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The Effects of Exchange Rate Change on Imports and Exports: The Sudanese Case

AHMED ABD ALLAH IBRAHIM[1]
MOHAMMED B. YUSOFF[2]

Introduction

Most of the developing countries have faced serious economic crises over the past four decades in various forms such as low growth rates, balances of payments deficits, and high foreign debt. The causes for this poor economic performance include deteriorating terms of trade, high interest rates, protectionism, the devaluation of the British sterling pound in 1967, the French franc in 1969, the US dollar in 1971 and 1973 and the two oil price hikes in 1973/74 and 1979/80. The Sudan economic crises are due to slow growth rates and increasing balance of payments deficits. As the government budget worsens, the government has resorted to increasing external and domestic borrowings to finance the deficit causing excessive monetary growth and inflation. Besides, non-economic factors, namely political instability has also played a significant role in the economic crisis. As the economic situations worsened, Sudan devalued the pound (Sudanese currency) by 14.25% on 8th June 1978, which was the first formal devaluation, in order to prevent the country's import bills from rising to unmanageable level, to encourage exports, to protect the products of local industries from excessive competition from abroad and to accelerate the rate of growth through opti-

[1] Ph D canditate, Department of Economics, Faculty of Economics and Management, Universiti Putra Malaysia, Serdang.
[2] Professor, Department of Economics, Faculty of Economics and Management, Universiti Putra Malaysia, Serdang.

mal allocation of resources by exploiting the Sudan's present and potential comparative advantage, particularly in agriculture and agro-industries.

The main objective of this paper is to determine whether there are long-run equilibrium relationships between the variables in the imports and export demand functions. Specifically, we formulate the demand for exports and imports and estimate them by using the cointegration technique to test whether the variables in the equations are cointegrated. The long-run elasticities of exports and imports are estimated from the estimated cointegration equations.

Review of Literature

The trade balance is affected by a number of factors, including exchange rate changes, monetary and fiscal policies, domestic economic growth, income changes abroad, unexpected supply shocks, and the economy's international competitiveness. This paper will address some of these factors, mainly the real exchange rate changes and, hence, the international competitiveness, to show how they influence the exports, imports and the balance of payments of a country. The neo-classical theory of microeconomic analysis argues that the adjustment in the balance of payments center on the relative prices of home and foreign goods called the elasticities model. The essence of the theory is embodied in the famous and widely recognised Marshall-Lerner condition based on a number of simplifying assumptions. In its simplest form, the Marshall-Lerner condition states that if the sum of price elasticities of exports and import demands, in absolute value, exceeds unity then devaluation could improve the balance of payments. Several studies have been attempted to measure the effects of the exchange rate changes on aggregate exports and imports. The results of some of these studies have suggested that the exchange rate is an important determinant of trade balance while others find otherwise.

Gafar (1981) conducted a study on the effects of devaluation on the balance of payments in Jamaica and he found that devaluation could improve the balance of payments. Ogbonna (1982) analysed the 1973

devaluation of the Naira (Nigerian currency) in Nigeria and concludes that the devaluation had an insignificant effect on the balance of payments. Arize (1987) conducted a study using annual data to investigate the price responsiveness of export and import demand and supply in eight African countries. The results indicate that the export and import demand price elasticities were generally large. Briguglio (1989) investigated whether a decrease in the external value of the Maltese Lira would improve the Maltese balance of trade and found that the sum of the export and import demand price elasticities was larger than one, indicating that the Marshall-Lerner condition was satisfied. In Malaysia, Yusoff and Baharumshah (1993) analysed the effects of Ringgit real exchange rate on the demand for exports of Malaysian primary commodities and they found that the price and exchange rate elasticities were inelastic. Although the real exchange rate has the ability to influence the demand for exports of primary commodities from Malaysia, the effects are small implying that depreciation of the Ringgit may not improve the trade balance of Malaysia. A further study by Yusoff (1994) on the exchange rate and trade balance in Malaysia finds that exchange rate is not an important factor in determining the export and import demand and that the sum of the two price elasticities in less than unity, suggesting that exchange rate depreciation may not improve the Malaysian trade balance. Reinhart (1995) re-examined the relationship between relative prices of imports and exports in a sample of twelve developing countries using annual data and he found that for the majority of cases, the relative prices were significant determinant of the demand for imports and exports but the price elasticities tended to be low and in most instances were well below unity. Bahmani-Oskooee (1998) has conducted a study to estimate the long-run trade elasticities in LDCs, namely Greece, Korea, Pakistan, the Philippines, Singapore and South Africa employing the cointegration technique, over the floating exchange rate period of 19731-1990IV. The results suggest that in most LDCs considered in the study, devaluations could indeed improve their trade balances.

