

An Aggregate Import Demand Function for Sudan

A Cointegration Analysis

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دالة الطلب الكلية على الواردات في السودان: تحليل التكامل المشترك

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Abstract:

The current research article studies about the existence of aggregate import demand function for Sudan for the time period spanned between 1978 and 2018. In this study, the authors' deployed auto regressive distributed lag (ARDL) and bounds-testing approach for the purpose of co-integration. Further, the study followed error correction model to segregate both short- and long-run elements present in import-demand relationship. Based on the results attained from unit root tests, especially Phillips-Perron (PP) test as well as augmented Dickey-Fuller (ADF) test, it was inferred that all the series got integrated in the order of one. This scenario infers that there exists a prolonged relationship between the main determinants such as foreign exchange reserves, real income, relative prices and terms of trade with that of the aggregate imports. The error correction term strongly recommended quick convergence to equilibrium. There is no proof exposed by the stability tests in terms of serial correlation problem in the residuals. The results infer that the international reserves play the vital role and are touted to be the most important determinant of aggregate import demand for Sudan. The results further exhibits that when there is an increase observed in foreign exchange reserves, it enhances the import demand as well. In this way, the policies which are focused at increasing foreign exchange reserves tend to increase the imports.

Keywords: ARDL cointegration; import demand function; international trade

JEL Classification Codes: C13; C51; F14; O24

ملخص:

تبحث هذه الورقة في وجود دالة الطلب على الواردات الكلية في السودان خلال الفترة 1978-2018م، وتستخدم الورقة نموذج الانحدار الذاتي للإبطاء الزمني الموزع (ARDL) ومنهجية اختبار الحدود للتكامل المشترك، ويقدم البحث تقديراً لنموذج تصحيح الخطأ من أجل الفصل بين العناصر قصيرة وطويلة الأجل في العلاقة بين الطلب على الواردات ومحدداته، وتشير نتائج اختبارات جذر الوحدة، وتحديد اختبار ديكي فولر الموسع واختبار فيليب-بيرون إلى أن جميع السلاسل متكاملة من الفرق الأول، كما تظهر النتائج وجود علاقة طويلة الأجل بين الواردات الكلية والمحددات الرئيسية التي تشمل: الدخل الحقيقي، والأسعار النسبية، واحتياطيات النقد الأجنبي، وشروط التبادل التجاري، ويشير نموذج تصحيح الخطأ إلى سرعة الوصول إلى الوضع التوازني، أما اختبارات الاستقرار فتؤكد عدم وجود مشكلة في الارتباط الذاتي التسلسلي في البواقي، وتظهر النتائج أن الاحتياطيات الأجنبية هي أهم محددات الطلب على الواردات الكلية، وتكشف نتائج البحث أن التحسن في احتياطيات النقد الأجنبي يزيد من الطلب على الواردات السودانية. وبالتالي، فإن السياسات الرامية إلى زيادة احتياطيات النقد الأجنبي ستعزز من الواردات.

الكلمات المفتاحية: التكامل المشترك؛ الانحدار الذاتي للإبطاء الزمني الموزع؛ دالة طلب الواردات؛ تجارة دولية

الترميز الاقتصادي (JEL): C13 ; C51 ; F14 ; O24

I- Introduction:

Developed as well as developing countries experience a number of advantages from their international trade opportunities. This might be attributed to few benefits brought by international trade to countries such as exploitation of economy of scale, high employment opportunities and resource management in line with comparative advantage, leveraging high capacity and technology advancements. In addition, a major chunk of income is generated by the developing countries from the export of agricultural and other such primary commodities. While depending on the income generated by export, the developing countries further heavily rely on the import of capital and consumer goods to fulfill the consumption needs of its citizens and to feed the industries.

In international economics, empirical investigation of import demand function has a prominent role and most research studies are conducted in this area. This activity is evidenced by the several reviews on this topic, most of which focus on both developed and developing economies (Goldstein & Khan, 1985; Faini et al., 1992; Saker, 2018; Ngoma, 2020). There are few prominent reasons behind the strong emphasis given to this research area because its application influences a wide range of economic policy issues with regards to exchange rate management and trade balance, its association with external balance, and its impact on economic growth (Senhadji, 1998, 236–237).

1. Overview of the Composition of Sudan's Imports

Sudan is a small commodity-producing country that depends on the import of manufactured and capital goods such as crude oil and intermediate production inputs. Sudan also started importing non-durable consumer goods. This might be attributed to the decrease observed in domestic production capacity and the ever-changing preferences of consumers due to globalization. These imported consumer goods are expected to fulfill the huge domestic demands by supplementing the existing domestic supply.

The primary sources of imports are industrialized countries, especially European Economic Community (EEC). Among the EEC countries, the United Kingdom remains the primary supplier for Sudan due to historical reasons that dates back to colonial era (Ibrahim & Ahmed, 2017, 2). In Asian region, the most important market is china whereas in Middle East region, Saudi Arabia is the prominent trading partner which leads the list of suppliers as a single leader. The overall magnitude of the imports became too high and achieved significant growth during the period 1978-2018 in Sudan. Figure 1 shows that when compared to 929 million USD of imports in the year 1978, in 2018, the imports increased to 10 Billion USD, as per International Monetary Fund (IMF) report (International Monetary Fund, 2020). Since the country was undergoing developmental processes during this time period and raising inflationary trends, the increase in the import value became inevitable.

