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Public investment in irrigation and training for an agriculture-led development: a CGE approach for Ethiopia

(Revised version)

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Acronyms

ADLI	Agricultural development-led industrialization
AEZ	agro ecology zone
ATVET	Agricultural Technical and Vocational Education and Training
BAU	Business As Usual
CAADP	Comprehensive Africa Agriculture Development Programme
CGE	Computable General Equilibrium
CPI	Consumer Price Index
DAs	Development Agents
EDRI	Ethiopian Development Research Institute
FTCs	Farmer Training Centres
GDP	Gross Domestic Product
GOE	Government of Ethiopia (GOE)
GTP	Growth and Transformation Plan
HICES	Household Income Consumption and Expenditure Survey
MoFED	Ministry of Finance and Economic development
NBE	National bank of Ethiopia
PASDEP	Plan for Accelerated and Sustained Development to end Poverty
PIF	Ethiopia's Agricultural Sector Policy and Investment Framework
SAM	Social Accounting Matrix
SIM	Simulation

Abstract

Agricultural activities have been and remain key for sustained growth and pro-poor development in Ethiopia. However, the sector under utilizes its irrigation capacities as well as its abundant human resources. This paper aims at measuring the impact of public investment in small-scale irrigation and training for farmers on growth in the agricultural sector and the overall economy, on food security, and poverty in Ethiopia. It is line with the current five year development strategy of the government and will give insights on the attainability of selected targeted indicators. We use a dynamic Computable General Equilibrium (CGE) model to capture the outcomes of public investment shocks. Public investment is modeled in such a way that it increases the supply of skilled agricultural labor and the supply of irrigated land by transforming unskilled labor and non irrigated land. Two types of technologies are utilized in agriculture to produce the same crop: a more productive technology that is intensive in skilled labor and irrigated land and a less productive technology that is intensive in unskilled labor and non irrigated land. Households have the ability to increase their endowments in labor and land. Hence, the increase in skilled labor due to public investment in the form of short term training enables households to increase the share of skilled labor they detain while reducing the share of unskilled labor. The same applies for land. Finally, the model has a poverty module using a top-down approach where changes in the CGE model are imported in the household data. The CGE model is a PEP type model and is calibrated to a SAM of Ethiopia for the fiscal year 2005/06. The poverty module uses the 2005 Household Income and Expenditure Survey.

This exercise showed that the Ethiopian government policy strategy regarding agriculture sector development has a great potential for reducing poverty and food insecurity. Simulation results show that investing in training and irrigation contributes to the effort towards achieving the MDGs. Exports expand and in particular export of cash crops that generate higher income at household and national levels. The results also show that an agriculture-led development is less likely to occur because of weak forward and backward production linkages between agriculture and manufacturing sectors where a great deal of manufacturing inputs are imported. The increment in public investment has a crowding-out effect that affects the expansion of manufacturing and services sectors which are highly intensive in private capital. Financing such investment plans may require an alternative allocation of public resources or even a different financing mechanism.

Acknowledgment

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Introduction

Like many developing nations, Ethiopia's government goal is to alleviate poverty via accelerated and sustained economic growth. To attain this, the Government of Ethiopia (GOE) has designed a development strategy called Agricultural development-led industrialization (ADLI). The ADLI policy strategy has been implemented since 1993.

The objective of ADLI is to strengthen the linkages between agriculture and industry by increasing the productivity of small scale farmers, by expanding large scale private commercial farming, and by reconstructing the manufacturing sector in such a way that it can use the country's human and natural resources.

The rationale of ADLI is based on the idea that growth in agriculture will induce overall economic growth (through structural transformation) by stimulating supply and demand. On the demand side, expansion in agricultural activities would increase demand for industrial products (inputs and consumer goods) produced by domestic industries. On the supply side, the agriculture sector would supply food to domestic market, raw materials to industries and export products (Diao et al, 2007). In the ADLI framework the "key assertion is that the primary driver of demand for industrial output will be domestic, rather than foreign demand, based on first initiating growth in agriculture." (Dercon and Zeitlin 2009). This reflects the view that the process of industrialization should build on domestic inputs.

The implementation of ADLI has been supported by an important public investment program geared towards the agricultural sector. The trend of public spending in Ethiopia reflects a tremendous increase reaching Eth. Birr 46.9 Billion in Fiscal year 2007/08. Public spending has soared since the EFY 2006/07 which marks the beginning of the five-year development strategy, the Plan for Accelerated and Sustained Development to end Poverty (PASDEP). The PASDEP was designed to allow the GOE meet the MDGs and it upgrades and builds upon the ADLI strategy. Accordingly, it targets poverty-oriented sectors namely: education, health, agriculture and rural development and roads.

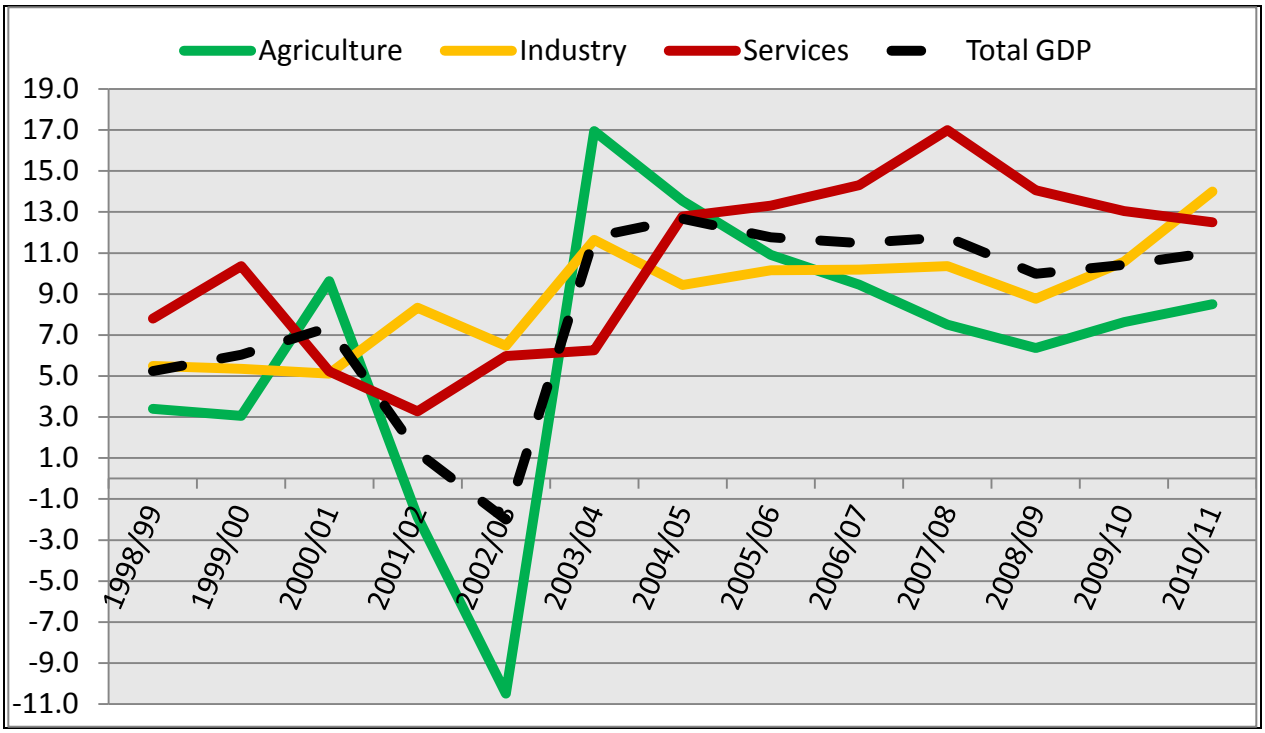
Stylized facts of the Ethiopian economy

Performance of the economy

The Ethiopian economy has been performing at a higher growth rate since 2003/04.,Real GDP has grown by 11.9% and 10.5% in 2003/04 and 2004/05 respectively. This has been sustained during the last five years too; overall real GDP has grown rapidly at an average of 11% per annum during the PASDEP period (2005/06-2009/10) (See Table 1. and Figure 1. below.).

During the last five years all sectors of the economy registered a significant growth. However the service sector grows tremendously, which makes the sector play the major role towards enabling the overall economy grows this fast. Agriculture, industry and service sectors have registered an average annual growth rate of 8.4%, 10% and 14.6%, respectively.

Figure 1. Trend in GDP (at basic prices) Growth by Economic Sector (%)

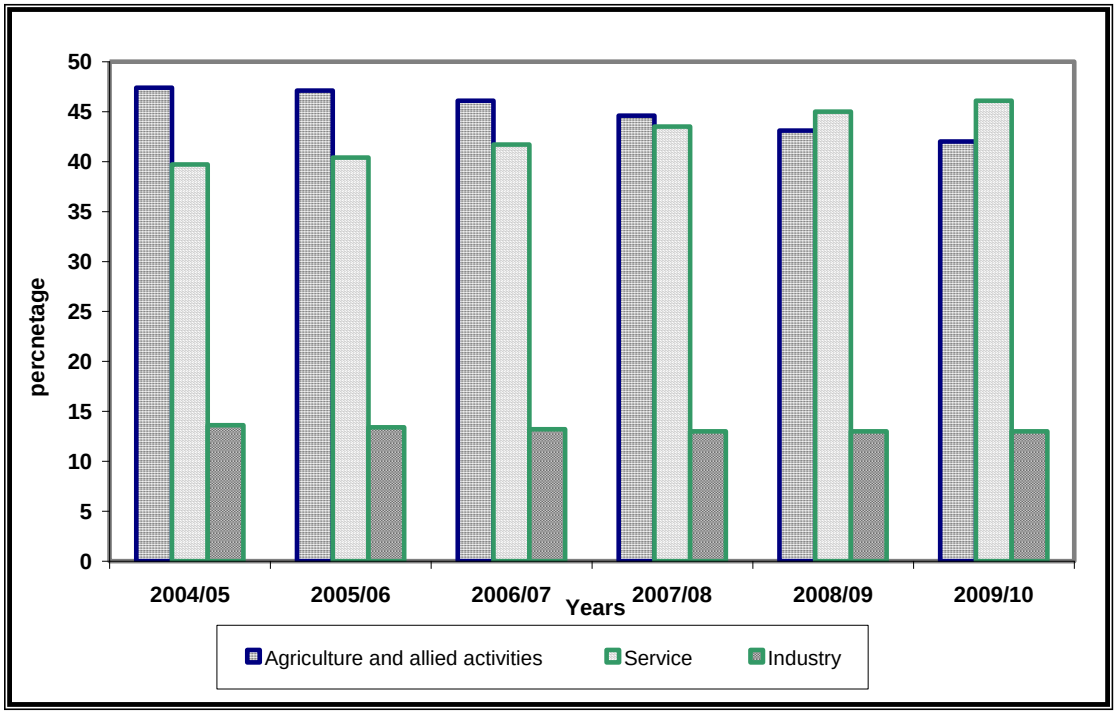


Source: Authors computation

The contribution (percentage share) of each of the three sectors (agriculture, industry and service) to overall GDP in 2009/10 was 41.6%, 12.9% and 45.5%, respectively (See Figure 2). In terms of structural change the decline in the agricultural sector's share of GDP was taken up by the service sector. Services achieved a higher share of GDP which makes the sector the major contributor to the country's GDP which is a different story for the agrarian economy.

With the construction, real estate, retail and wholesale trade, transportation and financial services being the major drivers, the service sector is becoming a significant source of the growth and has benefited from increased public investment (Figure 2 & 3). Government investment that has peaked during the period in nominal terms is one major contributor to service sector growth. The services sector is also emerging as a source for exports (tourism and air transport).

Figure 2. Percentage share of GDP by Economic Sector



Source: MoFED 2010

On the demand side, GDP growth is attributable to both consumption and investment increases. Significant public investments have been made to support the expansion of economic and social infrastructures, primarily roads, telecommunication infrastructures, hydroelectric dams, and health and education facilities.

Agriculture sector, its role and performance

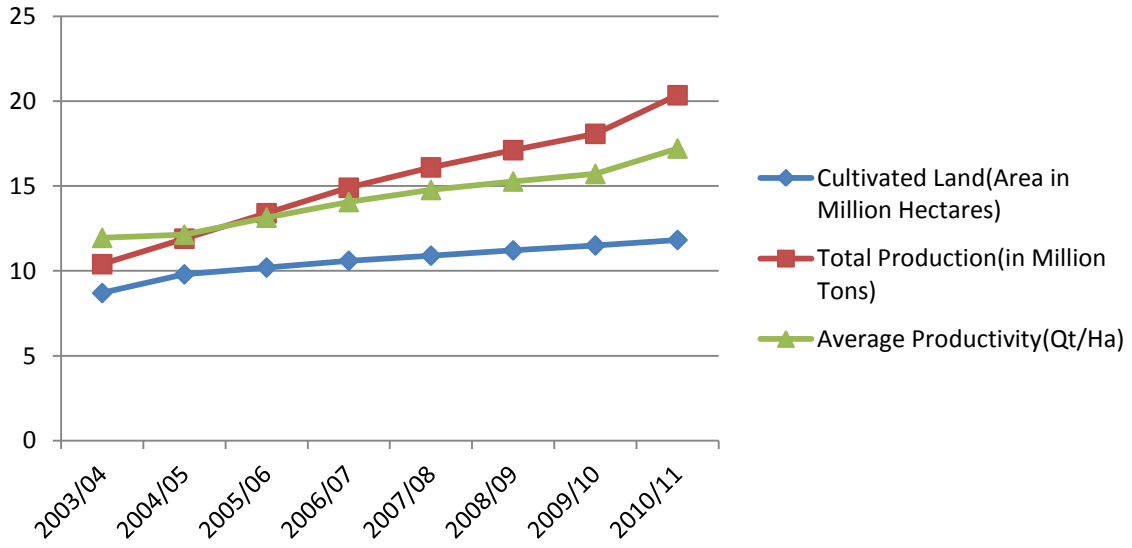
Agriculture is the mainstay (back bone) of the Ethiopian economy. Looking at the sector's role to the economy, the agricultural sector contributes up to 41.6 % of GDP and 82 % of export (MoFED and NBE). Even if it remains the major sector to the economy regarding export earnings, there has been increased diversification in the export volume in recent years. Coffee, which contributed 70% of export earnings some decade ago, now contributes less than 40%, while flower, leather, oilseeds and pulses, gold and chat have become increasingly more important, each contributing about USD 50 million per year. Despite the change in role, the diversification remains within the sector.

Even though, agriculture is the backbone of the Ethiopian economy, its production and productivity has long been unsatisfactory. The overall GDP is highly influenced by trends in the agricultural sector. The rate of growth of agricultural production has constantly been lagging behind the rate of growth of the GDP and the rate of growth of population. The country has not for the large part been able to produce enough food to feed its population because of the poor performance of the agricultural sector.

Ethiopian agriculture sector is characterized with its backward technology and dominance of small holder farmers with subsistence mode of production.

Despite the implementation of ADLI for the last 18 years, the rate of return of the agricultural sector remains relatively low and production is growing unsatisfactorily and it is still heavily dependent on weather conditions. Even though it is not sufficient the sector is growing with a rate, which by pass by far the CAADP target of 6% (CAADP, 2009). Average productivity was 12 quintal per hectare of land before the PASDEP period and it showed a slower improvement and reached 15.7 at the end of PASDEP (2009/10). In fact, with a special attention of the government it exhibited faster progress during the first year of the GTP. The productivity gains are to a large extent due to the expansion in cultivated are and favorable climate with a minimal role of improved technology. Area cultivated is more or less increasing at a constant rate through the period from 2004/05 to 2010/11. Total harvest has been increasing at a little bit decreasing rate during 2003/04 – 2009/10. The growth rate showed faster pace during 2010/11.

Figure 3 Performance of Ethiopian agriculture sector (2003/04-2010/11)

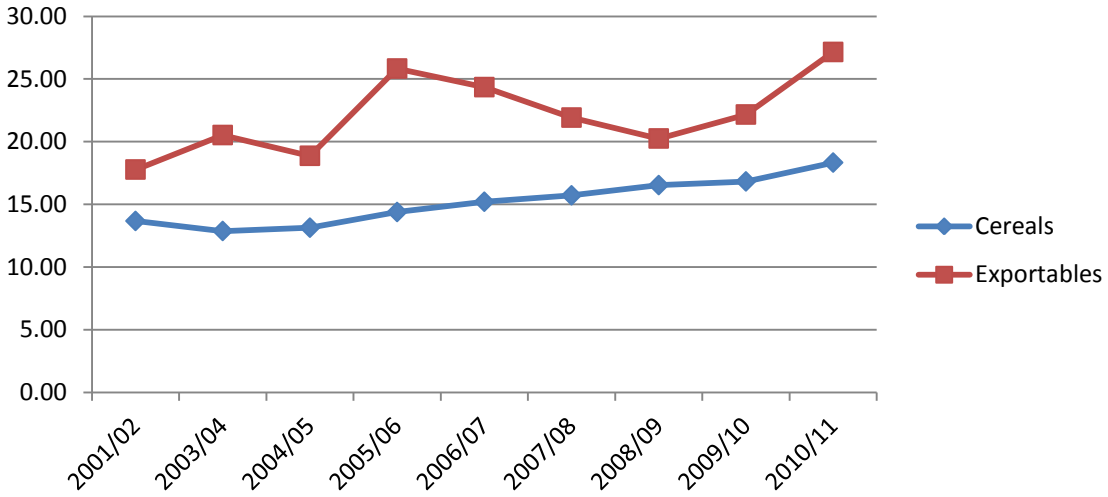


Source: CSA data with authors computation

Regarding poverty, the food poverty head count decreased from 42% in 1999/00 to 38% in 2004/05 and brought down to 33.6% 2010/11) (MoFED, 2012). The per capita grain production increased from below 1.5 quintal in 2003/04 to 2.13 in 2007/08.

When we look at detailed performance of crop types exportable crops are performing well as compared to cereals. Average productivity of exportables has been higher for all the years displayed in figure 4. Cereals' productivity has been increasing more or less at a constant rate but that of exportables decreased from 2005/06 to 2008/09 and has been increasing at a faster rate than that of cereals especially in the recent years. This shows that besides staple foods exportables need government's attention for the economy benefit more from their enormous potential.

