

# The Economy-Wide Impact of Harnessing Human Capital Development: A Dynamic Computable General Equilibrium Model Analysis

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# Abstract

This study uses a Computable General Equilibrium (CGE) model to analyse the impact of skilled and semi-skilled labour supply shocks on the overall Ethiopian economy and sectoral outputs. The study considers three policy scenarios: a 10% increase, a 15% increase, and a 20% increase in skilled and semi-skilled labour supply compared to a business-as-usual (BAU) scenario. The results of the study show that all the three scenarios lead to higher economic growth, investment, and exports. The impact on sectoral outputs is also positive, with the industry and services sectors performing better than the agriculture sector. Specifically, the results of a 20% increase scenario show that real annual Gross Domestic Product (GDP) growth rate will be 0.79 percentage points higher than the business-as-usual scenario. It also shows that annual growth rates of investments and exports will be 2.69 and 2.31 percentage points higher, respectively, than the business-as-usual scenario counterparts. Furthermore, annual production of the agriculture sector grows marginally by 0.16 percentage points, higher than the business-as-usual scenario. Output in the industry sector also increases by 1.61 percentage points higher than the business-as-usual scenario, while outputs in the services sector improve significantly as well. Overall, the study finds that increasing the supply of skilled and semi-skilled labour has a positive impact on the economy. This is because skilled and semi-skilled workers are more productive and can contribute to higher economic growth. The findings of this study have important implications for policy makers. Governments could implement policies to increase the supply of skilled and semi-skilled labour, for example by investing in education and training programmes. This would boost economic growth and improve the living standards of the population.

**Keywords:** *Skill-biased labour supply shock, Computable General Equilibrium (CGE) model, Social Accounting Matrix (SAM), Learning-by-Doing Growth Hypothesis, Skill mismatch, Business As Usual (BAU), High Growth (LS20), Medium Growth (LS15), Low Growth (LS10), and Investment in education and training programmes.*

# 1. Introduction

## Background of the study

Since the 1980s, the critical role of human capital for economic growth and poverty reduction has been recognised, and many theories on the role of human capital on economic growth have evolved. In these theories, human capital, which refers to skills, talents, education, and abilities that human workers possess, fundamentally affect the development endeavour. From a macroeconomic perspective, the accumulation of human capital improves labour productivity, facilitates technological innovations, increases return to capital and makes growth more sustainable, which in turn helps to reduce poverty. This implies that human capital at the macro level is a key factor of production in the economy-wide production function. From a microeconomic point of view, education, which is proxy for human capital, increases the probability of being employed in the labour market and enhances the earnings' capacity of an individual. Therefore, at the micro level, human capital contributes to an individual's labour productivity and earnings, while being an important component of firm production. In this context, human capital refers to the ability and efficiency of an individual to transform raw materials and capital into goods and services, and there is a consensus that these skills can be gained through the educational system.

In growth theory, Solow-Swan's growth model has been considered as the workhorse model of growth theory against which alternative economic growth models are referenced. The growth model of Solow-Swan, which is commonly referred to as the neoclassical growth model, concluded that there is no long-run economic growth attained by accumulating capital alone without technological progress in the economy, due to the assumption of diminishing returns to factors that force the economy to stop growing (Andreas and Thanasis, 2009; Acemoglu, Laibson and John, 2019; Romer, 2019). Technological improvements over time are assumed to overcome the effect of diminishing returns, as can make factors (labour) more productive. In the human capital extended neoclassical (Solow-Swan) growth model of Mankiw, Romer and Weil (1992), in which both physical and human capital are included in the production function, it was found that the source of growth is again technological progress (Andreas and Thanasis, 2009).

An alternative growth model as a way to get out of the effect of diminishing returns is to assume a production function that is not subject to diminishing returns. Such a model, often termed as AK model, assumes that output is a linear function of capital,

such that economies characterised by such production functions will accumulate physical capital continuously without experiencing diminishing returns. The AK model seems to be a modified version of the Harrod-Domar growth model, which concludes that the rate of output growth is determined by the ratio of savings and capital-output ratios. The proposition of this growth is that since savings rate is low and capital-output ratio is high due to scarcity of capital in many developing countries, it is essential to accelerate growth by increasing the savings rate to absorb the growing labour force and reduce poverty (Ararat, 2009).

However, in the endogenous growth model, the process of technical change or accumulation of knowledge is not constant and predetermined; it is rather dependent on the model's features. Accumulation of knowledge can be explained as new production techniques, implementation of new management and organisational structure and accumulation of scientific knowledge. Such knowledge accumulation can boost the level of human capital in the economy, which has a positive effect on the productive capacity of an economy (Andreas and Thanasis, 2009). Thus, human capital accumulation is useful to avoid the limiting influence of diminishing returns, and leads to economic growth even in the absence of technical progress, at least in the short-term. It is agreed that a way to achieve sustainable long-run growth is by means of continuous improvement of the production process through adoption of new technology and methods. In this context, Romer (1990) stated that human capital development will lead to higher economic growth by virtue of innovation-enhancing effect of educated workers, as they carry out research and development (Romer, 1990). Therefore, human capital contributes to raising the rate of productivity by enhancing faster innovation of domestic products and services, and by adopting technologies developed elsewhere.

## **Human capital development in Ethiopia**

Ethiopia, with a population of over 115 million, is the second-most populous country in Africa. It has a young population, with 40% of Ethiopians below the age of 15. However, with decreasing agricultural land per holder, the potential of the agricultural sector to support the youth bulge is not promising, as shown in the works of Schmidt and Woldeyes (2019). Accordingly, if not proactively managed, the youth would not find employment opportunities, and jobless youth could be unused potential and a source of discontent. With the right policy, however, the youthful population could be an asset in driving the development agenda the country has set, aimed at reducing poverty.

Moreover, from an individual perspective, studies suggest that individuals with more education tend to have better employment opportunities and greater earnings, and produce more output than those with less education. These findings have been a strong rationale for governments and households to invest a significant proportion of their funds in education, hoping that higher benefits will accrue over time to the economy and households. In this context, education is believed to be an investment that enables individuals to be equipped with knowledge and skills that improve the chance of being employed by enhancing their productive capacities.

The Government of Ethiopia recognised that education is a critical tool to prepare the youth so that they engage positively in the transition from an agrarian to a modern society. Thus, the government has allocated significant funds to the education sector in recent years. This has increased the total number of education centres (formal education), and many youths have enrolled. Since 2015/16, school enrollment has exceeded 20 million and 2.4 million students in primary and secondary schools, respectively. The number of technical and vocational education and training (TVET) centres has also increased. Likewise, the number of primary and secondary schools has reached 37,742 and 3,687 in the years 2019/20, respectively. The number of students in primary and secondary schools surpassed 20.4 million and 3.4 million in 2019, respectively.

Despite the commendable gains in growth of the number of students, there are questions regarding the quality of education, where a large portion of those in primary education could not make it to secondary education. Moreover, there are also disparities among the different regions of the country in terms of access. The fact that students fail to complete secondary education means that they are less likely to benefit through gaining employment.