According to the studies conducted earlier, both domestic income variables and relative prices are significant components that determine the import demand in both developing and developed countries. However, there is a lack of studies regarding to crucial determinants of import demand, for the developing countries. The aim of the current research work is to fill this research gap by deploying advanced, yet empirically-reasonable determinants of import demand for the developing countries. The current study focuses especially upon Sudan on the basis of appropriate theoretical approach. So

the primary objective of the research article is to assess the major determinants of aggregate import demand of Sudan during the time period 1978-2018.

The current research paper is organized as follows: In the second (II) section, the authors reviewed the recent literature while the third (III) section discusses about the methodology and data sources. While the fourth section (IV) details about the results, the study is concluded with its main findings and future policy implications in section V.

2- Literature Review:

In developing as well as developed countries, numerous studies have been conducted regarding to aggregate for imports. Previous studies have used several determinants of import demand, including relative prices and gross domestic product (GDP). They have involved several methodologies and econometric techniques and measures and have reached contrary results.

In the study conducted by Ngoma (2020), the import demand determinants were investigated for the period 2004-2017 in Zimbabwe. The study made use of a gravity model on the basis of Ordinary Least Squares (OLS) with and without fixed effects. According to the findings of the study, the import demand in Zimbabwe was positively influenced by both GDP and trade openness. Further, a negative correlation was found between import demand and few factors such as bilateral distance, inflation and population of the country. The results also suggested that de-dollarization is the most efficient strategy to mitigate too much of import demand.

In the study conducted by Keho (2019), the aggregate import demand function was estimated for Côte d'Ivoire. This study leveraged a traditional import model to estimate the import demand on the basis of annual data for real GDP, domestic and import prices followed by real imports. With the study period being 1980-2017, the results revealed that there existed a long-term relationship among domestic and import prices, income and the imports. In the long-run as well as short-run, there was a positive relationship between imports to that of the real income and domestic prices, whereas the former has a negative relationship with foreign prices. When the domestic prices changed, it got strongly exhibited in demand for imports. But there was no such effect for income and import price. The results further revealed that the assumption of prime homogeneity has no hold upon the market. This implies that it is not appropriate to calculate import demand function on the basis of relative price formulation, with specific reference to Côte d'Ivoire.

The import demand function was assessed for Pakistan during the period 1982 to 2010 by Muhammed and Raiz (2018). This study specifically assessed the influence of income level, impact of prices, exchange rate, foreign reserves and trade liberalization programs of the nation. The results inferred that there exists an inelastic response from the major commodities with respect to relevant import prices. Further, from the income elasticities of these commodities, the study also inferred that the major imports of Pakistan were growth-based ones.

Turkey's import demand function was assessed for the period 2003-2018 by Çulha et al. (2019). The study analyzed the evolution of income as well as price elasticities with respect to time. Demand functions were separately determined for total imports and their supplementary components. The authors obtained the corresponding time-varying elasticities as well. According to the results, income and relative price changes were the primary determinants of total import growth. The expenditure and income elasticities diminished in the course of time for both total imports as well as its supplementary components, excluding intermediate goods. Further, no significant change was observed in relative

price elasticity for investment and consumption goods' imports. However, there was a significant increase observed for intermediate goods' imports and total imports.

In the study conducted by Saker (2018), both export as well as import demand functions of Bangladesh were considered on bilateral basis while the time period was between 1995 and 2015. Johansen co-integration approach was followed in this study in addition to vector error correction mechanism. The results inferred 'income' as the primary and influential determinant in case of both import as well as export demand of Bangladesh. However price had a negligible influence since the export prices of Bangladesh' garments are already quite low. So 'price change' failed to make any significant impact. But, in case of imports, a high impact of trade liberalization was experienced compared to dynamic global prices.

In the study focusing Cambodian import demand function, the authors Hor et al. (2018) deployed time series data for the period 1993-2015. The autoregressive distributed lag (ARDL) model was used in this study to assess the impact of relative prices, final consumption expenditure, exchange rate, foreign direct investment, export volume, foreign exchange reserve for short- as well as long-run import demand. The study results inferred that there was a negative effect exerted by relative prices and exchange rate upon import demand in terms of long-run as well as short-run. However, export volume had a positive impact on import demand. Further, no significant impact was exerted by final consumption expenditure, foreign exchange reserve and foreign direct investment upon import demand. The study findings suggested the government of Cambodia to have a close watch on the domestic effective price.

Ibrahim and Ahmed (2017) conducted a study on the determinants of aggregate import demand function during the period 1978-2014 for Sudan. The study made use of Johansen cointegration technique to determine the import demand function in the long-run. The results revealed the existence of a long-run co-integration relation among the variables such as exchange rates, domestic incomes, imports and relative prices. The study concluded that high impact was exerted by GDP upon the quantity of imports in comparison with other determinants such as exchange rate and price ratio.

