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Agricultural Efficiency Gains and Trade Liberalization in Sudan

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Abstract

The traditional agriculture in Sudan occupies 60% of the total cultivated land and employs 65% of the agricultural population. Nevertheless, it is characterized by its low crop productivity, which is mainly driven by low technical efficiency, while drought and civil conflicts threaten most of its areas countrywide. Therefore, it has contributed only an average of 16% to the total agricultural GDP during the last decade. This paper addresses from an empirical point of view the sectoral and macroeconomic implications of agricultural efficiency improvement in Sudan and assesses the efficiency gains under the assumption of trade liberalization. Efficiency improvement experiments are implemented by augmenting the efficiency parameters of labor, capital, and land in a Computable General Equilibrium (CGE) framework. The CGE model of the study relies on the newly produced Sudanese Social Accounting Matrix (SAM), which provides data on 10 agricultural sectors, 10 industrial sectors and 13 service sectors. Results show that improving the agricultural efficiency would lead to improvements in GDP, welfare level, and trade balance. In addition it would also improve the output and competitiveness of the Sudanese agricultural exports and increase their strength to face the challenges of liberalization.

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Key words: Agricultural efficiency, liberalization, Sudan SAM, CGE analysis.

1. Introduction

Sudan is an agricultural country endowed with enormous resources such as arable land, animal resources, fresh water sources and a variation in climate that qualify the country to contribute significantly to the Arab world food security. Moreover, the extraction of petroleum in 1999 and the signing of a Comprehensive Peace Agreement (CPA) in 2005, which ended a 20 years civil war and led to establishing peace in Southern Sudan, have created a climate that is conducive to additional foreign investments. These factors have led to considerable increases in the volume of foreign investment particularly from Arab countries (MOI, 2009).

Despite the deterioration in the share of agriculture in total exports from 73% in 1998 to 5% in 2008, due to the increase in oil exports, agriculture remains an important sector in the Sudanese economy. It contributed an annual average of 45 % to total GDP during the last ten years in addition to its employment of about 80% of the total labor force including agricultural-related activities (Siddig, 2009). Moreover, agriculture contributes to other activities such as transportation, agro-industries, and commerce, in the industrial, trade, and service sectors which account for a large share of the GDP.

Nonetheless, the agricultural contribution to the GDP started to deteriorate in recent years. For instance, it has fallen from 48% in 1997 to 31% in 2009 (CBOS, Annual Reports). Therefore, concerns have been raised recently about this (neglect) of the agricultural sector and emphasis on the natural oil resources, reminiscent of the famous (Dutch Disease). This will result in increased pressure on importing food from abroad given the dramatic increase in food prices.

In this regard, it is worth mentioning that the decline in the contribution of agriculture to total GDP is only in percentage terms as the sector's GDP value has been increasing, implying that the sector is not deteriorating but other sectors are growing faster. For instance, the share of the industrial sector in total GDP grew from 15% in 1997 to 31% in 2008. Similarly, the share of the services sector increased from an average of 33% during the last ten years to 34% in 2007, and 33% in 2008 (CBOS, Annual Repots).

Agriculture in Sudan is composed of three main farming systems, namely traditional rain-fed sector, mechanized rain-fed sector, and irrigated sector. The traditional rain-fed sector has occupied an average of 60% of the total cultivated land and employed about 65% of the agricultural population during the last ten years. Nevertheless, this sector is characterized by low crop productivity that is mainly driven by lower technical efficiency that has led to its average contribution to the total agricultural GDP being only about 16% during the last ten years (Siddig, 2009).

Efficiency literature in the Sudanese context reveals that technical efficiency in the overall Sudanese agriculture is low especially in the traditional sector that provides staple food for the majority of the subsistence farmers and other domestic consumers besides its contribution to the export sector. Siddig *et.al* (2011) employed a multiregional Computable General Equilibrium (CGE) model to investigate the national and regional implications of improving the efficiency of cereals and oilseeds in Sudan. They used the Africa Database of Global Trade Analysis Project (GTAP) that includes the Sudanese Input/output Table (IOT)[3] as the underlying database representing several neighboring countries in the analysis e.g. Egypt and Ethiopia, as well as other sub-regions like COMESA (Common Market of Eastern & Southern Africa) and MENA

[3] For details on the construction of the Sudanese Input/output Table see Siddig (2009a).

(Middle East & North Africa). The comprehensive literature survey of their study and the analysis outcome confirm the low technical efficiency in the agricultural sector, while they show at the national and regional levels, significant positive effects that could be achieved by efficiency improvement.

In their global assessment of agricultural efficiency, Trueblood and Coggins (2001) used the Malmquist index approach to examine inter-country agricultural efficiency and productivity. They carried out an inter-country agricultural productivity and efficiency survey, in which they studied 151 countries including Sudan covering the period between 1961 and 1991. The Malmquist approach can distinguish between two sources of productivity growth, namely, technical efficiency and technical change. Their results show that developing countries' productivity has declined over the study period. Table (1) shows the productivity weighted growth rates for aggregated groups of countries and regions throughout the period between 1963 and 1990.

Table 1. Productivity weighted growth rates by geographical regions (1963-1990)

Region	1963-1965	1966-1970	1971-1975	1976-1980	1981-1985	1986-1990
World	-2.3	-1.9	-2.4	-1.6	0.0	0.2
N. America / Oceania	-0.4	1.4	0.7	2.8	2.6	2.7
Latin America	-3.2	-1.6	0	-0.7	0.0	0.9
Western Europe	1.6	2.5	1.3	1.5	2.9	2.4
E. Europe and Soviet Union	-1.1	0.2	-0.8	-1.4	0.4	2.6
North Africa / Mid East	-1.5	-1.7	-1.2	-2.2	1.3	1.5
Sub-Sahara Africa	-2.8	-2.3	-2.8	-1.1	0.5	2.1
Asia	-3.4	-1.9	-1.8	-1.2	0.6	-0.1
People's Rep. of China	6.1	-0.8	-2.3	1.2	4.7	3.9

Source: Trueblood and Coggins (2001).