**Table 1.1: Formal education developments**

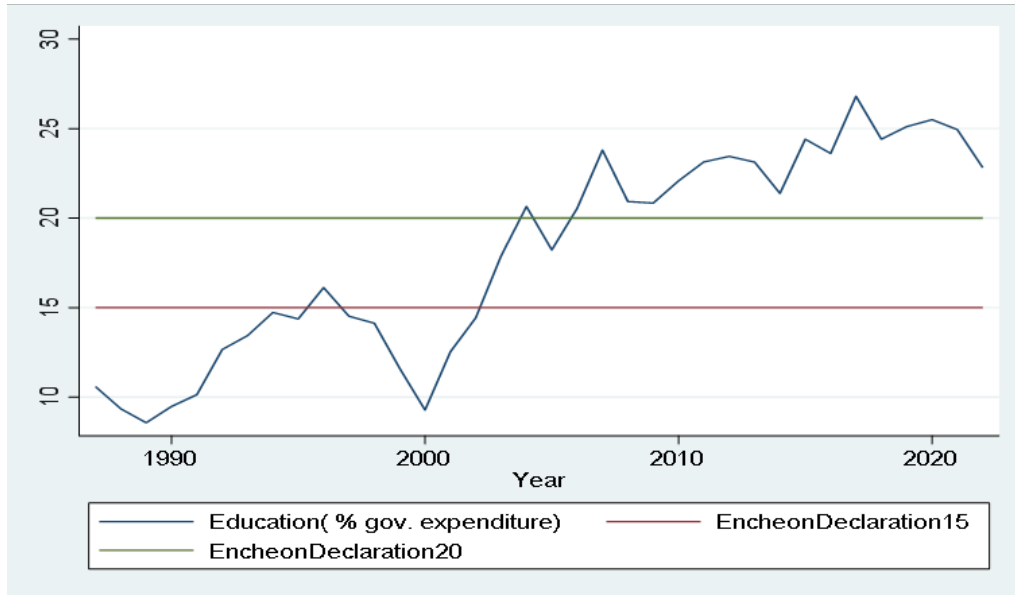
Particulars	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
Primary schools	33,373	34,867	35,887	36,437	37,039	37,742	35,980
Secondary schools	2,830	3,156	3,380	3,589	3,739	3,687	3,481
No. of universities	33	37	37	49	50	55	56
<b>School enrolment</b>							
Primary (million)	18.7	20	20.8	20.7	20.04	20.4	18.4
Secondary (million)	2.11	2.42	2.56	2.67	2.82	3.47	3.54
TVET (thousands)	265.75	304.14	302.08	292.38	317.73	386.81	283.97

Source: National Bank of Ethiopia, Annual Report 2020/21

Ethiopia has also made technical and vocational education and training (TVET) central to the education strategy. The TVETs are meant to develop the skills of the youth and help them join the labour market. As of 2015/16, there were over 300,000 students in TVET institutions. However, Krishnan and Shaorshadez (2013) argue that the TVET programme in Ethiopia has been supply-driven, despite the strategy emphasizing flexibility in the TVET programme to accommodate the demand for TVET students (Krishnan and Shaorshadez, 2013).

Spending on education is the most important policy tool that policy makers have at their disposal. Accordingly, the Incheon Declaration for implementing the Sustainable Development Goal (SDG) 4 recommends spending 4% to 6% of GDP or 15% to 20% of total government expenditure on education (UNESCO, 2015). In Ethiopia, education expenditure as a share of total government expenditure has been increasing and was 24% in 2018, up from 14% in 1994. In fact, Ethiopia has been exceeding the internationally set target of 20% total expenditure.

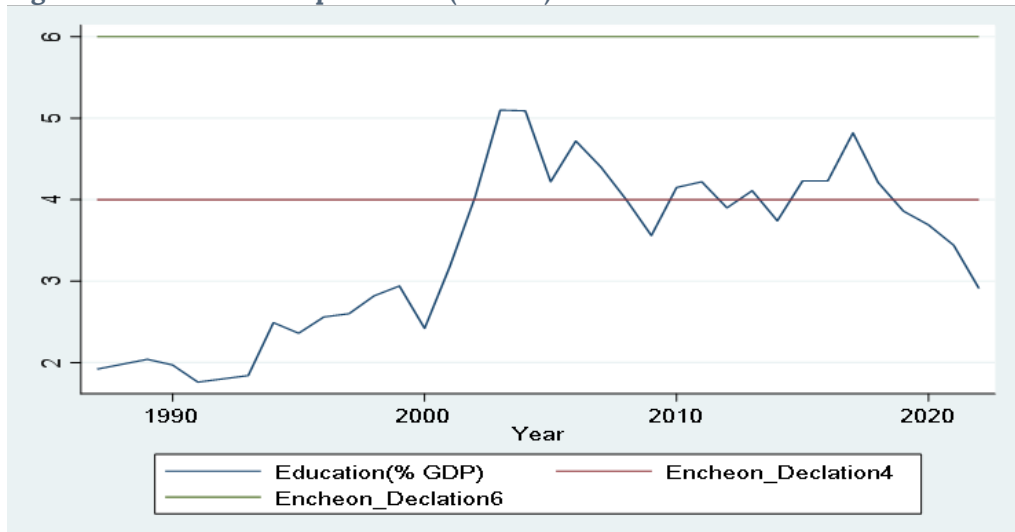
**Figure 1.1: Education expenditure (% total government expenditure)**



Source: Ministry of Finance

Ethiopia has been spending above 4% of GDP on education since 2005. In short, Ethiopia spent significant resources to promote education. As a result, access to education has improved. However, anecdotal evidence suggests that the impact on development has fallen short of expectation. Prichett (2001) argues that a perverse governance environment, falling marginal return, and low quality of education are possible explanations for the lackluster performance in several developing countries (Pritchett, 2001)

**Figure 1.2: Education expenditure (% GDP)**



Source: Ministry of Finance

As of 2018, the total education expenditure was US\$ 3.4 billion (or 92.6 billion ETB), up from just US\$ 1 billion a decade ago. Education expenditure has increased in shares and in levels and per capita terms over the last couple of decades.

Despite the public investment in education, the largest share of income (34%) went to labour without formal education in 2016, and it was even after a slight decline from what it was in 2011. However, progress is slower than expected, considering the investment that went into the education sector.

The educational strategy has been designed with special attention to TVET and science and technology education. Moreover, it is supposed that university (and TVET) industry linkage is given due attention in the human capital development strategy. It is also widely accepted that in-service training is one way of enhancing human capital development as workers are more likely to specialise and become skilled with moderate level of training. Tables 1.2 and 1.3 reveal a compelling trend: a shift in the way human capital is utilised within the economy. The proportion of unskilled labour (Lab – No Education) has dipped from 36.47% in 2011 to 34.04% in 2015/16. Conversely, the share of skilled labour (Lab – Tertiary Education) has grown from 5.70% in 2011 to 8.46% in 2015/16. This coincides with a rise in the contribution of non-agricultural capital, from 26.45% in 2011 to 36.76% in 2015/16. These figures point towards a structural transformation. The economy appears to be moving its focus towards sectors with higher productivity, such as industry and services, and away from agriculture.

**Table 1.2: The share of factors in value added in 2011**

<b>Factors of Production</b>	<b>Share of Income</b>
Lab – No Education	36.47
Lab – Primary Education	7.09
Lab – Secondary Education	7.37
Lab – Tertiary Education	5.70
Capital Land Rural	11.88
Capital Livestock Rural	4.07
Non-Agricultural Capital	26.45

Source: IFPRI SAM for 2011

**Table 1.3: The share of factors in value added in 2016**

<b>Factors of Production</b>	<b>Share of Income</b>
Lab – No Education	34.05
Lab – Primary Education	7.37
Lab – Secondary Education	3.29
Lab – Tertiary Education	8.46
Capital Land Rural	7.32
Capital Livestock Rural	2.75
Non-Agricultural Capital	36.76

Source: PSI-EU SAM 2016

Given that the government has allocated significant amounts of funds to the education sector, enabling a large population of youths to access schooling in the formal education and in-service training, it is essential to assess the contribution of skilled and semi-skilled workers to economic growth of Ethiopia.

## **Objective**

The objective of the study is to analyse the economy-wide impact of skilled biased technological progress on economic growth and income distribution.

The specific objectives are the following:

- (i) Analyse the effect of human capital development on economic growth and on sectoral output growth.
- (ii) Analyse the effects of skilled and semi-skilled labour supply shock on economic growth and other macroeconomic performances.
- (iii) Analyse the contribution of skilled and semi-skilled labour supply shock on sectoral growth and structural transformation.
- (iv) Investigate the effect of skilled biased labour supply shocks on factor income, government revenue and income changes by types of households.