Figure 4 Average productivity by crop type



Source: Authors' computation

Despite these achievements the GOE has made poverty and hunger reduction its top priorities. It recognizes much has to be done in the agriculture sector to tackle these problems. Generally, the agriculture sector has been growing slower. The main reasons for the slower growth of production and productivity of the sector could generally be put as follows:

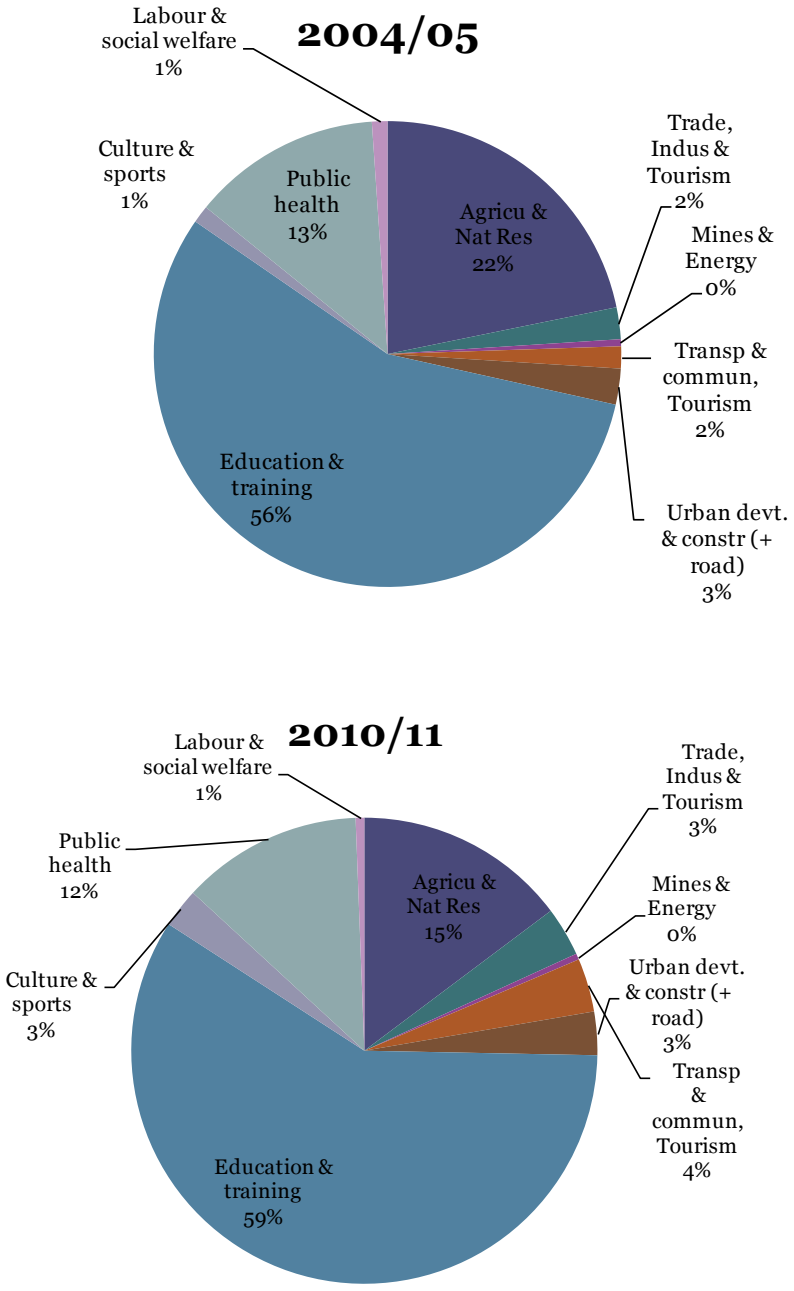
i. Limited access to modern agricultural inputs (chemical fertilizers, insecticides, pesticides, high yielding seeds, farm machinery) and advanced methods of farming.
ii. Limited extension services and also lack of proper know-how of agro-technical means, which could increase productivity.
iii. Inadequate and underdeveloped economic infrastructures including transportation and communication facilities have been serious impediments to the development of the sector.
iv. Lack of proper marketing and financial facilities and services.
v. Shortage of trained manpower in the rural areas and very low level of utilization of the irrigation potential of the country.

Having this in mind government of Ethiopia pays attention to this sector which is the back bone of the economy. The agriculture sector benefits from a significant amount of public investments. The agriculture sector budget which was Birr 6.8 Billion (including both recurrent and capital) by 2008/09 is expected to be Birr 7.3 Billion by 2010/11 and Birr14.7 Billion by 2014/15, and Birr29.5 Billion by 2020. This means it is expected to be more than tripled by 2020. In line with ADLI the agriculture sector budget ratio from GDP is to increase at a decreasing rate during the next 10 years.

Sectoral shares of total recurrent expenditure are provided in Figure 5 below. It is clearly visible that education is getting the larger share of government recurrent expenditure in both years, Agriculture and

natural resources' share of the budget declined from 22% in 2004/05 to 17% in 2020/11. However, shares of almost all the other sectors have not been significantly changed.

Figure 5 Share in recurrent expenditure

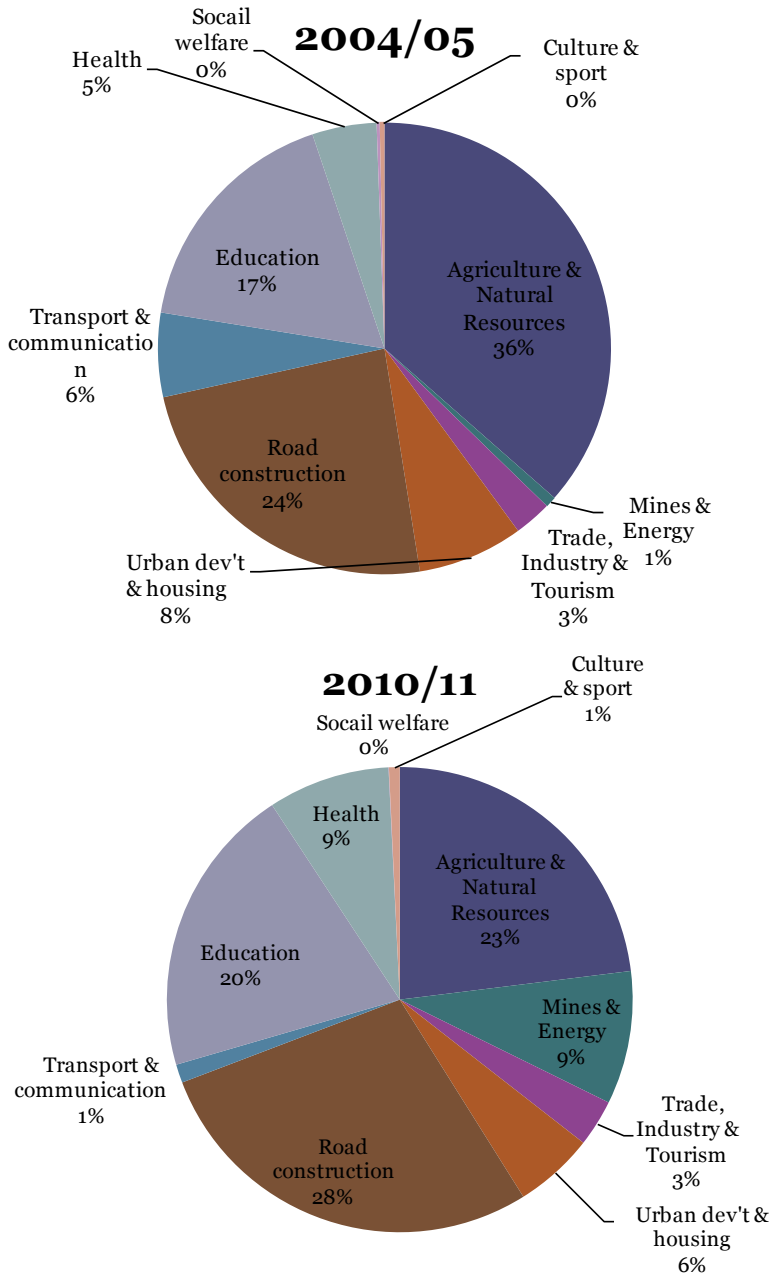


Source: Authors' computation

There has been a boom in public capital expenditure since the early 2000's. Besides, there are changes in the sectoral shares. Agriculture got the highest share in 2004/05 but road construction takes over the highest share in 2010/11. The road construction sector is believed to be one of the key areas that could

contribute to agricultural development through a better access to markets and lower transaction and transport costs. Agriculture and natural resources still get significant amount of the budget. The other sector which gets greater attention is education whose share of capital investment increased from 17% 2004/05 to 20% in 2010/11.

Figure 6 Share in Capital Expenditure



Source: Authors' computation

When allocating the capital budget for agriculture and natural resources, proposed budget estimates for the next 10 years (2010-2020) is to allocate 31, 48, and 21 percent of the capital budget for natural

resources, agricultural development (farm income improvement pillar), and agricultural marketing interventions, respectively.

The four focal areas which are considered as lead pillars or subsector indicators has been set. These are
- Increasing productivity and production;
- Establishing modern agricultural marketing system;
- Strengthening sustainable natural resource development, conservation and utilization, and
- Strengthening disaster risk management.

With this in mind the government is working on increasing productivity and production using a strategy of scaling up best practices of model small farmers, and also striving to intensify the use of water and natural resources with priority to small scale irrigation schemes.

Currently, the government is giving more emphasis to irrigation by way of enhancing the food security situation in the country. Irrigation development measures were taken to put in place small, medium and large scale irrigation schemes. Efforts are being made to involve farmers progressively in various aspects of management of small-scale irrigation systems, starting from planning, implementation and management aspects, particularly, in water distribution and operation and maintenance to improve the performance of irrigated agriculture.

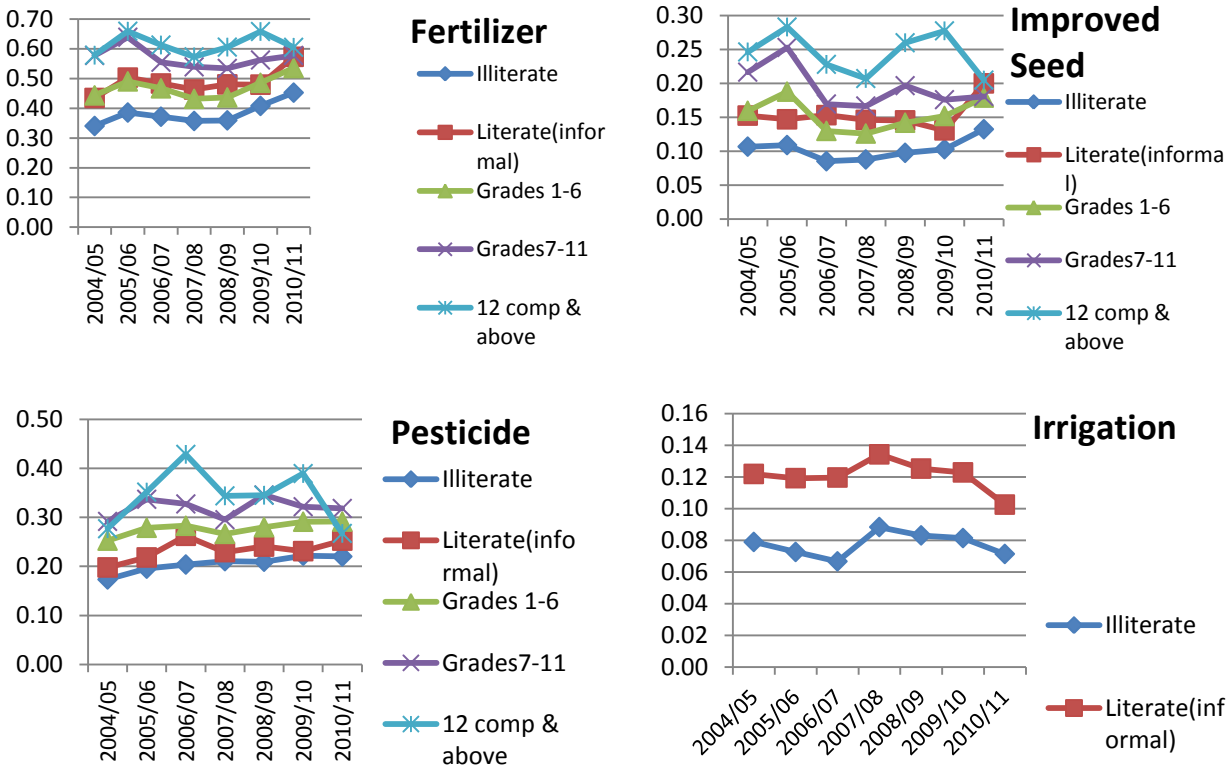
It was planned to develop 58,750 hectares by establishing 470,000 water harvesting schemes and small irrigation systems; by the end of the plan period 122,430 hectares of land were developed by these means. During the PASDEP period, 853, 000 ha of land serviced by small scale irrigation systems was developed well in excess of the target of 487,000 ha (MoFED, 2010).

Towards increasing production and productivity, the other major strategy government giving due emphasis is agricultural extension service: during PASDEP 52,023 graduates had completed training in the fields of plant, animal and natural resource sciences and cooperatives development to support the agricultural extension services, at agricultural and vocational training colleges. In the same period government managed to increase the number of minimum package trainees to 12.7 mln. Household family package trainees increased to 5.4 mln, which is higher than the planned target by 12.5% and the number of farmers training centers increased by 9,265. The necessary equipments were also supplied for these newly built training centers. With these, it is clear how much government pays attention to farmers' education and towards educating extension workers.

Theoretically and empirically it has a strong logical ground that the more educated the farmers are, the more likely they are to adopt improved technology. Actually this holds true for Ethiopia looking at the data from 2004/05 to 2010/11. For adoption of fertilizer, improved seed and pesticide farmers who got education up to 12 and above are adopting the best and the next best educated, grades 7-12, are adopting the next best. Illiterate farmers are more attached to back ward technology and are more-off risk- averse, so that their adoption of improved technology is poor as compared to the other educated

farmers. The same is true for adoption of irrigation; the literate farmers are adopting irrigation more than the illiterate farmers.

Figure 7 - Adoption of improved technology by education level



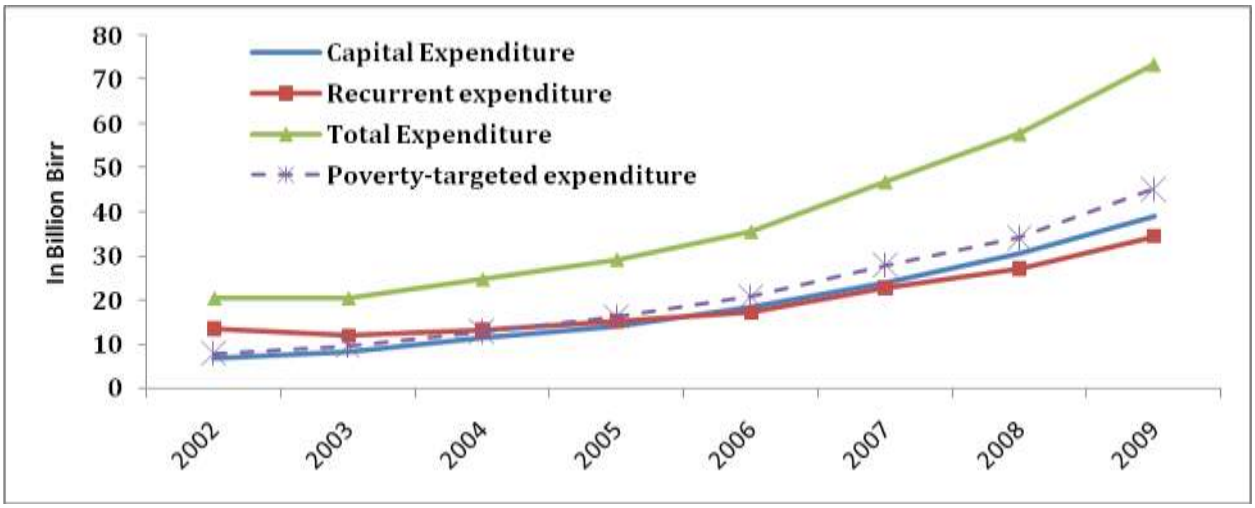
Source: Authors' computation

Despite unprecedented economic growth reported over the past consecutive five years, Ethiopia remains one of the most food insecure countries in the world (WDI, 2009).

Public investment in pro poor sectors

In line with the PASDEP, poverty-oriented sectors accounted for 46% of current and over 80% of capital expenditure in EFY 2007/08 (Figure 1). Poverty targeted expenditure constituted 46.6 % of the recurrent expenditure in 2007/08 showing an increase of 36.3 % compared to the previous fiscal year; and 80.5 % of the capital expenditure, witnessing a 33.3 % increase compared to fiscal year 2006/07 (MoFED, 2009). Investment in agriculture and food security and education sector took the lion's share. For the last four years, poverty-oriented public spending has amounted more than 60 % of public spending.

Figure 8: Trend of pro-poor public spending



Source: MOFED Annual Progress Report 2007/08

When considering all economic and social sectors, the Fiscal Year 2006/07 marks a boom in capital expenditure in the services sector, mainly in road construction, transport and communication, urban development and housing (Figure 2).

In addition to these facts, there is currently a debate on whether Ethiopia should continue on its current Agricultural development led industrialization strategy or if it should make adjustments to its growth approach.

On the one hand, Mellor and Dorosh (2009) argue that "A high rate of agricultural growth has far-reaching positive implications for economic development of low-income countries in terms of increasing employment and accelerating poverty reduction. High agricultural growth also helps avoid the creation of mega-cities with large slum populations. In order to achieve this rapid agricultural growth with positive economy-wide linkages, however, it is necessary to engage "middle farmers", large enough to adopt new technologies and produce significant marketed surpluses, but small and numerous enough to have spending patterns that drive a vibrant rural non-farm sector. Finally, public and private investments in road, electricity and telecommunications are also needed to reduce marketing costs and enable growth in rural market towns and secondary cities." Their argument noted that for agriculture to be driver of the economy farmers required to be "middle farmers", unlike Ethiopia's concentration of small scale farmers with less new technology adoptive capacity. They have also noted that Agricultural led industrialization requires high levels of government spending. In line with their argument, Ethiopia's government has been allocating high proportion of public resources towards agriculture through its pro-poor spending strategy.

On the other hand, Dercon and Zeitlin (2009) noted that with modest consumption linkages agricultural innovation will not suffice to drive growth in industry. "More positively, the increasing frequency of trade 'in tasks' suggests that it may not be necessary for Ethiopian agriculture to be oriented toward the supply of raw materials for industry, nor for all industrial energies to focus on the processing of

domestic raw materials. However, the most effective policies to stimulate growth may be those that strengthen domestic and international linkages," Dercon and Zeitlin (2009).

In light of this, the paper attempts to test empirically the outcomes and sustainability of ADLI policy strategy through an increase in public investment keeping in mind the main objectives of the ADLI-PASDEP policy: food self-sufficiency, rapid and sustainable growth, and poverty reduction.

Agricultural activities have been and remain key sectors for sustained growth and pro-poor development. The sector underutilizes its irrigation capacities as well as its abundant human resources. There is therefore room for remarkable progress in the sector. Some demonstration projects in the country using irrigation and water harvesting schemes have proven to be very efficient in increasing land productivity and output. Provision of short trainings to farmers on a more efficient utilization of the inputs has proven to increase productivity and output in other demonstration projects.

General objective

The project will answer the following question: How can Ethiopia's overarching development strategy outlined in ADLI and upgraded in PASDEP and GTP be met through a reallocation of public resources?

Specific objectives

More specifically, the study will assess the impact of public investment in small-scale irrigation and training for farmers on growth in the agricultural sector and the overall GDP, on food security, and poverty.

