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ABSTRACT

Sectoral Linkage in the Ethiopian Economy: A Social Accounting Matrix Multiplier Analysis

This research investigates the Ethiopian economy's sectoral linkages. It examines the forward and backward production and total linkages of the industry with the agriculture and service sectors. The import penetration and export intensity of the agriculture-based industry and the manufacturing industry are also discussed. The study used the Ethiopian Social Accounting Matrix (SAM) database and made a multiplier analysis to explore the linkages and estimate the multiplier coefficients. The results show that agriculture has a relatively strong linkage with other sectors while the agriculture-based industry has weak forward linkages, and the manufacturing industry has weak backward and forward linkages with other sectors of the economy. The multiplier analysis shows that an exogenous shock to the agriculture-based industry has a higher multiplier effect than a shock to the manufacturing industry. Economic policy should focus on agriculture-based industry investments to positively augment the Ethiopian industrialization process and the overall economy.

JEL Classification: C60, L60, L70, L80, O14, Q19

Keywords: sectoral linkages, social accounting matrix, multiplier analysis, Ethiopia

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1. Introduction

Traditional agriculture and modern industrial sectors along with their interdependency are crucial for a country's overall economic development (Hirschman, 1966; Gabriel and de Santana Ribeiro, 2019). Industrial demand for agricultural commodities determines agricultural growth whereas an increase in the purchasing power of the agricultural sector for the industry's products and the provision of raw materials for processing determine industry's growth (Koo and Lou, 1997). Every individual sector plays a role in the working of the whole economy which cannot be accomplished by other sectors. Indeed, one sector uses intermediate inputs from other industries for producing an output and part of its output is sold to the other sectors to be used as an input (Elbushra et al., 2000).

Linkages among the sectors of an economy is a crucial factor that plays a significant role by providing opportunities for further activities in different sectors (Park, 1989; Park and Chan, 1989; Wild and Schwank, 2008). Every sector's production output has two impacts on other sectors of the economy as backward and forward linkages (Gemmell et al., 2000; Mbanda and Bonga-Bonga, 2018; Miller and Blair, 2009; Saikia, 2009). Backward linkage signifies the demand of inputs by an activity or represents inducing local production of inputs while forward linkage indicates supply effects or providing inputs locally for downstream producers (Miller and Blair, 2009). There are two necessary conditions for these linkages to work. One is the scale effect without which the linkages will be meaningless, and the other necessary condition is the responsiveness of the private or public sectors to incentives (Hirschman, 1966).

The sectoral composition in Ethiopia showed that in earlier periods agriculture contributed the lion share percent to GDP and employment followed by service sector and industry respectively (Ejigu and Singh, 2016; Gebreeyesus, 2010). In contrast, recently, the service sector has 47 percent share while agriculture has 37 percent share followed by industry with 17 percent share of GDP (EEA, 2016; Kebede, 2018). This shows the dominance of the service sector followed by agriculture. The manufacturing industry contributed 5 percent to Ethiopian GDP (EEA, 2016).

Literatures consent with strong interdependency among economic activities as pillar factor that induces industrialization process and structural change (Park, 1994; Koo and Lou, 1997; Saikia, 2009; Khan, 2020). Sectoral linkage also provides opportunity for further production in different activities (Wild and Schwank, 2008). However, despite extensive research on sectoral linkages, there is a gap in literature on linkage of the industry with the rest of the economy in developing countries including Ethiopia. Studies on the interdependency of industry with other sectors mainly focuses on developed countries (Kim and Kim, 2015; Ilhan and Vaman, 2011). In the case of developing economies, literature mainly focuses on the agriculture sector's linkages and commonly ignored the industry sector (Hafeez et al., 2010: Thaiprasert, 2006). Existing studies also do not provide an in-depth analysis of the linkages between agriculture-based and the manufacturing industry with other sectors of the economy. Hence, this study addresses two specific research objectives: (i) examining the direct and total linkages of the industry sector with other sectors in the Ethiopian economy, and (ii) identifying a priority sector for policy focus that can lead to economic development in Ethiopia.

Previous research focused on the direct linkages and skipped the multiplier effect which signifies the direct effect of exogenous shocks. They focus on other sectors than manufacturing and agriculture-based industry. This research studies how the multi-faceted industry is inter-

related with the other sectors of the economy taking Ethiopia as a case study. For the analysis, it uses the Ethiopian Social Accounting Matrix (SAM) database and made a multiplier analysis to explore the linkages and for estimating the coefficients. The results show that agriculture has strong direct backward and forward linkages while the agriculture-based industry has weak forward linkages and the manufacturing sector has weak backward and forward linkages with the other sectors of the economy. The multiplier analysis shows that an exogenous shock to agriculture-based industry has a stronger multiplier effect as compared to a shock to the manufacturing industry. In fact, the economy is more elastic to a shock in the agriculture-based industry than in the manufacturing and other industries. Hence, the development policy should focus on investments in the agriculture-based for positively augmenting the overall economy coinciding with unbalanced development strategy in terms of sectoral linkage.

The rest of this research is organized as follows. Section 2 reviews relevant theoretical and empirical literature focusing on balanced versus unbalanced growth theories, sectoral linkages, and multiplier effects. Section 3 gives the social accounting matrix methodology and a multiplier analysis. Section 4 describes the data and the variables of interest with Section 5 discussing the results. The last section gives the conclusion and policy implications.

2. Review of Related Literature

This section briefly discusses the theoretical literature on balanced and unbalanced growth along with concepts of linkages and multiplier effects. It also does a succinct empirical review of sectoral linkages in the context of different countries followed by critical evaluation of the existing empirical findings.

2.1. Theories of Economic Growth and Development

In literature there are two contrasting theories of growth and development: the theory of balanced growth and the theory of unbalanced growth. The former stresses the need for different sectors in a developing economy to avoid supply difficulties indicating that balanced growth is derived from the demand side (Hirschman, 1958). Lewis (1954) argues in favor of balanced growth in which the government plans investments that avoid unnecessary bottlenecks and shortages in the economy (Lewis,1954; Nath, 1962). Balanced growth is also suggested by others for all sectors to develop simultaneously for promoting economic development (Nurkse, 1953; Saliminezhad and Lisaniler, 2018). According to the theory of balanced growth, at every stage of development the pattern of resource allocations is chosen in a way that production capacity is fully utilized by all the sectors of an economy (Lewis, 1954; Wilfred, 1975).

The unbalanced growth theory, however, recognizes the problem of limited professional skills, inadequate capital supply, and low quality of labor in developing countries suggesting the need for a concentrated and sequential pattern of development that achieves economies of scale and could result in a significant breakthrough in inducing development (Hirschman, 1958; Wilfred, 1975). Others are not in favor of the balanced growth theory on the ground that for developing countries financial capital is limited for simultaneous investments in various sectors and it is difficult to create a climate for massive parallel investments at the same time (Saliminezhad and Lisaniler, 2018; Singer, 1958). Balanced growth requires a huge capacity for investments,

enormous specific skills, and a conducive investment climate. Hence, Hirschman claims that unbalanced growth should focus on the strong sectors that can stimulate other sectors in the economy (Hirschman, 1958; Saliminezhad and Lisaniler, 2018; Singer, 1958). For developing countries, it is better to encourage sectors with strong linkages with other sectors instead of balanced investments in all activities in an economy (Hirschman, 1958).

