

## AGRICULTURAL ECONOMICS

# Oil crisis and the potential role of agriculture in the post-separation of Sudan\*\*

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### Abstract

The Comprehensive Peace Agreement (CPA) signed by the Government of the Republic of Sudan (hereafter, the Sudan) and the Sudanese People's Liberation Movement ended more than 20 years of civil war. According to the CPA, in addition to the oil produced from northern wells, which represents about 30% of the total oil production in Sudan, Sudan's Government receives 50% of the oil exploited from wells of the southern part of country. In January 2011, the people in southern Sudan voted for separation from Sudan and in July 2011, the Republic of South Sudan was officially announced as Africa's newest state. Now, South Sudan possesses its entire oil production, yet it needs to pay a negotiated amount of fees and customs to utilize the export infrastructure of the Sudan so that its oil can be exported. The independence of South Sudan created a huge loss in oil revenue for the Sudan since oil revenue constituted a growing share in its trade, government revenue, and GDP during the last decade. This paper investigates the consequences of the independence of South Sudan on Sudan's economy using a Computable General Equilibrium model. Results show that the entire economy would be greatly affected by the applied scenarios as represented by GDP, Households welfare, domestic production and trade. The study introduces non-oil agricultural exports as an alternative to oil and recommends enhancing agricultural efficiency and promoting agricultural exports to gradually recover the economy.

*Key words:* Agriculture, Oil, Sudan, Separation, CGE, GTAP Model

JEL Classification: E2, E6, F4, N5, O1, O13

## 1 Introduction

Oil, agriculture, and development are complex, interrelated, and overlapping issues in most oil-producing developing countries. The situation becomes even more complicated if politics, peace building, and state building come into play. This describes the recent situation in the Republic of Sudan (North Sudan, hereafter "the Sudan"), and the Republic of South Sudan with many complexities including conflicts, oil and border demarcation.

The interrelating and overlapping spheres of these different issues are beyond the scope of this paper. However, this paper attempts to describe

how the division of Sudan and the establishment of South Sudan affect Sudan's economy, in general, and its agricultural sector, in particular.

Oil has taken a cornerstone position within the united Sudanese economy since its exploitation which began in 1999. As depicted in the reports of the Central Bank of Sudan (CBoS), the importance of oil is demonstrated by its weight in at least three major economic variables: the GDP, the foreign trade sector, and government revenue. The importance of oil has spread to almost all aspects of the economy and society. The first economic variable analyzed here is the GDP. As shown in Figure 1, before 1999 and even in 1999 – the year which witnessed the beginning of Sudanese oil exports – the contribution of the oil sector to GDP was negligible. Prior to 1999, the shortage of petroleum products was a permanent problem constraining the economy's development by raising the costs of production and specially limiting the agricultural growth (Gadkarim, 2010).

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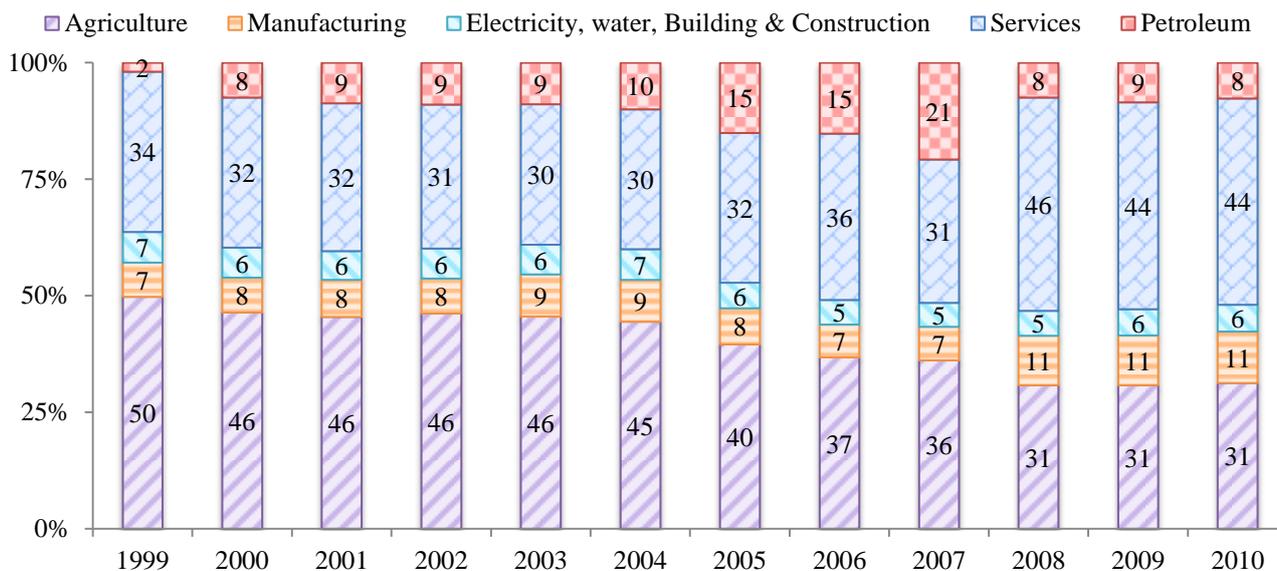


Figure 1. Sectorial Composition of the Sudan's GDP, 1999 – 2010 (in %).  
 Source: Central Bank of Sudan's Reports (various issues).

Figure 1 illustrates four major trends in the composition of the GDP: 1) an increasing contribution of the oil sector to the GDP from 2% in 1999 to 21% in 2007 and a declining average contribution of 9% in 2008-2010; 2) a declining significance of the agricultural sector to the GDP, from 50% in 1999 to 31% in 2008-2010; 3) slight changes only in the contribution of building and construction, electricity and water, and manufacturing; and 4) an increasing contribution of services to GDP, in particular after the deterioration of oil revenues in 2009 (Central Bank of Sudan, 1999-2010).

The structure of the economy has clearly changed from being dominated by the agricultural sector to an economy with a greater share of services, petroleum and manufacturing, besides agriculture. However, it was also obvious that, the oil sector has not contributed largely to the development of other sectors, especially

agriculture. Instead, it has facilitated the continuing neglect of the productive sectors, namely, agriculture and manufacturing (Gadkarim, 2010).

