Agriculture-Industry Linkages for Employment and Economic Transformation in Ethiopia

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Abstract

The quest for structural transformation, sectoral linkages, and employment creation are among the most primary development aspirations of Ethiopia. Using two Social Accounting Matrices (SAMs) (2005/2006 and 2015/2016), the study investigated sectoral linkages between agriculture and agro-processing to examine the Ethiopian economy's potential for structural transformation and job creation. The study used the Hirschman index to analyze the linkage between agricultural and agro-processing activities and SAM decomposition to sort out the key sources of the forward and backward linkages between agricultural and agro-processing activities and a decomposition of structural change analysis to examine the primary source of growth of outputs in key agro-processing activities. The study also examined the contribution of technical change to the total change in total production of various activities in the Ethiopian economy. The results in general showed that there was a weak linkage between the agriculture and agro-processing sectors over the period from 2005 to 2016. As of the result, all key agricultural activities have strong backward linkages. However, except for cereals and livestock, all agricultural activities have weak forward linkages. which entails that that there is no strong agro-processed sector that uses intensively domestically produced agricultural outputs as intermediate inputs. Some agro-processing activities, notably bakery/grain, vegetable oil, dairy, and alcohol, have higher backward linkages while the rest of the agro-processing sectors have weaker forward and backward linkages. Using the SAM decomposition analysis, the study found that the closed loop (consumption effect) is quite stronger than the within effect (production linkage). The study shows that there was a significant

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change in the production of various activities in the economy between 2005 and 2016. However, the change was due to a massive increase in final demand than to technical changes. The analysis further signified that the agricultural sector creates more demand for labor than agro-processing activities. The study recommends that policymaking focus on improving implementation capacity to promote systemic linkages between the agricultural and industrial sectors to improve the economy's overall productive capacity. Furthermore, national planners should give more attention to improving linkages between the agriculture and the agro-processing activities by focusing on technological or technical upgrades and fixing the looseness in the value chains of each agro-processing activity.

Keywords: SAM multipliers, linkages, structural change, structural transformation, Ethiopia
JEL Classification: E24; L16, O13

1. Introduction

There has been a strong consensus among scholars of development economics that the industrial sector, particularly manufacturing, possesses relatively much bigger potential than other sectors in terms of sustainably absorbing large amounts of labor force and achieving successful economic structural transformation. This mainly emanates from the sector's benefit from technological improvements, its high capacity to exhibit prolonged periods of increasing returns to scale, and its high potential for inducing the development of other sectors through its strong backward and forward linkages (Newman et al., 2016). As a result, manufacturing has historically received disproportionately favorable policy and financial support in many countries in different epochs.

It is evident that structural transformation cannot be achieved without strong linkages between agriculture and manufacturing, particularly at the early stages of the development process. Cognizant to this, economic development theories have given considerable attention to sectoral linkages since the 1950s. For instance, Lewis (1954) considered agriculture as less productive compared to manufacturing. He then suggested that the agricultural labor should be reallocated to the most productive manufacturing sector. According to Lewis, the role of agriculture was mainly to supply labor to the manufacturing sector, which expands continually through adoption of productivity-enhancing technologies. In a

definitive form, the essence of sectoral linkage was introduced by proponents of the unbalanced growth model, which believed that the manufacturing sector with higher forward and backward linkages should be promoted to induce growth and development (Hirschman, 1958)[4].

The development process of many countries has also clearly shown that at the earlier phase, countries tend to produce commodities which intensively use agricultural outputs as intermediate input and heavily rely on labor-intensive techniques. For instance, from recent experiences in South-East Asia, South Korea gave prime focus to the development of agro-processing industries such as textile and garment, food, and beverage at the early stages of industrialization in the 1970s (UNIDO, 2017). This development pathway helped South Korea and other South-East Asian countries to achieve sustainable growth, and structural transformation. For instance, from 1950 to 1990, industrial employment soared from 7% to 26.9% in South Korea, from 12% to 32% in Taiwan and from 19% to 29.5% in Singapore (UNCTAD, 1996).

Ethiopia has introduced a series of economic development policies and strategies since the formulation of its First Five-Year development plan (1957-63) to transform the economy and improve the lives and livelihoods of its citizens (Welteji, 2018). These development policies and strategies have promoted some selected sectors in their respective implementation periods. For instance, during the mid-1960s, the government anchored its economic development strategy on the development of sectors, such as agro-processing, mining, and power generation, with the ultimate objective of propping up domestic manufacturing capacity. This enabled the manufacturing sector to grow at an annual average rate of 16%, and thus the sector's share in the total Gross Domestic Product (GDP) reached 13% in 1967 from 9% in 1963 (UNDP, 2017). Aside from the usual role of supplying food for household consumption, agriculture was primarily intended to supply raw materials for the industrial sector. Unfortunately, the industrial growth could not be sustained with the same pace after Ethiopia joined the socialist block in 1974. The shift in the political ideology had been accompanied by reforms that encouraged public ownership of private enterprises and thus, the booming of the private sector left way for communal ownership. This adversely affected the status of the overall economy while industry sector growth drastically decelerated with a

[4]This theory explicitly recognizes the linkage between agriculture and the manufacturing as a source of sustainable economic development.

negative growth rate averaging 1.4% per annum over the seventeen-years (1973/1974 to 1990/1991) of the Dergue period.

Ethiopia reverted to a market-led economic system after the downfall of the socialist Dergue regime in 1991. Consequently, various reforms[5] have been initiated to speed up the transition into a market-based economic system partly supported by the structural adjustment program spearheaded by the World Bank and the International Monetary Fund. Ethiopia also introduced the Sustainable Development and Poverty Reduction Program (SDPRP) and the Plan for Accelerated and Sustained Development to End Poverty (PASDEP), which were used as guiding strategic frameworks during 2002/03-2004/05 and 2005/06-2009/10, respectively. The country has also introduced the Agricultural Development Led Industrialization (ADLI) strategy in 1993, and this has continued to be the overarching strategy for Ethiopia's development efforts, complementing the initiatives under the SDPRP and PASDEP, until the first Growth and Transformation Plan (GTP) was put in place in 2010. The main aim of the ADLI strategy was to achieve initial industrialization through robust agricultural growth and strong linkages between agriculture and industry.

Following many years of implementing SDPRP, PASDEP, and ADLI and recognizing their failures to deliver the intended goals in sustainably developing agriculture, let alone transforming the general economic structure, Ethiopia designed and implemented two successive growth and transformation plans (GTP I and GTP II) to induce comprehensive economic structural change. Again, the GTP I (2010/2011-2014/2015) and GTP II (2015/2016-2019/2020) also gave peculiar attention to industrialization. Priority industries, namely textile and apparel, leather and leather products, sugar, metal and engineering, chemical products, paper products, pharmaceutical products, and agro-processing industries, have been prioritized (MoFED, 2010). The argument was that industries can help diversify exports, increase foreign exchange earnings, promote linkages with the agricultural sector, create employment for the abundant labor force, and ensure rapid technology transfer.

Although Ethiopia has shown progress in selected indicators of economic development, the process of transitioning from agriculture to sectors with better productivity and higher returns on scale has been sluggish. The manufacturing subsector, which is conventionally known for its higher productivity and increasing returns to scale, has not been performing well in Ethiopia. For instance, the share of

[5] Such as devaluation, liberalization, and privatization.

the manufacturing subsector to GDP has remained low at less than 6.8%, and its share in merchandise export earnings stood at less than 13% by the end of 2019/2020 (PDC, 2021). In addition to this, the Ethiopian manufacturing sector is characterized by a lower degree of sophistication and integration, both within itself and with other sectors. As a result, the sector is dominated by light industries and has undergone a tardy transformation over several decades. Besides, average capacity utilization remained persistently low, partly due to high reliance on imported inputs, weak forward and backward linkages, frequent energy outages, and an inadequate supply of skilled labor (PDC, 2021).

The low intersectoral linkages within domestic economy and the lack of substantial improvements in both the agriculture and the industry sectors over the past few decades can also be looked at from the extent of the country's substituted imports of agro-processed products. Much of the agro-processed products in big supermarkets in Ethiopia have been imported (GAIN, 2016), signifying mainly very low level of import substitution and sluggish structural transformation, despite the implementation of various industrial development plans and strategies including the growth and transformation plan.

It is evident that sound policy making often requires a detailed assessment to reap larger economic benefits in the long-term. Among these, the link between agriculture and industry dominates the debates very often; and Ethiopia's urge for economic structural transformation revolved around this fact for the past several decades.

It is evident that the forward and backward interlinkages between agriculture and manufacturing sectors are important elements of the development process. Thus, the assessment of sectoral linkages lays the foundation to ensure sustainable economic development. Therefore, a proper understanding of sectoral linkages between agriculture and industry is necessary for designing appropriate long-term policies and strategies to achieve sustainable development by addressing the following research questions:

- To what extent do the priority industries (agro-processing) have backward and forward linkages?
- What are the hindering factors for sectors not to have high sectoral linkages within the economy?

There are numerous empirical studies on the topic of sectoral linkages in Ethiopia. However, these studies heavily focus on examining the impact of external

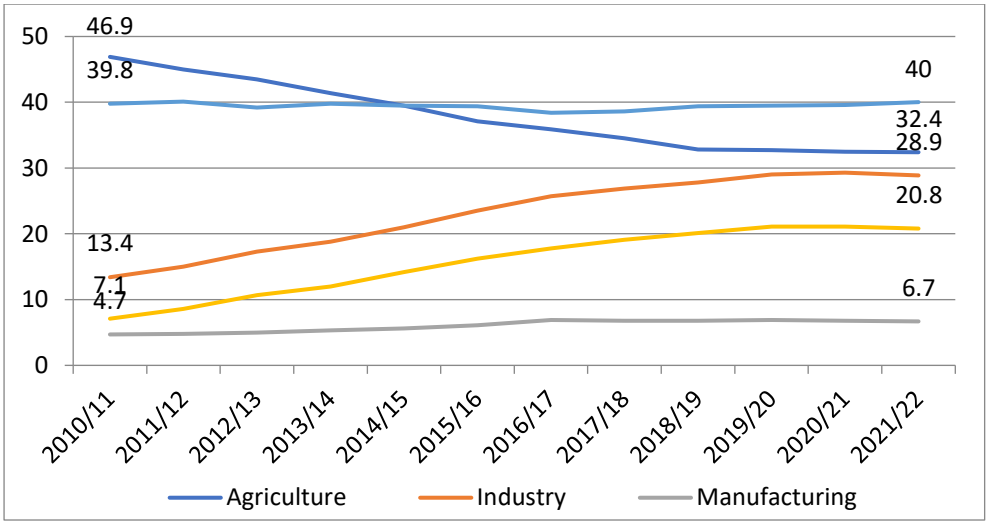
shocks (Tadele and Philip, 2005; Fekadu, 2007; Solomon, 2015). A critical examination of the policy context of Ethiopia from a sectoral linkage perspective using a quantitative method of analysis is lacking. Thus, this study aims at filling the research gaps using a Social Accounting Matrix (SAM) multiplier and decomposition analysis.