The SAM

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The CGE model used in this analysis is calibrated on a social accounting matrix (SAM) of Ethiopia, based on 2005/2006 data was built by the Ethiopian Development Research Institute (EDRI). The EDRI 2005 SAM distinguishes 47 activities (14 agricultural, 20 manufacturing and 13 services) producing 69 commodities (25 agricultural, 30 manufacturing and 14 services). There are 5 primary factors of production (agriculture labor, non agriculture labor, agriculture capital-land, livestock capital, non agriculture capital). Non agriculture labor is also disaggregated by occupational category (administrative, professional, unskilled and skilled). There are 4 aggregate household groups: rural and urban, and by poverty level: poor and non poor that become 6. The SAM has 17 tax accounts as well as aggregate accounts for trade margins, transport margins, government, investment, and the rest of the world.

The SAM required aggregation and disaggregation work to correspond to the needs of the study and modeling requirements. In addition, the SAM has been updated until 2009/10 to reflect to the extent possible the macroeconomic situation during that period. The value of the GDP for 2009/10 at constant market price was taken as a reference. Information was taken from the National Bank of Ethiopia (NBE) and the Ministry of Finance and Economic Development (MOFED) data. The following were taken as benchmarks to update the SAM using their shares in the 2009/10 GDP:

- Agricultural GDP: 42%
- Manufacturing GDP: 13%
- Imports: 33%
- Exports: 13.6%
- Gross fixed capital formation: 22.3%
- Private final consumption: 86.1%
- Tax revenue: 11.3%
- Current net income and transfers: 8.3%
- Current account Balance: 30%

To update the SAM, the first step consisted in expressing all the values in the sum as a share of the total of rows and columns. The next step consisted in scaling up the GDP at purchaser price in the SAM to its value in 2009/10 as this is the only reference utilized to update the indicators above. The third step consisted in incorporating one by one the above indicators by introducing them through constraining equations. The optimization process is run at each step making sure that there is a solution and the new SAM is balanced.

Furthermore, agricultural labor and land have been disaggregated using data from the 2011 Agricultural Sample Survey. Agricultural labor was disaggregated by skill between skilled and unskilled labor. Skill was defined using five proxies: use of improved seeds, use of fertilizer, use of irrigation, use of extension services and literacy rates. To disaggregate land between irrigated and non-irrigated land types, the same survey was utilized combined with information from the Ethiopia's Agricultural Sector Policy and Investment Framework (PIF) 2010-2020. All the data shows that a very small share of agricultural land is irrigated although the potential is high for irrigation practices. Similarly, the share of skilled labor is very low.

The following presents major characteristics of the 2009/10 SAM.

Value added is labor-intensive in agricultural sectors (75.2%) while manufacturing and services sectors are intensive in capital (61.9% and 77.8%). Agricultural labor and land are only employed in agricultural production. Non agricultural capital is employed by manufacturing and services sectors and livestock capital is only utilized in agricultural production. Overall value added is intensive in labor (48.5%) followed by capital (44.9%).

Table 1-Structure of value added

	Agriculture	Manufacturing	Services	Total
Agricultural labor	75.2%	0.0%	0.0%	34.1%
Non agricultural labor	0.1%	38.1%	22.2%	14.4%
Land	14.4%	0.0%	0.0%	6.5%
Capital	10.2%	61.9%	77.8%	44.9%
Total	100%	100%	100%	100%
	Agriculture	Manufacturing	Services	Total
Agricultural labor	100.0%	0.0%	0.0%	100.0%
Non agricultural labor	0.5%	37.0%	62.5%	100.0%
Land	100.0%	0.0%	0.0%	100.0%
Capital	10.3%	19.3%	70.4%	100.0%
Total	45.3%	14.0%	40.6%	100.0%

Within agricultural activities, cereal crop, pulses and oil seeds, vegetable and fruit and forestry and fishing production is relatively more intensive in labor with over 82% of value added. Cash crops, coffee, enset and livestock farming are relatively less intensive in labor and more intensive in land (42%).

One third of agricultural labor is concentrated on cereal crop sectors as well as 35% of land which produce 30.8% of agricultural output. These sectors are important as they are the key to ensuring food security and price of food. Cash crops concentrate 29.5% of agricultural labor and use 65% of land producing 31.6% of agricultural output. These sectors play an important role are most of these products are destined for the export market. The livestock sector is important as it concentrates alone 27.6% of agricultural labor, 32.2% of non- agricultural labor and 91.7% of agricultural capital producing 27.3% of output in the agricultural sector. It is the sector that finished and semi-finished goods destined to be exported such as meat and meat products and leather.

The following table presents the disaggregation of agricultural labor by skill and land by use of irrigation or not.

Table 2 - Disaggregation of agricultural labor by skill and land by use

	Teff	Barley	Wheat	Maize	Sorghum	Pulses	Vegetables and fruit	Oil seeds	Cash crops	Enset	Crops	Coffee	Livestock farming	Forestry & fishing	Total
Skilled Agri. labor	18.9	18.9	21.5	20.5	15.6	15.8	20.7	16.4	16.7	15	18	16.5	15	15	17
Unskilled Agri. labor	81.1	81.1	78.5	79.5	84.4	84.2	79.3	83.6	83.3	85	82	83.5	85	85	83
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Irrigated land	5.3	5.7	5.4	7.3	6.1	5.3	22.9	5.2	5.1	5	5.2	8.1			6.8
Non irrigated land	94.7	94.3	94.6	92.7	93.9	94.7	77.1	94.8	94.9	95	94.8	91.9			93.2
Total	100	100	100	100	100	100	100	100	100	100	100	100			100

Overall skilled agricultural labor represents 17% of total agricultural labor while the remaining is unskilled as it does not utilize improved seeds, fertilizer, and irrigation nor extension services and is illiterate. Vegetables and fruit, wheat and maize production are relatively more intensive in skilled agricultural labor.

The share of irrigated land in agricultural production is very low averaging 6.8%. Vegetables and fruit production is relatively more intensive in irrigated land reaching 22.9% followed by coffee and maize. Cereal crop producing agricultural sub-sectors concentrate 35.7% of skilled labor and 26.5% of irrigated land. Cash crop sub-sectors concentrate 33.6% of skilled labor and 73.5% of irrigated land.

Value added is combined with intermediate consumption of goods and services to produce sector output. As reflected in the table below, agriculture is intensive in value added and uses little intermediate consumption. The manufacturing sector is relatively more intensive in semi finished and finished goods and services as intermediate inputs. In contrast, the services sector is intensive in intermediate inputs.

Table 3 - Shares in output

Share in output				
	Agriculture	Manufacturing	Services	Total
Value added	87	62	47	62
Intermediate Consumption	13	38	53	38

Regarding the nature of these intermediate inputs, agriculture uses 47% of agricultural products, 37% come from manufacturing essentially composed of fertilizers and chemicals. It also uses services mainly financial services. The manufacturing sector uses 62% of manufacture products, 23% of agriculture products and 15% of services. 70% of agricultural inputs is demanded by agro processing industries. The services sector uses 50% of its intermediate inputs from the manufacturing sector and 44% from the services sector.

Agriculture produced 32.3% of total output. Its share in GDP is 40.9%. it represents 39.4% of exports and 41.7% of household consumption. The manufacturing sector is highly dependent on imports as 56% of total domestic supply is imported (manufacturing products represent 69.4% of imports) while only representing 17.1% of GDP and 14.4% of output.

Table 4 – Sectoral shares in GDP, output, exports, imports and household consumption

	Agriculture	Manufacturing	Services	Total
GDP	40.9	17.1	42	100
Output	32.3	14.1	53.6	100
Exports	39.4	21.2	39.4	100
Imports	4.6	69.4	26.1	100
Household consumption	41.7	34.7	23.7	100

The services sector is the most important in terms of share in GDP, share of total output and share of exports. Its share in total household consumption is relatively low amounting 23.7%.

Export intensity is low averaging 9.1%. 11.1 agricultural products are exported although they represent nearly 40% of total exports. Services are exported to 6.7% representing 39% of total exports and manufactured products to 13.7%. Import penetration amounts nearly 20% of total domestic supply with manufacturing products reaching 56% while agricultural products are mainly locally supplied with only 4% of imports.

63.4% of income from skilled agricultural labor is distributed to non poor rural households and the remaining to poor rural households. The share of the two households is similar regarding unskilled agricultural labor. non agricultural labor is distributed among urban households. 15.7% of irrigated land and 10% of non-irrigated land income is distributed to poor rural households. The remaining goes to non-poor rural households. Livestock income is distributed to the two rural households (respectively 32.6% and 67.4%). Non-poor rural households receive 60% of non-agricultural capital. The remaining is mainly distributed between public firms (10.8%), non-poor households in small urban settlements (13%) and poor rural households (7.3%).

Table 5 - Income composition of the different institutions

Accounts	Skilled Agri. labor	Unskilled Agri. labor	Admin & Prof labor	Unskilled n-a lab	Skilled n-a labor	Irrig. land	Non-irrig. land	Livestock	Non-agri capital	Transfers	Taxes	Total
Public firms									99.9	0.1		100
Government										19.1	80.9	100
Poor rural households	11.6	55.7	1			0.4	3.3	7.6	16.2	4.3		100
Non-poor rural households	6.6	32.8	1.7			0.7	9.9	5.2	41.1	2		100
Poor households in small urban settlements			6.8	20.3	51				8.2	13.7		100
Poor households in large urban settlements			15.8	8.4	46.5				10.9	18.3		100
Non-poor households in small urban settlements			9.6	7.5	31.3				43.9	7.7		100
Non-poor households in large urban settlements			10.4	4.2	35.7				29.6	20.1		100
Rest of the World									4.4	22.6		27

For households, the most important source of income is labor income. Land income is low representing 3.7% for poor rural households and 10.6% for the non-poor rural. Its share is much less than livestock income (7.6% and 5.2%). Non-agricultural capital represents 16.2% and 41.1% of poor and non-poor rural households. Public firms earn almost all their income from non-agricultural capital. 80.9% of government income comes from taxes while the remaining is from transfers. The rest of the world income is composed of return to capital (4.4%), transfers (22.6) and exports (73%).

In regards expenditure, households spend a bulk of their income on consumption of goods and services. Government account is in deficit implying that public investment is financed through loans and grants.

Table 6 – Expenditure of institutions

Accounts	Public firms	Government	Poor rural households	Non-poor rural households	Poor households in small urban settlements	Poor households in large urban settlements	Non-poor households in small urban settlements	Non-poor households in large urban settlements	Rest of the World
Transfers	30.9	92.6						8	3.6
Taxes	19.1		0.3	0.2			12.1	11.2	
Consumption of G&S		59.4	96.2	97.6	97.6	95.4	86.3	77.1	30.1
Savings	50	-52	3.6	2.2	2.4	4.6	1.6	3.7	66.3
Total	100	100	100	100	100	100	100	100	100

Public firms invest half of their income and spend the rest on transfers and taxes. The current account balance is positive despite a trade deficit reaching 20% of GDP.

This section presented the major structure of the SAM. This structure will shape an important part of the simulation results.

The CGE Model

The study uses a dynamic computable general equilibrium (CGE) model. Major features of the model are presented in the following.

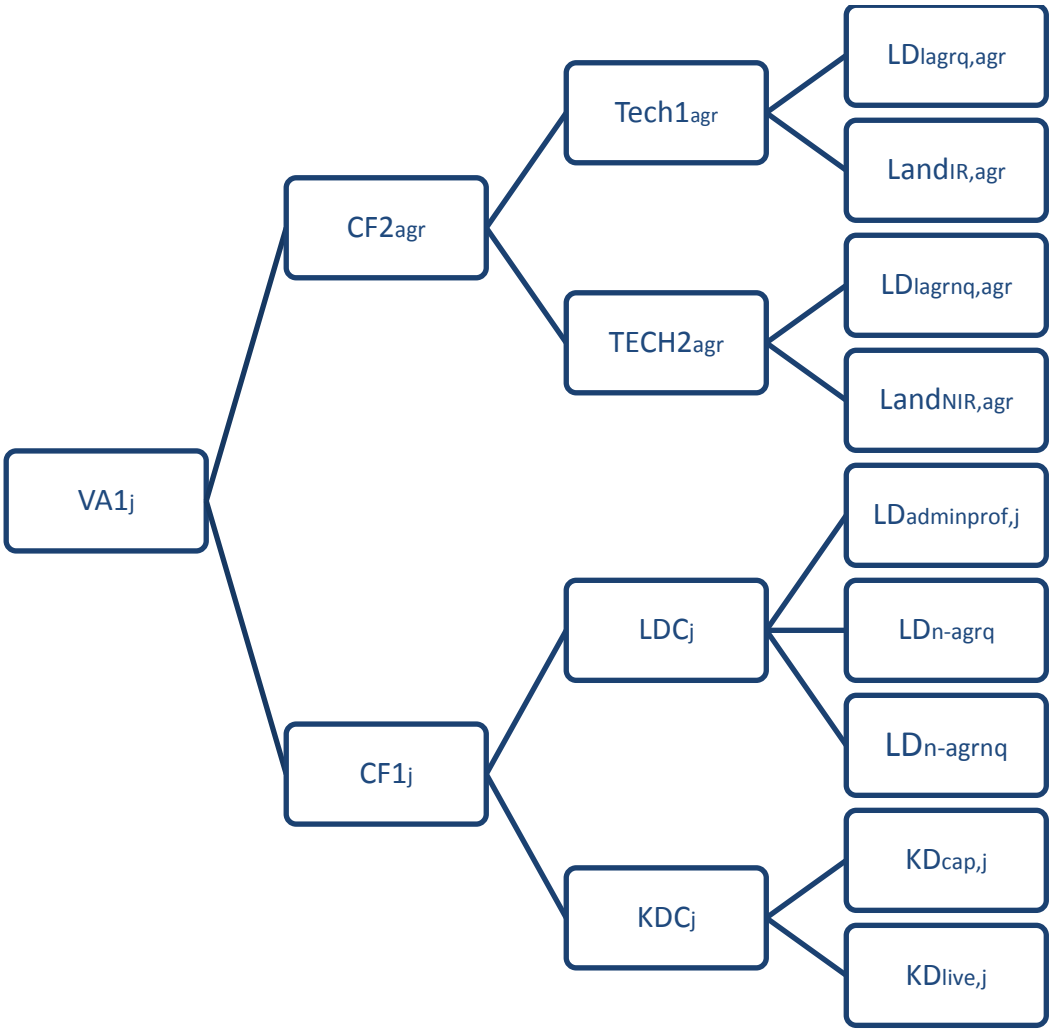
The CGE model used in this study follows the sectoral and socioeconomic structure of the SAM described in the previous section. This study uses an adapted version of the standard CGE model presented in Decaluwé, Martens and Savard (2001) and PEP standard CGE model presented in Decaluwé et al (2009).

Our model runs on a dynamic basis enabling the evaluation of long-term impacts. We use a sequential dynamic model, to evaluate long-term impacts. The model will work in such a way that in each step or period, the stock of capital is accumulated and investment is allocated by sectors of destination following adapted specification for our case. The model runs for a period of 10 years starting from 2009/10 where the year 2015 is an important reference. 2015 marks the deadline for the attainment of the MDGs but also marks the end of the GTP, which will be implemented from EFY 2010/11 to 1014/15. The tenth year time line corresponds with the end of Ethiopia's Agricultural Sector Policy and Investment Framework (PIF) 2010-2020.

The static standard model structure

Production - The production function in the model is a three level constant elasticity of substitution (CES) function. At the lowest level, skilled agricultural labor and irrigated land are aggregated into a more productive composite factor. In parallel, unskilled agricultural labor is combined with non-irrigated land into a less productive technology. Non-agricultural labor is also combined into a composite labor and the same for capital. To reflect the fact that the use of irrigation techniques requires skilled agricultural labor, the substitution elasticity is set at 0.3. Non-irrigated land is combined with unskilled agricultural labor with a low elasticity of substitution as well of 0.8. At the intermediate level, we aggregate the high productivity composite factor with the lower productivity composite factor with a substitution elasticity of 1.5. In a similar approach, composite non-agricultural labor and composite capital are combined into a composite non-agricultural factor with a substitution elasticity of 1.5. The production function has an upper level which combines the latter with the composite agricultural factor with a substitution elasticity of 1.5. Finally, value added is combines in fixed proportions with intermediate inputs to make gross output.

Figure 9 -Structure of value added – three-level nested CES structure



VA_j	Value added in industry j
$CF1_j$	Composite factor in industry j
$CF2_j$	Composite factor in agricultural sectors
$Tech1_{agr}$	Technology 1 combining skilled agricultural labor and irrigated land in agricultural sectors
$Tech2_{agr}$	Technology 2 combining unskilled agricultural labor and non-irrigated land in agricultural sectors
LDC_j	Industry j demand for composite non-agricultural labor
KDC_j	Industry j demand for non-agricultural capital and livestock capital
$LD_{lagrq,agr}$	Demand for skilled agricultural labor by agricultural sectors
$LD_{lagrnq,agr}$	Demand for unskilled agricultural labor by agricultural sectors
$Land_{IR,agr}$	Demand for irrigated land by agricultural sectors
$Land_{NIR,agr}$	Demand for non-irrigated land by agricultural sectors
$LD_{adminprof,j}$	Demand for administrative and professional labor by industry j
$LD_{n\text{-}agrq,j}$	Demand for non-agricultural skilled labor by industry j
$LD_{n\text{-}agrnq,j}$	Demand for non-agricultural unskilled labor by industry j

Trade - The treatment of trade in the model is standard. We assume that the relationship between the rest of the world and the domestic economy is determined by an imperfect substitutability between imported and domestically produced goods and services on the consumption side (Armington hypothesis). Likewise, local producers divide their output between the home and export markets; the shares vary with the ratio of domestic prices to exports process. Thus, allocation between domestic and foreign markets for demand and supply respond to relative prices of foreign goods defined by exogenous international (import and export) prices, the real exchange rate and the local tax levels. Price elasticity of the world demand for exports of product is set at 2.

Factor market - To capture existing differences in labor markets, the model classifies employed labor into different sub-categories, including skilled and unskilled workers based on occupational categories. There are a total of 4 labor categories: Agricultural labor, Administrative workers and Professionals, Unskilled workers, and skilled workers. Agricultural labor is further disaggregated between skilled and unskilled farmers. This is important as the rationale behind an increase in investment in training for farmers (directly or through DAs) is that unskilled agricultural farmers will be enabled to acquire skill through training and thus transform from unskilled to skilled farmers (with higher productivity and thus higher wages). The model is calibrated in such a way that skilled agricultural wages are 30% higher that the unskilled enabling a level of skilled agricultural labor wages always higher than that of the unskilled even when the former fall. There are four labor markets corresponding to the four labor categories. Labor supply is fixed and wages adjust to changes in demand maintaining full employment. Agricultural labor is only employed in agriculture production and is mobile across agricultural sub-sectors.

Land is specific to agricultural production but can move freely across agricultural subsectors implying a shift in the type of crop produced (crop substitution). Each agricultural activity utilizes two types of land: irrigated and non-irrigated and there is a possibility to transform non-irrigated land into irrigated land through public investment in irrigation schemes. The model is calibrated in such a way that return to irrigated land is 11.5% higher than that of non-irrigated land. Non agricultural capital is sector specific.

