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Full Length Research Paper

Impact of exchange rate reforms on Sudan's economy: Applied general equilibrium analysis

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Exchange rate is one of the major trade policy instruments used to correct current account deficit. This study used the standard computable general equilibrium (CGE) model developed by the International Food Policy Research Institute (IFPRI) to analyze the possible effects of exchange rate policy on the Sudanese economy. Sudan social accounting matrix (SAM) for year 2000 was used as a core database for the model. The results revealed that depreciation of exchange rate improved the GDP, due to improvement in the balance of trade, regardless of deterioration in total absorption level and agricultural exports benefits more from depreciation than the industrial sector. On the other hand, appreciation resulted in deterioration of gross domestic product (GDP) and improvement of private consumption. Finally, depreciation of the exchange rate had better implication on the economy as a whole and on the agricultural sector in particular, than appreciation of the exchange rate.

Key words: Exchange rate, computable general equilibrium model, social accounting matrix.

INTRODUCTION

Since independence, Sudan has experienced poor economic performance attributed to external as well as domestic factors, particularly policy failure and resource mismanagement. However, the economic performance has improved since early 1990s when the government initiated the three-year national economic salvation (NESP, 1990-1992)) and the comprehensive national strategy (CNS, 1992-2000)) programs. The programs focused on key issues, such as, liberalization of trade and foreign exchange regimes, sound monetary and fiscal policies, phasing out of price controls and privatization of public corporations (UN, 2003).

Exchange rate is defined as the rate at which one native currency unit exchanges for one unit of internationally traded currency. Exchange rate policy is one of the most important price policy tools and it is directly linked to the current account situation of the country.

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In 1990, Sudan adopted a policy of a floating exchange rate; the multiple and highly overvalued exchange rate was replaced by a unified exchange rate. In 1992/93, the exchange rate began to revalue and the government reintroduced the multiple exchange rates system. Accordingly, there were three exchange rates, an exchange rate for exports determined by the Bank of Sudan, an exchange rate for imports determined by a committee of government Bank's representatives and an exchange rate for individual foreign accounts determined by the free market. All this led to inefficiency in agricultural production and declining exports. Therefore, the government in 1994 adopted a unified rate for all transactions. The new exchange rate was adjusted within 20 - 25% in excess of its market value. However, since 1995, the exchange rate has been somewhat stable because of the unified system (FAO, 2003).

In 1998, a more comprehensive strategy for exchange rate reform was introduced. An oil-related inflow of foreign currency backed by heavy intervention by the Bank of Sudan contributed to a stable exchange rate. As a result, the real exchange rate appreciated significant while

foreign reserves declined. Recently, the foreign exchange policy has been revised from a fixed exchange rate to a managed floating exchange rate with the objective of removing the implicit taxes on agricultural products caused by overvalued exchange rate.

The objective of this paper is to assess the effects of exchange rate policy (depreciation and appreciation) on the Sudan's economy, with respect to GDP, balance of trade, total absorption, private consumption, government budgets, level of domestic output, imports and exports.

ANALYTICAL FRAMEWORK

Chacholiades (1990) stated that a change in the exchange rate throws all commodity market out of equilibrium. It leads to changes in domestic production, consumption, exports, imports and supply and demand of foreign exchange and terms of trade. Thus, a comprehensive computable general equilibrium (CGE) model is needed to simulate the economy-wide aspects.

The CGE models are multi-sectoral, economy-wide-nonlinear equilibrium models. Their comparative advantage lies in the analysis of policies when linking between different producing sectors, and links between macro and micro levels exist. It also analyses the disaggregated impact of changes in policies and in exogenous shocks on sectoral structure, household welfare and on income distribution (Löfgren, 2001).

The CGE model is based on a social accounting matrix (SAM). The SAM is a comprehensive, economy-wide data framework presented in the form of a square matrix. The column of the SAM refers to the expenditure and the row to the income of each account and each column should equal to its corresponding row. This study uses the standard CGE model developed by the International Food Policy Research Institute (IFPRI). It is composed of a set of simultaneous equations, many of which are nonlinear and there is no objective function (Löfgren et al., 2002).