Sudan's decrease in agricultural productivity among other countries like Afghanistan, Korea, Nicaragua, Nigeria, and Turkey was due to decreases in both efficiency and technology adoption. The study of Trueblood and Coggins (2001) reveals that the average technical efficiency scores by scale assumption during the period 1961 - 1990 was 0.67. The productivity profile of Sudan in their study shows the multifactor productivity to at -1.21, an efficiency change of -1.21, and the technical change to be -0.10. Appendix 2 shows a comparison between the productivity profiles of selected 19 countries including Sudan, several African countries, and countries from the Middle East, Europe and the United States.

At the crop level, several studies have addressed the efficiency of crop production in Sudan. For instance, Mohamed et al. (2008) estimated the technical efficiency of producing sorghum in western Sudan. Their results showed that the mean technical efficiency of sorghum production is 0.65, which is very close to the technical efficiency of 0.67 estimated for Sudan by Trueblood and Coggins (2001). Mohamed et al. (2008a) also carried out a similar study to measure the technical efficiency of sesame production in Kordofan State. Their results showed that the average technical efficiency of sesame production is 0.72. These results indicate that sorghum and sesame farmers can increase their level of production by 35% and 28%, respectively at the given set of inputs and technology.

In a single country CGE model, Siddig (2009) has studied the effects of agricultural efficiency improvement in Sudan under an unstable exchange rate regime. He simulated several efficiency improvement experiments at different levels of devaluation or appreciation of the exchange rate. His results reveal that improving the efficiency under a devalued Sudanese pound by 5% would improve the Sudanese exports, trade balance, and the GDP. However, the devaluation component

of the experiment would have major inflationary effects that increase the domestic prices for both imported and domestic goods (Siddig, 2009).

This literature survey clearly shows that agricultural production in Sudan and particularly in the traditional sector is technically less efficient. Therefore, introducing advanced technologies in the agricultural practices, improved seeds, and improved extension services could enhance the sector's performance, and hence the people's livelihood. This is particularly important because the traditional sectors employs about 65% of the Sudanese agricultural labour force, however, its contribution to the agricultural GDP falls short relative to the proportion of population depending on it. It contributed an average of 15% to agricultural GDP during the period between 2000 and 2006, while the proportions of population depending on it during the same period were 70% of the total agricultural population, which shows the need for enhancing the efficiency of production (Siddig, 2009). Efficiency improvement is necessary to produce higher quality goods in a more efficient manner, which results in lower costs to consumers, and raise per capita incomes over time. At the macro-level, an efficient agricultural production is important for the development process because it allows the country to produce more food at lower cost, improve nutrition and welfare, and release resources to other sectors (Abadi & Ahmed, 2006).

Based on this background, which show the need for further assessment and elaboration on the efficiency issue in order to reflect its particular importance in the Sudanese context to the policy makers and all concerned people around the world; this paper tries to simulate improving the efficiency of the major crops in the Sudanese traditional agriculture. Moreover, it tries to raise the awareness about the linkages between efficiency and competiveness by adding another scenario that accompanies efficiency improvement by unilateral liberalization of trade. This assumption is

relevant as well to the country's ongoing negations to join the World Trade Organization (WTO).[4]

The study employs a single country CGE model together with a detailed Social Accounting Matrix (SAM) for Sudan. The basic assumptions behind the experiments in the context of the modeling framework is that efficiency improvement could be achieved by improving labor skills, enhancing the land use and farming practices, and increasing capital flows into the sector as well as the relevant infrastructure. Land use can be improved through better use of inputs and land preparation practices based on the additional capital flows. Moreover, better agricultural practices, new technologies, and high yielding varieties could be adopted in the sector. Therefore, the issues discussed in this paper are timely and justified as well by the recent hikes in food prices and the demand for renewable energy worldwide.

2. Methodology and Data

A CGE model of Sudan is constructed and used for this study. It is an open-economy single-country model that treats the rest of the world as one region. The model allows for two-way trade, assuming that imports and domestic demand as well as exports and domestic supply, respectively, are imperfect substitutes. Producers maximize profits subject to Leontief production function, and households maximize utility with respect to interlinked Linear Expenditure Systems (LES). The model is static in nature solving for a new equilibrium within a single period, given a specified policy change, which is in general, a reasonable approach to be used for the objectives of this paper, given the lack of data that allow for using a dynamic model.

[4] Sudan has firstly submitted its application to WTO before 15 years; however the issue is progressing very slowly. In this regard it is important to confirm that the intended liberalization scenario is only unilateral and does not consider any negotiation-related reductions of trade distortions.

The paper focuses on the analysis of how the economy will adjust and the nature of the new equilibrium of the economy under certain efficiency and trade liberalization policy changes according to macroeconomic constraints and assumptions. The macroeconomic closure rules of the model and the specification of its factor markets are crucial to describe this convergence process properly and to determine the short, medium, or long-term character of the model. Thus, within a certain period, under some given conditions and some applied policies, the shocked economy adjusts to achieve a new state of equilibrium. Generally, this study's approach to CGE modeling follows the type of Dervis *et al.* (1982), and particularly based on the model developed at IFPRI and documented in Lofgren *et al.* (2002).

To implement the intended simulations, a modified closure of the model is used. For the government balance of the model, the closure assume that the government saving is flexible, while tax rates which represent a major component of the government revenue are fixed.

