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What does the OECD-FAO Agricultural Outlook 2017-2026 imply for income distribution in the Sudan and Ethiopia

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Abstract

The OECD and FAO provide growth paths (projections over a period of 10 years) for the agricultural sectors of different countries in their joint OECD-FAO Agricultural Outlook. This study assesses the implication of the projected agricultural growth paths for the Sudan and Ethiopia on the structures of the economies and the distribution of incomes among the different household groups in the two countries. First, single country, recursive dynamic computable general equilibrium (CGE) models for the two countries were calibrated to the most recent social accounting matrices (SAMs) of the two countries. Second, a baseline scenario for each country was developed until 2026. These projections were based on GDP projections (value, growth rates and composition) developed by the IMF World Economic Outlook, the World Bank World Development Indicators and the national statistical offices in the two countries. Third, the growth paths of the OECD-FAO Agricultural Outlook were implemented for the agricultural sectors of the two countries while preserving the aggregate GDP projections. Finally, results of the models under the OEDC-FAO growth paths are

reported with a special focus on the distribution of income in the two countries. The main findings highlight that, in both countries, agricultural growth is significantly behind that of industry and services. Due to the slower growth, returns to factors of production (e.g. labor and capital) employed in agriculture are much lower than to those employed in the other economic sectors. Unless sensible interventions are made, poor agricultural households will be particularly worse-off within these two countries. Therefore, economic and agricultural policies in these two countries should pay more attention to agricultural sector growth (productivity) within their poverty reduction/eradication efforts.

Keywords: OECD-FAO Agricultural Outlook, Sudan, Ethiopia, economy-wide analysis

Content

List of tables

List of figures

1 Introduction

The OECD and FAO, in their jointly published 2017 Agricultural Outlook (OECD-FAO 2017), provided projections for the performance of world agricultural markets during the 2017 and 2026 period.

Considering a range of conditioning assumptions, the OECD-FAO (2017) have developed a plausible baseline scenario. These assumptions are represented by a set of macroeconomic, policy and demographic indicators which underpin the evolution of supply and demand for agricultural products. The outlook has a wide outreach and is commonly used by policy makers, stakeholders and researchers to identify possible future challenges and opportunities for the agricultural sector. The outlook provides information related to agricultural markets and commodities including consumption, production, trade and prices at national, regional and global levels. However, the report does not provide information on how these projections trickle down to factor markets and household groups in individual countries, i.e. the distribution of projected growth, generated income and demand at the household group level.

Thus, more information is required in order for policy makers and stakeholders to design sensible policies related to future sources and distribution of income across production factors and household groups. For example, at the present it is not possible to determine the impact of future policies targeting food security, poverty reduction, and income equality on household groups in rural and urban areas as well as across income groups solely based on the information provided by the outlook. Such policies, however, are highly relevant in countries where agriculture represents a high share of the Gross Domestic Product (GDP), employment and local livelihoods such as is the case in both the Sudan and Ethiopia.

In this study, we aim to depict the OECD-FAO's (2017) projections into single country Computable General Equilibrium (CGE) models of the Sudan and Ethiopia with the purpose of studying the implications for the distribution of income and welfare in these countries.

The CGE models are calibrated to Social Accounting Matrices (SAMs) for the two countries, which differentiate among household groups (by location and income levels) and production factors. After the calibration of the models to the SAM of each country, the CGE models are run until the year 2026 simulating two scenarios: (i) a baseline scenario depicting the most plausible development paths of the two economies without the information on the agricultural sector provided by the OECD-FAO (2017) projections; we call this scenario the baseline scenario. And (ii) a scenario that integrates, the growth paths of the different agricultural activities from the OECD-FAO (2017) into the previous baseline scenario, while preserving the overall GDP growth; we call this scenario the Agricultural Outlook scenario.

Accordingly, this report documents the process of calibrating a single country CGE model to the SAMs for the Sudan and Ethiopia as well as calibrating it to the detailed agricultural information from the OECD-FAO Agricultural Outlook. The report then analyzes the

consequences of the Agricultural Outlook Scenario on income distribution in these two countries.

The following Section 2 provides a description of the modeling approach used in the study including data, calibration of the CGE models and the development of the baseline without the information from the OECD-FAO Agricultural Outlook. Section 3 describes the sectoral correspondence between the accounts included in the models of the two countries and those reported in the Agricultural Outlook, as well as the implementation of the OECD-FAO 2017-2026 projections in the models of the two countries. Section 4 presents the results highlighting the implications of the projected agricultural growth on income distribution in the two countries. Finally, in Section 5, the conclusions are presented and brief policy recommendations are put forward.

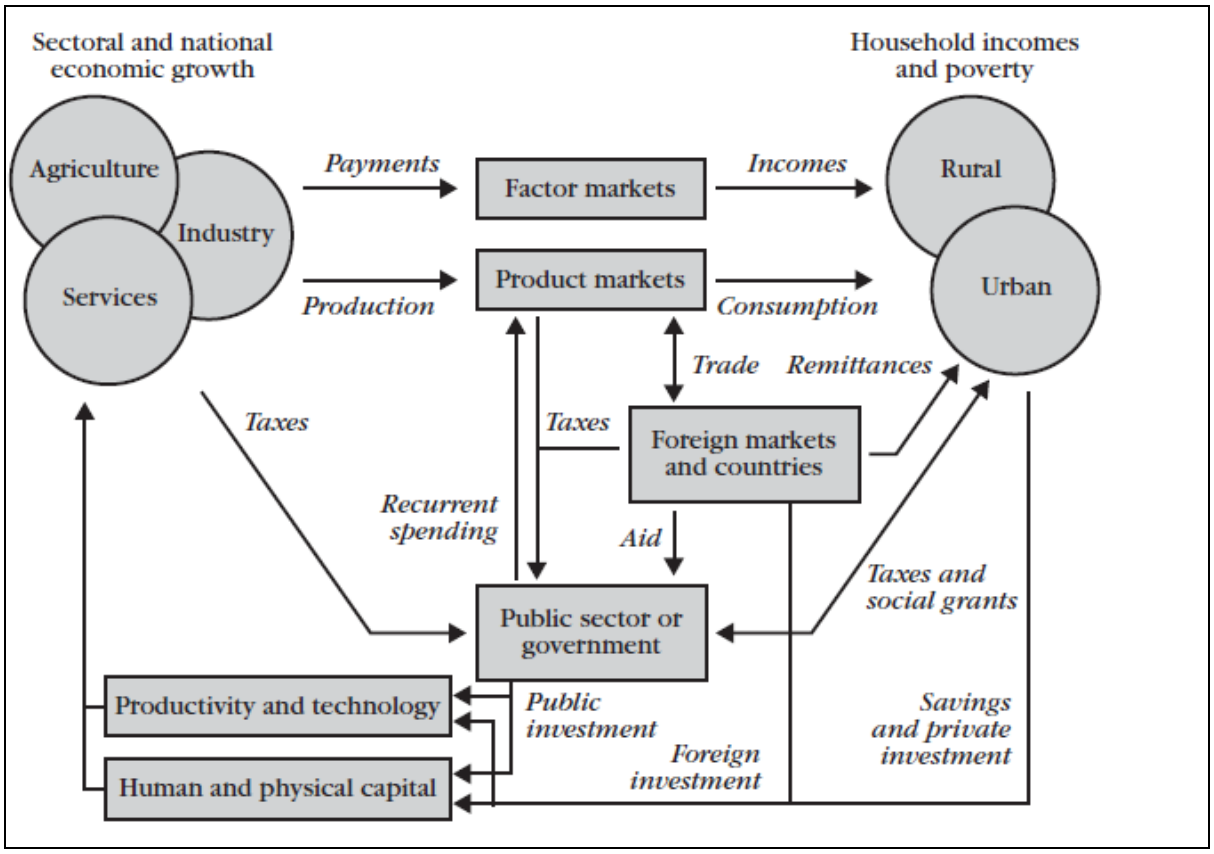
2 Description of the modeling approach

2.1 Concept of CGE models

CGE models are designed to capture the inter-relationships between the sectoral and national economy as well as the interlinkages between the different economic agents in an economy such as producers, consumers and institutions (i.e. households, enterprises, government and the rest of the world) (Figure 1) (Diao and Thurlow, 2012). Links between sectors are established through production factors (e.g. labor, land and capital) and product (intermediate inputs) markets. Intermediate inputs are products that are produced by different economic sectors and are used in the production process of a defined product. For example, metals used by the construction sector or agricultural products used by the food sector. In this way, growth of a sector results in the growth of the sectors linked to it up or down-stream. Furthermore, growth on output is linked to growth on factor payments and to the income of the institutions that own the corresponding factors. Thus, the structural way in which an economy develops (based on agriculture, industry or service) determines the distribution of income in an economy. Moreover, income distribution has an influence on economic growth through consumption behavior, which is different for different household groups (i.e. consumption behavior of rural households is different than that of urban households). That in turn, affects commodity prices and production patterns.

In single country CGE models, the government and the rest of the world (ROW) are further economic agents that invest, collect taxes (government) and provide the supply of imports and demand for exports (ROW), respectively. Some of the main drivers of growth in a single country CGE model are changes in factor productivity and factor supply.

Figure 1. Conceptual framework for a typical single-country CGE model



Source: Diao and Thurlow (2012)

2.2 The CGE models for the Sudan and Ethiopia

We use a multi-sector recursive-dynamic CGE model for the Sudan and Ethiopia that distinguishes several agricultural and agro-processing sectors as well as industrial and services sectors. A detailed description of the model structure and equations are provided in Diao and Thurlow (2012).

The economies of the two countries are modeled as competitive economies with flexible prices and market conditions. Agents represented in the models are consumers, who maximize utility; producers, who maximize profits; and the government. Each country is connected with the rest of the world via trade flows, remittances and other transfers.