The Sudan CGE model is based on the Sudan SAM for year 2000 (Table 1). It consists of six types of accounts. Production factor accounts (labor and capital), institutional accounts (households and government), aggregate capital account (savings–investment), separate accounts of the activities and commodities (agriculture, industry, trade and services sectors), and rest of the world account. Each account could be further disaggregated to reflect the structure of the economy if detailed information is available (Elbushra, 2007).

The CGE model follows the disaggregating SAM level. The activities are responsible to carry out production, receiving their revenue from selling the commodities. These revenues are used to pay for intermediate inputs, wages and taxes. The model assumes that the activities maximize profit subject to a Leontief function between value added and intermediate inputs. Value added is itself a constant elasticity of substitution (CES) functions of primary factors whereas the aggregate intermediate input is a Leontief function of disaggregated intermediate inputs. Factors are fully employed with mobile labor and activity-specific capital.

Factor incomes generated in the production process are paid to the households and government. The households use these incomes to pay taxes, save and consume (according to demand functions derived from utility maximization). In addition to factor income, the government receives transfers from the rest of the world, as well as direct and indirect taxes. The government uses this revenue for consumption, transfer to households, and savings. The rest of the world supplies imports and demands exports.

Armington function is used to capture the assumption of imperfect substitutability between imports and domestic output supplied to the domestic market. On the domestic production side, the constant elasticity of transformation (CET) is used to capture the assumption of imperfect transformability between domestic output that is exported and sold domestically (Löfgren, 2001).

Equilibrium in a CGE model is defined by a set of constraints that need to be satisfied by the economic system but are not considered directly in the decisions of micro agents. Aside from the supply-demand balances in product and factor markets, three macroeconomic balances are also specified. These are firstly, the current government balance characterized by flexible government savings and fixed direct tax rates. Secondly, the saving-investment balance specified by investment– driven model, and thirdly the current account balance for the rest of the world, with fixed foreign savings and the real exchange rate is the equilibrating variable. Mathematically, the model is expressed in four blocks of equations: prices, production and trade, institutions, and system constraint blocks (Appendix 1).

The model is calibrated such that equilibrium in the base year reflects the observed equilibrium as represented by the social accounting matrix. In the calibration process, approximate values for elasticities were used, as there are no published elasticities for Sudan adopting the common rule of Sadoulet and Janvry (1995) in CGE modeling. The model was implemented using general algebraic modeling system (GAMS) software.

MODEL SIMULATIONS AND RESULTS

World Bank and the International Monetary Fund (IMF) recommend devaluation as a remedy for the problem of currency overvaluation. Devaluation has been pursed by some countries to increase international competitiveness and improve the balance of payments. Thus, two scenarios has been performed to assess the impact of devaluation (depreciation) on the Sudan economy. Firstly the exchange rate was devaluated by 5% (Scenario 1) and then by 10% (Scenario 2).

The exchange rate of the Sudan was appreciated in 2005/2006 by more than 20%. However, in this study,

Table 1. Social accounting matrix of Sudan economy for the year 2000 (SD billion).

Receipts / Expenses		Production factor		Current accounts		Capit. acc.	Production activities account				Goods and services account				Rest of the world	Total
		Labor	Capital	Hous.	Gov.		Agric.	Industry	Trade	Service	Agric.	industry	Trade	Service		
Production factor account	Labor						218.7	131.7	201.2	356.1						907.8
	Capital						979.5	310.1	626.2	459.7						2375.6
Current accounts	Household	907.4	2221.8		32.8											3162.0
	Govern.		153.8	39.1			5.2	34.5	11.9	-0.5	16.8	10.6	30.6	19.6		321.6
Capital account				95.3	104.3										189.2	388.3
Production activities	Agric.										1524.4					1524.4
	Industry											1060.9				1060.9
	Trade												1126.3			1126.3
	Services													1291.3		1291.3
Goods and services account	Agric.			872.9	11.6	37.3	132.6	259.2	90.5	218.7					91.1	1713.9
	Industry			456.1	1.5	57.1	16.9	131.6	42.7	95.9					357.0	1158.9
	Trade			607.1	2.9	215.2	99.8	136.1	102.4	88.0					5.5	1257.0
	Services			1004.4	168.6	79.1	71.5	57.6	51.3	73.4					36.6	1542.6
Rest of the world acc.		0.4		87.2							172.7	87.5	100.1	231.7		679.5
Total		907.8	2375.6	3162	321.6	388.8	1524.4	1060.9	1126.3	1291.3	1713.9	1158.9	1257.0	1542.6	679.5	