2.2. Sectoral Linkages and Multiplier Effects

Sectoral linkages theoretically represent a sector's relationships with the rest of the economy concerning intermediate purchases and sales. Sectoral linkages can be discussed either from the perspective of the supply side or the demand side. The demand side refers to backward linkages that show the connection between a sector with the upstream sectors that supply intermediaries for it (Miller and Blair, 2009). These linkages arise through the interdependence of the sectors for meeting final consumption downstream (Saikia, 2009).

On the other hand, the supply side refers to forward linkages indicating a sector's linkages to the downstream sectors demanding its output (Mbanda and Bonga-Bonga, 2018; Miller and Blair, 2009). On the supply side, agriculture supplies food grains to industry which facilitates the absorption of labor in the industry sector; the agriculture sector provides inputs such as raw cotton, tea, coffee, and jute for food processing in the agroindustry. On the other side, industry supplies industrial inputs such as pesticides, fertilizers, and machinery to the agriculture sector. The agriculture sector creates demand for the industry sector through consumption and higher productivity. Savings in the agriculture sector can be used as a source of investments in the industry sector (Saikia, 2009).

Sectoral interdependence impacts the entire economy and each sector exerts a two-way impact on other sectors: first a sector receives or demands intermediate inputs from other sectors directly or indirectly which is called backward linkages. When a sector provides an intermediate output to all sectors directly and implicitly it is called forward linkages (Elbushra et al., 2000). Linkages can be direct or total, that is, either backward or forward linkages or direct as well as indirect effects denoted as a multiplier effect which shows the magnified effect of the direct forward and backward linkages among the sectors (Breisinger et al., 2009; Humavindu and Stage, 2013). Backward linkages measure the proportion of a sector's direct inputs that come from other sectors in the economy instead of primary inputs used in the production process. On the other hand, forward linkages measure the proportion of a sector's direct output that goes to the other sectors of the economy (Kim and Kim, 2015).

According to Hirschman's (1958) unbalanced growth theory the sectors with the highest linkages should stimulate a more rapid growth in production, employment, and income as compared to the other sectors. Basically, if the backward linkage of a sector is greater than one while the forward linkage is less than one, then this will be termed as strong backward linkage. If the backward linkage of the sector is less than one while the forward linage is greater than one, then we have strong forward linkage. When both forward and backward linkages of a sector is less than one it is termed as weak linkage sector (Temursho, 2016). Yet, when the linkage value of a sector is greater than one for both backward and forward linkages, then it is termed as a strong linkage sector (Ilhan and Vaman, 2011; Kim and Kim, 2015).

A multiplier effect shows the magnified effect of a shock and conventionally can be classified into two parts: output and input multipliers (Kim and Kim, 2015) or into three parts as output multiplier, GDP multiplier, and income multiplier (Breisinger et al., 2009). Output multiplier measures the total effect of a monetary unit change in the final demand for a sector's goods and services on the output of the other sectors of the economy. Input multiplier measures the effect of a monetary unit change in the primary inputs provided to a sector on the inputs of all sectors in the economy (Bon et al., 1999; Kim and Kim, 2015).

The results of a linkage and multiplier analysis help assess and improve policy decisions by identifying key linkage sectors. This also provides a better understanding of how exogenous shocks will impact the complex structure of an economy (Blancas, 2006). Literature stresses that a country's optimal industrial structure is endogenous to its endowments (Dietsche, 2017; Lin and Chang, 2009). Under such conditions, any intervention should focus on encouraging the production of goods and services for which a country has abundant factors of production. In this case industries with comparative advantages should be encouraged through interventions along with a hands-off approach (Dietsche, 2017; Lin and Chang, 2009).

Industrial production especially manufacturing production through interdependence and forward and backward linkages, induces productivity in all the other sectors and it triggers a process of institutional, political, and infrastructural progress (Lin and Chang, 2009). Besides, the linkages between the different sectors of an economy and the sectoral composition of output has growth inducing effect (Wild and Schwank, 2008). Figure 1 shows how an exogenous shock impacts the structure of an economy. As shown in the figure, a shock has both direct and indirect effects and the indirect effects can be classified into two parts as production and consumption linkages in which the former consists of backward and forward linkages. The total effect is captured as a multiplier effect of an exogenous shock (Breisinger et al., 2009; Hirschman, 1958).

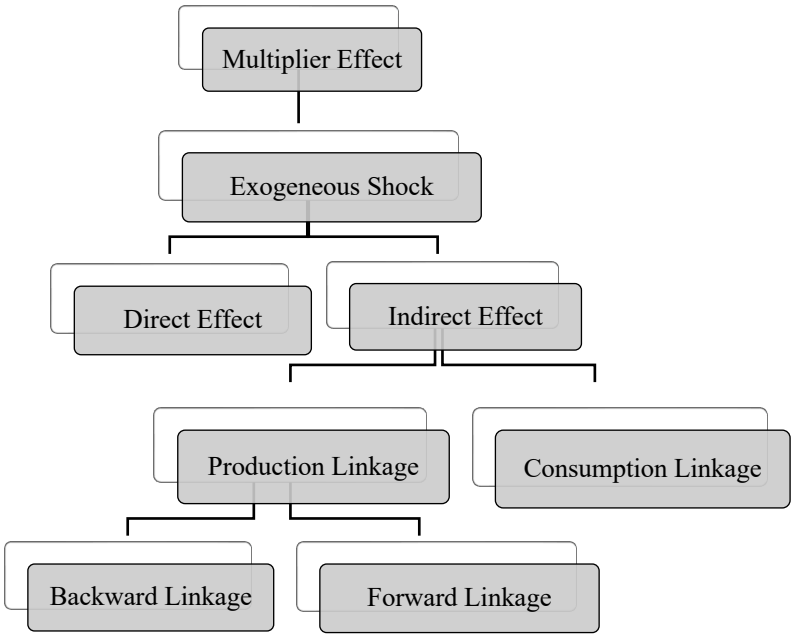

Figure 1. Basic framework for the linkage effects of an exogenous shock

2.3. Review of Empirical Literature

Empirical research on economic growth has expanded enormously and focuses on the determinants of aggregate economic growth with less emphasis on the determinants of sectoral growth.[1] Some exceptions are the classical contributions of Lewis (1954) and Hirshmann (1958). These studies discuss the dual economic model explaining economic growth by emphasizing the role of the agriculture and industry sectors and the linkages between them (Lewis, 1954; Hirshmann, 1958; Subramaniam, 2010).

Very few empirical investigations at different levels of aggregation have been done in literature. Kim and Kim (2015) investigated the impact of the hotel industry on other industries in the Texas economy using an input-output approach for estimating employment, output, and income multiplier's coefficients. Their findings show that the hotel industry impacted Texas' economy due to a huge induced effect of output, income, and employment but with a relatively lower multiplier effect. The accommodation industry generated more labor income and employment opportunities than the hotel industry provided that the hotel industry had a strong interdependence on the finance and insurance industries.

Hampson (2012) on a review of the industry policy and its historical background in Australia he showed that since the 1980s reforms in the country's industrial policy followed an economically liberal approach. The study showed that leaving the industries to the market had strong implications on the interdependency of different sectors of the economy and the overall structure of the economy. However, this approach was compromised by political pragmatism and ultimately led to a need for an interventionist policy in selective industries.

