

The Determinants of Aggregate Demand Function of Sudan

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Abstract

The main objective of this study is to estimate the determinants of the aggregate import demand function for Sudan during the period 1978 to 2014. The year 1978 was chosen because was the first year of devaluation as recommended by the IMF, and the year 2014 where the data were available. The study tests the stationarity of individual series namely, domestic income, relative prices and exchange rate using the widely used the Augmented Dickey-Fuller (ADF) and Phillips-Peron (PP) statistics and Johansen co-integration techniques to estimate import demand function in the long-run. The estimated results indicate that there is long-run co-integration relation among the volume of imports, domestic income, relative prices and exchange rate. The results of this study suggest that GDP has greater effect on the quantity of import than the other determinants (price ratio and exchange rate).

Keywords: Sudan; Import aggregate demand; Unit root test; Co-integration

Introduction

Sudan is a small-open agricultural-based economy in which the agricultural sector constitutes 36.3% of its GDP, while its exports is made up of cotton on average 39.8%, sesame 8.9%, groundnuts 5.5%, Arabic Gum 12.2% and livestock 8.7% of GDP during the period of study (Economic Reviews, various issues).

The country relying heavily on the production and exportation of these cash crops which comprise a large portion of merchandise export for her foreign exchange earnings, which in turn used to finance the importation of goods from the industrialized nations.

Production in agricultural sector is below capacity and low trend growth coupled with tremendous variability due mainly to the influence of weather on the dominant agricultural crops. Natural shocks such as droughts and desertification between 1982 and 1985, flood and locusts in 1988, these have had severe adverse impacts on the growth of agricultural output and consequently on GDP. Virtual stagnation of real exports is due to the poor production performance as well as policies that directly act as disincentives to exportation. Overall agricultural production has grown more slowly than population coupled with the declining food production per capita has led to rising food imports.

The exploration of her oil resources and the subsequent development of the oil sector have only made Sudan not to rely on the exportation of primary products for her foreign exchange earnings. Consequently, growth in personal and business incomes has led to an increase in consumer and business spending particularly on imports. The increase in demand for imports has also occurred for all sectors of the economy, partly because of rapid population growth. Between 2000 and 2014; population increased from 31.1 million to 36.2 million in annual rate of 0.36.

There has been a tremendous rise in Sudan's level of imports over the last few years, especially following the liberalization regime of the 1990s. In addition, the economy has experienced a rise in foreign exchange reserves and economic growth. However, as a result of its limited export profile, Sudan's trade deficit has worsened. In light of these circumstances, it has become essential to determine which factors explain the abrupt variations and continuous growth in imports for Sudan.

Composition of imports

Sudan like many small primary-commodity producing countries resorted to import more intermediate and capital goods from abroad for its import substitution and industrialization programs and to support and sustain economic growth. Sudan also imports of consumer goods to complement domestic supply, or in some cases to meet the entire requirement of domestic demand have been increasingly tremendously. Sudan is heavily dependent on merchandise imports. Imports of Sudan were growing over time during 1970 to 1998.

Sudan's imports consist largely of consumer goods and some capital and intermediate goods for investment purposes. Consumption imported goods formed a sizeable proportion of total imports, decrease in the middle part of the period, but towards the end of the period under study became more prominent again. Fluctuations in domestic agricultural production are the chief reasons for such a trend. On the other hand, imports of capital goods were increasing both in absolute terms and in terms of dominance over other imports. These capital goods were used primarily in manufacturing, and facilitating industries.

For Sudan, import consists largely of consumer and producer goods (capital equipment, maintenance items, and imported components) and there are no adequate domestic substitutes.

Table 1 shows that the share of consumer goods formed a sizeable proportion of Sudan's total imports.

Source of imports

As regards to the sources of imports, the industrial countries mainly European Economic Community (EEC) represents the primary sources of imports and the most important trading partner supplying 12.5% of Sudan's total imports in 1995. Among the EEC, UK used to be Sudan's main supplier, this may be due to historical reasons, that

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Variable (Series)	No. of lags	First diff. test stat.	Order of Integration
lnM	1	-6.14	I (1)
lnYD	1	-6.13	I (1)
lnPR	1	-8.66	I (1)
lnEX	1	-3.84	I (1)

The variables are integrated of order I (1) at the 5% and 1% significance level.

Table 1: The calculated ADF test statistics for unit root for first differenced data (1978-2014).

is, colonial bond. In Asia, China has become the most important market. Saudi Arabia, as in the case of exports, is the most important trading partner in Middle East, supplying about 10.3% of Sudan's total imports in 1995, leading the list of suppliers as a single dealer. The bulk of imports from this country consisted mainly of petroleum and petroleum products (this percentage dropped substantially due to its reduced imports of petroleum as Sudan turned in 1998 from a net importer to a net exporter of that commodity).

