A Contribution to the Analyses of the Effects of Foreign Agricultural Investment on the Food Sector and Trade in Sub-Saharan Africa

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Selected paper prepared for presentation at the 14th Annual Conference on Global Economic Analysis, Venice, Italy June 16-18, 2011 Venice, Italy

The views expressed in this paper are the author's own and do not represent the views of FAO

Abstract

The growing interest of foreign investors in Sub-Saharan Africa's vast agricultural potential raises debates about the investment impacts on the food sector and the economy at large. This paper analyzes the likely effects of foreign agricultural investment in Sub-Saharan Africa with a focus on the impacts on the food sector by simulating the effects of the reduction of investment risks triggering an entry of foreign investment flow. The analysis employs the Global Trade Analysis and Policy (GTAP) model and simulates three investment scenarios that affect land uses, labour market conditions, and technological progress. The data are aggregated over three main sectors: food, manufacturing and services. Simulation results show that although foreign agricultural investment in Sub-Saharan Africa would lead to an increase in food prices and a decline in domestic food supply that would in turn cause an increase in food imports, the increases in factor returns and in employment would boost households' real income to offset the loss from higher food prices. The positive income effects would be magnified if the agricultural investment brought technological progress to the food sector. Moreover, foreign agricultural investment would widen the current account deficit but improve terms of trade, whose effect on total welfare is large. The improvement of the terms of trade in the model is mainly due to a strong increase in the export price of tradable goods from the manufacturing sector. The service sector would unambiguously experience the strongest output growth as it benefitted from the formation of capital goods. Overall, the simulation results show that entry of foreign agricultural investment would generate a net welfare gain.

1. Introduction

Many resource abundant low-income countries in Sub-Saharan Africa (SSA) have recently been the target of a growing foreign agricultural (including food) investment inflow, but accounting fully for the exact extent of the impacts remains difficult. Although agricultural investment represents less than 5% of foreign direct investment to Africa, it has been part of the upward trend in foreign direct investment, which between 2003 and 2010 grew on average by 17% per year in Africa (World Bank, 2011).[1] Foreign agricultural investment is often driven by the richer countries' search for a more stable food and energy supply following food price hikes. Among explanations of the effects of this investment on the recipient countries, the most touted assertion is that foreign agricultural investment provides employment opportunities leading to increased purchasing power and increased tax revenues from payroll, along with eventual tax profits. From these investments, host countries may also expect new benefits such as enhanced skills, improved infrastructure, and faster technology transfer. However, one of the main drawbacks stems from the concern that if the host countries are food insecure, the foreign agricultural investment may worsen the problem by reducing the competitiveness of domestic food and agricultural production (Wimberley, 1991; Wimberley and Bello, 1992; Born Black Magazine, 2009; Cotula et al. 2009; *The Economist*, 2011). The reduced competitiveness arises from the increased demands on resources such as water, labour, and arable land, if these resources are in limited supply. This competition for resources leads to increases in food production costs harming poor farmers and in food prices hurting poor consumers in the host countries. The food-security concern is particularly important because Africa is already home to one fourth of the world's food-insecure population and because, in many cases, most if not all of the products of the agricultural investment are exported and unavailable to local consumers (Aykut and Sayek, 2007). Butwithout thorough analysis, it remains difficult to conclude whether the benefits from increased purchasing power or increased tax revenues and technological progress offset consumers' losses due to increased food prices.

Another concern is that agricultural investment leading to changes in factor input uses and prices may also alter SSA's comparative advantages and terms of trade. Labour–intensive sectors such as textile and small manufacturing--current sources of growing export--may be affected by the changes in input demand following investment. These changes in input demands in SSA raise also some concerns about the implications of the foreign agricultural investment in SSA for the trade patterns and welfare in the rest of the world, and particularly in other developing regions. . . All these concerns point to the need for further investigation into the likely impacts of foreign agricultural investment on food security and food trade for SSA.

My objective of this paper is to analyze the likely effects of the increase in foreign agricultural investment in SSA using the Global Trade Analysis and Policy (GTAP) model. Specifically, I analyze the agricultural investment effects on the food production sector, especially on food prices and food trade, and also on SSA's terms of trade and total welfare. The analysis focuses on the effects of three main aspects of agricultural investment: the reallocation of investment among the regions, the resource uses (mainly labour and land), and the likely technological progress in the food sector. The data are aggregated over three main

[1] Agricultural investment is less than 5% of total foreign direct investment to Africa, according to Weissleder (2009). See also Gerlack and Liu (2010) and Deng (2011).

sectors: food, manufacturing, and services. Although the main focus is on the region host (SSA) and its food sector, the analysis intends to provide broader insights into the effects on all sectors and other regions outside SSA. Section 2 presents a summary of the issues at the heart of the debate about foreign agricultural investment. Section 3 describes the simulation method based on the investment component of the GTAP model. Section 4 summarizes and interprets the simulation results. Section 5 concludes the study.

2. Informing the debate about foreign investment in agriculture in Sub-Saharan Africa

The entry of foreign investors in agriculture and especially the channel through the so-called 'land grabbing' in SSA have stirred passionate debates among analysts, policy makers and stakeholders alike.[2] However, resolving arguments about the rights and wrongs of foreign investment in agriculture requires thorough analysis of the economy–wide impacts of the investment. Though analysts and policy makers have expressed the will to assess the full extent of the impact of agricultural investment in SSA, they have found only limited and unstructured guidance from existing literature, especially when the assessment requires exhaustive data on the effects on other sectors in both the host countries (or regions) and the rest of the world.

There has been a renewed interest in impact assessment at local or subnational levels of agricultural investment, but as the size and number of sectors to be covered increase, so does the difficulty in assessing the impacts of investment. The majority of prominent past work (e.g. Borenzstein et al., 1998; Alfaro et al., 2003; Mihalache-O'Keef and Li, 2011) on foreign agricultural investment in African countries remains focused on identifying the correlation or causality between foreign investment in agriculture and some indicators of growth, trade and development without revealing much about how the mechanisms controlling the entry of capital and formation of capital goods in the host countries affect the various sectors and stakeholders in the economy. As a result, decision makers rely on financial analyses that focus more often on the profitability and benefits to the host countries and hardly touch on the impacts on other sectors in both the host countries and the rest of the world. Sadly, the impacts on food security and trade for the host countries have been at best blurred by losses caused by shrinking land availability or by the benefits such as employment creation and tax revenues.

The lack of sound and rigorous analytical guidance obscures the debates over the real motivation behind the investment in agriculture and, more important, its consequences on the host countries over a long time horizon. To fill this gap and inform the debate, I briefly review the channels through which the foreign agricultural investment starts and works its way into and across sectors in SSA economies.

[2] See Barrro and Roth (1990); Von Braun and Meizen-Dick (2009); Born Black Magazine (2009); World Bank (2010); and *The Economist* (2011).