Ilhan and Vaman (2011) studied the impact of the construction industry on the rest of the Turkish economy by conducting a comparative analysis with EU countries following the input-output approach. The results of their study showed a strong backward linkage but weak forward linkages with the sectors of some EU countries such as the Czech Republic, Portugal, Slovakia, and Hungary showing the important role that the construction sector plays in the Turkish economy.

Subramaniam (2010) examined the role of market liberalization and its impact on the agriculture sector and intersectoral linkages between agriculture, industry, and service sectors in Romania, Poland, Hungary, and Bulgaria using the vector error correction model and the impulse response function. His results show that in the short-run a sector can have negative linkages with the other sectors but not in the long-run. The impulse response analysis showed that a shock in an endogenous variable was absorbed by the agriculture sector as well as by the other sectors in all the four countries.

Koo and Lou (1997) investigated the interdependency among the industry and agriculture sectors in China. They found the labor input to be significant for Chinese economic development while capital investments primarily impacted Chinese industrial development. However, labor contributed less to the agriculture sector while land contributed less to the

[1] The literature review is not organized chronologically. It is instead starting with the developed countries' experience and moving to the developing countries' empirical context.

development of both the agriculture and industry sectors in China. The Chinese agriculture sector depends on the industry sector, but the industry sector's growth does not rely on agricultural growth. Chen and Song (2019) investigated the forward and backward linkages in the Macau industry sector with other industries in the economy using the input-output approach and a direct coefficient analysis. Their findings show a weak linkage between both upstream and downstream industries though it made a significant contribution to Macau's overall economic performance.

Hafeez et al. (2010) examined the implications of service-led growth and an industrial policy along with its contribution to the Pakistan and Asian economies. They show that the sectoral composition of output and growth meant a structural transformation from an agrarian economy to a service sector dominating the economy. The industry structure too has transformed from an import substitution strategy to an export-oriented industry with an insignificant impact on the industry sector's diversification, employment contribution, and competitiveness. This shows the need for inclusive service led growth and industrial policy. Thaiprasert (2006) used a key sector and multiplier analysis to show that agriculture was a major sector impacting the development of Thailand's economy with high backward and forward linkages. Together with agroindustry the manufacturing sector made small contributions to the economy and a multiplier analysis confirmed the potential of the agriculture and agroindustry sectors as compared to the non-agriculture sectors.

Tadele (2000) investigated intersectoral linkages in Ethiopia using SAM for 2000. The multiplier analysis showed that in the agriculture sector, teff, maize, wheat, and coffee had relatively strong linkages with the rest of the economy. In the industrial sector food processing, beverages, metals, and textiles had a strong impact on labor incomes for an exogenous shock in the demand for these activities. These linkages have strong implications for development strategies focusing on agriculture and other sectors.

The review so far shows that the existing empirical studies related to sectoral linkages in the different countries mainly focus on the tourism industry's linkages with other sectors, the game industry, the construction industry, and the agriculture industry using an input-output analysis. These studies focus on the direct linkages and skip the multiplier effect which signifies the direct effect of a shock. The studies also focus on other sectors than manufacturing and agriculture-based industry and this is a gap that the study will fill by exploring the Ethiopian case. Tadele (2000), investigated intersectoral linkages in Ethiopia by disaggregating the activities into micro level without a specific focus on a specific sector and neglecting the aggregated interlinkages among the sectors. This study however explores the industry's linkages classified into agriculture-based industry, manufacturing, and other industries with the rest of the sectors in the economy using a multiplier SAM analysis. The study uses an updated SAM database available in Ethiopia. This approach enables us to capture consumption linkages and the total multiplier effect of an exogenous shock.

3. Method

Different methodologies can be used for analyzing and estimating sectoral linkages such as the input-output (IO) approach, the social accounting matrix (SAM), and the computable general equilibrium (CGE), statistical causality tests, and econometric modeling (Leontief, 1986; Pyatt, 1988, Roland-Holst and Sancho,1995; Breisinger et al., 2009; FAO, 2012). The input-output

method is an economic model with a theoretical foundation in Walras' general equilibrium theory which reflects the mutual quantitative relationships between the inputs and outputs of various sectors in an economy. The input-output approach helps to analyze the inter-related effects of each sector in the industrial structure and the whole economic system (Chen and Song, 2019). SAM, on the other hand, is a double entry and money metric economic accounting system recording transactions among economic activities. It shows the complete circular flow of income from production to distribution and expenditure reflecting the socioeconomic structure of the economy (Mbanda and Bonga-Bonga, 2018).

SAM is also an accounting framework that represents the economy by assigning numbers to the income and expenditure in a circular flow diagram. The entire circular flow of income in an economy is depicted in SAM in a square matrix form with each cell representing a flow of funds from a column account to a row account (Pyatt, 1988, Roland-Holst and Sancho,1995; Huseyin,1996; Lofgren et al., 2002; Breisinger et al., 2009; Temursho, 2016). The columns track expenditure while the rows track the receipts, and the total represents the total expenditure and total receipts respectively. In SAM, we usually have six accounts aggregated as activities; commodities disaggregated into agriculture, industry, and services; factor account including labor and capital; institutions consisting of households and the government; capital account holding investments and savings; and the rest of the world account (Breisinger et al., 2009; Temursho, 2016; Mbanda and Bonga-Bonga, 2018; Tadele, 2000). The latter comprises the balance of foreign exchange where the row indicates the outflows, and the column indicates the inflows (Temursho, 2016).

However, SAM is not without limitations as it assumes a fixed price and the unconstrained one assumes unlimited supply response for a change in demand. The input-output approach unlike SAM shows only the production linkage ignoring the consumption side. CGE relaxes the fixed price assumption and unconstrained supply sharing other assumptions with the two models (Breisinger et al., 2009; FAO, 2012). In comparing the different approaches this study does only a SAM multiplier analysis that addresses the research objective. SAM organizes the information about the economic and social structure of a country for a given period and provides a view of the flows of receipts and payments in an economic system (FAO, 2012). As compared to the other approaches, SAM has the advantage that it provides a chance to explore not only direct production linkages but also consumption linkages as well as the total linkages among the sectors (Breisinger et al., 2009). Further, a multiplier decomposition can also be done using SAM based framework (Ge and Lei, 2013) which is beyond the scope of this study.

Table 1 shows SAM's basic structure with its accounts and the transactions made among the accounts. As can be seen, there are seven accounts: production activities, commodities, factors, households, government, capital account, and the rest of the world account. In the activity column, we have an intermediate demand for the commodity market and value added as a payment from the activity to the factors which give us the total of the intermediate and value added in the column as the gross output. In the rows the activity account gets domestic supply of an output through production activity which gives us total activity income. In the commodity column, it is an expenditure by the commodity account on activities for domestic supply of goods and services, a payment of sales tax and import tariffs for commodities imported from the rest of the world, and payment for total imported commodities which gives the total supply. In the rows of the commodity account income is generated from an intermediate demand from the activity account, consumption demand from households, recurrent demand for

commodities by the government, and investment demand, income is generated from the rest of the world account from a demand for exports and the sum gives the total demand. The column on the factor account is an expenditure by the factors to the households which gives total factor spending while the row is income generated by the factors from an activity being used as value added which gives the total factor income.