2. Overview of Ethiopia's Economy

2.1 General structure of Ethiopia's economy

Ethiopia is one of the poorest countries in the world. The country's per capita income reached US$ 1,021 in 2021/2022 (PDC, 2022), which is substantially lower than the Sub-Saharan Africa (SSA) regional average of US$ 1,645. In Ethiopia, the average economic growth rate of 10.5% from 2004-2018 over the last decade was far beyond the average 5.2% economic growth rate recorded in SSA countries, (PDC, 2021). As a result, the level of poverty in Ethiopia has declined from 45.5% in 1995 to 29.6%, in 2011 (MoFED, 2012) and is estimated to reach as low as 19% in 2020 (PDC, 2021).

Figure 1: Share of major economic sectors in total GDP (percent)

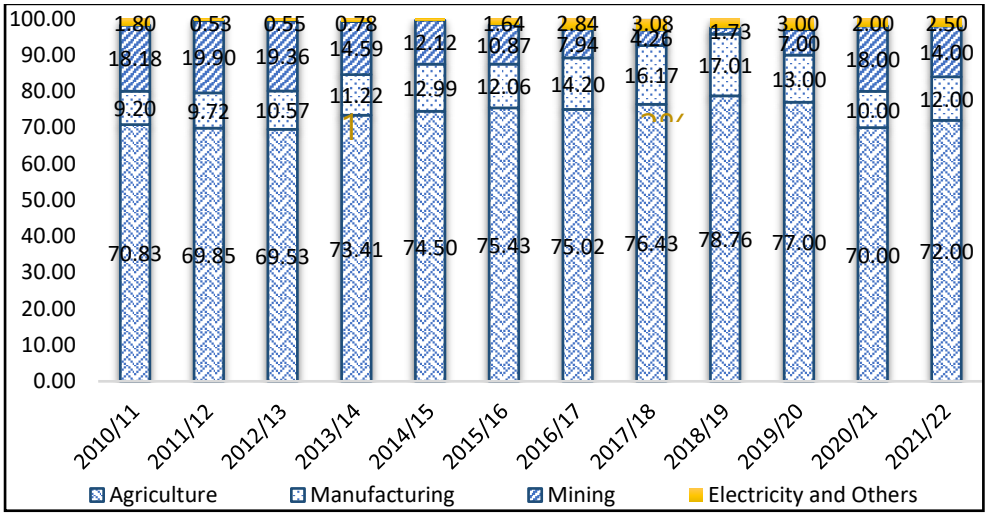


Source: Ministry of Planning and Development (2022)

Nevertheless, such remarkable growth has not been accompanied by adequate structural transformation of the economy, which should be reflected by a sustainable shift from low productivity and labor-intensive activities, such as

agriculture to a high productivity and skills-intensive activities both within and between sectors and subsectors. Although the share of agriculture in GDP had been steadily shrinking from about 47% of the GDP in 2010/2011 to 32.4% in 2021/2022 (Figure 1), the share of the manufacturing sub-sector in the GDP increased from 4.7% in 2010/2011 to 6.7% by 2021/2022. An apparently interesting development is that the country's high growth rate has been driven primarily by growth in the service and industrial sectors (that was driven by the boom in the construction sector), which respectively accounted for 40% and 29% of the GDP in 2021/22.

Figure 2: Trends in sectoral share in merchandise export (percent)

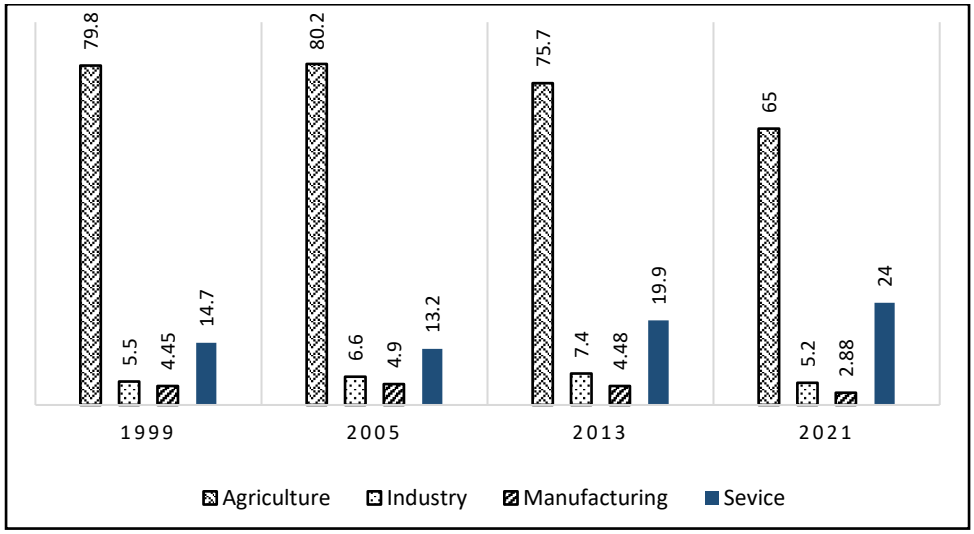


Source: Compiled Based on data from National Bank of Ethiopia

One of the indicators of economic structural change is the change in the composition of merchandise exports, particularly a rise in the share of manufacturing goods in total merchandise export. In this regard, the share of manufacturing goods in the total merchandise export increased from 9% in 2010/2011 to 17% by 2018/2019, while the share of agriculture in merchandize export increased from 71% to 79% during the same period (Figure 2). However, the share of manufacturing fell back to 10% in 2020/2021, before it slightly revived to 12% a year later. Thus, there has not been a shift both in terms of the diversity of the products and the sectoral composition of exports, implying weak structural change in the economy. Besides, the weak performance in exports coupled with high import demands led to huge trade deficits.

Besides changes in the sectoral compositions of the GDP and exports, structural change can also be mirrored through shifts in the composition of labour force participation in the economy. At the national level, 65% of the labour force is engaged in agricultural activities in 2021, which declined from 80% in 1999 and 72.7% in 2012/2013 (CSA, 1999 and 2013; ESS, 2021). The data also indicates that the share of labour force participation in the industry sector, which includes manufacturing, mining, quarrying and construction activities together employ only 5.2% of the labour force in 2020/2021. This is a significant decline from 7.4% in 2013 (Figure 3). While the labour force participation in agriculture noticeably declined over the past two decades, this was compensated by a rise in the share of services and informal sector, since the industry sector's share has been falling during the same period, testifying challenges for economic structural change.

Figure 3: Change in the composition of labour force (percent)



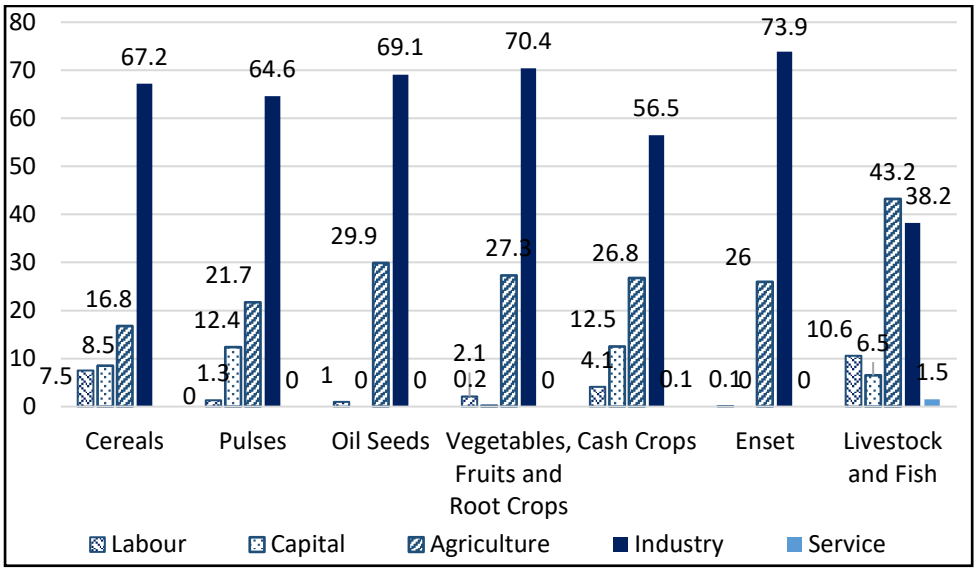
Source: Based on data from CSA (1999, 2005, 2013) and ESS (2021)

2.2 The SAM description of the structure of the economy

The production system of agricultural and industrial activities determines the level of sectoral linkages in the economy. In this regard, SAM-based characterization has been made based on the input consumption pattern of manufacturing and agricultural activities. The results have shown that agricultural

activities relatively use more of labor and capital[6] than intermediate inputs. For instance, the share of labor out of the total value added of cereals is 67.2% and the figures go as high as 70.4% and 73.9% for vegetables/frits/root crops and Enset, respectively (Figure 4). On the other hand, the share of intermediate inputs from the industry sector by cereals is only 7.5% and it is as low as 1.1% for oil seeds. The results further revealed that agricultural activities mainly use intermediate inputs from the agricultural sector itself. This is evidenced by the fact that the share of intermediate inputs from the agricultural sectors by cereals and pulse out of the value of the total output are 8.5% and 12.4%, respectively. The figure goes as high as 12.5% by cash crops. This entails that the linkage of the agricultural sector with the industrial sector is relatively weak. Since the agricultural activities are mostly rain fed and do not use that much agro-chemicals and fertilizers, the share of agro-chemicals and fertilizers from the total value of the agricultural outputs is low.

Figure 4: Production factors and intermediate inputs share from total value of agricultural outputs



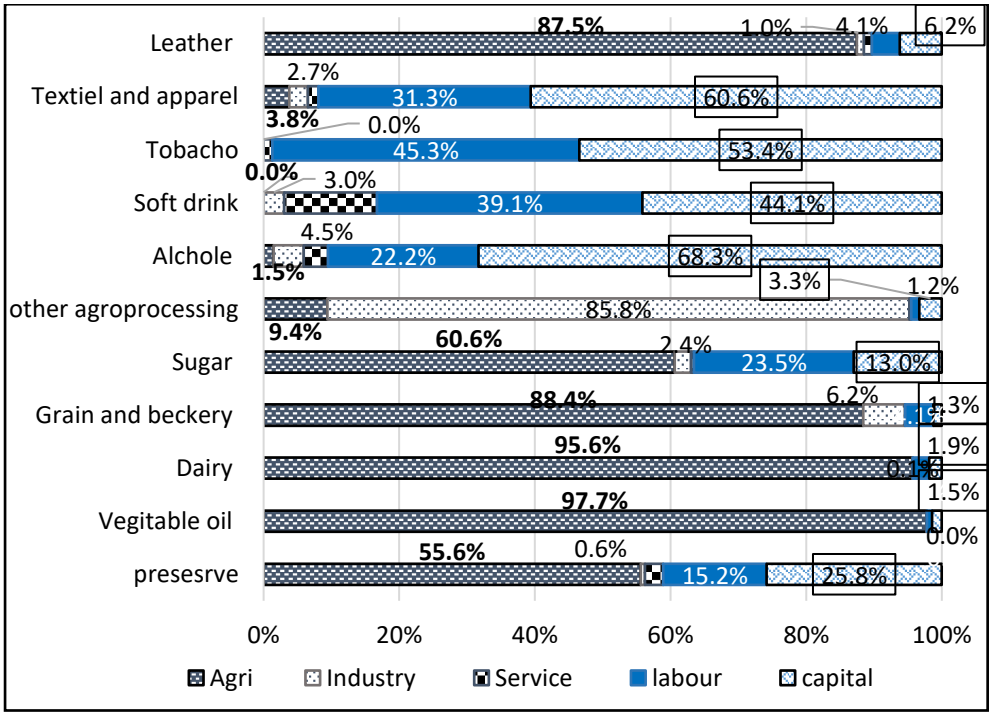
Source: Authors' computation based on SAM (2015/16)

The industrial sector relatively uses more of intermediate inputs compared to the agricultural sector. The input consumption pattern of manufactured activities

[6] Land is included in capital for simplicity.

varies across activities. Some use more of intermediate inputs, while others use production factors intensively. For instance, 87.5% of the total value of the leather sector goes to the agricultural intermediate inputs. The figures go as high as 97.7%, 95.6%, and 88.4% for vegetable oil and dairy processing industries, and millers/bakeries, respectively. Some of the industries notably textile and apparel, tobacco, beverage and, alcohol intensively use labor and capital (Figure 5). For example, from the total value of textile 60.6% goes to capital and 31.3% of it goes to labor. This entails that these industries have the potential to create more employment opportunities.