2.1. On the drivers of the increase in foreign agricultural investment

Control of the supply of food and energy in rich countries

Smaller and Mann (2009) and Weissleder (2009) state that food and energy security, especially following the 2008 increase in global food prices, is one of the main triggers of the renewed interest in foreign agricultural investment. Many emerging and advanced economies have limited arable land, and despite their high levels of productivity, their production capacity may not be up to the growing food and energy demands fuelled by income growth. Their food and energy demands are relatively inelastic, so that any decrease in supply in the international market leads to a substantial rise in prices that these countries want to avoid.

Uses of input resources for development and economic growth

The vast agricultural potential of Sub-Saharan Africa associated with low costs of local inputs (including land) attracts foreign investors and promises high returns. The entry of foreign investment in agriculture is often based on the assumption that it allows the use of the host countries' untapped resources such as idle or marginal lands and unemployed workforce (especially unskilled labour), and hence increases the returns to the owners of these factors, i.e., the government, firms and households in the host countries (Cotula et al., 2009). This hypothetical 'win-win' outcome provides further impetus to the growing interest in foreign (World Bank 2010).

Diversification of activities for investors' portfolios and host countries' income

To minimize risks, investors and policy makers hedge against uncertainties arising from concentration of activities by investing in agricultural production (Blas and England, 2008; Weissleder, 2008). Investors believe that investing in agriculture abroad helps diversify their portfolios, especially at times of high uncertainties in the financial markets. Similarly, policy makers in host countries rely on foreign agricultural investment to take up new activities that diversify their export revenue (Blas and England, 2008; Cotula et al., 2009) . Examples of this latter behaviour include the fruit and vegetable production focus in East Africa and meat exports from Sudan.

Opportunity to seize capital good formation

One of the motivations for host countries to attract foreign agricultural investment stems from the windfall of capital goods, especially in the building and upgrading of infrastructures (such as warehouses, dams, roads, and harbours). The formation of capital goods is reminiscent of agricultural investment during the colonial era that brought the construction of railroads and upgraded ports and harbours in many parts of Africa. In Ethiopia, for instance, the construction of dams for irrigation and energy has been a deciding factor in sealing the deal for the entry of foreign investment in the sugar industry. Moreover, the formation of capital goods benefits other sectors, such as the service sector, and makes the economy-wide impacts more ramified and significant.

Improvement in the business and investment environment

Although the level of inflow of foreign direct investment in SSA remains low and the risks of doing business and investment in many SSA countries is still high due to conflicts and natural

disasters, there has been an agreement that the SSA's investment environment has improved. For instance, the global risk assessment performed by Aon (a global risk management services) and Oxford Analytica (2011) reveals that in 2010, only 11 countries worldwide received an upgrade on the basis of reducing risks linked to doing business, and 5 of these upgraded countries are from SSA (Kenya, Mozambique, Rwanda, Uganda and Zambia). [3] Moreover, only two SSA countries (Benin and Comoros) are downgraded. Such a positive development in the investment outlook and ratings for SSA stems from the improvement in the political as well as in socio-economic environment that allows business and investment, including agricultural investment, to take roots and flourish.

2.2 The likely effects of agricultural investments

How agricultural investment works is viewed from several angles and interpreted differently on either side of the debate. It is important to review some of the rationale of the likely effects here.

Natural resource and environmental effects

One of the most controversial issues in foreign agricultural investment in agriculture is its impacts on the amount and quality of resources employed and the effects on the environment and also climate (Clapp, 1998; Woodhouse and Ganho, 2011). This is highly relevant in many natural-resource abundant but ecologically fragile countries in Sub-Saharan Africa. For instance, increases in water use may reduce wildlife activity and affect recreational values. Moreover, extension of cultivated land may lead to irreversible loss of forest and biodiversity. Assessment of these impacts is often included in feasibility studies, but the conclusions of these studies differ much depending on the values assigned to these losses.

Primary factor (land, labour) and endowment effects

If investors use areas that were not cultivated (idle land) and unskilled labour that were not employed(i.e. wage is relatively fix) , then land price and wages of unskilled labour are not much affected. It is known that some foreign investors target idle land and are attracted by labour abundance since full employment of arable land and unskilled labour seems a rare case in many SSA countries. In these cases, land use or employment may increase without affecting directly the wage and rental price of land. Similarly, if the investors import all inputs including skilled labour, there is little or no direct effect on factor prices. . For instance, Aykut and Sayek, (2007) reported some cases (e,g, dairy or bakery) where the investors use only limited amounts of local inputs and instead import most of what they need, including the raw materials, with minimal impacts on the quantity and prices of local inputs. . .

[3] This is also reported in Private Equity Africa (2011),

However, if the foreign investment uses existing arable land and other local factor inputs (such as unskilled and skilled labor) whose supplies are price inelastic, then local factor prices (especially land prices and wages) are directly affected. Some investors in horticulture and especially fruits and vegetables in East Africa for example use the host countries' labour, land and natural resources intensively, and these investments have strong and direct implications for the hosts' factor markets, at least at the local community where the production takes place. More important, some debaters argue that even when an agricultural investment only employs factors that were previously untapped , it may still raise the opportunity costs of these factors when the factor returns from the investment are higher than what would have been sunder any other 'first-best' uses of these factors. Those concerned about food security argue, for instance, that the true cost of using an idle land lies between the returns from the agricultural investment and the social cost of not being able to feed hungry people on that land. These arguments are indeed the basis of the contentions under the 'land grabbing' debates in which more analyses (The Economist, 2011) brought evidence that many of the sizeable land deals in Africa have been harmful to the countries' poor people.

Skills and technological effects

Whether agricultural investment brings about specific types of technological progress that may be factor or sector specific has important implications for the ways to assess the economywide impact. New agricultural investment may introduce imported equipment and improved seeds or may provide direct training or learning–by–doing of the labour force. Similarly investment may bring about some types of innovation in production, distribution or management and may facilitate the spillover effects of the product knowledge from increased trade on Research and Development. For SSA in particular, the technological aspect of agricultural investment is highly important in both the production and processing of food and agricultural commodities, because SSA's productivity and level of human capital still lag far behind those of other regions, let alone developed countries (FAO-World Bank, 2009).

Dries and Swinnen (2004) conclude that technology transfers that accompany foreign direct investment can be beneficial to farmers. The direct impacts of the increased skills (production and managerial) and technology (factor– or output–specific) often translate into an increase in output in the domestic food sector, and especially in production cost efficiency. The full impact depends on the level of use of the skills and technology acquired and the degree of exposure of the agricultural products (from the investment) in all sectors of the economy. Moreover, there are indirect and long run impacts that often escape the assessment of the investment effects. For instance, some workers who acquire skills from the new foreign investment may use the same skills in other sectors or even in their own firms or farms for years to come. Similarly, there could be technology transfer and accumulation of knowledge that 'spills over' to the local domestic sector when the latter's output competes in the market with the products from the foreign investment. These indirect effects, though difficult to quantify, have to be taken into account.