Total government revenue (YG) is defined as shown in the flowing equation as the sum of revenues from taxes, factors, and transfers from the rest of the world. Taxes include income tax ($TINS_i \,.\, YI_i$), taxes on factors of production ($tf_f \,.\, YF_f$), VAT ($tva_a \,.\, PVA_a \,.\, QVA_a$), taxes on production ($ta_a . PA_a \,. QA_a$), import tariffs ($tmc_c \,.\, pwm_c \,.\, QM_c$), export taxes ($te_c \,.\, pwe_c \,.\, QE_c$), sales taxes ($tq_c \,.\, PQ_c \,.\, QQ_c$), and transfers from the rest of the world ($trnsfr_{gov\ row}$).

$$YG =$$

$$\sum_{i \in INSDNG} TINS_i \,.\, YI_i + \sum_{f \in F} tf_f \,.\, YF_f + \sum_{a \in A} tva_a \,.\, PVA_a \,.\, QVA_a + \sum_{a \in A} ta_a . PA_a \,. QA_a +$$

$$\sum_{c \in CM} tmc_c \,.\, pwm_c \,.\, QM_c \,.\, EXR + \sum_{c \in CE} te_c \,.\, pwe_c \,.\, QE_c \,.\, EXR + \sum_{c \in C} tq_c \,.\, PQ_c \,.\, QQ_c +$$

$$\sum_{c \in C} YIF_{gov\,f} + trnsfr_{gov\ row} \,.\, EXR$$

On the other hand, the following equation defines the government consumption demand for commodity (c) as (QG_c), which is the base-year quantity of government demand (qg_c) multiplied by an adjustment factor (*GADJ*) that is exogenous and, hence, the quantity of government consumption is fixed.

$$QG_c = \overline{GADJ} \,.\, \overline{qg_c}$$

For the external balance, which is expressed in foreign currency, the real exchange rate is flexible while foreign savings (the current account deficit) is fixed. Given that all other items are fixed in the external balance (transfers between the rest of the world and domestic institutions), the trade balance is also fixed. If, ceteris paribus, foreign savings are below the exogenous level, a depreciation of the real exchange rate would correct this situation by simultaneously (1) reducing spending on imports (a fall in import quantities at fixed world prices) and (2) increasing earnings from exports (an increase in export quantities at fixed world prices).

This could be described as: (*Import expenditure + transfers to the rest of the world = exports revenue + transfers from the rest of the world +* <u>*foreign savings*</u>), where foreign savings will adjust to assure the equilibrium. The balance of payments equation that is expressed in foreign currency requires total payments for imports and the transfers from production factors to the rest of the world to equal total receipts for exports plus foreign savings ($FSAV$) and transfers from the rest of the world, as shown in the following equation:

$$\sum_{c \in CM} pwm_c \,.\, QM_c \; + \; \sum_{f \in F} trnsfr_{row\, f} = \sum_{c \in CE} pwe_c \,.\, QE_c + \sum_{i \in INSD} trnsfr_{i\, row} \; + \overline{FSAV}$$

Where pwm_c the world imports price of the commodity (c) is, QM_c is the imported quantity of commodity (c), $trnsfr_{row\, f}$ is the transfers to the rest of the world, $pwe_c \,.\, QE_c$ are the world

export price and quantity of commodity (c), $trnsfr_{i\,row}$ are the transfers from the rest of the world, and $FSAV$ are the foreign savings.

Finally for the saving-investment balance, the model assumes an investment-driven environment, in which the value of base savings adjusts with same percentage points as investment (Siddig, 2009). At the end, the model should close by that total savings and total investment are equal. As defined in the following equation, total savings is the sum of savings from domestic nongovernment institutions (*YI*), the government (*GSAV*), and the rest of the world (*FSAV*), with the last item converted into domestic currency using the exchange rate. Total investment is the sum of the values of fixed investment and stock changes ($qdst_c$).

$$\sum_{i\in INSDNG} MPS_i \,.\, (1 - TINS_i) \,.\, YI_i + GSAV + EXR \,.\, \overline{FSAV} = \sum_{c\in C} PQ_c \,.\, QINV_c + \sum_{c\in C} PQ_c \,.\, qdst_c$$

CGE models are known to be very demanding in terms of data, because they basically rely on the Social Accounting Matrix (SAM). The SAM is a consistent data framework that captures the information contained in the national income and product accounts and the Input-output Table (IOT), as well as the monetary flows between institutions within the economy under consideration (Pyatt & Round, 1985). Moreover, it is a self-controlled accounting framework, because total receipts must equal total payments for each account contained within its square matrix. It follows the principle of double entry bookkeeping, presenting expenditures in the column and receipts in the row accounts; that is, each entry represents a monetary flow from a column to a row (Pyatt & Round, *op cit.*).

In order for the SAM to be constructed, an IOT is required. Unfortunately it is always difficult to find recent IOTs as they are normally developed each several years due to the amount of data and effort required. This problem is apparently severe in a developing country like Sudan, where the advanced tools and experts for data collection, monitoring and manipulation are always scarce. In the case of Sudan, the only IOT that was developed by the statistical authorities was produced in 1961. Nonetheless, the CGE model and SAM of this study is benefiting from the most recent IOT for Sudan, which is developed and documented in Siddig (2009a) for the year 2004. Therefore, the study's CGE model lies on the Sudanese 2004's SAM, which is based on the current IOT and documented in Siddig (2009)[5].

The 2004's SAM and IOT are based on data collected from official sources in Sudan. Namely the Central Bureau of Statistics, the Central Bank of Sudan, Ministry of Finance and National Economy, and the Ministry of Agriculture and Forestry in addition to several relevant administrations such as custom administration and tax administration.

The Sudanese IOT and SAM contain data on 33 sectors and commodities including 10 agricultural sectors, 10 industrial sectors, and 13 service sectors. Each activity in the SAM is assumed to produce only one single commodity, i.e. there are 33 commodities as well. Production factors are disaggregated to Labour, land, and capital, while households are grouped based on income to three groups; namely high, middle, and low. The government account is divided into four subaccounts including current government accounts, tariffs, direct taxes, and indirect taxes (excluding tariffs). In addition, the SAM also includes accounts for saving-and-investment, enterprises and separates one account for the rest of the world.