Producers in the two models are price takers in output and input markets and maximize profits using constant returns to scale technologies. Demands for primary factors of production are derived from constant elasticity of substitution value added functions, while intermediate input demand by commodity groups is determined by a Leontief fixed-coefficient technology. When deciding between productions for domestic and foreign markets producers are governed

by constant elasticity of transformation functions that distinguish between exported and domestic goods in each traded commodity group in order to capture any quality-related differences between the two products. Under the small-country assumption, the Sudan and Ethiopia face perfectly elastic world demand curves for their exports at fixed world prices. On the demand side, imported and domestically-produced goods are treated as imperfect substitutes in both final and intermediate demand under a constant elasticity of substitution (Armington) specification. Households use part of their incomes to consume commodities according to a Stone-Geary (Linear Expenditure System) utility function.

Labor factors in the models are assumed to be fully employed and mobile across sectors. The assumption of full employment is consistent with widespread evidence that, while relatively few people have formal sector jobs, most working-age people engage in activities that contribute to GDP. Capital accumulation is modeled assuming a "putty-clay" formulation whereby new investment is allocated across sectors between periods in response to the rate of return differentials, but once installed, capital remains immobile within periods (Diao and Thurlow, 2012). In agriculture, cultivated land is assumed to be fully employed and mobile across agricultural uses. The Sudan dynamic CGE model is based on a 2012 social accounting matrix (SAM) (Siddig et al., 2016), while that for Ethiopia applies a 2010 SAM (EDRI, 2010).[1]

The model includes three macroeconomic accounts that should be in balance, namely a government, a current account and a savings-investment accounts. To balance the macro accounts, it is necessary to specify a set of macro-closure rules, which provide a mechanism through which balance is achieved. In the government account, the fiscal balance, and therefore the public savings, are assumed to be endogenous in the model, with government demand fixed to absorption and all tax rates held constant so that government savings depend on the level of economic activity. For the savings-investment identity, an investment-driven balanced closure is assumed. It fixes the share of investment in total absorption, while uniform changes in household savings rates adjust to generate the necessary funds and to balance total savings and total investments. Finally, for the external balance it is assumed that voluntary external capital inflows are exogenously determined, while the exchange rate adjusts.[2]

[1] Details on the SAMS for the Sudan and Ethiopia are presented in the following subsections.

[2] Since June 2012, the Central Bank of the Sudan introduced measures aiming at increasing exchange rate flexibility. Within this arrangement, the Central Bank only intervenes if the exchange rate exceeds a band of + or -3 percent around the closing rate of the previous day (Jenkins et al. 2013; Ebaidalla 2017). Accordingly, a flexible exchange rate regime is applied in the model.

2.3 The social accounting matrices for the Sudan and Ethiopia

The CGE models of the two countries are calibrated to Social Accounting Matrices (SAMs), which are the main data source for the models, apart from other elasticity parameters such as substitution, income and demand elasticities. A SAM is a tabular exposition of the economic data of an administrative unit (country, region, village, etc.) in which the payments of each account (outgoings) are reported in the columns, while the receipts (incomings) are reported in the rows (Siddig et al, 2016). The SAMs can be aggregated to give a macro-economic summary (Macro-SAMs) or disaggregated to provide individual accounts such as agricultural activities (e.g. wheat, maize, cattle, etc.) and industrial activities (processed rice, dairy products, chemicals, etc.). When the data of a country in a particular year is organized in the form of a SAM, it becomes a snapshot of that particular country's economy reflecting the entire structure of the economy and its interdependencies (Siddig et al. 2016).

2.3.1 Description of the SAM for the Sudan

The 2012 SAM for the Sudan (Siddig et al., 2016) is the latest SAM that depicts the economy of the country after the separation of South Sudan. Given the importance of agriculture for income generation and the satisfaction of consumption needs, the SAM for the Sudan captures the sectors of crop production and their linkages to other sectors such as food processing, other manufacturing and services. The SAM includes 71 production sectors and 58 commodities, 14 factors of production, and 10 household types, distinguished by their regional affiliation and income level. The 35 agricultural production activities are split into livestock (7), forestry (1), rubber (1) and crops (13). The crop activities are further differentiated mostly according to the mode of irrigation (irrigated or rain-fed), and those which are rain-fed are further differentiated according to the method of cultivation (mechanized or traditional), collectively totaling to 26 crop activities. Production sectors other than agriculture include 17 industrial and 17 service activities.

Household groups are separated into rural and urban, while each group is differentiated by income quintiles (from the lowest income quintile 1 to the richest quintile 5). This differentiation of household groups allows us to capture the distinctive patterns of income generation and consumption as well as the distributional impacts of the FAO-OECD projections of agricultural growth. Production factors include 12 labor categories, one capital category and an aggregated factor comprising land and natural resources. The labor factors are categorized by location (rural and urban), skill-level (skilled, semi-skilled and unskilled) and gender (male and female).

2.3.2 Description of the SAM for Ethiopia

For our exercise on Ethiopia, we calibrate the model to a 2010 SAM for Ethiopia (EDRI, 2010). It is a well-detailed SAM with 113 activities producing 64 commodities, 16 production factors and 12 household groups. The industry and services activities, fish and forestry are all single activities representing the entire production of the corresponding commodity. The remaining agricultural activities are disaggregated based on four different regions in which they are produced, namely, highlands cereals, humid lowlands, drought prone, and pasture.

The primary production factors in the SAM include capital, four agricultural lands representing land in four different regions (highlands cereals, humid lowlands, drought prone, and pasture), four livestock factors representing the same regions of land, and seven labor categories. The labor categories include three non-agricultural labor categories classified by skill level (skilled, semi-skilled and unskilled) and four agricultural labor categories reflecting the previously mentioned regions.

The SAM includes 12 household groups comprised of households residing in rural and urban areas. Urban households are either poor or non-poor, while rural household are classified into farming and non-farming households with each group divided to poor and non-poor.

2.4 Calibration of the CGE models

By the "calibration of the CGE models" we refer to the matching of the theoretical framework of the model with the underlying database. For this study this means solving the recursive dynamic model from Diao and Thurlow (2012) using the SAMs for the Sudan and Ethiopia. We parametrize (calibrate) the model equations in such a way that they reproduce the underlying situation (the snapshot of the economy given by the SAM).

After the calibration, different development scenarios are implemented in the model. This is done by changing the values of independent (exogenous) variables to the model from their base values to counterfactual values. The equation system is then solved using the alternative values and a new equilibrium is generated.

2.5 Baseline development in the recursive dynamic framework

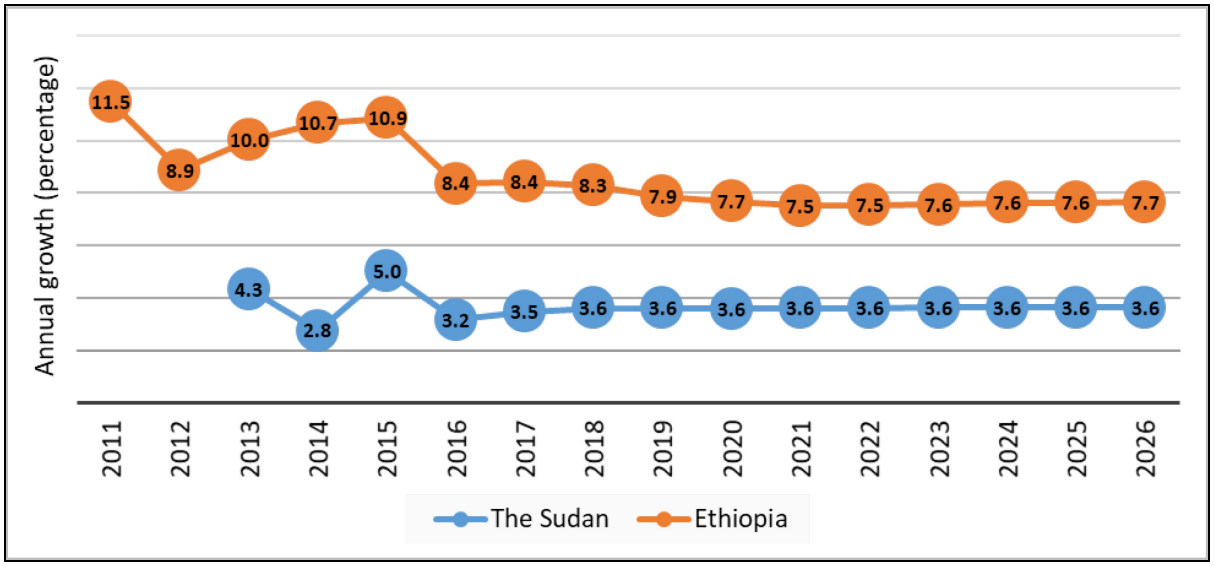
The baseline scenario serves as the benchmark for the evaluation of alternative development scenarios. It intends to depict the most plausible development path of an economy, which results in GDP projections that go along with projected data. These data can be obtained from national or international sources. Popular sources for GDP indicators are the World Economic Outlook Database of the International Monitory Fund (IMF) and the Shared Socioeconomic Pathways (SSPs). Other information on expected development paths of the different economic sectors as given by national statistics (e.g. from ministries or central banks) can also be useful if available. In this study, the CGE baselines are developed making use of exogenous data on population growth, capital accumulation, agricultural land available for production, government expenditure, the development of the current account and total factor productivity.

For the Sudan the baseline scenario depicts the GDP development expected by the IMF while using the contributions to GDP by agriculture, industry and services reported by the Central Bank of Sudan (CBoS) as a reference. The IMF projections on GDP are taken from the World Economic Outlook from April 2017 that publishes values until 2022. From 2023 to 2026, the growth rate from 2022 is assumed. With respect to the sectoral contributions to GDP, the data from the CBoS annual reports, for the years 2013 to 2015, is used (CBoS, 2013; 2014; 2015). The trend on the development of the shares from 2013 – 2015 is projected into 2016 and 2017. Afterwards, the shares are kept close to the level from 2017.

The baseline for Ethiopia is based on the IMF GDP forecasts from the World Economic Outlook (IMF, 2017). The contribution of the agricultural, industrial and service sectors to GDP is based on 2005-2016 data from the World Development Indicators (World Bank, 2017).