Figure 5: Share of production factors and intermediate inputs from total values of agro-processing



Source: Authors' computation based on SAM (2015/16)

Sectoral linkages also depend on the consumption pattern of households and other economic agents. For instance, if households, firms, and the government consume more of domestically produced goods that heavily use domestically produced raw materials and intermediate inputs, they will induce more linkages and spillover effects in the economy. In this regard, agro-processing firms which use

domestically produced agricultural outputs as intermediate inputs can boost demand for domestically produced agricultural goods through its backward linkage. In light of this, an assessment has been made of the sources of demand for goods and services. Results have revealed that from the total production of cereals, 85% is consumed as intermediate input by agro-processing enterprises, mainly grain mills and bakeries/grain mills. The rest 8% and 7% are consumed by households for final consumption and as intermediate input by the agriculture sector itself (for example, seed usage), respectively. Similar demand pattern holds true for pulses and oil seeds (Table 1). But the lion shares of the demand of vegetables, Enset, cash crops, and livestock are consumed directly by households. This reality signals that many of the agro-processing enterprises are engaging in very few sectors notably grain mill, bakery, and vegetable oil production while agro-processing related to fruit and vegetables and livestock are not well developed.

Table 1: Demand structure for agricultural commodities (percent)

Type of Commodity	Intermediate input for agricultural sector	Intermediate input for industrial sector	Consumption by households	Investment	Export
Cereals	7	85	8	0	0
Pulses	11	57	13	0	19
Oilseeds	0	60	23	0	17
Vegetables and fruits	0	34	64	0	1
Cash crop	10	12	34	0	43
Enset	0	0	100	0	0
Livestock and fish	6	27	63	2	2

Source: Authors' computation based on SAM (2015/16)

It is evident that the lion's share of the manufacturing sector in Ethiopia is comprised of agro-processing and simple labor-intensive industries (Table 2). Examining the sources of demand for these products allows us to examine the level of linkages they tend to create with the rest of the economy's activities. For instance, the lion's share of the demand for agro-processed products comes from households. This signifies that these products are not heavily used as intermediate inputs. It is mainly the textile and leather industries that export their outputs to the rest of the world.

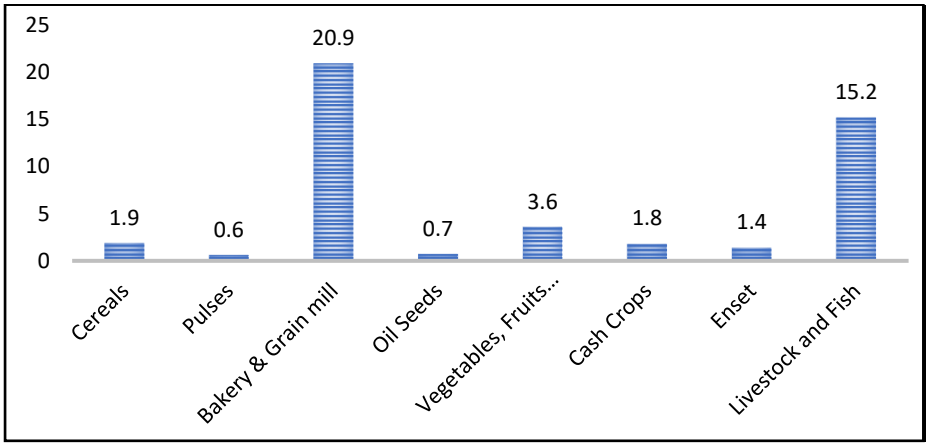
Table 2: Demand structure for agro-processed commodities

Type of Agro-processed commodities	Intermediate input for agricultural sector	Intermediate input for industrial sector	Consumption by households	Export
Preserve	0	36	52	12
Vegetable oil	24	18	58	0
Dairy	0	8	92	0
Bakery and grain mills	0	28	71	1
Sugar	0	20	80	0
Other agro-processing	23	2	75	0
Alcohol	0	3	97	0
Beverage	0	52	48	1
Tobacco	0	47	53	0
Textile/apparel	0	9	85	6
Leather	0	2	90	9

Source: Authors' computation based on SAM (2015/16)

An assessment has been made on the consumption pattern of different households in Ethiopia based on the 2015/2016 SAM. As presented in Figure 6, households nearly spend 55% of their income on food, which are heavily coming from domestic sources. Bakeries and grain mills account for the greatest proportion of household spending, followed by livestock and fish.

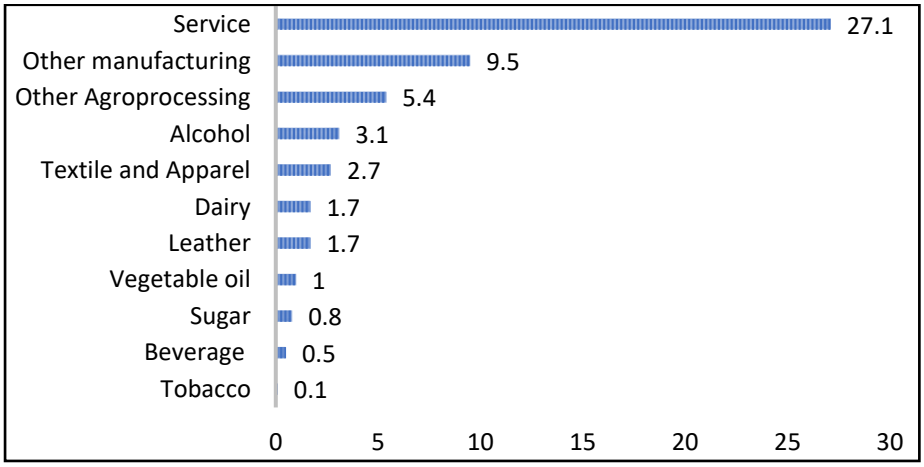
Figure 6: Household consumption patterns of agricultural commodities



Source: Authors' computation based on SAM (2015/16)

Households spend nearly 27% of their expenditure on services (Figure 7). Textile and apparel and leather together accounts 5% of the total expenditure of households "Other agro-processing", alcohol and dairy are the other important commodities, where households spend their income. Besides, the share of imports in the total supply of basic cereals is less than 0.5%, which is extremely small. However, the corresponding import shares of textile (38percent), paper (37%), sugar (11%), and leather (6%) are relatively higher. It is only the leather industry that exports more than it imports.

Figure 7: Share of expenditures of households on non-agricultural commodities



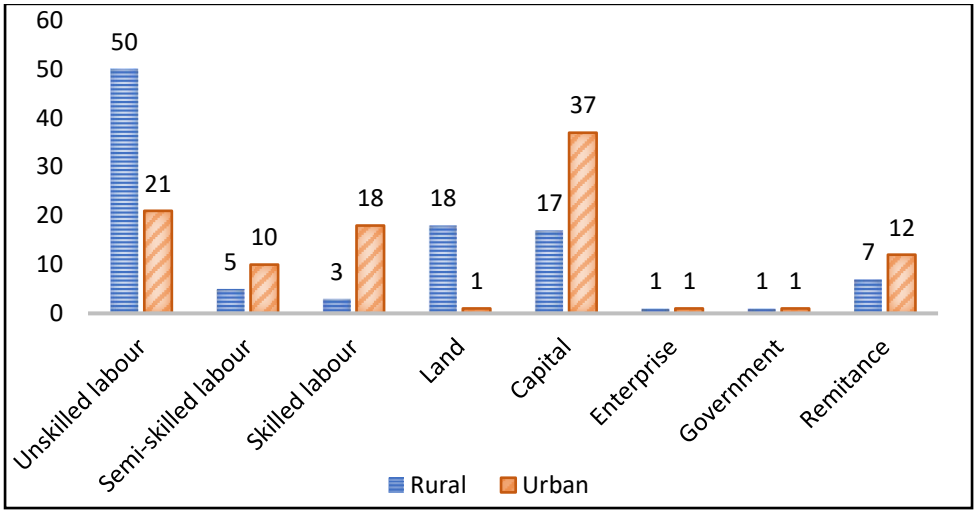
Source: Authors' computation based on SAM (2015/16)

Households get income mainly from labor (64.7%), capital (33.6%), land (1.14%), and remittance (0.3%). These are agricultural labour, non-agricultural labour, capital and land. These factors contribute more than 90% of the income of poor rural households. This number is more than 83% for non-poor rural households.

A thorough analysis has been made on the sources of income of the households. The result shows that rural households earn nearly 50% of the total income from unskilled labor, while the share is as low as 21% for urban household which earn 37% and 18% of its income from capital and skilled labor, respectively. Apart from this, both rural and urban households get income from the government in the form of transfers. The contribution of the government to both rural and urban households is extremely infinitesimal. In this regard, the government transfers a

higher income share to the urban households compared to the rural households. The other source of income of the households is remittance from the rest of the world. This is evidenced by the fact that nearly 12% of the income of the urban households and 7% of the rural households come from remittances sent from the rest of the world.

Figure 8: Sources of income of households (percent)



Source: Authors' computation based on SAM (2015/16)

3. Data and Methods

3.1 Data

The secondary data was collected using appropriate data collection tools. The data were collected from various sources including national and sectoral plans, policies, strategies, reports, national accounts statistics, and other relevant documents. Macroeconomic and sectoral data were collected mainly on agriculture and manufacturing, especially from the Ethiopian Statistics Service, Ministry of Planning and Development, Ministry of Industry, Ministry of Agriculture, Ministry of Trade and Regional Integration, Ethiopian Investment Commission, Ministry of Finance, and the National Bank of Ethiopia.