The second economic variable influenced by the oil sector, which we consider is the foreign sector. Figure 2 shows total Sudanese exports classified to oil and non-oil, as well as the country's total imports between 1997 and 2010. The vertical axis measures total exports and imports in US\$ billion and the horizontal axis shows the years. The relative contributions of oil and non-oil exports to total exports are also differentiated by the shading of the vertical columns. The decline in the significance of non-oil exports (from comprising 100% of export earnings in 1998 to less than 10% during the 2000s) is incomparable with the lower drop in non-oil export earnings, especially during years like 2006 and 2007. This is clearly attributed to the increase in oil export revenues.

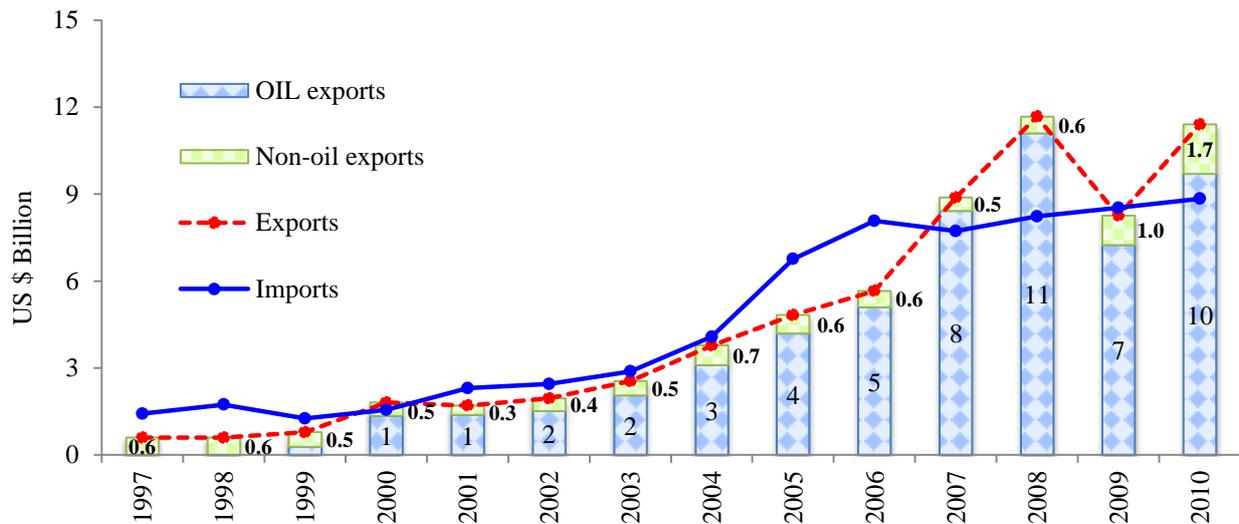


Figure 2. Oil and Foreign Trade in the Sudan, 1997 – 2010 (in \$ billions and %)  
 Source: Central Bank of Sudan’s Reports (1997–2010).

The contribution of the oil sector was more than 90% to export revenues during the period between 2003 and 2010, implying that the economy was becoming highly dependent on the export of one product. Moreover, the insignificant increase in the export value of non-oil products indicates that oil has not played a positive role in developing non-oil agricultural exports (Gadkarim, 2010).

The third economic variable examined in this study to demonstrate the growing role of the oil

sector in the Sudanese economy is government revenue.

Figure 3 shows that, government revenue has also witnessed radical changes due to the evolving production and exportation of oil. The contribution of tax revenues to the total government income between 1997 and 1999 were about 75%, with non-tax revenues contributing only about 25%. However, after the extraction of oil, the share of non-tax revenue expanded at the expense of tax proceeds (Figure 3).

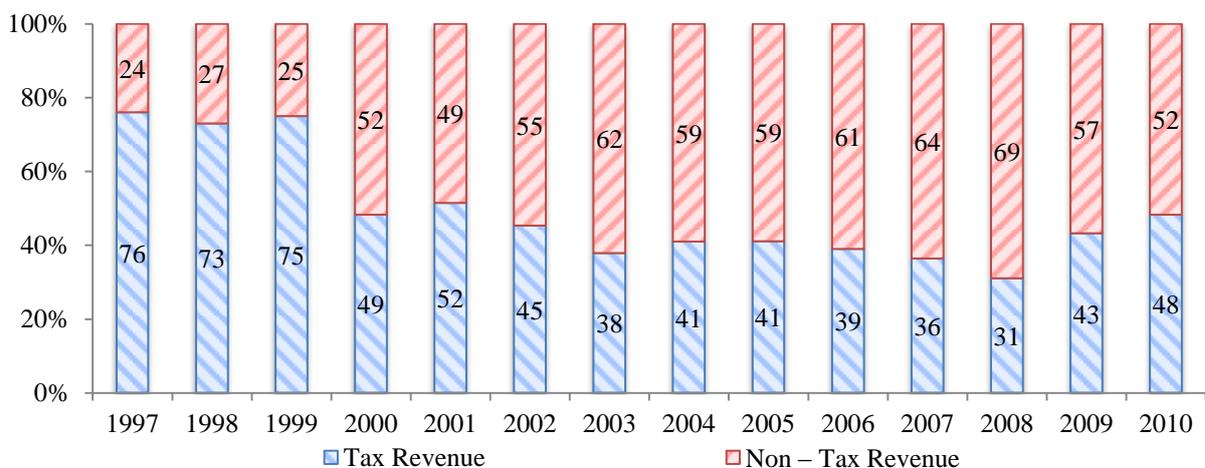


Figure 3. Sources of Government Revenue in the Sudan, 1997-2010 (in %).  
 Source: Central Bank of Sudan’s Reports (1997-2010).

This background manifests the reliance of the Sudanese economy on oil as a major source of foreign exchange, government revenue, and GDP. According to the Comprehensive Peace Agreement<sup>1</sup> (CPA) signed in 2005, the Government of the Sudan received a 50% share in oil revenues from oil extracted from southern wells. This share was used as a reference for the distribution of revenue during the transitional period, from 2005 to 2011 (CPA, 2005). However, after the establishment of the Republic of South Sudan (RSS), the Sudanese government lost its share in the oil of the south.