The baseline GDP growth for the Sudan and Ethiopia as depicted in the CGE models are presented in Figure 2.

Figure 2. Projected GDP growth in the Sudan and Ethiopia in the baseline scenario



Source: CGE models results.

3 Implementation of the Agricultural Outlook Scenario

3.1 Correspondence between CGE accounts and the Agricultural Outlook

Before passing on the information provided by the Agricultural Outlook to the models for the Sudan and Ethiopia (i.e. applying the growth path of the Agricultural Outlook to the data of the two countries), first a consensus must be made on the definition of the agricultural markets in both the Agricultural Outlook and the single country CGE models. The partial equilibrium model AGLINK-COSIMO (the model used to generate the projections of the Agricultural Outlook) and the CGEs might depict the agricultural sectors differently. For example, the sectoral coverage (the production activities covered by each model) and/or their definitions (the detailed specification of what is included in a particular sector) are different. Furthermore, AGLINK-COSIMO reports the agricultural output in quantities (kilograms and/or tonnes) while the CGE models give their results in value terms. All of these differences are accounted for during the generation of a consensus between the data reported in the SAMs of the two countries and the agricultural outlook.

We start by matching the agricultural activities in the models for the Sudan and Ethiopia to those of the Agricultural Outlook based on their definitions. This is based on the information provided in the metadata of these models. For example, for the Sudan, the activity "sorghum" in the SAM is mapped to the aggregated commodity "other coarse grains". However, in the Agricultural Outlook since the definition of "other coarse grains" contains sorghum as one of the commodities considered in the aggregate, a further disaggregation is not possible. In the Agricultural Outlook, "other coarse grains" is defined as:

> *Barley, oats, sorghum and other coarse grains in all countries except Australia where it includes triticale, and in the European Union where it includes rye and other mixed grains (OECD-FAO 2017b).*

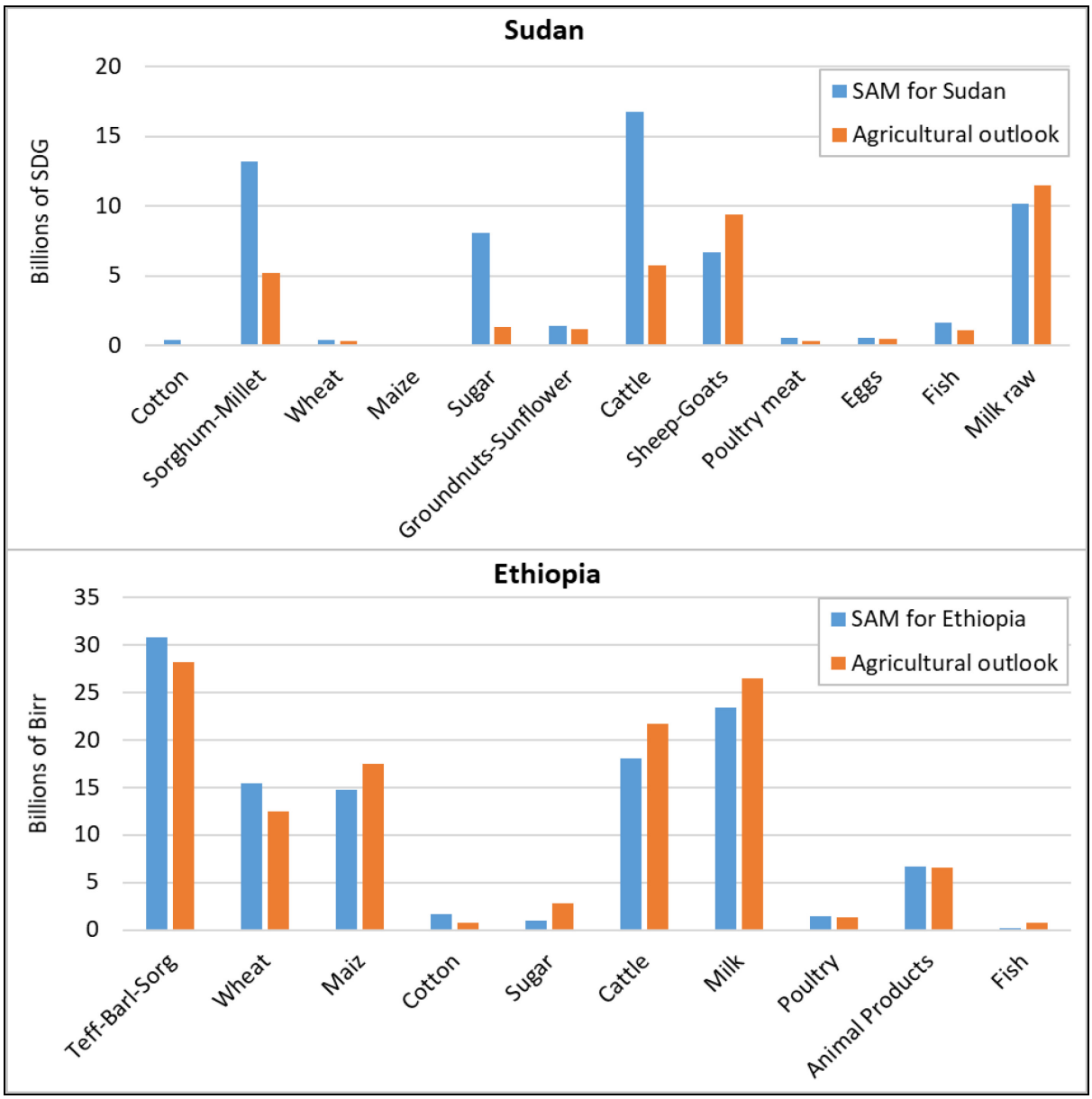
Millet is an example of a production activity where the consensus between the two models is not straightforward. It is represented as an individual activity in the SAM for the Sudan. However, it is not explicitly listed as an activity in the Agricultural Outlook. The best match is the production activity "other coarse grains".

For some agricultural activities in the SAMs, there is no clear one-to-one matching partner in the outlook. For such activities, we assumed a growth rate that is equivalent to the average growth rate of all the commodities in the Agricultural Outlook for the corresponding country. The final mapping for the Sudan and Ethiopia is presented in Table 1 and Table 2 in the annex.

Figure 3 shows the activity output of the agricultural sectors as depicted by the CGE models of the two countries in the base year compared to the output (in value) of the corresponding commodities from the Agricultural Outlook. This shows the extent to which the Agricultural Outlook and the CGE models are homogenized in terms of commodity definitions and data

used. Differences in the price data used to generate the values of output is probably the main reason for the differences observed in the value of output (Figure 3). These differences are more apparent in the case of the Sudan than that of Ethiopia.

Figure 3. Sectoral output of agriculture in the data of the models for the Sudan and Ethiopia versus the Agricultural Outlook



Note 1: There are agricultural commodities produced in the two countries and depicted by their SAMs/models, however because they are not considered in the Agricultural Outlook, we excluded them from the figure. They include 11 commodities in Ethiopia and 6 commodities in the Sudan.

Note 2: The quantity values from the Agricultural Outlook are transformed into local currency value through multiplication with the current prices. The producer prices are used for the conversion to local currency value (AGLINK-COSIMO contains producer and consumer prices). The only exemption is fish for which AGLINK-COSIMO only provides consumer prices.

Source: Authors' own figure

3.2 Depicting the sectoral growth of the Agricultural Outlook in the CGE models

After mapping comes the implementation of the sectoral growth rates of the OECD-FAO 2017-2026 Agricultural Outlook in the CGE models of the two countries. As opposed to the baseline scenario in which the growth was guided by local data, the growth path of the agricultural activities in the models for the Sudan and Ethiopia under the Agricultural Outlook scenario is guided by the reported growth path of the OECD-FAO Agricultural Outlook from 2017.

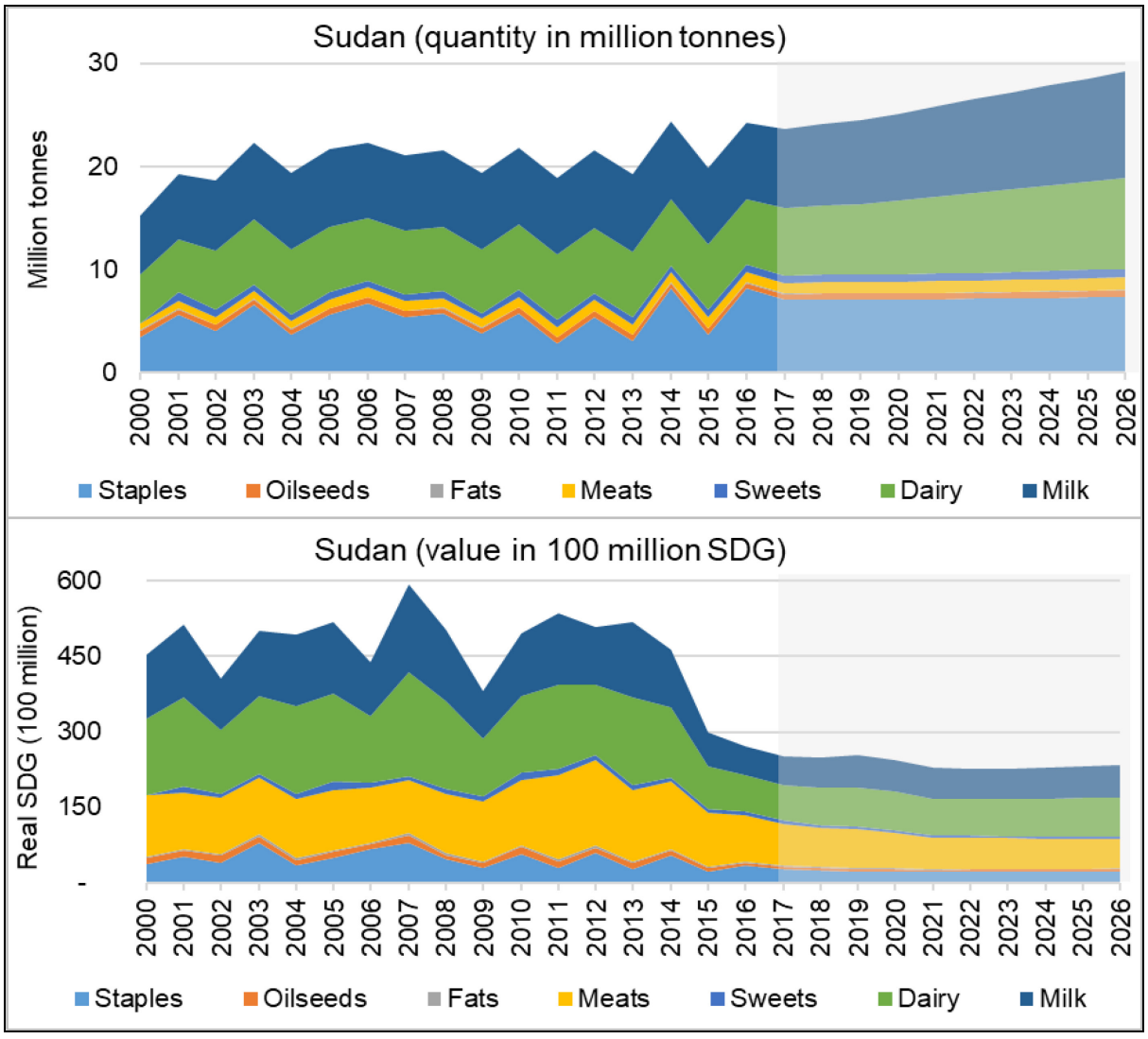
In order to generate activity outputs (with CGE models) that resemble the reference growth rates obtained from the Agricultural Outlook, the total factor productivity parameter of the corresponding activities is adjusted. This allows for replication of the projected output of the Agricultural Outlook for the two countries. While implementing the reference agricultural output growth, the outputs of industry and services are adjusted to make the overall GDP consistent with the IMF projections that were used to guide our aggregate GDP projection both under the baseline and the Agricultural Outlook scenario. This process is applied to the entire period considered (i.e. until 2026).