This study is organised as follows. Section two is a short review of related literature on the human capital and growth nexus. Section three covers database description and specification of methodology of the study and section four presents empirical results and discussions of the main findings. Lastly, section five concludes the major study results and suggests recommendations based on the findings of the study.

## 2. Review of related literature

Economic growth theory has evolved over time, with different perspectives emerging from different historical periods. Modern growth theory is often associated with the work of Frank Ramsey in 1928, who used an inter-temporality separable utility function to show that reducing current consumption in favour of savings would lead to higher future consumption and output. In the aftermath of World War II, growth economists began to formulate growth models based on the economies of developed countries. These models focused on factors such as capital accumulation, technological progress, and human capital as drivers of economic growth.

The Harrod-Domar model is considered as the first growth model in the modern growth theories, which came to existence after the Great Depression. It created a coherent economic growth analysis in terms of putting the present theories in their historical perspective. It is a synthesis of the results of two consecutive independent studies conducted by Roy Harrod titled "An Essay in Dynamic Theory" and by Evsey Domar with the title "Capital Expansion, Growth and Employment" (Harrod, 1939; Domar, 1946). The Harrod-Domar model is basically a Keynesian model of economic growth and explains an economy's growth rate in terms of the level of savings and of capital. According to this growth model, with historically determined and constant savings rate and capital output ratio, the maximum rate of growth of the capital stock is determined by the ratio of savings rate to capital output ratio (Ararat, 2009). With the assumption that the rate of growth of capital stock is the same as the rate of economic growth and a constant capital-output ratio, then economic growth rate is an increasing function of the savings rate.

The implication of the Harrod-Domar model is that since savings ratio is low but capital output ratio is high in developing countries, there will be low growth, a priori that cannot absorb the rapidly growing population. To absorb the growing labour force, countries need to accelerate economic growth beyond the traditional limit of savings rate and capital output ratio by increasing the savings rate to the level that generates rates of economic growth that are sufficient to absorb the new labour force. Since the model assumes a direct relationship between output and the capital stock, with incremental capital-output ratio, physical capital accumulation is emphasised (Andreas and Thanasis, 2009). The Harrod-Domar model and other earlier models neglected in their analyses the role played by technological advances and human capital in economic growth.

The neoclassical growth model of Solow–Swan is considered as a workhorse model of growth theory against which alternative growth models are refined and referenced. The model demonstrated a situation of zero growth at the steady state, since an increase in savings increases growth temporarily but cannot last indefinitely and offers insights into how the economy can achieve an alternative steady state with positive economic growth (Andreas and Thanasis, 2009; Ararat, 2009). The Solow–Swan model is based on a production function that displays diminishing returns in the factors of production (capital and labour) and admits constant returns to scale together with the Inada conditions<sup>1</sup> and the assumption of essentiality<sup>2</sup> and constant savings rate in which households save a fixed proportion of their income (Andreas and Thanasis, 2009; Acemoglu, 2009; Robert and Xavier, 2004; Philippe and Peter, 2009).

With a diminishing return to factors, the Solow–Swan model shows how economic policy can raise economic growth rate by inducing savings rate, but such an increase in growth cannot last indefinitely; that is, there will be no long-run economic growth and the economy will stagnate to its zero growth in dynamic equilibrium. Therefore, countries with higher savings rate will have higher per capita income at the steady state than poor countries, but will have zero economic growth in the long-run. For the long-run growth to take place, there must be a way to overcome the diminishing returns so that productive inputs accumulate over time through introduction of exogenous technological progress.

The main message from the simple Solow–Swan model is that accumulation of capital alone without technological progress cannot act as a source of long-run economic growth because, at some point, diminishing returns will set in and the economy will stop growing. This steady state property is not changed, with the extension of Solow–Swan model by Mankiw, Romer and Weil (1992) that assumes an aggregate output function which includes physical capital, human capital and labour measured in efficiency units (Andreas and Thanasis, 2009). Another extension of Solow–Swan model that relaxed the assumption of a constant savings and adopting consumer maximising behaviour named as Cass-Koopmans-Ramsey model (CKR model) also does not lead to qualitatively different equilibria outcomes from the basic Solow–Swan model.

According to endogenous growth theory, accumulation of human capital is an important contributor to economic growth. There are several cross-country studies which suggest that educational attainment can contribute significantly to the production of overall output in an economy. Accordingly, the process of technological change or accumulation of knowledge takes many forms, from accumulation of basic research to scientific types that deal with experience acquired in connection with skills that are used at the firm level. New production techniques and implementation of new management and organisational structures are part of this process. All these forms of knowledge accumulation exert different influences on the productive capacity of the economy.

Thus, the endogenous growth model incorporates a new concept of human capital; the skills and knowledge that makes workers more productive. Accordingly, unlike physical capital where there are constant returns, human capital has increasing rates of return, such that economies never reach a steady state, and growth does not slow as capital accumulates.

It is important to note that modern growth theory is not without its critics. Some economists argue that the theory is too simplistic and does not adequately account for the complex factors that influence economic growth. Others argue that the theory is more applicable to developed countries than developing countries. Despite its limitations, modern growth theory remains an important framework for understanding the drivers of economic growth. It has been used to inform policies in many countries around the world.

## **3. Database and model specification**

### **Introduction**

Ethiopia is endowed with human capital as the country's population is expected to exceed 120 million by 2021. The fact that a country has a large young population increases the possibility of enhancing human capital to support the economy. Recognising the contribution of human development, the Government of Ethiopia has allocated significant amount of budget to the education sector.

In a country such as Ethiopia where a huge amount of money is spent in the development of human capital, labour is an important factor and a source of livelihood for many. This means that labour-use and labour-related policies will have far-reaching implications on the economy and livelihood. Therefore, to analyse the impact of alternative labour-use and labour-related policies, we need a framework that takes the economy as a whole; that is, the contribution of human capital development on economic growth and other effects need to be analysed. A Computable General Equilibrium (CGE) model specifies the economy as a whole and allows us to analyse the impact of a policy change on the economy as a whole and its sectoral breakdown. Moreover, the framework will allow us to examine the distributional impacts of a policy change on households and government income, which is crucial for financing development projects and other public services.

In this study, a Computable General Equilibrium (CGE) model analysis is used to better understand the contribution of education or human capital development in economic growth and other sectoral effects in Ethiopia.

### **The CGE model description and scenarios**

In this study, we use the recursive dynamic version of the IFPRI CGE model (Thurlow, 2008; Dorosh, Robinson and Ahmed, 2011).<sup>3</sup> The model simulates the functioning of an economy and tracks detailed backward and forward linkages between different actors in the economy. In line with the behaviour of economic agents, the model is formulated as a set of simultaneous linear and non-linear equations. It also captures the economic environment in which these different agents operate. This environment is often represented by market equilibrium conditions, macroeconomic balances, and dynamic updating equations (Thurlow, 2008).

To bring about equilibrium in the various macro accounts, it is essential to specify a set of macro closure rules, which provide a mechanism through which adjustments will take place. The model that we are going to use includes three macroeconomic closures that are useful for balancing the macro variables. For the government balance, the model assumed a flexible government savings regime with fixed tax rates and government consumption. This implies that government savings adjust to balance a possible gap between government income and expenditure. For the external (current account) balance, the model assumed a flexible exchange rate regime with fixed foreign savings, indicating exchange rates adjustment to balance the gap between exports and imports. To balance the savings and investments, the model uses a savings-driven investment closure that assumes a fixed marginal propensity to save for all non-government institutions. This choice of closure is consistent with the neoclassical and recent endogenous growth theory that prior savings is the most important in determining the economy's level of investment and outputs. Accordingly, savings is exogenous and that investments adjust passively to maintain the savings-investments balance. However, the Keynesian view reverses the causality found in the neoclassical growth theory by arguing that investment is exogenous and savings adjust to balance the savings-investments gap. Moreover, consumer price index is chosen as a numeraire, such that all prices in the model are relative to the weighted unit price of households initial consumption bundle (Thurlow, 2008).