The demonstrated importance of petroleum in the Sudanese economy during the last decade raises many questions about the performance of the economy in the post-separation period. This paper examines the influence of the decrease in oil revenues for the Sudan's economy and provides recommendations for additional measures which Sudan's government could take in light of any changes.

## 2 Objectives

The major objective of this study is to investigate and evaluate the impact of the division of the Sudan as per the referendum of South Sudan of July 2011, exemplified by the essential decline in the production and exports of oil on the Sudan's economy. It also aims at proposing possible options, which the Sudan's government could take in light of any changes generated by such a loss in oil revenue. More specifically, the paper quantifies three situations, all representing the economy of the Sudan in order to discuss the following research concerns:

- 1) What were the state and structure of the Sudanese economy before the separation?
- 2) What are the main economic changes triggered by the separation in its form that is represented by the declining production and exports of oil and the resulting deterioration in the government revenue.
- 3) What is the bundle of policies and actions that may be considered to recover the Sudanese economy to its pre-separation situation?

## 3 Scenarios

The research concerns of this paper are quantified using two major simulation scenarios

considering oil and nonoil-related variables. In addition to returns from the output of southern wells, the Sudan's total revenue from oil during the pre-separation period included the output of northern wells which accounted for about 20 to 30% of the total output of both the Sudan and South Sudan. After the signature of the CPA and until the establishment of the RSS in July 2011, the Sudan received 50% of the oil produced by wells in the South (CPA, 2005). Therefore, the total revenue of the government of the Sudan from oil comprised total production in the North (20-30%) plus 50% of the oil produced in the South. Together the Sudan received 65% of the total oil produced in the Sudan and South Sudan. The remaining 46% accrued to South Sudan.

After the establishment of the RSS, the oil produced in South Sudan is to be exported through the port of the Sudan (Port-Sudan), at least in the short-run. This is due to the fact that oil infrastructure, including pipelines, refineries, and Red Sea ports, exist in the Sudanese (North) territory. Needless to say that, the RSS is a land-locked country with no direct access to the sea. As a result, the RSS would need to pay fees and customs to the Sudanese government for processing, transporting, and exporting its oil. The exact amount to be paid was subject to many political and economic negotiations, which involve several other issues including border demarcation (in the oil rich zone of Abyei and other border areas), nationality, and foreign debts.

In establishing a hypothetical scenario to investigate possible implications on the economy of the Sudan caused by the loss in oil income, this paper assumes a 20% reduction in oil revenue to the Sudan as a quantification of loss in oil revenue due to separation. This 20% is realistic since it is approximated by taking into account the recent reduction in oil revenue to the Sudan and by considering the customs and fees which will be earned from South Sudan.

Population is another variable which needs to be considered in quantifying post-separation implications. According to the last census, the total population of the Sudan is estimated to be 40.1 million people in 2009 (CBS, 2009), while the RSS population is estimated to be 8.3 million in 2010 (SSCCSE, 2010). However, a considerable proportion of South Sudan's population did not originate from Sudan and is instead composed of citizens from neighboring countries. Moreover, many northerners who resided in the south are expected to have departed to the north. Therefore,

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<sup>1</sup> The Comprehensive Peace Agreement (CPA) is an agreement signed by both the Sudanese government and the Sudanese People's Liberation Movement (SPLM) in Nifasha, Kenya. It marks the end of the civil war that lasted more than 20 years.

for the purpose of this paper, it is plausible to assume a loss of 10% to the Sudan's population.

Accordingly, the following separation and recovery scenarios are formulated and simulated:

a) Separation: in this scenario, there is a reduction in oil output by 20% and in the total population by 10%. Other factors, such as land, labor, and natural resources, are assumed to be non-determinant in the entire production process, at least in the short-run.

b) Recovery: in this scenario, the updated database that was obtained after the separation scenario -reflecting the state of the economy after the separation- is used as a baseline and various efficiency improvements are applied to help the economy recover to its original GDP.<sup>2</sup>

The motivation behind the recovery scenario is to provide alternatives to oil as the main contributor to exports and to the economy at large for policymakers in the Sudan. The scenario focuses on the agricultural sector as a major contributor to the GDP and as a likely substitute for oil in export markets.

#### 4 Methods and Data

This study uses the global Computable General Equilibrium (CGE) modeling framework of the Global Trade Analysis Project (GTAP). The GTAP model is multi-regional model for analyzing the impacts of regional economic policies. The GTAP model is a comparative static, global CGE model based on neoclassical theories. It is a linearized model which assumes perfect competition in all markets, constant returns to scale in all production and trade activities, and profit and utility maximizing behavior of firms and households, respectively (Hertel, 1997). It is solved by using GEMPACK software.<sup>3</sup>

The rationale of applying a regional model to this study is to complement other studies which are currently being conducted on regional implications of the separation of the Sudan and South Sudan on the economies of neighboring countries. The focus of this paper targets the impact on the Sudan from this separation and emphasizes the possibility of the agricultural sector to be a sensible substitute to petroleum. Another reason for applying this model is that it has a special version of its comprehensive database on Africa, namely the GTAP Africa database which includes the Sudanese Input/Output Table (IOT) for 2004 (Siddig, 2009).

Each region in the GTAP model has a single representative household, called the regional household. The income of the regional household is generated through factor payments and tax revenues net of subsidies. Governed by a Cobb-Douglas per capita utility function, expenditure categories include private household expenditure, government expenditure, and savings. The private household buys commodities to maximize utility subject to its expenditure constraint which is represented by a Constant Difference of Elasticity (CDE) as an implicit expenditure function. The household spends its income on consumption of both domestic and imported commodities as well as on tax contributions. This consumption is a Constant Elasticity of Substitution (CES) aggregate of domestic and imported goods, where the imported goods are also CES aggregates of imports from different sources (regions). Taxes paid by the private household are commodity taxes for domestically produced and imported goods as well as the income tax net of subsidies. The government also spends its income on domestic and imported commodities and pays taxes. For the government, taxes consist of commodity taxes for domestically produced and imported commodities. Similar to the private household, government consumption is a CES composition of domestically produced goods and imports, but a Cobb-Douglas sub-utility function is employed to model the behavior of government expenditure (Hertel, 1997).

