A Temporary General Equilibrium Framework for The Analysis of Macro-economic influences on Agriculture in Sudan

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Abstract

Unfavourable macro-economic conditions were blamed for the failure of devaluation and liberalization to correct the bias against agricultural exports in Sudan. A general equilibrium model with endogenous money creation mechanism is constructed to analyze macro-economic linkages to Agriculture. Stronger economic performance is achieved when exchange rate adjustments are supported with monetary control and less indirect taxation.

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Protectionist trade regimes, monetary disequilibrium, overvalued exchange rates, and administered prices were found to distort economic incentives in Sudan against exportables, which are mainly agricultural tradables, and in favour of the urban based manufacturing and home goods sectors (IMF; Nashashibi; World Bank; Elbadawi). The indirect impacts of Sudan's commercial and foreign exchange policies were shown to further confound the direct bias against agricultural exports in favour of non-tradables (Elbadawi). Inspite of the various economic reforms implemented by Sudan over the last decade, the bias against agriculture, where more than 90% of the country's foreign exchange earnings and about 85% of the total value of food is generated and the livelihood of more than 70% of the population is earned, continued. Failure of the economic recovery programs to eliminate the bias against agricultural exports in Sudan was attributed mainly to the unfavourable macro-economic environment in which devaluation and liberalization policies were introduced (Hassan; Elbadawi).

Studying the indirect impacts of macro-economic and non-agricultural policies on the farm sector was not part of the research agenda in agricultural economics for a long time. The important connections between nominal exchange rate movements and agricultural trade and prices was first discussed by Schuh (1974). Several studies were conducted since then,researching the impact of exchange rate and other macro-forces on agriculture (Tweeten; Champers and Just; Shei; Champers). Another category of models using the international trade theory and the real exchange rate framework have examined the incidence of foreign exchange, commercial and macro-policies on the structure of incentives to agricultural producers and internal terms of trade (Valdes; Cavallo and Mundlak; Krueger,Schiff and Valdes).

A more neoclassical approach to studying macro-economic linkages to agriculture was used in the Walrasian group of computable general equilibrium (CGE) models (Adelman and Robinson; Taylor and Lysy; Dervis, de Melo and Robinson). Serious attempts were also made to incorporate Keynesian features and loanable funds markets in the CGE model (Adelman and Robinson; Dungan; Feltenstein). Except for the Feltenstein study, however, which is basically a trade model, money supply remained exogenous to the system in these models. An endogenous money creation mechanism, an important feature of developing economies, is modelled in the present study to allow for a feedback effect from the macro-sectors to agriculture. The economy wide impacts of movements in nominal macro-aggregates are transmitted by the general price level via real price movements. The model accommodates micro-structural features in the foreign exchange and domestic credit markets where nominal interest and exchange rates are fixed in Sudan. Partial adjustment and expectations schemes are also used to model supply. Subsystems methods are used for stochastic specification of the model parameters. Econometric estimation provided superior statistical basis for

model validation over the commonly used calibration procedure. Dynamic simulation is employed to solve the model for validation and policy analysis. Six policy experiments are conducted representing various combinations of fiscal, monetary and exchange rate plus sector specific policies.

The core CGE model and the special structural features of the Sudan economy are discussed first. Section two describes the policy environment and scenarios of the intended analysis. Section three performs the policy analysis and compares the results. A summary section concludes the study.

NEO-CLASSICAL CGE AND THE SUDAN MODEL :

The core CGE model builds on the linear, multi-sector input-output model adding more flexible specifications that allow for substitution possibilities in the demand and supply spheres of the economy. Production and consumption decisions are modelled on the basis of neo-classical theory of the firm and consumer behavior. The CGE model also specifies the institutional set up within which agents interact and defines equilibrium conditions of the system. The stylized CGE model is micro-founded and structural in nature with intersectoral linkages explicitly modelled. The structure of the neo-classical CGE model ~~are~~ discussed in more detail in Dervis,de Melo and Robinson.

Special structural characteristics of the economy, data limitations and specific features of agricultural supply in Sudan led to several modifications in the basic CGE model. The present model is based on the multi-sector Walrasian structure of decentralized economies with the macro-components and financial sectors of the economy integrated explicitly. There are fifteen commodity groups, land, labor, capital and money in the model. Two main deviations from the core CGE outlined above involve modelling domestic supply and the treatment of money and macro-equilibrium.

