et al., 2015; Mason et al., 2012). Hence, consumers are buying more convenient and processed products, reflecting urbanization (Mason et al., 2012). Therefore, wheat consumption is closely associated with urbanization and higher incomes, hence an increasing component in Kenyan's diets. On the other hand, proportions of the rural household taking wheat flour in Kenya increased among households with low income, remained constant for middle income and declined among highest-income households between 2013 and 2015. The decline in consumption for the high-income households could be related to health awareness of gluten content in wheat that is linked to certain health risks (Onyango et al., 2016). The rise in consumer demand for wheat is largely fueled by burgeoning urban consumers who prefer convenience food. In return, cheap

[1]Economic factors include crisis in agricultural sector, import capacity, re-export trade and food security policies. Example of non-economic factor is urban bias in protecting the standards of living of the urban population for social and political reasons.

[2]Developed countries are countries with high living standards for instance European Union (EU), United States of America (USA) and Australia.

imports will shift demand towards themselves and over time, tastes and preferences change as people get used to imported foods (Morris and Byerlee, 1993).

Kenya increasing dependence on food imports has resulted in a decline in domestic production. In this case, Kenya food security is endangered because the country has a weak resource base for importing food products due to its reliance on agricultural exports for foreign exchange (Nyangito et al., 2004). Hence, in the short run trade affects direct food production, employment, food prices and government revenues. In the long run, trade affects competitiveness, distribution networks and infrastructure development. These effects translate into changes in food security indicators through the total food supply, household income level and government services (FAO, 2017).

In Kenya, the wheat import bill has been growing reaching approximately US$355 million in 2018 (KNBS, 2019). According to United States Department of Agriculture (USDA) estimates wheat is the main imported agricultural product in Kenya for domestic consumption, draining the foreign exchange (USDA, 2020). A study by Wanjau (2014), found that there is a high demand for imports and consequently a relatively lower demand for exports in Kenya. This will in turn intensify the import bill of Kenya as more products are imported in relation to the level of exports.

The ratio of Kenya imports to export (trade openness) is on the general rise an indication that the country is spending more of its foreign exchange in incurring high import bills. This affects the government to finance other socio-economic development activities (Nyangito et al., 2004). In the case of wheat, Kenya fails to recognize the increasing importance of wheat in the diets of Kenyans, especially in urban areas and there is silence on more than KES 30 billion lost in foreign exchange to import wheat on yearly basis (Macharia, 2018). Therefore, it is of great concern to determine wheat import demand model and provide policy guidelines on wheat importation in Kenya.

MATERIALS AND METHODS

Data collection

The study used secondary annual time series statistical data from 2000 to 2019. This time frame was selected due to the burgeoning of wheat imports in Kenya over this period. The data were collected from the following national and international sources; the statistical abstracts of Kenya, Kenya National Bureau of Statistics(KNBS), Ministry of Agriculture, Livestock, Fisheries and Co-operatives (MoALFC), World Integrated Trade Solution (WITS), World Bank database (WB), United Nations Commodity Trade Statistics Database (UN COMTRADE), Food and Agriculture Organization Corporate Statistical Database (FAOSTAT), International Monetary Fund (IMF) and United States Department of Agriculture (USDA).

Unit root tests

The study carried out unit root tests and cointegration test to ensure that there was no spurious correlation. The study employed ADF and DFGLS for unit root tests, and Auto-Regressive Distributed Lag (ARDL) bound test for cointegration. The ADF and DFGLS are modelled as follows;

$$\Delta Z_t = \beta_1 + \beta_{2t} + \delta Z_{t-1} + \sum_{i=0}^{n} \alpha_i \Delta Z_{t-1} + \varepsilon_t \quad (1)$$

The ARDL bound test is specified as follows:

$$\Delta Y_t = \alpha + \Sigma_{i=0}^{n} \delta Y_{t-1} + \Sigma_{i=0}^{n} \beta X_{t-1} + \varepsilon_t \quad (2)$$