In addition to these three macro-closures, the system also relies on factor market closures. First, the total labour supply for each type is exogenous and fully employed in the static version of the model. However, while skilled labour is assumed to be fully employed and activity-specific, semi-skilled and unskilled labour is assumed to be partially unemployed and mobile across activities. Capital is also assumed to be fully employed and sector-specific (Diao, Thurlow and Benin, 2012). Productivity improvements due to growth in skilled labour and semi-skilled labour developments are introduced by improving total factor productivity (TFP).

In analysing the impact of skilled and semi-skilled labour supply shocks on the entire economy and sectoral outputs, we have adopted policy scenarios. A benchmark scenario is the base case scenario or **Business As Usual** scenario (**BAU**), where policy makers pursue the same approach on labour use and related policies as before. In this scenario, labour supply growth is maintained at 2.7%, which is equal to the growth rate of population. We further consider three scenarios, a 10% increase of skilled and semi-skilled labour supply in all sectors so that growth rate of such factor will be maintained at 2.97%, which we refer to as **Low Growth Scenario (LS10)**.<sup>4</sup> The second scenario is a 15% further increase of skilled and semi-skilled labour supply so that skilled and semi-skilled labour increases by 3.105%, which we refer to as **Medium Case Scenario (LS15)**. The third scenario is a 20% increase in skilled and semi-skilled labour supply, which we refer to as **High Growth Scenario (LS20)**.

In this recursive dynamic model, selected parameters are updated based on the modelling of inter-temporal behaviours and results of the previous year. Current economic conditions such as availability of capital are therefore endogeneously

estimated from the past investment generating new capital stock in the subsequent period but remained unaffected by forward looking expectations. Allocation of new capital investment across sectors is influenced by each sector's initial share of aggregate capital income, but the total sectoral allocation of capital in the current period depends on capital depreciation and sectoral profit from earlier periods. The demographic and technological changes are also updated based on projected trends. In other words, population growth is exogenously imposed on the model based on separately calculated growth projections, and it is also assumed that the new consumer preferences are the same as the existing ones. Moreover, factor-specific productivity growth is imposed exogenously on the model based on observed trends of capital and labour. Growth in government consumption and transfers spending is also exogenously determined between periods.

The dynamic model is solved as a series of equilibria, each one representing a single year. Thus, by imposing several policy independent dynamic adjustments, the model produces a projected or counterfactual growth path. Policy changes can then be expressed in terms of changes in relevant exogenous parameters following the policy shocks. The model is then resolved for a new series of equilibria. The difference between policy-induced growth path and that of counterfactual can then be interpreted as economy-wide impact of the simulated policy.

## The database

The main database that will be used for this study is the 2015/16 Ethiopian SAM, which is referred to as PSI-EU-SAM. The PSI-EU-SAM was developed by the Policy Studies Institute and Joint Research Centre of the EU. This SAM for Ethiopia has disaggregated activity groups, commodity groups, factors, household groups, tax instruments, and aggregate accounts for trade and transport margin, government, enterprise, investment, and the rest of the world. There are two versions of the SAM with different disaggregation of agricultural activities. One uses administrative regions, and the other uses agroecological zones.

Each activity in the SAM uses intermediate inputs and factors to produce one or more commodities. The section of the SAM dealing with intermediate inputs and factors is referred to as the Use Table. Each activity uses commodities that are either produced by the same activity or other activities, and imported commodities as intermediate inputs. Value added is the payment by activities to factors of production, such as labour, capital, and land. In the PSI-EU-SAM, four categories of labour are identified based on their education<sup>5</sup> (i.e., uneducated, primary, secondary, and tertiary). A SAM version with disaggregation of labour into urban and rural, based on residence, is also available. Capital is categorised into land, livestock, and non-agricultural capital.

Table 3.1 presents the macro version of the PSI-EU-SAM that represents the Ethiopian economy at an aggregate level. It is composed of activity (A) that is an aggregate of several activities, each producing commodities that are aggregated and represented by a single commodity account (C). The macro-SAM also includes an

aggregated factor of production F (aggregate of labour, capital, land, and livestock), an enterprises (ENT) account, an aggregated household (H) account, Government (GOV) and different taxes (TAX), savings and investment (S-I), rest of the world (ROW) accounts, and a total (TOTAL) account. This macro-SAM is of the period 2016.

**Table 3.1: Endogenous and exogenous accounts of Ethiopian Macro-SAM (in billions Birr)**

	A	C	F	ENT	H	GOV	TAX	S-I	ROW	TOTAL
A		2,103.2			213.6					2,316.8
C	907.3				883.8	148.8		588.7	122.4	2,651.0
F	1,409.5								3.8	1,413.2
ENT			542.4			8.0			0.5	550.8
H			868.2	388.5		11.0			132.3	1,400.1
GOV				19.9	7.6		192.7		27.2	247.3
TAX		121.4		42.0	29.2					192.7
S-I				99.2	259.1	75.5			154.8	588.7
ROW		426.4	2.7	1.2	6.8	3.9				441.0
TOTAL	2,316.8	2,651.0	1,413.2	550.8	1,400.1	247.3	192.7	588.7	441.0	

Source: Based on PSI-EU-SAM

## 4. Empirical results and discussions

### Some statistical facts

The pace of structural transformation in terms of creating employment opportunity in Ethiopia is slow and dominated by agriculture. According to data from the UN Statistical Yearbook (2022), the share of job opportunity in the agricultural sector was about 78% in 2005, while this figure dropped to 63% in 2021. Whereas the industry and services sectors provided less than 20% in 2005, employment in such sectors improved modestly to 36% in 2021, where the services sector takes the larger share during this period.

**Table 4.1: Trends of employment by sector and gender**

<b>Employment</b>	<b>Sector</b>	<b>2005</b>	<b>2010</b>	<b>2015</b>	<b>2021</b>
(%) Male and Female	Agriculture	78.1	73.6	68.3	63.7
	Industry	7.3	7.9	8.9	10.1
	Services	14.5	18.4	22.8	26.2
(%) Male	Agriculture	82.1	78.7	74.6	70.7
	Industry	3.0	7.1	9.3	12.1
	Services	12	14.2	16	17.2
(%) Female	Agriculture	73.4	67.7	60.9	55.3
	Industry	9.1	8.9	8.2	2.4
	Services	17.5	23.4	30.9	36.6

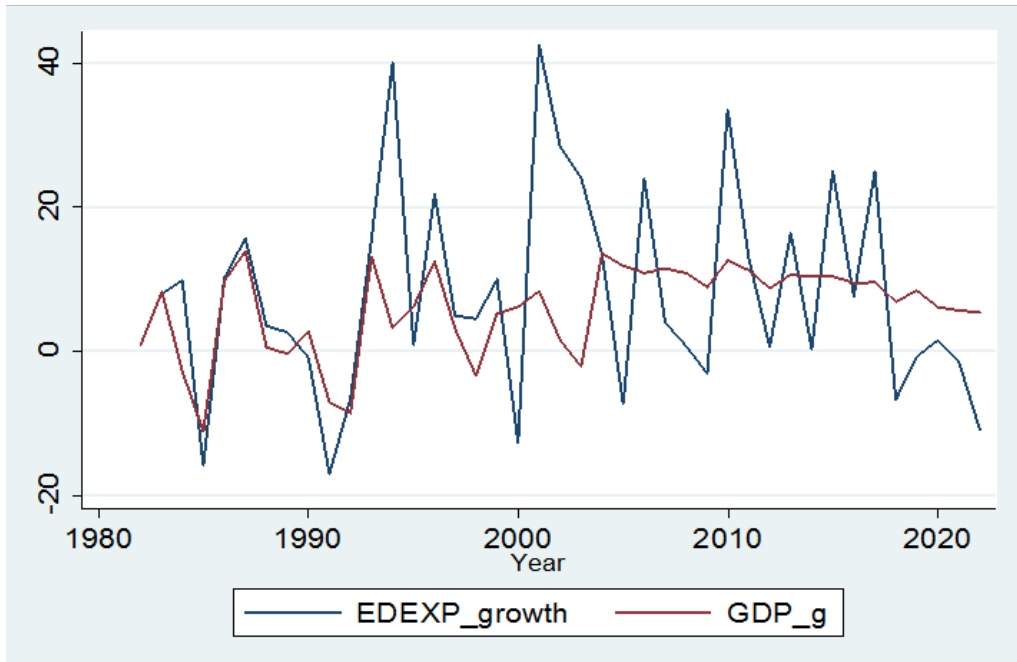
Source: UN Statistical Yearbook 2022 edition

Another important point to be raised is the real growth of education expenditure compared to the growth rate of real GDP. As shown in Figure 4.1, the real growth rate of education expenditure before 2018 was oscillating around the growth rate of real GDP. However, after 2018, the growth rate of educational expenditure departs further from the growth rate of real GDP.