Objective of the study

The main objective of this paper is to determine which factors cause import fluctuations by empirically estimating the import demand function of Sudan on the basis of annually data for the period 1978-2014.

This paper is organized as follows: section II provides a discussion of the literature review (theoretical framework and empirical studies). Section III provides An Econometric Model of Demand for imports. Section IV. Method of Estimation used for the study. The empirical results follow in section V, while section VI contains a summary of our result, conclusion and policy implications. Section VII contains recommendations, section VIII provides limitations of the study and suggestions for further research. Finally, section IX contains data definitions or descriptions and sources are listed in the Appendix.

Brief Overview of the Empirical Estimates of the Import Demand Function

There are numerous empirical studies of import demand function most of which estimate best-fit models using different econometric techniques and measures or different determinants of import demand. Explanatory variables such as relative prices and GDP appear to explain most of the variations in import demand.

The objective here is to review some of these studies as a guide to the choice of appropriate variables used in this study. The studies are organized in ascending order.

Tirmazee and Naveed [1], estimates empirically the conventional import demand function for Pakistan using time series data for the period 1970 to 2010. That is the determinants of imports (relative prices measured as the ratio of the import price index to domestic price index; real income was measured by the real GDP, net barter terms of trade measured as the ratio of the unit value index of exports to unit value of imports multiplied by 100, and foreign exchange reserves as a fraction of real GDP), in the long run and the short run using a vector error correction model and impulse response functions. Their main findings indicated that, for the given period there was a long-run equilibrium relationship between import demand and real GDP, relative prices, the terms of trade and foreign exchange reserves availability, it also showed that, relative prices and income lose their significance as long-run determinants of import demand. The authors argued that, this loss of significance indicated additional determinants. However, their model was not included exchange rate.

Kim and Lee [2] estimated the future soybean import demand for China, Japan and South Korea. The results indicated that China's soybean import demand will increase faster than demand in Japan and South Korea. The data used are the 20 years of annual data from 1991 to 2010 for China. Forty years of annual data from 1971 to 2010 are used for Japan and South Korea. The determinants are world soybean price, exchange rate, GDP and WTO as dummy variable.

Aziz and Bhaban [3] focused on empirical modelling of import demand function for a developing country: the study used annual data from 1978 to 2008, all the variables are in real term and data are in local currency. The Engle-Granger and Johansen co-integration techniques and the error correction mechanism are employed to estimate import demand functions in the long-run. The estimated results indicated that in addition to the real income and the relative prices of imports, foreign exchange reserves are also found to be a significant determinant of import demand. Export demand which is overlooked by the existing literature, was found to be significant determinant in both the short-run and long-run for the country which imports 'capital goods' for its exporting industries.

Yue [4] examined an econometric estimation of disaggregated import demand function for Cote D'Ivoire using time series data for the period 1970-2007. An Autoregressive Distributed Lag (ARDL) modelling process is employed to capture the effect of final consumption expenditure, the investment expenditure, the export expenditure and the relative prices on import demand, and the dummy variable which captures structural change due to trade liberalization. Thus the dummy variable takes the values 0 for 1970-1994 and 1 for 1995-2007. They found that a long-run co-integration relationship between the variables; and showed inelastic import demand for all the expenditure components and relative prices. In the long run, investment and exports are the main determinant in Cote d'Ivoire imports. However, in the short run both of the components of expenditures are the major determinants of import demand. Import demand is not sensitive to price changes.

Anaman and Samantha [5] conducted analysis of the determinants of aggregate import demand in Brunei during the period 1964-1997. Ordinary least method (OLS) was used to estimate the aggregate import demand as a function of the real effective exchange rate, real GDP and population. The study hypothesized that population had an important influence on imports. The results indicated that the real effective exchange rate, real GDP and population all significantly influenced the level of aggregate imports. It was found that population was the most important determinant of demand for aggregate imports. Aggregate imports were both price inelastic and income inelastic but were elastic with regard to population.

Estimated import demand function for Bangladesh from its South Asian partners. Using single equation ordinary least square method and the function is simple linear form using the following variables as explanatory variables, GDP, unit price index of import and exchange rate, the study based on annual observations.