Ideally, the agricultural output growth rates would be computed on the basis of domestic production projections depicted in value units and in real terms, since the calibrated variables from the CGE models are also given in real monetary values. Thus, the production of the Agricultural Outlook would be transformed from quantity to value terms by multiplying it by producer prices (in real local currency units -LCU). The obtained growth rates then resemble the countries real agricultural growth. However, for the Sudan we were confronted with the challenge that real prices and agricultural production growth (in real LCUs) were projected to fall within the Agricultural Outlook. This resulted in a large discrepancy between the production growth rates that were computed based on real LCUs and those based on quantity units (kilo tonnes). However, for Ethiopia, real prices were projected to remain close to the 2016 levels, increasing slightly for livestock commodities.

To be consistent, we explored two options, namely, we calibrated the CGE models to the production growth rates resulting from values (in real LCUs) and we calibrated the models using output quantities (in kilo tonnes). The analysis reveals that for the Sudan, the calibration to the negative growth rates that were computed based on values in real LCUs, results in large loses in agricultural productivity, increasing agricultural prices and factor mobility from the industrial and service sectors into the agricultural sector. However, the OECD-FAO 2017-2026 Agricultural Outlook neither assumes a growth in real agricultural prices (it rather assumes a decrease) nor factor mobility into the agricultural sector. For Ethiopia, the CGE results obtained with the growth rates based on both options (i.e. values and quantities) indicate a clear growth of the agricultural sector with similar consequences on the distribution of income among factors and households. Thus, in order to avoid simulating behaviors not assumed in the Agricultural Outlook, we implemented the Agricultural Outlook growth path for the two countries based on the quantity-based approach.

A summary of the differences in the projected growth in quantity and value terms (from the Agricultural Outlook) are shown in Figure 4 and Figure 5. In the two figures, the output is presented for the main agricultural commodity groups, namely, staples, oilseeds, fats, meats, sweets, dairy and milk. Sudan's agricultural outlook is quite modest in quantity terms while decreasing in real value terms. For Ethiopia, the outlook increases in both.

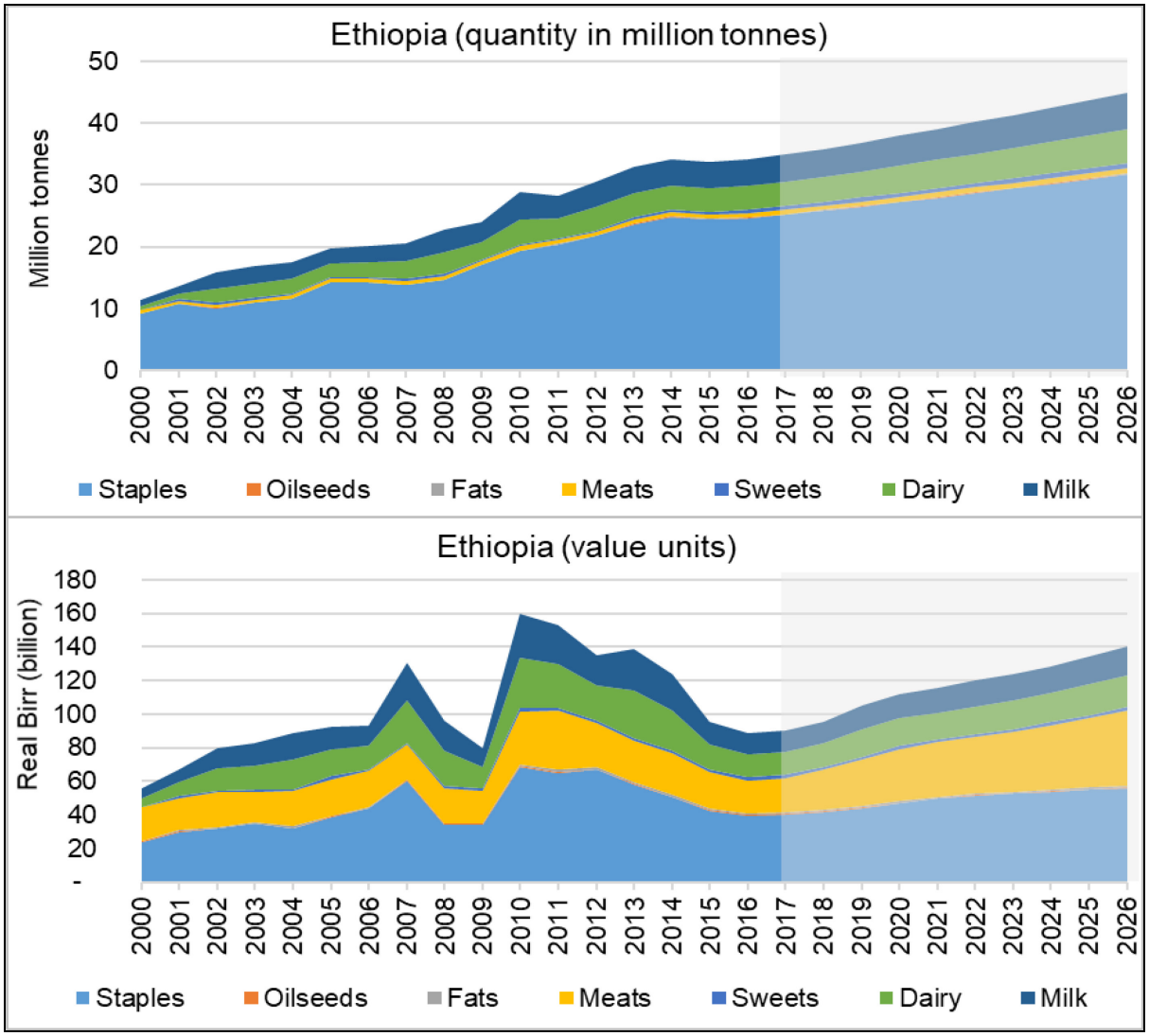
Figure 4. Agricultural Outlook's historical and projected agricultural output for the Sudan (quantity in million tonnes and values in 100 million SDG)



Note: For the computation of real prices, the nominal producer prices of each commodity in the Agricultural Outlook are deflated using their corresponding cost of production index (CPCI). For fat and meat commodities, no CPCI is available; thus, nominal prices are deflated using the consumer price index (CPI). Consumer prices are used only for fish, since no data is given for the Sudan by the Agricultural Outlook on producer prices. Prices are given in real 2012 local currency units.

Source: Authors' own compilation based on the OECD-FAO 2017-2026 Agricultural Outlook database.

Figure 5. Agricultural Outlook's historical and projected agricultural output for the Sudan (quantity in million tonnes and values in billion Birr)



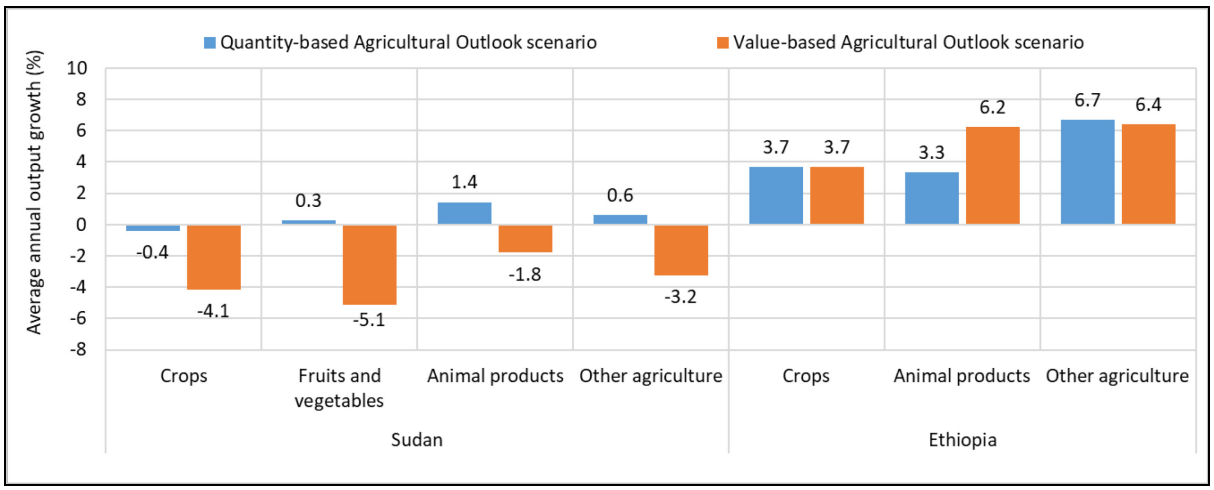
Note: For the computation of real prices, the nominal producer prices of each commodity are deflated using its cost of production index (CPCI). For fat and meat commodities, no CPCI is available; thus, nominal prices are deflated using the consumer price index (CPI). The Agricultural Outlook has no data on fish production for Ethiopia as it is a landlocked country with minimal fish production; thus, fish is not considered in the group of meats. Prices are given in real 2010 local currency units.