Public investment in training and irrigation

Public investment, like private investment, is introduced in such a way that it increases the volume of capital. Total investment is the sum of both and an increase in public investment can have a crowding out effect.

Training will enable the production of skilled farm labor. Indeed, public investment in the form of the provision of free short term training for farmers combined with less skilled farm labor will enable the production of skilled/trained farm labor. In the case of irrigation investments, a combination of non-irrigated land with public investment capital for irrigation will allow the production of irrigated land.

In our model, public investment in training enables the increase in the supply of skilled agricultural labor by transforming the unskilled labor. As agricultural labor supply is fixed, the supply of unskilled

agricultural labor decreases while skilled agricultural labor increases. The same applies for land where public investment in irrigation enables the transformation of non-irrigated land into irrigated land.

Total agricultural labor supply (LST) is the sum of skilled $LS_{lagrq,t}$ and unskilled $LS_{lagrnq,t}$ agricultural labor supply. Skilled agricultural labor supply is fixed and grows with the population rate and public investment in training $IND_{cap,aeduc,t}$. Training is provided for free by government agents or in farmer training centers and does not have an opportunity cost.

$$LST_t = LS_{lagrq,t} + LS_{lagrnq,t}$$

$$LS_{lagrq,t} = LS_{lagrq,t-1}.pop_t.\left[\frac{IND_{cap,aeduc,t}}{IND_{cap,aeduc,t-1}.pop_t}\right]^{\sigma\_aeduc}$$

σ_aeduc is the elasticity of skilled labor supply to changes in public investment. It is set at 2.5. Unskilled agricultural labor supply is endogenously determined as the residue between total agricultural labor and skilled agricultural labor. The latter are both fixed and grow at the population growth rate.

Public investment in irrigation, $IND_{landir,j,t}$, increases the level of irrigated land, $KD_{landir,j,t}$, at agricultural sub-sector level. This is interesting as it enables to differentiate public investment in irrigation in food crops essentially destined for the domestic market and cash crops which are export intensive.

$KD_{lanir,j,t} = KD_{landir,j,t-1}.1 - delta_{landir,j,} + IND_{landir,j,t-1}{}^{\sigma\_ir}$

σ _ir is the elasticity of irrigated land supply to changes in public investment. It is set at 1.25. Sector level land capital is the sum of irrigated and non-irrigated land types. Land is mobile across agricultural sub-sectors. There is therefore possibility for crop substitution. Non-irrigated land, $KS_{landnir,t}$, is determined residually. It is the difference between total land supply (SLAND) which is fixed and increases with population growth and irrigated land, $KS_{landir,t}$, which increases through public investment and population growth.

$$KST_{j,t} = KD_{landir,j,t} + KD_{landnir,j,t}$$

$$SLAND_t = KS_{landir,t} + KS_{landnir,t}$$

Endogenous household endowments

In a standard CGE model, households maintain fixed endowments in land, labor and capital. Our modeling approach will assume that households' endowments in labor (trained/skilled and untrained) and in land (irrigated and non-irrigated) is endogenous. As a consequence, the model will allow

households to modify their factor endowments in land type and labor type. Households can modify, by getting training (by getting public capital for irrigation), the proportion of skilled/trained and unskilled labor (irrigated and non-irrigated land) they detain. It is to be noted that households do not have a demand function for getting training. We assume that receiving training does not have direct or opportunity costs at the household level.

Each household supplies ($LSTH_{h,t}$) a fixed share ($\theta 1_h$) of total agricultural labor supply (LST_t).

$$LSTH_{h,t} = \theta 1_h . LST_t$$

Here, the share of each household in irrigated land and skilled labor supply remains unchanged. That is, if the total supply of skilled agricultural labor increases by 10%, each household will have the same level $\lambda\_WL_{h,lagrq,t}$ of increase. This implies that a 25% increase in skilled labor endowment does not have the same implications for the poor and the non-poor. However, if one assumes that public investment targets in priority the poor, one can modify the income distribution scheme enabling for instance poor rural households to transform a greater share of their unskilled labor compared to the non-poor rural households.

$$LSH_{h,lagrq,t} = \lambda\_WL_{h,lagrq,t} . LS_{lagrq,t}$$

Unskilled agricultural labor is determined residually for each household enabling a change in their labor endowments by skill, $\lambda\_HH_{h,l,t}$.

$$LSH_{h,lagrnq,t} = LSTH_{h,t} - LSH_{h,lagrq,t}$$

$$LSH_{h,lagrq,t} = \lambda\_HH_{h,lagrq,t} . LSTH_{h,t}$$

$$LSH_{h,lagrnq,t} = (1 - \lambda\_HH_{h,lagrq,t}) . LSTH_{h,t}$$

The same procedure is used for land supply. Each household supplies (SLANDH) a fixed share (theta) of total agricultural land supply ($SLANDH_{h,t}$).

$$SLANDH_{h,t} = \theta_h + SLAND_t$$

Like agricultural labor, the share of each household in irrigated land income and supply, $\lambda\_RK_{h,lanir,t}$, remains unchanged but increases in the same rate for each household following public investment.

$$KSH_{h,landir,t} = \lambda\_RK_{h,lanir,t} . KS_{landir,t}$$

Non-irrigated land supply is set residually enabling a change in household endowments, $\lambda\_HL_{h,l,t}$ given that total household land supply is fixed and grows with population rate.

$$KSH_{h,landnir,t} = SLANDH_{h,t} - KSH_{h,landir,t}$$
$$KSH_{h,landir,t} = \lambda\_HL_{h,l,t}.SLANDH_{h,t}$$
$$KSH_{h,landnir,t} = (1 - \lambda\_HL_{h,l,t}).SLANDH_{h,t}$$

Household income - Households are defined by rural and urban areas and poor/non-poor categories. Income and expenditure patterns vary considerably across these household groups. These differences are important for distributional change, since incomes generated by agricultural growth accrue to different households depending on their location and factor endowments. Each representative household in the model is an aggregation of a group of households in the household survey. Households in the model receive income through the employment of their factors in both agricultural and non-agricultural production, and then pay taxes, save and make transfers to other households. The major source of income for households is factor income. Rural households earn income from labor, capital, and land. Urban households earn income from capital and labor. Both types of households also get income from transfers from other institutions including the ROW. The disposable income of a representative household is allocated to commodity consumption derived from a Stone-Geary utility function. This detailed specification of production and factor markets in the model allows it to capture the changing scale and technology of production across sectors and sub-national regions, and therefore, how changes in the economic structure of growth influences its distribution of incomes.

Dynamic model specifications

We use a sequential dynamic model to evaluate long term impacts. In each period, the stock of capital (KD) is accumulated using the following equation.

$$KD_{k,j,t} = KD_{k,j,t-1}.\left(1 - \delta_{k,j}\right) + IND_{k,j,t-1}$$

$\delta_{k,j}$ Depreciation rate of capital k in industry j

$IND_{k,j,t}$ Investment demand by sector of destination

The allocation of new private capital between categories and industries follows a modified version of the Jung-Thorbecke (2001) investment demand specification. The volume of new type *k* capital allocated to business-sector industry *bus* is proportional to the existing stock of capital; and the proportion varies according to the ratio of the rental rate to the user cost of that capital. Investment demand is defined following the specification of Bourguignon et al (1989). It is given by the equation below.

$$\frac{IND_{k,bus,t}}{KD_{k,bus,t}} = \varphi_{k,bus}.\left[\frac{R_{k,bus,t}}{U_{k,bus,t}}\right]^{\sigma\_INV_{k,bus}}$$

Capital accumulation rate (the ratio of investment demand, IND, to capital demand, KD) increases with the ratio of the rate of return, $R_{k,bus,t}$ and its user cost, $U_{k,bus,t}$. The user cost of capital is as follows:

$$U_{k,bus,t} = PK_{PRI_t}(\delta_{k,bus} + ir_t)$$

PK_{PRI_t}	Price of new private capital
ir_t	Interest rate
$R_{k,bus,t}$	Rental rate of type k capital in industry j
$\varphi_{k,bus}$	Scale parameter (allocation of investment to industries)
$\sigma\_INV_{k,bus}$	Elasticity (investment demand)

An increase in public investment may result in crowding out private investment as specified below.

$$IT\_PRI_t = IT_t - IT\_PUB_t - \sum_i PC_{i,t} VSTK_{i,t}$$

IT_t	Total investment expenditures
IT_PRI_t	Total private investment expenditures
IT_PUB_t	Total public investment expenditures
$PC_{i,t}$	Purchaser price of composite commodity i
$VSTK_{i,t}$	Inventory change of commodity i

Public investment by category and by public sector industry grows at the population growth rate pop(time). The user cost of public capital is similar to that of private capital:

$$IND_{k,pub,t} = IND_{k,pub,t-1}.pop_t$$
$$U_{k,pub,t} = PK\_PUB_t.(\delta_{k,bus} + ir_t)$$

PK_PUB_t	Price of new public capital

The population growth rate is used in the model to update the values of variables, both endogenous and fixed variables, and parameters that are assumed to grow at that rate.

Model closure

The model is run for 10 periods of time. Non-agricultural capital is sector-specific and exogenously set at the base year level for the first period of time. Land is mobile across agricultural sub-sectors. Non-agricultural labor is fully mobile across all sectors. Agricultural labor is mobile in agricultural sub-sectors. Both agricultural and non-agricultural wages adjust to ensure full employment.

All commodity markets follow the neoclassical market-clearing system in which each market is cleared when the total endogenous demand equals the total demand through price adjustment. Our numeraire is the nominal exchange rate. World import and export prices are set fixed following the small price-taking economy hypothesis. Current account balance is set fixed at the first period and increases yearly with population growth.

Other variables that grow at the population growth rate are: minimum consumption of commodities in the LES demand equations, government current expenditures, public investment by category and by public sector industry, and changes in inventories. Likewise, total investment expenditure is equal to the sum of agents' savings. For the savings-investment account, real investment adjusts to changes in savings (i.e., savings-driven investment). Also, the sum of the different forms of investment expenditure is equal to total investment.

Calibration of parameters

Based on the SAM, the production technologies across all sectors are calibrated to their current situation, including each sector's use of primary inputs, such as land, labor and capital, and intermediate inputs. Exogenous elasticities including substitution and transformation elasticities have been taken from other studies focusing on the same country.

Poverty analysis within the CGE framework

When considering impacts of public investment, it is important to evaluate poverty effects. Increased or more efficiently allocated public resources within the agricultural sector are expected to generate increased growth. However, the nature of the growth process is determinant for poverty reduction. Poverty reduction requires an increase in real wages or real income. Here, the extent to which agricultural growth involves growth in marginal product of labor is important. A poverty analysis is therefore essential to capture the full impact of an alternative reallocation of public resources for the agricultural sector as the resulting economic growth may not be pro-poor.

The study investigates this by using a "top-down" approach where changes in the CGE model are imported in the household data. It uses micro data from the 2004/05 HIES. The survey does not provide data on household income but rather on household expenditure. Household income will therefore be approximated by consumption expenditure. The top-down approach captures effects of changes in consumption prices on household expenditure and poverty. At the top level, the CGE model is used to measure changes in commodity prices and household consumption. These changes are then fed into the HIES to evaluate changes in household expenditure. Each representative household in the CGE model is linked to its corresponding households within the micro simulation model.

Poverty changes are then evaluated using the standard measures. The Foster Greer and Thorbecke (FGT) measures are applied.

$$\boldsymbol{P_{\alpha}} = \frac{\mathbf{1}}{\boldsymbol{Nz^{\alpha}}} \sum_{\boldsymbol{j=1}}^{\boldsymbol{J}} (\boldsymbol{z} - \boldsymbol{y_j})^{\boldsymbol{\alpha}}$$

Where j is a subgroup of individuals with consumption below the poverty line (z), N is the total sample size, y is expenditure of a particular individual j and α is a parameter for distinguishing between the

alternative FGT indices[1]. This poverty extension enables us to calculate poverty incidence, poverty depth and the severity.

The data used is from the 2004/5 Household Income Consumption and Expenditure Survey (HICES) of Ethiopia. The survey is nationally representative and has detailed information on household consumption expenditure, consumption patterns, income and household characteristics such as agro ecology zone (AEZ), number of persons (household size) and socio-economic characteristics. Non-parametric approaches are used based on the observed distribution of these households in the survey, their sample weights, number of individuals in the household and their location (i.e rural/urban). Each household questioned in HICES 2004/05 is linked directly to the corresponding representative household in the model.

The SAM used in the CGE component of the model is the 2005/06 EDRI SAM updated for 2009/10. So that the survey data used in the micro simulation component has to be of the same year. Unfortunately, the 2009/10 HICES hasn't been yet released. For that reason the recent available 2004/05 HICES was updated. The 2004/5 weight of the survey households was scaled up to achieve the country's 2009/10 total population but we assume household size remains the same. The per capita consumption expenditure is inflated by a factor which gives us the 2009/10 poverty incidence. As a result, the base year poverty incidence is a reasonable rate based on the government report (MoFED 2012).

[1] When $\alpha=0$ the expression simplifies to J/N, or the headcount ratio. This is a measure of the incidence of poverty. When $\alpha=1$ the expression gives us poverty depth measured by the poverty gap. When $\alpha=2$ the expression gives us the severity of poverty measured by the squared poverty gap.

Simulation results

Scenarios

The scenarios are inspired by the five-year national development plan, the Growth and Transformation Plan (GTP). The GTP has the overall objective of eradicating poverty, improving citizens' livelihood and transforming Ethiopia into a middle income country. It intends to attain this through a sustained, rapid and equitable economic growth and by maintaining agriculture as the major source of economic growth.

An agriculture-led development requires investment in a country's capacity to market its products but supply side constraints also need to be addressed. Accordingly, boosting productivity through the use of improved seeds, fertilizer, small and medium scale irrigation, and investment in human capital, access to credit, as well as switching to higher value crops and multi-cropping are the major areas of intervention in Ethiopia. Our focus is on irrigation and farmers' training in line with the GTP. Extension and training programs are designed to enhance farmers' capacity to use water resources and other resources efficiently. The government plans to reproduce the results obtained by model farmers in a larger scale. Irrigation will have the impact of increasing land productivity and output while training will increase labor productivity for the same level of other inputs but also through the use of better technologies.

The two Strategies outlined in the GTP that apply to our research are:

- Scaling up best practices of model small farmers to increase productivity and production which is simulated through the increase in public investment for training farmers;
- Intensify the use of water and natural resources with priority to small scale irrigation schemes simulated through public investment for irrigation.

Ethiopia's Agricultural Sector Policy and Investment Framework (PIF) 2010-2020 is another document utilized as a reference to design the scenarios and in particular the scope of the simulated shocks. . The PIF is a 10-year road map for development that identifies priority areas for investment and estimates the financing needs to be provided by Government and its development partners. According to the PIF, increasing productivity in smallholder agriculture is Government's top priority, recognising the importance of the smallholder sub-sector, the high prevalence of rural poverty and the large productivity gap. The document explains that in the coming years the key challenge is to re-balance policy and investments to pursue sustainable productivity and profitability objectives, whilst executing a carefully controlled phasing down strategy of social safety-net activities. Regarding the investment framework, government is expected to continue its strong commitment to financing agriculture and rural development over the next decade, and the expectation of continued strong economic growth will grow the agricultural sector budget from around USD 0.7 billion in 2010-11 to as much as USD 1.7 billion per annum by the end of the PIF period. Additional investments of around USD 6.2 million are also foreseen.

The document sets out five basic directions for agricultural development of which the first two are:

- A labor intensive strategy, which sees the mobilization of under-utilized and un-productive rural labor as a key driver of growth, rather than capital-intensive approaches. It envisages high levels of training and technology adoption in order to boost agricultural productivity without drawing heavily on the country's scarce capital resources; and
- Proper utilization of agricultural land, by guaranteeing the availability of land to people who seek to make a living out of land, and assisting them to utilize it productively on a sustainable basis through irrigation, multi-cropping and diversified production;

Smallholder agriculture is expected to remain the principal source of agricultural growth. Increasing smallholder productivity and production is the main thrust of the plan and is planned to be achieved in three major ways:

- by scaling up best practices used by leading farmers whose productivity is 2-3 times higher than the average
- by improving the management of natural resources with a focus on improving water utilization and the expansion of irrigation
- by encouraging farmers to change from low value to high value products in order to increase their cash incomes, with complementary investments in market and infrastructure development.

The document indicated that these initiatives will be supported by farmer training and measures to improve access to agricultural inputs and product markets using cooperatives as the delivery mechanism. It recognizes that the agricultural extension system is a major element of the agricultural and rural development strategy where core institutions are the Agricultural Technical and Vocational Education and Training (ATVET) centres and the Farmer Training Centres (FTCs). These institutions are currently functioning to produce, as well as use, the human capital that is embodied in Development Agents (DAs). ATVETs train DAs and the DAs in turn use FTCs to train farmers.

Under the agricultural productivity strategic objective, agricultural productivity (value outputs/value inputs) per crop and livestock unit is expected to increase by 4% annually. Under the strategy objective that aims to reduce degradation and improve productivity of natural resources, an 8% annual increase of arable land is expected to be irrigated as well as a 5% annual increase in crop yield per unit of water used due to water conservation and water use efficiency interventions.

With regard to funding of this agricultural development strategy, between 13 and 17 per cent of government expenditure (equivalent to over five per cent of GDP) has been channeled towards agriculture (including natural resource management) in recent years. About 60 per cent of agricultural investments are funded from the Government budget, 30 per cent from grants, and 10 per cent from concessional loans. More than half of this expenditure supports chronically food insecure households through the safety net programs. Investments are also directed towards expanding the extension system, irrigation development, and rural commercialization and agro-processing. In the coming years the objective is to re-balance policy and investments to pursue sustainable productivity and profitability objectives, whilst executing a carefully controlled phasing down strategy of social safety-net activities. Based on the assumption that the economy will continue to grow at 10% over the ten years of the PIF,

an investment framework was projected under which there would be a gradual increase in the funds allocated to the budget for agriculture and rural development from 7.0% of GDP in 2008/09 to 7.5% by the end of the PIF period. On this basis, 38.2% of the budget would be allocated to irrigation development at the end of the PIF from 34 million USD in the first period to 5,921 million USD the last year of the PIF. About 8% of the budget would be allocated to agricultural research, extension and seeds at the end of the PIF from 8 million USD in the first period to 1,179 million USD the last year of the PIF; 80% of the total budget being allocated to capital expenditure.