Table 1. SAM's basic structure

	Activities	Commodities	Factors	Households	Government	Savings and investment	Rest of world
Activities		Intermediate demand	Value Added				
Commodities	Domestic Supply				Sales taxes and import tariffs		Import Payments
Factors				Factor payments to Households			
Households		Consumption Spending			Direct Tax	Private Savings	
Government		Recurrent Spending		Social transfers		Fiscal surplus	
Savings and investment		Investment demand					
Rest of world		Export earnings		Foreign Remittance	Foreign grant and Loan	Current account Balance	
Total Activities	Activity Income	Total Demand	Total Factor Income	Total household income	Government Income	Total Savings	Foreign exchange outflow

Total Activities	Gross Output	Total Supply	Total Factor spending	Total Household Spending	Government Expenditure	Total investment Spending	Foreign Exchange Inflow	

Sources: Pyatt, (1988), Elbushra et al. (2000) and Breisinger et al. (2009).

In the household account, the column shows the expenditure on consumption of commodities, direct taxes paid to the government, and private savings which are summed as total household spending. The row side of the household account is an income that goes to a household as a factor payment as the household source of the factors, a social transfer income from the government, and a remittance transfer from the rest of the world account which in sum is the total household income. Another institutional account is the government account with the column showing expenditure for commodities as recurrent expenditure, payment to households as a social transfer, and government savings as a fiscal surplus which give the government's expenditure. The row in the government account gives the income for the government from the commodity market as sales tax and import tariffs, direct taxes from households, and loan and foreign grants from the rest of the world which make total government income.

The capital account consists of savings and investments in the column which is an expenditure as investments in the commodity market which gives the total investment spending. The row in the capital account shows income from household savings, fiscal surplus with the government, and the current account balance summing up to total savings. Finally, in the rest of the world account, the column is an expenditure for domestically produced commodities, transfers to households as remittances, foreign grants and loans for the government, and the current account balance for the capital account which add up to total foreign exchange inflows. In the row of this account an income from the rest of the world is generated from payments for imports in the commodity account which gives the total foreign exchange outflows. The accounting matrix SAM is also presented using alphabets in Table 2. The glossary of letters used in the table is:

A denotes activities,
C represents commodities,
F stands for factors of production,
H represents households,
E stands for the exogenous components of demand including government account, capital account, and the rest of the world account,
X represents the gross output of each activity,
Z stands for the total demand for each commodity,
V is total factor income, and
Y stands for total household income.

Table 2. SAM using alphabets

		A_1	A_2	A_3	C_1	C_2	C_3	F	H	E	Total
Activities	A_1				X_1						X_1
	A_2					X_2					X_2
	A_3						X_3				X_3
Commodities	C_1	Z_{11}	Z_{12}	Z_{13}					C_1	E_1	Z_1

	C_2	Z_{21}	Z_{22}	Z_{23}					C_2	E_2	Z_2
	C_3	Z_{31}	Z_{32}	Z_{33}					C_3	E_3	Z_3
Factors	F	V_1	V_2	V_3							V
Household	H							$V_1+V_2+V_3$			Y
Exogenous demand	E				L_1	L_2	L_3		S		E
Total		X_1	X_2	X_3	Z_1	Z_2	Z_3	V	Y	E	

Sources: Elbushra et al. (2000) and Breisinger et al. (2009).

Table 3 gives the basic multiplier matrix with the letters in Table 2 and the coefficients as ratios are defined as:

a's represent technical coefficients,
b's represent share of domestic output in total demand,
v's are value added or factors of production as a share of total output,
c's are household consumption expenditure,
s stands for the household saving rate,
l's are total demand value share of imports or commodity taxes
$a_{11} = Z_{11}/X_1$, $a_{21} = Z_{21}/X_1$, $a_{31} = Z_{31}/X_1$
$a_{12} = Z_{12}/X_2$, $a_{22} = Z_{22}/X_2$, $a_{32} = Z_{32}/X_2$
$a_{13} = Z_{13}/X_3$, $a_{23} = Z_{23}/X_3$, $a_{33} = Z_{33}/X_2$
$b_1=X_1/Z_1$, $b_2=X_2/Z_2$, $b_3=X_3/Z_3$
$v_1=V_1/X_1$, $v_2=V_2/X_2$, $v_3=V_3/X_3$
$c_1=C_1/Y$, c2= C_2/Y, $c_3= C_3/Y$ and s=S/Y
$l_1=l_1/Z_1$, $l_2=l_2/Z_2$, $l_3=l_3/Z_3$

Table 3. A basic multiplier matrix

		A_1	A_2	A_3	C_1	C_2	C_3	F	H	E	Total
Activities	A_1				b_1						X_1
	A_2					b_2					X_2
	A_3						b_3				X_3
Commodities	C_1	a_{11}	a_{12}	a_{13}					c_1	E_1	Z_1
	C_2	a_{21}	a_{22}	a_{23}					c_2	E_2	Z_2
	C_3	a_{31}	a_{32}	a_{33}					c_3	E_3	Z_3
Factors	F	v_1	v_2	v_3							V
Household	H							1			Y
Exogenous demand	E				l_1	l_2	l_3		s		E
Total		1	1	1	1	1	1	1	1	1	

Source: Elbushra et al. (2000).

According to SAM, in each sector total demand is the sum of intermediate inputs, a household's consumption demand, and an exogenous source of demand consisting of investments and public consumption. According to Breisinger et al. (2009), the total demand (Z) can be mathematically represented with the unconstrained multiplier matrix as:

$$(1) \quad Z = aX + cY + E$$

where total demand Z has X, Y, and E as its components defined as intermediate inputs, consumption demand, and exogenous sources of demand such as investments and public consumption. The lower-level characters a and c denote technical coefficients and the household expenditure's share is defined as:

(2) $X = bZ$

where X indicates gross output as part of total demand Z taken from Table 2, $b_1=X_1/Z_1$, $b_2=X_2/Z_2$, $b_3=X_3/Z_3$. The consumption demand is defined as:

(3) $Y = vX, Y = vbZ$

Equation (3) denoting household income depends on the share of factor income. In Table 2 $V_1+V_2+V_3=Y$ and $V_1= v_1X_1$, $V_2= v_2X_2$ and $V_3= v_3X_3$ which gives $Y=vX$. Then, by substituting Equations (3) and (2) in the first equation we get Equation (4), with the total demand as:

(4) $Z = abZ + cvbZ + E$

Now we can collect the coefficients of Z together leaving only the exogenous term to the right-hand side as:

(5) $Z - cbZ - cvbZ = E$

(6) $[I - cb - cvb]Z = E$

We can denote the term in the bracket as the difference between the identity matrix and the coefficient matrix (I-A) as:

(7) $[I - A]Z = E$

After rearranging, we reach to the multiplier formula:

(8) $Z = [I - A]^{-1}E$

Here the coefficient for the exogenous demand E is defined as the multiplier matrix that shows the amplified effect of exogenous demand on endogenous accounts. In this study, the Ethiopian SAM for 2011 is used as the database for examining the forward and backward linkages of the manufacturing industry with other sectors of the economy along with the output multiplier, GDP multiplier, income multiplier, and demand multiplier.

4. Data

This study uses the social accounting matrix (SAM) database for 2011 released by the International Food Program Research Institute (IFPRE) in Ethiopia. The data post-2011 is not available. The SAM covers 75 sectors and there are 70 production activities, 71 commodities, and the factor account consists of 14 components with labor disaggregated based on the level of education, land, and capital. 15 household accounts are disaggregated based on location as urban and rural along with differences in the income percentiles. Other accounts include the government account, three tax accounts, the savings and investments account, transaction cost account, enterprise account, and the rest of the world account.