Dutta and Ahmed [6] investigated the existence of a long-run aggregate merchandise import demand function for Bangladesh during the period 1974-1994. The co-integration and error correction modelling approaches have been applied. Empirical results suggested that there exists a unique long-run or equilibrium relationship among real quantities of imports, real import prices, real GDP and real foreign exchange reserves. The dynamic behaviour of import demand has been investigated by estimating two types of error correction models,

in which the error correction terms have been found significant. Real import prices, real GDP and dummy variable capturing the effects of import liberalization policies have all emerged as important determinants of import demand function. The error correction models have also been found to be robust as they satisfy almost all relevant diagnostic tests.

Mwega [7], conducted study on import demand elasticity and stability during trade liberalization: a case study of Kenya. The study utilized an error correction model to estimate demand elasticities for aggregate imports and components in Kenya over 1964-91. The results showed the short-run relative price and real income aggregate import demand elasticity to be non-significant or weakly significant. On other hand, aggregate imports were strongly responsive to lagged foreign exchange reserves and foreign earnings. The non-significant or weakly significant relative price and real income elasticity suggest that devaluation and stabilization policies pursued in the past did not effectively assist trade liberalization efforts; at least at the rate they were implemented. More generally, they suggest that policies that directly increase export earnings and access to external capital inflows are likely to have a larger impact on import volumes than those that concentrate exclusively on aggregate demand and exchange rate management.

An Econometric Model of Import Demand

The aggregate demand for imports by a country as a dependent variable is assumed to depend upon the level of income in the country, relative price of imports (price ratio is the import price to domestic price level), and the real exchange rate (this formulation assumes a degree of substitutability between imports and domestically produced goods) as independent variables.

The functional forms of import demand model used in this paper is standard in the empirical trade literature. This function has been estimated by Khan [8], Mohsen [9-11], Arize and Afifi [12], Aggarwal [13], Moazzami and Wong [14], Dutta and Ahmed [6].

A logarithmic functional form is adopted because it allows imports to react proportionally to changes in their arguments. In addition, Khan [8] pointed out that this specification avoids the problem of drastic falls in elasticity. Haque et al. [15] argue that to capture the partial adjustment behaviour, a lagged term in both dependent and independent variables should be included in the estimated equation. Hence, the inclusion lags in the model.

In the natural log-linear terms the estimating equation has the following form:

$$\text{Log}M_t^d = \beta_0 + \beta_1 \text{Log}YD_t + \beta_2 \text{Log}(PM / PD)_t + \beta_3 \text{Log}E_t + \mu_t \quad (1)$$

Where: M is the real quantity of aggregate merchandise imports as dependent variable.

The first explanatory variable is YD (the real GDP) comes first as an important explanatory variable in the import demand function. Increase in GDP boosts a country's total consumption demand; some of this increased demand is met by increasing import. Hence, GDP and import are hypothesized to be positively related.

The second explanatory variable is the relative prices or price ratio (ratio of import price index to domestic price index) PM is the unit value of imports; PD is the domestic price level, measured in Sudan's CPI. Since we are dealing with total import instead of single commodity, the unit price index (UPI) of import rather than the price of a particular commodity has been used as an explanatory variable.

Fluctuations in the import price index show percentage change in overall import situation. We expect import to decline with the increase in UPI of import, other things (e.g. GDP, exchange rate etc.) remaining the same or constant [16].

The third explanatory variable is the exchange rate E. Since effective exchange rate between Sudan and its main trading partners (USA, Germany, UK, China and Saudi Arabia) could not be found, the exchange rate between Pounds and US dollar was used as proxy variable.

μ_t is the stochastic disturbance (error) term initially assumed to be independently and normally distributed with zero mean and constant variance.

The superscript d refers to demand and t for time periods under consideration.

Ln denotes natural logarithm operator. All the variables are log-transformed.

Following the Keynesian line of argument, it is expected that an increase in domestic income will stimulate imports yielding a positive income elasticity $\beta_1 > 0$ [17]. However, there are indications in the literature that if increase in domestic income is due to an increase in the production of import substitute goods, imports may actually fall, resulting in a negative income elasticity $\beta_1 < 0$, (That is, sign of β_1 could be negative if increases in domestic output exceed the increase in domestic demand for the types of product imported, or if imports from certain countries tend to be inferior goods, or imports are negative difference between consumption and production, for more discussion of this point see. Imports is the difference between consumption and production of domestically produced goods, then as production rises faster than consumption in response to increase in real income, it is possible that the imports will drop, thus yielding a negative income elasticity.

It is expected that an increase in import price relative to domestic price level will hurt import volume resulting in a negative import price elasticity $\beta_2 < 0$. It can also be explained by demand theory which stated an inverse relationship between quantity demanded and price.

A rise in the relative price of imports decreases the quantity demanded, conversely a rise in real income increases import demand.