The aggregate import function was analyzed for India by Mishra and Mohanty (2017) for the period, 1980-81 to 2013-14. The study used five kinds of co-integration tests including ARDL bounds test, in order to assess the stability of aggregate import demand function. The authors exposed the existence of a co-integration relation among the factors such as domestic activity, import demand, foreign exchange reserves and relative prices of import. The results inferred that the long-run response of import demand was negative to relative import prices and less than unity. While at the same time, the former's response to domestic activity/income was positive and higher than unity. A positive effect was exerted upon the imports by foreign exchange reserve.

In the study conducted by Gouvêa and Schettini (2015), the aggregate imports of Brazil were determined using econometric estimates for the period 1996-2010. The study investigated the co-movements among few variables such as household consumption, gross fixed capital formation and total imports. Domestic income was found to be the key determinant of total imports and its role got emphasized in the study results. When the domestic supply of capital goods becomes low, it denotes that the allocation of domestic income has a relationship with import dynamics. The study findings showcased the excellent performance of long-run vectors of alternative models in terms of predicting the aggregate imports. To the best of authors' knowledge, no direct empirical research work has been

conducted so far in Sudan, deploying ARDL approach. The current research paper attempts to fulfill this research gap in Sudanese literature by making use of current time series data and ARDL approach in co-integration.

II– Methodology and Data Sources:

1. Model Specification

An imperfect substitute model is used in the current study to assess the aggregate import demand function for Sudan. The authors assumed that both imports as well as exports are not the perfect candidates that can substitute the domestic goods in the country considered i.e., Sudan (Goldstein & Khan, 1985). Since the global imports to Sudan is comparatively lesser compared to global imports, it is quite acceptable to assume that the global supply of imports to Sudan is perfectly elastic. Based on this assumption of finite import supply elasticity, the selected model is reduced as a single equation model of aggregate import demand function.

The widely-used conventional aggregate import demand function in log-linear terms takes the following theoretical form:

$$\ln M_t^d = \beta_0 + \beta_1 \ln YD_t + \beta_2 \ln(RP)_t + \beta_3 \ln RE_t + \mu_t, \quad (1)$$

Where M is the quantity of merchandise imports = V_m/P_m ,

V is the value of imports,

P_m is the import price index,

M denotes the volume of imports which is calculated through the division of import value by import price index.

YD denotes the real income or a collective of domestic economic activity which is measured in terms of real GDP.

RE denotes the real exchange rate which is defined as a unit of domestic currency/ unit of foreign currency.

So it is hypothesized that GDP has a positive relationship with imports. This is in line with the literature that in case of an increase in the economy reflects in the income of citizens, then the people tend to demand more imports.

$RP = \frac{P_m}{P_d}$ denotes the relative import prices whereas the import prices index is denoted by P_m is the import prices index. Further, the domestic price is corresponded to P_d and is proxied by Consumer Price Index (CPI).

$RE = (EP^*/P)$ denotes the real exchange rate in which the official nominal exchange rate is denoted by E . Here P^* denotes the foreign price i.e., CPI of the main trading partner of Sudan.

μ is a random stochastic disturbance or otherwise an error team which has its own classical properties. This value is assumed, at the beginning, to be independently-, randomly-, and normally-distributed, with zero mean and constant variance and helps in the determination of random factors that influence the imports. Here, the demand is referred by the superscript d , whereas t denotes the periods.

In line with the Keynesian line of argument, one can predict that, with increment in the domestic income, the imports get stimulated which results in positive income elasticity $\beta_1 > 0$. This denotes the scenario i.e., income variable is indeed predicted to be positive (Bonnici, 1987)).

According to an expectation, with increasing import price which is related to domestic price level, the import volume gets affected. This phenomenon leads to negative import price elasticity $\beta_2 < 0$. As per standard demand theory, the partial derivative of the demand for imports should be negative with regards to import price. This can be defined otherwise as, when there is an increase in import prices, it should lead to reduction in the demand since the imports become lavish. The assumption of substitution between domestic and foreign goods can otherwise be understood via the positive domestic price level effect, according to Ariz (1987). From the negative coefficient of relative price, it can be understood that the imports may get reduced with increasing prices. This is because the consumers start replacing the imported products with domestic products due to increasing price of imports (Tirmazee & Naveed, 2014).

In equation (1), it is assumed that when the domestic real income increases, it aggravates more number of imports. At the same time, if the import price is higher, it demotivates the imports. When the currency value gets depreciated, the import price in the domestic currency gets increased due to which the imports tend to fall. When there is an increase observed in real income and/or real exchange rate, it triggers massive level of imports. It is a complex task to find and quantify the factors which exert significant impact upon the imports. So it is important to choose the best and crucial one. The current research work adds foreign exchange reserve as major determinant to the selected model. As per the theoretical approach, there is a positive effect exerted by foreign exchange reserves. The foreign exchange reserves serve as the key medium of exchange for every nation in the foreign market. So it can challenge the capability to import. The specification of the model is given below.

$$\ln M_t^d = \beta_0 + \beta_1 \ln YD_t + \beta_2 \ln(RP)_t + \beta_3 \ln RE_t + \beta_4 \ln IR_t + \beta_5 \ln TOT_t + \beta_6 D_t + \mu_t, \quad (2)$$

where interest rate is foreign exchange reserves (minus gold, and where the expected coefficient sign of β_4 is positive.