Source: Authors' own compilation based on the OECD-FAO 2017-2026 Agricultural Outlook database.

The average annual output growth obtained from the CGE models in the two Agricultural Outlook scenarios (with the calibration of output growth based on quantity and on value units) is presented in Figure 6. It can be observed that in general the projected average growth for the agricultural sector in the Sudan is lower than the one projected for Ethiopia. For the Sudan, the average projected growth in output (based on quantity) is between 0 and 2% while in value terms it is between -2 and -5%. For Ethiopia, the average quantity and value-based growth rates are similar and strongly positive. Only in the case of animal products, are the

value-based growth rates much higher than quantity-based rates. This is explained by the growth in the projected real prices that is associated with a stronger increase in demand rather than in supply.

Figure 6. Value-based vs. quantity-based average annual agricultural output growth (2017 – 2026) obtained from the CGE models



Source: CGE models results

4 Implications of the Agricultural Outlook Scenario on Income Distribution

In this section, we present the effects of the growth paths suggested by the Agricultural Outlook on income distribution in the two countries as depicted by the CGE models. We first present the obtained GDPs and underlying structures of the two economies. Then we discuss the implications on sectoral growth, the return to factors and the income distribution of households. Results are presented in a way that allows contrasting the outcomes in the two countries.

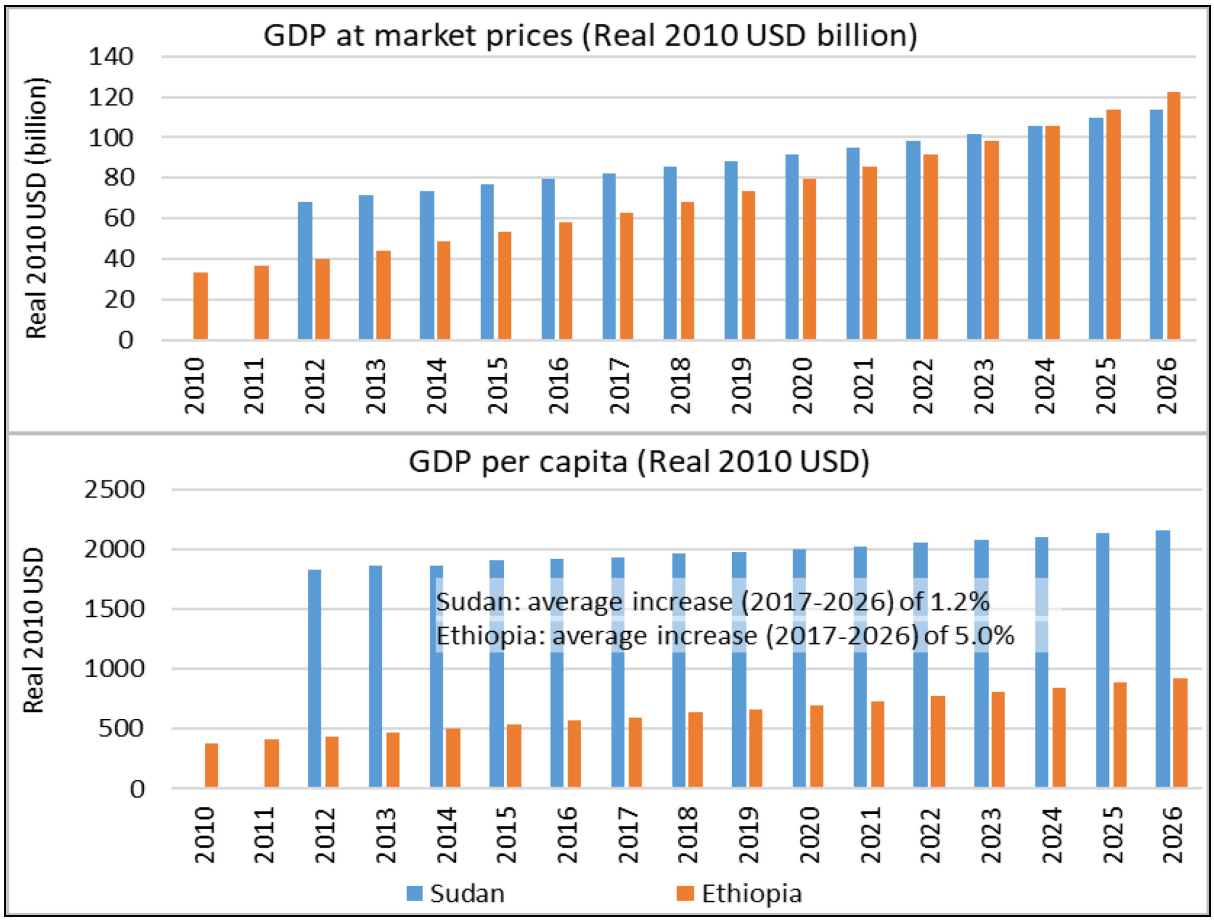
Ethiopia has very low-income levels but is catching up, however, much larger growth rates are necessary in order to significantly reduce the gap between the per capita income levels of Ethiopia and the Sudan

Ethiopia is classified by the World Bank as a low-income country. In 1990, it was the country with the second lowest GDP per capita in the world, Mozambique being the only country with lower values (based on purchasing power parity—PPP—data from the International Comparison Program 2018). Since 2003, Ethiopia has experienced a rapid growth improving its position from the 2nd in the world for lowest GDP in 1990 to the 17th in the world in 2017. Sudan has a higher per capita GDP than Ethiopia but it is still relatively low. It is classified by

the World Bank as a lower middle-income country and was ranked 58th (by lowest GDP) in the world in 2017.

The results reveal that a stronger annual GDP growth is expected for Ethiopia (close to 8%) than for the Sudan (close to 4%) (Figure 2). This stronger growth means that Ethiopia is catching up to the Sudan in terms of GDP, growing from approximately 2/3 of Sudan's GDP in 2012 to slightly higher levels in 2026 (Figure 7, first graph). The lower income level of Ethiopia is depicted by the annual GDP per capita shown in Figure 7 (second graph). The GDP per capita grows at a stronger annual rate of 5.0% in Ethiopia (compared to a rate of 1.2% in the Sudan). However, since the initial level is much lower in Ethiopia, larger growth rates are necessary in order to significantly reduce the gap between them and the Sudan and other higher income countries. It is also important to note that the GDP per capita growth rates are smaller than the growth rates for GDP. This occurs because the populations in both countries are also projected to grow at a fast rate (for both countries the average annual growth rate is projected to 2.3% (2017-2026); based on the medium variant of the United Nations World Population Prospects (2017).

Figure 7. GDP (USD billion) and per capita GDP (USD) in the Sudan and Ethiopia (2010-2026)