It seems that the growth rate of education expenditure in Ethiopia has been outpaced by the growth rate of real GDP in recent years. This suggests that the Ethiopian government is giving lower weight to education in terms of allocating funds. This is a concerning trend, as education is essential for economic growth

and poverty reduction. Individuals with more education tend to have higher earnings and are more likely to be employed. Education also helps to promote social cohesion and reduce crime. The Ethiopian government should reconsider its approach to education funding and ensure that education receives a fair share of the budget. This will ensure that Ethiopia's youth are equipped with the skills and knowledge they need to succeed in the workforce and contribute to the country's development.

**Figure 4.1: Growth rates of per capita GDP and education expenditure**  
CGE Model Simulation Results and Discussion



In this sub-section, we are going to discuss the estimated result of the CGE model under several scenarios. The focus of this sub-section is to analyse the effect of skill-biased labour supply shock on the entire economy and sectoral effects on agriculture, industry and services sectors in Ethiopia.

### ***Impact on GDP and other macroeconomic variables***

The trend in GDP and other major macroeconomic variables under the different labour supply scenarios is provided in Table 4.1. There are three trends worthy of note.

Under the high growth scenario (LS20), annual compounded GDP growth rate will be 0.79 percentage points higher than BAU scenario, in which the annual compounded growth rate of GDP in the base case scenario is 4.91%, while that of the high growth scenario is 5.70%. This result points to the fact that mobilising

skilled and semi-skilled workers can increase economic performance under the high growth-oriented scenario, although the growth difference in the such a case is not that much higher compared to that of the medium case scenario (LS15). In other words, the current human resource expansion trajectory has improved significantly, coming closer to the production possibility frontiers. Likewise, in the high growth scenario, annual investment and export growth will be 6.92% and 12.33% respectively, compared to the initial values, implying that these growth rates are 2.69 and 2.31 percentage points higher than under the BAU scenario, respectively. The growth rates under the high growth scenario (LS20) are higher than the growth rate of the medium growth scenario (LS15). This suggests that there is an unexploited growth potential, which improves and sustains the growth path and employment opportunities.

Under the second scenario (LS15), the annual real GDP growth will be 0.74 percentage points higher than the BAU counterpart, since annual real GDP grows by 5.65% in the LS15 scenario, while the growth rate under the base case scenario is 4.91%. The performances of exports and investments under this scenario are also extraordinary, with average annual growth difference against the BAU scenario of 2.23 and 2.63 percentage points higher, respectively, where exports will grow by 12.25% and investments will grow by 6.86%. Imports grow annually by about 5.38% of the initial value, whereas in the base case scenario, it grows by 4.23%, implying that imports' growth is 1.15 percentage points higher than the BAU scenario.

In the third scenario (LS10), annual real GDP growth will be 5.61% of the initial value, and this growth rate is 0.70 percentage points higher than the growth rate in the BAU scenario. Exports and gross capital formation (investments) will also grow, on average, by 12.16% and 6.79%, respectively, per annum. These growth rates are 2.14 and 2.56 percentage points higher than the growth rate under the BAU scenario.

In general, the resulting increase in GDP and other macroeconomic variables are significant, with the impact in the high growth (LS20) scenario being much substantial compared to the low growth (LS10) scenario and the BAU scenarios. Yet, in all the scenarios, private consumption declines modestly by close to 1 percentage point compared to the BAU scenario, although there is an average yearly increase of more than 4% in every scenario. However, there will be a continuous and sustained growth in domestic absorption due to a continuous growth of imports and domestic production. There will also be an increase in net indirect tax and imports in all the scenarios considered.

**Table 4.2: Simulation results of major macro variables (annual compounded % change from initial value)**

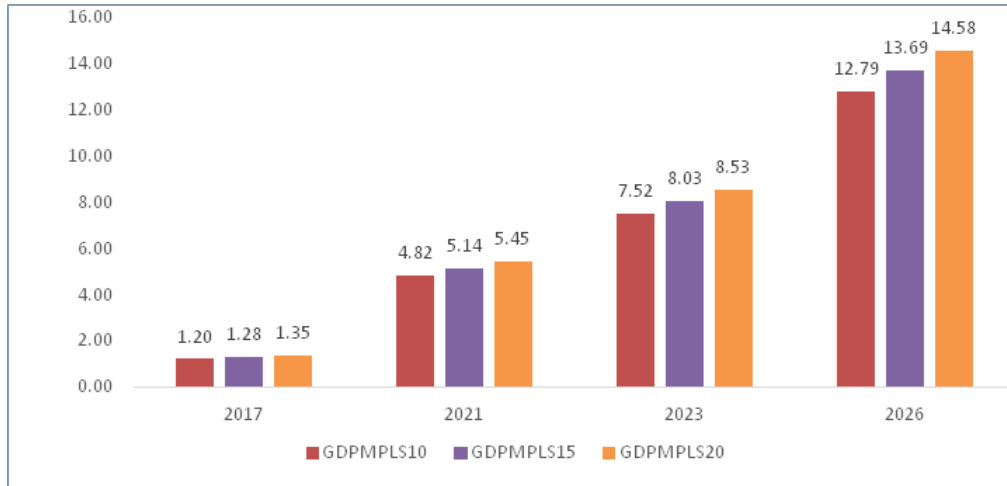
Variable	Base	LS10	LS15	LS20
GDP at market price	4.91	5.61	5.65	5.70
Absorption	4.3	4.92	4.96	5.01
Private consumption	4.82	4.36	4.39	4.42
Gross fixed investment	4.23	6.79	6.86	6.92
Exports	10.02	12.16	12.25	12.33
Imports	4.23	5.33	5.38	5.43
Net Indirect TAX	3.50	3.62	3.65	3.68
Percentage % from BAU scenario				
GDP at market price		0.70	0.74	0.79
Absorption		0.62	0.66	0.71
Private consumption		-0.46	-0.43	-0.40
Gross fixed investment		2.56	2.63	2.69
Exports		2.14	2.23	2.31
Imports		1.10	1.15	1.20
Net Indirect TAX		0.12	0.15	0.18

Source: Model simulation results based on PSI-EU-SAM

As Figure 4.2 shows, the impact of skilled and semi-skilled labour supply shock on GDP is low at earlier times, and the effect has become substantial in the high growth scenario and in the latter times. There could be two possible reasons as to why the impact on GDP is higher in the high growth scenario and at the latter times:

- The effect of an increase in skilled and semi-skilled labour supply under the LS20 in the simulation, is higher than the case in the medium growth scenario (LS15) and other scenarios, suggesting that a higher proportion of skilled and semi-skilled workers will increase the aggregate productivity more than the case where the proportion of skilled and semi-skilled is low.