[5] The authors are proud to provide the detailed Sudanese SAM of the year 2004 in Appendix 1, to be publicly available as a base for further investigation. Detailed documentation of the SAM could be found in Siddig (2009).

3. Simulation Setup and Results Discussion

To implement the intended changes on the agricultural efficiency in Sudan described previously, two different simulation scenarios are setup. Both scenarios assume that the efficiency parameters of the value added functions of the sectors for which efficiency will be improved are exogenously augmented. Sectors considered for the efficiency change are wheat, other cereals, cotton, oilseeds, and other crops. The level of augmentation in the efficiency parameters is 10% from the base value. More specifically, scenario (1) simulates 10% increase in the efficiency parameters of the value added functions of the predetermined sectors, and designed to reflect the pure efficiency improvement effects, while scenario (2) simulates in addition to the efficiency improvement a situation where import tariffs and production taxes are completely eliminated. The two scenarios are introduced unilaterally against the status quo with respect to the rest of the world.

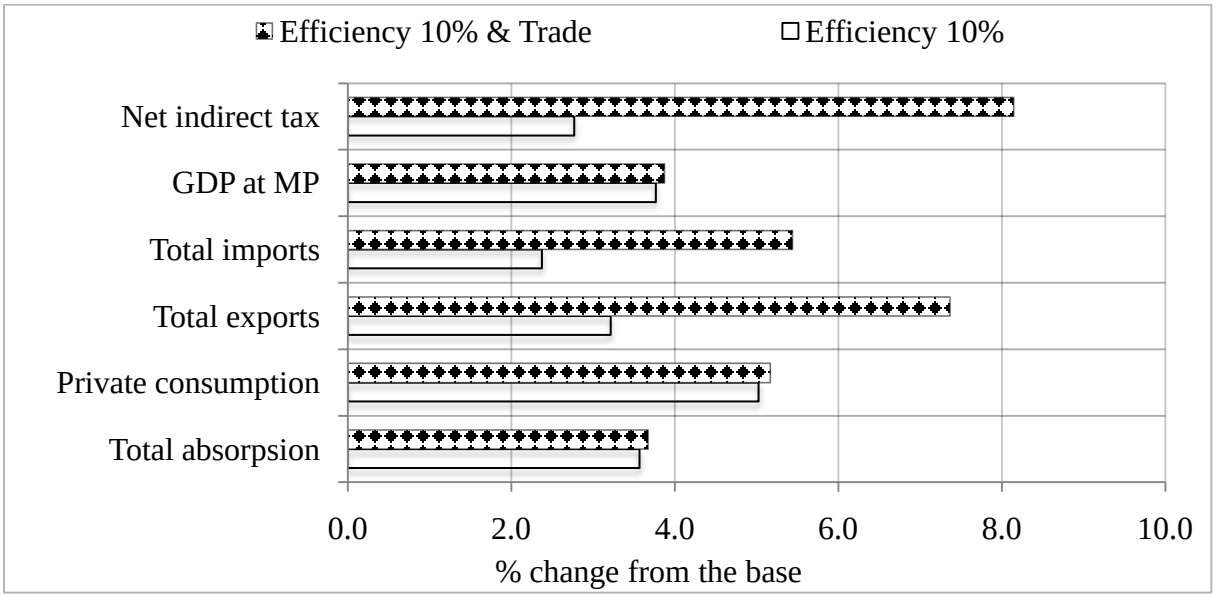
The following sub-sections show and discuss the simulation results. It covers the effects of the two efficiency improvement scenarios on the Sudanese economy represented by some macroeconomic indicators such as GDP, trade balance, government revenue, and household income. The possible changes in the production structure, factors demand, and intermediate input use will also be described. In addition, the impact of the two scenarios on the sectoral output, trade balance, and final demand as well as the resulting consequences on producers and consumers reflected on the welfare changes will also be discussed.

3.1 Effects of efficiency improvements and liberalization on macroeconomic indicators

Results of the two scenarios show that agricultural efficiency improvements would improve most of the macroeconomic indicators including private income and consumption, total absorption, and the GDP as well as total imports and total exports. Scenario one (10% increase in the

efficiency) improves GDP, private income and consumption, government income, and the overall balance of trade. This is attributed to improvements in the agricultural sectors' output shown in Table (1). The average percentage change in the output across all the sectors is 9%, which in turn increases factors income by an average of 5% and hence the private income. When efficiency improvement is combined by trade liberalization (scenario two), the impact is even more apparent especially in net indirect tax revenue, which is driven by the tariff revenue that is in turn due to the increase in imports. The efficiency scenario alone increases total exports by 3% compared to 7% when combined with liberalization. The two scenarios would increase total imports by 2.4% and 5.4%, respectively (Figure 1).

Figure 1: Effects of efficiency improvement and liberalization on macroeconomic indicators



3.2 Effects of efficiency improvements and liberalization on output and value-added

At the individual commodity level, increasing agricultural efficiency would lead to an average percentage change in the domestic output of 3% while improve the GDP at factor cost by 4%.

These increases are further boosted under the full liberalization assumption when combined with scenario one (Table 2). Considering a major sector classification at the levels of agriculture, industry, and services; the two scenarios came very much in favor of agriculture leading to an average percentage change of 9% and 10%, respectively. Within the agricultural sector, the export oriented crops have shown significant increase in their output due to the two scenarios. Cotton, oilseeds, and forestry[6] are leading with 13%, 14%, and 9% increases, respectively under scenario one and 19%, 18%, and 13%, respectively under scenario two. Results also show that all the agricultural sectors that have competitive imports will show lower increases in their output under scenario two compared to scenario one, while the reverse is true for the export oriented sectors. The findings of Siddig (2009) in which he simulated a separate trade liberalization scenario show that most of the agricultural sectors' output would decline due to liberalization. Therefore, the increasing output of the different agricultural sectors of scenario two (Table 2) confirm that agricultural efficiency improvement will enhance the competitiveness of the Sudanese agricultural products.