Output prices (including food prices) and food security effects

If foreign investment in agriculture contributes to rising factor prices, it also leads to increases in output prices in all sectors, not just in the agriculture sector. But even when factor prices are fixed, newly empowered consumers (the formerly unemployed that become employed

because of the investment) increase the demand for products (including food) as a result of the increase in their income; household consumption then rises, leading to a further increase in output prices. The agricultural investment impacts on food prices depend also on whether the production is to be sold in the domestic (host) market only, in foreign markets only, or in both markets. The impacts on food prices would be greater when the production is sold in the domestic market than when it is wholly exported.
Studies like Wimberley (1991) and Mihalache-O'Keef (2011) highlight serious concerns about the impact of any foreign direct investment on food prices and food consumption in developing countries. Overall, the debate over the impacts of foreign investment on food security can be hastily concluded if one focuses only on the increase in food prices harming consumers but fails to notice the increase in household income and consumption. This then requires a thorough analysis to compare the loss from increased output prices to the gain from increased factor returns. The impact on food security requires such comparisons among household groups, especially on the most vulnerable ones such as the rural poor, urban poor, children and elderly, although such detailed decomposition is beyond the scope of this study.

Trade and welfare effects

The trade effects of the agricultural investment depend on how much a host's input and output markets are linked to its trading partners. In an open economy, any change in factor prices or output prices in the host country (or region) leads to changes in input and output trade, including food trade. But even if factor prices remain fix in real terms in the host country, the increase in income, as a result of the investment, would lead to not only an increase in output demand and output prices but also a surge in import demand (Hertel, 1997). This means that agricultural investment may affect the host countries' trade balance.

The impact of foreign agricultural investment on total welfare is complicated and depends on how one models the complexity of the price linkages among sectors and the importance of the contribution of the agents/stakeholders (government, firms, households) in the economy. Welfare changes often refer to measures of the changes in consumer and producer surpluses but should also include other changes such as those in terms of trade and in levels of efficiency. For instance, foreign agricultural investment may lead to increases in household income, hence payroll tax revenue from the households and firms for the government; however, as explained earlier, foreign agricultural investment may also raise production costs and output prices, and that may dampen demand and terms of trade.

As in financial analysis, aggregate figures offer limited information on the welfare effect. Therefore, the following types of welfare contribution should be assessed in detail: allocative efficiency that is obtained through a more efficient use of scarce resources (land, skilled labour); endowment efficiency that arises from use of factors previously untapped (unemployed unskilled labour, idle land); technical efficiency that estimates gain from technology use; terms–of–trade effects, which measures the welfare changes arising from variation of export and import prices; and the investment savings effects, which estimates the gain or losses from the change in the price of capital. For the host region or countries, the problem is then to know what the net effects are and what drives most of these effects.

Impacts on the rest of the world

The impact of agricultural investment on regions or countries outside the host region depends on the relative size of the agricultural sector of the host and the trade link it has with the rest

of the world: the larger the sector and stronger the link, the larger the impacts For instance, if factors (especially labour) are mobile among countries, that agricultural investment in a large host region may affect agricultural production costs in other t regions. Similarly, if output prices change in the rest of the world (as a result of the trade adjustment from the agricultural investment in the host), households' and firms' consumption outside the host country (region) are also affected. Additionally, sectors other than the food and agricultural sectors are affected by price changes.

With SSA's agricultural trade being small at less than 5% of the world agricultural trade, the impact of the foreign agricultural investment on the rest of the world may be limited. Nevertheless, some investment impacts may be felt in other developing regions that compete with some SSA African countries in the international agricultural markets. Also , if the agricultural investment consists of producing food to be exported directly to other regions, the direct effect is the increase in food supply leading to a decline in food prices and an increase in consumption in these destination regions. Thorough analysis of these effects on the rest of the world deserves closer attention but is beyond the scope of this paper.

3. Model and Application

3.1 Investment in the GTAP model

To convey the workings of the simulation of the impacts of investment on the food sector, I briefly outline the investment mechanism in the model. **I** take advantage of the investment feature in the GTAP model (Hertel, 1997; Hertel and Tsigas 1997) to analyze the impact of foreign direct investment in agriculture. The GTAP model is a General Equilibrium approach for which investment is viewed mainly through its production and trade effects, As it will be explained later in this section, investment in the GTAP model is defined as the creation of capital goods (CGDS) using a mix of intermediate goods (such as constructions, machinery, vehicles, and services) . The GTAP model is chosen among other general equilibrium models for its straightforward focus on the links between changes in factor prices and sector production, and especially trade. Another key advantage of the model is its ability to decompose the aggregate welfare effects of any type of shocks.

Global bank and model closure

Savings and the idea of 'global bank' play an important role in explaining investment in the GTAP model. Savings enters household's utility functions directly because it provides utility in offering promise of future consumption. The assumption derived from the neoclassical standard assumption is that investment I is allowed to adjust but it has to accommodate savings S; savings minus investment must be identical to current account balance export X minus import I, or $S\text{-}I \equiv X\text{-}M$. It must be then that any change in global demand for savings matches the change in global demand for investments. Any regional level change in any element on both sides of the identity (e.g., an exogenous increase in investment, or an increase in rate of returns because of some trade policy changes) may alter this identity. So to keep the identity between savings minus investment and current account balance, there has to be a quick adjustment. On the investment and savings side, this adjustment is made in GTAP through an imaginary 'global bank' which can re-allocate investment and savings to each region in the model. More generally, the GTAP model assumes that the global bank uses

receipts (money) from the sale of 'saving' commodity to individual regional households in order to purchase at price *PSAVE* some shares in a portfolio of regional investment goods. The size of the investment portfolio is adjusted to accommodate changes in savings. To ensure global closure, the global bank buys investment shares until the demand for global savings is equal to the demand for investment.

Regional adjustment due to investment changes

I now summarize the change in the level of investment is captured in the GTAP model. Although the global closure holds, investment across regional households may change through exogenous shock or can also be subject to a reallocation of funds. An increase in investment in one region (whether it comes directly from other regions through re-allocation or from an exogenous increase in investment in a particular region) alters regional allocation and volume of investment and savings at the global level, but it would still maintain the neoclassical closure, i.e., the identity $S\text{-}I \equiv X\text{-}M$ stated above. Similarly, change in trade policy leads to a reallocation of savings and investment among the regions. Summarily, i the change in investment is captured and modelled in the GTAP model via the two investment components, namely, the 'rate of return' and the 'alternative investment' models.

The Rate of return model

The first component of investment model in GTAP, the 'rate of return' model, assumes that the percentage changes of the rate of returns *rore* (r) are the same across the regions and are all equal to the global rate of return *rorg*..

(1) *rore* (r) = *rorg*.

In this case, the identity ($S\text{-}I \equiv X\text{-}M$) still holds at the global level but the levels of investment across regions may not be the same.