<u>SUPPLY :</u> As Sudan is predominantly an agricultural country, the farm sector represents the main focus of modelling the supply side of the economy. The farm sector is thus disaggregated into ten agricultural tradables produced in four distinct farming systems representing different technologies and institutional environments. The ten crops modelled here contribute nearly 90% of the export earnings and provide most of the food supply in the country. There are two main producing regions, the irrigated and the dry land subsectors, each of which divides into two distinct farming systems. Decision making is highly centralized in the public irrigation schemes. Allocations of land areas and chemical inputs are made by the scheme administration.

Crop rotations are not fixed and production decisions are decentralized in the other three agricultural regions. Farmers in these regions also sell their products in competitive markets except for cotton and gum arabic in the traditional rain-fed subsector where marketing boards monopolize their exports.
Only wheat in the private irrigation schemes and cotton in the dry land sector use chemical inputs. Agricultural producers in the mechanized rainfed sector, on the other hand, use intensive mechanization and have much better access to formal credit.

As area allocations to wheat and cotton, which occupy more than 50% of the land, are set by the government agency in the public irrigation schemes, farmers decisions are assumed to influence yield rather than production. It is therefore chosen to model agricultural supply by using yield and area response instead of output supply functions. Yield and area response functions are used elsewhere in a general equilibrium framework for a number of reasons (Nargana, Parikh and Srinivasan). Also, lack of sufficient time series on levels of input use, particularly labor and capital, by crop and region precluded the use of primal methods in modelling farm supply. Reduced form response functions are alternatively specified for crop yields and areas in each of the four agricultural regions. The specified yield and area response functions reflect partial adjustment in domestic production of agricultural tradables. Agricultural tradables markets are assumed to adjust in a sequence of temporary equilibria along which agricultural producers adjust their expectations and production plans to desired levels.

Reduced form output supply functions are again used to model supply in the non-agricultural tradables(NAT) and homegoods(HG) sectors, due to lack of data on input levels. Non-agricultural tradables represents the manufacturing industry in Sudan. It comprises mainly the textile, sugar, and oil industries plus food processing. All non-tradables are grouped into the homegoods sector. Services, transport and construction are the major economic activities in the homegoods sector. Manufacturing and homegoods are mainly urban based and compete with each other for private investment and labor.

The homegoods sector is the only domestic supplier of capital goods. Homegoods are also used for final consumption and as intermediate inputs. The other source of capital goods in this model is capital imports which are considered non competitive to domestic capital. Intermediate imports are also used by agriculture, manufacturing and the non-tradables sectors. Foreign manufactured goods are imported for final consumpion and like capital and intermediate imports is considered non competitive to domesticaly manufactured goods and hence earn a different price. Foreign wheat, on the other hand,is assumed a perfect substitute to domestically produced wheat where the same price rules for both. The small country assumption is maintained for all imports and exports except for long staple cotton where Sudan is assumed to supply a significant share of the world market.

FACTOR DEMAND, INCOME AND CONSUMPTION SPENDING : In addition to labor and capital, land represent a third primary factor in our model. Area response functions defined earlier derive demand for land. The labor and capital markets, however, are suppressed in the present model due to data problems. No time series are available on labor use by crop or region to allow estimation of labor demand and supply functions. The nominal wage rate is therefore fixed exogenously to define an infinite supply of labor by region. There is one type of labor in this model, namely unskilled labor. Labor groups, however, are distinguished by region and as rural and urban. Again no data is available on the demand for capital by sector of destination. Government

investment is set exogenously whereas, a private investment function is specified. Total investment spending is thus used to allocate capital demand by sector of origin.

Functional distribution of value added among owners of primary factors is not derived due to data limitations, as discussed earlier. All income generated in this model is paid to a single household sector. From this income the government collects tax revenue. Accordingly there are only two sectors of final demand in the model: households and the government sector. Government consumption spending is set exogenously. Private consumption spending, on the other hand, is endogenously determined and allocated among seven final consumption goods: sorghum, wheat, beans and vegetables, meets and other, imported manufactured goods, non-agricultural tradables and homegoods. The Almost Ideal Demand System(AIDS) of Deaton and Muellbauer (1980) is used to allocate private final consumption demand.