3.2 Ethiopia's Social Accounting Matrix (SAM)

The most recent SAM of Ethiopia was constructed in 2015/2016. The 2005/2006 and 2015/2016 SAMs have been used to carry out the analysis. The 2015/2016 SAM contains 81 activities and 83 commodities. The factors taken into account include agricultural labor, non-irrigated land, irrigated land, skilled labor, semi-skilled labor, other agricultural capital, and capital. The SAM also has four household accounts: urban poor, urban non-poor, rural poor, and rural non-poor. Similarly, the tax account contains direct tax, sales tax, value-added tax, excise tax, and import duty. For this analysis, the SAM has been re-adjusted in such a way that it fits the purpose of our analysis.

The 2015/2016 SAM for Ethiopia used multiple surveys, covering different dimensions of economic activities. Likewise, the SAM used certain coefficients of the service sector built from the most recent Tanzanian SAM (Randriamamonjy and Thurlow, 2015) to fill the data gap considering the similarity in economic structure and the level of economic development between Ethiopia and Tanzania as per international practices and the recommendations of the system of national accounts[7].

Table 3 lists the main data sources used for the 2015/2016 SAM's construction. Most of the input data were originated from the Central Statistics Agency (CSA). The SAM exhaustively utilized "Meher" Season Post Harvest Survey data to estimate agricultural components of the activity account. Multiple surveys covering various aspects of economic activity were used to construct Ethiopia's SAM. We also used the National Account Statistics (NAS) data for subjects not adequately covered by surveys.

The two SAMs have been modified into a form that is suitable to compare results and to conduct the SAM decomposition analysis. Toward this end, the agricultural activities have been aggregated into cereals, pulses, oil seeds, fruits, vegetable and root crops, Enset, cash crops and livestock and fish. The industrial sectors have been aggregated into agro-processed and non-agro-processed activities. Since the main aim of the study is to look at the linkage between agriculture and manufacturing sectors, the agro-processed activities have been disaggregated into preserve, vegetable oils, dairy, bakery and grain, sugar, other agro-processed, alcohol, beverage and soft drinks, tobacco, textile, and apparel and

[7] When data for specific economic activities are inadequate, alternative constructs might be used, according to the most recent System of National Accounts (SNA) (2008).

leather. The activity and the commodity account have been merged so that the SAM decomposition analysis can be carried out.

Table 3: Data sources for the construction of the 2015/16 SAM for Ethiopia

Source of Data	Title of the Survey	Abbreviation
CSA	The 2015/16 Agricultural Sample Survey	AgSS
CSA	The 2015/16 Ethiopian Socioeconomic Survey	ESS
CSA	The 2015/16 Large and Medium Scale Manufacturing and Electricity Industries Survey	LMMIS
CSA	The 2015/16 Small Scale Manufacturing Industries Survey	SMS
CSA	The 2015/16 Ethiopian Household Consumption – Expenditure Survey	HCES
CSA	Retail and Producer Price Survey Data for the Year 2015/16	RPPSD
PDC	2015/16 Supply and Use Table	Supply and Use Table
PDC	2015/16 Annual GDP estimate	
Randriamamonjy and Thurlow	2015 Social Accounting Matrix for Tanzania	

Source: Authors 'compilation and elaboration

3.3 Methods of analysis

A quantitative approach was used in this study. To determine the extent of the linkage among agricultural and industrial sectors, a SAM multiplier analysis using the 2005/206 and 2015/2016 SAMs has been used. This enabled to sort out subsectors with strong forward and backward linkages during the two periods and make comparisons. This enabled us to sort out subsectors with strong forward and backward linkages in these two periods. In addition, SAM decomposition and structural change analysis have been conducted using the same data sets. The details of the approach are featured below.

3.3.1 SAM multiplier analysis

The input-output analysis and the subsequent measurement of linkage coefficients, including SAM multiplier analysis have been used excessively for the

identification of key economic sectors. Since the pioneering work of Rasmussen (1958), Chenery and Watanabe (1958), and Hirschman (1958), numerous studies applying input-output techniques have relied on linkage analysis to describe the linkage between economic sectors and to assist the formulation of economic development policies and strategies. In order to examine forward and backward linkages of agricultural and industrial sectors, the study employed a SAM-multiplier analysis. To use this technique, endogenous and exogenous accounts have been specified in order to capture the magnitude of influence caused by one sector over the other. The accounts of production activities, factors of production and domestic or institutions (such as households) were considered as endogenous, and those of government, combined capital and the rest of the world accounts were considered as exogenous.

This could be presented using the following matrix representation:

$$\mathrm{Y} = (I - A)^{-1} X = MX \qquad \textbf{(1)}$$

Where Y represents the column vector of outputs or products in the left-hand side, X represents the column vector of the final consumptions, A represents the coefficients, and I is the nxn identity matrix. The matrix $M = (I - A)^{-1}$ is known as the accounting multiplier matrix. Each cell M_{ij} of M quantifies the change in total income of account i as a result of a unitary increase in the exogenous component of account j. The forward linkage (in percentage terms) of sector j quantifies the change in income in sector r relative to the average change in the economy, caused by a unitary injection in the final demand of all sectors. If the forward linkage for sector j is greater than 100percent, the change in sector j's income is higher than the average income changes in the economy after a unitary injection in all sectors. On the other hand, the backward linkage of sector j quantifies the change in economy wide income relative to the average change in the economy, caused by a unitary injection in the final demand of sector j. A key sector is usually defined as one with both backward and forward linkages greater than 1. If a sector has a backward linkage greater than 1, and forward linkage less than 1, is called backward oriented. On the other hand, if it has a forward linkage greater than 1, and backward linkage less than 1, it is called forward oriented. If none of the

linkages is greater than 1, the sector is said to have weak linkages with other sectors (Parra and Wodon, 2009).

Let V denote the sum of all cells of the inverse matrix: $V = \sum_i \sum_j M_{ij}$. Let $M_{i\bullet}$ and $M_{j\bullet}$ denote the sum of the ith row and the jth column of the inverse matrix, respectively. $M_{i\bullet} = \sum_k M_{ik}$, and $M_{j\bullet} = \sum_k M_{jk}$. Then the Hirschman-Rasmussen backward linkage index of sector i is given by

$$BL = \frac{nM_{\bullet i}}{V} \quad \textbf{(2)}$$

and the forward linkage index is given by $FL = \frac{nM_{\bullet j}}{V}$ **(3)**

The Hirschman-Rasmussen indices do not consider the relative importance of each sector in terms of GDP, final demand, or total production. Thus, adjustment has been made to capture the importance of the sector in the economy using weighed average. In this regard, the total production share of activities has been computed, so that a weighted linkages index can be formulated as follows: Let α_i be sector i's total production share; the weighted sums of the ith row and column of the inverse matrix are given by $WM_{i\bullet} = \sum_i \alpha_i M_{ik}$ and $WM_{j\bullet} = \sum_j \alpha_k M_{jk}$ respectively. The weighted backward and forward linkage indices can be written as $WBL_i = \frac{nWM_{\bullet i}}{WBV}$ and $WFL_i = \frac{nWM_{i\bullet}}{WBV}$ respectively, where $WVB = \sum_i \sum_j \alpha_i M_{ij}$ and $WVF = \sum_i \sum_j \alpha_j M_{ij}$. A unitary injection in sector k will cause a change in income across other sectors in the amounts indicated by the kth row of the inverse matrix. These changes can be separated into self-induced component and non-self-induced component, together adding up to one. On the output side, the self-induced effects for sector k (in percentage) can be computed as $\frac{M_{kk}}{M_{k\bullet}}$. On the input side, these effects can be computed as $\frac{M_{kk}}{M_{\bullet k}}$, also in percentage.

3.3.2 SAM decomposition

The above multiplier matrix can be decomposed into three economically meaningful components or sub-matrices following Stone (1981), Pyatt and Round (1979), and Round (1985) decomposition techniques (see the detailed specification in the Appendix 1). This enables us to identify which of these linkages induce a higher multiplier in the economy. The multiplicative form is depicted below.

$$\bar{Y_n} = M_{a3}M_{a2}M_{a1}F \quad \textbf{(4)}$$

The above specification could be converted into an additive form in the following way.

$$\bar{Y_n} = (I + (M_{a1} - I) + (M_{a2} - I) * M_{a1} + (M_{a3} - I) * M_{a2} * M_{a1})\text{*F} \quad \textbf{(5)}$$

$$d\bar{Y_n} = d(I + (M_{a1} - I) + (M_{a2} - I) * M_{a1} + (M_{a3} - I) * M_{a2} * M_{a1}) \quad \textbf{(6)}$$

Since the above equation is in additive form, the total change on y could be written as

$$d\bar{Y_n} = \big(I + (M_{a1} - I)\big) * dF + (M_{a2} - I) * M_{a1}) * dF + d(M_{a3} - I) * M_{a2} * M_{a1}) * dF \quad \textbf{(7)}$$

Since the multiplier component is constant in each sub matrix in the above expression, change in the total output is the result of the multiplication of the change in the total demand and the multiplier component.

The first of these matrixes ($(M1 = M_{a1} - I)$) shows both the direct effects on the endogenous accounts of one-unit exogenous shocks (appearing as unit increases in the diagonal) and subsequent interaction effects among accounts within the same institutional group. The direct effect captures the multiplier effects resulting from direct transfers within institutions, households, and the inter-industry transfers. This component of the SAM multiplier depicts the part of the multiplier which mainly comes from the forward and backward linkages among activities in Ethiopia where intra-household transfer is limited. The first part of the M1, which is $(I - A_{11})^{-1} - I$, is the only active matrix in Ethiopia and it shows the typical input-output multiplier in the economy.

$$M_1 = \begin{bmatrix} (I - A_{11})^{-1} - I & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & (I - A_{33})^{-1} - I \end{bmatrix} \quad \textbf{(8)}$$

The second component, the open-loop matrix, captures cross-effects between different institutional groups. These effects are transmitted from one category of endogenous institutions to other endogenous categories, and in turn, set in motion multiplier processes of within-category interaction effects, which amplify the initial stimulus. The open-loop effects capture the interactions among and between the three endogenous accounts, notably activities, production factors, and households. The diagonal elements are zero and this component of the multiplier captures the off-diagonal elements which are typically cross account effects[8].

$$\text{OL} = \begin{bmatrix} 0 & A_{13}^{*}A_{32}^{*} & A_{13}^{*}(I - A_{33})^{-1} \\ A_{21}^{*}(I - A_{11})^{-1} & 0 & A_{21}^{*}A_{13}^{*}(I - A_{33})^{-1} \\ A_{32}^{*}A_{21}^{*}(I - A_{11})^{-1} & A_{32}^{*} & 0 \end{bmatrix} \quad \textbf{(9)}$$

The third component, closed-loop matrix details the multiplier effects of an exogenous change on one institutional group, after it has travelled through the rest of endogenous accounts and returned to the original recipient. Thus, the closed-loop matrix captures the full circular multiplier effects net of own and open loop effects; that is, from production activities to factors to institutions and then back to activities in the form of consumption demand. This component is basically linked to the consumption effect of an external shock that comes from institution to the activity account.

$$\text{CL} = \begin{bmatrix} C_{132}(I - A_{11})^{-1} & C_{132}A_{13}^{*}A_{32}^{*} & C_{132}A_{13}^{*}(I - A_{33})^{-1} \\ C_{213}A_{21}^{*}(I - A_{11})^{-1} & C_{213} & C_{213}A_{21}^{*}A_{13}^{*}(I - A_{33})^{-1} \\ C_{321}A_{32}^{*}A_{21}^{*}(I - A_{11})^{-1} & C_{321}A_{32}^{*} & C_{321}(I - A_{33})^{-1} \end{bmatrix}$$

$$C_{132} = (I - A_{13}^{*}A_{32}^{*}A_{21}^{*})^{-1} - I, C_{213} = (I - A_{21}^{*}A_{13}^{*}A_{32}^{*})^{-1} - I, C_{321} = (I - A_{32}^{*}A_{21}^{*}A_{13}^{*})^{-1} - I \quad \textbf{(10)}$$

[8] See the details of the SAM decomposition and the denomination of each element of the matric in the Appendix 1.