To apply this theory on rate of return, the model introduces the elasticity of the region's rate of return next period with respect to the end of the period capital stock (KE) defined as *RORFLEX*, i.e.,

RORFLEX= - dLog(*RORE*)/dLog(*KE*).

The smaller (larger) the elasticity *RORFLEX*, the more (less) sensitive is the supply of capital stock change with respect to the rate of return, and to equalize the rate of return across regions, a large (small) change in regional investment is produced by the model. In general, however, the RORFLEX values are large, meaning that the standard assumption is that only small changes in investment are needed to equalize the rate of return across regions.[4]

The lternative investment model

[4] The rules on the equalization of rate of return across region requires that at least a significant adjustment on RORE from investment be necessary: when *ROREFLEX* is high any significant adjustment on RORE can be produced by just a tiny adjustment in capital. Conversely with a low *ROREFLEX*, a sizable change in capital stocks is needed to produce any significant adjustment in rate of return

The second component also known as the 'alternative investment'' assumes that the regional composition of the capital stocks is fixed (i.e., fixed proportion of investment across the regions) but that the regional and global net investments may move up or down together. In this case it is assumed that the global rate of return is a weighted average of the regional rates of return.

(2)
rorg = Σ (*NETINV*(r)/*GLOBINV*] * *rore* (r)
where *NETINV (r)* is the difference between regional investment *REGINV (r)* and the value of the depreciation VDEP (r).

A generic expression combining the two components

Finally, these two components can be combined by introducing a binary parameter *RORDELTA* that determines which model to use in the two following equations:

(3)
*RORDELTA * rore (r)+(1 - RORDELTA)* [REGINV(r)/NETINV(r)] * qcgds(r) – [VDEP(r)/NETINV(r)] * kb(r) =*
*RORDELTA * RORG + (1 - RORDELTA)* globalcgds*

and
(4)

*RORDELTA * globalcgds + (1 - RORDELTA) * rorg =*
RORDELTA ∑ [REGINV (r) / GLOBINV] * qcgds (r) - [VDEP(r)/GLOBINV] * kb (r) +(1 - RORDELTA)* ∑ [NETINV (r) / GLOBINV] * rore (r)*

where:
r is region;
RORDELTA is a binary parameter;
RORG is the global rate of return and *rorg* is its percentage change;
RORE is the regional expected rate of return and *rore* is its percentage change;
GLOBINV, REGINV, NETINV are global, gross regional, and net regional investments;
VDEP the value of depreciation;
globalcgds is the percentage change in global supply of new capital goods;
qcgds is the percentage change in the quantity of capital goods; and
kb is the percentage change of capital stock.

In practice, if the 'rate of return' component model is chosen, i.e., if the interest is in the reallocation of savings (transfer of capital), say, from a rich to a poor region, then the parameter *RORDELTA* in the equation above is set to 1. But if the second component is preferred, the parameter *RORDELTA* is set to zero.

'Investment' good and 'saving' good

After the investment shocks (exogenous increases or reallocation), the new levels of investment at the regional level are known. The next steps are to examine how the new reallocation of investment affects the rest of the economy at regional level and to formulate the production of unit of fixed capital (investment good). This is done by a CES production

function using intermediate (not primary) inputs from domestic and import sources (see Hertel and Tsigas, 1997). One unit of capital goods is produced by domestic and intermediate inputs. Primary inputs enter only in the production function through the intermediate inputs. Moreover, the price of the capital goods *pcgd(r)* is determined by its production cost.

The change in the price of savings (the price at which the global bank sells the savings, and then later uses the receipts to place investment in regions) is calculated as the weighted average of the change in price of capital goods across the regions *pcgd(r)* using the regions' net investment shares of global investment, (*NETINV*(r)/*GLOBINV,)* as weights: *psave (r)* = $\sum_r$ *(NETINV (r) / GLOBINV]. pcgd(r)*

3.2 Application of the GTAP model

Model structure

My aim is to measure the impact of foreign investment in agriculture in Sub-Saharan Africa. I use a version of the GTAP model (Hertel et al.) explained above but aggregate the countries into three regions, namely Sub-Saharan Africa (SSA), the European Union (EU) and the Rest of the World (ROW). This regional aggregation choice stems from the consideration that the EU countries have long been and remain important trading partners and sources of foreign investment for SSA countries after the latter's independence. More recently, however, there has been a rise in investment flows from the ROW with the rise of countries like India and China. The EU and ROW remain alternative and competing investment sources for SSA countries. To remain focused on the implication for the food sector, I assume that there are only three sectors, namely, food, manufacturing and services (see Annex 1 for detail).

Investment parameters

I employ the 'rate of return' model, one of the two features of the investment model in the GTAP summarily described in previous section. The underlying assumption in the rate of return model is that in equilibrium the rates of return on investments are the same across regions and equal to a global rate of return. Malcom (1998) employed this feature and further assumed that any discrepancy between the regional rates and global rate can be considered as the level of investment 'risk', and that through a global bank this discrepancy triggers a reallocation of the investment among the regions until the rates are again equalized across regions. In other words, equation (1) is rewritten as:

(5) *rore* (r) = *rorg* + *risk* (r),
Or *risk* (r) = *rore (r) – rorg*

where *risk (r)* is the change in 'risk ratio'. [5]
The simulation proceeds in the model by assuming that change in the risk ratio, *risk (r)* in equation (5) is equivalent to the rate of changes of the slack of capital goods *cgdslack* because a diminution of the slack of capital goods invites inflow of investment.
(6) *cgdslack = rore (r) – rorg*

[5] See Malcom (1998) and Hertel and Tsigas (1997). The main hypothesis is that as the amount of investment in the present time increases, the expected rate of return (in the future) declines. In other words, a decrease in *risk (r)* is associated with a decrease in *rore(r)* as shown in equation (5).

The exogenous negative shock on capital goods' slack triggers the inflow of foreign investment and this will entice capital good formation and increase in demand of factor inputs in the economy. However, to create a situation where investment grows faster than savings, trade balance is assumed and allowed to be flexible.

Agricultural parameters and model closures

These assumptions and procedures capture the idea that the SSA region has become more attractive to investment. But to emphasize that the foreign investment is on SSA agriculture, it is important to take into account the possibility that the investment in agriculture may drive away some amounts of unskilled labour and arable land from domestic production. Similarly, the model associates the increase in investment capital with an anticipated increase in technological progress in the food sector. Accordingly, the main assumptions on the model closures relate to trade balance and especially unskilled wage flexibility while the main variable shocks include capital good slack (*cgdslack*), the amount of unskilled labour (*qo Unsk*) and land, and output augmenting technology (*a0all*) in the food sector. [6]

3.3 The main scenarios

I specifically run simulations on three main scenarios (see table 1):

Scenario 1: flexible trade balance; flexible wage of unskilled labour; decrease in investment risk; increase in food technology; reduction of available agricultural land;

Scenario 2: flexible trade balance; flexible wage of unskilled labour; decrease in investment risk; no change in food technology; reduction of available agricultural land;

Scenario 3: flexible trade balance; fixed wage of unskilled labour; decrease in investment risk; no change in food technology; no reduction of available agricultural land.