MACRO-ECONOMIC CLOSURE AND MONEY : The macro-structure of Sudan economy is specified such that excess aggregate demand is allowed in the model. Total private investment in excess of private savings and the fiscal deficit represent the domestic resource gap or excess aggregate demand (in local currency) which is balanced with net capital inflows(trade balance TB). With a fixed exchange rate regime, as in Sudan, this specification allows for disequilibrium in the external balance. Accordingly net capital inflow (TB) is not rationed here but endogenously determined to serve as the alternative equilibrating mechanism as the exchange rate is inflexible. Price of money (P) is endogenously determined in the present model as another equilibrating factor that clears the money market where the nominal interest rate is fixed.

As there is practically no bonds market in Sudan, internal imbalances are financed by creation of domestic credit. The limited ability of the central bank in monetry control through open market operations, as typical to most developing countries, is thus recognized in making money supply endogenous to the present model. Change in money supply (Mt-Mt-1) is made function of fiscal deficits (GD), expected real saving rate (ER) and income (VAD).

(1) $Mt-Mt-1 = M(GDt,ERt,VADt)$

Similar specifications are used by varios authers to allow for endogeneity of money supply in studying the important link between fiscal deficits and inflation (Aghevli and Khan; Taylor; Scobie). Demand for real money balances (MD/P), on the other hand, is explained by real gross national product, the expected rate of inflation and the expected change in parallel market exchange rate. This specification follows closely the error correction model used by Domowitz and Elbadawi(1987) to estimate demand for money in Sudan. The free market rather than the official exchange rate is used as the opportunity cost of holding domestic currency in this study.

An equilibrium solution is obtained in this model by clearing product markets. Equilibrium in factor markets is maintained and not derived explicitly due to data limitations

that precluded adequate modelling of factor markets. To close the model an additional condition is required to clear the money market :

(2) $Mt = MDt$

Condition 2 determines the general price level. The impact of excess public demand (e.g. fiscal deficit) on inflation and economic activity is given by the money supply linkage. Short run non-neutrality of money is allowed as some prices and quantity flows are slow to adjust in this model e.g. agricultural supply and the exchange and interest rates.

Subsystem estimation is employed to generate parameter values for this study. Adaptive price expectations schemes are used where last year realization is used as the expected price. Dynamic simulation is used to test the model performance and conduct several policy analysis experiments. The Jacobian algorithm GAMS/MINOS is used to solve the present model as it stands between the fixed-point technique and the tatonnement process representing a reasonable compromise between efficiency and cost effectiveness. The model gave very close forecasts of the actual path of the economy during 1981-1986. The model is solved for only two consecutive years for policy analysis. Solving for two years in each policy experiment allows for the effects of dynamic lags in the model.

POLICY ENVIRONMENT AND SIMULATION RESULTS:

Various policy scenarios are designed to evaluate the impact on agriculture and the economy of measures believed to have supported devaluations and liberalization accomplish success if adopted. The following policy packages are thus examined:

EXCHANGE RATE REGIMES: Multiple exchange rates are commonly used in Sudan, and elsewhere, for various purposes such as export promotion and industrial protection. They, however, distort internal terms of trade and induce inefficient allocation of domestic resources. Overvalued exchange rates, on the other hand, is considered the main obstacle to elimination of external imbalances as it taxes exports and subsidizes imports. Unification of the nominal exchange rates for all tradables and gradual devaluation are adopted in this experiment.

FOOD SUBSIDIES: Bread wheat is highly subsidized in Sudan being the basic food for urban population where political power centers. The wheat subsidy is also partially borne by domestic wheat producers as they are paid an official procurement price that is usually lower than the import parity price for wheat. In addition to the exchange rate policy (I), wheat pricing and importation are liberalized in this experiment (II). The tax/subsidy structure in the wheat sector is lifted such that all wheat is traded at its import parity cost, and Sudan is assumed to face an infinite supply of foreign wheat.

STABILIZATION AND MONETARY CONTROL: Expansionary fiscal and monetary policies are blamed for the excessive inflation that wipped away the positive effects of devaluation and liberalization. Reduced government spending is attempted as a

measure of monetary control to evaluate the impact of conducive macro-economic conditions on the effectiveness of the exchange rate and wheat policies discussed above (I and II).