To determine the import demand function of wheat in Kenya

Theoretical model

Hemphill (1974) and Moran (1989), established the theoretical basis of the import demand model used in this analysis. This model is based on the desire to minimize fluctuations of current imports in presence of foreign exchange constraints from the long term equilibrium import level (Safoulanitou and Ndinga, 2010). The policymakers are assumed to give import licenses in a flexible way to minimize the costs of deviating from both the long-run and short-run desired levels (Moran, 1989). Following Hemphill (1974) and Safoulanitou and Ndinga (2010), the explicit quadratic function is used to capture the costs of imports.

$$C_t = \alpha_1 (M_t - M^*)^2 + \alpha_2 (R_t - R^*)^2 + \alpha_3 (M_t - M_{t-1})^2 + \alpha_4 (M_t - M_t^d)^2 \quad (3)$$

Where; C_t -cost of imports, M_t -current level of imports, M* -imports' long-term equilibrium., R_t -current level of exchange reserves, R* -desired level of exchange reserves, M_{t-1}-lagged imports in period t, M_t^d -desired level of import volumes, α_1, α_2, α_3 and α_4 are all expected to be positive.

In the import decision-making process economic agents minimize the costs of adjustment to the long-run import level (M*) by using reserves to smoothen imports (Moran, 1989). The argument raised in the literature is that foreign exchange is not used exclusively to pay the import bills. Under this context, the currency reserves will remain at a point that will sustain the imports over time. Nevertheless, it was assumed that the amount of exchange reserves needed is directly linked to the level of foreign currency received from abroad (Safoulanitou and Ndinga, 2010).

$$R_t^* = \beta_0 + \beta_1 F_t^* \quad 0 \leq \beta_1 \leq 1 \quad (4)$$

R_t^* - desired level of exchange reserves, F^* - level of foreign currency at equilibrium.
In the long run, $F^* = M^*$; in the short run, the two variables are linked by their identical existence in the balance of payments accounting (Safoulanitou and Ndinga, 2010). This identical nature is written as follows:

$$\Delta R = F_t - M_t \quad (5)$$

It is presumed in general that F^* can be estimated from its current point. This proposition arises from the assumption that the future can be viewed as the product of previous innovations. Consequently, if the short-term exchange assets stay stable over time, their long-term variability can be assumed to be negligible. Therefore, in the long run, those balances remain unchanged. The short-term changes of foreign currency influence the view of decision-makers as reflected in the foreign currency acquired in the long run (Moran, 1989). These shifts often influence their decision as to whether foreign exchange variations are transient or permanent. Given what precedes, it can be assumed that;

Table 1. Description of variables.

Variable	Symbol	Source	Definitions	Expected sign
Wheat import	Mt	WITS and FAOSTAT	Quantity of wheat imported in Kenya in MT	+
GDP per capita	GDPTAt	WB	Proxy for the real income measured in US$	+
Foreign exchange rate	FOREXt	IMF	Represents the foreign exchange rate in US$	±
Yield of wheat production	YLDS	FAOSTAT	Domestic wheat yields measured in Hg/Ha	-
Relative price of wheat imports	RPt	UN COMTRADE	Price of wheat imports divided by the price of domestic wheat in US$	-
Ending stock of wheat	STKt	FAOSTAT and USDA	Wheat reserve at the end of the year in MT	±
Tariff on wheat import	TARt	Statistical abstracts of Kenya, KNBS and MoALFC	This represents tariff on wheat imports in Kenya captured as a dummy variable	-
Lagged wheat import	LMt	Generated	Lagged quantity of wheat imports in Kenya in MT	±

Source: Author

$$F_t^* = F_t - \lambda \Delta F_t \quad (6)$$

In this relation, λ represents how decision-makers perceive the exchange reserve fluctuations. A positive value of λ means that they consider the fluctuation to be temporary. While a negative value of λ means that decision-makers perceive the fluctuation to be permanent. To make things easier, and following the study of Moran (1989), the current level of exchange reserves is assumed to be the same both in the short run and long term, which implies that λ =0. This argument is also used in relation to the demand for imported goods. Thus, the demand for imported goods by a consumer or country is influenced by foreign currency, exchange reserves, previous imports, income, import prices and domestic prices (Safoulanitou and Ndinga, 2010). Formulated in an equation as follows;

$$M_t = \beta_0 + \beta_1 F + \beta_2 R_{t-1} + \beta_3 M_{t-1} + \beta_4 \left(\frac{Pm}{P}\right) + \beta_5 Y_t + \varepsilon_t \quad (7)$$