Table 7 – Summary of scenarios

	Scenario	Time frame
Simulation 1	10% increase of public investment in training for farmers 2% skilled labor and irrigated land productivity shock	2nd period and shock takes effect on the 3rd period to increase skilled labor supply 3rd period and level maintained until last period
Simulation 2	15% increase of public investment in irrigation uniformly across all agricultural sub-sectors 2% skilled labor and irrigated land productivity shock	2nd period and shock takes effect on the 3rd period to increase irrigated land supply 3rd period and level maintained until last period
Simulation 3	Combination of the above two simulations	2nd period and shock takes effect on the 3rd period to increase skilled labor and irrigated land supply

Simulation results

Simulation 1

The first scenario simulates a 10% increase of public investment in training for farmers the second period taking effect in the third period. This is complemented by a productivity shock of skilled labor and irrigated land in the third period. As presented in precedent sections, the model closure assumes full employment in the agricultural sector. This implies that an increase in the supply of skilled agricultural labor due to public investment will result in the reduction of skilled labor wages. However, this is not realistic in the way that skilled labor has higher productivity and thus higher wages. To partially offset this effect, we introduce a productivity shock applied to skilled labor which introduces rigidity in wages and by the same token increases skilled labor productivity and land productivity. This is based on the fact that the provision of training to farmers by development agents or through farmer training centers is aimed at improving labor productivity by enabling farmers to better utilize inputs such as improved seeds and fertilizer as well as irrigation techniques which in turn will increase land productivity. Improved labor productivity will therefore result in even more improved land productivity and production. The 2% skilled labor and irrigated land productivity shock we introduced simulates this. For the same level of skilled agricultural labor and irrigated land, total agricultural output increases by 2%.

Impact on agricultural growth and overall GDP: is there an agriculture-led development?

The 10% increase in public investment for training results in the transformation of 3.8% of unskilled agricultural labor into skilled labor. Given the full employment assumption, all newly skilled labor is employed in the 14 agricultural sub-sectors depending on their labor intensity. Skilled agricultural wages decline by 17.4%. Given the low substitution elasticity between skilled agricultural labor and irrigated land, the increase in skilled labor translates into the increase in demand for irrigated land, which is fixed. Return to irrigated land almost doubles. In parallel, unskilled agricultural wages increase by 0.2% becoming relatively rare. The latter is combined with non-irrigated land in a CES with low substitution elasticity translating into a contraction in return to non-irrigated land by 5.5%. Non-irrigated land becomes now relatively more abundant compared to unskilled agricultural workers, thus, its price drops.

The increased pool of skilled labor combined with a greater productivity enables a higher level of composite factor (37.7%) at a lower cost (-21%). Total agricultural value added increases by 2.4%. Value added in manufacturing sector declines (-0.3%) while it increases in services sector (0.1%) because of crowding out effect. Overall value added increases by 1% in volume but GDP at basic prices slightly contracts (-0.04%) as the price of value added falls (-0.5%).

Overall GDP at market price remains nearly unchanged (+0.002%). Agricultural growth contracts by 0.5% while GDP slightly increases by 0.1% in manufacturing and by 0.4% in services. In addition, the increase in public investment in training has a crowding-out effect. Private investment contracts by 0.5% while public investment increases by 1.2% affecting the growth potential of the economy, in particular the manufacturing and services sectors that are highly capital-intensive.

There is some level of agriculture-led development. Agriculture is linked to other sector through forward and backward linkages. Backward linkages imply an increase in demand for industrial products used as inputs for agricultural production. Public investment in training results in an increase in agricultural output of 2.5%. Although agriculture is not intensive in the intermediate inputs, it uses 47% of agricultural products, 37% of manufacturing inputs essentially composed of fertilizers and chemicals 17% of services mainly financial services as intermediate inputs in production. The expansion in agricultural output may translate into an increase in demand for manufacturing good and services. Public investment in training and irrigation results in an increase in agricultural output by 2.2% the year following the shock and by 2% the last period. Agriculture-led development through backward linkages does not take place here to generate growth in manufacturing sector where output contracts by 0.3% the year following the shock and by 0.01% the last period. Output in services sector increases a little (0.1% at T3 and 0.3% at T10).

Due to the fall in the prices of agricultural products, those industries that are intensive in agricultural intermediate inputs will benefit, in particular agro-processing industries. Forward linkages whereby the agricultural sector would provide inputs and raw materials to the industrial and other sectors also operate here. 23% of intermediate inputs utilized in the manufacturing sector and 17% of those utilized in the services sector are agricultural products for which prices have fallen by 4% since the the third

year. Forward linkages whereby the agricultural sector would provide inputs and raw materials to the manufacturing and other sectors operate here but the decline in agricultural prices does not translate into an expansion in the manufacturing sector.

Similarly, consumption linkages whereby increases in agricultural income would lead to increased demand for non-agricultural final consumption goods do not operate here. Total agricultural labor income declines by 2.2% driven by the drop in skilled agricultural wages. The productivity shock introduced is not high enough to counter this. Similarly, land income declines by 0.2% despite the near doubling of return to irrigated land (because the share of irrigated land in total land is only 6.8%). Finally, income from livestock capital declines by 0.64%. Livestock capital is utilized only in this sector. It is private capital that has been slightly affected (-0.06%) by the crowding out effect of public investment.

Impact on trade

Total exports increase by 1.2% the third period and by 1.6% the last period pulled by agricultural exports which represent 39.4% of total exports. The latter expand by 3.9% and 4% the third and last year respectively. Agricultural output has increased and commodities prices have declined making the products more competitive. Export increase the most in export-intensive sectors mainly producing cash crops. Exports increase the most for pulses followed by flowers, oil seeds and vegetable and fruit. Exports of food crops also increase as local prices have fallen more than international prices making it more profitable for producers to export that to supply the local market. Export of non agricultural products decline as output has declined and prices have increased. Considering a fixed current account balance, the expansion in exports enables the country to increase its imports.

Total imports increase by 0.4% the third period and by the same scope the last period. Imports of agricultural products decline by 4.9% and 4.7% in the third and last periods. Import Demand falls for these products as the locally produced are less expensive. Imports of manufacturing goods which represent 70% of total imports increase by 0.5% in particular imports of fertilizer increases the most (3.8%) as it is utilized in the agricultural sector and pulled by the expansion of output. Imported services increase by 0.9% the last period pulled by demand for trade services utilized by the agricultural sector for exporting purposes.

The effect of the policy on agriculture led development was low partly because even if agricultural production uses 37% of intermediate manufacturing inputs, a significant share of the latter are imported. This weakens the production linkages between agriculture and manufacturing sectors.

Impact on food insecurity

Availability of food and access are common indicators of food security. Availability of food can be measured by nationwide food supply indicators while access can be captured through household consumption of food staples. Access to food can also be captured the country's capacity to finance its current food imports through trade. We focus on the availability approach.

To measure the impact on food insecurity, we use as proxy the volume of total agricultural output, the total labor force, and commodities' price. If total agricultural output divided by total labor force increases (FSindex1), this means that there are more goods produced per individual. The simulation results indicate an encouraging result towards reducing food insecurity. The ratio total output over total labor increases by 2.2% the third period and by 2% the last period.

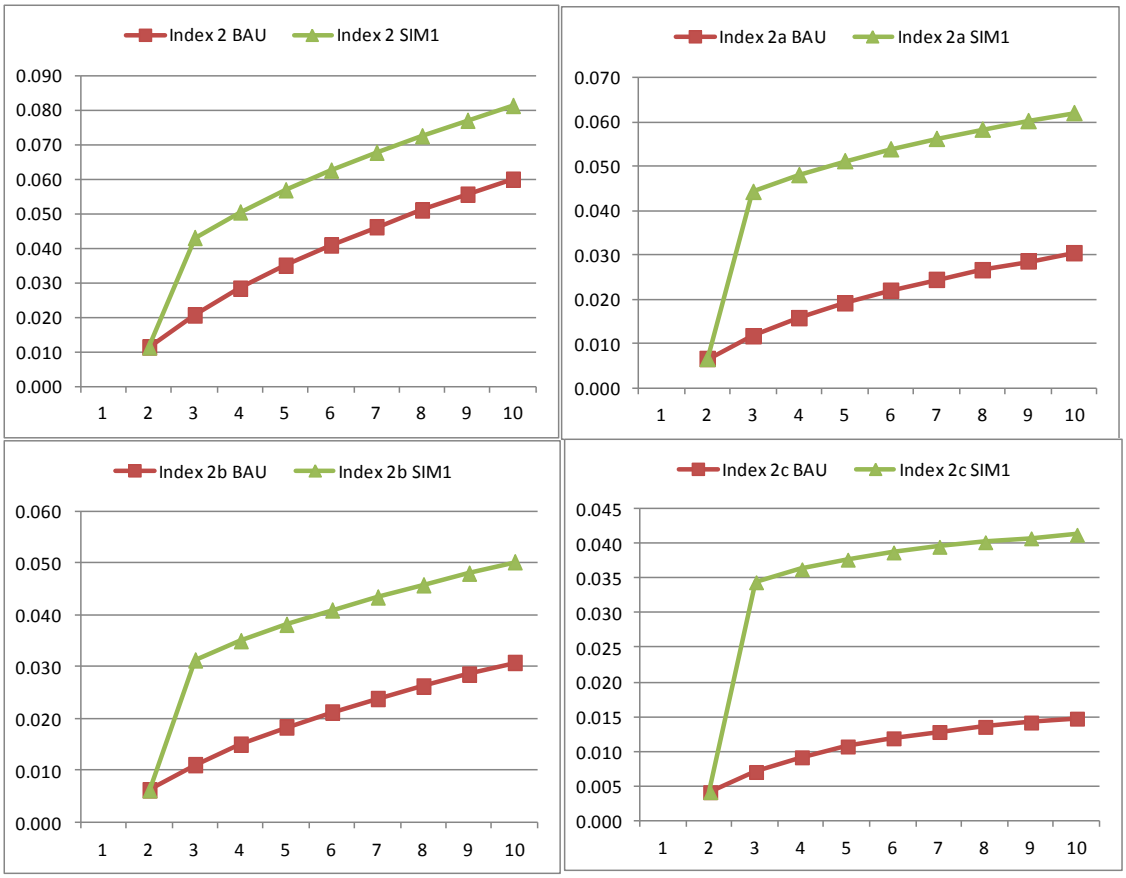
This is a first indication on the potential for such a policy intervention on reducing food insecurity. However, as our labor force is fixed within one period of time, the food insecurity indicator will only reflect changes in volume of output. To verify whether this type of policy intervention has a real potential to contribute to reducing food insecurity, it is important to look at the changes across time in the food security index to check whether it allows a more accelerated reduction (relative to the first period) in food insecurity compared to the Business As Usual (BAU) (FSindex2a).

$$FSindex1_{agr_t} = \frac{\sum_{agr} XST_{agr,t}}{\sum_l LS_{l,t}}$$

$$FSindex2_{agr_{t>1}} = \left[\frac{\left(\frac{\sum_{agr} XST_{agr,t}}{\sum_l LS_{l,t}} \right)}{\left(\frac{\sum_{agr} XST_{agr,t1}}{\sum_l LS_{l,t1}} \right)} - 1 \right]$$

The results show that the policy has potential for reducing food insecurity as reflected in the figure below.

Figure 10 – Changes in food security index 2, 2a, 2b, and 2c



The results may show that the policy has a potential to reducing food insecurity. However, this applies if consumer prices remain unchanged or decrease. We upgrade our simplified food insecurity index by integrating the consumer price index (FSindex3).

$$FSindex3_{agr_{t>1}} = \left[\frac{\left(\frac{\sum_{agr} XST_{agr,t}}{\sum_{l} LS_{l,t}}\right)}{\left(\frac{\sum_{agr} XST_{agr,t1}}{\sum_{l} LS_{l,t1}}\right)} - 1\right] \cdot \left[\frac{1}{1 + \left(\frac{CPI_t}{CPI_{t1}} - 1\right)}\right]$$

The figure below presents the changes in this index. As prices of agricultural commodities have fallen (-2.6% on average), the index increases even more showing a greater potential for reducing food insecurity.

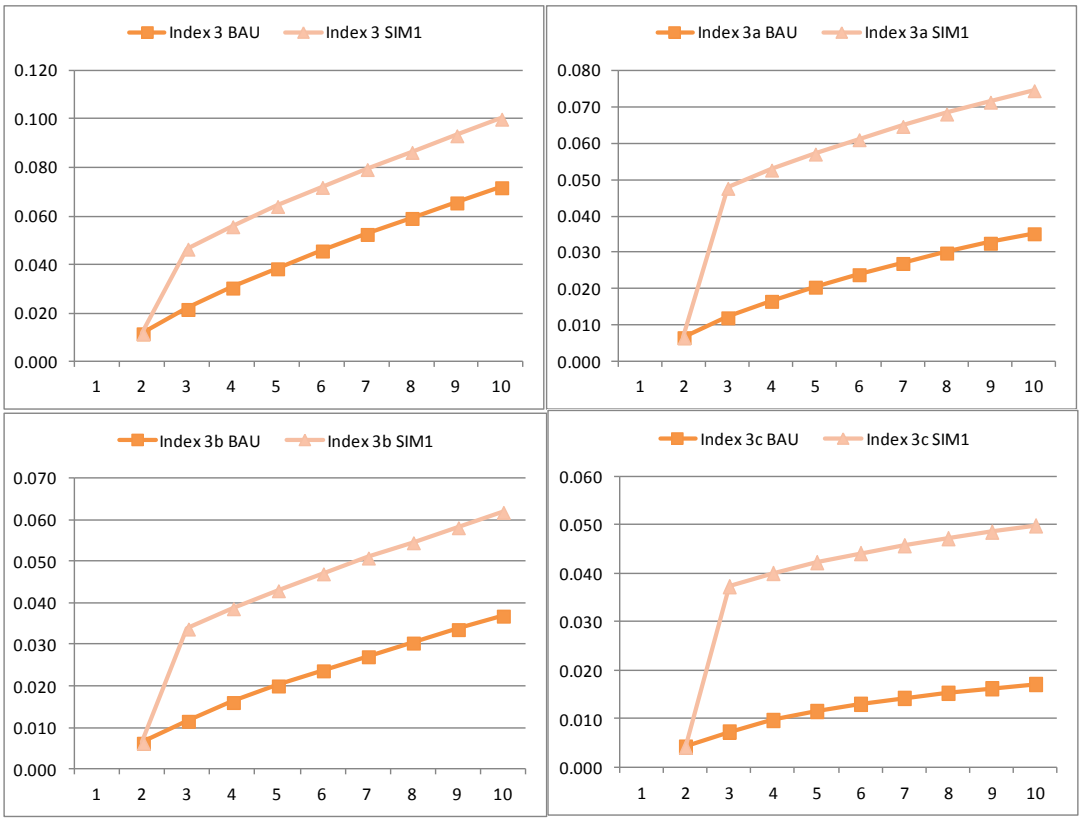
Another point that may be raised when using such an index based on the total agricultural output is the relevance of this indicator as total agricultural output is composed of food as well as non-food items. In addition, when it comes to reducing food insecurity, it is important to focus on the major food staples. In the Ethiopian case, the latter are composed of cereal namely teff, barley, wheat, maize, sorghum and other cereal crops such as oats. We therefore recalculate our food security index by using the total output in these food crops (the indexes are FSindex1a, FSindex2a, and FSindex3a). Finally, agricultural output may be destined to exports reducing the food available on the local market. Similarly, food may

be imported increasing food availability. We therefore push our analysis of the impact of public investment in training and irrigation further by using total domestic supply of agricultural products (local output minus exports plus imports). Our index distinguishes between total domestic supply of agricultural goods and that of food crops as discussed above (the indexes are FSindex1b, FSindex2b, and FSindex3b when using total domestic supply of agricultural goods and FSindex1c, FSindex2c, and FSindex3c when using total domestic supply of major food staples).

The policy has potential for reducing food insecurity when using output of major food staples. FSindex1a is 3.1% higher after the shock compared to the BAU scenario over the period after the shock. The same applies when using total domestic supply of agricultural products. FSindex1b is 1.9% higher after the shock compared to the BAU scenario over the period after the shock. Finally, when using total domestic supply of major food staples, FSindex1c is 2.7% higher on average after the shock compared to the BAU scenario.

The following figure presents the changes in the food security index3 which takes into account changes in consumer price index. All type 3 indexes show the policy has potential for reducing food insecurity and this in a more accelerated manner compared to BAU scenario. Food supply increases faster than in the BAU scenario and prices decrease in a more important pace compared to the BAU scenario. The result tables are available in the Annex.

Figure 11 – Changes in food security index 3



Impact on poverty

The public investment in training simulated in this scenario will reduce poverty if it increases household real consumption. It will be pro-poor if it improves the situation of the poorest. Total agricultural labor income declines by 2.2%, land income declines by 0.2% and income from livestock capital declines by 0.6%. In contrast, capital income increases 1.25%.

Rural poor and rural non-poor households see their nominal income decline as shown below. Their major income sources are employed in agriculture where return to factors have declined. Total agricultural labor income declines driven by the drop in skilled agricultural wages. The productivity shock introduced is not high enough to offset this. Although poor rural households detain only 36.6% of total skilled labor, its share in total household agricultural labor is 12.7%. For the non-poor rural households who detain 63.4% of skilled labor in the economy, its share in total household agricultural labor is 12.4% only. The policy shock increases household endowment in skilled agricultural labor to 14% for the poor and to 13.6% for the non poor. In addition, these two types of rural households differ in their sources of income. Poor rural households earn 11.6% of their income from skilled agricultural labor, 55.7% from unskilled agricultural labor, 3.7% from land, 7.6% from livestock capital and 16.2% from non-agricultural capital. For the non-poor, the income composition is less dependent on agricultural labor income and relatively more intensive in non-agricultural capital income. Non-poor rural households earn 6.6% of their income from skilled agricultural labor, 32.8% from unskilled agricultural labor, 10.6% from land, 5.2% from livestock capital and 41.1% from non-agricultural capital. This explains why the poor who are less endowed in non-agricultural capital, for which income has increased, are relatively more affected by the drop in agricultural factor income.

Table 8 – Changes in income by household type

	BAU	SIM1	% change
Poor rural households	24307560	24007007	-1.2%
Non-poor rural households	75950181	75670969	-0.4%
Poor households in small urban settlements	3260943	3290836	0.9%
Poor households in large urban settlements	1887656	1902447	0.8%
Non-poor households in small urban settlements	16995065	17170533	1.0%
Non-poor households in large urban settlements	13456738	13560931	0.8%

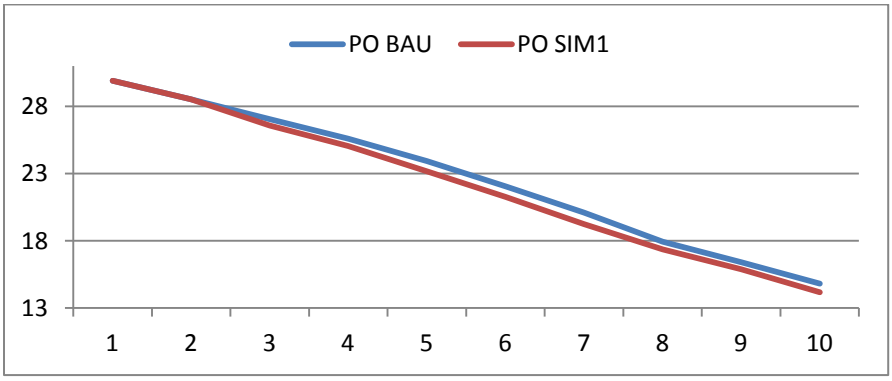
Urban households however experience an increase in nominal income as most of their income comes from non-agricultural labor and non-agricultural capital. Both non-agricultural wages and return to capital have increased due to the little expansion in the services sector which concentrates 62.5% of total non-agricultural capital and which is highly intensive in it (77.8%).