Empirical Models

The model of trade flows to be developed in this section is conventional in the sense that it includes variables found in many other studies of

imports and exports. The import (export) demand model is conceptually like any other demand model except that the exchange rate is included as an explanatory variable.

Import Demand Model

In log-linear terms, the import demand equation has the following form:

$$M_t^d = \beta_0 + \beta_1 YD_t + \beta_2 (PM/PD)_t + \beta_3 EER_t + \mu_{1t} \quad (1)$$

where M is the quantity of imports, YD is the Sudanese GDP, PM is the unit value of imports, PD is the domestic price level (measured in Sudan's CPI), EER is real effective exchange rate in US dollar, μ is the error team, superscript d refers to demand and subscript t to time period. 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 $\beta_1 > 0$. However, if the increase in the 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, the sign of β could be negative if increase in domestic output exceed increase in domestic demand for the types of product imported or if the imports from certain countries tend to be inferior goods (Khan and Rose, 1975). It is expected that an increase in the import price relative to domestic price level will hurt import volume resulting in a negative import price elasticity $\beta_2 < 0$. The coefficient of EER, β_3, in equation (1) is expected to be positive, that is a decrease in the external value of Sudanese pound will reduce imports.

Export Demand Model

It is postulated that the export demand depends on income of the world, export prices relative to the price of foreign substitutes and the real effective exchange rate. A log-linear equation of the world demand for Sudan's exports is specified as:

$$X_t^d = \alpha_0 + \alpha_1 YF_t + \alpha_2 (PX/PF) + \alpha_3 EER_t + \mu_{2t} \quad (2)$$

where X is the quantity of exports, YF is foreign income measured in

gross domestic product (GDP) of six major trading partners of Sudan representing the rest of the world (countries are United States, United Kingdom, Japan, Germany, China and Saudi Arabia). PX is the unit value of exports, PF is world consumer price index (CPI) measured in consumer price index of the mentioned Sudan's trading partners. The other variables are as defined before. Equation (2) states that, foreign real income is positively related to export demand; and increase in foreign income would spur the demand for Sudanese exports, that is the sign of α_1 is positive. On the other hand, an increase in export price relative to that of the rest of the world is expected to hurt the country's export, thus, α_2 is negative. The coefficient of EER, α_3, is expected to be negative, since devaluation of domestic currency is expected to stimulate exports.

Methods of Estimation

In this paper, we employ the Johansen cointegration techniques to test the effects of exchange rate adjustment on Sudan's exports and imports. Where cointegration is found, an error-correction model is applied.

Unit Root Tests

Over the past decade, the unit root tests in autoregressive time-series models have received considerable attention in the econometric literature. The unit root test is the test for the order of integration. The basic idea is that, the order of integration of a series is given by the number of time a series must be differenced in order to produce a stationary series. If non-stationarity is detected in a series it can be eliminated by differencing the series until stationary is obtained. In time series jargon, a non-stationary series which can be transformed to a stationary series by differencing d times is said to be integrated of order d denoted by I((d). When the time series are non-stationary then the estimated coefficients are likely to be inconsistent. Furthermore, the assumption of the usual asymptotic econometric properties will not hold, and the standard statistical tests will not be valid (Philips, 1986). To determine whether a variable is level or first differenced stationary, the most popular tests are the Augmented Dickey-Fuller, ADF, (Dickey and Fuller, 1979) and Phillips-Perron, PP, (Phillips and Perron, 1988) tests. Both the ADF and

PP tests are unit root tests and the null hypothesis is that the series are non-stationary.

Cointegration and Granger (Temporal) Causality

The cointegration technique pioneered by Engle and Granger (1987), Hendry (1986) and Granger (1986), made a significant contribution towards testing the Granger-causality. Two or more variables are said to be cointegrated i.e. they exhibit long-run equilibrium relationship(s), if they share common trend(s). As long as the two variables have a common trend, causality (in the Granger sense), must exist in at least one direction, either unidirectional or bi-directional [Granger (1986), 1988]. However, although cointegration indicates the presence or absence of Granger-causality, it does not indicate the direction of causality between variables. This direction of the Granger (or temporal) causality can be detected through the vector error correction model derived from the long-run cointegrating vectors.