Defined as units of foreign currency per unit of domestic currency (foreign currency quotation or indirect quotation), or in which the unit of home currency is kept constant, and the exchange rate is expressed as so many units of foreign currency. The expected sign coefficient of E, β_3 , in equation (1) is expected to be positive.

Equation (1) postulated that an increase in domestic real income would encourage more imports while higher import price discourage imports. A devaluation of pound increases the import price in domestic currency, therefore imports fall [18].

In summary, we would expect that: $\beta_1 > 0$ or < 0 , $\beta_2 < 0$ and $\beta_3 > 0$.

β_1 and β_2 measuring income and price elasticity of import demand, respectively. This elasticity is partial elasticity.

Time trend variable was added to the equation, a part from capturing the influence of time on imports, time trend as a variable may help by capturing the influence of any omitted variable on the dependent variable. The assumption here is that the combined influence of the variables left out in the true equation is a smooth function of time.

Method of Estimation

There is now a general consensus that models which have been estimated by standard econometric methods [Ordinary Least Squares (OLS)] do suffer from the so called “spurious regression” problem. The problem is that if the time series variables in the model are non-stationary (which most time series are) the t-ratio (tabulated and calculated t) cannot be used to establish the impact of one variable on the others.

In other words, non-stationary time series data can produce “Spurious” regression coefficients. It is crucial for the estimation model that the data series be stationary [19]. If not, the estimated model may produce “Spurious” results.

Consequently, before estimating levels regressions, it is important to carry out the appropriate tests to ensure all data used are stationary and are of the same order of integration, to avoid spurious regression results.

It has become a standard practice to begin the analysis by examining the time series properties of the data. Two Tests of Unit Root are used in this study:

Augmented Dickey Fuller (ADF) test

This test was proposed as an improvement of the original Dickey-Fuller (DF) test in 1979. A weakness of the (DF) test is that it does not take into account possible autocorrelation in the error process, ϵ_t . As a solution, the (ADF) test uses lagged left-hand side variables as additional explanatory variables to get rid of the problem of possible autocorrelation [20]. The test consists of running a regression of the first difference of the series against the series lagged once, lagged difference terms, and optionally, a constant and a time trend. With two lagged difference terms the regression is equation can be expressed as:

$$\Delta Y_t = \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \beta_3 Y_{t-2} + \beta_4 + \beta_5 t$$

There are three choices in running the (ADF) test regression. One is whether to include a constant term in the regression. Another is whether to include a linear time trend. The third is how many lagged differences are to be included in the regression. In each case the test for a unit root is a test on the coefficient of $Y_{(t-1)}$ in the regression.

The output of the (ADF) test consists of the t-statistic on the coefficient of the lagged test variable and critical values for the test of a zero coefficient. If the coefficient is significantly different from zero then the hypothesis that Y contains a unit root is rejected and the hypothesis that Y is stationary is not rejected. If the (ADF) t-statistic is smaller (in absolute value) than the reported critical values, we cannot reject the hypothesis of non-stationary and the existence of a unit root [21]. We would conclude that the series may not be stationary. We may then wish to test whether the series is I(1) (integrated of order one) or integrated of higher order. A series is I(1) if its first difference does not contain a unit root. We can repeat the (ADF) test on the first difference of the series to test the hypothesis of integration of order 1 against higher orders. We can repeat the test on second differences if we find that the first difference may be non-stationary.

The ADF type regression is of the form:

$$\Delta Y_t = \alpha + \beta_t + \gamma Y_{t-1} + \text{extra lags of } \Delta Y_t$$

To ensure that the residuals are white noise.

Phillips Perron (PP) unit root test

The above DF methodology suffers from a restrictive assumption

that the error processes are i.i.d. i.e., it confines itself to pure ARIMA (1,0,0) process. By many economic time series exhibit time – dependent heteroscedasticity and serial correlation. In order to overcome these problems, have proposed different tests using the z-statistic [22]. These are non-parametric tests because no parametric specification of the error process is involved. Given the overwhelming evidence of heteroscedasticity and non-normality in the raw time series data, the Phillips-Perron (PP) tests are preferable to the DF and ADF tests.

An alternative test for the existence of unit roots was developed. Like the (ADF) test, the (PP) test is a test of the hypothesis $\rho=1$ in the equation:

$$\Delta Y_t = \mu + \rho Y_{t-1} + \epsilon_t$$

But unlike the (ADF) test, there are no lagged difference terms, instead the equation is estimated by Ordinary Least Squares (OLS) (with the optional inclusion of constant and time trend) and then the t-statistic of the ρ coefficient is corrected for serial correlation in ϵ_t .