(Table 1, here)

For all three scenarios, the first common assumption is that SSA's skilled labour is fully employed (i.e., their wages are flexible). This assumption is justified by the well-known fact that the level of SSA' human capital in is fairly low relative to those of other regions. The second common assumption is the reduction of the risk ratio by 15% under all three scenarios; this figure is a rough approximation of the results of the analysis on risk assessment by Aon and Oxford Analytica (2011). The five countries (Kenya, Mozambique, Rwanda, Uganda and Zambia) that received an upgrade in investment ratings represent about 11% of the number of SSA countries and about 20 % of the countries and sub-regions in SSA included in the model. Moreover the 15% risk reduction figure is closer to the 13.5% that Malcom (1998) employed to represent risk reduction in his study of investment flow in South Africa and Sub-Saharan Africa.

[6] In the GTAP model language: - *dpsaving* becomes fixed (exogenous) while *trdbal* become mobile (endogenous).

The other assumptions are specific to the scenarios. The first two scenarios characterize investment that takes a sizeable amount of land out of the food production in a situation where wages are flexible. Likewise these first two scenarios allow the comparison between the likely outcomes with and without technological progress specific to the food sector. I chose as one of the variable shocks the 10% reduction in agricultural land availability because the literature (Wessleder 2009; Friis and Reenberg, 2010; Deng, 2011) shows this to be a plausible figure for land deals at least for some countries in central and east Africa targeted by foreign investors.[7] I include a 2% increase in output–augmenting technology, which is a small but minimum level expected from a foreign investment in the food sector at least to keep up with the 2-3% population increase for SSA region. Scenario 3 represents the type of investment where investors target idle land and unemployed unskilled labour in the economy. Also, this last scenario is what many investors and host countries have in plan as a valorization of untapped resources.

It is important to note that under scenarios *1* and *2*, food produced directly from the new foreign investment is assumed to be exported outside SSA and not to add to SSA production or trade, whereas in Scenario 3, all outputs including food produced from the agricultural investments reach both domestic and foreign markets.

4. Simulation results and interpretations

4.1 Effects on SSA factor markets:

I start by summarizing the effects on the factor market and factor prices. Results in Table 2 show that although the levels of increase are not the same across scenarios, all factor prices rise under the three investment scenarios. One common cause of these factor price increases is the rise in the demand for intermediate goods needed for the production of capital goods. Primary factors enter indirectly in the formation of capital goods, because in the GTAP model capital goods are produced using only intermediate goods. In other words, intermediate goods employ primary factors, and this is why the demand for primary factors is affected, though indirectly, by the reallocation of investment. Conversely, the change in the amount of land available to food and other sectors affects the demand in these primary inputs directly.

(Table 2, here)

It is important to note that input price increases are slightly higher under scenario 1 than under scenario 2; this is due to the effects of the 2% increase in the output–augmenting technology under scenario 1. The output–augmenting technology that accompanies the investment in the food sector has increased the demand for these primary inputs in the food sector. Technological progress in scenario 1 leads to an increase in the marginal value product of all factor inputs, hence their prices. Below I detail what happened to the main factor inputs.

[7] For instance, Friis and Reenberg (2010) report that whereas the percentage of land deals over agricultural land can be as low as 1% in Nigeria, it is as high as 15% in Uganda and 21% in Mozambique.

Land

As expected, land price goes up significantly when the investment in agriculture takes away agricultural land from current agricultural domestic production. When agricultural land is reduced by 10%, land price goes up by about 21% in scenario 1. It is also important to note that land price still increases, although by considerably less (about 3%) when, in scenario 3, the investment employs idle land (land not currently used for food production). Besides the rise in the demand for intermediate goods prompted by the investment entry, this slight increase in land price under scenario 3 is triggered by the increase in demand for food due to the increase in overall consumption, especially as the employment is allowed to increase.

Labour

Wages of unskilled labour rise under the three scenarios and (in scenario 1) peak at about 5.4% when technological progress accompanies investment under full employment. The same trend goes with the wages of skilled labour: the increase is in general much higher than that of unskilled labour across all scenarios, and specifically in scenarios 1 and 3. Also the investment under scenario 3 leads to an increase in the employment of unskilled labour by 2.8%. This is a non–negligible gain considering that there is no reduction in usable land, and all this new employment creates an increase in regional household income.

Capital and Natural Resources

Returns to capital follow similar patterns as the returns to labour and land with an increase of 5-6% . Additionally, prices of natural resources have not changed much under any of the scenarios. This is due to the structure of the model and the simulation considered here (as I did not perform any shock to the level of natural resources) where the investment inflow does not employ natural resources. However, it is entirely feasible to assign arbitrarily a percentage decrease in natural resource availability due to the agricultural investment.

4.2 Prices and quantities of outputs in all sectors

The capital goods in the model

As the focus is on investment, and because investment brings about creation and growth in capital goods, it is important to summarize the formation of capital goods in the model. This will also help explain the changes in prices and levels of output for the rest of the interpretation of the results. Table (3) shows the structure of the formation of capital goods.

(Table 3, here)

Table 3 shows that creation of capital goods (CGDS) relies mostly on domestic factors. Food and service products needed to build capital goods are overwhelmingly supplied by domestic sectors. However, the manufacturing product required for CDGS comes in almost equal share from domestic and import sources. Moreover, the food sector contributes little to capital goods formation (only about 1.6%); the impact of CGDS formation alone on the food sector is expected to be relatively small. Conversely, the manufacturing and service sectors contribute to 46% and 52% of inputs to the formation of capital goods . These values show that as

CGDS grows, one expects that the service sector will grow much more than the other sectors, and also that domestic and imported intermediate goods for manufacturing will increase. These information help explain further the simulation results.

Impact on output level and prices

Table 4 shows that all output prices increase under all the three scenarios. The increase in price is slightly higher in the service sector than in other sectors (except in scenario 2). The increases in factor prices, which raise production costs, contribute to the increases in output prices in all sectors in SSA.

(Table 4, here)

The levels of SSA output in food and especially manufacturing sectors took a hit under all three scenarios, whereas both price and output levels in the service sector rise significantly. The large decline in output in the manufacturing sector can be explained by the significant rise in the price of capital and wages of unskilled labour. The manufacturing sector also uses relatively high share of intermediate goods produced from the service sector, whose output price rises significantly, and this contributes to the fall of manufacturing output. After all, the declines in food and manufacturing outputs are not surprising because the demands for intermediate goods from both food and manufacturing sectors fall back as results of the increases in the primary factor prices and in the output prices.