$\beta_1, \beta_5 > 0$; $0 \leq \beta_2, \beta_3 \leq 1$; $\beta_4 \leq 0$

The log-linear formation of the model is;

$$lnM_t = \beta_0 + \beta_1 lnF + \beta_2 lnR_{t-1} + \beta_3 lnM_{t-1} + \beta_4 ln\left(\frac{Pm}{P}\right) + \beta_5 lnY_t + \varepsilon_t \quad (8)$$

where; β_0 -constant term, $\beta_{1...}$ β_5 -variable parameters, F_t - level of foreign currency, P_m -import price that takes into account tariff and non-tariff measures, P-domestic price index, ε_t - random error term, *ln* -natural log.

Empirical model

The study used the empirical model stated below to determine wheat import demand function in Kenya;

$$logM_t = \beta_0 + \beta_1 logGDPTA_t + \beta_2 logTAR_t + \beta_3 logFOREX_t + \beta_4 logYLDS_t + \beta_5 logRP_t + \beta_6 logSTK_t + \beta_7 logM_{t-1} + \varepsilon_t \quad (9)$$

Where; β_0 -constant, β_1 ... β_7 -variable parameters, t -time period (t=1,2…20) and ε_t - stochastic error term.

Table 1 provides the summary of variables used in the study with data sources and apriori expected signs.

RESULTS AND DISCUSSION

Descriptive statistics

The study compared the data collected through the data triangulation process, in other words comparing data from more than one source. This is key in determining data reliability, consistency and validity (Nightingale, 2009). The data collected converged and complement each other indicating that the data was accurate. The data used in the analysis included seven quantitative time series data with one qualitative variable (dummy). Their descriptive statistics are captured in Table 2 and Table 3.

The results in Table 2 show the descriptive quantitative statistics of the variables used in modelling wheat imports (Mt) in Kenya. The variables used for wheat imports in Kenya followed the works of Hor et al. (2018) and Musyoka (2009).

From the data in the last two decades our dependent variable which is wheat imports to Kenya had an average of 1018.81 MT with the highest value of 1998.80 MT while the minimum value of imports was 404.06 MT (units are in thousands). Gross Domestic Product per capita (GDPTAt) was 966.25 US$ on average in the last two decades with the highest value of 1816.55 US$ and a minimum value of 460.77 US$. The foreign exchange rate had an average value of 84.155 with a standard deviation of 11.55 and a range lying between 67.32 and 103.41. The yields had an average value of 22.46 hectogram per hectare (Hg/Ha) and the values deviate by 5.69 from its mean with a minimum value of 12.58 Hg/Ha and the highest figure being 31.00 Hg/Ha (units are in thousands). The average ending stock was 174.3 MT with a standard deviation of 106.4MT as well as a minimum value of 43MT and 449MT being the highest ending stock. The relative price of wheat in Kenya had an average value of 1.50 and deviated by 0.266 from the

Table 2. Descriptive of quantitative statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Mt (000') (MT)	20	1018.81	510.05	404.06	1998.80
FOREXt (US$)	20	84.155	11.55	67.318	103.411
YLDS (000') (Hg/Ha)	20	22.46	5.69	12.58	31.00
STKt (MT)	20	174.3	106.433	43	449
GDPTAt (US$)	20	966.246	460.772	389.543	1816.547
RPt (US$)	20	1.503	.266	1.063	2.184
LMt(000') (MT)	19	967.23	467.38	404.07	1854.95

Source: Author

Table 3. Descriptive of qualitative statistics.

TARt	Frequency	Percent	Cumulative %
No tariff (1)	8	40.00	40.00
Tariff (0)	12	60.00	100.00
Total	20	100.00	

Source: Author

mean and with a range of between 1.063 and 2.184. The lagged wheat imports figures were closely related to those of wheat imports and there were slight differences in their values. This was attributed to variation in the number of observations between the two variables, with 20 for wheat imports and 19 for lagged wheat imports.