If the time series variables of $M_t, YD_t, (PM/PD)_t$ and E_t have a unit roots, then we need to take the first difference of the variables (as in equation 2) in order to obtain stationary series:

$$\Delta \log M_t^d = \beta_0 + \beta_1 \Delta \log YD_t + \beta_2 \Delta \log (PM / PD)_t + \beta_3 \Delta \log E_t + \mu_t \quad (2)$$

Equation (2) ignores any reference to the long-run aspects of decision-making. That is, this procedure of differencing results in a loss of valuable ‘long-run information’ in the data. The theory of co-integration addresses this issue by introducing an error-correction term (ECT). The ECT lagged one period (i.e., $ECT_{(t-1)}$) integrates short-run dynamics in the long-run import demand function [23]. (Here exist a long-run equilibrium relationship between the dependent and explanatory variables, and then we get a co-integrating regression. The co-integration regression attempts to fit a long-run relationship among those variables which have the same order of integration. The residuals from the co-integrating regression can be used as the $ECT_{(t-1)}$ to explain the model’s short-run dynamics. This leads us to the specification of a general error correction model (ECM):

$$\Delta \log M_t^d = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta \log M_{t-i} + \sum_{i=0}^n \beta_{2i} \Delta \log YD_{t-i} + \sum_{i=0}^n \beta_{3i} \Delta \log (PM / PD)_{t-i} + \sum_{i=0}^n \beta_{4i} \Delta \log E_{t-i} + \beta_{5i} ECT_{t-1} + \epsilon_t \quad (3)$$

Where $ECT_{(t-1)}$ = error correction term lagged one period.

Thus, equations (1) and (2) are estimated and used to evaluate the effect of changes in exchange rate on the demand import.

If the time series variables for example, import demand function have a unit roots, then we need to take the difference of the variables in order to obtain stationary series:

$$\Delta M_t = \beta_0 + \beta_1 \Delta Y_t + \beta_2 \Delta (PM/PD)_t + \beta_3 \Delta E_t + \mu_t$$

This procedure of differencing results in a loss of valuable long-run information in the data. The theory of co-integration addresses this issue by introducing an error-correction term.

If the series do not follow the same order of integration, then there can be no meaningful relationship among them.

If the series are integrated of the same order, we can proceed to the co-integration test.

Tests for co-integration: The concept of co-integration was

first introduced in literature and is further extended and formalized. (Two or more non-stationary time series are co-integrated if a linear combination of these variables is stationary.

Let us suppose the regression model is $Y_t = \beta X_t + \mu_t$ where Y_t is I(1) and X_t is I(1): then if there is a nonzero β such that $Y_t - \beta X_t$ is I(0), then Y_t and X_t are said to be co-integrated),

The concept of co-integration is based on the idea that, although economic time series exhibit trending behaviour (implying that they are non-stationary), an appropriate linear combination between trending variables could remove the trend component and hence time series could be co-integrated.

Co-integration is relevant to the problem of determination of long-run or 'equilibrium' economic relationships. The importance of co-integration lies in that it allows us to describe the existence of an equilibrium (long-run) relationship among two or more time series, each of which is individually non-stationary. The existence of a long-run relationship among the variables can then be tested.

There are two main approaches to testing for co-integration:

(1) Tests based on the residuals from a co-integrating regression two-step procedure, and ADF test.

(2) And the systems-based tests using the vector auto regression (VAR) Full-information maximum likelihood (FIML) and FIML procedure.

To test for co-integration among the macroeconomic variables we adopt the procedure developed, since this particular method is claimed to be superior to the regression-based Engle and Granger procedure. The Johansen-Juselius method sets out a maximum likelihood procedure for the estimation and determination of the presence of co-integration vectors in a Vector Autoregressive (VAR) system.

For the JJ method, two tests are used to determine the number of co-integrating vectors(r) or where (r) is the number of co-integrating vector: the trace test and the maximum eigenvalue test.

In the trace test, the null hypothesis is that the number of co-integrating vectors is less than or equal to (r), where (r) is 0, 1, or 2. In each case, the null hypothesis is tested against a general alternative. (The trace statistics test the null hypothesis that the number of co-integrating relations is r against k co-integrating relations, where k is the number of endogenous variables).

In the maximum eigenvalue test, the null hypothesis (r)=0 is tested against the alternative that r=1; r=1 against the alternative r=2, etc. (the critical values for these tests are tabulated.

If there is any divergence of results between these two tests, it is advisable to rely on the evidence based on the maximum eigenvalue test, since the results of the latter test are more reliable in small samples.