Producers receive their income from selling consumption goods and intermediate inputs to consumers in the domestic market and/or to other regions. To satisfy the zero profit assumption employed in the model, producer's income must be spent on intermediate inputs, factor payments, and taxes paid to the regional household. For production, a nested production technology is employed which assumes that every industry produces a single output, that constant returns to scale prevail in all markets, and that the production technology is Leontief. Producers maximize profits by mixing a composite of factors and intermediate inputs. Value added itself is a CES function of labor, capital, land, and natural resources, while the intermediate composite is a Leontief function of material inputs which are a CES composition of domestically produced goods and imports. Imports are sourced from all regions according to a CES function (Brockmeier, 2001).

In the multiregional setting, the model is closed by assuming that regional savings are homogenous and contribute to a global pool of savings (global savings) and by assuming that the demand for

<sup>2</sup> The detailed changes in the efficiency parameters of the targeted sectors are shown in Appendix 1.

<sup>3</sup> For more details about GEMPACK and its related software packages, see Harrison and Pearson (1996).

investment in a particular region is savings driven. Regional savings are then allocated among regions for investment in response to changes in the expected rates of return in the different regions. If all other markets in the multiregional model are in equilibrium and all firms earn zero profits while all households are on their budget constraint, such a treatment of savings and investment will lead to a situation where global investment must equal global savings, satisfying Walras' Law (Kelali, 2006).

The GTAP Africa Database (GAD) is a special version based on the GTAP 6 Database.<sup>4</sup> It includes data of the 57 sectors of the GTAP 6 Database for 39 regions. The Sudanese IOT is contributed to such a database in 2008 together with six other IOTs for selected African countries. A detailed documentation of the Sudanese IOT is available in Siddig (2009). The missing bilateral trade flows for the African regions have been econometrically estimated using the gravity approach documented in Villoria (2008).

For the purpose of this paper, the database has been aggregated to meet the intended objectives of this research. Regions are aggregated from the 39 regions of GAD into two regions: one region is Sudan and the other region is an aggregation of all other regions. Sectors (commodities) are aggregated to reflect their contributions to the country's production, consumption, and trade. Petroleum, agricultural exports, and the country's major imports are setup to have their sectors distinguished in the final aggregation. Therefore, the 57 sectors of GAD are aggregated into 14 sectors, which are shown in Table 1.<sup>5</sup>

Table 1. Names and Codes of the Aggregated Sectors of the Study.

No.	Sector (commodity) name	Codes*
1	Oilseeds	Oilseeds
2	Wheat	Wheat
3	Other cereals	Other Cereals
4	Other crops	OtherCrops
5	Meat and livestock	MeatLstk
6	Forests and fisheries	ForestFish
7	Petroleum	Petroleum
8	Processed food	ProcFood
9	Textile and wearing apparel	TextWapp
10	Light manufacturing	LightMnfc
11	Heavy manufacturing	HeavyMnfc
12	Utilities and constructions	Util_Con
13	Transports and communications	TransComm
14	Other services	OthServices

<sup>4</sup> For details about the GTAP Database Version 6, see Dimaranan (2006).

<sup>5</sup> The detailed mapping between the standard GTAP Africa database sectors and the aggregated version of Table 1 is shown in Appendix 2.

\* These codes, rather than the sector (commodity) names, are used throughout this paper.

## 5 Results and Discussion

Figure 4 shows the impacts of the two scenarios (separation and recovery) on the GDP and its expenditure components. The 2010 GDP is introduced here as an update of the database based on the shares revealed by the model results and the macro data of the Central Bank of the Sudan for 2010. GDP declines by 19.97% in the separation scenario, which is the target to be recovered in the recovery scenario. The recovery scenario then relied on the new state of the economy -reflected the updated database after the separation scenario- from which it shows a GDP increase of 19.74%. The idea of the recovery scenario is to increase the efficiency parameters of the sectors that are negatively affected by separation to boost their output and hence push the GDP to recover from the separation consequences. Accordingly, similar percentage changes in the separation and recovery scenarios are obtained. However, this does not imply any similarity in the structure of the economies in the *ex-ante* and *ex-post* separation scenarios.

In the two scenarios, except for exports and imports, each component of the GDP from the expenditure approach moved in the same direction in both the separation and recovery scenarios. Consumption decreases strongly in the separation scenario as a result of higher domestic prices and lower purchasing power by households. While total exports deteriorate by only 0.15% in the separation scenario, they increase by 3.54% in the recovery scenario. Similarly, imports decline by 3.51% in the separation scenario and increase by 4% in the recovery scenario. This is justified by the improvement of the efficiency of factors in non-oil export-oriented sectors, such as sesame and livestock, which increases exports and provides sufficient foreign exchange to enhance imports under the recovery scenario.

The impact of the two scenarios on the output of different sectors is depicted in Figure 5. It shows that the separation scenario would markedly increase the output of many exports and imports substitutes. The production of oilseeds, the first Sudanese agricultural export, would increase by 30.2%, while that of wheat, which represents about 7% of the total imports in the baseline data, would increase by 15.5%. The increase in the production of both commodities seems to be the result of the automatic reallocation of factors of production from oil and oil-constrained sectors to substitutes, which is governed by the factor mobility assumption of the model.