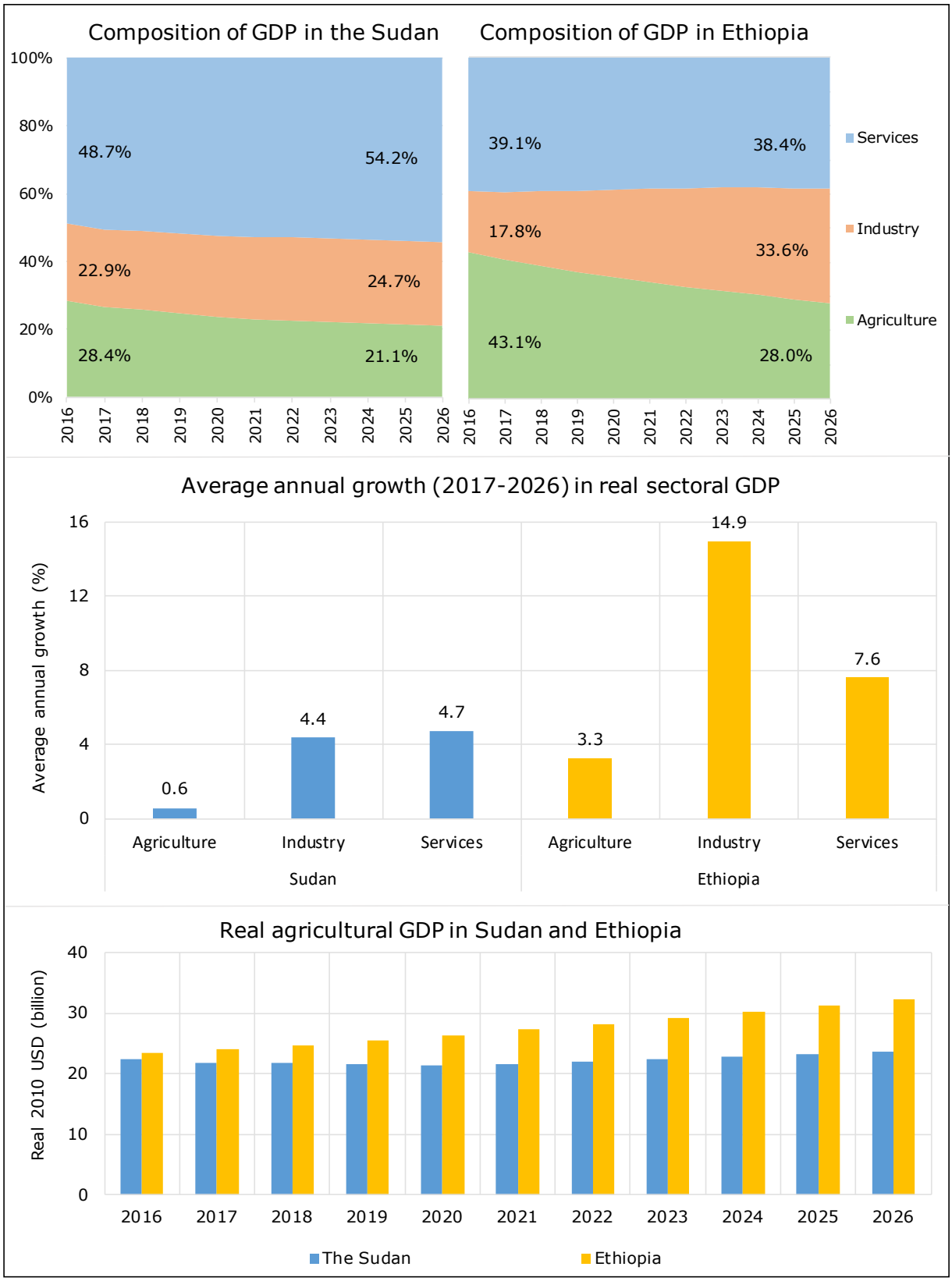
Source: CGE models results

The lowest sectoral growth rates are obtained in agriculture

In both countries, modest growth rates are obtained for the agricultural sectors, which are accompanied by higher growth rates for the industrial and service sectors. Remarkably high growth rates are expected for the industrial and service sectors in Ethiopia, while remarkably low rates (average annual growth of 0.6%) are projected for the agricultural sector in the Sudan (Figure 8, middle graph). In Ethiopia, the agricultural sector grows faster (3.3%) than in the Sudan (0.6%). However, it has a much lower growth than industries (14.9%) and services (7.6%). These differences result in structural changes in both economies during 2016-2026 with a decline of the contribution of agriculture to GDP. However, the changes in Ethiopia are much stronger. The country moves from being an agricultural-based economy (agriculture makes more than 43% of the GDP) to an economy where the contribution of aggregate industry and aggregate services are larger than that of agriculture (Figure 8, upper graphs).

Interestingly, the agricultural sectors in the Sudan and Ethiopia present very similar real value-added levels (real GDP) in 2016. Yet, Figure 8 (lowest graph) shows how in the simulation period the agricultural sector in Ethiopia grows while it almost remains constant in the Sudan (first dropping and then growing modestly).

Figure 8. GDP composition and simulated growth (2017-2026)

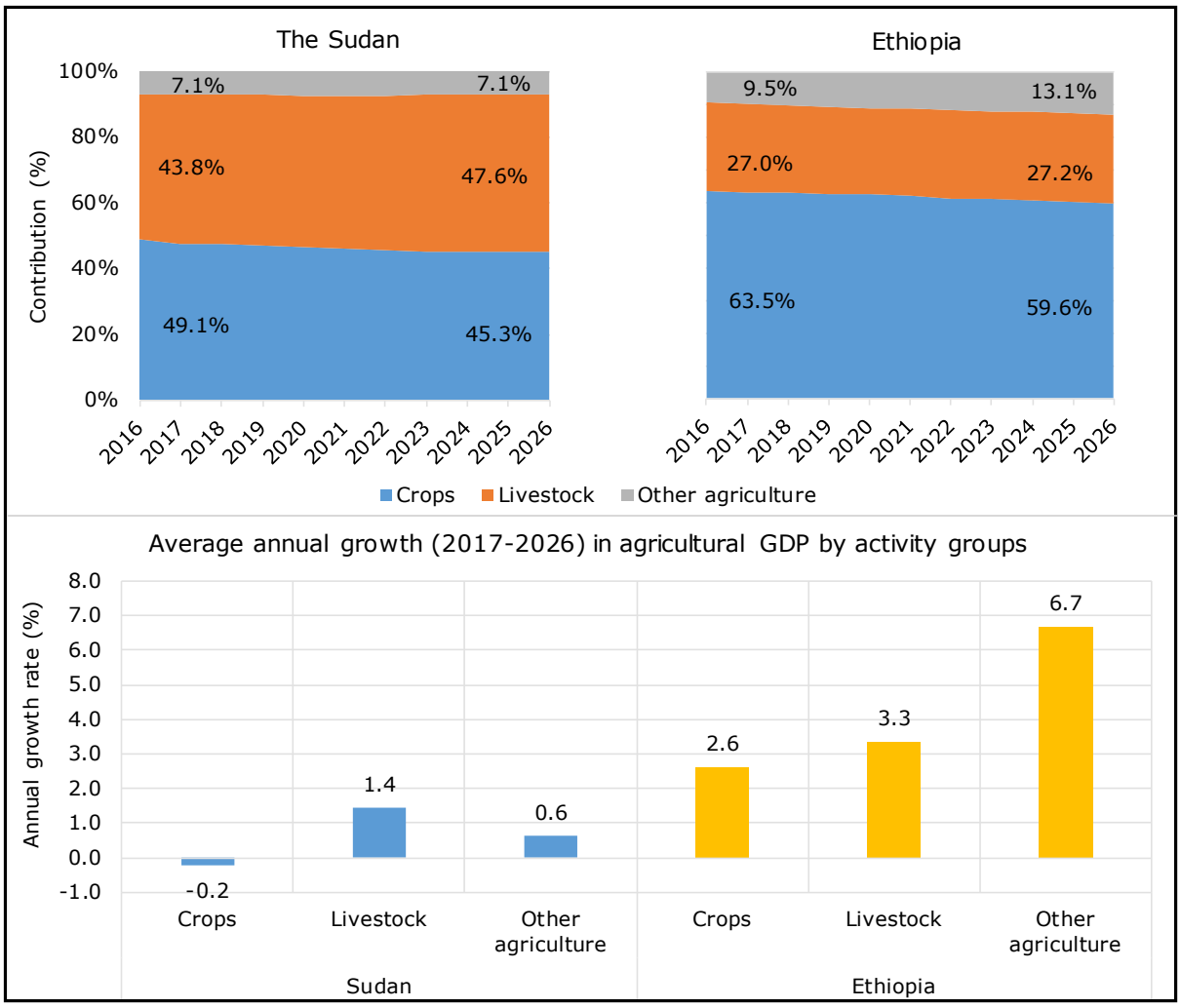


Source: CGE models results

Higher incomes result in higher livestock outputs

Figure 9 shows that livestock sectors grow faster than crop sectors in both economies, thus, the livestock share of the agricultural GDP in these two countries increases at the cost of the crops share. The OECD-FAO projection does not include other agriculture (i.e. mainly forest products) however, in Ethiopia this sub-sector grows faster, more strongly linked to the projected growth for the industrial and service sectors. It can also be seen that livestock plays a stronger role in the Sudan, while crops are more dominant in Ethiopia. Furthermore, the pattern of stronger growth for Ethiopia (relative to the Sudan) is also reflected on the average growth rates of crops and livestock. The simulation results show that on average, for the Sudan, the GDP of crops remain practically constant (average annual rate of -0.2%) and livestock GDP increases slightly at a rate of 1.4%. For Ethiopia, the growth rates are higher (2.6% and 3.3% for crops and livestock, respectively) (Figure 9, lower graph).

Figure 9. Composition and annual growth of the agricultural sector in the Sudan and Ethiopia



Note: Livestock includes fisheries. However, Ethiopia is a landlocked country and fish production is negligible.