In this paper, we therefore apply these two tests for our empirical analysis.

Where co-integration is found, an error-correction model is applied.

Formulation and estimation of Error Correction Model (ECM)

Once the variables included in the VAR model are co-integrated, we can use an error correction model (ECM), following both approaches. The correspondence between the co-integration and error correction model is formalized in the Granger Representation Theorem.

In order to estimate ECM the usual procedure followed by applied researchers is to choose to employ only that co-integrating vector which seems to make more 'economic sense' i.e., to use the residuals (ECT) from the preferred co-integration vector. The model may be interpreted as possessing a long-run equilibrium, although random shocks push the system away from equilibrium in the short-run. The error correction term picks up such disequilibrium and guides the variables of the system back to equilibrium. The ECT, therefore, causes changes in the variables of the model. In an error correction model, the dynamics of both short-run (changes) and long-run (levels) adjustment processes are modelled simultaneously.

The size of the error term indicates the speed of adjustment of any disequilibrium towards a long-run equilibrium state. The low coefficient of the error correction term indicates the low speed of adjustment with a prolonged period of disequilibrium.

In order to select an ECM, it needs to satisfy a range of diagnostic tests. The diagnostic tests usually include LM test for autocorrelation, Goldfeld-Quandt test for heteroscedasticity, RESET test for specification.

Empirical Results of Analysis

Unit root tests

We start by checking the order of integration of the variables. As mentioned, the study employs the ADF and PP test statistics in order to examine the order of integration of each series. These two tests are widely used for testing stationary in economic time series.

The null hypothesis for ADF and the PP tests are (same), 'unit root'. Unit root tests for stationary are performed on both levels and first differences of all the 4 variables (M, YD, (PM/PD=PR) and E). The tests results indicate that at 5% level of significance all series (lnM, lnYD, lnPR and lnEX) are non-stationary at level and stationary at first difference, i.e., they are I (1). These two tests (ADF and PP) confirm the existence of unit roots, and therefore non-stationary, in the levels of all the 4 variables. The test results are presented or reported in Table 2.

The results indicate a unit root in the original series but stationary in the first difference in all of the series. Thus the level variables are integrated to order one represented as I (1).

The unit root hypothesis is tested using the ADF test, the length (k) in the ADF regression is selected using the Schwarz criterion.

The results from these tests clearly indicate that almost all series are integrated processes of order 1, or are I (1). In light of this, we proceeded to check if the level variables are able to form a co-integrating vector.

Johansen co-integration results

Since the series are integrated of the same order I (1), we can apply a

Variable (Series)	First diff. test stat.	Order of Integration
lnM	-6.13	I(1)
lnYD	-4.93	I(1)
lnPR	-13.34	I(1)
lnEX	-3.84	I(1)

The variables are integrated of order I (1) at the 5% and 1% significance level. All series are (Constant and trend)
If test statistic > critical value, we reject H₀ of non-stationary.
All the variables were taken in their natural log form and in first-differenced series.
Source: Authors' calculation.

Table 2: The calculated PP test statistics for unit root for first differenced data (1978-2014).

more recent approach to co-integration that has been developed. Their method, which is based on maximum likelihood estimation procedure, two test statistics known as maximum eigenvalue and trace tests that are used to determine the number of co-integrating vectors. The results of the maximum eigenvalue and trace tests to determine the number of co-integrating vectors among the variables of import demand function is reported in Table 3. Given that there are four variables in the model, there can be at most a maximum of three co-integrating vectors, so that r could be equal to 0, 1, 2 or 3.

The trace values obtained are greater than the critical value for $r=1$, implying that the null hypothesis of no co-integration is rejected for trace tests at a 5% level of significance.

The study uses the 'trace' and 'maximum eigenvalue' statistics based on Johansen's multivariate co-integration approach. Both the 'trace statistic' and the 'eigenvalue test' leads to the rejection of the null hypothesis of $r=0$ (no co-integrating vectors) against the alternative hypothesis $r>0$ (one or more co-integrating vectors) while the null of $r \leq 1$ against the alternative of $r>1$ (two or more co-integrating vectors) cannot be rejected at 5% level of significance.

Since, there is no consensus whether the 'trace statistic' or the 'maximum eigenvalue' is superior to its counterpart, the study accepts the 'maximum eigenvalue' results for the model. Hence, it can be concluded from estimation that there is one co-integration relation in the model of import demand function.

Lags interval for all the series are 1.