Source: Elbushra (2007). SD = Sudanese Diner, with one US$ = 257.1 SD in year 2000.

appreciation of the exchange rate was limited to 5% decrease in the exchange rate (Scenario 3) as suggested by the model design, which works only with 5% or less.

The ultimate impact of a change in exchange rate on the balance of current account depends on the changes in expenditure associated with the exchange rate. If home country demand is elastic, then the current account balance definitely improves with depreciation; since the increase in the domestic price of imports leads to reduction on total expenditure on imports and the reduction price of exports to foreigners lead to increase in their expenditure on home country exports (Appleyard et al., 2001). The model results (Table 2) confirmed this statement as there was an improvement in the balance of trade (Scenario 1 and 2) which resulted in an improvement of the gross domestic product (GDP) despite the reduction in the total absorption level. That reduction was mainly due to decrease in private consumption brought about by lower consumption of expensive imported goods in the domestic market. It is worth noting that the exports of agricultural sector benefited more from depreciation than that of the industrial sector.

The increase in exports and decreased imports (Figure 1) due to depreciation resulted in improvement of government income and savings and total investment. The model results also revealed that depreciation of exchange rate increased domestic output of the industrial sector being the main exporting sector in year 2000 leading to improvement in total domestic output level.

On the other hand, the model results showed that appreciation of exchange rate (Scenario 3) resulted in reduction of the GDP (Table 2) due to increased deficit in the balance of trade brought about by increase in imports and decrease in exports

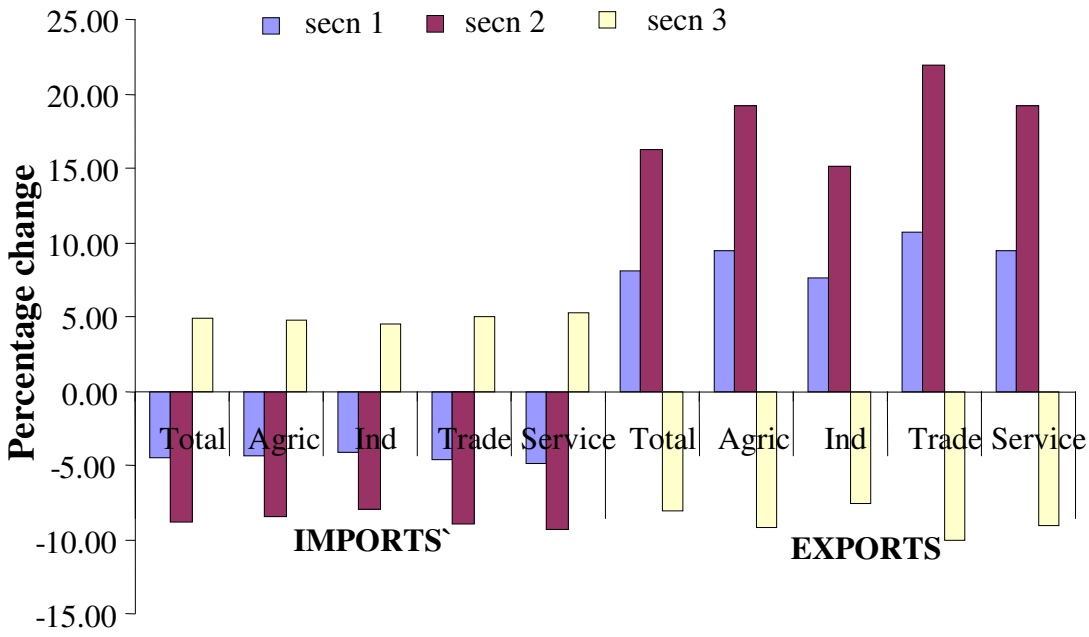

Figure 1. Impacts of exchange rate reforms on the level of sectoral imports and exports.
Source: Model results.