The only sector that experiences an increase in output is the service sector. The reason is that the service sector alone supplies 52% of intermediate goods for the formation of capital goods (as Table 3 shows); as there is an increase in investment leading to the increase in capital goods, the demand in service (as an intermediate good) should increase significantly. This strong increase in demand for service explains why the price increase is higher in the service sector than in the food or manufacturing sectors. Also note as tables 5a and 5b show that the service sector uses 86% of the skilled labour supply and is the most skilled–labour intensive sector (22 % of its input values.
(Table 5a, here)
(Table 5b, here)

Impact on the food sector (price, production and consumption)

Because the impact on host countries' food security is a chief concern in the debate about the effects of foreign agricultural investment in SSA, I now examine more closely the results on the food sector (output and demand) under the three scenarios (see table 4) . Three findings stand out from the simulation results. The first finding is that food price increases by about 5% in scenario 2 when investment removes 10% of land from agricultural production but with no technological progress in the food sector. This food price increase is partly an immediate consequence of the increase in factor prices (especially land and unskilled labour).

The second finding is that food output shrinks by less than 3% under all scenarios. The output decline is relatively small at 1% in scenario 1 because of the increased productivity that contributes to an increase in food production (the technological shock in the food sector softens the increase in food prices and limits the decrease in domestic production). Moreover, although the food sector uses land more intensively than do the manufacturing or service sectors, land represents only 11% of the value of factor uses on food production; the rest

comes from capital (25%) and especially unskilled labour (63%), as Table 5b shows. This explains why even the 21% increase in the price of land does not increase food prices much. Output shrinkage is slightly more severe at 3% in scenario 2, as investment takes away a sizeable amount of land from food production but does not bring any technological progress to SSA's food sector.

The third finding is that despite the food price increase and food output's slight decline, total (both private household and government) demand for and consumption of food increase. The result shows that under the three scenarios, private household demand for food rises by 1-2%. Why is household food consumption rising when food prices are up and when food production is down? An explanation of the increase in household demand comes from the increase in income (both nominal and real income) as household members, who are owners of factors, receive higher factor returns (see Table 4, last two rows). It is important to stress that regional household members are both the owners of some of the factor inputs and consumers of final goods, and any changes in factor and output prices affect also the purchases of final goods including food. This finding also implies that the investment leads to an increase in food import, harming SSA's food trade balance.

These results provide some insights into how agricultural investment may affect food security in SSA. It can be said that because of the entry of investment, even when 10% of land production is taken away by foreign investors, food price goes up but not by much compared to what it has actually been under other type of shocks (such as policy shocks, weather shocks, and speculation). Moreover, investment triggers the increase in factor returns that benefits households (private and government) that are factor owners; this leads to the increases in income and hence consumption. In other words, greater factor returns from foreign investment may offset the risk of a diminished domestic food sector; the result points towards greater household consumption. How this consumption is distributed among households is beyond the scope of this study, as the GTAP model employed here does not distinguish among household groups. However, the model provides a trade and welfare analysis that pursues the origin and net values of these investment effects at the regional level.

4.3 Trade effects

Any change in input prices or output prices in SSA leads to a change in its trade ability and SSA's trade is also determined by how much the SSA region is linked to its two trading partners (the EU and ROW) in the model. Results in Tables 6a and 6b show that under the three investment scenarios, SSA's current account deficit widens significantly because of sharp increases in imports and decreases in export for all the three sectors. The main source of SSA's current account deficit following the entry of investment in agriculture is the manufacturing sector, which sees its trade deficit tripled. Manufacturing plays an important role in the widening account deficit mainly because manufacturing's import growth and its export decline are significant and especially because manufacturing is the sector that trades (both export and imports) the most with SSA's partners. For instance, exports and imports in manufacturing are 4 and 7 times larger, respectively, than those in food sector.

For food trade in particular, the standard baseline scenario assumes hypothetically that SSA starts with a slight food trade surplus. Based on the simulation results under the three scenarios, the food–trade balance remains positive (SSA food export volume is still higher than its food imports), but the food trade surplus shrinks considerably; food imports grow (by 6-10%) while food exports decline significantly (by 10-17%). In scenario 2, the cut in food surplus is deepest as the rates of increase in food import and of decline in food export are the largest. The impacts on the ROW and EU trade for all sectors remain small on aggregate, about 1%. This is because their economies are far larger than that of SSA.

(Table 6a, here)
(Table 6b, here)

4.4 Welfare decomposition and implications

Table 7 summarizes welfare changes (values are in million dollars) under the three scenarios, and the results specify how the gains and losses from the increased investment in the model are distributed among the sectors and especially among the owners of factor inputs, such as firms and regional households. The welfare decomposition allows an attempt to explain the origins of these welfare gains and losses, which are consistent with the various effects discussed so far.

(Table 7, here)

To begin with, investment under all the three scenarios yields important increases in welfare. This is not surprising as it has always been mentioned (at least in financial analyses) that there are overall gains by allowing foreign investment in agriculture. The largest welfare increase is under scenario 3, where the investment entails no reduction in available,(non-idle) land and SSA has a fixed real wage. This result means that investment targeting idle land and tapping a large pool of unemployed unskilled labour will yield large gains to SSA. The increase in welfare under all three scenarios is consistent with what happened to the final consumption and real income. The increases in factor prices lead to an increase in SSA households' nominal income, but the increases in sector prices (including food prices) working against consumption and savings reduce nominal income. The net result is that real income increases by about 1-2% when wage is flexible, and by about 3% when unskilled labour and land are not constrained (fixed wage or SSA). The difference is due to the entry of newly employed unskilled workers, whose payrolls raise the average income per capita despite the sticky (fixed) real wage.

Welfare decomposition results show that endowment effects through job creation are the most welfare enhancing (i.e. provide the biggest welfare advantage) of the investment in agriculture when that investment reduces unemployment of unskilled labour. In scenario 3, the foreign investment creates employment (2.8%) for previously unemployed unskilled labour; the newly employed workers' income boosts regional household consumption, and their entry to various sectors contributes to keeping production costs lower than they would have been under a flexible wage. This increases the competitiveness and profits in many sectors. Conversely, there is a welfare loss in Scenarios 1 and 2 associated with the reduced endowment effects when the supply of unskilled labour is fixed and especially when cropland is scarce. The SSA region gains in allocative efficiency effect as the foreign agricultural investment allows more efficient uses of scarce resources such as land and skilled labour.

The gain is indeed larger under Scenario 3 when the investment does not reduce land availability from the local food production sector.

Results in Table 7 also show that the terms–of–trade effect of the investment contributes significantly to the increase in total welfare: the welfare effect of the increased export prices is larger than the welfare effect of the increased import prices. Further decomposition of the terms–of–trade effect (see Table 8) shows that under the three scenarios, the manufacturing sector contributes to more than half of the total terms–of–trade effect. One reason why manufacturing contributes so much is that in the model structure, manufacturing is the backbone of SSA trade; about 68% of SSA trade is from the manufacturing sector, and hence the large effects of investment on the manufacturing trade. Also about 38% of intermediate good imports goes to the manufacturing sector, which stresses again the importance of the manufacturing sector in SSA's trade and terms–of–trade effects (see Table 9a, Table 9b).