In parallel to the income effects, there are price effects that also affect the consumption level and pattern of representative households. The CPI has dropped by 1.1% and agricultural commodities prices

have fallen even more (-3.2%). These commodities hold an important share in the consumer food basket in Ethiopia making the drop in agricultural CPI more important for increasing household consumption.

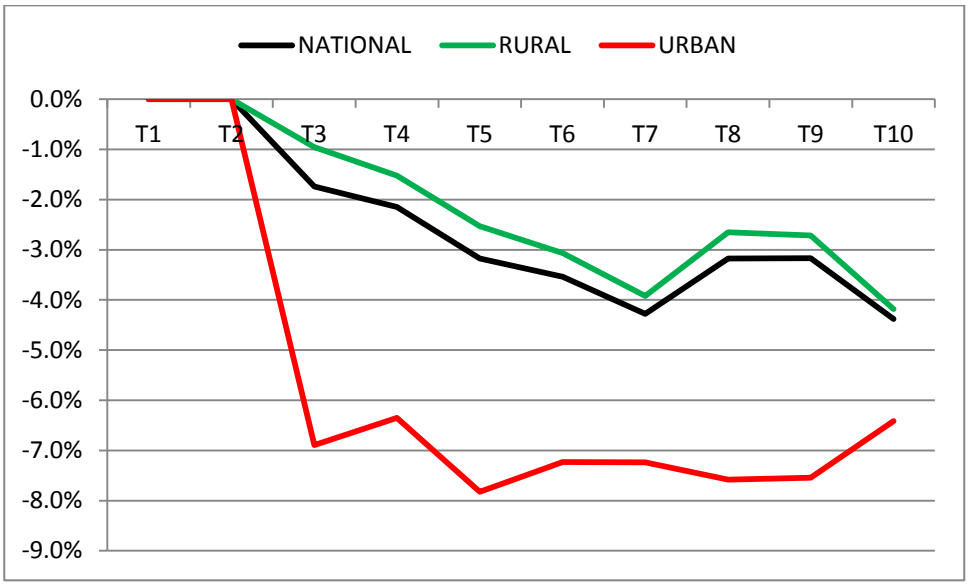
The micro-simulation results show that poverty declines by 1.7% for the year following the public investment shock (T3). Over the period of 10 years, the number of poor declines by 8.1% in total. In addition, the rate of decline in poverty rate accelerates over the years compared to the BAU scenario.

Figure 12 – Changes in poverty incidence



The following presents impacts on poverty differentiated by location.

Figure 13 – Changes in poverty incidence: national rural and urban



As reflected by the above figure, urban poverty declines more than rural poverty. This is due to the fact that urban households' income increased while that of rural households declined. This means that the policy has positive outcomes in terms of reducing poverty but it is not pro-poor. Indeed, if we look at the poverty incidence at the base year, it is higher than the national average (29.9%) for rural households (30.6%) while it is much lower for urban ones (26.5%). P0 declines significantly more for urban households.

Table 9 – Changes in FGT indices

	BAU T1			SIM1 T3			SIM1 T10		
	P0	P1	P2	P0	P1	P2	P0	P1	P2
NATIONAL	29.9	6.3	1.9	26.5	5.2	1.6	14.1	2.4	0.7
RURAL	30.6	6.5	2.0	27.9	5.5	1.6	15.3	2.6	0.7
URBAN	26.5	5.6	1.8	19.7	3.9	1.2	8.6	1.4	0.4
NATIONAL				-1.9%	-3.5%	-3.7%	-4.7%	-4.3%	-4.3%
RURAL				-1.2%	-3.0%	-3.6%	-4.6%	-4.0%	-4.0%
URBAN				-6.4%	-7.4%	-8.7%	-5.2%	-7.8%	-9.5%

Poverty depth and poverty severity also decline when considering national level variations. However, at a more disaggregated level, the policy intervention is not pro-poor. The poverty gap is much higher for the rural population but it declines less than that of urban households. According to the poverty severity index, compared urban households, rural households have a higher risk of being in poverty, but their poverty is not significantly more severe. Nevertheless, the policy is not pro-poor as P2 declines much more for urban households. However, it is to be noted that although it is not pro-poor, poverty incidence, poverty gap and poverty severity decline for all types of households. In addition, rural settings concentrate over 80% of the population. Therefore, a 1.2% decline in poverty incidence in rural areas will pull out of poverty a much greater number of poor than a 6.4% reduction in urban settings.

Simulation 2

The second scenario simulates a 15% increase of public investment in irrigation uniformly across all agricultural sub-sectors during the second period taking effect in the third period. This is complemented by a productivity shock of skilled labor and irrigated land of the same type as in the first simulation.

Impact on agricultural growth and overall GDP: is there an agriculture-led development?

The 15% increase in public investment in irrigation results in the transformation of 4.7% of non-irrigated land into irrigated land. Given the full employment assumption, all newly irrigated land is utilized in the 12 agricultural sub-sectors depending on their irrigated land intensity. Return to irrigated land drops significantly (-70.3%). This is due to the fact that the initial share of irrigated land in total land is very low and transforming 4.7% of total non-irrigated land increases the total irrigated land supply by 64.6%. Given the low substitution elasticity between skilled agricultural labor and irrigated land the increase in irrigated land results in the increase of demand for skilled labor, which is fixed. Skilled agricultural wages increase by 7.3%. In parallel, return to non-irrigated land increases by 5.5% becoming relatively rare. The latter is combined with unskilled agricultural labor in a CES function with low substitution elasticity. Unskilled agricultural wages remain nearly unchanged (+0.02%) in the third period where the public investment policy increases irrigated land capital and start declining at the fifth year although only by less than 1%. This is explained by the fact that the agricultural sector is highly intensive in agricultural labor (0.752) of which 83.6% is unskilled.

The increased pool of irrigated land combined with a greater productivity enables a higher level of composite factor (13.1%) at a lower cost (-10%). Total agricultural value added remains however unchanged as well as value added in manufacturing sector and in services sectors. This is due to low land-intensity in agricultural sub-sector output. At the end of the 10 period simulations, the impact is still insignificant on value added (-0.04%). GDP at basic prices slightly augments (0.14%) at an increasing rate as the price of value added increases (0.5%) at a sustained rate.

Overall GDP at market price increases slightly (+0.13%) at the third period and continues growing a little. Likewise, changes in GDP at sector level showed little progress over the ten-year period. Agricultural growth expands by 0.24% and GDP slightly increases by 0.19% in manufacturing while it remains nearly unchanged in services sector. In addition, the increase in public investment in irrigation across all agricultural subsectors has a crowding-out effect. Private investment contracts by 0.3% after the shock and contracts a bit more until the last period (-0.04%). Total investment contracts by 0.1% while public investment increases by 0.7%. This affects the growth potential of the economy, in particular the manufacturing and services sectors that are highly capital-intensive.

There is no agriculture-led development in this scenario through backward and forward linkages. Total output contracts by 0.1%. Agricultural output contracts by 0.2% and total manufacturing output declines by 0.03% while output in services sector slightly expands (0.01%). Here, consumption linkages whereby increases in agricultural income would lead to increased demand for non-agricultural final consumption goods may operate to a very small extent. Total agricultural labor income increases by 1.3% driven by the rise in skilled agricultural wages. Land income declines by 3.9% despite because of the significant drop in return of irrigated land. Finally, income from livestock capital also declines by 0.06% while income from livestock capital increases by 0.6%. Overall, given that agricultural labor income holds a significant share of total household income, it offsets the contraction in land and capital income.

Impact on trade

Total exports increase by 0.2% the third period and by 0.1% the last period pulled by agricultural exports. The latter expand by 3.9% and 4% the third and last year respectively. Agricultural output has dropped in all subsectors except in coffee, chat and vegetable and fruit which are the most intensive in irrigation but also are export-intensive. Export of non agricultural products decline as output has declined and prices have increased. Considering a fixed current account balance, the expansion in exports is not big enough to enable the country to increase its imports which contract by 0.02%.

Impact on food insecurity

To measure the impact on food insecurity, we use as proxy the volume of total agricultural output, the total labor force, and commodities' price. If total agricultural output divided by total labor force increases (FSindex1), this means that there are more goods produced per individual. As total output as well as agricultural output decline, the policy does not have the potential to reduce food insecurity. This is due to the fact that the initial share of irrigated land in total land is very low and transforming 4.7% of total non-irrigated land does not have much impact in addition to the low intensity of in land (14.4%).

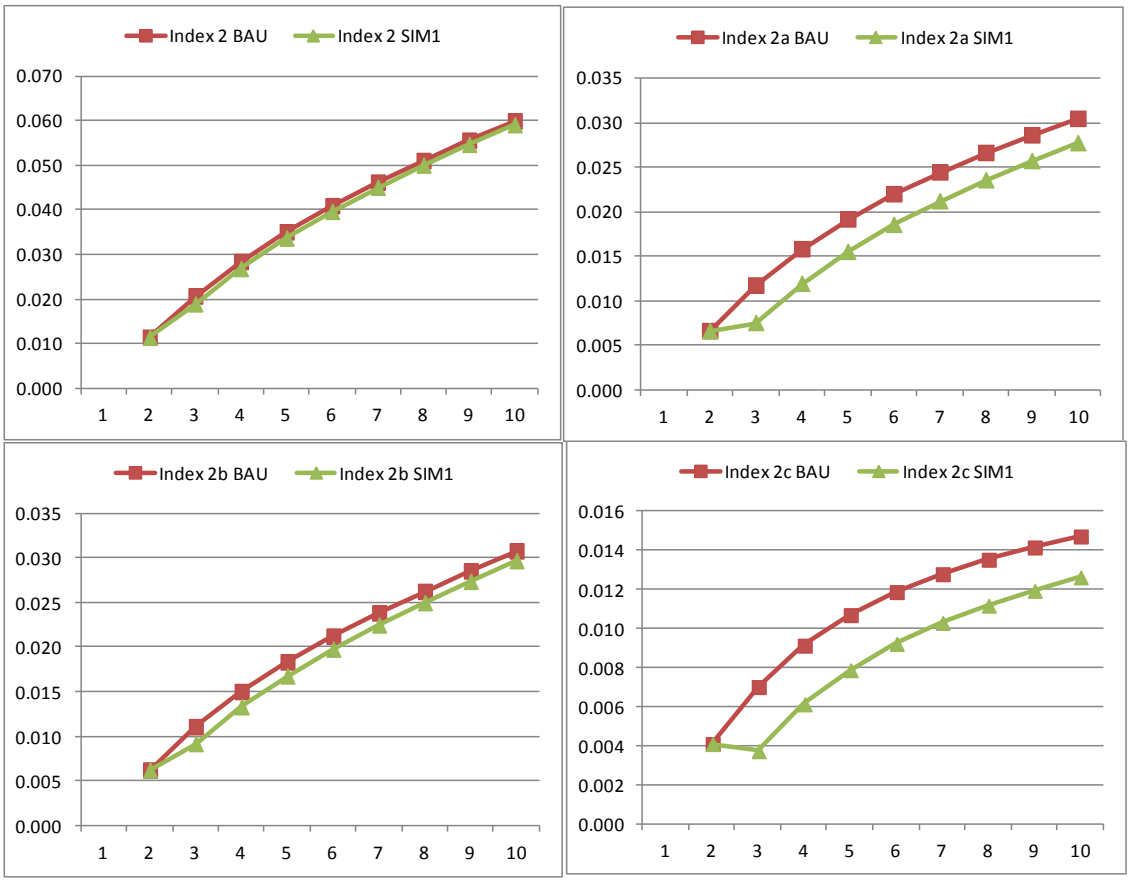
The ratio total agricultural output over total labor decreases by 0.2%. This is a first indication on the impact for such a policy intervention on reducing food insecurity.

This is a first indication on the potential for such a policy intervention on reducing food insecurity. When looking at the changes across time in the food security index to check whether it allows a more accelerated reduction (relative to the first period) in food insecurity compared to the Business As Usual (BAU) (FSindex2), we find the negative impact to be worse. FSindex2 declines by 8.6% at T3 and by 1.4% at T10 showing that the intervention decelerates the effort in reducing food insecurity.

The results show negative outcomes of the policy impact on food insecurity as reflected in the figure below. The figure shows that the impact is even worse when using total output of major food staples instead of total agricultural output.

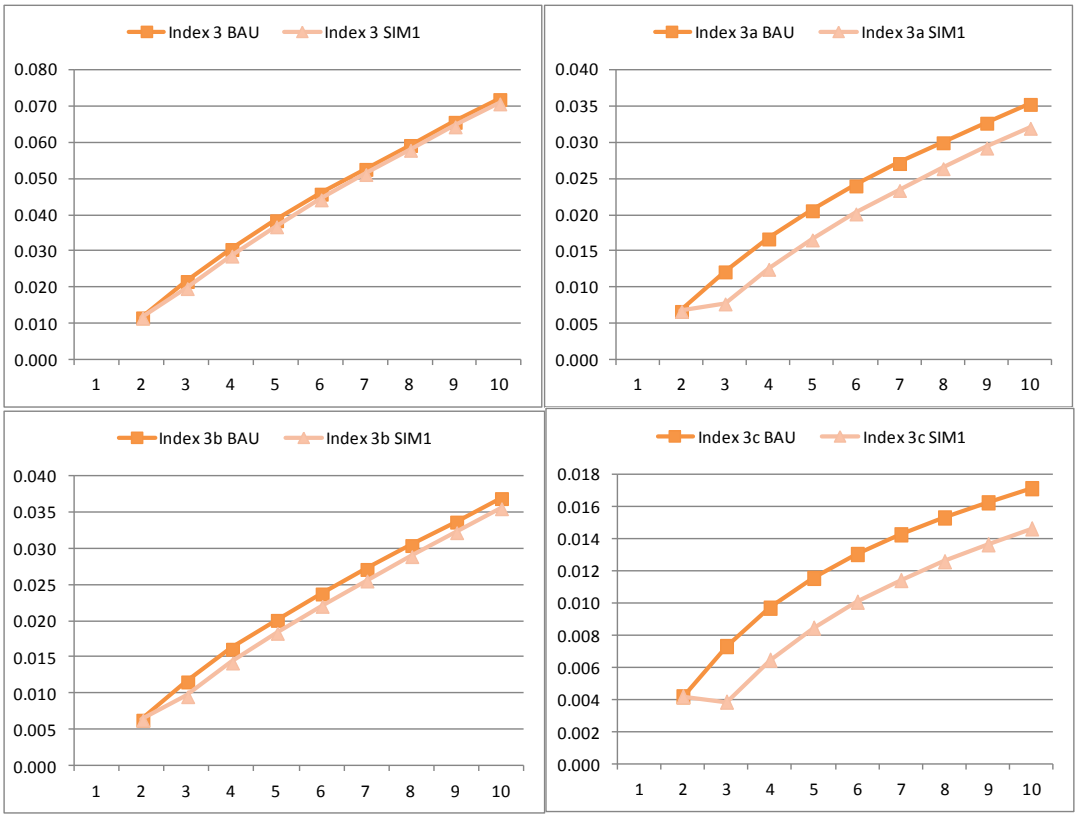
Given that exports in agricultural products have increased despite a fall in production, the impact is even worse on food insecurity. In addition, the expansion in exports is not big enough to enable the country to increase its imports which contract by 0.02%. This is reflected in the food insecurity index 2b and 2c where the policy significantly affects the efforts towards reducing food insecurity.

Figure 14 – Changes in food security index 2, 2a, 2b, and 2c



The results are even more negative when incorporating consumer prices in the calculation of the index (FSindex3). The figure below presents the changes in this index. As prices of agricultural commodities have gone up (0.4% at T3 and 0.2% at T10), the index falls even more showing a greater risk challenge for reducing food insecurity. The following figure presents the changes in the food security index3 which takes into account changes in consumer price index.

Figure 15 – Changes in food security index 3



Impact on poverty

The public investment in training simulated in this scenario will reduce poverty if it increases household real consumption. It will be pro-poor if it improves the situation of the poorest. Total agricultural labor income increases by 1.3%. Land income declines by 3.9%. Income from livestock capital also declines by 0.06% while income from livestock capital increases by 0.6%. Overall, given that agricultural labor income holds a significant share in total household income, it offsets the contraction in land and capital income.

Poor rural households earn 67.3% of their income from skilled and unskilled agricultural labor, 3.7% from land, 7.6% from livestock capital and 16.2% from non-agricultural capital. For the non-poor, the income composition is less dependent on agricultural labor income and relatively more intensive in non-agricultural capital income. Non-poor rural households earn 39.4% of their income from skilled and

unskilled agricultural labor, 10.6% from land, 5.2% from livestock capital and 41.1% from non-agricultural capital. Rural poor and rural non-poor households see their nominal income slightly increase as shown below. For the rural poor, their major income sources are employed in agriculture where return to factors increased a little. That is why they benefit more in terms of income. Other households have an income composition where the contribution of non-agricultural capital is relatively high.

Table 10 – Changes in income by household type

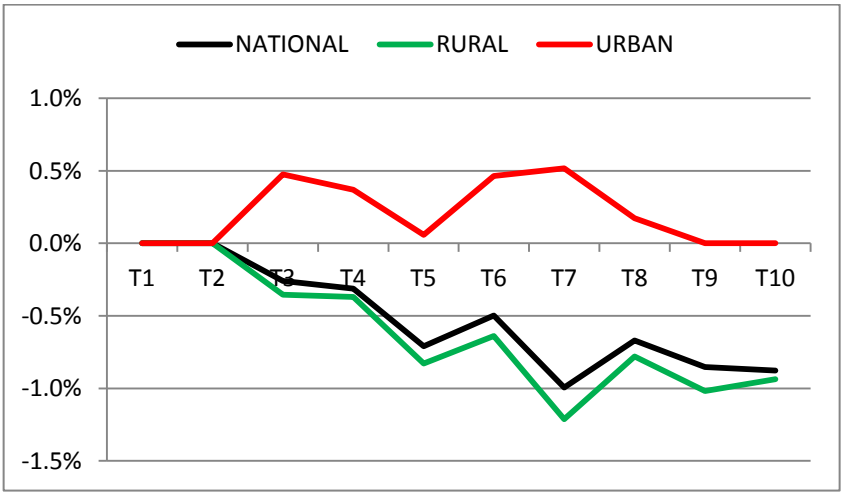
	BAU	SIM1	% change
Poor rural households	24307560	24392862	0.35%
Non-poor rural households	75950181	76070601	0.16%
Poor households in small urban settlements	3260943	3260872	0.00%
Poor households in large urban settlements	1887656	1887915	0.01%
Non-poor households in small urban settlements	16995065	16993846	-0.01%
Non-poor households in large urban settlements	13456738	13459665	0.02%

In parallel to these income effects, there are price effects that also affect the consumption level and pattern of representative households. The CPI has increased by 0.2% and agricultural commodities have become even more expensive (0.4%). These commodities hold an important share in the consumer food basket in Ethiopia making the increase in agricultural CPI more adverse for household consumption in particular the poor.

The micro-simulation results show that poverty declines by 0.3% for the year following the public investment shock (T3). Over the period of 10 years, the number of poor declines by 1.6% in total. In addition, the rate of decline in poverty rate accelerates over the years compared to the BAU scenario although changes in poverty incidence are minor.