According to Aziz and Bahban (2012), the following equation can be used to estimate the import demand function which is inclusive of foreign exchange reserves as one of the primary determinants

$$TOT = \frac{UVOE}{UVOI} \times 100$$

where

TOT stands for net barter terms of trade,

UVOE is the unit value index of exports, and

UVOI is the unit value index of imports.

$$TOT = (P_X/P_M) 100$$

The terms of trade of a nation are given by the ratio of price index of its exports P_X to the price of index of its imports P_M . This ratio is generally multiplied with 100 in order to present the trade terms as a percentage (Salvatore, 1998). According to Krugman and Obstfeld (2000), the terms of trade can be defined as a ratio of price of country's exports with the price of its imports.

But the coefficient β_5 sign, in terms of trade, should yield a positive influence upon import demand. When there is an increase observed in the prices of country's exports, with respect to its

imports, this scenario infers that the terms of trade has transformed in a favorable direction. This is because the country receives more number of imports now for every good exported.

D denotes the rapid changes that occurred in time series import data which mandated the usage of a dummy variable. The model has a dummy variable so as to grasp the impact of import liberalization policy upon import demand volume. Import liberalization, by easing the access to imports, is likely to result in high amount of aggregate import demand from the economy. The dummy variable takes a value of 1 for import liberalization, from 1990 up to 2018, and 0 for all other years from 1978 to 1989 for import restrictions.

The whole set of variables used, are expressed in real terms. The natural algorithm (L) is considered for all the variables so that the resulting parameters are interpreted as elasticities. In equation (2), $\beta_1, \beta_2, \beta_3, \beta_4$, and β_5 are the real income, relative price, real exchange rate, international reserve and terms of trade, and elasticities, respectively.

2. Method of Estimation

2.1 Unit Root Tests

Prior to starting the data analysis process, it has become a mandatory exercise to analyse the time series properties of the data. The current study used Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests to assess the stationarity in macroeconomic data. If the unit roots are present in time series variables such as YD, RP, RE, IR and TOT, then one should consider the first difference of the variables so as to attain a stationary series. Thus, model can be written as given herewith.

$$\Delta \ln M_t = \beta_0 + \beta_1 \Delta \ln YD_t + \beta_2 \Delta \ln (RP)_t + \beta_3 \Delta \ln RE_t + \beta_4 \Delta \ln IR_t + \beta_5 \Delta \ln TOT_t + \beta_6 D_t + \mu_t, \quad (3)$$

where Δ represents the first difference operator.

2.2 The Determination of Lag Length

The determination of optimal lag can be used to set the value of lag based commonly on the tests of Akaike information criteria (AIC) and Schwarz information criteria (SIC) (Liew, 2004).

2.3 Co-integration Process

The current study used co-integration analysis in order to get rid of challenges involved in spurious regression and violation assumptions present in traditional regression. Further, this analysis is used to analyze the long-run relationship among the variables cited earlier i.e., TOT, M, YD, RP and IR. Due to the fact that a number of macro time series possess unit root, the development of non-stationary time series analysis theory got spurred. According to Engle and Granger (1987), a linear combination of two or more non-stationary series may stay stationary. In the presence of such stationary linear combination, it is assumed that the non-stationary time series remain co-integrated. The aim of this co-integration test is to identify whether “a group of non-stationary series is co-integrated or not” (Quantitative Micro Software, 1994; 519).

3. Autoregressive Distributed Lag Approach

3.1 The Advantages and Specification of the ARDL Approach

The current study is aimed at identifying both short-run and long-run response in the aggregate import demand function. This remains the primary reason to choose error-correction model (ECM) and co-integration technique. A bounds-testing approach was designed by researchers [Pesaran and Shin (1995) and Pesaran et al. (1996; 2001)] in which the long run is incorporated into ECM. One of the main advantages of this approach is that it can simultaneously assess both long-run as well as short-run coefficients.

In order to assess the long-run relationships as well as dynamic interactions that occur among the considered variables, the current study model was analyzed using bounds-testing method or else ARDL approach to co-integration, which was developed by the researchers [Pesaran and Shin (1999) and Pesaran et al. (2001)]. There is no requirement in ARDL such as all the considered variables should be under same order. This can be applied when the underlying variables are integrated under order zero or under one or otherwise fractionally integrated. Further, the approach can be used on whatever types the regressors are, such as $I(0)$ or $I(1)$. The co-integration must be established for the long-run coefficients to remain valid. According to Pesaran et al (2001), F -test has some new critical values, in this content, when tabulated (Bahmani-Oskooee & Fariditavana, 2015; Harris & Sollis, 2003; Constant & Yue, 2010).