Vector Error-Correction Modelling (VECM)

Engle and Granger (1987) demonstrate that once a number of variables are found to be cointegrated, there always exists a corresponding error-correction representation which implies that changes in the dependent variable are a function of the level of disequilibrium in the cointegrating relationship (captured by the error-correction term) as well as changes in other explanatory variable(s). By Granger Representation Theorem we may write the import demand model in terms of vector error-correction model:

where $\Delta Z_t = Z_t = Z_{t-i}$ and Z represents the logarithm of quantity of imports, price ratio, domestic income and real effective exchange rate [i.e. QM_t, PMR_t, YD_t, EER_t respectively]. ECT refers to error-correction term(s) derived from the long-run cointegration relationship using the Johansen maximum likelihood procedure, and μ_{ht} 's (for h = 1, 2, 3, 4) are serially uncorrelated random error terms with mean zero. Equations (3) to (6) will be used to test the causality.

The Granger-causality or endogeneity of the dependent variable can be exposed either through the statistical significance of: (1) the lagged ECTs (λ's) by a t-test; (2) a joint test applied to the significance of the sum of the lags of each explanatory variables (β's, θ's, δ's and γ's) by a joint F or Wald χ^2 test; or a joint test of all set of terms just described in (1) and (2) by a joint F or Wald χ^2 test. The insignificance of both the t and F or Wald χ^2 test in the vector-correction model (VECM) indicates econometric exogeneity of the dependent variable. In addition to indicating the direction of causality among the variables, the VECM approach allows us to distinguish between "short-run" and "long-run" Granger causality. When the variables are cointegrated, then in the short-run, deviations from this long-run equilibrium will feed back on the changes in the dependent variable in order to force the movement towards the long-run equilibrium. If the dependent variable (say quantity of import) is driven directly by this long-run equilibrium error, then it is responding to this feedback. If not, it is responding only to short-run shocks to the stochastic environment. The F-tests of the "differenced" explanatory variables give us an indication of the "short-run" causal effects, whereas the "long-run" causal relationship s implied through the significance or other wise of the t-test (s) of the lagged error-correction term(s) that contains the long-term information since it is derived from the long-run cointegration relationship(s). The coefficient of the lagged error-correction term, however, is a short-term adjustment coefficient and represents the proportion by which the long-run disequilibrium (or

imbalance) in the dependent variable is being corrected in each short period.

The Data: Sources and Definitions

The data for this paper are compiled from published sources: Sudan's Government publications, particularly Bank of Sudan, Annual Reports, and Ministry of Finance, Economic Review, and various issues; international publications, namely, IMF publications, particularly, International Financial Statistics. All the data are annual data from 1970 to 1998 and are in the index form in which the base year chosen for the study in 1990 = 100. All the variables are expressed in terms of US dollars. Where a series is only available in domestic currency, it will be converted by use of the equivalent official exchange rate.

Results and Discussion

In this section, we shall discuss the results of the unit root test, cointegration test and Granger causality test based on the vector error-correction model.

Unit Root Tests

The results of the unit root test on the level and its first-difference of the series are given in Table 1. In all the cases for the unit root tests on the levels, the absolute value of test statistics are smaller than the absolute critical value of McKinnon, suggesting that the null hypothesis of unit root cannot be rejected and all the series under study are nonstationary in their level forms. Since all the series are integrated of the same order,

Table 1: Unit Root Test

Test type	ADF		PP	
Variable	Levels	First Difference	Levels	First difference
QM	-2.960339	-5.595186***	-1.777346	-8.096300***
YD	-2.942357	-3.948231***	-2.650684	-4.699517***
PMR	1.659332	-3.826985***	-1.995772	-7.362252***
QX	-2.594323	-5.386082***	-2.707686	-5.272738***
YF	-2.037839	-3.181593**	-2.469441	-3.573074**
PXR	-1.755334	-3.473678*	-1.738775	-4.899117***
EER	-2.918089	-4.935727***	-2.790983	-6.078771***

Note:
(***), (**), and (*) denote 1%, 5% and 10% levels of significance respectively. These levels are Mackinnon critical values for rejection of null hypothesis of a unit root.

I(1), the series can be further tested for the existence of long-term relationships among them using the cointegration technique.

Cointegration Test

The results of the maximum eigenvalue (λ_{max}) and trace test to determine the number of cointegrating vectors among the variables of import and export demand equations are reported in Table 2 and Table 4. Given that there are four variables in the model, there can be at most a

Table 2: Cointegration Results for Import Demand Equation

Hypothesis			Test statistics		Critical Values			
Null	Alternative				95%	90%	95%	90%
	λ_{max}	trace	λ_{max}	trace	λ_{max}		trace	
r = 0	r = 1	r >=21	30.28**	49.26**	27.42	24.99	48.880	45.70
r<= 1	r = 2	r >= 2	11.26	18.98	21.12	19.02	31.540	28.78
r <=2	r = 3	r >= 3	7.51	7.73	14.88	12.98	17.860	15.75
r <=3	r = 4	r = 4	0.22	0.22	8.07	6.50	8.070	6.50

Notes:
** significance at 5% level of significance.
r = number of cointegrating vector and λ_{max} is the maximal eigenvalue.

maximum of three cointegrating vectors, so that r could be equal to 0, 1, 2 or 3.