Wheat imports had the highest standard deviation followed by lagged wheat imports, GDP per capita, ending stock, foreign exchange rate, yields and relative price. This shows that there is more variation in wheat imports in Kenya in the last two decades compared to the other variables in the study for a similar period. Therefore, it can be deduced that wheat imports are highly volatile compared to other variables in the study.

A tariff dummy representing government policy was used with 0 representing the period with tariff in place and 1 representing the time in which the government does not impose any tariff on wheat imports in Kenya. From the results, in the two decades' tariff imposed on wheat had a frequency of 12 while the period without tariff had a frequency of 8. This translated to 60 and 40% respectively as noted in Table 3.

Normality test for the variables

The data were transformed into logarithms (log to base 10). According to Pek et al. (2017), the applicability of data transformation helps to address non-normality issues usually associated with small sample sizes. The transformation addressed non-normality and serial correlation problems that could arise since the sample size was small (20 observations). Table 4 shows the central tendency and dispersion characteristics of the various variables calculated. After transformation, the results of all the variables were normally distributed as captured by the Jarque Bera test statistics. This is because the Jarque Bera p-values are greater than 0.05 and therefore the null hypothesis cannot be rejected implying the normality in the time series data.

Unit root tests

The stationarity test of variables using the ADF test is captured in Table 5 with the null hypothesis being non stationary. The findings indicate that the log of ending stock and log of relative price was stationary around the intercept at original level. Log of wheat imports and log of lagged wheat imports were stationary around intercept and trend at the original level. At first difference the tariff, log of yields and log of GDP per capita were stationary around intercept. The log of the foreign exchange rate was neither stationary at level nor first difference, therefore other testing techniques were applied to ensure robustness in the unit root results.

Table 6 presents the findings of the DFGLS unit root test. From the results, the log of ending stock and log of relative price are stationary around the mean at original level. However, log of wheat imports, tariff, log of foreign exchange, log of yields, log of lagged wheat imports and log of GDP per capita are stationary around the constant at first difference.

The outcome of ADF and DFGLS tests on unit roots

Table 4. Description of transformed data.

Variable	Obs.	Mean	Std.Dev.	Min	Max	S	K	Jb statistic	Jb chi^2 p-value
logMt	20	5.956	0.218	5.606	6.301	0.1554	1.6444	1.612	0.4467
logGDPTAt	20	2.932	0.229	2.591	3.259	-0.2840	1.7116	1.652	0.4378
TARt	20	0.4	0.503	0	1	0.4082	1.1667	3.356	0.1867
logFOREXt	20	-1.921	0.058	-2.015	-1.828	0.3187	1.9395	1.276	0.5284
logYLDSt	20	4.337	0.117	4.1	4.505	-0.4718	2.2199	1.249	0.5355
logRPt	20	.171	0.076	0.027	0.339	0.0875	3.0807	0.0309	0.9846
logSTKt	20	2.161	0.282	1.633	2.652	-0.3327	2.4991	0.578	0.749
logLMt	19	5.938	0.208	5.606	6.268	0.1986	1.6842	1.496	0.4734
DlogMt	19	.026	0.102	-0.15	0.24	0.4614	2.5886	0.808	0.6676

Jb- Jarque Bera, S- Skewness; K- Kurtosis.
Source: Author

Table 5. ADF stationarity results.