3.2 The Two Stages of the ARDL Approach

In the beginning, the researcher analyzed the presence of long-run relation among the variables considered for the study. This was done by calculating F -statistic in order to assess the significance of the lagged levels of variables in error correction form of the underlying ARDL model. Co-integration analysis is used to test the presence of long-run equilibrium relationship among the variables under study i.e., co quantity of imports (M), domestic income (YD) measured by GDP, unit value of imports (PM), domestic price level measured by CPI (PD) and real exchange rate (RE), international reserves (IR), and terms of trade (TOT). The co-integration exists if the coefficients θ_1 , θ_2 , and θ_3 differ from zero. Specifically, the null hypothesis of the “non-existence of the long-run relationship” is tested. Therefore, the null hypothesis, stating that there is no long-run equilibrium relationship defined by

$$H_0: \theta_1 = \theta_2 = \theta_3 = 0$$

is tested against an alternative hypothesis:

$$H_1: \theta_1 \neq \theta_2 \neq \theta_3 \neq 0$$

This implies the presence of cointegration.

The relevant statistic is the familiar F -statistic for the joint significance of θ_1 , θ_2 , and θ_3 .

The bounds-testing procedure is based on the F - statistic or Wald statistic and is the stage of the ARDL cointegration method.

In the second step, the ECM is determined. An error-correction term (ECR), derived out of long-run relationships with the help of ARDL procedure, has been included herewith as an independent variable. This is to ensure there occurs no loss of information from the co-integrated variables and no misspecification of different variables involved in the study. Due to the fact that whole set of variables remain stationary in the system, it is possible to model the short-run adjustment mechanism as ECM. ECT, which lags by around one year, is utilized in the ECM, along with past as well as current set of different fundamentals in addition to other variables that impact the domestic price index and its determinants in the short-run.

In equation (2), the researcher rejects any citation with regards to long-run features of decision-making i.e., differentiating the results with the loss of “long-run information” in the data (Maddala, 1992). The co-integration theory overcomes this challenge with the introduction of ECT. Though ECT is lagging behind one period (i.e., EC_{t-1}), it is integrated with short-run dynamics in the long-run import demand function. This results in the general ECM specification as given herewith.

$$\Delta M_t = \beta_0 + \sum_{i=1}^n \beta_1 \Delta YD_{t-i} + \sum_{i=1}^n \beta_2 \Delta (RP)_{t-i} + \sum_{i=1}^n \beta_3 \Delta RE_t + \sum_{i=1}^n \beta_4 \Delta IR_t + \sum_{i=1}^n \beta_5 \Delta TOT_t + \beta_6 EC_{t-1} + \beta_5 D_t + \varepsilon_t, (4)$$

where EC_{t-1} denotes the ECT lagging behind one period, parameter β_6 denotes the coefficient of EC which determines the adjustment speed so as to obtain equilibrium when there is a shock to the system. It also calculates the response of the regress during every period until the departure from equilibrium. The short-run impact is denoted by lagged explanatory variables while the ECT provides the long-run impact.

As we consider only annual observations, in order to achieve maximum order of lags in ARDL model, the researcher selected 2 and estimated the data from 1978 to 2018. The error-corrected version of ARDL (2, 2, 2) model with regards to the variables under study, is defined as follows.

$$\Delta \ln M_t = \beta_0 + \sum_{i=1}^n \beta_1 \Delta \ln YD_{t-i} + \sum_{i=1}^n \beta_2 \Delta \ln (RP)_{t-i} + \sum_{i=1}^n \beta_3 \Delta \ln E_t + \delta_1 \ln M_{t-1} + \delta_2 \ln YD_{t-1} + \delta_3 \ln (RP)_{t-1} + \delta_4 \ln RE_{t-1} + \delta_5 \ln IR_{t-1} + \delta_6 \ln TOT_{t-1} + \theta ECT_{t-i} + \mu_t \quad (5)$$

When $(\delta_1 - \delta_6)$ seems to be significant in a joint-fashion, then the variables are deemed to be cointegrated.

Here, δ_i denotes the short-run dynamic elastic effects of the convergence of independent variables to long-run equilibrium. Further, θ denotes ECT and determines ECM which trigger the independent variables as well as dependent variable back to their long-run equilibrium relationship i.e., the number of lags that needs to be a part of ECM specification. The coefficient θ denotes the speed of adjustment. This measures the speed of adjustment so as to attain equilibrium when there is a shock to the system.

Δ denotes a first difference operator and ecm_{t-1} denotes one-period lagged error correction term which is estimated from the equation (2).

3.3 Diagnostic Recursive Methods

Recursive estimation method is one of the diagnostic tools used in the detection of non-constancy over the sample period. This method ensures that the constancy challenges are evaluated via graphical illustrations. If there is a significant variation shown in the graphs of coefficients, one can suspect the presence of a regime shift or instability during the period under consideration.