Cointegration Test: Import Demand Function

It is clear from Table 2 that the null hypothesis of no cointegrating

vector (r+0) among all variables in the import demand equation can be rejected at the 5% level of significance by both λ_{max} and trace tests. This is because at least one of the statistics is greater than its critical value. However, the null hypotheses of r <= 1, r <= 2 and r <= 3 for both λ_{max} and trace cannot be rejected at a five per cent level of significance. Consequently, we conclude that there is only one cointegrating vector among the variables of import demand function. The estimated cointegration equation of import demand is:

$$QM = -1.039179\ PMR + 1.418707\ YD + 5.216860\ EER + 0.639027$$
$$\qquad\qquad (0.31396) \qquad (0.60758) \qquad (0.11695)$$

The numbers in parentheses are standard errors, PMR is the price ratio (PM/PD). Generally, the results of the import demand equation as shown above are found to be satisfactory in terms of correct signs. It is seen that the price ratio of imports is significant at 1% level and it has correct positive sign where the elasticity is 1.04 which implies that the imports are elastic to the price ratio changes. Domestic incomes as proxied by Sudan GDP, is significant at 5% level and it has correct positive sign and the elasticity is 1.4 which is also elastic. This implies that the Sudan demand for imports is responsive to the changes of Sudan GDP implying that a ten per cent increase in GDP would result in 14 per cent increase in import demand. The real effective exchange rate is significant at 5% level of significance. The elasticity of demand with respect to real effective exchange rate is 5.2; a ten per cent devaluation would increase import by 52 per cent.

Granger Causality Based on VECM of Import Demand

Since the cointegrating equation does not indicate the direction of causality, therefore the VECM model is used to ascertain the causality both in the short and long run. The Granger causality test is then carried out after the variables are found to be cointegrated. The results of VECM for the import demand function are presented in Table 3. Given the

Table 3: Granger Causality Tests of Import Demand Based on VECM

Dependent Variables	Independent Variables				Error Correction Term
	Δ QM	Δ PMR	Δ YD	Δ EER	ECT
		F-statistics			t-test
QM	-	2.898*	5.208**	3.775**	-1.859*
PMR	1.170	-	4.344**	2.811*	-1.400
YD	0.344	2.016*	-	2.481*	-1.308
EER	5.181**	0.475	12.892***		0.191

Notes: (***), (**), and (*) denote 1%, 5% and 10% levels of significance respectively.
All series are log-transformed and as defined before.

presence of a unique cointegrating vector in the VAR model, one error-correction term is incorporated in the model.

Table 3 shows the results of the causality test on the import equation. The F-tests suggest that, in the short-run, all the explanatory variables: the price ratio (PMR), domestic income (YD) and real exchange rate (EER) could affect quantity of imports at 10% and 5% significant levels respectively. But feedback occurs among quantity of imports and the real effective exchange rate. This indicates the significance of the exchange rate in the Sudanese economy. In the price ratio equation, only domestic income and the real effective exchange rate could affect the price ratio. In the domestic income equation, only the price ratio and the real effective exchange rate could affect the domestic income at 10% level of significance and there is feedback causality between price ratio and domestic income. In the real exchange rate equation, only quantity of imports and domestic income could affect the real exchange rate at 5% and 10% level of significance respectively. The results also suggest that the real exchange rate, price ratio and domestic income are likely to be weakly exogenous variables in the system as their error-correction terms (ECT) are not significant.

Cointegration Test: Export Demand Function

Table 4 shows that there is only one cointegrating vector at the 5% level of significance as the null hypothesis of no cointegrating vector ($r = 0$) was rejected for both λ_{max} and trace at the same levels of significance. However, the null hypotheses of $r <= 1$, $r <= 2$ and $r <= 3$ for both

Table 4: Cointegration Results for Demand Equation Hypothesis

Hypothesis			Test statistics		Critical values			
Null	alternative				95%	90%	95%	90%
	λ_{max}	trace	λ_{max}	trace	λ_{max}		trace	
R = 0	R = 1	R >= 1	34.03**	69.21**	31.79	29.13	63.00	59.16
R <= 1	R = 2	R >= 2	22.25	35.17	25.42	23.10	42.34	39.34
R <= 2	R = 3	R >= 3	7.08	12.92	19.22	17.18	25.77	23.08
R <= 3	R = 4	R >=4	5.85	5.85	12.39	10.55	12.39	10.55

Notes:
** Significant at 5% level of significance.
R is the number of cointegrating vector and λ_{max} is maximal eigenvalue.