The following presents impacts on poverty differentiated by location.

Figure 16 – Changes in poverty incidence: national rural and urban



The public investment policy is pro-poor. Urban poverty increases while rural poverty declines. This is due to the fact that urban households' income declined or increased less while that of rural households increased and this more than the changes CPI enabling a rise in their real consumption. This means that the policy has positive outcomes in terms of reducing poverty in particular for the poorest.

Table 11 – Changes in FGT indices

	BAU T1			SIM1 T3			SIM1 T10		
	P0	P1	P2	P0	P1	P2	P0	P1	P2
NATIONAL	29.9	6.3	1.9	27.0	5.4	1.6	14.7	2.5	0.7
RURAL	30.6	6.5	2.0	28.2	5.6	1.7	15.9	2.7	0.7
URBAN	26.5	5.6	1.8	21.1	4.2	1.3	9.0	1.5	0.4
NATIONAL				-0.3%	-0.4%	0.0%	-0.9%	-0.8%	0.0%
RURAL				-0.4%	-0.5%	-0.6%	-0.9%	-1.1%	-1.3%
URBAN				0.5%	0.5%	0.8%	0.0%	0.0%	0.0%

Poverty depth and poverty severity also decline for rural households and at national level. However, at a more disaggregated level, although the policy intervention is pro-poor, the poverty gap and poverty severity are still much higher for the rural population. Despite this, it is to be noted that poverty incidence, poverty gap and poverty severity decline rural households. Rural settings concentrate over 80% of the population and investing in irrigation schemes has the potential of pulling out of poverty a significant number of poor.

Simulation 3

The third scenario is a combination of the two previous scenarios. It simulates a 10% increase of public investment in training for farmers combined with a 15% increase in public investment for irrigation. This is complemented by a productivity shock of skilled labor and irrigated land of 2% with regard to agricultural output.

As presented in precedent sections, the model closure assumes full employment in the agricultural sector. This implies that an increase in the supply of skilled agricultural labor due to public investment will result in the reduction of skilled labor wages. In parallel, all newly irrigated land is utilized in the 12 agricultural sub-sectors through adjustment in return to irrigated land. Increased levels of skilled labor and irrigated land imply an improvement in total factor productivity which in turn increases factor income.

Impact on agricultural growth and overall GDP: is there an agriculture-led development?

The increase in public investment for training and irrigation schemes results in the transformation of 3.8% of unskilled agricultural labor into skilled labor and 4.7% of non-irrigated land into irrigated land.

Return to irrigated land drops by 51.6% the third year and by 40.4% the last period. Skilled agricultural wages decline by 10% the third year and by 10.7% the last period. The decline in the two factors'

payment is less than the rate registered in the previous two scenarios. In parallel, unskilled agricultural wages increase by 0.2% the third year and increase by 0.3% for the remaining period. Return to non-irrigated land remains unchanged until the sixth period where it declines by 1.9% and by 2% the following year to stabilize at its BAU value the remaining three periods.

Table 12 – Changes in return to factors

Time	Return to factors			
	Skilled agricultural labor	Unskilled agricultural labor	Irrigated land	Non-irrigated land
1	0.0%	0.0%	0.0%	0.0%
2	0.0%	0.0%	0.0%	0.0%
3	-10.0%	0.2%	-51.6%	0.0%
4	-10.0%	0.3%	-49.2%	0.0%
5	-10.1%	0.3%	-48.4%	0.0%
6	-10.2%	0.3%	-47.5%	-1.9%
7	-10.3%	0.3%	-45.0%	-2.0%
8	-10.4%	0.3%	-44.1%	0.0%
9	-10.6%	0.3%	-43.1%	0.0%
10	-10.7%	0.3%	-40.4%	0.0%

The increased pool of skilled labor and irrigated land combined with a greater productivity enables a higher level of composite factor (60.6%) the third year and the last period (57.9%) at a lower cost (-30.9% and -29.7%). Total agricultural value added increases by 2.9% at T3 and by 2.7% at T10. Value added in manufacturing sector declines (-0.4% at T3 and -0.2% at T10) while it increases in services sector (0.1% at T3 and 0.2% at T10). Overall value added increases by 1.2% in volume the year following the public investment shock and by 1.3% the last period. GDP at basic prices slightly increases 0.2% the third year, declines progressively to reach a negative growth rate the last two periods.

Table 13 – Changes in GDP at basic price and final demand

Time	GDP_BP	GDP_FD	GDP_Fd agriculture	GDP_FD manufacturing	GDP_FD services
1	0.0%	0.00%	0.0%	0.0%	0.0%
2	0.0%	0.00%	0.0%	0.0%	0.0%
3	0.2%	0.3%	-0.07%	0.5%	0.4%
4	0.2%	0.2%	-0.07%	0.4%	0.4%
5	0.1%	0.2%	-0.08%	0.3%	0.3%
6	0.1%	0.1%	-0.10%	0.2%	0.3%
7	0.04%	0.1%	-0.1%	0.2%	0.2%
8	0.01%	0.05%	-0.1%	0.1%	0.2%
9	-0.02%	0.02%	-0.2%	0.1%	0.2%
10	-0.04%	-0.004%	-0.2%	0.0%	0.1%

Overall GDP at market price increases slightly (+0.3%) at the third period and drops slowly to zero. Changes in GDP at sector level showed little progress over the ten-year period in manufacturing and services sectors. Agricultural growth contracts by 0.07% and GDP increases by 0.5% in manufacturing and by 0.4% in services sector the year following the investment shock. At the last period, total GDP starts to decline and sectoral GDP grows a little except for the agricultural sector.

Table 14 – Changes in total, private and public investment

Time	Total investment	Private investment	Public investment
1	0.0%	0.0%	0.0%
2	0.0%	-0.8%	1.9%
3	0.9%	0.3%	2.6%
4	0.8%	0.2%	2.5%
5	0.8%	0.1%	2.4%
6	0.7%	0.1%	2.3%
7	0.7%	0.1%	2.3%
8	0.6%	0.04%	2.3%
9	0.6%	0.02%	2.2%
10	0.6%	-0.002%	2.2%

The increase in public investment in training and irrigation has a crowding-out effect the year of the investment shock. Private investment contracts by 0.8% the second period but picks up a bit the third period. Public investment increases by 1.9% the second period and grows by 2.2% the last period.

There is some level of agriculture-led development. Agriculture is linked to other sector through forward and backward linkages. Backward linkages imply an increase in demand for industrial products used as inputs for agricultural production. Public investment in training and irrigation results in an increase in agricultural output by 2.6% the year following the shock and by 2.4% the last period. Agriculture-led development through backward linkages does not take place here to generate growth in manufacturing sector where output contracts by 0.4% the year following the shock and by 0.2% the last period.

Table 15 – Changes in total and agricultural output

Time	Total output	Agricultural output
1	0.0%	0.0%
2	0.0%	0.0%
3	0.9%	2.6%
4	0.9%	2.6%
5	0.9%	2.5%
6	0.9%	2.5%
7	0.9%	2.5%
8	0.9%	2.5%
9	1.0%	2.5%

10	1.0%	2.4%

Unlike backward linkages, forward linkages are likely to operate in a positive manner following the public investment shock in irrigation and training. Due to the fall in the prices of agricultural products, those industries that are intensive in agricultural intermediate inputs will benefit from the decline in agricultural input price.

Table 16 – Changes in intermediate demand price index

Time	Intermediate demand price index	Intermediate demand Price index for agricultural commodities
1	0.0%	0.0%
2	0.0%	0.0%
3	-0.1%	-4.2%
4	-0.2%	-4.2%
5	-0.3%	-4.3%
6	-0.4%	-4.3%
7	-0.4%	-4.3%
8	-0.5%	-4.4%
9	-0.5%	-4.4%
10	-0.5%	-4.4%

23% of intermediate inputs utilized in the manufacturing sector and 17% of those utilized in the services sector are agricultural products for which prices have fallen by 2.5% the third year and more after. Forward linkages whereby the agricultural sector would provide inputs and raw materials to the manufacturing and other sectors operate here but the decline in agricultural prices does not translate into an expansion in the manufacturing sector. Output slightly increases in services sector (0.1% at T3 and 0.3% at T10).

Another form of agriculture-led development is attained through consumption linkages whereby increases in agricultural income would lead to increased demand for non-agricultural final consumption goods.

Table 17 – Changes in agricultural factors income

Time	Agricultural labor income	Land income	Livestock income
1	0.0%	0.0%	0.0%
2	0.0%	0.0%	0.0%
3	-0.6%	-5.5%	-0.7%
4	-0.5%	-5.6%	-0.4%
5	-0.5%	-5.7%	-0.6%
6	-0.5%	-5.8%	0.0%
7	-0.6%	-3.9%	-0.1%

8	-0.6%	-4.0%	-0.1%
9	-0.6%	-6.0%	-0.2%
10	-0.7%	-6.1%	-0.2%

This does not operate with the simulated scenario. Total agricultural labor income declines. Similarly, land income declines even more. Finally, income from livestock capital also falls.

The combined public investment in training and irrigation does not result in an agriculture-led development except when it comes to backward linkages between the agricultural sector and the manufacturing sector. But even that does not translate into an expansion of the manufacturing sector.

Impact on trade

Total exports increase by 1.9% the third period and by 2.2% the last period pulled by agricultural exports. The latter expand by 5.8% and 5.9% the third and last year respectively. Agricultural output has increased and commodities prices have declined making the products more competitive. Exports increase the most in export-intensive sectors mainly producing cash crops such as vegetable and fruit, coffee, pulses, oil seeds and flowers. Export of non agricultural products decline as output has declined and prices have increased. Considering a fixed current account balance, the expansion in exports enables the country to increase its imports.

Total imports increase by 0.5% the third period and by the same scope the last period. Imports of agricultural products decline by 4.0% and 4.1% in the third and last periods. Demand falls for these products as the locally produced are less expensive. Imports of manufacturing goods which represent 70% of total imports increase by 0.5% in particular imports of fertilizer increases the most (3.9%) as it is utilized in the agricultural sector and pulled by the expansion of output. Imported services increase by 1.1% the last period pulled by demand for trade services utilized by the agricultural sector for exporting purposes.

The effect of the policy on agriculture led development was low partly because even if agricultural production uses 37% of intermediate manufacturing inputs, a significant share of the latter are imported. This weakens the production linkages between agriculture and manufacturing sectors.

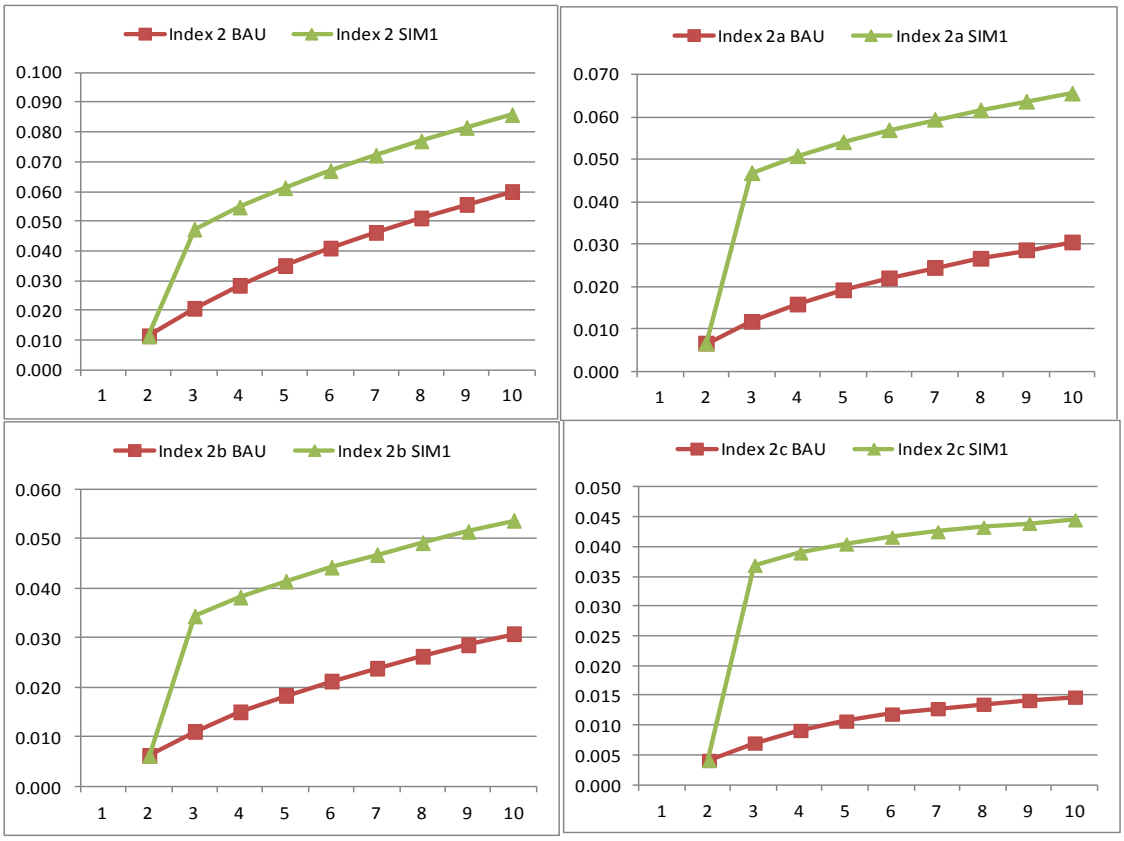
Impact on food insecurity

To measure the impact on food insecurity, we use as proxy the volume of total agricultural output, the total labor force, and commodities' price. If total agricultural output divided by total labor force increases (FSindex1), this means that there are more goods produced per individual. The simulation results indicate an encouraging result towards reducing food insecurity. The ratio total output over total labor increases by 2.6% the third period and by 2.4% the last period.

This is a first indication on the potential for such a policy intervention on reducing food insecurity. However, as our labor force is fixed within one period of time, the food insecurity indicator will only reflect changes in volume of output. To verify whether this type of policy intervention has a real

potential to contribute to reducing food insecurity, it is important to look at the changes across time in the food security index to check whether it allows a more accelerated reduction (relative to the first period) in food insecurity compared to the Business As Usual (BAU) (FSindex2). The results show that the policy has potential for reducing food insecurity (see figure below).

Figure 17 – Changes in food security index 2, 2a, 2b, and 2c



The results may show that the policy has a potential to reducing food insecurity. However, this applies if consumer prices remain unchanged or decrease. We upgrade our simplified food insecurity index by integrating the consumer price index (FSindex3). The figure below presents the changes in this index. As prices of agricultural commodities have fallen, the policy has a greater potential for reducing food insecurity.

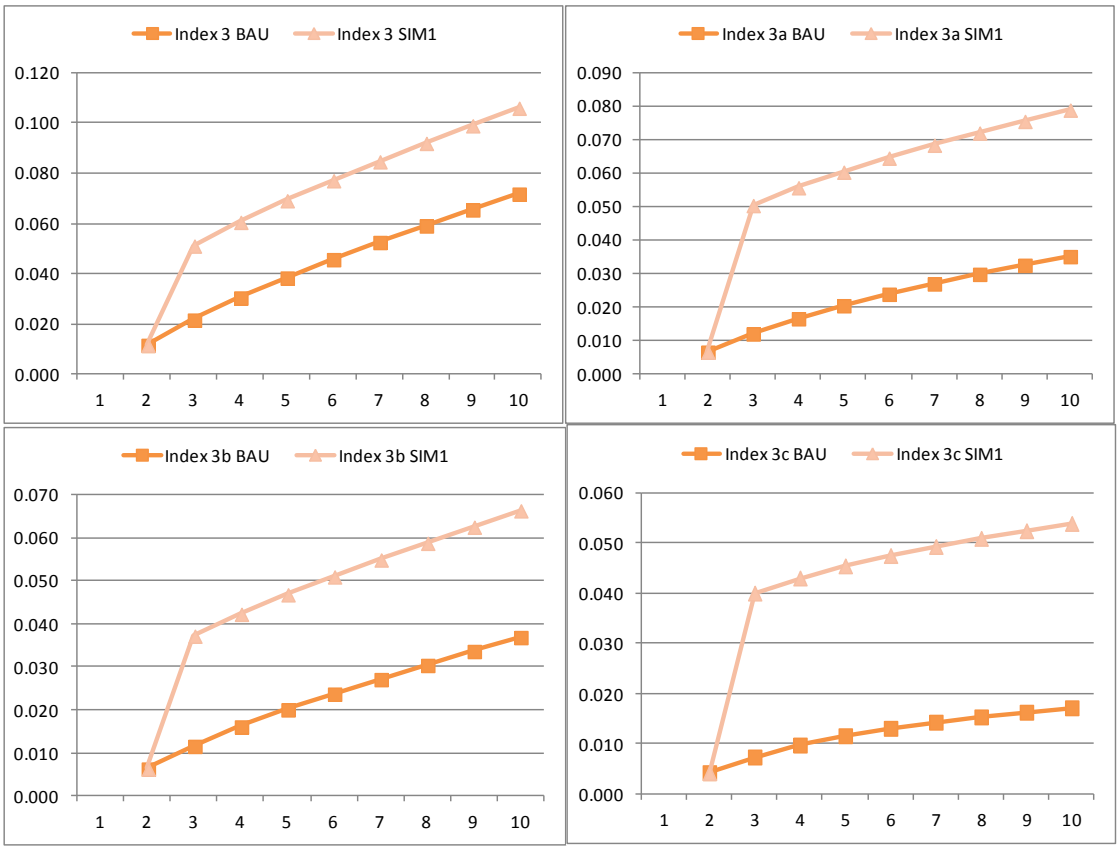
Another point that may be raised when using such an index based on the total agricultural output is the relevance of this indicator as total agricultural output is composed of food as well as non-food items. In addition, when it comes to reducing food insecurity, it is important to focus on the major food staples. In our case, the latter are composed of cereal namely teff, barley, wheat, maize, sorghum and other cereal crops such as oats. We therefore recalculate our food security index by using the total output in these food crops (the indexes are FSindex1a, FSindex2a, and FSindex3a). Finally, agricultural output may

be destined to exports reducing the food available on the local market. Similarly, food may be imported increasing the food available. We therefore push our analysis of the impact of public investment in training and irrigation further by using total domestic supply of agricultural products (local output minus exports plus imports). Our index distinguishes between total agricultural goods and food crops as discussed above (the indexes are FSindex1b, FSindex2b, and FSindex3b when using total domestic supply of agricultural goods and FSindex1c, FSindex2c, and FSindex3c when using total domestic supply of major food staples).

The policy has potential for reducing food insecurity when using output of major food staples. FSindex1a is 3.5% higher after the shock compared to the BAU scenario. The same applies when using total domestic supply of agricultural products. FSindex1b is 2.3% higher after the shock compared to the BAU scenario. Finally, when using total domestic supply of food major staples, FSindex1c is 3% higher after the shock compared to the BAU scenario.

The following figure presents the changes in the food security index3 which takes into account changes in consumer price index. All type 3 indexes show the policy has potential for reducing food insecurity and this in a more accelerated manner compared to BAU scenario. Food supply increases faster than in the BAU scenario and prices decrease in a more important pace compared to the BAU scenario. The result tables are available in the Annex.