The skilled and semi-skilled labour supply expansion will have limited economic effect at the earlier periods because it takes time for productivity improvements to have economy-wide impact. This is because productivity of skilled and semi-skilled labour is impacting the economy after few years of workers' engagement, consistent with the learning-by-doing growth hypothesis of endogenous growth theory.

**Figure 4.2: Change in GDP (% change from BAU)**

Source: Model simulation results based on PSI-EU-SAM

### ***Impact on sectoral output***

The following are major effects of the different skilled and semi-skilled labour supply shocks on the resulting sectoral compositions (Table 4.2).

First, the agriculture sector benefits the lowest across all scenarios. Under the high growth scenario (LS20), the annual production of the agriculture sector increased marginally by 0.16 percentage points compared to the BAU scenario. Under the medium growth scenario (LS15), growth in the agriculture sector output is still modest, and it is only 0.13 percentage points higher compared to the BAU scenario, which is still lower than the impact on GDP. In other words, the impact on agriculture, in proportion, is lower than the impact on GDP, as the impact on GDP is 0.84 percentage points high per annum on average terms in the high growth scenario compared to the BAU scenario. The impact will also be 0.74 percentage points high in the medium growth scenario compared to the BAU scenario. In the low growth scenario (LS10), the impact on agricultural outputs is still minimal but positive and much smaller than the impact on GDP. The reason for low impact of the simulation results on agriculture is that the agriculture sector is the one that is more reliant on unskilled labour, whose supply is reduced as more workers are migrating to the industry and services sectors following improved human capital development.

Second, although the contribution to GDP of the industry sector is still small, the role of the industry has been improving over time. Its contribution increased by 1.61 percentage points higher than the BAU scenario, and under the high growth scenario (PS20). It also increased by 1.57 percentage points higher than the BAU scenario under the medium growth scenario (LS15). The effect on the services sector is also relatively better than the case in agriculture in all the scenarios. Under the

high growth scenario (LS20), the services sector grows by about 1.04 percentage points higher than the growth in the BAU scenario, while in the medium growth scenario (LS15), the services sector grows by nearly 1 percentage point higher than the growth in the base case (BAU) scenario. Likewise, under the low growth scenario (LS10), the services sector grows by a margin of 0.93% compared to growth under the BAU scenario, which is still higher than the impact on GDP. Part of the reason for the higher impact on the industry sector is because of its moderate skill-intensive nature of industries' (manufacturing) activities compared to agricultural activities. The same is true for the services sector.

**Table 4.3: Simulation results of sectoral output growth**

Sector	BAU	LS10	LS15	LS20	% change from BAU		
					LS10	LS15	LS20
Agriculture	5.42	5.51	5.54	5.58	0.09	0.13	0.16
Industry	4.94	6.47	6.51	6.55	1.53	1.57	1.61
Services	4.54	5.47	5.52	5.58	0.93	0.99	1.04
Total VAD FC	5.02	5.76	5.81	5.86	0.74	0.79	0.84

Source: Model simulation results based on PSI-EU-SAM

### ***Factor income effect***

Table 4.4 shows the effect of the different scenarios on employment income in the country. Reflecting the decline in unskilled labour supply following increase in the supply of skilled and semi-skilled labour under the several scenarios, employment income of unskilled labour and semi-skilled labour will be lower compared to the BAU scenario by 2026. Annualised compounded growth rates comparison of the simulated impacts also show decrease in wage income for such labour. However, the total labour income for the skilled labour increases because of the increased proportion of these labour types being employed in the economy despite the decrease in wage rates compared to the BAU scenario. The highest increase of skilled labour income is observed under the low growth (LS10) scenario followed by the medium growth scenario (LS15), which might be associated with the moderate decline of wage rates in such scenarios.

Income from rural land and livestock increase marginally in all the scenarios considered, with the highest rent income increment in the high growth (LS20) scenario. This suggests that there are improvements on productivity of land and livestock due to increment in the supply of skilled and semi-skilled labour. However, income from non-agricultural capital is smaller in all the scenarios compared to the BAU scenarios. This may be due to the low marginal productivity of capital following excess skilled and semi-skilled labour supply shock, which is not accompanied by equivalent increase of capital.

**Table 4.4: Simulation results of factor income**

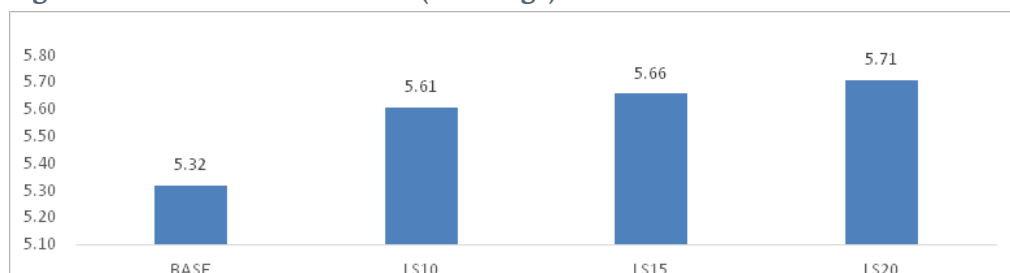
<b>Last year's % changes from INITIAL</b>				
<b>Labour type</b>	<b>BASE</b>	<b>LS10</b>	<b>LS15</b>	<b>LS20</b>
lab-n	62.78	58.28	59.09	59.90
lab-p	79.69	58.77	58.87	58.96
lab-s	79.65	70.61	70.55	70.49
lab-t	15.90	52.56	51.24	49.96
Capital Land Rural	93.18	106.19	107.45	108.70
Capital Livst Rural	82.32	84.36	85.47	86.58
Non-Agg-capital	68.63	36.61	37.51	38.40
<b>Annual compounded average % changes from INITIAL</b>				
lab-n	4.53	4.26	4.31	4.36
lab-p	5.47	4.29	4.30	4.30
lab-s	5.47	4.98	4.97	4.97
lab-t	1.35	3.91	3.83	3.75
Capital Land Rural	6.17	6.8	6.86	6.92
Capital Livst Rural	5.61	5.72	5.78	5.83
Non-Agg-capital	4.86	2.88	2.94	3.00

Source: Model simulation results based on PSI-EU-SAM

### ***Impact on the income of government and poor households***

Figure 4.3 shows that the change in government revenue, vis-à-vis BAU, follows an increasing pattern. Accordingly, government revenue is 0.29% higher than its BAU counterpart under the low growth (LS10) scenario. While the agricultural sector might not be a major source of direct tax revenue for the government, a surge in skilled and semi-skilled labour presents a significant opportunity. This is because these workers tend to be employed in industries and services – sectors that are typically easier and more efficient to tax compared to agriculture. As a result, a skill-biased shift in the labour supply can lead to a substantial increase in government tax revenue. In fact, as of 2015/16, tax from agriculture income and rural land use fee accounted for 0.04% of GDP (Mengistu et al., 2018).<sup>6</sup> Therefore, it is interesting to realise that government revenue increases, albeit marginally, by increasing the outputs of non-agricultural sectors.

A closer look at the macro simulation results, however, shows that there is a significant increase in imports and a decline in household consumption. As imports are one of the major sources of tax revenue, the increase in imports has generated more tax revenue than the potential revenues lost due to a decline in domestic consumption. In other words, the fiscal impact of the shock works through the decrease in domestic tax revenues that results from lower consumption of households and an increase in international trade taxes from increased imports. This works for all the scenarios; the high growth (LS20) scenario provides more revenue compared to the other scenarios. This is because the income under the BAU scenario is attributed to those who are self-employed, which is not taxable, whereas under the high growth (LS20) and medium growth (LS15) scenarios, increased income goes to labour in the formal sector, which is taxable compared to the BAU as growth is the result of productivity improvement.

**Figure 4.3: Government income (% change)**

Source: Model simulation results based on PSI-EU-SAM

Although understanding the full extent of the income distribution of the change in labour use is interesting, it is particularly important to examine the impact on the poor and in the middle (excluding those in the top 20%) as any change in their income leads to severe consequences.