Table 2. Impact of exchange rate reforms on the Sudan's economy.

Variables	Base value	Percentage change from the base		
Macroeconomic variables	**(10 Billion SD)**	**Scenario 1**	**Scenario 2**	**Scenario 3**
Government income	1.00	0.7	1.5	-0.71
Government savings	32.25	0.8	1.8	-0.63
Private consumption	10.45	-1.8	-3.7	1.69
Total absorption	18.51	-1.4	-2.9	1.32
Fixed investment	351.29	0.4	0.8	-0.47
Stock change	32.7	0.7	1.4	-0.70
GDP	6.23	0.4	0.9	-0.37
Balance of trade	328.18	-39.2	-77.3	40.30
Total output	500.26	0.15	0.30	-0.16
Agriculture	152.42	-0.02	-0.04	0.02
Industry	106.1	1.99	4.01	-1.93
Trade	112.64	-0.42	-0.88	0.38
Service	129.11	-0.65	-1.33	0.61

Source: Model results.

exports in all sectors (Figure 1). It also indicated that the current government income and savings deteriorated due to decrease in exports, while there was an improvement in private consumption and total absorption due to decrease in the prices of imported commodities.

Exchange rate appreciation would lead to a decrease in total domestic output due to the dominance of the negative impact on the industrial sector over the relative small improvement of the other sectors (Table 2).

In conclusion, depreciation of the exchange rate had positive implications on the economy (GDP, balance of trade, investments, government budget, and exports of agricultural sector) as opposed to appreciation (Appleyard and Field, 2001).

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APPENDIX

Mathematical model statement

The model equations are classified into four blocks: prices, production and trade block, institutions block and system constraint block.

Prices block

$$PM_c = pwm_c * (1 + tm_c) * EXR$$

$$PE_c = pwm_c * (1 - te_c) * EXR$$

$$PX_c = (PDS_c * QD_c + PE_c * QE_c) / QX_c$$

$$PINTA_a = \sum PQ_c * ica_{c\,a}$$

$$CPI = \sum PQ_c * cwts_c$$

Production and trade block

$$QA_a = \alpha_a^a * (\delta_a^a * QVA_a^{-\rho_a^a} + (1 - \delta_a^a) * QINTA_a^{-\rho_a^a})^{-1/\rho_a^a}$$

For the CES function

$$\sigma = 1/1 + \rho$$

$$QVA_a = \alpha_a^{va} * (\sum_{f \in F} \delta_{f\,a}^{va} * QF_{f\,a}^{-\rho_a^{va}})^{-1/\rho_a^{va}}$$

$$WF_F * WFDIST_{f\,a} = PVA_a(1 - tvq_a) * QVA_a * \sum_{f \in F} \delta_{f\,a}^{va} * QF_{fa}^{-\rho_a^{va}})^{-1} * \delta_{fa}^{va} * QF_{f\,a}^{-\rho_a^{va}-1}$$

$$QQ_c = \alpha_c^q * (\delta_c^q * QM_c^{-p_c^q} + (1 - \delta_c^q) * QD_C^{-\rho_c^q})^{-1/\rho_c^q}$$

$$QM_c \div QD_c = \left(PDD_c / PM_c * (\delta_c^q / 1 - \delta_c^q)\right)^{1/1 + p_c^q}$$

$$QX_c = \alpha_c^t * (\delta_c^t * QE_c^{p_c^T} + (1 - \delta_c^t) * QD_C^{-\rho_c^t})^{1/\rho_c^t}$$

$$QE_c \div QD_c = \left(PE_c / PDS_c * (1 - \delta_c^t / \delta_c^t)\right)^{1/p_c^t - 1}$$