TAX POLICIES: While structural adjustment calls for reducing indirect taxes which distorts relative prices, it has been argued by many authors that this strategy works against stabilization. This is because indirect taxation is the main anti-inflationary mean of financing budget deficits particularly in developing countries (Mussa). Taxes on foreign trade were reduced by 40% and the value added (direct) tax is increased from 4% to 6%. This experiment, again applies the mentioned tax policy together with the above devaluation, wheat and stabilization regimes.

Two other agricultural policies are attempted. In order to evaluate the impact of removing institutional rigidities,cotton and wheat areas are changed exogenously. This has important implications for net foreign exchange earnings, food supply and the external balance. The following plans are therefore examined:

EXPERIMENT V: In addition to the above described four policies, cotton area in the public irrigation schemes is reduced by 20%. As wheat land is fixed the extra acreage freed from cotton is allocated by the model (farmers) to groundnuts and sorghum.

EXPERIMENT VI: 25% of the wheat area in the public schemes is given to cotton. Again this plan is implemented simultaneously with the first 4 policy regimes (exchange rate, wheat, stabilization and tax policies).

Demand for final consumption adjusts instanataneously to external shocks in this model. The full effect of policy changes, however, completes one year later due to partial adjustment in supply, private investment and money demand. Therefore, results obtained for the second year only (1982), when full adjustment is completed, are reported in table 1.Table 1 shows that devaluation (experiment 1) generated positive impacts on supply of the most important agricultural products (cotton, wheat and sorghum) leading to enhanced exports and higher self-sufficiency in food. Its demand effects, however, were offsetting. Demand for intermediate imports increased due to expanding production of wheat and cotton being the largest users of imported inputs. Moreover, at the new unified exchange rate foreign manufactured goods and subsidized wheat became relatively cheaper to consume than sorghum and non-tradables given the new inflation rate. This led to increased importation of manufactured consumer and intermediate goods with the net effect being negative on the trade balance. External deficit increased by 14% according to Table 1. The government balance together with other nominal variables in general has improved. Value added and the general price level (inflation) rose by 34% leaving real GDP nearly unchanged.

Better results are obtained with a more competitive wheat policy (experiment II). Larger improvements in the supply of cotton and sorghum, exports and wheat self-sufficiency, slower inflation and lower trade deficits are realized. Wheat consumption and importation dropped significantly as consumer subsidy is lifted. Domestic wheat supply, however, fell inspite of improved producer prices. While the import parity price of

wheat is higher than the procurement price at which producers in the public irrigation schemes deliver their wheat, the new price is lower than the free market price received by private wheat producers under the quota system (controlled wheat imports). The fact that wheat area is fixed in the public schemes limited the impact of better prices on wheat supply to small improvements in yield. Wheat production in the private schemes, on the other hand, where lower prices are received is more responsive to changing economic incentives as farmers are free to adjust areas. The net effect was thus negative on domestic wheat supply. Higher self-sufficiency ratio therefore, results from reduced consumption e.g. less imports. It is important to note however, that the positive price effect on wheat production would have been much larger if area allocations in the public schemes, where more than 70% of domestic wheat is produced, are decentralized.

Experiment III evaluates the efficacy of devaluation and liberalization under a balanced budget. Exchange rate and wheat policies are supported with reduced government consumption spending. The government consumes only homegoods and domestic manufactured products. The indirect impact of reduced spending, on the other hand, works through the budget deficit, money supply, price of money and real price linkages. It therefore extends to all sectors of the economy. Substantial improvements are realized in the foreign trade and government deficits with reduced spending. Supply of money declined resulting in much slower inflation and real value added gains. Much higher gains in supply of cotton and sorghum are obtained under the tax experiment IV. Total value of exports grew significantly reducing Trade deficit by about 2%. Substitution of direct for indirect taxation also did not produce inflationary pressures on the economy as the budget deficit continued to shrink.