λ_{max} and trace cannot be rejected at the five per cent level of significance. Consequently, we conclude that there is a unique cointegrating vector among the variables of export demand function.
The estimated cointegration equation of export demand is:

$$Qx = -0.788391\ PXR + 3.543633\ YF - 2.161517\ EER + 1.980128$$
$$(0.20235) \qquad (0.79991) \qquad (0.57409)$$

where the numbers in parentheses are standard errors. The results of the long-run export demand equation are similar to those of the import demand equation. Generally, the results of the export demand equation as shown above are found to be satisfactory in terms of correct signs. It is seen that the price ratio of export is significant at the 5% level and it has the correct negative sign. The elasticity of exports demand with respect to price ratio PXR, was found to be inelastic at 0.79. The world income, YF, as proxied by the Sudan's trading partners' GDP, is significant at the 1% level. The elasticity with respect to income is 3.5 which implies that the foreign demand for Sudan's exports is responsive to the changes in world income. In other words, a ten per cent increase in foreign GDP, would result in 35 per cent increase in the demand for Sudan's exports. The real effective exchange rate, EER, is significant at 5% level. The elasticity of export demand with respect to real effective exchange rate is 2.2. This implies that the demand is responsive to the changes in the real effective exchange rate; a ten per cent devaluation would increase export demand by 22 per cent. The results of the estimated cointegration equations of import and export demand functions show that the sum of the absolute values of price elasticities is greater than unity at 1.788,

indicating that the Marshall-Lerner condition is satisfied. Thus, in the long run, devaluation could improve the trade balance of Sudan.

Granger Causality Based on VECM of Export Demand

Table 5: Granger Causality Tests of Export Demand Based on VECM

Dependent Variables	Independent Variables				Error Correction Term
	Δ QX	Δ PXR	Δ YF	Δ EER	ECT
		F-statistics			t-test
Δ QX	-	1.088	0.591	5.409***	-6.818***
Δ PXR	0.423	-	1.710	2.653*	0.6151
Δ YF	2.517	2.718*	-	2.281	-1.763
Δ EER	8.767***	7.762***	6.104***	-	-0.599

Notes: (***), and (*) denote 1%, 5% and 10% levels of significance respectively.
All series are log-transformed and as defined before.

The results of the temporary causality based on VECM of export demand function are presented in Table 5.

Table 5 shows that in the export equation, only one explanatory variable could affect the quantity of export, that is, the real effective exchange rate which is significant at the 1% level. When examining the error-correction term in the model, the quantity of exports showed weak endogeneity as the error-correction term was statistically significant at the 5% level. In the price ratio equation, likewise, only the real effective exchange rate could affect the price ratio which is significant at the 10% level. The error-correction term in the model was not significant, indicating that the price ratio was weakly exogenous. In the foreign income equation, only price ratio could affect foreign income is significant at 10% level. The error-correction term in this equation of the model is not significant. In the real exchange rate equation, all the explanatory variables: quantity of export, price ratio and foreign income could affect real exchange rate at the 1% level of significance. Feedback occurs among real exchange rate with quantity of export, and real exchange rate with price ratio. When examining the error-correction term in the model, the real exchange rate proved to be weakly exogenous as the error-correction term was not significant.

Conclusion and Policy Implications

The main objective of this paper is to investigate the relationship of

the exchange rate changes on the aggregate imports and exports of Sudan. The recently developed time-series technique such as unit-root testing, multivariate cointegration and vector error-correction modeling are employed.

The findings of the study suggest that there is a significant long-run relationship between Sudan's pound exchange rate and the aggregate exports and imports demand supporting the proponents of currency devaluation as an important macroeconomic policy to reduce the trade deficit. This is supported by a cointegration analysis on the relationship between exchange rate changes, aggregate exports and imports. The long-run elasticity of import demand with respect to relative price is 1.04, while the long-run elasticity of export demand with respect to relative price is 0.79. Thus, the sum of the absolute values of price elasticities is greater than unity, indicating that the Marshall-Lerner condition is satisfied. The Granger causality test shows that in the short run the real effective exchange rate could affect both the quantities of imports and exports. Hence, the exchange rates changes will make the exports cheaper in the foreign market and imports dearer in the domestic market, so that promoting exports and discouraging imports will help to improve the balance of trade of Sudan.

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