It is clear from the above Table 3 that the null hypothesis of no co-integrating vector ($r=0$) among all variables that enter into the import demand equation can be rejected at 5% level of significance by maximum eigenvalue, that is the maximal-eigenvalue test indicates no co-integration at both 5% and 1% levels. The trace test indicates 1 co-integrating equation at the 5% level, and it indicates no co-integration at the 1% level.

Our results clearly show that there is at least one co-integrating vector. Therefore, we conclude that, although the individual data series are non-stationary, their linear combination is stationary.

To estimate the equation using OLS:

$$\ln M = \ln M(-1) + \ln YD + \ln PR + \ln EX$$

$$\ln M = 1.23 + 0.87M(-1) + 0.26YD - 0.13PR - 0.02EX$$

Std. Error	(0.69)	(0.08)	(0.21)	(0.08)	(0.03)
t-Statistic	(1.7)	(10.57)	(1.23)	(-1.52)	(-0.59)
Prob.	(0.09)	(0.0000)	(0.21)	(0.14)	(0.55)

R-squared is 0.98 and Durbin-Watson stat is 2.255

All the expected signs are correct, except the sign of exchange rate

which should be positive instead of negative, and this may be due to the inaccurate of the data.

R-squared is very high which indicates the high effects of independents on the dependent variable. DW stat is greater than two it indicates the absence of autocorrelation between the errors terms.

Dividing the coefficient of YD by two and compared with standard error we have found that 0.13 less than 0.21, and t-statistic is 1.28 compared with tabulated t (1.697) indicating that YD can affect the quantity of import.

Comparing probability value (p-value) (0.2106) with the level of significance we have found that it's greater than 0.05, indicating its effect on the dependent variable.

Dividing the coefficient PR by two and compared with its standard error we found that 0.065 is less than 0.08, and its t-statistic is -1.52 compared with tabulated t (1.697) indicating that price ratio has little effect on the quantity of import.

Comparing probability value (p-value) (0.1392) with the level of significance we have found that its greater than 0.05 indicating that its less effect on the dependent variable.

Dividing the coefficient Ex by two and compared with its standard error we found that 0.008 is less than 0.03, and its t-statistic is -0.59 compared with tabulated t is 1.697 indicating that the calculated t (-0.59) is less than the tabulated t (1.697), we accept the null hypothesis, the exchange rate changes has less effect on the quantity of import.

Comparing probability value (p-value) (0.5538) with the level of significance we have found that its greater than 0.05 indicating that its less effect on the dependent variable.

Note: for the calculated t: degree of freedom (df)=n-k (37-4)=33, one-tailed test and significance level (α) is 0.05. n: is sample size and k is number parameters to be estimated.

This relationship indicates that 10% devaluation in the nominal exchange rate will decrease the value of imports by 0.2%. The negative elasticity of imports reflects the elastic nature of Sudanese imports.

The positive sign of income indicated that a 10% increase in the real income of Sudan increase the value of its imports by just 2.3%.

The negative sign of relative price indicates that 10% increase in relative price will decrease the quantity demanded of import by 1.3%.

The quantity demanded of import in current period depends on the quantity demanded of the previous period.

The real income rather than the nominal exchange rate is important in determining the import demand for Sudan.

Conclusion and Implication

Sudan is small open economy, requires import of capital goods

Null hypothesis	Alternative hypothesis	Trace test			λ_{max}				
		Statistic	C.V.	5%	1%	Statistic	C.V.	5%	1%
$r=0$	$r=1$	59.28		54.64	61.24	26.85		30.33	35.68
$r \leq 1$	$r=2$	32.43		34.55	40.49	17.48		23.78	28.83
$r \leq 2$	$r=3$	14.95		18.17	23.46	10.23		16.87	21.47
$r \leq 3$	$r=4$	4.72		3.74	6.4	4.72		3.7	6.4

Abbreviation: r=number of co-integrating vector; λ_{max} =Maximal eigenvalue; and C.V.=Critical Value.

Table 3: Johansen's multivariate co-integration tests.

for exporting industries to develop and grow. The country also has to maintain a good foreign exchange reserves position to convince the trade partners about its ability to pay for imports.

The country face a foreign exchange problem, hence it is expected that their spending on imports will be directly related to their export earnings.

The export sector may depend on use of materials and capital goods which are usually imported. Hence, an increase in exports is likely to be accompanied by an increase in imports.

The results of this study suggest that one of the most important tools at the disposal of policy makers to achieve certain policy targets with respect to imports is the exchange rate. Manage floating exchange rates my success in bringing about a reduction in excessive levels of import demand better to reflect international market conditions.

Recommendations

The direction of trade should be changed away from Asia to USA and Europe.