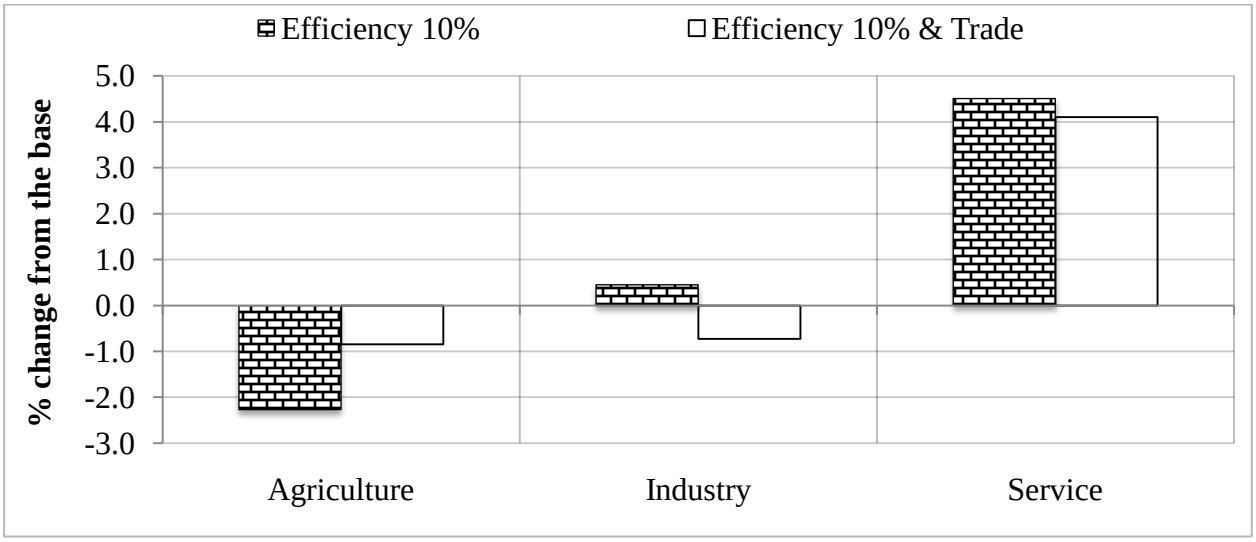
[6] It is important to note that the major component of this sector is Arabic Gum, which is one of the major Sudanese agricultural exports.

Table 2: Effects of efficiency improvement and liberalization on sectoral output

Produced commodities	Base value (SG million)	Percentage changes from the base	
		Efficiency 10%	Efficiency & Trade
Agriculture (average)	**302.2**	**9.2**	**10.3**
Wheat	42.0	9.3	9.9
Cereals	183.6	7.0	6.6
Cotton	106.7	12.8	18.7
Oilseeds	93.1	14.4	18.2
Other crops	765.6	8.2	7.7
Livestock	1547.5	9.5	9.4
Milk	11.8	8.4	6.3
Forestry	19.6	9.3	12.8
Sugar	197.5	7.3	6.5
Fishery	54.4	5.5	6.8
Industry (average)	**241.2**	**-0.1**	**-0.7**
Food industries	801.1	1.5	3.9
Other mining	65.1	1.6	1.4
Petrol	924.1	-2.6	-0.6
Textile	82.7	-0.3	-5.5
Wood	14.7	0.1	-2.6
Paper	35.7	0.2	-1.0
Chemical	286.4	2.1	1.0
Metal	90.7	-1.5	-1.9
Machinery	71.2	-1.4	-0.7
Other manufactories	40.7	-0.7	-0.9
Service (average)	**307.0**	**1.5**	**1.2**
Electricity	271.0	1.3	-1.7
Water	63.7	2.3	1.2
Construction	653.1	0.1	-0.2
Trade	643.2	1.1	1.7
Other transports	676.3	1.1	0.3
Water transports	39.8	2.0	2.5
Air transports	41.1	2.0	2.2
Communication	75.6	1.6	2.0
Finance	84.9	2.0	2.2
Insurance	18.1	2.9	3.3
Business services	252.3	1.6	1.8
Other services	474.8	1.4	0.4
Public services	697.2	0.2	-0.4

All service sectors are benefiting from the efficiency scenario (scenario one) with an average percentage change of 2%, and from scenario two with an average percentage change of 1%. This could be attributed to shifts in production factors from agriculture to services, which is confirmed by the results exhibited in Figure (2), where the total value added demand by each sector (agriculture, industry, and services) is shown, as the settings of the model allow the limited amounts of the production factors to freely move between sectors. Nonetheless, scenario two would lead to slight deterioration in the output of construction and public service sectors.