As cotton area is reduced in experiment V more sorghum is produced and exported and less intermediate inputs are imported. The real price of homegoods appreciated inducing substitution in demand for more wheat and less consumption of non-tradables and domestic manufactured goods. Exports improved with a positive net effect on trade balance (reduced by 2.2%). Self-sufficiency from wheat dropped due to increased consumption and importation of wheat. Giving wheat area to cotton in experiment VI, on the other hand, led to poorer performance with respect to real GDP, trade balance and wheat self-sufficiency. The results of Table 1 indicate that production of cotton and sorghum have the comparative advantage over other crops in using domestic agricultural resources. While cotton is a better foreign exchange earner than wheat, expanding cotton area at the expense of wheat generated unfavourable demand effects. Except for experiment I, all policy scenarios caused private consumption to decline in real terms freeing more real resources for saving and investment as well as for balancing the external and inetrnal resource gaps.

SUMMARY AND CONCLUSIONS:

Failure of the partial liberalization and devaluation policies to eliminate the bias against agricultural exports in Sudan is believed to be due to prevailing unfavourable macro-economic environment. An empirical general equilibrium

model with endogenous money creation mechanism, is constructed, validated and used to research macro-economic linkages to agriculture in Sudan. The model accommodates micro-structural features in the foreign exchange and domestic credit markets where nominal interest and exchange rates are fixed in Sudan. Partial adjustment expectations schemes are also used to model supply. Subsystems methods are employed for stochastic specification of the model parameters. Validation and policy analysis are conducted using dynamic simulation. The model showed powerful performance in recovering the historical path of the economy.

Policy experiments provided further empirical support to the argument that expansionary fiscal and monetary policies have worked against stabilization and economic recovery in Sudan. The thesis objecting to removal of indirect taxation for budgetary reasons is challenged by the tax policy experiment results. Results suggested that for positive growth and improved performance of the Sudan economy, monetary control and minimal indirect taxation are required to support exchange rate adjustments. Removal of the institutional rigidities in the public irrigation schemes proved essential for promoting desired agricultural supply responses and for stronger economic performance.

Table (4)

Policy Simulation results (1982)

	Control solution	Devaluation % change I	Devaluation wheat policy a) % change II	Devaluation wheat and a) % change III	Devaluation wheat, stab. a) % change IV	IV & reduced cotton area a/ % change VI	IV, expand DIN, & reduced wheat a/ % change VI
1. Value added (Ls billion)	5.9	34.5	26.8	18.8	16.6	15.6	16.2
Agriculture (share).	.32	-11.6	-10.2	8.1	4.3	9.3	5.4
2. Agric. supply (000 ton)							
Cotton	147	9.9	10.8	9.6	10.4	-8.6	18.2
Sorghum	2073	3.8	5.4	5.6	16.3	21.5	13.6
Wheat	137	19.6	-1.1	-1.4	-6.6	-4.2	-25.6
Groundnuts	818	-3.4	-4.7	-6.5	-14.4	-14.4	-13.7
3. Imports (Ls billions)	1.72	25.6	22.4	20.1	21.8	23.0	32.4
Intermediate (000 ton)	4261	1.04	.96	.8	1.1	-.8	1.3
Consumer (000 ton)	1414	34	38	33	42	38	32
Wheat	372	0.0	-58	-51	-57	11.1	137
4. Real consumption (billion unit)	.64	1.6	-2.8	-4	-1.3	-4.9	-2.6
Sorghum (000 ton)	1384	-21.1	-29	-26	-29	-25.4	-23.1
Wheat (000 ton)	509	5.3	-43	-38	-44	6.5	92.9
Domestic Manuf. (000 ton)	5282	-2.6	1.7	-6	-.5	-11.1	-16.2
Foreign Manuf. (000 ton)	1414	34	38	33	42	38	32
Non-tradable (000 ton)	9407	-.76	-1.6	4.8	.3	-3.5	-4.5
5. Exports (Ls. Billion)	.48	55.3	55.9	71	83	88	110
6. Trade balance (Ls Billion)	-1.24	14	9.4	.4	-1.9	-2.2	2.4
7. Govt deficit (Ls. billion)	.64	-48	-43	-84	-55	-47	-50.5
8. Money supply (Ls. billion)	1.71	17	12	-11	3.5	5.2	8.3
9. Price of money (Ls.)	7.4	34	26	14.4	15.7	14.8	15.4
10. Price of home good (Ls)	7.9	51	33	13.6	17.5	16.3	17.6
11. Real GDP (billion units)	0.8	0.3	.3	.9	.4	.36	.4
12. Wheat self-sufficiency ratio	.27	13.2	72	57	62.9	-11.1	-76.4

a) Refers to percentage change ralative to control solutions