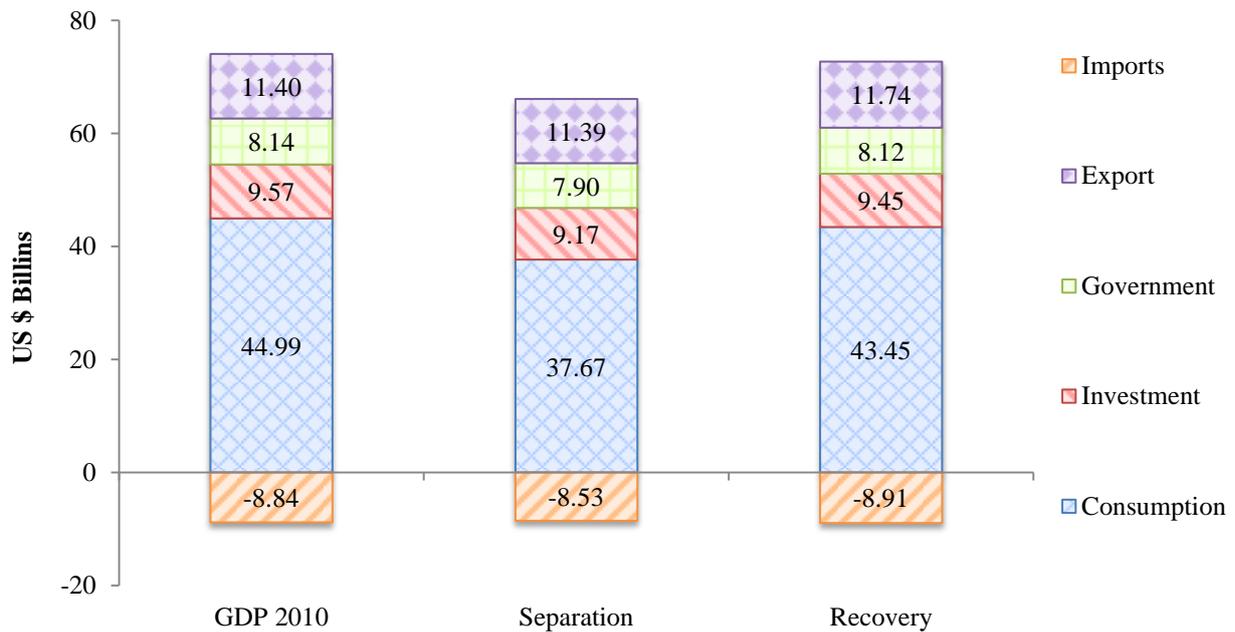


Figure 4. GDP Expenditure Shares in the Sudan Separation and Recovery Scenarios.

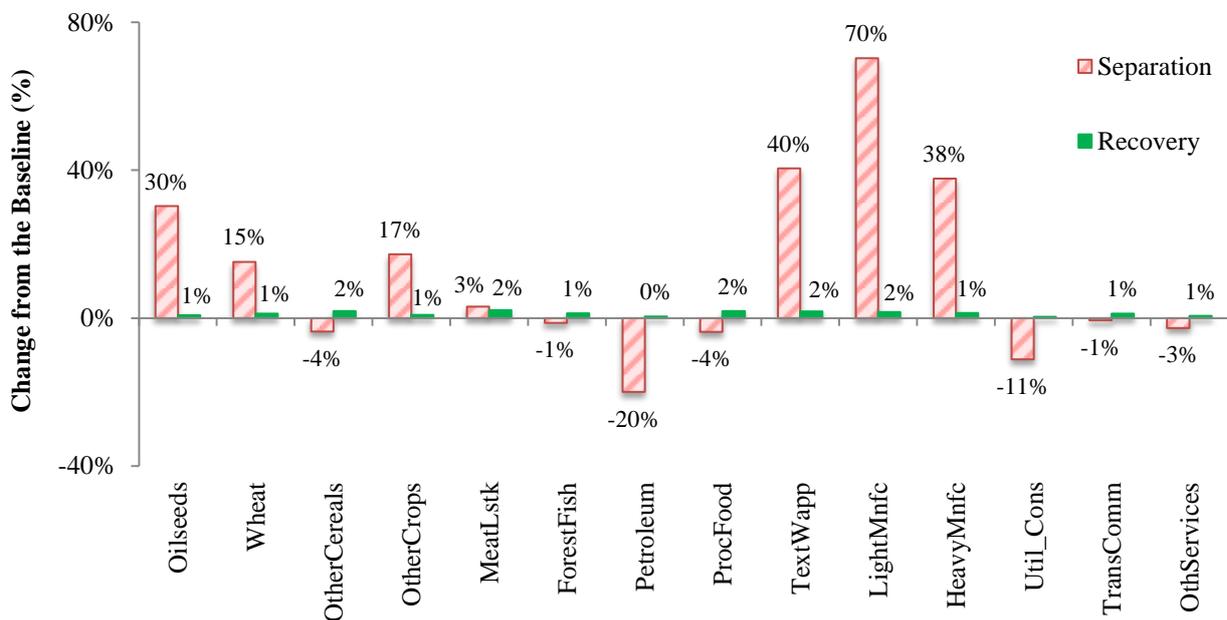


Figure 5. Changes in the Domestic Output in the Separation and Recovery Scenarios.

It is important to observe the share of each sector in the total output value of the baseline data (pre-separation), shown in Appendix 3. Sector size thus, reflects the importance of the contribution of each sector to the total output. The sector size (in percentage of total size) is shown in the second

column of the Table in Appendix 3. In Figure 5, scenario results, measured on the left vertical axis, are shown in percentage change from the baseline. Results of the two scenarios must be read in relation to the relative importance of each sector. For example, the 40% increase in the textile output

in the separation scenario is less important than the decrease in the output of processed food by 4% because the relative shares of the two sectors in total domestic output are 1% and 28%, respectively.

The percentage changes of exports of different commodities in the two scenarios are shown in Figure 6. Commodities with less than 1% share in total exports are excluded. Similar to Figure 5, the

relative importance of the sector's contribution to total exports (pre-separation) in percentage, is shown in Appendix 3 and the results of the two scenarios are measured on the vertical axis (in percentage change from the baseline). Results show that the exports of oilseeds, other crops, and livestock would increase in the separation scenario.