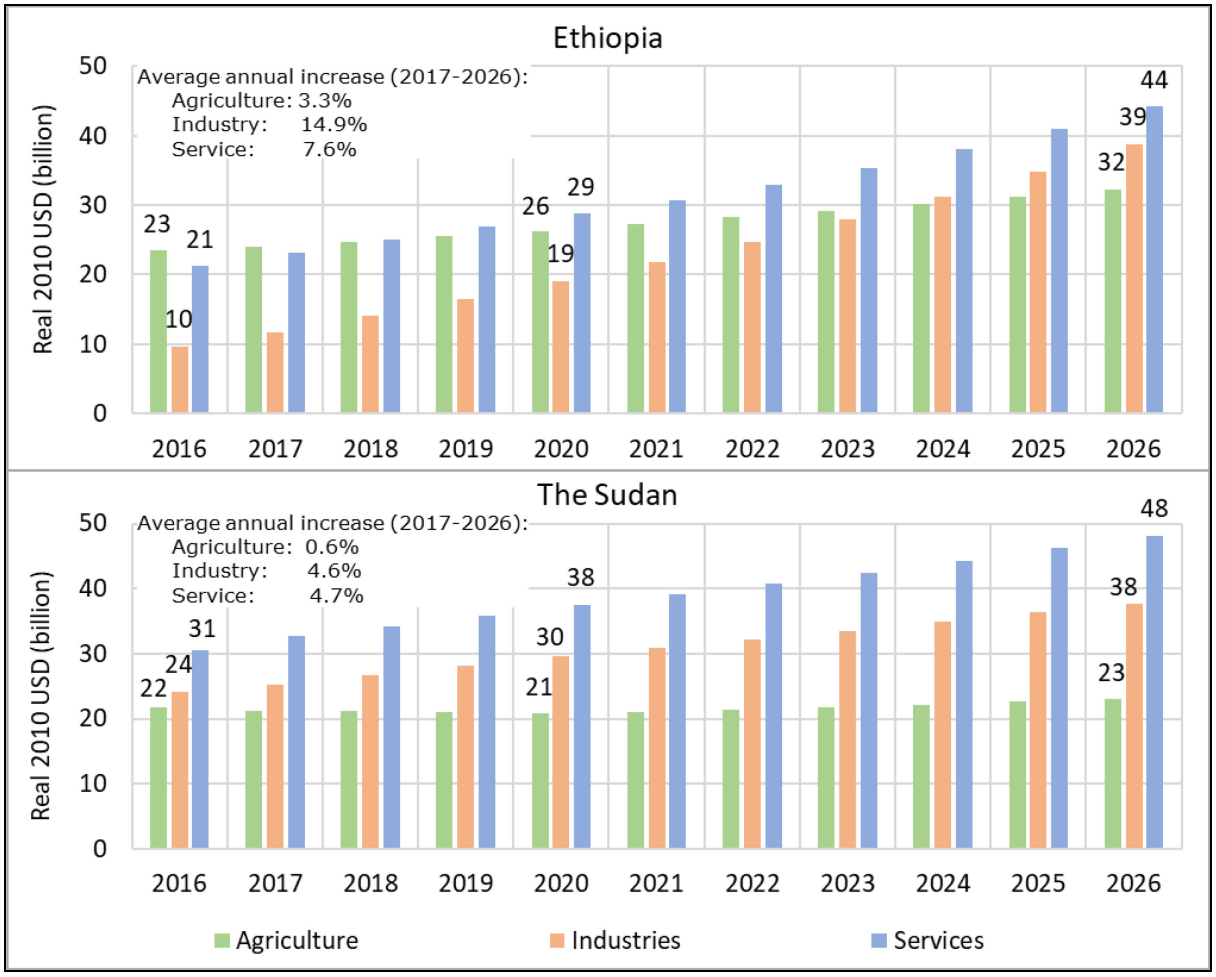
Source: CGE models results

The microeconomic foundations of the projections of the Agricultural Outlook include customized income elasticities according to commodity groups (staples, fats, sweets, meats and dairy). These explain the differences on agricultural output growth between crops and livestock commodities. The income elasticities for fats, sweets, meats and dairy are higher than those for staples (especially in low income countries). Thus, the resulting income increases in the Sudan and Ethiopia lead to a stronger increase of demand for fats, sweets and livestock products (relative to crops). This therefore, results in the observed higher output growth for livestock commodities, in order to satisfy the growing demand.

Return to factors employed in agriculture are much lower than to those employed in industries and services

The results on real factor returns can be linked to the previous discussions on the sectoral composition of the GDP and the simulated growth. Returns to production factors employed in agriculture (in USD billion) are the lowest among the three aggregate sectors (agriculture, industry and service) in the Sudan throughout the period (2017-2026), while in Ethiopia, this is only true in the last three years. However, the average annual growth (2017-2026) in the returns to factors employed in agriculture is lower than that of the other two aggregate sectors in both countries (Figure 10). Consequently, income in poor agricultural households is also the lowest among all households.

Figure 10. Total returns to production factors in agriculture, industry and services sectors in the Sudan and Ethiopia (2016-2026)



Note: The production factors include labor, capital, land and livestock. However, livestock is considered explicitly as a production factor only in the model for Ethiopia. In the model for the Sudan, livestock is part of agricultural capital.

Source: CGE models results

Rural households (especially the poor) would be left behind if no actions are taken

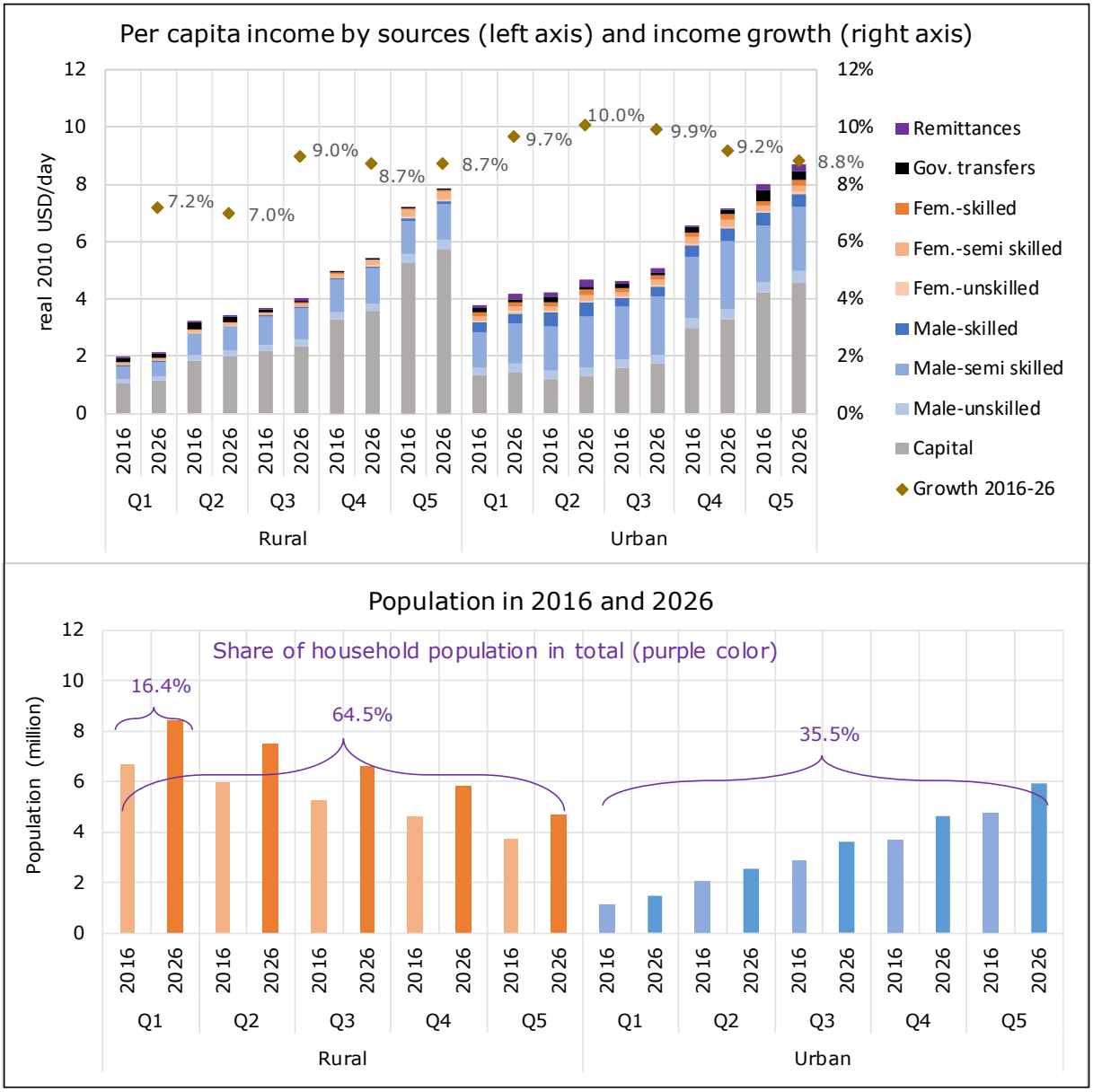
In both countries, the rural poor have the lowest incomes, however in Ethiopia the income level is much lower than in the Sudan. According to the models and their base data, in 2016 the rural poor in Ethiopia received close to 0.8 real 2010 USD/day while the rural poor in the Sudan received close to 2 USD (Figure 11 and Figure 12, upper graphs). Furthermore, there is a large gap between the rural and the urban poor. In both countries, the urban poor received a per capita income that was approximately double as high as the rural poor. Additionally, the urban poor represents a smaller share of the population while the rural poor represents a large share (approximately 16% in the Sudan and 35% in Ethiopia) (Figure 11 and Figure 12, lower graphs).

The rural poor not only have the lowest income levels but they also have the lowest income growth rates (2016-2026) (Figure 11 and Figure 12, upper graphs). In absolute terms, their income level hardly changes between 2016 and 2026, and the gap between poor and high-income households widens. The gap especially grows in Ethiopia, where the economic growth is larger than in the Sudan and it is based on strong developments of industry and services, which are the economic sectors in which the rural poor are scarcely employed.

In the Sudan, the main income sources for the rural poor are agricultural capital (primarily livestock) and male semi-skilled labor. For Ethiopia, the main sources of income for the rural poor are agricultural capital (also primarily livestock), agricultural and unskilled labor (Figure 11 and Figure 12, upper graphs).

These figures highlight that both the Sudan and Ethiopia have very low-income levels, with there being an even higher prevalence of extreme poverty in Ethiopia. Furthermore, the rural poor in both countries experience the lowest income growth rates indicating that these households are weakly linked to the simulated economic growth paths. Attention should be drawn to addressing the livelihoods of the rural poor in these countries.