Figure 2: Effects of efficiency improvement and liberalization on value added



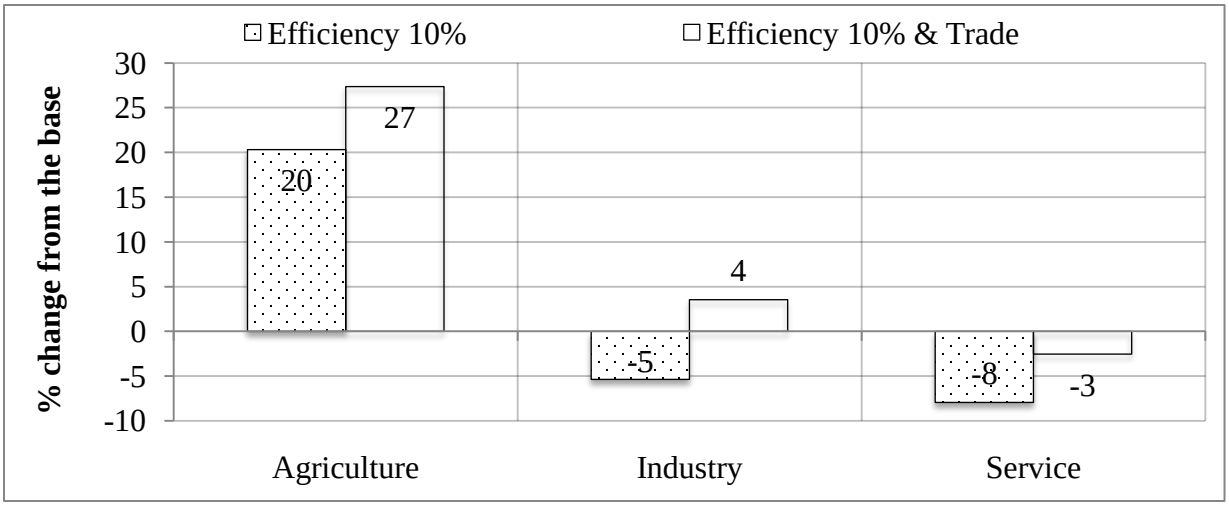
In the industrial sector, the liberalization scenario would lead the output of all the sectors to decline. This could be justified by the increasing competitive imports after the tariff elimination on one hand and the lower effects of the production taxes elimination on the other hand, as production taxes are originally low in the Sudanese industrial sector. Moreover, the impact of improving the efficiency as another component of scenario two is also minor as it was setup to

increase the efficiency in the agricultural sectors; hence its impact on the industrial sectors is indirect and confined to the cheaper agricultural intermediate inputs into industries.

3.3 Effects of agricultural efficiency improvements and liberalization on foreign trade

A 10% increase in the agricultural efficiency creates an average percentage increase in the agricultural exports of 20%, but reduces industrial exports by 5% and service exports by 8%. Figure (3) shows the average percentage changes in the agricultural, industrial, and service sectors due to the respective two simulation scenarios. The trade liberalization scenario would further boost the agricultural exports by an average of 27% and increase the industrial exports by an average of 4%. These results reflect the tied relations between the agricultural and industrial sectors in Sudan, which is further explained by that, the tendency to export in the agricultural sector would reduce the share of agricultural commodities used as intermediate inputs in the industrial sector. This is also confirmed by the declining domestic intermediate input quantities and the increasing intermediate input prices in the industrial sector. Furthermore, the 4% average increase in the industrial exports under scenario two confirms the previous argument because liberalization of trade will allow using the imported intermediate inputs by the industrial sector instead of the domestic intermediates, provided that import prices are lower.

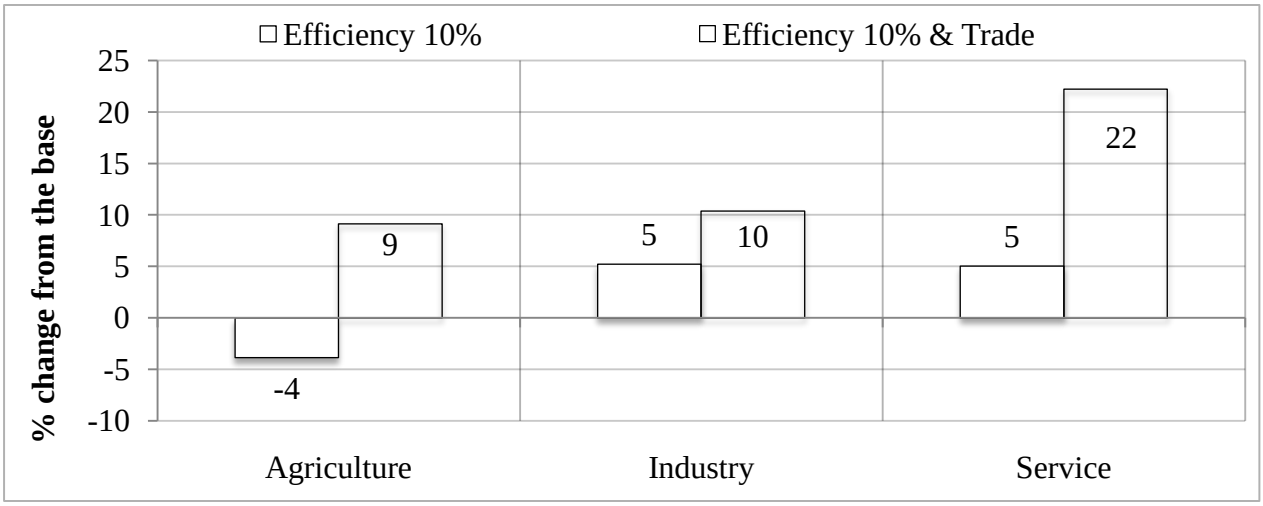
Figure 3: The impact of efficiency improvement and liberalization on exports



Siddig (2009) combined efficiency improvement with various exchange rate policies as an attempt to address efficiency and agricultural trade in a different way. He simulated efficiency improvement first with exchange rate devaluation and then with appreciation. His results show that the devaluation would lead the efficiency improvement to boost the agricultural exports by eight times as it does with industries and services, while exports of all sectors, on average, are increasing. However, his conclusions confirm the huge negative inflationary effects of devaluation on the welfare levels of the Sudanese people.