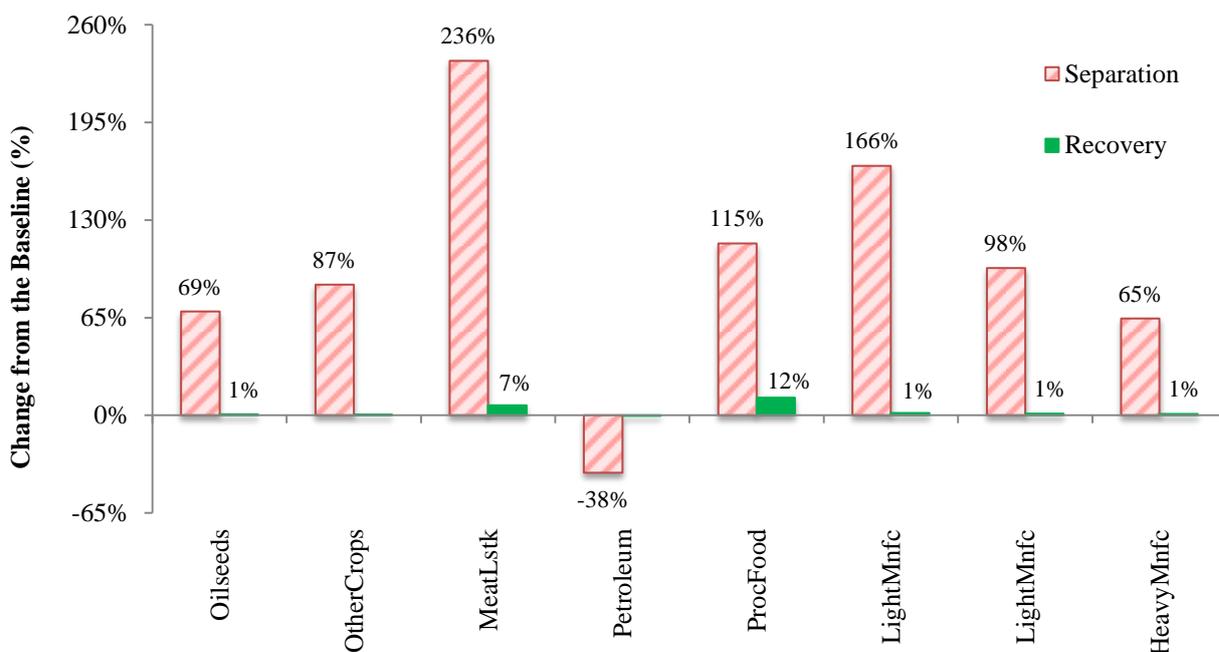


Figure 6. Changes in Sectorial Exports in the Separation and Recovery Scenarios.

This is an automatic response of the model governed by its factor mobility assumption which expects mobile factors to automatically allocate away from sectors paying lower wages to sectors paying higher wages. Oilseeds, other crops, and livestock sectors are default alternatives for oil exports. They represent of major agricultural exports with oilseeds alone accounting for about 8% of the total Sudanese exports in the base data.<sup>6</sup>

The separation scenario would also lead to the expansion of processed food and light manufacturing exports. This is also related to changes witnessed in the agricultural sector since both sectors (processed food and light manufacturing) rely on agricultural raw materials as inputs. There are minimal impacts on exports in the recovery scenario because the scenario uses updated data (the results of the separation scenario)

which already have an increase in the production of most of agricultural and manufacturing sectors.

Imports of all commodities other than petroleum<sup>7</sup> would decline in the separation scenario. This is shown in Figure 7<sup>8</sup> in which the results in percentage change from the baseline are shown. For reference, the share of each commodity in the total Sudanese imports of the baseline is shown in the third column of Appendix 3. These declines in imports are driven by the huge loss in foreign exchange earnings which is generated by the approximately 40% decline in oil exports. Therefore, the ability of the entire economy to import is reduced and total imports deteriorate.

<sup>6</sup> 2004 is the baseline year of the model database. See Siddig (2009) for further details.

<sup>7</sup> Petroleum represents about 2% of the Sudan's total imports in the baseline data.

<sup>8</sup> Commodities contributing less than 1% to the total Sudanese imports in the baseline data are excluded.

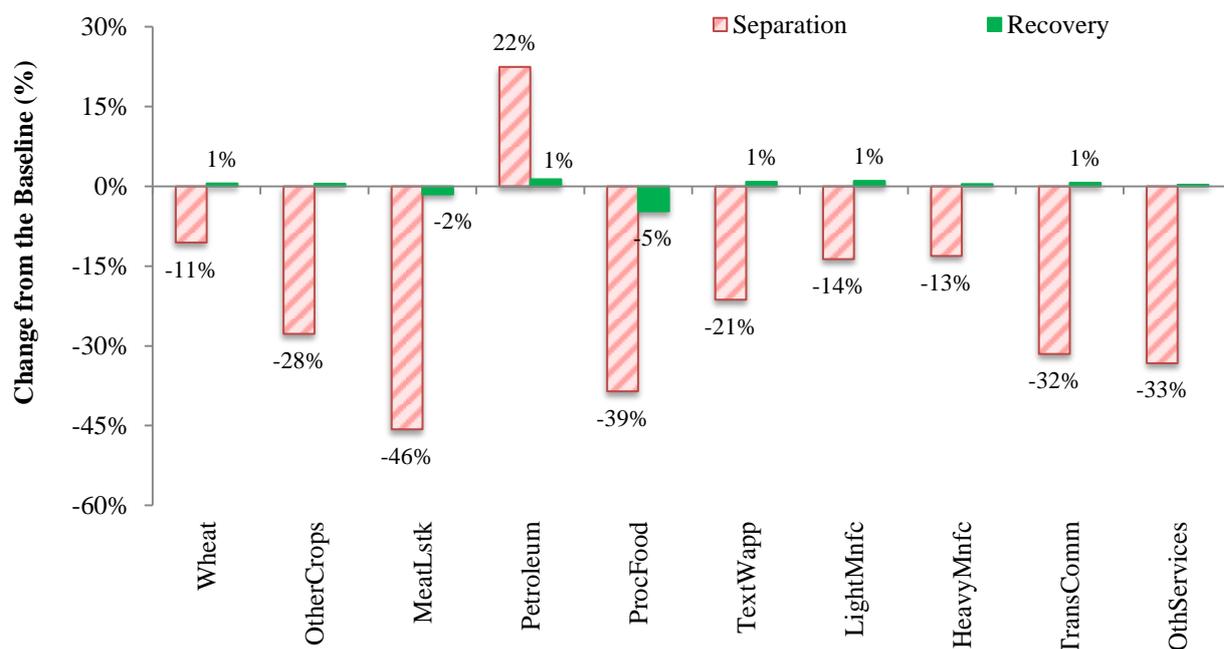


Figure 7. Changes in Sectorial Imports in the Separation and Recovery Scenarios.