Variable	Level				First difference				
	Intercept(constant)		Intercept and trend		Intercept(constant)		Intercept and trend		Decision
	t- test	p-value	t- test	p-value	t- test	p-value	t- test	p-value	
logMt	-0.075	0.9519	-3.60	0.0299*	-3.593	0.0059*	-3.585	0.0311*	I{0}
TARt	-0.728	0.8395	-2.09	0.5516	-2.915	0.0436*	-2.814	0.1919	I{1}
logFOREXt	-0.398	0.9105	-2.04	0.5795	-2.245	0.1903	-2.334	0.4155	Not I{1/0}
logYLDSt	-2.582	0.0968	-2.80	0.1981	-4.154	0.0008*	-3.904	0.0120*	I{1}
logSTKt	-3.435	0.0098*	-3.83	0.0150*	-4.730	0.0001*	-4.641	0.0009*	I{0}
logLMt	-0.155	0.9437	-3.45	0.0446*	-3.466	0.0089*	-3.438	0.0465*	I{0}
logGDPTAt	-1.015	0.7478	-2.40	0.3808	-2.921	0.0430*	-3.016	0.1278	I{1}
logRPt	-5.832	0.0000*	-5.65	0.0000*	-6.710	0.0000*	-6.427	0.0000*	I{0}

Source: Author

Table 6. Dickey-Fuller generalized least squares stationarity results.

Variable	Level				First difference				
	Constant		Trend		Constant		Trend		
	Test statistic	Critical value	Test statistic	Critical value	Test statistic	Critical value	Test statistic	Critical value	Decision
logMt	-0.212	-2.559	-2.902	-3.485	-3.689*	-2.575	-3.867*	-3.498	I{1}
TARt	-0.749	-2.559	-2.075	-3.485	-2.983*	-2.575	-3.035	-3.498	I{1}
logFOREXt	-0.369	-2.559	-1.682	-3.564	-3.797*	-2.618	-3.999*	-3.584	I{1}
logYLDSt	-2.433	-2.559	-2.602	-3.485	-3.774*	-2.575	-4.195*	-3.498	I{1}
logSTKt	-3.493*	-2.559	-4.047*	-3.485	-4.846*	-2.575	-4.973*	-3.498	I{0}
logLMt	-0.326	-2.575	-2.851	-3.498	-3.463*	-2.589	-3.727*	3.509	I{1}
logGDPTAt	-0.740	-2.559	-2.658	-3.485	-2.625*	-2.575	-2.873*	-3.498	I{1}
logRPt	-3.219*	-2.559	-4.964*	-3.485	-4.819*	-2.575	-5.692*	-3.498	I{0}

Source: Author

shows with the robustness that none of the variables tested was integrated of order two I (2). Therefore, the results of variables being either stationary at level or first difference makes it possible to apply ARDL bound test

Table 7. ARDL Bounds Test for cointegration.

	Test statistic	Lower bound [I_0]	Upper bound [I_1]
F-statistic	10.596	2.750	3.990
t-statistic	-5.976	-3.130	-4.660

Source: Author

Table 8. Estimated import demand function using GLS (Cochrane Orcutt) regression analysis.

LogMt	Coeffient.	Std.Err.	t-value	p-value	[95% Conf	Interval]	Sig
logGDPTAt D1	0.894	0.555	1.61	0.138	-0.342	2.13	
TARt	-0.031	0.052	-0.60	0.559	-0.147	0.084	
logFOREXt D1	-1.317	0.953	-1.38	0.197	-3.44	0.806	
logYLDSt	-0.358	0.144	-2.49	0.032	-0.678	-0.038	**
logRPt	-1.001	0.274	-3.66	0.004	-1.612	-0.391	***
logSTKt	0.168	0.059	2.84	0.017	0.036	0.299	**
logLMt	0.996	0.13	7.69	0	0.707	1.284	***
Constant	1.398	0.86	1.62	0.135	-0.519	3.315	
Mean dependent var		5.973	SD dependent var		0.223		
R-squared		0.982	Number of obs		18		
F-test		76.181	Prob > F		0.000		
Akaike crit. (AIC)		-41.782	Bayesian crit. (SBC)		-34.659		

***p<0.01 and **p<0.05.
Source: Author

approach in testing cointegration of the variables.

Cointegration test

The results of the bound test in Table 7 shows that there is long run cointegration because the F test statistic (10.596) is greater than the I(1) upper bound (3.990). Therefore, the null hypothesis is rejected in favor of the alternative hypothesis of existence of levels relationship.

This is confirmed by the t-test statistic (-5.976) being absolutely greater than I (1) upper bound (-4.660). The confirmation of the cointegration in the time series data shows that the variables move together over time and there is no likelihood of having spurious analysis.