3.3.1 Stability Tests. These tests are highly important in a way that a movement of cumulative sum (CUSUM) and cumulative sum of squares (CUSUMQ) outside the critical lines recommend the instability of parameter variance and estimated coefficients during the sample period (Habibi, 2010).

4. Data Definitions and Sources

The present paper is based on annual time series data observations because quarterly or bi-annual data for the variables considered, are unavailable from the existing data sources. The observations are for the 40 years from 1978 to 2018. The database series used in this paper are published secondary sources obtained from the Central Bank of Sudan (CBOS) and Central Bureau of Statistics. The price term used in this paper is measured in ratio form. All data are converted into U.S. dollars and are in constant terms.

III- Results and discussion:

1. Unit Root Tests

The researcher used ADF and PP tests to examine the stationarity of individual series. The author conducted these unit root tests at both levels while the beginning difference of overall set of variables had both intercept as well as trend. Both ADF as well as PP tests has the same null hypothesis i.e., variable contains a ‘unit root’. As per the results shown in Table 1, with 5% significance, all series become stationary at first difference $I(1)$ and non-stationary at level $I(0)$. In Table 2, PP test results are shown which infers that, at first difference, all the variables remain stationary. It is to be inferred that the null hypothesis of non-stationarity of complete variables got rejected, with the application of PP test to the first difference of data series.

2. Co-integration Analysis

Co-integration analysis is conducted generally to know the existence of an equilibrium relationship as hypothesized by economic theories. This analysis is used to test whether a model is well-defined or not (Perman, 1991). The test results tabulated in Table 3 were found to be above the upper-bound critical value. This infers that that null hypothesis of no co-integration got rejected. Further, it can be established that the long-run relationship that exists among TOT, RE, RP, IR and YD can be considered as ‘long-run forcing’ variables that can explain M. In other words, these variables can be understood to move together in the long-run. From the results, the author infers that when the foreign exchange reserves increases, it automatically increases the import demand. Further, the authors also found a positive and significant relationship exists between foreign exchange reserves and imports due to their long-run relationship which tend to have an impact on import demand of Sudan. So, those policies which are framed with an aim to increase foreign exchange reserves tend to boost imports.

3. Short-Run Dynamic Equation

ECT coefficient ecm_{t-1} was significant according to the results and it denotes the speed of adjustment. This further carries an exact negative sign, a mandatory feature to prove the stability of the model. So one can achieve the long-run equilibrium among the variables given in equation (2). The ECT coefficient (-1.011873) was estimated to be statistically significant at 5% level with a proper negative sign. This denotes the reliability of a long-run equilibrium relationship among the variables used in the first equation. When it comes to Sudanese markets, the short-run to long-run adjustment equilibrium is too rapid. This calculated coefficient value recommends that the system autocorrects the disequilibrium of the previous period by about 100%, a year.

4. Lagrange Multiplier

The current study made use of Breusch–Godfrey large sample test for autocorrelated disturbances. This test is applied in case of any disturbances following $AR(\rho)$ or $MA(\rho)$ process. Here ρ can be denoted in any kind of positive order. Further, it can also be applied if the lagged values of the dependent variable present or not among the regressors i.e., in the presence of a lagged dependent variable on the right-hand side of an equation (Quantitative Micro Software, 1994, 184). When R^2 goes beyond the critical chi-square value at the chosen significance level, the null hypothesis can be rejected. In this case, atleast one ρ should be notably varied from that of the value 0 (Gujarati, 1995). Table 5 shows that there is a lack of evidence for the autocorrelation, since the p -value is above 5%.

5. Stability Tests

The current study applied the established CUSUM and CUSUMQ tests to the residuals of optimum model in order to assess the stability of coefficient estimates. In Figure 2, the CUSUM plot seems to be unstable within 5% of the critical bands; however, the deviation appears to be slightly transitory, as there is a sign that the plot is returning back toward the criteria bands. Figure 3 also provides evidence confirming that the deviation is just slightly transitory; the plot of the CUSUMQ statistic returns completely to within the criteria bands. Therefore, we can argue that the estimated model is approximately stable within the bounds of the 5% level of significance.

V- Concluding Remarks and Policy Implications:

The current research work was conducted with a primary objective i.e., to determine the aggregate import demand function for Sudan and to identify the key determinants of aggregate import demand levels. The research article quantified the Sudanese import demand function on the basis of annual data, for the period spanned between 1978 and 2018. The study made use to ARDL bounds-testing approach to co-integration in order to assess the relationship exists among international reserves, terms of trade, relative prices, real GDP, real exchange rate and aggregate import demand in Sudan. The results attained in the study inferred that there existed a long-run relationship among the factors such as foreign exchange reserves, real income, relative prices and aggregate imports. The study further found that the international reserves were the critical determinant of aggregate import demand in Sudan. According to the attained results, when the foreign exchange reserves increase, it proportionately increases the import demand too. As a consequence, the policies which are aimed at incrementing the foreign exchange reserves tend to boost the imports in turn. ECT coefficient, which denotes the speed of adjustment, remained significant. It further carried an appropriate negative sign, a feature mandatorily required to establish the stability of the model and it can suggest quick convergence to equilibrium.