In terms of imports, the manufacturing sectors suffer the largest losses, with heavy manufacturing imports alone accounting for half of the Sudan's total import value in the baseline data. Light manufacturing, textiles, and processed food suffer the next largest losses since they represent 16%, 7%, and 8%, respectively, of the baseline imports. In this context, the declining imports of processed food in the separation scenario require more attention. In this context, economic plans with the objective of a better performance of both the agricultural sector and agricultural-based industries need to be developed.

Generally speaking, the recovery scenario has proven that while the increase in the efficiency of individual sectors would stimulate output in these sectors, this increase has a limited impact on trade. The results thus confirm that there is a need for other trade-encouraging measures, particularly for export goods. Some of these measures, although not investigated in this study, could be related to the exchange rate policy (see for instance Siddig, 2012).

The impact of the two scenarios on households' demand for goods is shown in Figure 8.<sup>9</sup> The share of demand for each commodity in the total

households' demand is shown in the fourth column of the table in Appendix 3. Processed food constitutes about 50% of household demand, followed by livestock products, transport, and other services.

Unlike impacts on production and trade, the impact of the two scenarios on the households' demand is clearer. Demand is reduced in the separation scenario by a larger amount than demand increases in the recovery scenario. In addition, demand for different commodities responded differently in the two scenarios based on factors including commodity-specific elasticities of demand and sensitivity to changes in market variables such as returns to production factors and commodities price.

The total welfare loss due to separation is estimated to be US\$ 3.7 billion, of which only 16% would be recovered in the designated recovery scenario. This implies that policymakers in the Sudan need to carefully consider the negative implications of separation on people's livelihoods. Recently, substantial increases in prices have occurred and the negative implications of separation on food prices in the Sudan are already evident.

<sup>9</sup> Commodities contributing less than 1% to total household good demand in the baseline data are excluded.

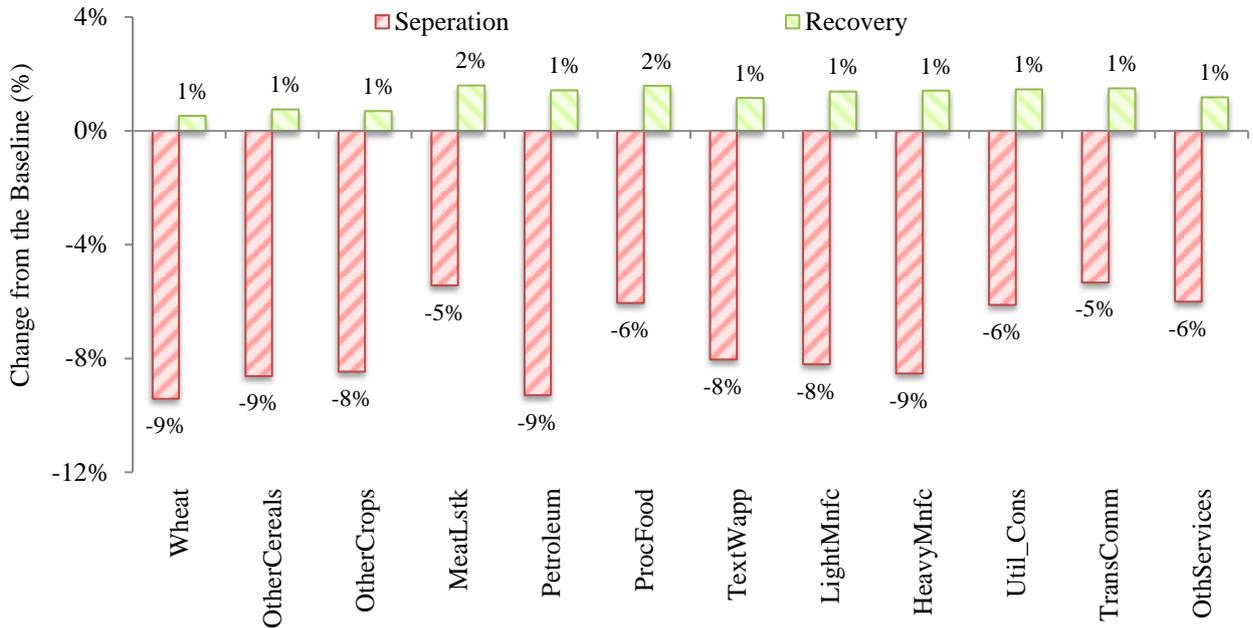


Figure 8. Changes in household demand for goods in the Separation and Recovery Scenarios.

## 6 Conclusions

This paper has investigated implications of the separation of Sudan and the establishment of the RSS on the Sudan's economy. The paper is motivated by the fact that the Sudan is losing a significant part of its revenue from oil. Oil has contributed considerably to its economy in the last decade, which is evident in the Sudan's GDP, exports, and government income. The objectives of this study were to evaluate the impact of separation, estimate expected losses, and propose recovery scenarios which may regain some of the losses caused by the separation.

GTAP CGE model with together with GTAP Africa database were used for the analysis. The database and closure assumptions were modified to match the objectives of the analysis. The separation scenario is exemplified by a 20% cut in petroleum output and a 10% reduction in total population of the Sudan from the baseline. The recovery scenario uses updated data (post-separation scenario data) as a baseline and simulates efficiency improvements in the negatively affected sectors as an approach to boost GDP. The effectiveness of enhancing the efficiency of the agricultural sector in the Sudan is covered in a study by Siddig et al. (2011), which found several positive implications at the national and regional levels from enhancing the agricultural sector's productivity.

Results show that separation would be costly to the economy at large as well as to households. Despite the restoration of GDP in the recovery scenario, many variables of the economy would remain unrecovered from their losses due to separation. The GDP would decline by 19.97% due to separation. This loss in GDP becomes the target to be recovered in the recovery scenario by increasing efficiency parameters of the negatively affected sectors so that their output increases and therefore, GDP recovers to its pre-separation level. However, this does not imply any similarity in the structure of the economies of the ex-ante and ex-post separation scenarios.