Estimated import demand function

The import demand function was estimated using Generalized Least Squares (GLS)/Cochrane Orcutt regression analysis to address heteroscedasticity and serial correlation violations. The findings are captured in Table 8.

The results in Table 8 indicate that the variables in the import demand function jointly explain 98.2% of the total variation in wheat imports in Kenya. The statistically significant variables are yields and ending stock at 5% significance level. At the same time, relative price and lagged wheat imports are significant at 1% level. The statistically significant variables are inelastic to the wheat imports except for relative prices which was elastic in the estimated import demand function.

In Kenya, wheat import demand function estimated was found to be inelastic and significant with a negative relationship with yields as captured in Table 8. This implies that when yields increase by one per cent wheat imports decline by 0.358% at *ceteris paribus* conditions. According to Sandström et al. (2018) when a country produces more of a commodity which it consumes, it helps to reduce outsourcing of that product. Hence, addressing factors that cause a decline in the country yield trends should be a priority to ensure profitable domestic production. Due to inelastic property, wheat imports are less responsive when yields change. Thus, government should not only rely on increasing yields but also incorporate other mechanisms to be effective in reducing wheat imports.

Stock is usually used to buffer the changes in the supply of a commodity and in return, this helps in price stabilization and food security (Boansi and Favour, 2015; Sandström et al., 2018). From the results ending stock was significant, implying that when ending stock increased by one per cent wheat imports increased by

0.168%. Therefore, Kenya being a wheat deficit country utilizes its stock when there are shortages of wheat grain. Thus, for each wheat import procured by the country, ending stock increases the volume of imports demanded because it is factored when importing. In inventory management, the challenge of having more stock increases the handling costs and puts the capital in idle condition. Even though having more stock of wheat is necessary for Kenya it has cost implications. Therefore, the stock should be kept at economically efficient levels to avoid losses and wastages in the system. This can be done by applying economic order quantity theory to address issues of when to order, how to make an order to maintain overall stock and quantity to order (Agarwal, 2014).

Relative price was elastic and statistically significant at 5% level. This implies when relative prices increase by one per cent wheat imports decline by 1.001%. Since the relative price was elastic in the analysis it implies that wheat import in Kenya is more responsive with relative price (this indicates that when relative price change by small per cent wheat import changes by large quantity). This may suggest that due to increase in prices wheat imports have been affected in Kenya tremendously. The finding conforms to demand theory and corroborates with the works of Musyoka (2009), that when relative price increases it leads to a decline in imports. This has led to policy implications in Kenya ranging from the need to be more competitive to compete globally to the need for government to provide support measures for wheat producers such as training farmers and researching on wheat varieties that are of high yield.

In time series analysis, the effect of a variable may not necessarily be instantaneous because of the delayed response. Hence this effect is felt gradually over time (Mukherjee et al., 2017). In the model analyzed, lagged wheat import was statistically significant at one per cent significance level with its value being less than one. This implies when lagged wheat imports increase by one per cent wheat imports increase by 0.996% holding other factors constant. This is because for Kenya wheat import and consumption has been seen to be changing food preferences for most of the urban consumers in the long term. This contradicts with works of Baiyegunhi and Sikhosana, (2012) with a negative sign in the coefficient. Perhaps this may be possible for lagged wheat imports to be related to wheat stock used as buffers because Kenya is not wheat sufficient country.

Moreover, an interesting scenario to many SSA countries, they are deficient in most agricultural products yet they have large parcels of land resources not being utilized. However, the easiest solution they seek to this problem is importation, which adds to the deficit already existing in their trading systems. This may explain why there are high import bills by the wheat importers in Africa and Kenya is not exceptional to it. This has been found in the long run to pull away resources from other social-economics activities without solving the problem of food insecurity (Iloh et al., 2020).