Huge number of observations are required, if the co-integration model needs to be estimated appropriately. But the data with small sample size poses as a serious issue for Sudan because there is no high-frequency data available on a monthly or quarterly basis. In spite of the presence of few annual data, the records are highly complicated to process due to availability, consistency, creditability, comprehensiveness, and reliability. We suggest that future studies on this topic obtain high-frequency data as well as a larger sample size. This will enable us to provide robust and reliable results. Future research should also focus on export demand as a determinant of import demand.

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-Appendices:

Table (1): Augmented Dickey-Fuller (ADF) Test

Variable	Level		First Difference		Integrated Order
	Intercept	Trend intercept	Intercept	Trend intercept	
Lnir	-1.05	-2.34	-7.14	-7.06	I(1)
LnM	-0.97	-1.90	-5.72	-6.08	I(1)
Lnre	-1.52	-3.37	-7.04	-7.21	I(1)
Lnrp	-0.70	-2.32	-6.30	-6.21	I(1)
Intot	-1.26	-3.04	-6.06	-5.99	I(1)
LnYd	-1.23	-1.08	-5.92	-5.96	I(1)

Source: Author's calculations in EViews-10.

Table (2) Phillips-Perron (PP) Test

Variable	Level		First Difference		Integrated order
	Intercept	Trend intercept	Intercept	Trend intercept	
lnir	-1.05	-2.30	-7.14	-7.06	I(1)
lnm	-0.84	-1.74	-6.15	-12.35	I(1)
lnre	-1.51	-3.45	-9.52	-11.79	I(1)
lnrp	-0.68	-2.39	-9.52	-6.21	I(1)
lntot	-0.97	-2.94	-11.44	-11.98	I(1)
lnyd	-1.23	-1.14	-5.92	-5.97	I(1)

Source: Author's calculations in EViews-10.

Table (3): Long Run Form and Bounds Test

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Sign.	I(0)	I(1)
F-statistic	7.770163	10%	1.99	2.94
K	6	5%	2.27	3.28
		2.5%	2.55	3.61
		1%	2.88	3.99

Source: Author's calculations in EViews-10.

Table (4): ARDL Error Correction Regression

Dependent Variable: D(LONM)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LONIR)	-0.028414	0.061982	-0.458421	0.6505
D(LONIR(-1))	0.188805	0.060279	3.132172	0.0043
D(LONRE)	0.120401	0.102707	1.172283	0.2517
D(D1)	2.193089	0.344105	6.373320	0.0000
CointEq(-1)*	-1.011873	0.113919	-8.882401	0.0000
R-squared	0.772379	Mean dependent var.		-0.005339
Adjusted R-squared	0.744789	S.D. dependent var.		0.641235
S.E. of regression	0.323942	Akaike info criterion		0.705572
Sum squared resid.	3.462958	Schwarz criterion		0.921044
Log likelihood	-8.405865	Hannan-Quinn criter.		0.782235
Durbin-Watson stat	1.807509			

Note: * P-value incompatible with t-Bounds distribution.

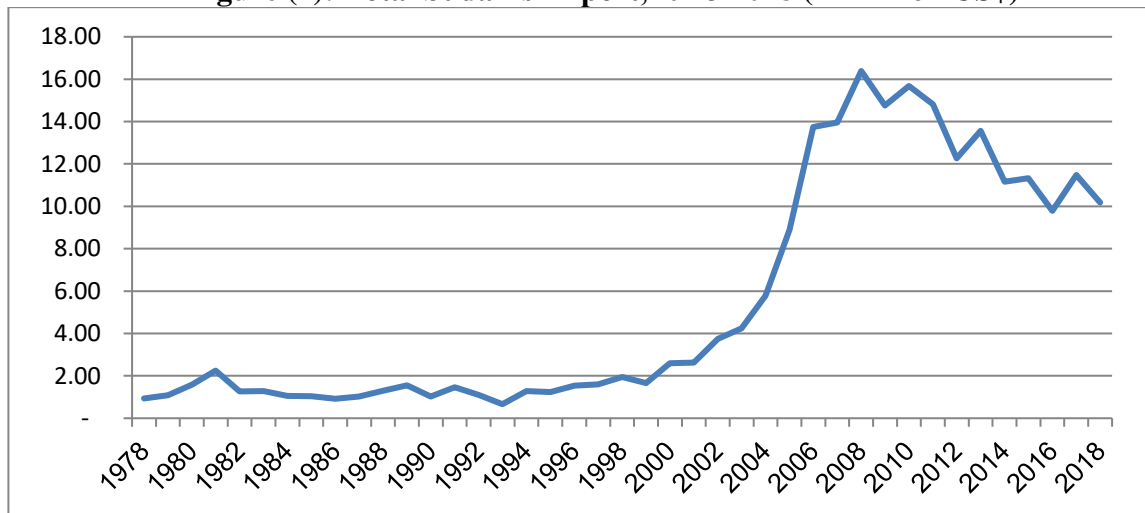
Source: Author's calculations in EViews-10.