Figure 18 – Changes in food security index 3



Impact on poverty

The public investment in training simulated in this scenario will reduce poverty if it increases household real consumption. It will be pro-poor if it improves the situation of the poorest. Total agricultural labor income declines. Similarly, land income declines even more. Income from livestock capital also falls. The productivity shock introduced is not high enough to counteract the fall in agricultural skilled labor and irrigated land income. In contrast, capital income increases by 0.95% the third year and by 0.39% the last period.

Rural poor and rural non-poor households see their nominal income decline as shown below. Their major income sources are employed in agriculture where return to factors has declined although for non-poor rural ones, 41.1% of their income comes from non-agricultural capital. Urban households in contrast see their income increase essentially due to positive changes in capital income. Rural households' disposable income and consumption budget fall while it is the opposite for urban households.

Table 18 – Changes in household total income, disposable income and consumption budget

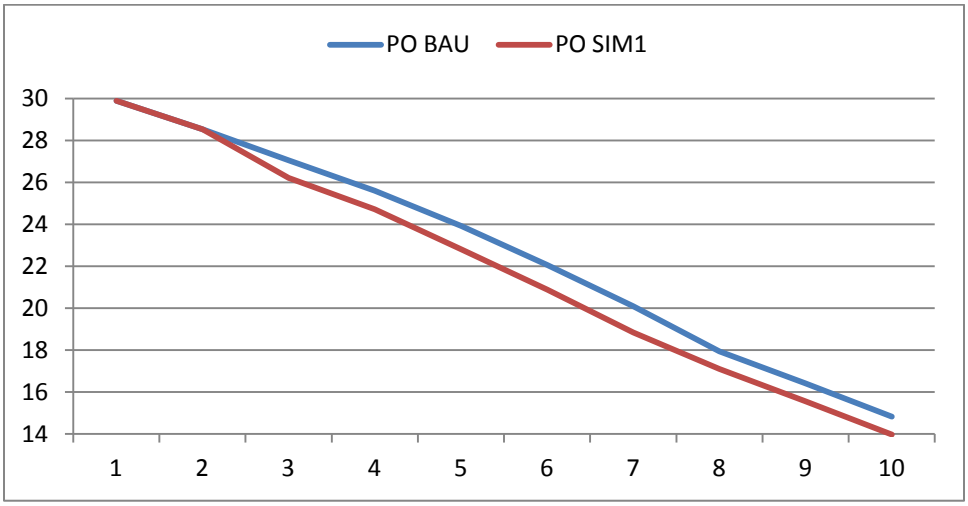
	Household income		Household disposable income		Household consumption budget	
	T3	T10	T3	T10	T3	T10
Poor rural households	-0.7%	-0.6%	-0.7%	-0.6%	-0.7%	-0.6%
Non-poor rural households	-0.2%	-0.4%	-0.2%	-0.4%	-0.2%	-0.4%
Poor households in small urban settlements	1.1%	0.5%	1.1%	0.5%	1.1%	0.5%
Poor households in large urban settlements	1.0%	0.4%	1.0%	0.4%	1.0%	0.4%
Non-poor households in small urban settlements	1.2%	0.6%	1.2%	0.6%	1.2%	0.6%
Non-poor households in large urban settlements	1.0%	0.5%	1.0%	0.5%	1.0%	0.5%

In parallel to the income effects, there are price effects that also affect the consumption level and pattern of representative households. The CPI has dropped by 0.5% and agricultural commodities prices have fallen even more (-1.7%) at the third period and price changes are amplified across time. These commodities hold an important share in the consumer food basket in Ethiopia making the drop in agricultural CPI more important for increasing household consumption.

The micro-simulation results show that poverty declines by 1.6% for the year following the public investment shock (T3). Over the period of 10 years, the number of poor declines by 8.4% in total. In

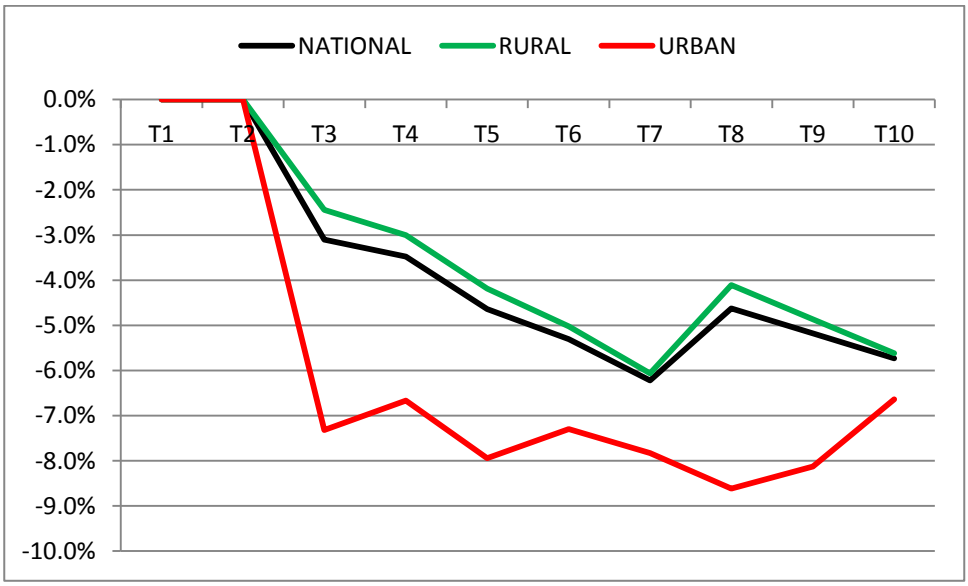
addition, the rate of decline in poverty incidence accelerates over the years compared to the BAU scenario.

Figure 19 – Changes in poverty incidence



The following presents impacts on poverty differentiated by location.

Figure 20 – Changes in poverty incidence: national rural and urban



As reflected by the above figure, urban and rural poverty decline. However, urban poverty falls more than rural poverty. This is due to the fact that urban households' income increased while that of rural households declined. This means that the policy has positive outcomes in terms of reducing poverty but it is not pro-poor. Indeed, if we look at the poverty incidence at the base year, it is higher than the national average (29.9%) for rural households (30.6%) while it is much lower for urban ones (26.5%). P0 declines significantly more for urban households.

Table 19 – Changes in FGT indices

	BAU T1			SIM1 T3			SIM1 T10		
	P0	P1	P2	P0	P1	P2	P0	P1	P2
NATIONAL	29.9	6.3	1.9	26.2	5.2	1.5	14.0	2.4	0.7
RURAL	30.6	6.5	2.0	27.6	5.4	1.6	15.1	2.6	0.7
URBAN	26.5	5.6	1.8	19.5	3.8	1.1	8.4	1.4	0.4
NATIONAL				-3.1%	-4.8%	-5.0%	-5.7%	-6.3%	-5.8%
RURAL				-2.4%	-4.2%	-4.7%	-5.6%	-5.8%	-6.7%
URBAN				-7.3%	-8.9%	-9.5%	-6.6%	-9.1%	-11.9%

Poverty depth and poverty severity also decline when considering national level variations. However, at a more disaggregated level, the policy intervention is not pro-poor. The poverty gap is much higher for the rural population but it declines less than that of urban households. According to the poverty severity index, compared to urban households, rural households have a higher risk of being in poverty, but their poverty is not significantly more severe. Nevertheless, the policy is not pro-poor as P2 declines much more for urban households. However, it is to be noted that although it is not pro-poor, poverty incidence, poverty gap and poverty severity decline for all types of households. In addition, rural settings concentrate over 80% of the population. Therefore, a 2.4% decline in poverty incidence in rural areas will pull out of poverty a much greater number of poor than a 7.3% reduction in urban settings.

Overall, the three simulations have shown that investing in irrigation alone does not translate into increased growth, lower food insecurity and the impact on poverty is negligible. As the economy is labor intensive, investing in training for farmers has a great potential for reducing food insecurity and poverty. A combination of investment targeted towards increasing the skill of farmers combined with an investment in irrigation is more efficient. In addition, these trainings and irrigation schemes should enable a greater increase in productivity as the 2% increase simulated here is not sufficient to bring about notable changes in particular with raising the income of the rural poor.

Conclusion

This research paper attempted to measure the potential impact of public investment in farmer training and irrigation schemes. Skill development and irrigation are two targeted areas of government agriculture development policy. We use a dynamic CGE model to simulate a 10% increase in public investment for farmers' training and a 15% increment in investment for irrigation. Three scenarios are simulated, one for each type of investment and a third one that combines the two. All public investment increment simulations are complemented by a productivity shock that increases the productivity of skilled agricultural labor and irrigated land with regards to agricultural output. The model is run over a period of 10 years. A poverty module is constructed using a top-down approach based on household income and expenditure survey. The analysis of simulation results is structured to address three major questions: i) What is the impact on growth and is there an agriculture-led development? 2)What are the potentials of the policy to reduce food insecurity? Iii) Can such investments reduce poverty and is the policy pro-poor?

A 10% increase in public investment in training for farmers results in the contraction of agricultural GDP while growth is positive in manufacturing and services sectors. Although agricultural GDP contracts, public investment increases agricultural output resulting in some level of agriculture-led development. Backward production linkages operate as the increase in agricultural output implies some increase in demand for industrial products used as inputs for agricultural production which represent 37% of total inputs used in agriculture. Also, due to the fall in the prices of agricultural products, those industries that are intensive in agricultural intermediate inputs will also benefit (23% of intermediate inputs utilized in the manufacturing sector are agricultural products). However, these forwards and backward production linkages do not to generate growth in manufacturing sector where output contracts. Consumption linkages whereby increases in agricultural income would lead to increased demand for non-agricultural final consumption goods do not operate here as agricultural labor and land income fall. Although there is no apparent agriculture-led industrialization, the policy intervention has a real potential to contribute to reducing food insecurity as agricultural output increases and prices fall, in particular agricultural commodities prices that constitute more than half of household consumption basket, i.e. major food staples. The same applies for domestic supply of food. The micro-simulation results show that poverty declines by 1.7% the year following the public investment shock. Over the period of 10 years, the number of poor declines by 8.1% in total. At a disaggregated level, the public investment shock reduced urban poverty more than rural poverty. It is therefore not pro-poor. However, it is to be noted that although it is not pro-poor, poverty incidence, poverty gap and poverty severity decline for all types of households. In addition, rural settings concentrate over 80% of the population. Therefore, a 1.2% decline in poverty incidence in rural areas will pull out of poverty a much greater number of poor than a 6.4% reduction in urban settings.

The 15% increase in public investment in irrigation results in the transformation of 4.7% of non-irrigated land into irrigated land. The policy generates economic growth as overall GDP at market price increases slightly. Changes in GDP at sector level also show little progress over the ten-year period. Agricultural

growth expands by 0.24% and GDP increases by 0.19% in manufacturing while it remains nearly unchanged in services sector. There is no agriculture-led development in this scenario through backward nor forward linkages. Total output contracts by 0.1%. Agricultural output contracts by 0.2% and total manufacturing output declines a little less. Consumption linkages operate to a small extent as agricultural labor income increases by 1.3% offsetting the contraction in land and capital income. As agricultural output as well as agricultural output of major food staples decline, the policy does not have the potential to reduce food security. The food security index declines further because commodity prices have increased. Supply of food through imports is not possible as the little increase in exports does not allow importing more food. The micro-simulation results show that poverty declines by 0.3% for the year following the public investment shock. Over the period of 10 years, the number of poor declines by 1.6% in total. Poverty declines because the income effect offsets the price effect. The policy is more beneficiary to the rural poor while poverty rises in urban settings.

The last scenario combines the two types of public investments along with a 2% productivity increase. The increase in public investment for training and irrigation schemes results in the transformation of 3.8% of unskilled agricultural labor into skilled labor and 4.7% of non-irrigated land into irrigated land. The policy simulation slightly increases economic growth but agriculture GDP contracts a little. There is some level of agriculture-led development. Public investment in training and irrigation results in an increase in agricultural output by 1.5% the last period. Agriculture-led development through backward linkages does not generate growth in manufacturing sector where output contracts but increases a bit in services sector. Forward linkages are likely to operate in a positive manner following the fall in the prices of agricultural products, those industries that are intensive in agricultural intermediate inputs will benefit from the decline in agricultural input price. Development through consumption linkages does not take place as income from factors employed in agriculture falls reducing agricultural income. The policy has a potential to reducing food insecurity as agricultural output increases while the consumer price index falls. Output of major food staples increases even more while prices fall further. Food security approached through total domestic supply of agricultural products and major food crops also shows an even greater potential for reducing food insecurity. The micro-simulation results show that poverty declines by 1.6% for the year following the public investment shock. Over the period of 10 years, the number of poor declines by 8.4% in total. In addition, the rate of decline in poverty incidence accelerates over the years compared to the BAU scenario. Poverty depth and poverty severity also decline when considering national level variations. Poverty in both urban and rural areas decline. However, urban poverty falls more than rural poverty. This is due to the fact that urban households' income increased while that of rural households declined. This means that the policy has positive outcomes in terms of reducing poverty but it is not pro-poor. Despite this, poverty incidence, poverty gap and poverty severity decline for all types of households. In addition, rural settings concentrate over 80% of the population. Therefore, a 2.4% decline in poverty incidence in rural areas will pull out of poverty a much greater number of poor than a 7.3% reduction in urban settings.

Overall, the research shows that investing in training and irrigation contributes to reducing food insecurity and to accelerating poverty reduction. Exports expand and in particular in cash crops that

have the potential of generating higher income at household level and national level by increasing foreign currency inflows necessary for importing inputs including fertilizers for agricultural production.

The results also show that an agriculture led development is less likely to occur because even if over one third of intermediate inputs utilized in agricultural production come from the manufacturing sector, a significant share of these inputs are imported. This weakens the production linkages between agriculture and manufacturing sectors.

The three simulations have shown that investing in irrigation alone does not translate into increased growth, lower food insecurity and the impact on poverty is negligible. As the economy is labor intensive, investing in training for farmers has a great potential for reducing food insecurity and poverty. A combination of investment targeted towards increasing the skill of farmers combined with an investment in irrigation is more efficient. In addition, these trainings and irrigation schemes should enable a greater increase in productivity as the 2% increase simulated here is not sufficient to bring about notable changes in particular with raising the income of the rural poor.

The increment in public investment has crowding-out effects that affects the expansion of manufacturing and services sectors which are highly intensive in non-agricultural private capital. This exercise showed that the Ethiopian government policy strategy regarding agriculture sector development has a great potential for reducing poverty and food insecurity. An agriculture-led development does not occur in our case also because of the contraction of private investment in the manufacturing sector. Financing such investment plans may require an alternative allocation of public resources or even a different financing mechanism.

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Annex

Table A1 – Changes in food security index - Simulation 3

Time	Index 1			Index 2			Index 3		
	BAU	SIM1	Change	BAU	SIM1	Change	BAU	SIM1	Change
1	0.878	0.878	0.0%						
2	0.888	0.888	0.0%	0.011	0.011	0.0%	0.012	0.012	0.0%
3	0.896	0.920	2.6%	0.021	0.047	128.8%	0.022	0.051	135.5%
4	0.903	0.926	2.6%	0.028	0.055	92.7%	0.031	0.061	98.5%
5	0.909	0.932	2.5%	0.035	0.061	74.6%	0.039	0.069	79.9%
6	0.914	0.937	2.5%	0.041	0.067	63.6%	0.046	0.077	68.5%
7	0.919	0.942	2.5%	0.046	0.072	56.2%	0.053	0.085	61.0%
8	0.923	0.946	2.5%	0.051	0.077	50.8%	0.059	0.092	55.4%
9	0.927	0.950	2.5%	0.056	0.081	46.6%	0.066	0.099	51.0%
10	0.931	0.954	2.4%	0.060	0.086	43.2%	0.072	0.106	47.6%
Time	Index 1a			Index 2a			Index 3a		
	BAU	SIM1	Change	BAU	SIM1	Change	BAU	SIM1	Change
1	0.333	0.333	0.0%						
2	0.335	0.335	0.0%	0.007	0.007	0.0%	0.007	0.007	0.0%
3	0.337	0.349	3.5%	0.012	0.047	298.3%	0.012	0.051	313.9%
4	0.338	0.350	3.4%	0.016	0.051	221.0%	0.017	0.056	233.6%
5	0.340	0.351	3.4%	0.019	0.054	182.1%	0.021	0.061	193.2%
6	0.341	0.352	3.4%	0.022	0.057	158.7%	0.024	0.065	168.9%
7	0.341	0.353	3.4%	0.024	0.059	142.9%	0.027	0.069	152.5%
8	0.342	0.354	3.4%	0.027	0.061	131.3%	0.030	0.072	140.6%
9	0.343	0.354	3.4%	0.029	0.064	122.4%	0.033	0.076	131.4%
10	0.343	0.355	3.4%	0.030	0.065	115.2%	0.035	0.079	123.9%
Time	Index 1b			Index 2b			Index 3b		
	BAU	SIM1	Change	BAU	SIM1	Change	BAU	SIM1	Change
1	0.707	0.707	0.0%						
2	0.712	0.712	0.0%	0.006	0.006	0.0%	0.006	0.006	0.0%
3	0.715	0.732	2.3%	0.011	0.034	210.9%	0.012	0.037	219.9%
4	0.718	0.734	2.3%	0.015	0.038	154.4%	0.016	0.042	162.0%
5	0.720	0.737	2.3%	0.018	0.041	125.9%	0.020	0.047	132.7%
6	0.722	0.739	2.2%	0.021	0.044	108.4%	0.024	0.051	114.6%
7	0.724	0.741	2.2%	0.024	0.047	96.3%	0.027	0.055	102.3%
8	0.726	0.742	2.2%	0.026	0.049	87.4%	0.030	0.059	93.2%
9	0.728	0.744	2.2%	0.029	0.051	80.3%	0.034	0.063	85.7%
10	0.729	0.745	2.2%	0.031	0.054	74.4%	0.037	0.066	79.7%
Time	Index 1c			Index 2c			Index 3c		
	BAU	SIM1	Change	BAU	SIM1	Change	BAU	SIM1	Change
1	0.346	0.346	0.0%						

2	0.348	0.348	0.0%	0.004	0.004	0.0%	0.004	0.004	0.0%
3	0.349	0.359	3.0%	0.007	0.037	426.8%	0.007	0.040	447.5%
4	0.349	0.360	3.0%	0.009	0.039	327.1%	0.010	0.043	343.9%
5	0.350	0.360	2.9%	0.011	0.040	278.6%	0.012	0.045	293.5%
6	0.350	0.361	2.9%	0.012	0.042	250.7%	0.013	0.047	264.5%
7	0.351	0.361	2.9%	0.013	0.043	232.7%	0.014	0.049	245.9%
8	0.351	0.361	2.9%	0.014	0.043	220.0%	0.015	0.051	232.8%
9	0.351	0.362	2.9%	0.014	0.044	210.4%	0.016	0.052	222.9%
10	0.351	0.362	2.9%	0.015	0.045	202.5%	0.017	0.054	214.8%