The objective of this study is examining the direct and total linkages of the industry sector especially the agriculture-based industry and manufacturing industry with the rest of sectors of the economy. The SAM must be aggregated to sectors to make it coincide with the objective of the study. Accordingly, the aggregated SAM has six production activities: agriculture, agriculture-based industry (agroindustry), manufacturing industry, other industries, trade services, and other services sectors. Likewise, the commodity account is aggregated into six sub-accounts listed above. Factors are aggregated into three accounts as labor, land, and capital.

Household account is aggregated into rural and urban households. Ultimately, the government account, capital account, and the rest of the world account are taken as they are.

5. Discussion of the Results

This section discusses SAM characterization, direct linkages consisting of both forward and backward production linkages along with the output, GDP, and income multipliers for the Ethiopian SAM database of 2011. Import penetration and export intensity of the industry too are discussed. Special attention is paid to the agriculture-based industry and manufacturing industry towards exploring their direct and total linkages with other sectors of the economy.

5.1 SAM Characterization

The first step is aggregating the SAM database consistent with the specific objective of the study which is exploring the direct forward and backward production linkages of industry basically the agriculture-based industry[2] and manufacturing industries with other sectors of the economy. Yet, it assesses the multiplier effects of an exogenous shock to these sectors on the overall economy. Accordingly, a SAM aggregation is done which consisted of activity and commodity accounts classified into agriculture, agriculture-based industry written on the tables as agroindustry, manufacturing, other industries, trade services, and other services. The factors are aggregated into labor, land, and capital. The household account is aggregated into rural and urban households while the government, savings and investments, with the rest of the world account being taken as they are. Then, using the technical coefficient matrix characterization of the SAM will follow through. The activities and commodities as components of the aggregated SAM is shown in Annex Table A1. The other components of aggregated SAM matrix are found in Annex Table A2 and industrial categories in Annex Table A3.

Table 4 shows the technical coefficient of the aggregated SAM. It shows that the agriculture sector used 10 percent intermediate inputs from agriculture, 4 percent from agriculture-based industry, 2 percent from manufacturing, 1 percent from other industries, and 6 percent intermediate inputs from the service sector. This implies that agriculture mostly relied on itself for intermediate inputs with little use of the manufacturing sector for inputs showing a traditional agriculture production system with limited room for commercialized agriculture. Agricultural production paid 45 percent for labor, 22 percent for land, and 10 percent for capital. This shows that the sector's production is not intermediate input-intensive and is instead factor-intensive. More specifically, agriculture is labor-intensive (see Table 4).

Table 4. Technical coefficient matrix

	Agriculture	Agroindustry	Manufacturing	Other Industries	Trade Service	Other Service
Commodities:						
Agriculture	0.10	0.45	0.02	0.00	0.00	0.02
Agroindustry	0.04	0.12	0.03	0.00	0.00	0.05
Manufacturing	0.02	0.14	0.54	0.37	0.01	0.13

[2] In the text agricultural- based industries is interchangeably used with Agroindustry. The classification is reported in the Annex Table A1.

Other Industries	0.01	0.02	0.07	0.13	0.01	0.07
Trade Service	0.03	0.00	0.00	0.03	0.00	0.03
Other Services	0.03	0.04	0.04	0.12	0.15	0.06
Production factors:						
Labor	0.45	0.04	0.05	0.21	0.47	0.37
Land	0.22	0.00	0.00	0.00	0.00	0.00
Capital	0.10	0.19	0.25	0.14	0.36	0.27

Source: Authors Computation

The agriculture-based industry used 45 percent intermediate inputs from the agriculture sector, 12 percent from agriculture-based industry, 14 percent from manufacturing, 2 percent from other industries, and 4 percent from the service sector with total intermediate inputs used by the agroindustry is totally 78 percent. This industry paid 4 percent for labor, 19 percent for capital, and 23 percent for value added making it intermediate input-intensive sector unlike the agriculture sector. The manufacturing industry used 2 percent agricultural intermediate inputs, 3 percent agroindustry inputs, 54 percent manufacturing inputs, 7 percent inputs from other industries, and 4 percent service inputs adding to 70 percent intermediate inputs used by the manufacturing industry. Hence, the lion's share of intermediate inputs for the manufacturing sector came from the manufacturing sector itself indicating that it used very little from the agriculture and agroindustry sectors as intermediate inputs. This sector paid 5 percent for labor, 25 percent for capital, and 30 percent for value added showing that the manufacturing sector is intermediate input-intensive unlike the agriculture sector and employs more capital than labor. Similarly, other industries used 50 percent intermediate inputs from the industry sector and 15 percent from the service sector with no intermediate inputs used from the agriculture and agroindustry sectors. Here, the percentage share of labor and capital used are 21 and 14 percent respectively.

The trade service sector used 2 percent intermediate inputs from the industry sector and 15 percent from the service sector, but it used no intermediate inputs from the agriculture sector. This sector used 47 percent labor and 36 percent capital adding to 83 percent value added and showing that production in the trade service sector is factor intensive. The other services sector used 2 percent intermediate inputs from agriculture, 5 percent from agroindustry, 20 percent from manufacturing and other services, and 9 percent from the service sector while it employed 37 percent labor and 27 percent capital with total value added of 64 percent making it a factor intensive sector.

Table 5 presents the share of domestically produced output of the total demand. Based on Table 5, 79 percent of agricultural commodities are supplied domestically while 54 percent and 11 percent commodities for the agroindustry and manufacturing sectors respectively are domestically supplied. Based on the coefficients from the table, 91 percent of other industries' commodity demands are supplied domestically with 100 percent and 85 percent domestic supply for trade services and other services respectively. This shows that the agroindustry and manufacturing sectors do not rely heavily on domestic production and instead there is more than 45 percent import leakage for agroindustry and approximately 70 percent import leakage for the manufacturing sector.

Table 5. Share of domestically produced output of total demand

	Agriculture Commodity	Agroindustry Commodity	Manufacturing Commodity	Other Industries	Trade Service	Other Service

Agriculture	0.79	0.00	0.00	0.00	0.00	0.00
Agroindustry	0.00	0.54	0.00	0.00	0.00	0.00
Manufacturing	0.00	0.00	0.11	0.00	0.00	0.00
Other Industries	0.00	0.00	0.00	0.91	0.00	0.00
Trade Service	0.00	0.00	0.00	0.00	1.00	0.00
Other Services	0.00	0.00	0.00	0.00	0.00	0.85

Source: Authors Computation

Table 6 provides factor spending on households (HH). Labor spent 73 percent on rural households while 27 percent went to urban households. Likewise, land spent 98 percent on rural households and the remaining on their urban counterparts. However, capital spent 83 percent on enterprises and the remaining on rural households. This implies factor spending concentrates more on rural households than on urban households.

Table 6. Factor spending on households

	Labor	Land	Capital	Enterprise
Labor	0.00	0.00	0.00	0.00
Land	0.00	0.00	0.00	0.00
Capital	0.00	0.00	0.00	0.00
Enterprise	0.00	0.00	0.83	0.00
Rural HH	0.73	0.98	0.16	0.40
Urban HH	0.27	0.02	0.00	0.37

Source: Authors Computation

Table 7 gives the pattern of household expenditure where 21 percent of the rural household expenditure is on agricultural activities while 25 percent is consumption expenditure for agricultural commodities and 12 percent goes for consumption of agroindustry commodities. Rural households spent 18 percent of their incomes on other service commodities and 6 percent of their incomes is allocated for manufacturing commodities. This shows that the demand for agroindustry and manufacturing among rural households is relatively low compared to demand for other commodities. On the other hand, 25 percent of consumption demand for urban households is for agricultural commodities and 34 percent consumption demand is for services other than trade while the consumption demand for agroindustry and manufacturing commodities among urban households is 9 and 7 percent respectively.