Thus, decomposing the general multiplier analysis into the above three components could clearly sort out the types of linkages that are strong in the Ethiopian agricultural and manufacturing sectors.

3.3.3 Structural transformation

The speed of technological progress in different sectors crucially depends on the dynamics of structural transformation in an economy (Dosi et al., 1990). Therefore, the speed of technical changes in different sectors could be a good proxy to examine the rate of structural transformation in Ethiopia. It is evident that the changes in a sector's level of output could emanate from two sources, namely changes in technology and changes in final demand. Here, positive contributions in change to output due to changes in technology should be interpreted as the degree to which interactions amongst activities have increased and leakages out of the domestic economy have declined. We follow the approach and notation of Millar and Blair (2009) and Hoai et al. (2016). Gross output in year 2005 and year 2015 can be written as:

$$\Delta Y=(I-M)_{2015}{}^{-1}\,F_{d2015}-(I-M)_{2005}{}^{-1}F_{d2005} \qquad \textbf{(11)}$$

We have two components on the right-hand side, notably $(I-M)_{2005}{}^{-1}$ and F_d.The$(I-M)_{2015}{}^{-1}$shows the multiplier part while F indicated the final demand of commodities. Thus, it is possible to decompose the change in output, ΔY, as the change in these two components. Changes in $(\boldsymbol{I-M})^{\boldsymbol{-1}}$ andF can be weighted in terms of the year 2005 or the year 2015'sfinal demands and technologies respectively or a combination thereof. We take an unweighted average and derive the decomposition in the following way:

$$\Delta Y=\left(\frac{1}{2}\right)\left((I-M)_{2015}{}^{-1}-(I-M)_{2005}{}^{-1}\right)(F_{d2015}+F_{d2005})+\left(\frac{1}{2}\right)\left((I-M)_{2005}{}^{-1}+(I-M)_{2015}{}^{-1}\right)(F_{d2015}-F_{d2005}) \qquad \textbf{(12)}$$

In this way, the component that is attributed to changes in technology is weighted by the unweighted average of the final demands of the initial and final year while the change in the final demand component is weighted by the average of the initial and final technologies.

4. Results and Discussion

4.1 Forward and backward linkages

In Ethiopia, agro-industries such as food and beverages contribute about 50% to the manufacturing sector output in the country. However, the sector's exports constituted only 1.3% in 2013 and import dependency remained strong (UNCTAD, 2021). This signifies that the sector has a weak linkage with the rest of the economy. The degree of economic linkage is expressed by the level of backward and forward linkages of activities in a given economic system. Backward linkages show the extent of dependence of an activity on inputs produced from other activities in the domestic economy, while forward linkages capture the economic sector's role in supplying inputs to other sectors. These two linkages are very decisive to identify the key but weakly linked sectors of an economy and to design effective intervention plans and strategies.

The multiplier analysis result has shown that the main agricultural commodities, except cereals and livestock, have weak forward linkages. Yet, almost all agricultural commodities have relatively strong backward linkages. Specifically, cereals, livestock, and bakery/grain are the leading sectors with strong forward and backward linkages in the economy. Of all agricultural activities, livestock has the highest forward and backward linkages followed by cereals. The major agricultural products including cereals, oilseeds, cash crops, fruits, and vegetables have high backward linkages. This signifies that any demand change in the outputs of these commodities can create significant spillover effects in the economy through backward linkages.

The results have shown that the status of the backward and forward linkages of activities did not significantly change in the decade preceding 2016 (Table 4). This could be partly, because the production pattern of activities did not technically alter between 2016 and 2025. For instance, when we compare the technical coefficients of 2005/2006 and 2015/2016 SAM of Ethiopia, there was no as such a huge difference on the share of factors of production and input intensity of activities. This shows that there has not been any significant change in the mode of production and the level of integration among activities in the Ethiopian economy during the decade under consideration.

Table 4: Forward and backward linkages of key agricultural outputs/activities

Type of Commodity	2015/16		2005/06	
	Backward Linkage	Forward Linkage	Backward Linkage	Forward Linkage
Cereals	1.042	1.428	1.090	1.32
Pulses	1.188	0.352	1.242	0.34
Oilseeds	1.141	0.372	1.193	0.32
Vegetables, fruits, root crops	1.142	0.378	1.194	0.52
Cash crops	1.160	0.329	1.213	0.44
Enset	1.184	0.199	1.238	0.21
Livestock and Fish	1.199	1.412	1.255	1.35

Source: Authors' computation based on SAM (2005/06, 2015/16)

Since Ethiopia's manufacturing sector is the least developed in the world, the majority of the main agro-processing industries have fallen under weakly linked sectors, with weak forward and backward linkages (Table 5). This signifies that any increases in the final demand for the agro-processing activities will have limited impact on the overall economy and agricultural sectors. Particularly, except the bakery and grain mill, all agro-processing activities have weak forward linkages. This is partly because the biggest demand of these goods come from households. Some agro-processing activities notably bakery/grain, vegetable oil, dairy and alcohol have higher backward linkages, while the rest of the agro-processing sectors have weak forward and backward linkages. This is mainly because many of the agro-processing sectors rely on imported intermediate inputs so that their impact on domestic production via backward linkages is weak.

Table 5: Forward and backward linkages of agro-processing outputs/activities

Type of Commodity	2015/16		2005/06	
	Backward Linkage	Forward Linkage	Backward Linkage	Forward Linkage
Preserve	0.817	0.139	0.857	0.15
Vegetable oils	1.269	0.211	1.387	0.14
Dairy	1.322	0.214	0.140	0.37
Bakery and grain mills	1.188	1.631	1.247	0.91
Sugar	0.888	0.175	0.931	0.2
Other agro-processing	1.308	0.491	1.374	0.27
Alcohol	1.072	0.284	1.116	0.13
Beverage and soft drink	0.947	0.165	0.989	0.33
Tobacco	0.643	0.138	0.674	0.17
Textile and apparel	0.584	0.264	0.613	0.4
Leather	0.816	0.214	0.857	0.17

Source: Authors' computation based on SAM (2005/06, 2015/16)

An assessment has also been made to examine the impact of a unit increase in the production of agro-processing activities on the demand for key agricultural activities. The results show that bakery/grain, other agro-processing, vegetable oils, and dairy activities create relatively more demand for the key agricultural products. When we look at the level of linkages of each agricultural item with the agro-processing manufacturing activities, oilseeds, and livestock will have relatively a higher demand if the production of the key agro-processing activities increase. For instance, if the demand for agro-processed products increases by one unit, the demand for cereals, livestock, and oilseed tend to increase by 0.97, 0.42, and 0.04, respectively. In the same way, if there is an expansion of vegetable oil by one unit, the demand for oilseed increases by 1.01, which shows that the sector tend to create a strong backward linkage with the agricultural activity (Table 6).

Table 6: Inter-sectoral multipliers between agricultural and agro-processing outputs/activities

Activities	Preserve	Vegetable oils	Dairy	Bakery & grain mill	Sugar	Agro-processing	Alcohol	Beverage	Tobacco	Textile &apparel	Leather	Wood	Total
Cereals	0.25	0.38	0.43	1.09	0.26	0.97	0.36	0.30	0.19	0.17	0.25	0.30	4.95
Pulse	0.04	0.06	0.07	0.16	0.04	0.15	0.06	0.05	0.03	0.03	0.04	0.05	0.78
Oilseeds	0.03	1.01	0.06	0.03	0.03	0.04	0.04	0.03	0.02	0.02	0.03	0.03	1.37
Vegetable & fruits	0.05	0.09	0.09	0.08	0.06	0.08	0.08	0.07	0.04	0.04	0.05	0.06	0.79
Cash crops	0.03	0.04	0.04	0.04	0.46	0.04	0.04	0.04	0.02	0.03	0.03	0.03	0.84
Enset	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.2
Livestock	0.51	0.35	1.38	0.32	0.24	0.42	0.33	0.28	0.18	0.16	0.75	0.26	5.18
Total	0.92	1.95	2.09	1.74	1.11	1.72	0.93	0.79	0.49	0.46	1.16	0.75	

Source: Authors' Computation

SAM decomposition analysis and sectoral linkages

The previous results of the SAM multipliers do not allow tracking the relative contribution of direct and indirect effects to sectoral linkages. The SAM multiplier decomposition enables to scrutinize which linkage induces more spillover effect in the economy. In a nutshell, there are three distinct effects in the SAM multiplier analysis. These are the own or the within effect, the open-loop effect, and the closed-loop effect. Since institutional/household transfer is limited in Ethiopia, the within effect captures the part of the multiplier occurring within activities through forward and backward linkages.

The magnitude of the within effect basically depends on the strength of forward and backward linkages among sectors in the economy. The open-loop or spill-over effect captures the part of the spillover effect that flows from activities to households via factor payments. The closed-loop or feedback effect shows the increase in the production of activities that emanates from household consumption after activities pay to factors and factors pay to households.

Results of the within effect have also revealed that an increase in the demand of cereals by one unit induces demand for agriculture, other industries, and services by 0.09, 0.07, and 0.19, respectively. Since cereals sector do not normally use any input from the agro-processing sector, it's within effect multiplier on agro-processing can safely be set to zero.

When we look at the strength of the consumption effect, which comes from the consumption of goods and services by households, through the closed-loop effects, they are quite stronger than the within effect. For instance, the total within effect of an increase in production of cereals by one unit goes as low as 0.35 while the closed-loop effect goes as high as 2.35. In the same way, an increase in a demand for livestock by one unit, increases the within production effect, among activities by 0.51, while the closed-loop effect goes as high as 2.69. When we split the effect across sectors, the highest within effect is created by the agro-processing (0.16) while the closed-loop effect for the agro-processing for the same demand change goes as high as 0.81(Table 7).

Table 7 clearly shows that the closed-loop effects of cereals and other agricultural crops creates more spillover effects and linkages with the agro-processing manufacturing activities. The change in demand of cereals or any of the agricultural activities by households or any agent induces more production.

Feedback effect that goes from industries' factor payments to households' income will stimulate production activities through demand effects. Because of this, the change in the final demand is the salient driver of the change in economy-wide gross output in Ethiopia. This is because much of the commodities produced by various activities are consumed as final demands by households and government than used as intermediate inputs by activities. This limits the spillover effect created in the economy through forward and backward linkages.