The country should try to remove the economic sanctions the imposed by USA.

When part of the imports is used as inputs for domestic production, devaluation increases the cost of production and hence may not only be a good policy to improve the trade balance of a country.

Limitations of the Study and Suggestions for Further Research

The estimation of the co-integration model requires large sample size to generate enough degrees of freedom for estimation. However, the small sample size of the data is a problem as Sudan has not started yet to publish high frequency data. Even for annual data, the records suffer from the usual problems of availability, consistency, creditability, comprehensiveness and reliability.

The macroeconomic data of Sudan suffer from various inconsistencies. The series of GDP and CPI for instances are recorded differently for the same year in different yearbooks published by the same source. Developing a consistence database was therefore a difficult task.

In other words, statistical estimates of the relevant macroeconomic variables are unavailable in many cases, and those that been published are often of inferior quality. The limited quantity and poor quality of economic data is the severe data problems.

Suggestions for further research

The empirical results are inconsistent with the existing literature. In particular, the exchange rate often seems to have either an insignificant or perverse. The results appear to be robust statistically.

It is suggested that future studies on this topic should be based on larger sample size so that the results are more reliable and robust.

Adding more variables such as foreign exchange reserves and population for determinant of import demand function.

References

1. Tirmazee ZS, Naveed R (2014) Reviewing Pakistan's Import Demand Function: A Time-Series Analysis, 1970-2010. *The Lahore Journal of Economics* 19: 371-393.
2. Kim CM, Lee ES (2014) Soybean Import Demand Analysis in East Asia: Korea, China and Japan. *Management Review: An International Journal* 9: 4-24.

3. Aziz MN, Bhaban MY (2012) Modeling of Import Demand Function for a Developing Country: An Empirical Approach. *Indian Journal of Economics and Business* 11: 571-586.
4. Yue Y (2010) An Econometric Estimation of Import Demand Function for Cote D' Ivoire. *International Journal of Business and Management* 5: 77-84.
5. Anaman KA, Samantha MB (2001) Analysis of the Determinants of Aggregate Import Demand in Brunei Darussalam from 1964 to 1997. *Asian Economic Journal* 15: 61-69.
6. Dutta D, Ahmed N (1999) An Import Demand Function for Bangladesh: A Cointegration Approach. *Applied Economics* 18: 1-48.
7. Mwega FM (1993) Import Demand Elasticities and Stability during Trade Liberalization: a Case study of Kenya. *Journal of African Economies* 2: 381-416.
8. Khan MS (1974) Imports and Exports Demands in Developing Countries. *Staff Papers, International Monetary Fund (Washington)* 21: 678-693.
9. Mohsen OB (1984) On the Effects of Effective Exchange Rates on Trade Flows. *Indian Journal of Economics* 65: 57-67.
10. Mohsen OB (1986) Determinants of International Trade Flows-the case of Developing Countries. *Journal of Development Economics* 20: 107-123.
11. Mohsen OB (1991) Is there a long Relation between the trade balance and real Effective Exchange Rate of LDCs. *Economic Letters* 36: 403-407.
12. Arize A, Afifi R (1987) An econometric Examination of Import Demand Function in Thirty Developing Countries. *Journal of Post Keynesian Economics* 9: 604-661.
13. Aggarwal, Ram M (1984) Devaluation, Determinants of International Trade Flows and Payments Imbalances. *Indian Economic Journal* 31: 24-33.
14. Moazzami B, Wong E (1988) Income and Price Elasticities of China's Trade. *Asian Economic Review* 30: 218-229.
15. Haque NU, Karjal L, Montiel P (1990) Estimation of Rational Expectations Macroeconomic Model for Developing Countries with Capital Controls. Washington: International Monetary Fund (Unpublished).
16. Central Bank of Sudan. Annual Reports (various issues), Khartoum.
17. John G (1981) Devaluation and the Balance of Payments Adjustment in a Developing Economy: An Analysis Relating to Jamaica: 1954-72. *Applied Economics* 13: 151-165.
18. Hemphill WL (1974) The Effect of Foreign Exchange Receipts on Imports of Less Developed Countries. *IMF Staff Papers* 21: 637-77.
19. Bert HG, Lawrence J (1973) Elasticities of Substitution and Export Demand in a World Trade Model. *European Economic Review* 4: 347-380.
20. IMF, Direction of Trade Statistics (various issues). Washington, DC.
21. IMF, International Financial Statistics (various issues). Washington, DC.
22. Sudan Central Bureau of Statistics. Annual Reports (various issues), Khartoum.
23. Sudan Ministry of Finance. Economic Review (various issues), Khartoum.