For CET function

$$\Omega = 1/(1 + \rho)$$

Institutional block

$$YF_f = \sum WF_f * WFDIST_{f\,a} * QF_{f\,a}$$

$$YIF_{i\,f} = shif_{i\,f} * ((1 - tf_f) * YF_f - trnsfr_{row\,f} * EXR)$$

$$YI_h = \sum YIF_{h\,f} + trnsf_{h\,gov} + trnsfr_{h\,row} * EXR$$

$$EH_h = (1 - \sum shii_{ih}) * (1 - MPS_i) * (1 - TINS_h) * YI_h$$

$$YG = \sum TINS_i * YI_i + \sum tf_f * YF_f + \sum tva_a * PVA_a * QVA_a + \sum ta_a * PA_a * QA_a + \sum tm_c * pwm_c * QM_c * EXR + \sum tq_a * PQ_a * QQ_a + \sum YIF_{gov\,f} + transf_{gov\,row} * EXR$$

$$EG = \sum PQ_c * QG_c + \sum trnsfr_{i\,gov} + GSAV$$

System constraint block (Model closures)

$$\sum QF_{f\,a} = QFS_f$$

$$\sum pwm_c * QM_c + \sum trnsfr_{row\,f} = pwe_c * QE_c + \sum trnsfr_{i\,row} + FSAV$$

$$S = I$$

$$S = \sum S_i + S_g + S_f * EXR$$

So

$$\sum MPS_i * (1 - TINS_i) * YI_i + GSAV + EXR * FSAV = \sum PQ_c * QINV_c + \sum PQ_c * qdst_c$$

Where ta(A) = rate of tax on producer gross output value; te(C) = rate of tax on exports; tf(F) = rate of direct tax on factors; tm(C) = rate of import tariff; tq(C) = rate of sales tax; tva(A) = rate of value-added tax; EG = government expenditures; QQ_c = quantity of exports; EH_h = consumption spending for household; $QF_{f\,a}$ = quantity demanded of factor f from activity a, EXR = exchange rate (LCU per unit of FCU); QG = government consumption demand for commodity; QH_{ch} = quantity consumed of commodity c by household h; GSAV = government savings; $QINT_{ac}$ = quantity of commodity c as intermediate input to activity a; $QINV_c$ = quantity of investment demand for commodity; MPS_i = marginal propensity to save for household; QM_c = quantity of imports of commodity; PA_a = activity price (unit gross revenue); QQ_c = quantity of goods supplied to domestic market (composite supply); PDD_c = demand price for commodity produced and sold domestically; PDS_c = supply price for commodity produced and sold domestically; QX_c = aggregated quantity of domestic output of commodity; PE_c = export world price (domestic currency); $QXAC_{ac}$ = quantity of output of commodity c from activity a;

PM_c = import world price (domestic currency); TABS = total nominal absorption; PQ_c = composite commodity price; $trnsf_{h\,\mathrm{gov}}$ = transfers from domestic government institution to household institution; $trnsf_{h\,\mathrm{rov}}$ = transfers from domestic rest of the world to household institution; PVA_a = value-added price; WF_F = economy-wide factor wage; PX_c = aggregate producer price for commodity; YIF_{if} = transfer of income to domestic institution I from factor f; $PXAC_{ac}$ = producer price of commodity c for activity a; YG = government revenue; QA_a = quantity (level) of activity a; YI = income of domestic non-government institution; QD_c = quantity sold domestically of domestic output; FSAV = foreign savings (FCU); $TINS_h$ = direct tax rate for domestic institution i or factor f; $WFDIST_{fa}$ = wage distortion factor for factor f in activity a; IADJ = investment adjustment factor; pwm_c = world price of import (in hard currency).