Table 7: Within and closed loop multipliers induced by agricultural activities on agro-processed outputs/activities

Category	Description	Cereals	Pulses	Oilseeds	Fruit & Vegetable	Cash crops	Enset	Livestock
Within effects	Agriculture	0.09	0.14	0.02	0.02	0.14	0.03	0.16
	Agro-processing	0.00	0.00	0.00	0.01	0.01	0.01	0.16
	Other industries	0.07	0.02	0.02	0.03	0.05	0.01	0.02
	Service	0.19	0.17	0.24	0.30	0.29	0.36	0.19
	Total	0.35	0.33	0.28	0.36	0.49	0.41	0.53
Closed-loop effects	Agriculture	0.55	0.64	0.62	0.61	0.61	0.64	0.63
	Agro-processing	0.71	0.83	0.79	0.79	0.79	0.82	0.81
	Other industries	0.23	0.27	0.26	0.25	0.25	0.26	0.26
	Service	0.86	1.01	0.97	0.96	0.96	0.99	0.99
	Total	2.35	2.75	2.64	2.61	2.61	2.71	2.69

Source: Authors' computation based on SAM (2016)

Similar to agricultural goods, the lion's share of outputs from manufacturing activities are consumed by households. In addition, some agro-processing activities are labor-intensive, while other activities intensively use agricultural intermediate inputs. Because of this, the linkage and spillover effects of agro-processing activities coming from within and closed-loop effects differ. For instance, the increase in demand for vegetable oil, bakery, and dairy by one unit

will induce additional demand for agricultural commodities through its within effect by 1.26, 1.47, and 1.38, respectively (Table 8).

Other key sectors, such as beverage, textile, and leather sectors don't generate strong within spillover effects. For instance, a unit increase in the demand of the textile and the leather sectors only induces 0.02 and 0.58 demand for output of the agricultural sector activities. This is because these commodities do not intensively use domestically produced agricultural goods as intermediate inputs. In the same way, when there is a unit increase in the demand of vegetable oil, it generates 0.62 demand for agricultural outputs via closed-loop effect but the value goes as low as 0.28 and 0.37 for textile and leather, respectively.

The other channel of the multiplier effect is through consumption. The increase in household income increases the production of agricultural activities through consumption effect. Agro-processing activities tend to have higher closed-loop effects, since they are heavily consumed by households. For instance, dairy and vegetable oils have the highest closed-loop effect. Since households relatively spend the lion's share of their income on food, agriculture, and agro-processing activities entertain more demand from household, when income of household increases. The result in general, entails that the consumption effect creates the highest spillover effect and sectoral linkages. This is because the consumption of goods and services by households are greater than the amount used as intermediate inputs by activities. In relative terms, activities, such as dairy and bakery/grain mills, and other agro-processing create more demand and linkage with the agricultural sector through direct and closed-loop effects compared to other agro-processing activities. This is because they intensively use domestically produced agricultural goods and are heavily consumed by households.

Table 3: Within and closed loop inter-sectoral multipliers induced by agro-processing activities on agricultural activities

Category	Description	Preserve	Vegetable oil	Dairy	Bakery & grain mill	Sugar	Agro-processing	Alcohol	Beverage	Tobacco	Textile apparel	Leather	Other manufacturing
Within effect	Agriculture	0.33	0.99	1.10	0.88	0.45	0.83	0.03	0.03	0.00	0.02	0.58	0.05
	Agro-processing	0.05	0.01	0.16	0.06	0.01	0.89	0.03	0.02	0.00	0.01	0.08	0.03
	Other industries	0.01	0.02	0.02	0.06	0.04	0.05	0.02	0.02	0.00	0.01	0.02	0.45
	Service	0.25	0.24	0.19	0.38	0.18	0.40	0.24	0.26	0.06	0.08	0.12	0.08
	Total	0.64	1.26	1.47	1.38	0.68	2.17	0.32	0.33	0.06	0.12	0.8	0.61
Closed- Loop effect	Agriculture	0.38	0.62	0.63	0.56	0.42	0.57	0.57	0.49	0.32	0.28	0.37	0.94
	Agro-processing	0.49	0.79	0.81	0.72	0.55	0.73	0.73	0.63	0.41	0.36	0.47	1.21
	Other industries	0.16	0.26	0.26	0.23	0.18	0.24	0.24	0.20	0.13	0.12	0.15	0.39
	Service	0.60	0.97	0.99	0.87	0.66	0.89	0.89	0.77	0.50	0.43	0.58	1.47
	Total	1.63	2.64	2.69	2.38	1.81	2.43	2.43	2.09	1.36	1.19	1.57	4.01

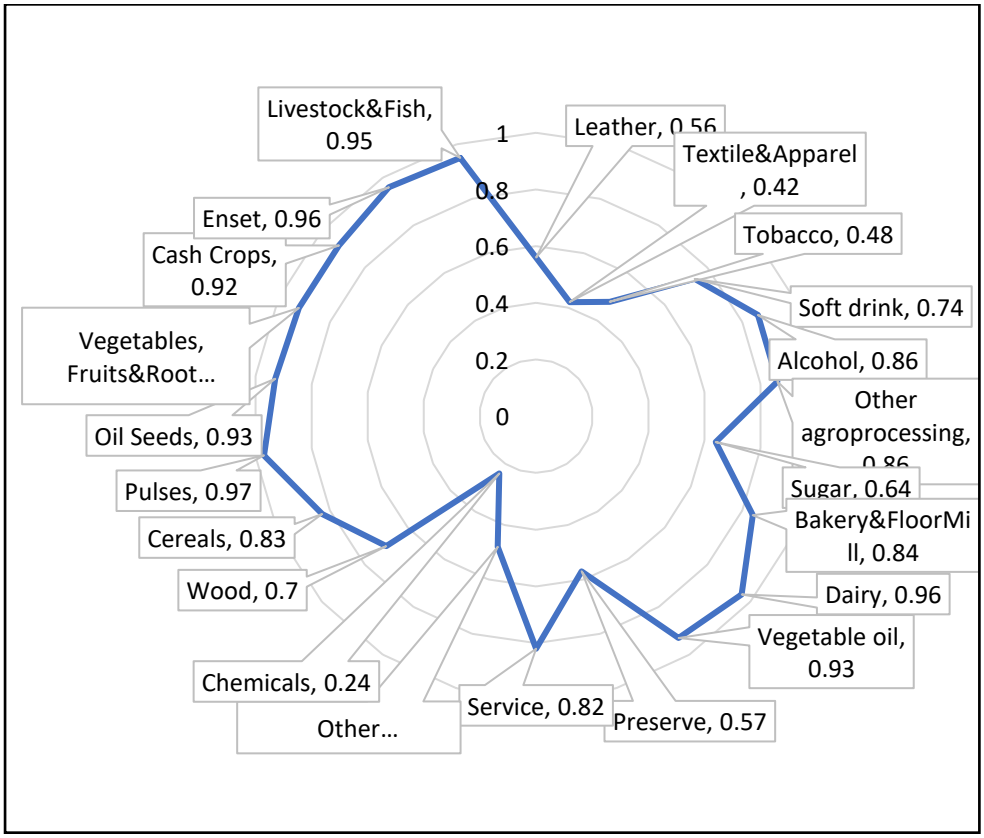
Source: Authors' computation based on SAM (2016)

Welfare and employment effects of sectoral linkages

The impact of an expansion of agro-processing and agricultural activities on the welfare of households partly depends on its effect on income. The effect of an increase in the production activities on income of households partly depends on the share of labor and capital in the values of goods and services. The results revealed that all agricultural activities: namely pulses, oilseeds, fruits, and vegetables, cash crops, Enset, and livestock induce higher impact on household's income compared to manufacturing activities. However, from the agro-processing activities, edible oils, dairy, bakery and grain mill, sugar, and alcohol ensure higher income gain compared to other manufacturing activities.

The results show that an increase in the demand of pulse, oil seeds, and livestock by one unit increase the income of households by 0.97, 0.93, and 0.95, respectively (Figure 9). The numbers for textile, tobacco, and leather go as low as 0.42, 0.48, and 0.56 in the order they are mentioned. This entails that those agro-processing activities which intensively use domestically produced agricultural goods as intermediate inputs, which are labor intensive, induce higher impact on the income of households.

Figure 9: Spillover effects from activities on household income



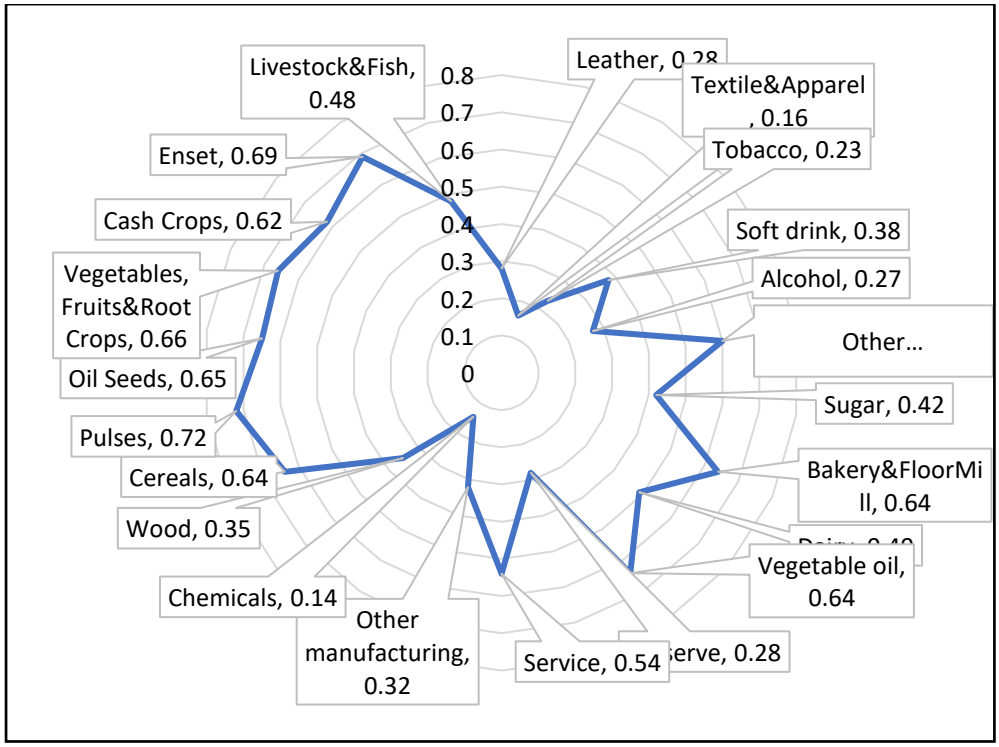
Source: Authors' computation based on SAM (2016)

Unemployment has remained one of the chronic problems of many developing countries, including Ethiopia. Thus, the decision to prioritize or expand the production of commodities from some of the key sectors partly depends on sector's capacity to create sustainable and decent employment opportunities.

Particularly in a situation, where there is massive unemployment, an increase in income of labor from a certain shock would entail that more employment would be created. In general, the impact of the expansion of activities on creating employment opportunity apparently depends on the effect of the expansion of activities on labor.