Table 7. Household consumption expenditure patterns

	Rural Household	Urban Household
Activities:		
Agriculture	0.21	0.01
Agroindustry	0.00	0.00
Manufacturing	0.00	0.00
Other Industries	0.00	0.00
Trade Service	0.00	0.00
Other Services	0.00	0.00
Commodities:		
Agriculture	0.25	0.25
Agroindustry	0.12	0.09
Manufacturing	0.06	0.07

Other Industries	0.01	0.02
Trade Service	0.00	0.00
Other Services	0.18	0.34

Source: Authors Computation

The import penetration ratio and export intensity of the different sectors are given in Table 8. According to the results, the proportion of imports in total demand was 3 percent for agriculture, 18 percent for agroindustry, 56 percent for manufacturing, and 7 percent for the service sector with a significant import penetration for the manufacturing sector. The proportion of exports in the total output for agriculture is 17 percent, for agroindustry 11 percent, and for services 17 percent. Hence, the lion shares of exports came from agriculture, but the largest proportion of imports is from manufacturing implying the existence of a large trade balance deficit in the economy as the export earnings generated from agricultural commodities will fall short in covering the cost of capital-intensive manufacturing goods from the rest of the world.

Table 8. Import penetration ratio and the export intensity of different sectors

	Import Penetration Ratio in Percent	Rank	Export Intensity in Percent	Rank
Agriculture	0.03	5th	0.17	1st
Agroindustry	0.18	2nd	0.11	3rd
Manufacturing	0.56	1st	0.05	4th
Other industries	0.07	4th	0.03	5th
Trade service	0.00	-	0.00	-
Other services	0.15	3rd	0.17	2nd

Source: Authors Computation

5.2. Direct and Total Linkages of Industry with other Sectors

This section provides the industry sector's direct backward and forward production linkage with other sectors of the economy. In addition, it also discusses the multiplier effect of a shock on endogenous factors. Finally, simulation is made by introducing a shock on both exogenous investment demand for agriculture-based industry and manufacturing to estimate the output, GDP, demand, and income effects on rural and urban households.

Table 9 presents the direct backward and forward production linkage of the sectors. The coefficient for direct backward linkages of the agriculture sector with other sectors is 2.86 which are greater than one and are found to be strong and the forward linkages are moderately strong compared to the other sectors. The results show that the agroindustry sector has a coefficient of 1.33 for backward linkages with other sectors, and it has forward linkage of 0.90 indicating strong backward but weak forward linkage with other sectors respectively. For manufacturing and other industries, the backward and forward linkages are considerably weak indicating that these industries are not using inputs from other sectors of the economy as they should, and they are also not providing their production output to the other sectors of the economy. With respect to the service sector, both the trade and other services have strong direct backward linkages showing the extensive use of output produced by the other sectors. However, the forward linkage in the service sector is less than one indicating weak direct forward linkage with other sectors. These direct backward and forward linkages of the sectors

show that the industry sector, mainly the manufacturing industry, failed to use inputs from the other sectors and to provide outputs for the other sectors. This is one reason for the sector's low contribution to GDP which has been limiting to achieve the poverty reduction and structural transformation goals of the country for several decades.

Table 9. Backward and forward linkages of the industry sector with other sectors in Ethiopia

	Backward Linkage	Linkage Status	Forward Linkage	Linkage Status
Agriculture	2.86	Strong	1.19	Strong
Agroindustry	1.33	Strong	0.91	Weak
Manufacturing	0.55	Weak	0.69	Weak
Other industries	0.80	Weak	0.41	Weak
Trade service	1.20	Strong	0.67	Weak
Other services	1.05	Strong	0.98	Weak

Source: Authors Computation

Table 10 gives the effects of an injection in the activity account and its effects on the production of activities, on commodity demand, value added, and household incomes. To begin with, an exogenous shock to the agriculture sector will lead to an increase in agricultural production by a relatively large amount and value added of labor. It also has a high increasing impact on rural household incomes. A unit exogenous shock to agroindustry will boost both agroindustry and agricultural production. It will also increase labor value added and incomes of rural households. An exogenous shock to manufacturing will increase its production and commodity demand but will not impact value added by labor. Relatively, it will increase rural household incomes rather than urban household incomes.

Table 10. SAM output, demand, value added, and income multipliers for a shock to activities

Activities:	Agriculture	Agroindustry	Manufacturing	Other Industries	Trade Service	Other Service
Agriculture	2.04	1.14	0.49	0.58	0.87	0.79
Agroindustry	0.21	1.22	0.11	0.12	0.17	0.18
Manufacturing	0.04	0.05	1.09	0.07	0.04	0.05
Other Industries	0.11	0.11	0.13	1.21	0.11	0.15
Trade Service	0.30	0.33	0.23	0.27	1.24	0.28
Other Services	0.61	0.55	0.38	0.52	0.67	1.56
Commodities:						
Agriculture	0.87	1.11	0.41	0.47	0.70	0.65
Agroindustry	0.38	0.40	0.20	0.22	0.32	0.33
Manufacturing	0.36	0.45	0.78	0.68	0.34	0.46
Other Industries	0.12	0.12	0.15	0.23	0.12	0.17
Trade Service	0.30	0.33	0.24	0.27	0.24	0.28
Other Services	0.72	0.64	0.45	0.61	0.79	0.66
Factors:						
[3]Trc	0.29	0.35	0.26	0.26	0.25	0.26
Labor	1.32	0.94	0.56	0.84	1.25	1.10
Land	0.45	0.25	0.11	0.13	0.19	0.17
Capital	0.54	0.63	0.55	0.50	0.78	0.67
Enterprise	0.45	0.53	0.46	0.41	0.64	0.55

[3] Trc represents transaction cost

Rural HH	1.67	1.25	0.78	0.99	1.48	1.30
Urban HH	0.52	0.45	0.32	0.38	0.57	0.50

Source: Authors Computation

Table 11 presents demand multipliers measuring the effect of an exogenous shock to the commodity account and its impact on production of different activities, the demand for its own and other commodities, value added, and households' incomes. An exogenous shock to agricultural commodity demand increased its own demand by 1.81 percent, its production by 1.76 percent, value added by labor increased 1.25 percent, and increased rural household incomes is 1.57 percent. A unit exogenous shock to the agroindustry's commodity demand will increase its own demand by 1.26 percent, increase agricultural commodity demand is 0.7 units, and agroindustry and agricultural production increase by 0.74 percent and 0.69 percent respectively. The same shock will also increase rural household incomes by 0.88 percent. A percentage exogenous shock to manufacturing commodity demand will increase its own demand by 1.16 percent but on average it will have a very low impact on its own production, and production in agriculture, agroindustry, and services. In addition, it has a very low value-added impact and low contribution to an increase in rural and urban household incomes.