Figure 11. Per capita income by household groups and their population in 2016 and 2026 in the Sudan

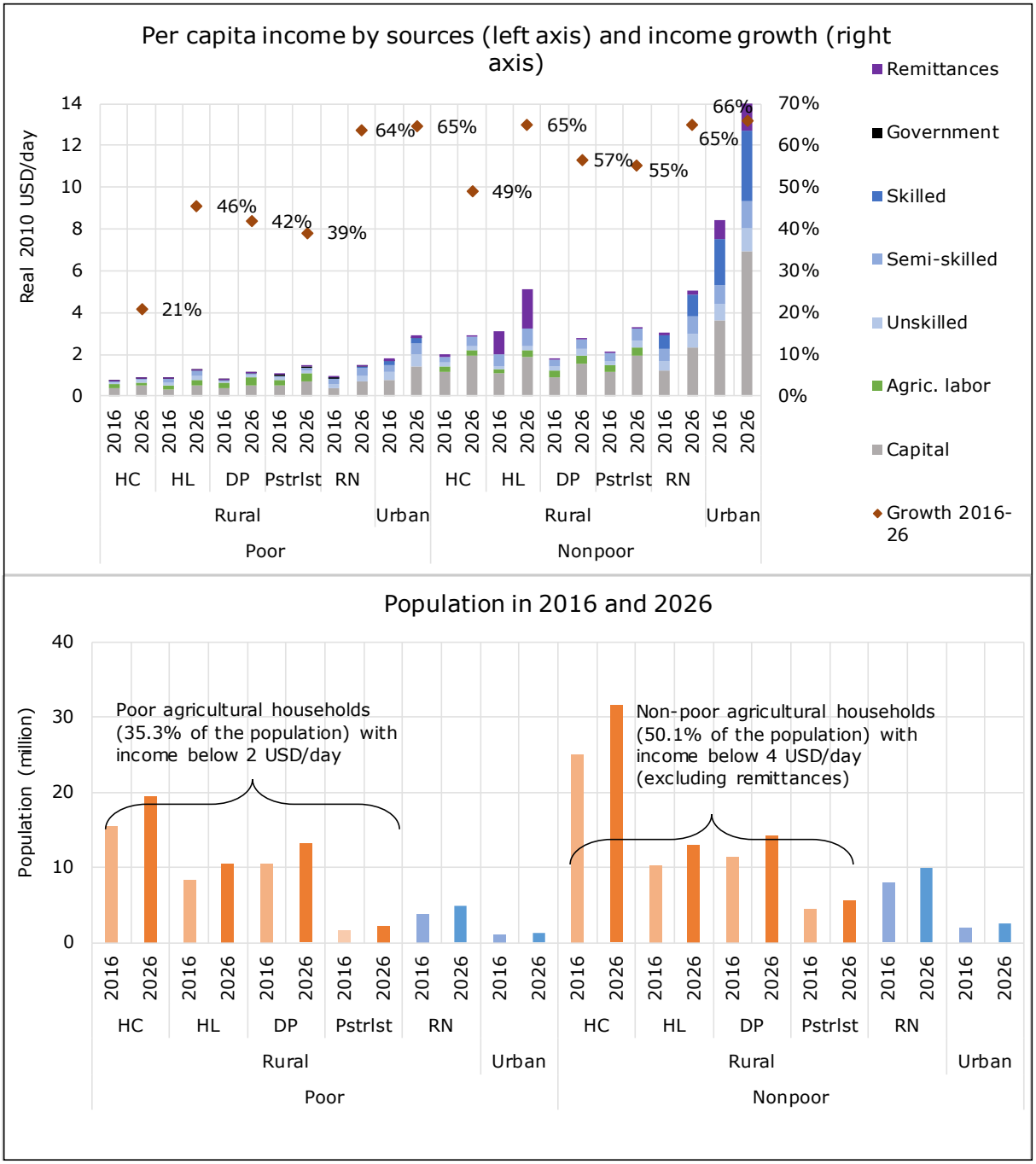


Note 1: The x-axis arranges the household groups into (i) rural and urban, (ii) income quintiles (Q1 - Q5), and (iii) time (2016 and 2026).

Note 2: Note that the difference between rural and urban income growth rates in the model might be underestimated. The model does not distinguish agricultural from non-agricultural capital and thus, part of the returns generated in the industry and service sectors are allocated to rural households (economy wide capital returns are distributed among households according to fixed shares).

Source: CGE models results

Figure 12. Per capita income by household groups and their population in 2016 and 2026 in Ethiopia



Note: The x-axis arranges the household groups into (i) poor and nonpoor, (ii) rural and urban, (iii) regions: HC (highland cereals), HL (humid lowlands), DP (drought prone), Pstrlst (pastoralist), RN (rural non-agricultural), and (iv) time (2016 and 2026).

Source: CGE models results

5 Conclusions and recommendations

In this study, we depict the projections suggested by the OECD-FAO Agricultural Outlook 2017-2026 in economy-wide models (single country CGE models) for the Sudan and Ethiopia. The Agricultural Outlook, as well as the CGE models, are both aligned with IMF (World Economic Outlook) GDP forecasts and the CGE models are calibrated to the most recent available databases (SAMs) for these two countries. We analyzed the implications of the projected agricultural output on the structure of the economies with special focus on changes in income distribution.

The following are the main findings of the analysis:

- Ethiopia comes from very low-income levels and is catching up; however, much larger growth rates are necessary in order to significantly reduce the gap of per capita income levels between Ethiopia and the Sudan, as well as other higher income countries.
- In both countries, agriculture has the lowest growth rates among sectors.
- Within agriculture, livestock is expected to grow at a higher rate than crops.
- Due to the comparably slower growth in agriculture, return to factors employed in agriculture are much lower than to those employed in industries and services.
- Rural households (and especially the poor) might be left behind in both countries if no actions are taken. Approximately 65% and 85% of the populations in the Sudan and Ethiopia, respectively, live in rural areas and are highly dependent on agriculture as major source of income.

Based on the main findings of the analysis, the following recommendations are put forward:

- Special attention should be payed to the development and application of policies that increase the productivity and growth of the agricultural sectors in both countries. Such policies are necessary in order to improve the income situation of the poorest and to revert the simulated growing income inequality.
- The income levels of poor agricultural households in both countries (but especially in Ethiopia) are of extreme poverty (close to 2 real 2010 USD per capita per day in the Sudan and less than 1 real 2010 USD per capita per day in Ethiopia). In the Sudan nearly 16% of the population are considered rural poor; in Ethiopia, about 35% are. Special attention should be drawn to addressing the situation of these households.
- The fast growth of industry and services could make a positive multiplier impact on the livelihoods of poor agricultural households in the two countries should it be accompanied by policies which focus on agro-industry development. This would encourage balanced growth in which agriculture can play an important role and hence, rural poor agricultural households would not be left behind.

References

Central Bank of Sudan. 53rd Annual Report 2013. http://www.cbos.gov.sd

Central Bank of Sudan. 54th Annual Report 2014. http://www.cbos.gov.sd

Central Bank of Sudan. 55th Annual Report 2015. http://www.cbos.gov.sd

Diao, X. and Thurlow, J. (2012). A Recursive Dynamic Computable General Equilibrium Model, in "Strategies and priorities for African agriculture: Economywide perspectives from country studies, International Food Policy Research Institute (IFPRI). http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/127080

EDRI. (2010). Ethiopia: Input–Output Table and Social Accounting Matrix, Addis Ababa: Ethiopian Development Research Institute (2010).

International Monetary Fund (IMF). (2017). World Economic Outlook Database, April 2017. https://www.imf.org/external/pubs/ft/weo/2019/01/weodata/index.aspx

OECD/FAO (2017). OECD-FAO Agricultural Outlook 2017-2026, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/agr_outlook-2017-en

OECD/FAO (2017b). Glossary", in OECD-FAO Agricultural Outlook 2017-2026, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/agr_outlook-2017-15-en

Siddig, Khalid, Elagra, Samir, Grethe, Harald, and Amel Mubarak (2016). A Post-Separation Social Accounting Matrix for the Sudan. Working paper No. 92/2016, Department of Agricultural Economics, Humboldt-Universität zu Berlin. https://www.agrar.hu-berlin.de/de/institut/departments/daoe/publ/wp/wp92.pdf

United Nations (2017). World Population Prospects: The 2017 Revision, DVD Edition. Department of Economic and Social Affairs, Population Division.

World Bank (2017). World Development Indicators. The World Bank Group. http://datatopics.worldbank.org/world-development-indicators/

World Bank (2018). The World Bank International Comparison Program. International Comparison Program database. https://www.worldbank.org/en/programs/icp

Annex

The Mapping

Table 1. Consensus between the activities in the CGE for the Sudan and the commodities in the OECD-FAO Agricultural Outlook

Activities in the CGE	Commodities in the Agricultural Outlook
Cattle	Beef and veal
Cotton	Cotton
Eggs	Eggs
Egyptian beans	Arithmetic mean*
Fish	Fish
Fruits	Arithmetic mean*
Goats	Sheep (which also includes goats)
Groundnut	Other oilseeds (rapeseed, sunflower seed and groundnuts)
Gum arabic	Arithmetic mean*
Maize	Maize
Milk	Milk
Millet	Other coarse grains (barley, oats, sorghum and other coarse grains)
Other crops	Arithmetic mean*
Other forest products	Arithmetic mean*
Other livestock	Arithmetic mean*
Poultry	Poultry
Sesame	Arithmetic mean*
Sheep	Sheep (which also includes goats)
Sorghum	Other coarse grains (barley, oats, sorghum and other coarse grains)
Sugar	Sugar
Sunflower**	Other oilseeds (rapeseed, sunflower seed and groundnuts)
Vegetables	Arithmetic mean*
Wheat	Wheat

* Arithmetic mean of the growth in the corresponding year of the commodities considered in the Agricultural Outlook.

** Sunflower was not calibrated to the outlook development since in the CGE it does not respond to changes in total factor productivity (TFP) due to a rigid demand by the food industry as an intermediate input.

Source: Authors

Table 2. Consensus between the activities in the CGE for Ethiopia and the commodities in the OECD-FAO Agricultural Outlook

Activities in the CGE	Commodities in the Agricultural Outlook
Animal products	Sheep
Barley	Other coarse grains (barley, oats, sorghum and other coarse grains)
Cattle	Beef and veal
Chat	Arithmetic mean*
Coffee	Arithmetic mean*
Cotton	Cotton
Enset	Arithmetic mean*
Fisheries	Fish
Flowers	Arithmetic mean*
Fruits	Arithmetic mean*
Maize	Maize
Milk	Milk
Oilseeds**	Arithmetic mean*
Other crops	Arithmetic mean*
Poultry	Poultry
Pulses	Arithmetic mean*
Sorghum	Other coarse grains (barley, oats, sorghum and other coarse grains)
Sugarcane	Sugar
Tea	Arithmetic mean*
Teff	Other coarse grains (barley, oats, sorghum and other coarse grains)
Tobacco	Arithmetic mean*
Vegetables	Arithmetic mean*
Wheat	Wheat

* Arithmetic mean of the growth in the corresponding year of the commodities considered in the Agricultural Outlook.

** Oilseeds are not mapped to any oilseed from the Agricultural Outlook since the conversion to value revealed no matching with the activity output of the SAM.

Source: Authors