The estimated import demand function in equation x captures 98.2% of total wheat imports in Kenya and this can be used to forecast and estimate the amount of wheat imports in Kenya. This will help in planning and strategizing on policies that are optimal in the economy (Mugableh, 2017). Since the relative price, lagged wheat imports, ending stock and yields are statistically significant in the wheat import demand. Hence, they are the reasons for the high level of wheat importation in Kenya. Therefore, policies that are targeted at the wheat sector should emanate from these variables.

$$\widehat{logM_t} = \widehat{1.398} + \widehat{0.894}\ logGDPTA_t - \widehat{0.031}\ logTAR_t - \widehat{1.317}\ logFOREX_t - \widehat{0.358} logYLDS_t - \widehat{1.001} logRP_t + \widehat{0.168}\ logSTK_t + \widehat{0.996}\ logM_{t-1} \quad (10)$$

Post estimation tests of the estimated import demand function using OLS

The OLS regression results in Table 9 violate assumptions of no serial correlation and existence of heteroscedasticity as captured by the p-values of 0.079 and 0.0496 for Breusch-Godfrey and Breusch-Pagan tests respectively. Therefore to correct for the violations Cochrane Orcutt regression analysis was used and the results are tabulated in Table 8. The results of Cochrane Orcutt were used to estimate import demand of wheat in Kenya.

The VIF results of the OLS import demand function captured in Table 10 shows that the model does not suffer from any multicollinearity issues because all VIF values are less than 10 as noted by (Franke, 2010).

Conclusion

The import demand function estimated explained 98.2% of total wheat imports in Kenya. Therefore, this model can be adapted to predict quantity of wheat imports to avoid over-importation of wheat in Kenya. The statistically significant variables were relative prices, lagged wheat imports, ending stock and yields which are easily available from government data structures.

On the basis of results, it can be concluded that lagged wheat imports, relative prices, yields and ending stock are the key determinants that affect wheat imports in Kenya. Therefore, policies that target wheat imports in Kenya should revolve around these four variables with relative price having the greatest impact on wheat importation.

Policy recommendations

Therefore, the study recommends that Kenya wheat

Table 9. OLS Linear regression on import demand function.

logMt	Coef.	Std.Err.	t-value	p-value	[95% Conf	Interval]	Sign
logGDPTAt D1	0.034	0.891	0.04	0.971	-1.928	1.995	
TARt	0.004	0.094	0.05	0.964	-0.204	0.212	
logFOREXt D1	0.392	1.505	0.26	0.8	-2.922	3.705	
logYLDSt	0-.378	0.212	-1.78	0.102	-0.845	0.088	
logRPt	0-.789	0.329	-2.40	0.036	-1.513	-0.064	**
logSTKt	0.163	0.073	2.23	0.048	0.002	0.324	**
logLMt	0.908	0.228	3.99	0.002	0.407	1.41	**
Constant	2.002	1.385	1.45	0.176	-1.046	5.05	
Mean dependent var		5.965		SD dependent var		0.220	
R-squared		0.918		Number of obs		19	
F-test		17.557		Prob > F		0.000	
Akaike crit. (AIC)		-36.049		Bayesian crit. (BIC)		-28.494	
Serial correlation							
Durbin-Watson d-statistic						2.521607	
Durbin's alternative probability value						0.112	
Breusch-Godfrey LM test for autocorrelation F (small)						0.079	
Breusch-Godfrey LM test for autocorrelation chi^2						0.050	
Heteroscedasticity							
White's test						0.3918	
Cameron & Trivedi's decomposition of IM-test chi^2						0.472	
Breusch-Pagan / Cook-Weisberg test for heteroscedasticity						0.0496	

** p<0.05.
Source: Author

Table 10. Multicollinearity check using variance inflation factors for import demand function run by OLS regression.

Variable	VIF	1/VIF
TARt	6.33	0.158
LogLMt	6.153	0.163
D.logFOREXt	3.452	0.29
D.logGDPTAt	2.263	0.442
logYLDSt	1.639	0.61
logRPt	1.441	0.694
logSTKt	1.242	0.805
Mean VIF	3.217	.

Source: Author

imports should be monitored to avoid over importation because it has adverse effects on the domestic wheat sector. This is because wheat grain has many policy implications since the crop is consumed as a food commodity as well as the most traded commodity internationally.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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