Table 11. SAM output, demand, value added, and income multipliers for a shock to commodity demand

Activities:	Agriculture	Agroindustry	Manufacturing	Other Industries	Trade Service	Other Service
Agriculture	1.76	0.74	0.22	0.55	0.87	0.67
Agroindustry	0.19	0.69	0.05	0.11	0.17	0.15
Manufacturing	0.04	0.03	0.13	0.07	0.04	0.04
Other Industries	0.11	0.07	0.04	1.10	0.11	0.13
Trade Service	0.42	0.32	0.23	0.27	1.24	0.24
Other Services	0.63	0.41	0.21	0.49	0.67	1.32
Commodities:						
Agriculture	1.81	0.70	0.18	0.44	0.70	0.55
Agroindustry	0.35	1.26	0.08	0.20	0.32	0.28
Manufacturing	0.35	0.30	1.16	0.63	0.34	0.39
Other Industries	0.12	0.08	0.04	1.21	0.12	0.14
Trade Service	0.43	0.32	0.23	0.27	1.24	0.24
Other Services	0.74	0.49	0.24	0.57	0.79	1.56
Factors:						
Labor	1.25	0.68	0.30	0.79	1.25	0.94
Land	0.38	0.16	0.05	0.12	0.19	0.15
Capital	0.56	0.45	0.21	0.47	0.77	0.57
Enterprise	0.46	0.37	0.17	0.39	0.64	0.47
Rural HH	1.57	0.88	0.37	0.93	1.48	1.11
Urban HH	0.51	0.32	0.14	0.36	0.57	0.42

Source: Authors Computation

Table 12 shows the effect of a shock to factors of production and its impact on output of activities, demand for commodities, value added, and income effect. A percentage shock to labor will increase labor value added by 1.84 percent, increase agricultural production by 1.02

percent, production of other services by 0.62 percent, increase demand for agricultural commodities by 0.81 percent, and demand for other services by 0.73 percent. The same shock will increase rural household incomes by 1.78 points. A unit shock to land will increase the value added to land by 1.24 percent and labor by 0.87 percent. It will also increase agricultural production by 1.10 percent and its demand by 0.81 percent. Other service production activities and commodity demand too will increase by 0.62 and 0.70 units respectively. A shock to land impacts rural household incomes (2.07) by a relatively high percentage than a shock to other factors of production. A unit shock to capital will increase agricultural activity production (0.78) and its commodity demand (0.64). It will also increase the production of other service activities (0.50) and commodity demand (0.59) relative to other sectors' production and demand. An increase in capital will also increase the incomes of rural households by 1.30 percent.

Table 12. SAM output, demand, value added, and income multipliers for a shock to factors of production

Activities:	Labor	Land	Capital
Agriculture	1.02	1.10	0.78
Agroindustry	0.20	0.21	0.15
Manufacturing	0.04	0.04	0.03
Other Industries	0.10	0.10	0.08
Trade Service	0.26	0.27	0.21
Other Services	0.62	0.60	0.50
Commodities:			
Agriculture	0.81	0.84	0.64
Agroindustry	0.36	0.38	0.28
Manufacturing	0.35	0.35	0.28
Other Industries	0.11	0.11	0.09
Trade Service	0.26	0.27	0.21
Other Services	0.73	0.70	0.59
Factors:			
Labor	1.84	0.87	0.66
Land	0.22	1.24	0.17
Capital	0.42	0.43	1.33
Enterprise	0.35	0.36	1.11
Rural HH	1.78	2.07	1.30
Urban HH	0.62	0.39	0.59

Source: Authors Computation

Table 13 depict multiplier coefficients for the effect of a shock to household income categorized as rural and urban households and its impact on the output of different production activities, their commodity demand, value added, and their own incomes. The shock to the rural household account affects agricultural production activity, labor value added, and rural household incomes more than other activities' output, demand, and value added. Likewise, a shock to the urban household account impacts incomes of urban households the most followed by agricultural production and commodity demand along with other service activities' production and demand respectively.

Table 13. SAM output, demand, value added, and income multipliers for a shock to household incomes

Activities:	Total Household Multiplier	Rural Household Multiplier	Urban Household Multiplier
Agriculture Activities	1.89	1.10	0.78
Agroindustry	0.38	0.21	0.17
Manufacturing	0.08	0.04	0.04
Other Industries	0.21	0.10	0.11
Trade Service	0.51	0.27	0.24
Other Services	1.27	0.60	0.67
Commodities:			
Agriculture	1.58	0.84	0.74
Agroindustry	0.69	0.38	0.32
Manufacturing	0.70	0.35	0.35
Other Industries	0.23	0.11	0.12
Trade Service	0.51	0.27	0.24
Other Services	1.50	0.70	0.79
Factors:			
Labor	1.62	0.87	0.75
Land	0.41	0.24	0.17
Capital	0.83	0.43	0.40
Enterprise	0.69	0.36	0.33
Rural HH	3.00	2.09	0.91
Urban HH	1.69	0.37	1.32

Source: Authors Computation

In the multiplier analysis, we analyzed the effect of an exogenous shock on overall endogenous accounts in the economy and made two simulations. The first simulation is increasing the investment demand for agriculture-based industry by 10 percent and the second simulation is increasing investment demand for manufacturing by the same percentage. The outcomes in the form of output, GDP, and income multiplier are given in Table 14.

In the first simulation, an increase in agroindustry's demand by 10 percent increased agricultural output by 7.4 percent, agroindustry's demand by 6.9, manufacturing's demand by 0.32, other industries demand by 0.7, trade by 3.2, and other services by 4.14 percent. As a result, an increase in investment demand in this sector mostly augmented agriculture and agroindustry production. Agriculture demand increased by 7.0 percent, agroindustry demand by 12.6 percent, manufacturing by 3 percent, other industries by 0.81 percent, and service demand by 8 percent. In the same simulation, value added from labor increased approximately by 7 percent, from land by 2 percent, and from capital by 5 percent. The introduced shock to agroindustry increased rural household incomes by nearly 9 percent and urban household incomes by 3.2 percent showing that rural households generated large incomes as compared to urban households when there is an increase in investments in agroindustry.

In the second simulation, a 10 percent increase in manufacturing investment demand is introduced to see its multiplier effects on the rest of the economy. The agriculture sector increased by 2.40 percent, agroindustry by 0.46, manufacturing by 1.25, other industries by 0.38, trade services by 2.28, and other services by 2.06 percent with a relatively lower response compared to an increase in investment demand by agroindustry. On the demand multiplier side,

the same shock increased manufacturing demand by nearly 12 percent indicating high elasticity for the shock but the impact on demand from the rest of the sectors, on average, was not more than 2 percent which was also less elastic. In terms of value added, labor and capital had the value of 3 and 2 percent respectively. However, this shock positively impacted rural households' income by 4 percent while the corresponding impact for urban households is 1.4 percent in terms of increasing incomes. Comparing both simulations, the multiplier coefficients for the shock in agriculture-based industry has large impact than the shock in manufacturing (see Table 14).