Table (5): Breusch-Godfrey Serial Correlation LM Test

F-statistic	1.205408	Prob. F(2,24)	0.3171
Obs*R-squared	3.468692	Prob. Chi-Square(2)	0.1765

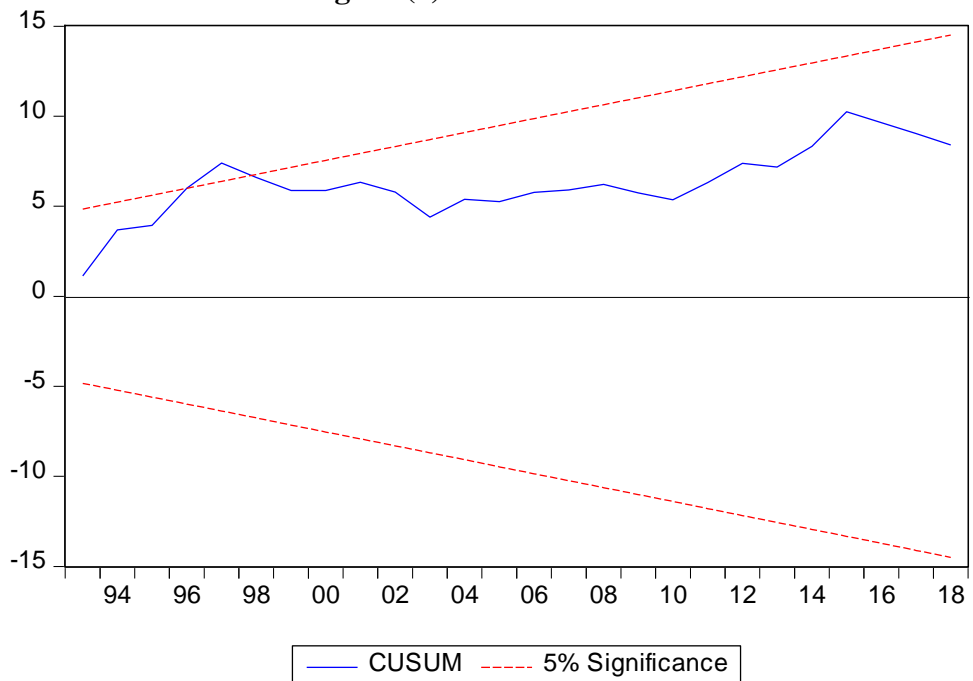
Source: Author's calculations in EViews-10.

Figure (1): Total Sudan's Import, 1978-2018 (in million US\$)



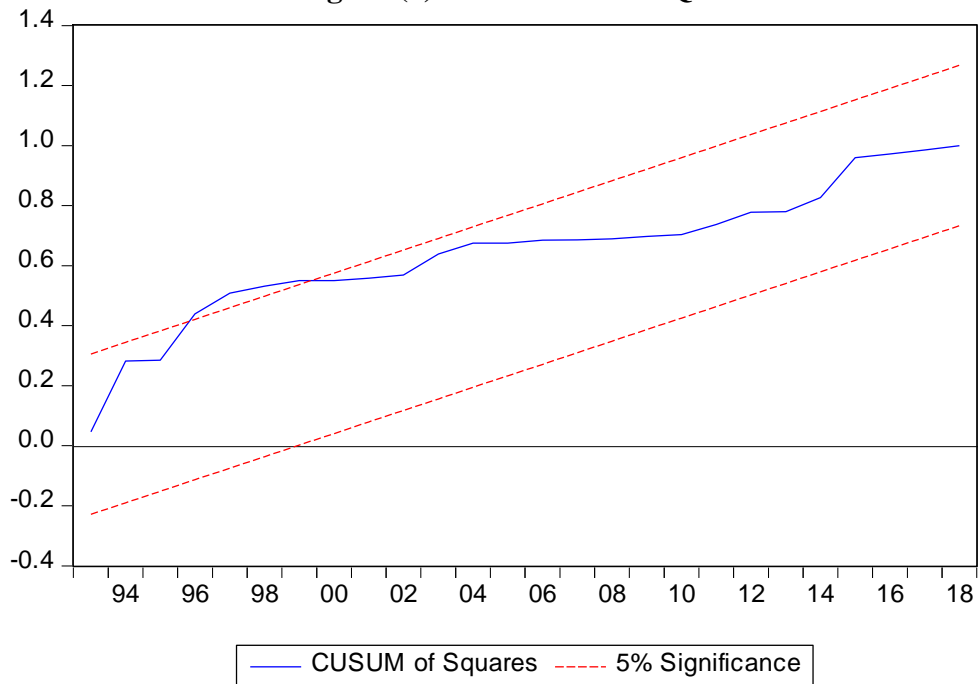
Source: International Monetary Fund, Balance of Payments Statistics Yearbook, 2020.

Figure (2): Plot of CUSUM



Source: Author's calculations in EViews-10.

Figure (3): Plot of CUSUMQ



Source: Author's calculations in EViews-10.

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