The results of the analysis have shown that the agricultural activities induce more demand for labor than the industrial sector. From all activities of the agro-processing, bakery, grain, dairy, vegetable oil, and other agro-processing activities induce more demand for labor than other sectors. The result has revealed that other agro-processing activities do not create more employment opportunities. This is because, they either intensively use intermediate inputs or capital in their production systems. For instance, a one unit increase in the demand for cereals and oil seeds each, their effect on income of labor would be 0.64 and 0.75, respectively. If the same shock happens on textile, leather, and sugar, their impact on labor income would be 0.16, 0.28, and 0.48 in the order mentioned (Figure 10).

Figure 3: Spillover effects from activities on labor employment



Source: Authors' computation based on SAM (2016)

Decomposition and technical change

It has been observed that there is a change in the production of goods and services in Ethiopia in the last few decades. There are two sources for this change of production patterns. One of it is the change in technical capabilities emanating from strong backward and forward linkages among sectors; and the other is the change in the final demand by economic agents. When the income of households increases, it again increases the demand for goods and services that eventually increases the demand for goods and services. This may not be accompanied by an increased in domestic production or strong technical change. The closed loop shows the effect of consumption on the production of goods and services. The result of this study clearly shows that the change in the production of goods and services in the economy occurred because of a boom in consumption. The results have shown that there is no significant change in the nature of the production function on sectoral linkages.

The decomposition of changes in the gross value of production between 2005/2006 and 2015/2016 shows contributions from changes in the technology and changes in the final demand. The results for this decomposition of change in gross output are presented in Table 9. The results show that the change in economy-wide gross output is predominantly due to the change in the final demand, with changes in technology only contributing a very infinitesimal amount. Although the final demand is the main driver of change in economy-wide gross output over the period under study, results vary across activities. Several activities rely solely on the final demand effects, while their technology effects associated with backward linkages to the other activities have become less intense. Pulses, oilseed, livestock, vegetable oil, grain, bakery, and agro-processing exhibit positive technology effects, although for all these activities the final demand remains the main source. The limited role of technical change indicates that there was no significant structural transformation in the economy over the ten years between 2005/2006 and 2015/2016.

Table 9: Decomposition of technical and demand changes of activities

Activities	Technical change	Change in Demand	Total Change
Cereals	(15.37)	303.10	287.72
Pulses	17.78	44.33	62.10
Oil seeds	1.48	35.45	36.93
Fruits and vegetables	(2.22)	68.56	66.34
Cash crops	(3.16)	74.03	70.87
Enset	(0.76)	18.86	18.10
Livestock and fish	14.34	277.41	291.74
Preserve	0.06	3.49	3.55
Vegetable oil	3.73	17.28	21.02
Dairy	(3.08)	29.20	26.12
Grain and bakery	44.18	311.15	355.33
Sugar	(3.56)	16.32	12.76
Agro-processing	4.52	81.55	86.07
Alcohol	0.42	36.09	36.51
Soft drink	(6.80)	20.42	13.62
Tobacco	0.32	2.19	2.51
Textile and Apparel	(2.86)	44.31	41.45
Leather	(0.08)	23.68	23.60

Source: Authors' computation based on SAM (2006 and 2016)

5. Conclusion and Policy Implications

This study has generated numerous results from the quantitative analyses. First, the results have shown that there is weak linkage between the agricultural and agro-processing sectors in Ethiopia. Agro-processing sectors, in particular, have weak links with agricultural activities. The linkage has been found to be very weak especially in the fruits and vegetables subsector although several other subsectors, activities have also exhibited weak intersectoral linkages with other sectors. On the contrary, cereals have strong forward linkage, showing that agro-processing is concentrating on flour production and bread production, or bakery business, which are fundamental for household consumption and catering businesses. Second, the SAM decomposition analysis has indicated that the closed loop effect is the strongest source of the multiplier. This shows the presence of stronger consumption effect in the economy than the within effect, which is linked to the forward and backward linkages of activities. Third, ensuring linkage between the agricultural

and manufacturing sector will have huge welfare effect through its impact on the demand for labor and income of households. Fourth, the results further revealed that the change in production of activities has been caused by the change in consumption than significant technical changes.

In general, this study made it clear that there is a long way to inducing effective structural transformation and creating jobs in the country if we continue to do things the same way. Particular attention should be paid to the fruit and vegetable sectors, where forward linkages of vegetable and fruit linkages are extremely weak. The major problem regarding weak linkages is more due to the structure of the economy and the weak implementation of the plans, policies, and strategies. It will remain an uphill battle to achieve sustainable development without building high-quality value chains and linkages within and between the agriculture and industry sectors, fostering economic structural transformation. The study recommends that policymakers should focus on improving implementation capacity to promote systemic linkages between the agricultural and industrial sectors. In addition, policies should give prime attention to allocate resource into the sectors which speed up economic linkages. Eventually, each priority agro-processing sector should be scrutinized to sort out the key binding factors that cause weak linkages in the sector.

Acronyms and Abbreviations

ADLI	Agricultural Development Led Industrialization
CSA	Central Statistical Agency
GDP	Gross Domestic Product
GTP	Growth and Transformation Plan
PASDEP	Plan for Accelerated and Sustainable Development to End Poverty
SDPRP	Sustainable Development and Poverty Reduction Programme
SSA	Sub-Saharan Africa

References

Berliant, M. (2007). Prospects for a Unified Urban General Equilibrium Theory. *Journal of Regional Science and Urban Economics*, 37(4), 466-471.

Bigsten, A., Gebreeyesus, M., & Söderbom, M. (2009). Gradual Trade Liberalization and Firm Performance in Ethiopia. CSAE Working paper Series.

Chenery, H., & Watanabe, T. (1958). International Comparisons of the Structure of Production. Econometrica, 26(4), 487-521.

Dosi G, Pavitt, K, & Soete, L. (1990). *The Economics of Technical Change and International Trade*. New York University Press. New York.

Federal Democratic Republic of Ethiopia, Ministry of Information. (2002). Industrial Development Strategy. Addis Ababa, Ethiopia.

Fei, J. C. H. & Ranis, G. (1961). A Theory of Economic Development. The American Economic Review, 51, 533-565.

Geda, A. (2001). Macroeconomic Performance in Post-Dergue Ethiopia. Northeast African Studies, 159-204.

Hirschman, A. (1958). The Strategy of Economic Development. New York: Yale University Press.

Hoai, D., T., Tarp, F., van Seventer, D., & Hoa, H. C. (2016): Growth and structural transformation in Viet Nam during the 2000s, WIDER Working Paper, No. 2016/108, ISBN 978-92-9256-152-9, The United Nations University World Institute for Development Economics Research (UNU-WIDER), Helsinki.

Kuznets, S. (1965). Economic Growth and Structure: Selected Essays. London: Heinemann Educational Books Ltd.

Kuznets, S. (1979). Growth and structural shifts. In: Galenson W, ed. Economic Growth and Structural Change in Taiwan. The Postwar Experience of the Republic of China. Cornell University Press. London.

Lewis, A. W. (1954). Economic Development with Unlimited Supplies of Labour. Manchester School of Economics Social Studies, 139–191.

Millar, R. E. & Blair, P. D. (2009). Input–Output Analysis, Foundations and Extensions. Cambridge: Cambridge University Press.

Mihretu, M., & Llobet, G. (2017). Looking beyond the horizon: a case study of PVH's commitment in Ethiopia's Hawassa Industrial Park. World Bank.

Ministry of Finance and Economic Development – MoFED. (2002). Ministry of Finance and Economic Development. Sustainable Development and Poverty Reduction Program (SDPRP). Addis Ababa, Ethiopia.

_____ (2005). A plan for accelerated and sustainable development to end poverty (PASDEP), Ministry of Finance and Economic Development, Addis Ababa

Ministry of Finance and Economic Development – MoFED. (2006). Ministry of Finance and Economic Development. Macroeconomic Developments in Ethiopia, Annual Report.

_____ (2010). Ministry of Finance and Economic Development. Growth and transformation plan of Ethiopia (GTP). Addis Ababa, Ethiopia.

_____ (2011). Ministry of Finance and Economic Development. Macroeconomic Developments in Ethiopia, Annual report. Addis Ababa, Ethiopia.

_____ (2012). Ministry of Finance and Economic Development, Ethiopia's Progress Towards Eradicating Poverty: An Interim Report on Poverty Analysis Study.

_____ (2013). Ministry of Finance and Economic Development. Annual Progress Report for F.Y. 2011/12 Growth and Transformation Plan. Addis Ababa, Ethiopia.

Ministry of Planning and Development – MoPD. (2022). National Accounts Statistics of Ethiopia 2014 EFY: GDP Estimates and Key Macroeconomic Aggregates. The Federal Democratic Republic of Ethiopia, Ministry of Planning and Development and Development.

Newman, C., Page, J., Rand, J., Shimeles, A., Söderbom, M., & Tarp, F. (2016). *Manufacturing Transformation: Comparative Studies of Industrial Development in Africa and Emerging Asia*. Oxford University Press.

Nigussie, T. (2012). Welfare Impacts of Rising Food Prices in Rural Ethiopia: A Quadratic Almost Ideal Demand System Approach. Paper Presented at the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil, 18-24.

National Planning Commission – NPC. (2015). The Second Growth and Transformation Plan (GTP II) (2015/16-2019/20). The Federal Democratic Republic of Ethiopia, National Planning Commission.

Planning and Development Commission – PDC. (2021). Ten-Years Development Plan: A pathway to prosperity, 2020/21-2029/30. The Federal Democratic Republic of Ethiopia, Planning and Development Commission.

Philip, J., & Tadele, F. (2005). Quantitative Impact Assessment of Trade Liberalization. In.

Pyatt, G., & Round, J. (1979). Accounting and Fixed-Price Multipliers in a Social Accounting Matrix Framework. *Economic Journal*, 89(356), 850-73.

Randriamamonjy, J., & Thurlow, J. (2015). Social Accounting Matrix for Tanzania: A Nexus Project SAM. International Food Policy Research Institute, Washington DC, USA.

Rasmussen, P. N. (1958). Studies in Inter-sectorial Relations. Amsterdam, North Holland P.C.

Rostow, W. W. (1956). The Take-Off into Self-Sustained Growth. *The Economic Journal*, 66(261), 25–48.

Suleiman, A., Morrissey, O. & Rayner, T. (2004). Aggregate agricultural response in Ethiopia: A farm level analysis. Journal of International Development, 16(4), 605-620.

United Nations Conference on Trade and Development – UNCTAD. (1996). The Least Developed Countries Report, United Nations, New York, and Geneva.

_____ (2021). The Least Developed Countries Report, United Nations, New York, and Geneva.

United Nations Industrial Development Organization - UNIDO (1991). Ethiopia: New Directions of Industrial Policy. Industrial Development Review Series, Regional and Country Branch. Vienna.

_____ (2017). Structural Change for Inclusive and Sustainable Industrial Development. Vienna.

WB, WDI (World Bank, World Development Indicators). (2020). Excel data base report on low-income Sub-Saharan Africa: Ethiopia. Washington D.C. USA.