Table 14. Simulation effect of an exogenous shock with increase in investments in the agroindustry and manufacturing sectors

	First Simulation	Second Simulation	
Activities:	10 percent Increase in Agroindustry Investment	10 percent Increase in Manufacturing Investment	Multiplier Effect
Agriculture Activities	7.36	2.18	Production Multiplier
Agroindustry Activities	6.88	0.46	
Manufacturing Activities	0.32	1.25	
Other Industries Activities	0.74	0.38	
Trade Service Activities	3.22	2.28	
Other Services Activities	4.14	2.06	
Commodities:			
Agriculture Commodities	6.99	1.78	Demand Multiplier
Agroindustry Commodities	12.64	0.84	
Manufacturing Commodities	2.95	11.56	
Other Industries Commodities	0.81	0.42	
Trade Service Commodities	3.22	2.28	
Other Services Commodities	4.87	2.43	
Factors:			
Labor Factor	6.79	2.97	GDP Multiplier
Land Factor	1.61	0.48	
Capital Factor	4.47	2.06	
Rural Household	8.76	3.66	Income Multiplier
Urban Household	3.21	1.43	

Source: Authors Computation

Table 15 gives the total multiplier effects of an exogenous shock to both agroindustry and manufacturing investment demand. The total production multiplier for an exogenous shock to agroindustry is 23 percent whereas for the shock to manufacturing it is 8.6 units. The demand multiplier for the first simulation is 31.5 percent while it is 19 percent for the second simulation. GDP multiplier for agroindustry simulation is approximately 13 percent while it is 5.5 percent for the manufacturing simulation. Ultimately, the income multiplier for a shock to the agroindustry is 12 percent while it is 5 percent for manufacturing. These results show that the total multiplier effect of the agroindustry shock is more elastic than the shock to manufacturing implying that policy needs to focus on investments in agriculture-based industry as they positively augment production, demand, value added, and rural household incomes. This

should be combined with inclusive industrial and developmental policies to structurally transform the Ethiopian economy and to reduce multidimensional poverty.

Table 15. Total multiplier effects of a 10 percent increase on agroindustry and manufacturing investments

Total Multiplier Effect	First Simulation on Agroindustry	Second Simulation on Manufacturing
Production Multiplier	22.66	8.61
Demand Multiplier	31.47	19.30
GDP Multiplier	12.88	5.50
Income Multiplier	11.97	5.09

Source: Authors Computation

6. Conclusion and Policy Implications

This study investigated the direct and total linkages of the industry sector with the other sectors of the Ethiopian economy using the SAM database for 2011 published by the International Food Program Research Institute in Ethiopia. Direct production linkages are estimated to examine the backward and forward production linkages of the industry with a special focus on agroindustry and manufacturing. In addition, the import penetration and export intensity of these sectors are also investigated. In parallel, a multiplier analysis has been done to show total production, value added, and demand and income changes on the other sectors due to an exogenous shock to agriculture-based industry and manufacturing industry investment demand respectively.

The results showed that agriculture has strong backward and forward production linkages with the other sectors in a relative sense while agroindustry has backward linkages to some extent, but it does not have forward production linkage with the other sectors. Manufacturing has weak forward linkage with the rest of the economy which can be attributed to several factors such as limited infrastructure and weak institutions. Other industries and the service sector too do not have strong linkages with the rest of the economy. Among the different sectors studied, manufacturing is the first with a high proportion of import ratio out of total demand followed by the service sector while the export intensity is significantly large in magnitude for the agriculture sector. This indicates a negative trade balance due to concentration of exports in the agriculture sector and imports in the manufacturing sector.

Two simulations are conducted to evaluate the impact of an exogenous shock to agroindustry and manufacturing investment demand. A 10 percent increase in investment demand in agroindustry increased agricultural production by 7.4 percent and agroindustry demand by 12.5 percent respectively. Besides, an increase in agriculture-based industry investment demand increased labor employment by 7 percent and rural household incomes by 9 percent. On the other hand, a 10 percent increase in manufacturing investment demand increased manufacturing production by 12 percent, labor employment by 3 percent, and rural household incomes by 4 percent. Based on the two simulations an increase in agriculture-based industry investment demand has a considerably larger impact on production, demand, employment, and incomes of rural households. Similarly, the total multiplier coefficients for a shock to agroindustry production is nearly 23 percent, the demand multiplier is 31 percent, GDP multiplier is 12 percent, and income multiplier is 12 percent while for the manufacturing shock,

production multiplier, demand, value added, and income multiplier is 9 percent, 19 percent, 6 percent, and 5 percent respectively. These results show that the multiplier coefficients of the manufacturing shock are less elastic than the agroindustry ones.

This study provided evidence on the possible effects of selective policy instruments for supporting the agriculture-based industry in Ethiopia for positively increasing production, demand, employment, and incomes of rural households. Hence, the policy on import duties should be revised to discourage imports of agroindustry products and encouraging the agriculture sector by enabling domestic industries to access the large local market. Yet, resources should be reallocated to the agriculture-based industries as it is the competitive advantage of the country. Another implication of the results is that policies should be as inclusive as possible complementing the existing development policies and industrial strategies as well as the overall economic and political conditions in the country.

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Annex

Table A1: Activities and Commodities as Components of the Aggregated SAM

Agriculture	Agroindustry	Manufacturing	Other Industries	Trade Service	Other Services
Maize	meat processing	wood	mining	trade service	transport
Sorghum	fish and seafood processing	paper	electricity		hotel
Rice	dairy	chemicals	water		accommodation
Teff	fruit and vegetable processing	nonmetals	construction		finance and insurance
Barley	fats and oils	metals			real state
Wheat	grain milling	machinery			business services
Pulses	sugar refining	equipment			public administration
ground nuts	Animal feed	vehicle			education
oil seeds	food processing	Other manufacturing			health
Root	beverage				other services
Vegetable	tobacco				
Sugarcane	textile				
Tobacco	leather and footwear				
Cotton					
Fruit					
Enset					
Coffee					
Leaf tea					
Chat					
Cut flowers					
other crops					
Cattle					
Milk					
poultry					
Sheep					
Goats					
Camels					
Other livestock					
Forestry					
Fishing					

Table A2: Other Components of Aggregated SAM Matrix

Factors (Labor, Land & Capital)	Households (UHH & RHH)	Other Accounts
Labor - rural uneducated	Rural farm - quintile 1	Transaction costs
Labor - rural primary	Rural farm - quintile 2	Enterprises
Labor - rural secondary	Rural farm - quintile 3	Government
Labor - rural tertiary	Rural farm - quintile 4	Taxes - activity
Labor - urban uneducated	Rural farm - quintile 5	Taxes - direct
Labor - urban primary	Rural nonfarm - quintile 1	Taxes - export
Labor - urban secondary	Rural nonfarm - quintile 2	Taxes - factor
Labor - urban tertiary	Rural nonfarm - quintile 3	Taxes - import
Land - agricultural crops	Rural nonfarm - quintile 4	Taxes - sales
Capital - crops	Rural nonfarm - quintile 5	Savings-investment
Capital - livestock	Urban - quintile 1	Change in stocks
Capital - mining	Urban - quintile 2	Rest of world
Capital - other	Urban - quintile 3	
	Urban - quintile 4	
	Urban - quintile 5	

Table A3: Industrial Categories in Ethiopia

Industry Category	Industrial Group
1	Food Products and Beverages Industry
2	Tobacco Products Industry
3	Textiles Industry
4	Wearing Apparel, Except Fur Apparel Industry
5	Tanning and Dressing of Leather; Footwear, Luggage and Handbags Industry
6	Wood and of Products of Wood and Cork, Except Furniture Industry
7	Paper, Paper Products and Printing Industry
8	Chemicals and Chemical Products Industry
9	Rubber and Plastic Products Industry
10	Other Non-Metallic Mineral Products Industry
11	Basic Iron and Steel Industry
12	Fabricated Metal Products Except machinery and Equipment Industry
13	Machinery and Equipment N.E.C Industry
14	Motor Vehicles, Trailers and Semi-Trailer Industry
15	Furniture; Manufacturing N.E.C. Industry

Source: CSA.