Table 4.5 shows that income distribution by household groups is found in all the scenarios and, for all types of households, income decreases compared to the BAU scenario. However, compared to the initial level of income, there is modest increase of income for rural households compared to that of urban households.

To understand these patterns, notice that skilled and semi-skilled labour expansion does not have much effect on the income of the poor because they are already unskilled. If we consider the full impact, the income decline will be rather large in the low growth (LS10) scenario. To sum up, it should be noted that in all the scenarios, the impact of increases on skilled and semi-skilled labour supply shock has been significant even though the magnitude in each scenario is smaller than the business as usual (BAU) scenario.

**Table 4.5: Simulation results of income distribution by poverty household groups**

<b>Last year's % changes from INITIAL</b>					
<b>Household type</b>	<b>INITIAL</b>	<b>BASE</b>	<b>LS10</b>	<b>LS15</b>	<b>LS20</b>
Rural poor	164.83	67.61	61.81	62.66	63.51
Rural middle class	529.38	65.13	58.15	58.90	59.64
Rural rich	162.03	61.27	54.58	55.06	55.55
Urban poor	19.96	53.92	43.84	44.38	44.91
Urban middle income	179.50	58.60	46.03	46.54	47.05
Urban rich	303.14	53.95	48.25	48.39	48.53
<b>Annual compound % changes from INITIAL</b>					
Household type	INITIAL	BASE	LS10	LS15	LS20
Rural poor	164.83	4.81	4.47	4.52	4.57
Rural middle class	529.38	4.67	4.25	4.30	4.34
Rural rich	162.03	4.44	4.04	4.07	4.10
Urban poor	19.96	4.00	3.36	3.40	3.43
Urban middle income	179.50	4.28	3.50	3.54	3.57
Urban rich	303.14	4.00	3.64	3.65	3.66

Source: Model simulation results based on PSI-EU-SAM

## 5. Conclusion

We have examined the effect of human capital in the economy by applying the Computable General Equilibrium (CGE) model approach using the Social Accounting Matrix (SAM) of PSI. This study investigated the skill-biased labour supply shock effects on the Ethiopian economy. Based on the review of the literature and the data, the CGE analysis is made to have three plausible scenarios and comparison with a scenario of no action, referred to as Business As Usual (BAU). These scenarios are high growth (LS20) scenario, medium growth (LS15) scenario, and low growth (LS10) scenario. The **High Growth (LS20)** scenario is a model of growth based on an increase in 20% of skilled and semi-skilled labour supply in the economy. The **Medium Growth (LS15)** scenario is primarily inspired by increasing the labour supply of skilled and semi-skilled by 15% targeted to analyse the impact on growth. Finally, the **Low Growth (LS10)** scenario where we increase the supply of skilled and semi-skilled labour by 10% is designed to investigate the economy-wide effect and sectoral output effects of the economy.

We found four interesting results. First, GDP and the non-agriculture sectors' output increase noticeably under the Low Growth (LS10) and Medium Growth (LS15) scenarios and in the **High Growth (LS20)** scenario. Under these scenarios, the performance of exports, fixed investments, imports and net indirect tax has been encouraging. Second, growth under the LS20 scenario is even higher than in the BAU scenario, reflecting the fact that skill-biased labour expansion is a potential source for further growth and there is possibility to secure growth before reaching the limit. Under these scenarios, exports, gross fixed investments, imports, government revenue and tax improve significantly. Third, the impact on poor households under LS20 is close to the BAU scenario, which is better than other scenarios. Fourth, skill-biased labour supply shock has not responded in the earlier times but responded notably years after the shock is implemented, which is due to the time required to internalise the skills and knowledge of the human capital, consistent with the learning-by-doing growth hypothesis.

The study also found that the impact of skill-biased labour supply shock is not immediate, but rather takes some time to materialise. This is due to the time required to internalise the skills and knowledge of the human capital consistent with the learning-by-doing growth hypothesis.

The study concludes that taking appropriate policy measures is essential for stimulating the economy and better allocation of the available resources to sustain economic growth. Without immediate action, sub-optimal outcomes with long-lasting impacts are certain. Policies aimed at sustaining growth with the optimal allocation of the abundant resources such as labour in developing countries, should be evaluated, considering not just their immediate growth impact but also for the future evolution. To this end, it is essential to match skills trainings with labour market demand so that the effect of excess supply of labour into the economy may be positive. Thus, employment and education policies could be aligned to the demand of the economy, and thereafter monitor the effectiveness of the policies.

Based on the findings of the study, we recommend that governments:

- Invest in education and training to increase the supply of skilled and semi-skilled labour, which is necessary for diversification of the economy beyond agriculture.
- Educational programmes should be designed to equip graduates with the skills that are in demand by the labour market. This will improve the employability of graduates and reduce skill mismatches.
- Education and employment policies be monitored regularly to assess the effectiveness in ensuring if they are aligned with the needs of the economy and make adjustments as required.
- Governments improve the financial inclusion of entrepreneurs and small businesses so that they will grow and create more jobs most often in the non-agriculture sector where government can collect better tax revenues.

# Notes

1. Marginal product of capital (or labour) approaches infinity as capital (or labour) goes to 0 and approaches 0 as capital (or labour) goes to infinity.
2. An input is essential if a strictly positive amount is needed to produce a positive amount of output.
3. Detailed description of the models and their workings are presented in the Appendix.
4. That is, in this scenario, skilled and semi-skilled labour supply is increased by 2.97% ( $2.7+2.7*0.1$ ) and in the second scenario, skilled and semi-skilled labour increases by 3.105%. In the last scenario, the rate of increase of skilled and semi-skilled labour is 3.24%. The rate of increase of uneducated labour is adjusted in such a way that the total labour supply grows by 2.7%.
5. Uneducated are those with no formal education. Primary education refers to those with some formal education but have not completed high school. Secondary education refers to those who completed high school but not college; and tertiary education refers to those that completed college education.
6. Andualem Mengistu, Firew Bekele, Kiflu Gedefe (2018), “Domestic Resource Mobilisation in Ethiopia: Trends, Causes, and Prospects”, unpublished PSI report.

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# Appendix

## The CGE Model Specification

The following tables provide a complete listing of the model's variables, parameters and equations. Although these tables describe the South African model, it is largely based on the equation listing found in the Standard Computable general Equilibrium (CGE) Model of Lofgren et al (2002) International Food Policy and Research Institute (Lofgren, Harris, Robinson, Marcelle, & El-Said, 2002). However, the equation numbers do not correspond to those found in Lofgren et al (2002). Rather, the ordering of equations follows the description of the model found in Section 2 of this paper.

**Appendix Table 1: Model sets, parameters, and variables**

Symbol Sets	Explanation	Symbol	Explanation
$a \in A$	Activities	$c \in CMR(\subset C)$	Regionally imported commodities
$a \in ALEO(\subset A)$	Activities with a Leontief function at the top of the technology nest	$c \in CMNR(\subset C)$	Non-regionally imported commodities
$c \in C$	Commodities	$c \in CT(\subset C)$	Transaction service commodities
$c \in CD(\subset C)$	Commodities with domestic sales of domestic output	$c \in CX(\subset C)$	Commodities with domestic production
$c \in CDN(\subset C)$	Commodities not in CD	$f \in F$	Factors
$c \in CE(\subset C)$	Exported commodities	$i \in INS$	Institutions (domestic and rest of world)
$c \in CEN(\subset C)$	Commodities not in CE	$i \in INSD(\subset INS)$	Domestic institutions
$c \in CM(\subset C)$	Aggregate imported commodities	$i \in INSDNG(\subset INSD)$	Domestic non-government institutions
$c \in CMN(\subset C)$	Commodities not in CM	$h \in H(\subset INSDNG)$	Households