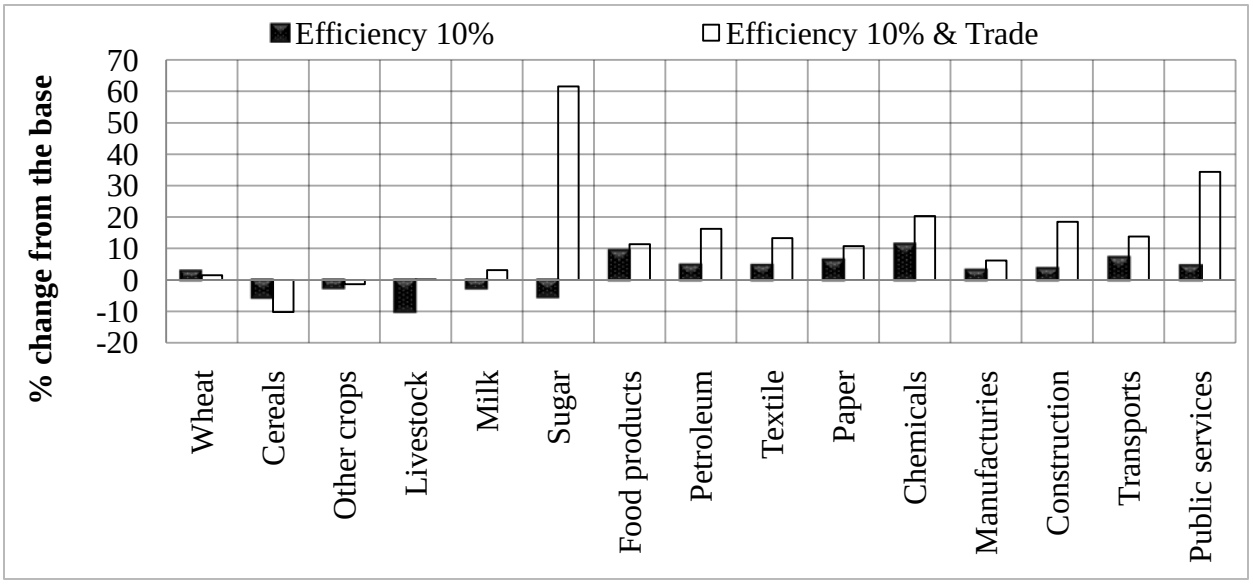
On the import side, the reverse is more or less true as depicted in Figure (4), where the average percentage changes in the exports of the agricultural, industrial, and services commodities are shown. Agricultural imports would decline by 4%, while industrial and service imports would increase by 5% each after the 10% increase in agricultural efficiency. However, combining the efficiency improvement with trade liberalization as in scenario two would further boost industrial and service imports by 10% and 22%, respectively while improving the agricultural imports by average of 9%.

Figure 4: Effects of efficiency improvement and liberalization on imports



Agricultural imports are declining under scenario one as result of the ability of the domestic agricultural output to satisfy a bigger amount of the domestic demand due to more efficient production capacities. In the industrial and service sectors, the increase in imports could be justified by that the sectors need more complementary imports to the available agricultural inputs due to the increasing output. Figure (5), portrays the percentage changes in the imports of the individual commodities due to the two scenarios. Wheat is the only agricultural commodity that exhibits an increase in imports under scenario one, while imports of the other agricultural commodities decline led by livestock, cereals, and milk products. The increase in wheat imports is attributed to that; wheat is a non-export commodity in Sudan. Domestic demand, which rising due to increases in income and substitution effects attributed to the efficiency gains, is met mainly by imports supplemented by domestic production.

Figure 5: Effects of efficiency improvement and liberalization on imports

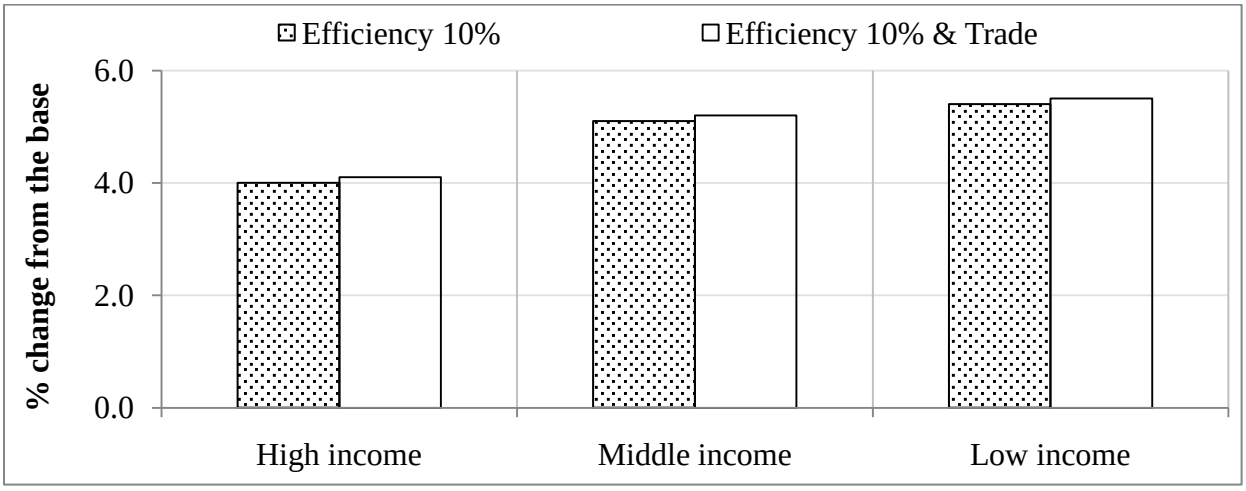


The percentage changes in the imports of cereals and livestock products could be misleading in the context of imports because their value in the baseline database is very small and they are basically non-import commodities. With regard to the second scenario, the results seem to be similar in the signs with more apparent increase in the magnitude. Imports of most of the industrial and service commodities will further increase due to tariff elimination, especially sugar imports, which enjoy the highest protection among the Sudanese industries with 30% tariff rate. Other commodities such chemicals, food industries, and transport show apparent increases by 11%, 9%, and 7% from their base import values, respectively due to scenario one and 20%, 11%, and 14%, respectively under scenario two.