(Table 8 here)
(Table 9a here)
(Table 9b here)

On the effects of technology, comparison of the results between scenarios 1 and 2 shows that investment accompanied by technological advance in the food sector (scenario 1) improves welfare further. In the simulation under scenario 1, the 2% output–augmenting technological progress doubles the welfare gain. This welfare gain is obtained through the increased competitiveness of the food production that leads to an extended gain in profit. In general, the direct effect of technology is seen through the increase in producer surplus as profits rise owing to the increased food production and sale. But, as it is explained earlier, there is another important benefit based on allocative efficiency. The increased technology in the food sector raises the marginal value products of the inputs used in the food sector. There is, therefore, a reallocation of factor uses between the food sector and the rest (more inputs move to food production as the marginal value product of inputs in the sector increases). This creates an additional allocative efficiency, which explains why the allocative efficiency in scenario 1 is higher than in scenario 2, as Table 10 shows.

(Table 10 here)

5. Conclusion and discussion

The impacts of foreign agricultural investment on the Sub-Saharan African economy deserve greater attention because of the food–insecurity and food–trade challenges the region is facing. This paper attempts to provide an accounting view and analyses offered by the GTAP model on the impacts of foreign agricultural investment among sectors and main stakeholders, and especially on food security and food trade. I aggregate the data to focus on only three regions (Sub-Saharan Africa, the European Union and the rest of the world), and merge the sectors into three categories (Food, Manufacturing and Services). I use three investment scenarios that model how taking away land, bringing an increase in technology, and straining the labour market may lead to welfare changes.

Simulation results on the effects of agricultural investment on the food sector are mixed. Results show that foreign agricultural investment would lead to a decline in domestic production for the local market and a rise in food prices. Although the food price increase is

relatively small, it raises immediate concerns about the state of food insecurity for SSA countries. Moreover, the investment in agriculture would widen the current account deficit and specifically increase SSA's dependency on food imports. However, the concerns for food security and rising food imports may be mitigated because investment in agriculture would lead to an increase in the regional household income when the investment triggers increases in wage and employment. The simulation results show that the net effect is that real income and real consumption would rise.

Welfare analysis confirms that overall, foreign investment in agriculture can increase welfare for the SSA region. The biggest gain would come from the terms–of–trade effects especially because of the increase in export prices in the food and manufacturing sectors. As factor prices rise, there would also be a significant gain in efficiency due to a better reallocation of factor inputs among the three sectors. The welfare effects would be even higher if the agricultural investment uses previously idle land and unemployed unskilled workers. More important, the simulation results clearly indicate that technology–enhancing investment would lead to further efficiency and hence welfare gains for SSA.

While the manufacturing sector plays an important role in the SSA economy and in the impact of investment, it is the service sector that would be the largest beneficiary of agricultural investment. Under the three scenarios, agricultural investment would lead to a significant growth in the service sector's output levels and prices. The reason is that the service sector contributes heavily to the formation of capital goods. This is the typical story of investment in which a services such as transportation and communication benefit from the construction and uses of infrastructure that accompany the entry of foreign investment. The growth in the service sector would be also enhanced by stronger demands in domestic intermediate goods from the food and manufacturing sectors.

The simulation results in this paper are presented and discussed within the understanding of the model's limitations. The aggregation levels remain too high, and breaking the data down to many more sectors would be a worthy expansion of this study. A more precise estimation of the impact on food security requires that households be categorized in ways that differentiate among various household groups. Moreover, the assumptions of how investment works through the various sectors require more analysis. For instance, it remains difficult to assess the direct impact of investment on factor prices because the model assumes that the formation of capital goods employs only intermediate goods (not primary factors directly). The model does not have also a sector–specific investment component, and investment has to enter as inflow of capital at the national or regional level. Besides, the investigation here focuses mostly on the immediate effects of the investment, but the simulation would be more revealing if it employed the dynamic version of the GTAP model. Such a dynamic approach, if data permitted, could capture the feedback of the immediate effects and especially account for the effects of depreciation of capital stock over time. Similarly, the use of natural resources (such as water and forest areas) in agricultural investment has been overlooked here but constitutes an important area of research that may contribute further to assessing the full impact of agricultural investment. The three scenarios presented here are far from exhaustive of the various types of investment in agriculture. My aim was to show that because foreign agricultural investment effects are not easy to track and assess because of the ramification across other sectors, hasty conclusions born out of passionate debates on limited aspects of the effects may mislead crucial decision making.

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Annex 1

The food sector includes: paddy rice, wheat, cereal grains nec, vegetables, fruit, nuts, oil seeds, sugar cane, sugar beet, plant-based fibers, crops nec, bovine cattle, sheep and goats, horses, animal products, raw milk, wool silk-worm cocoons, bovine cattle, sheep and goat, horse meat prods, meat products nec, vegetable oils and fats, dairy products, processed rice, sugar, food products nec, and beverages and tobacco products.

The manufacturing sector includes: forestry, fishing, coal, oil, gas, minerals nec, textiles, wearing apparel, leather products, wood products, paper products, publishing, petroleum, coal products, chemical, rubber, plastic products, mineral products nec, ferrous metals, metals nec, metal products, motor vehicles and parts, transport equipment nec, electronic equipment, machinery and equipment nec, manufactures nec.

The services sector includes: electricity, gas manufacture, distribution, water, construction trade, transport, financial, business, recreational services, public admin and defence, education, health, dwellings & Svces.

Table 1. Agricultural investment scenarios

	Base	**Scenario 1**	**Scenario 2**	**Scenario 3**
Key Closures:				
Trade balance	flexible	flexible	flexible	flexible
Unskilled labor	flexible wage (full employment)	flexible wage (full employment)	flexible wage (full employment)	fix wage (unemployment)
Skilled labor	flexible wage (full employment)	flexible wage (full employment)	flexible wage (full employment)	flexible wage (full employment)
Shocks:				
Reduction of risk ratio for SSA	None	-15%	-15%	-15%
Output augmenting technological change in food sector in SSA	None	2%	None	None
Reduction in arable land available to domestic production in SSA	None	-10%	-10%	None

Source: Author

Note: In GTAP language the shocks are on the following parameters and variable *cgdslack* for the reduction of risk; *a0all* for output augmenting technology, and qo("Land","SSA") for land.