The impact of the two scenarios on sectorial output demonstrates that the separation scenario would pronouncedly increase output in many exports as well as increase import substituting commodities. The increase in exports is led by oilseeds, a major Sudanese agricultural export commodity, and the increase in imports is led by wheat, a major import commodity, resulting in an increase in their production. It is also found that the exports of oilseeds, other crops, and livestock would increase encouraged by the need for foreign currency earning that was caused by the separation.

At the household level, the separation scenario reduces demand while the recovery scenario regains some parts of the lost demand. However,

the magnitude of change is always higher for the separation scenario (in which demand is reduced) and smaller for the recovery scenario (in which demand is increased). This translates into a huge welfare loss from separation, which was not recovered by the modeled recovery scenario. Thus, policymakers in the Sudan need to carefully consider the negative implications of separation, which are already reflected in the recent increase in consumer prices.

In this regard, it is important to note that the simulated cut in the output of oil in this study is on the optimistic side. In other words, the loss in oil revenue could be higher. Furthermore, many other implications are not incorporated in this simulation, such as currency issues, inflation, and other measures taken by the government such as the increase in the price of oil sold domestically and the removal of subsidies in some sectors. These policies and procedures could lead to further losses in welfare in the post-separation era.

Moreover, other fiscal policies which have been announced recently by the National Assembly may lead to further losses in welfare in the post-separation era. The announced policy package includes: a reduction of public expenditures (mostly on goods and services), a decrease in government spending by reducing subsidies on petroleum products and on sugar and by removing several safety net measures. The impacts of implementing some of these measures remain unclear. The World Bank recommends that authorities in the Sudan need to further assess its revenue and expenditure measures and also need to reassess the 2011 budget based on the new fiscal environment. According to a World Bank study which simulates several oil sharing scenarios, the fiscal shock to the Sudan's government will be large and permanent (Battaile, 2011). Therefore, it is vital to focus on non-oil revenues to reduce the Sudan's high dependency on oil. Measures to enhance the efficiency in both the production and expenditure sides are fundamental. Additional measures such as protecting pro-poor spending and diverting investment towards non-oil growth promotion and rural development are also needed. Such measures could help promote peace and political stability, which are highly significant to sustain economic growth.

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## 8 Appendices

Appendix 1. The Targeted Production Sectors and Factors in Recovery Scenario<sup>10</sup>.

Shock afeall ("Land", "OtherCereals", "Sudan") = 9.13;  
 Shock afeall ("Land", "MeatLstk", "Sudan") = 10.17;  
 Shock afeall ("UnSkLab", "OtherCereals", "Sudan") = 2.95;  
 Shock afeall ("SkLab", "OtherCereals", "Sudan") = 1.56;  
 Shock afeall ("Capital", "OtherCereals", "Sudan") = 1.87;  
 Shock afeall ("Land", "ProcFood", "Sudan") = 21.22;  
 Shock afeall ("UnSkLab", "ProcFood", "Sudan") = 8.31;  
 Shock afeall ("SkLab", "ProcFood", "Sudan") = 1.93;  
 Shock afeall ("Capital", "ProcFood", "Sudan") = 3.38;

Appendix 2. Sectorial Mapping Used to Aggregate the GTAP Africa Database to 14 Sectors.

No.	New code	Sector name	Comprised standard sector
1	Oilseeds		Oil seeds
2	Wheat		Wheat
3	OtherCereals		Paddy rice; Cereal grains nec
4	OtherCrops	Grains and Crops	Vegetables, fruit, nuts; Sugar cane, sugar beet; Plant-based fibers; Crops nec; Processed rice.
5	MeatLstk	Livestock and Meat Products	Cattle, sheep, goats, horses; Animal products nec; Raw milk; Wool, silk-worm cocoons; Meat: cattle, sheep, goats, horse; Meat products nec.
6	ForestFish		Forestry; Fishing
7	Petroleum		Coal; Oil; Gas; Petroleum, coal products.
8	ProcFood	Processed Food	Vegetable oils and fats; Dairy products; Sugar; Food products nec; Beverages and tobacco products.
9	TextWapp	Textiles and Clothing	Textiles; Wearing apparel.
10	LightMnfc	Light Manufacturing	Leather products; Wood products; Paper products, publishing; Metal products; Motor vehicles and parts; Transport equipment nec; Manufactures nec.
11	HeavyMnfc	Heavy Manufacturing	Minerals nec; Chemical, rubber, plastic prods; Mineral products nec; Ferrous metals; Metals nec; Electronic equipment; Machinery and equipment nec.
12	Util_Cons	Utilities and Construction	Electricity; Gas manufacture, distribution; Water; Construction.
13	TransComm	Transport and Communication	Trade; Transport nec; Sea transport; Air transport; Communication.
14	OthServices	Other Services	Financial services nec; Insurance; Business services nec; Recreation and other services; Public administration/ Defense/Health/Education; Dwellings.

<sup>10</sup> Numbers in the right-hand side of the equations shows the level with which the efficiency parameters of the model are shocked for each production factor, which is employed by one of the targeted sectors, namely, OtherCereals, MeatLstk and ProcFood.

Appendix 3. Sector/Commodity Share in Total Output, Trade and Household's Demand in the Base Data.

Sector/Commodity	Output (%)	Exports (%)	Imports (%)	Households' Demand (%)
Oilseeds	1.4	8.0	0.0	0.7
Wheat	0.2	0.0	7.6	2.3
OtherCereals	1.1	0.1	0.9	2.1
OtherCrops	2.5	5.9	3.8	3.8
MeatLstk	6.2	2.0	1.3	8.7
ForestFish	0.6	0.0	0.0	0.7
Petroleum	11.1	70.0	2.3	1.5
ProcFood	28.4	2.2	8.0	49.1
TextWapp	0.6	0.2	6.9	2.8
LightMnfc	1.0	2.8	15.8	2.9
HeavyMnfc	4.6	6.8	49.6	1.6
Util_Cons	7.6	0.0	0.0	2.1
TransComm	15.2	1.2	1.7	10.9
OthServices	19.6	0.5	2.0	10.7
Total	100.0	100.0	100.0	100.0