3.4 Effects of agricultural efficiency improvement and liberalization on welfare

The two efficiency scenarios are found to enhance the welfare of the Sudanese people represented by the household's private income and equivalent variation[7] (EV). The EV changes caused by the two scenarios with respect to three categories of households (high income, middle income, and low income) are depicted in Figure (6). Liberalization and efficiency together (scenario two) will have a slight increase over the separate efficiency scenario with respect to the three household categories. At the producers' level the increases in welfare are due to efficiency gains and factors income in the production side (scenario one) and the elimination of the production taxes that reduce the cost of production as well as the availability of cheaper intermediate imports after the removal of tariffs (scenario two).

Figure 6: The impact of efficiency improvement and liberalization on welfare



At the consumer level, welfare gains are due to the increase in the two components of the domestic supply, as both domestic output and imports have increased. The former is driven by

[7] EV values represented here are the percentage change from the base consumption values of households due to the two scenarios.

efficiency improvement and the latter by liberalization and particularly tariff removal. In the context of the effects of efficiency improvement on the welfare level in Sudan, Siddig (2009) has investigated the impact of several combined efficiency experiments. Among his experiments, the one that combines efficiency improvement with different exchange rate policies, particularly the appreciation of the Sudanese pound, is found to be the most effective experiment to boost welfare levels in Sudan. However, this policy has also proven to have the most negative effect of the Sudanese balance of trade and current account balance.

4. Conclusions and policy implications

This paper aims at improving the awareness of policy makers in Sudan and all the concerned people around the world about the effectiveness and importance of improving the agricultural efficiency in Sudan. In this context it further assess the momentarily importance of this issue in the context of the negotiation process of the Sudanese application to join the WTO. The latter is an assessment of the possible contribution that efficiency improvement can make to the competitiveness of the Sudanese agricultural commodities during the era of liberalization.

These two objectives are introduced in the context of the CGE model of this study based on the comprehensive relevant literature survey that confirms the lower technical efficiency of the Sudanese agriculture particularly in the traditional sector. Accordingly, the value added efficiency parameters of the agricultural sectors concerned, are simulated to improve by 10% at the status quo in scenario one, while it accompanies this 10% improvement by production tax and tariff removal in scenario two. These changes could be brought about in the current state of the Sudanese agriculture by the introduction of modern farming techniques, high yielding varieties, advanced machinery and improving the extension services.

Results of the two scenarios show that efficiency improvement can improve the GDP, private income and consumption, government income, and the balance of trade. These positive changes are mainly attributed to improvements in the agricultural output that in turn increases the factors income and hence the individual's welfare. Combining the efficiency improvement with trade liberalization shows the importance of efficiency improvement in the context of the competitiveness of the Sudanese agricultural commodities. Output and exports of the Sudanese agricultural commodities would increase benefiting from the efficient use of production factors and the cheaper intermediate and machinery imports. Therefore, the welfare level under the mixed scenario is more apparent for the three household groups including the high, middle and low income households.

It is also important to clarify the possible negative effects of trade liberalization represented by tariff removal of scenario two on some industrial and service sectors. Tariff removal will lead to a decline in the output of most of domestic industrial and service sectors especially food industries, chemicals and transport. That is mainly due to the increase in their imports after the elimination of tariff, as most industrial sectors in Sudan enjoy low level of taxes on production. Moreover, scenario two of the study improves efficiency only in the agricultural sector, while it eliminates production taxes and imports tariff from all sectors. Therefore, this could also confirm the need for assessing the importance of efficacy improvement in the industrial sector to face the challenges of liberalization, or to draw red lines for the Sudanese negotiators in the WTO with respect to tariff cuts for the industrial and services sector.

This study recommends that technical efficiency in the Sudanese agricultural sector needs to be improved by enhancing labor skills. That requires more effective extension services besides employing more advanced farming practices including agricultural machinery and improved

seeds. This could be a better utilization of the huge agricultural land occupied by the traditional sector. Moreover, improving the productive capacity of the subsistence farmers based on public investments in the rural infrastructure could crowd in additional private and foreign investments. Accordingly, the continuation in adopting more favorable environment for investment in the agricultural sector is crucial. In particular, the recent investment flows need to be fairly distributed among areas in the country, especially in the countryside.

In the context of trade liberalization, efficiency improvement in agriculture improves the competitiveness of the agricultural commodities. However, improving the competitiveness of the industrial and service sectors although not specifically investigated in this paper is crucial. Further investigation is required in this regard, especially with respect to the tariff cuts that the Sudanese negotiating team can consider acceptable or at least not harmful to the domestic industries.

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Appendix 2: Productivity Profiles of Selected Countries

Country	Multifactor productivity	Efficiency change	Technical change
Argentina	-2.8	-2.5	-0.3
Bangladesh	-2.6	0.0	-2.6
Brazil	2.6	-0.1	2.8
Canada	4.1	0.5	3.7
China	1.3	0.9	0.4
Egypt	1.0	1.0	0.0
Ethiopia	-0.6	-1.3	0.7
Germany	-13.9	0.0	-13.9
Jordan	0.6	1.1	-0.5
Kenya	-1.5	0.0	-1.5
Netherlands	1.6	0.2	1.3
South Africa	2.7	1.2	1.4
Sudan	1.6	0.6	1.0
Syria	3.7	0.6	3.2
Thailand	-0.6	0.0	-0.6
Turkey	0.2	0.0	0.2
Uganda	0.3	-0.7	0.9
United States	-1.0	-1.0	0.0
Zimbabwe	3.1	-0.3	3.4

Source: Trueblood and Coggins (2001).