Welteji, D. (2018). A critical review of rural development policy of Ethiopia: Access, utilization, and coverage. Agriculture and Food Security, 7(1), 1-6.

Zerihun, A. (2008). Industrialization policy and industrial development strategy in Ethiopia, in: T. Assefa (ed.), Digest of Ethiopia's national policies, strategies and programs, Addis Ababa: Forum for Social Studies, 239-281.

Appendices

Appendix 1: SAM decomposition

We recall that

$$Y_n = A_n \bar{Y}_n + X$$

Where Yn the total of each endogenous account. An is define as the matrix of average expenditure propensities. Xnre presents the exogenous accounts. From the multiplier analysis,

$\bar{Y}_n = (I - A_n)^{-1} X$ we can denote the multiplier matric as $M_a = (I - A_n)^{-1}$

$$\bar{Y}_n = M_a X$$

This matrix could be decomposed following Pyatt and Round (1978) into three economically meaningful components. This area transfer, an open-loop matrix, and a closed-loop matrix

Recall

$$Y_n = A_n \bar{Y}_n + X$$

Let us add and subtracted the same expression

$$\bar{A}_n \bar{Y}_n$$

$$Y_n = A_n \bar{Y}_n - \bar{A}_n \bar{Y}_n + \bar{A}_n \bar{Y}_n + X \; ; \qquad (I - \bar{A}_n)\bar{Y}_n = (A_n - \bar{A}_n)\bar{Y}_n + X \; ;$$

$$Y_n - \bar{A}_n \bar{Y}_n = (A_n - \bar{A}_n)\bar{Y}_n + X$$

$$\bar{Y}_n = (I - \bar{A}_n)^{-1}(A_n - \bar{A}_n)\bar{Y}_n + (I - \bar{A}_n)^{-1} X$$

Let $A^* = (I - \bar{A}_n)^{-1}(A_n - \bar{A}_n)$

$$\bar{Y}_n = A^* \bar{Y}_n + (I - \bar{A}_n)^{-1} X$$

$$\bar{Y}_n - (I - \bar{A}_n)^{-1} X = A^* \bar{Y}_n$$

Multiply $\bar{Y}_n = A^* \bar{Y}_n + (I - \bar{A}_n)^{-1} X$ by A^*

$$A^* \bar{Y}_n = A^{*2} \bar{Y}_n + A^* (I - \bar{A}_n)^{-1} X \quad \text{but} \quad \bar{Y}_n - (I - \bar{A}_n)^{-1} X = A^* \bar{Y}_n$$

$$\bar{Y}_n - (I - \bar{A}_n)^{-1} X = A^{*2} \bar{Y}_n + A^* (I - \bar{A}_n)^{-1} X$$

$$\bar{Y}_n - (I - \bar{A}_n)^{-1} X = A^{*2} \bar{Y}_n + A^* (I - \bar{A}_n)^{-1} X$$

$$\bar{Y_n} = A^{*2}\bar{Y_n} + A^{*}(I - \bar{A_n})^{-1}X + (I - \bar{A_n})^{-1}X$$

$$\bar{Y_n} = A^{*2}\bar{Y_n} + (A^{*}(I - \bar{A_n})^{-1} + (I - \bar{A_n})^{-1})X$$

$$\bar{Y_n} - (A^{*}(I - \bar{A_n})^{-1} + (I - \bar{A_n})^{-1})X = A^{*2}\bar{Y_n}$$

Multiply $\bar{Y_n} = A^{*}\bar{Y_n} + (I - \bar{A_n})^{-1}X$ by A^{*2}

$$A^{*2}\bar{Y_n} = A^{*3}\bar{Y_n} + A^{*2}(I - \bar{A_n})^{-1}X$$

replace $A^{*2}\bar{Y_n}$

$$\bar{Y_n} - (A^{*}(I - \bar{A_n})^{-1} + (I - \bar{A_n})^{-1})X = A^{*3}\bar{Y_n} + A^{*2}(I - \bar{A_n})^{-1}X$$

$$\bar{Y_n} = A^{*3}\bar{Y_n} + A^{*2}(I - \bar{A_n})^{-1}X + (A^{*}(I - \bar{A_n})^{-1} + (I - \bar{A_n})^{-1})X$$

$$\bar{Y_n} - A^{*3}\bar{Y_n} = (A^{*2} + A^{*-1} + I)(I - \bar{A_n})^{-1}X$$

$$(I - A^{*3})\bar{Y_n} = (A^{*2} + A^{*-1} + I)(I - \bar{A_n})^{-1}X$$

$$\bar{Y_n} = (I - A^{*3})^{-1}(A^{*2} + A^{*-1} + I)(I - \bar{A_n})^{-1}X$$

Let $Ma_1 = (I - \bar{A_n})^{-1}$ $Ma_2 = (A^{*2} + A^{*-1} + I)$ $Ma_3 = (I - A^{*3})^{-1}$

So,

$$\bar{Y_n} = M_{a3}M_{a2}M_{a1}X$$

We can convert the afore mentioned expression into additive form

$$\bar{Y_n} = I + (M_{a1} - I) + (M_{a2} - I) * M_{a1} + (M_{a3} - I) * M_{a2} * M_{a1}$$

I = the initial unitary injection

$(M_{a1} - I)$ = captures the net effect of a group of accounts on itself through direct transfers

$(M_{a2} - I) * M_{a1}$ = net contribution of open loop or cross multiplier effects

$(M_{a3} - I) * M_{a2} * M_{a1}$ = net contribution of circular or closed loop multiplier effect.

The nxnmatrix A (a partition of A) was chosen as follows, considering that the first row (and column) corresponds to the block of activities/commodities, the second to

the block of production factors, and the third to the block of enterprises/households:

$$\bar{A} = \begin{bmatrix} A_{11} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & A_{33} \end{bmatrix}$$

Given a matrix

$$A = \begin{bmatrix} A_{11} & 0 & A_{13} \\ A_{21} & 0 & 0 \\ 0 & A_{32} & A_{33} \end{bmatrix} \text{ such that } A - \bar{A} \text{ is } \quad A = \begin{bmatrix} A_{11} & 0 & A_{13} \\ A_{21} & 0 & 0 \\ 0 & A_{32} & A_{33} \end{bmatrix}$$

$$A^* = (I - \bar{A})^{-1}(A - \bar{A})$$

$$= \begin{bmatrix} (I - A_{11})^{-1} & 0 & 0 \\ 0 & I & 0 \\ 0 & 0 & (I - A_{33})^{-1} \end{bmatrix} \begin{bmatrix} 0 & 0 & A_{13} \\ A_{21} & 0 & 0 \\ 0 & A_{32} & 0 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 0 & A^*_{13} \\ A^*_{21} & 0 & 0 \\ 0 & A^*_{32} & 0 \end{bmatrix} \text{ where } A^*_{13} = (I - A_{11})^{-1} * A_{13}, A^*_{21} = A_{21}, A^*_{32} = (I - A_{33})^{-1} * A_{32}$$

$$M_1 = \begin{bmatrix} (I - A_{11})^{-1} & 0 & 0 \\ 0 & I & 0 \\ 0 & 0 & (I - A_{33})^{-1} \end{bmatrix}$$

$$A^{*2} = A^* * A^* = \begin{bmatrix} 0 & 0 & A^*_{13} \\ A^*_{21} & 0 & 0 \\ 0 & A^*_{32} & 0 \end{bmatrix} * \begin{bmatrix} 0 & 0 & A^*_{13} \\ A^*_{21} & 0 & 0 \\ 0 & A^*_{32} & 0 \end{bmatrix} = \begin{bmatrix} 0 & A^*_{13}A^*_{32} & 0 \\ 0 & 0 & A^*_{21}A^*_{13} \\ A^*_{32}A^*_{21} & 0 & 0 \end{bmatrix}$$

$$M_2 = I + A^* + A^{*2} = \begin{bmatrix} I & 0 & 0 \\ 0 & I & 0 \\ 0 & 0 & I \end{bmatrix} + \begin{bmatrix} 0 & 0 & A^*_{13} \\ A^*_{21} & 0 & 0 \\ 0 & A^*_{32} & 0 \end{bmatrix} + \begin{bmatrix} 0 & A^*_{13}A^*_{32} & 0 \\ 0 & 0 & A^*_{21}A^*_{13} \\ A^*_{32}A^*_{21} & 0 & 0 \end{bmatrix}$$

$$= \begin{bmatrix} I & A^*_{13}A^*_{32} & A^*_{13} \\ A^*_{21} & I & A^*_{21}A^*_{13} \\ A^*_{32}A^*_{21} & A^*_{32} & I \end{bmatrix}$$

$$A^{*3} = A^{*2} * A^* = \begin{bmatrix} 0 & A^*_{13}A^*_{32} & 0 \\ 0 & 0 & A^*_{21}A^*_{13} \\ A^*_{32}A^*_{21} & 0 & 0 \end{bmatrix} \begin{bmatrix} 0 & 0 & A^*_{13} \\ A^*_{21} & 0 & 0 \\ 0 & A^*_{32} & 0 \end{bmatrix}$$

$$= \begin{bmatrix} A^*_{13}A^*_{32}A^*_{21} & 0 & 0 \\ 0 & A^*_{21}A^*_{13}A^*_{32} & 0 \\ 0 & 0 & A^*_{32}A^*_{21}A^*_{13} \end{bmatrix}$$

$$Ma_3 = (I - A^{*3})^{-1} = \begin{bmatrix} (I - A^*_{13}A^*_{32}A^*_{21})^{-1} & 0 & 0 \\ 0 & (I - A^*_{21}A^*_{13}A^*_{32})^{-1} & 0 \\ 0 & 0 & (I - A^*_{32}A^*_{21}A^*_{13})^{-1} \end{bmatrix}$$

$$M_1 = \begin{bmatrix} (I - A_{11})^{-1} - I & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & (I - A_{33})^{-1} - I \end{bmatrix}$$

$$\text{OL} = \begin{bmatrix} 0 & A^*_{13}A^*_{32} & A^*_{13}(I - A_{33})^{-1} \\ A^*_{21}(I - A_{11})^{-1} & 0 & A^*_{21}A^*_{13}(I - A_{33})^{-1} \\ A^*_{32}A^*_{21}(I - A_{11})^{-1} & A^*_{32} & 0 \end{bmatrix}$$

$$\text{CL} = \begin{bmatrix} C_{132}(I - A_{11})^{-1} & C_{132}A^*_{13}A^*_{32} & C_{132}A^*_{13}(I - A_{33})^{-1} \\ C_{213}A^*_{21}(I - A_{11})^{-1} & C_{213} & C_{213}A^*_{21}A^*_{13}(I - A_{33})^{-1} \\ C_{321}A^*_{32}A^*_{21}(I - A_{11})^{-1} & C_{321}A^*_{32} & C_{321}(I - A_{33})^{-1} \end{bmatrix}$$

$$C_{132} = (I - A^*_{13}A^*_{32}A^*_{21})^{-1} - I, C_{213} = (I - A^*_{21}A^*_{13}A^*_{32})^{-1} - I, C_{321} = (I - A^*_{32}A^*_{21}A^*_{13})^{-1} - I$$