Table 2. Impacts of agricultural investment on factor input in Sub-Saharan Africa

	Scenario 1	Scenario 2	Scenario 3
Change (%) in:			
Input price			
Land	21.0	20.7	3.1
Unskilled labor	5.4	4.7	3.5
Skilled labor	7.3	6.5	7.8
Capital	5.3	4.6	5.9
NatRes	0.1	-0.0	0.9
Employment of unskilled labor	0.0	0.0	2.8

Sources: GTAP model; author

Table 3. Formation of capital goods in the model (pre-shock) for Sub-Saharan Africa

	Value share of domestic purchases of intermediate goods (%)	Value share of imported intermediate goods (%)	Share of total values (%)
Sector			
Food	89.9	10.1	1.6
Manufacturing	51.6	48.4	45.9
Services	99.4	0.6	52.5

Source: GTAP (core data, using array VDFM, VIFM); author

Table 4. Impacts of agricultural investment on output level, prices, consumption in Sub-Saharan Africa

	Scenario 1	Scenario 2	Scenario 3
Change (%) in:			
Output price			
Food	2.9	5.1	3.7
Manufacturing	3.6	3.2	3.5
Services	4.8	4.2	4.5
CGDS	3.4	3.1	3.3
Output level			
Food	-1.1	-2.9	-0.6
Manufacturing	-4.6	-4.2	-3.6
Services	3.1	2.8	4.3
CGDS	35.9	34.9	38.1
Private household consumption			
Food	1.9	0.8	2.3
Manufacturing	2.6	1.6	3.3
Services	2.3	1.3	3.1
Real income indicators			
Per cap utility from household expenditure(u)	2	1.1	2.7
per cap utility from gov expenditure (ug)	1.1	0.8	2.1
per cap utility from private expenditure (up)	2.2	1.1	2.8

Sources: GTAP model; author

Table 5a. Factor endowment uses in Sub-Saharan Africa (%)

	Food	**Manufacturing**	**Services**	Total
Factor (input)				
Land	100	0	0	100
Unskilled labour	30.9	19.7	49.4	100
Skilled labour	2.9	10.7	86.3	100
Capital	13.5	31.7	54.8	100
Natural Resources	0	100	0	100
Factor Share	20.3	27.2	52.5	100

Source: GTAP model (using core base data EVFA)

Table 5b. Factor intensity by sector in Sub-Saharan Africa (%)

	Food	**Manufacturing**	**Services**	Factor Share
Factor (input)				
Land	10.7	0	0	2.2
Unskilled labour	62.8	29.9	39	41.4
Skilled labour	2	5.4	22.4	13.6
Capital	24.6	43	38.6	36.9
Natural Resources	0	21.8	0	5.9
Total	100	100	100	100

Source: GTAP model (using core base data EVFA)

Table 6a. Current account for Sub-Saharan Africa (million USD)

	Export	**Import**	Balance
Sector:			
Scenario 1			
Food	13112.1	-9128.3	3983.8
Manufacturing	44933.8	-68676.2	-23742.4

Services	13856.7	-18285.8	-4429.1
			-24187.8 (-28.6%)
Scenario 2			
Food	12342.8	-9494.6	2848.19
Manufacturing	45622.8	-68049.2	-22426.4
Services	13985.1	-18047.0	-4062.3
			-23640.5 (-49.0%)
Scenario 3			
Food	12836.3	-9394.4	3438.0
Manufacturing	45127.7	-69431.4	-24303.0
Services	13925.5	-18401.9	-4476.0
			-25341.0 (-38.4%)

Sources: GTAP model; author

Note: export and import are the value at market prices. The percentage figures in parentheses represent changes relative to baseline trade balance.

Table 6b. Export and Import growth in SSA (%)

	Export	**Import**	**Balance**
Sector:			
Scenario 1			
Food	-10.3	5.6	
Manufacturing	-17.0	13.0	
Services	-12.7	10.1	
			-28.6
Scenario 2			
Food	-17.3	9.6	
Manufacturing	-15.4	12.0	
Services	-11.4	8.7	
			-49.0
Scenario 3			
Food	-12.9	8.6	
Manufacturing	-16.6	14.2	
Services	-12.0	10.8	
			-38.4

Sources: GTAP model; author

Note: Based on aggregate export (fob) and aggregate import (cif) values (qxw, qiw).

Table 7. Welfare decomposition (million USD)

	Allocative Efficiency	**Endowment**	**Technical Efficiency**	**Terms of Trade**	**Investment Savings**	**Total Welfare**

Scenario 1						
SSA	879.3	-653.9	2260.7	2590.8	464.1	5541
EU	-281.6	0	0	-744.8	-90.5	-1116.8
ROW	-414.7	0	0	-1892.6	-384.2	-2691.4
						1733.8
Scenario 2						
SSA	668.7	-652.3	0	2623.9	412	3052
EU	-452.5			-813.8	-79	-1344.2
ROW	-489.7	0	0	-1858.9	-344.1	-2692.7
						-984.1
Scenario 3						
SSA	1195.7	3209.9	0	2619.5	462.5	7487.6
EU	-357.9	0	0	-742.2	-90.5	-1190.6
ROW	-466.6	0	0	-1924.6	-382.6	-2773.7
						3523.2

Sources: GTAP model; author

Table 8. Decomposition of the terms–of–trade effects in Sub-Saharan Africa (million USD)

	Scenario 1	**Scenario 2**	**Scenario 3**
Sector:			
Food	352	600	446
Manufacturing	1587	1439	1556
Service	651	585	618
Total	2591	2624	2619

Sources: GTAP model; author

Table 9a. Share of intermediate goods from domestic sources for Sub-Saharan Africa (%)

	Food	**Manufacturing**	**Services**	**CGDS**
Intermediate goods				
Food	78.8	9.5	9.7	2

Manufacturing	7.5	51.4	31.3	9.8
Services	7.6	25.5	47	19.9
total	16.3	34.4	35.8	13.4

Source: GTAP model (using core base data VDFM, SSA)
Note: The table reads: 9.5 % of total sale in the domestic food sector goes as an intermediate input to the manufacturing sector.

Table 9b. Share of intermediate goods imported to Sub-Saharan Africa (%)

	Food	**Manufacturing**	**Services**	**CGDS**
Intermediate goods				
Food	65.8	18.2	14.3	1.8
Manufacturing	9.8	41.9	25.6	22.8
Services	14.6	27.8	55.8	1.8
total	14.4	38.2	29.1	18.3

Sources: GTAP model (using core base data VIFM, SSA)
Note: The table reads: 18.2 % of the imports of food (as intermediate goods) goes to the manufacturing sector.

Table 10. Decomposition of the allocative efficiency effects (million USD)

	Scenario 1	**Scenario2**	**Scenario3**
SSA			
Food	37	-98	46
Manufacturing	289	253	501
Service	553	514	649

Total	879	669	1196
EU			
Food	-176	-325	-243
Manufacturing	26.2	12.8	26.8
Service	-132	-140	-141
Total	-282	-453	-358
ROW			
Food	-116	-169	-140
Manufacturing	-54	-72.8	-66.6
Service	-244	-247	-260
Total	-415	-490	-467

Sources: GTAP model; author