*continued next page*

Appendix Table 1 Continued

Symbol Sets	Explanation	Symbol	Explanation
<b>Parameters</b>			
$cwts_c$	Weight of commodity c in the CPI	$pwm_c$	Import price (foreign currency)
$dwts_c$	Weight of commodity c in the producer price index	$pwmr_{cr}$	Import price by region (foreign currency)
$ica_{ca}$	Quantity of c as intermediate input per unit of activity a	$qdst_c$	Quantity of stock change
$icd_{cc'}$	Quantity of commodity c as trade input per unit of c' produced and sold domestically	$qg_c$	Base-year quantity of government demand
$ice_{cc'}$	Quantity of commodity c as trade input per exported unit of c'	$qinv_c$	Base-year quantity of private investment demand
$icer_{cc'r}$	Quantity of commodity c as trade input per exported unit of c' from region r	$shif_{if}$	Share for domestic institution i in income of factor f
$icm_{cc'}$	Quantity of commodity c as trade input per imported unit of c'	$shii_{ii'}$	Share of net income of i' to i (i' ∈ INSDNG'; i ∈ INSDNG)
$icmr_{cc'r}$	Quantity of commodity c as trade input per imported unit of c' from region r	$ta_a$	Tax rate for activity a
$inta_a$	Quantity of aggregate intermediate input per activity unit	$tins_i$	Exogenous direct tax rate for domestic institution i
$iva_a$	Quantity of aggregate intermediate input per activity unit	$tins01_i$	0-1 parameter with 1 for institutions with potentially flexed direct tax rates
$mps_i$	Base savings rate for domestic institution i	$tm_c$	Import tariff rate
$mps01_i$	0-1 parameter with 1 for institutions with potentially flexed direct tax rates	$tmr_{cr}$	Regional import tariff
$pwe_c$	Export price (foreign currency)	$tq_c$	Rate of sales tax
$pwer_{cr}$	Export price by region (foreign currency)	$trnsfr_{if}$	Transfer from factor f to institution i

Source: South African Model and Lofgren et al (2002)

Symbol	Explanation	Symbol	Explanation
<b>Greek Symbols</b>			
$\alpha_a^a$	Efficiency parameter in the CES activity function	$\delta_c^t$	CET function share parameter
$\alpha_a^{va}$	Efficiency parameter in the CES value-added function	$\delta_{fa}^{va}$	CES value-added function share parameter for factor f in activity a
$\alpha_c^{ac}$	Shift parameter for domestic commodity aggregation function	$\gamma_{ch}^m$	Subsistence consumption of marketed commodity c for household h
$\alpha_c^g$	Armington function shift parameter	$\theta_{ac}$	Yield of output c per unit of activity a
$\alpha_c^t$	CET function shift parameter	$\rho_a^a$	CES production function exponent
$\alpha_c^m$	Shift parameter in the CES regional import function	$\rho_a^{va}$	CES value-added function exponent
$\alpha_c^e$	Shift parameter in the CES regional export function	$\rho_c^{ac}$	Domestic commodity aggregation function exponent
$\beta^a$	Capital sectoral mobility factor	$\rho_c^g$	Armington function exponent
$\beta_{ch}^m$	Marginal share of consumption spending on marketed commodity c for household h	$\rho_c^t$	CET function exponent
$\delta_a^a$	CES activity function share parameter	$\rho_c^m$	Regional imports aggregation function exponent
$\delta_{ac}^{ac}$	Share parameter for domestic commodity aggregation function	$\rho_c^e$	Regional exports aggregation function exponent
$\delta_c^g$	Armington function share parameter	$\eta_{fat}^a$	Sector share of new capital
$\nu_f$	Capital depreciation rate		
<b>Exogenous Variables</b>			
$\overline{CPI}$	Consumer price index	$\overline{MPSADJ}$	Savings rate scaling factor (= 0 for base)
$\overline{DTINS}$	Change in domestic institution tax share (= 0 for base; exogenous variable)	$\overline{QFS}_f$	Quantity supplied of factor
$\overline{FSAV}$	Foreign savings (FCU)	$\overline{TINSADJ}$	Direct tax scaling factor (= 0 for base; exogenous variable)
$\overline{GADJ}$	Government consumption adjustment factor	$\overline{WFDIST}_{\ast}$	Wage distortion factor for factor f in activity a
$\overline{IADJ}$	Investment adjustment factor		

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## Continued

Symbol	Explanation	Symbol	Explanation
<b>Endogenous Variables</b>			
$AWF_{ft}^a$	Average capital rental rate in time t	$QF_{fa}$	Quantity demanded of factor f from activity a
$DMPS$	Change in domestic institution savings rates (= 0 for base; exogenous variable)	$QG_c$	Government consumption demand for commodity
$DPI$	Producer price index for domestically marketed output	$QH_{ch}$	Quantity consumed of commodity c by household h
$EG$	Government expenditures	$QINTA_a$	Quantity of household home consumption of commodity c from activity a for household h
$EH_h$	Consumption spending for household	$QINTA_a$	Quantity of aggregate intermediate input
$EXR$	Exchange rate (LCU per unit of FCU)	$QINT_{ca}$	Quantity of commodity c as intermediate input to activity a
$GOVSHR$	Government consumption share in nominal absorption	$QINV_c$	Quantity of investment demand for commodity
$GSAV$	Government savings	$QM_c$	Quantity of imports of commodity c
$INVSHR$	Investment share in nominal absorption	$QMR_{cr}$	Quantity of imports of commodity c by region r

Source: South African Model and Lofgren et al (2002)

Symbol	Explanation	Symbol	Explanation
<b>Endogenous Variables Continued</b>			
$MPS_i$	Marginal propensity to save for domestic non-government institution (exogenous variable)	$QER_{cr}$	Quantity of exports of commodity c to region r
$PA_a$	Activity price (unit gross revenue)	$QQ_c$	Quantity of goods supplied to domestic market (composite supply)
$PDD_c$	Demand price for commodity produced and sold domestically	$QT_c$	Quantity of commodity demanded as trade input
$PDS_c$	Supply price for commodity produced and sold domestically	$QVA_a$	Quantity of (aggregate) value-added
$PE_c$	Export price (domestic currency)	$QX_c$	Aggregated quantity of domestic output of commodity
$PER_{cr}$	Export price by region (domestic currency)	$QXAC_{\alpha}$	Quantity of output of commodity c from activity a
$PINTA_a$	Aggregate intermediate input price for activity a	$RWF_f$	Real average factor price
$PK_{ft}$	Unit price of capital in time t	$TABS$	Total nominal absorption
$PM_c$	Import price (domestic currency)	$TINS_i$	Direct tax rate for institution i (i ∈ INSDNG)
$PMR_{cr}$	Import price by region (domestic currency)	$TRII_{ii'}$	Transfers from institution i' to i (both in the set INSDNG)
$PQ_c$	Composite commodity price	$WF_f$	Average price of factor
$PVA_a$	Value-added price (factor income per unit of activity)	$YF_f$	Income of factor f
$PX_c$	Aggregate producer price for commodity	$YG$	Government revenue
$PXAC_{\alpha c}$	Producer price of commodity c for activity a	$YI_i$	Income of domestic non-government institution
$QA_a$	Quantity (level) of activity	$YIF_{if}$	Income to domestic institution i from factor f
$QD_c$	Quantity sold domestically of domestic output	$\Delta K_{fat}^a$	Quantity of new capital by activity a for time t
$QE_c$	Quantity of exports		

Source: South African Model and Lofgren et al (2002)



## Mission

To strengthen local capacity for conducting independent, rigorous inquiry into the problems facing the management of economies in sub-Saharan Africa.

The mission rests on two basic premises: that development is more likely to occur where there is sustained sound management of the economy, and that such management is more likely to happen where there is an active, well-informed group of locally based professional economists to conduct policy-relevant research.

Bringing Rigour and Evidence to Economic Policy Making in Africa

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- Ensure sustainability.
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