Agricultural Transformation Performance and Inter-Sectoral Linkages in Ethiopia

Alelign Ademe[1]*, and Abule Mehare[2]

Article History: Received: 26 July 2022; Revised: 07 March 2023;
Accepted: 16 March 2023

Abstract

The motivation for agricultural transformation is basically linked with structural relationships among sectors of the economy; transforming one sector cannot be successful without the corresponding transformation of the other. Therefore, this study assessed the performance of agricultural transformation and analyzed the linkage between agricultural and other sectors of the economy in Ethiopia using time-series data retrieved from the World Bank (WB) and FAOSTAT databases (1981-2019). The study employed trend analysis and the Vector Error Correction Model (VECM) which incorporated inter-sectoral linkages in the Ethiopian economy. In the trend analysis, though positive changes have been observed, agricultural transformation did not achieve the intended outcomes in terms of sustainability, productivity technical change, food self-sufficiency, and expansion of agro-industries, which calls government attention to a swift shift to market-oriented commercial farming involving mechanization. The model result illustrates how the linkages across different sectors vary in the short-run and long-run. In the short-run, the industrial sector has a negative effect on the performance of the agricultural sector, whereas the agricultural sector in turn affects the value added in the industrial sector positively. In the long-run, there was exhibited a positive and significant linkage between industrial and agricultural sectors. Thus, it needs to strengthen the effective use and adoption of new agricultural technologies in Ethiopia due to the existing negative short-run agriculture-industry relationship. The macroeconomic policy should also take into account the possible long-run interdependencies between agriculture and other sectors of the economy by giving emphasis to the problem of transferring resources from agriculture to other sectors and vice versa.

Keywords: Agriculture, Sectoral growth linkages, Cointegration, VECM, Ethiopia
Jel Classification: O10, O14

---

[1] Senior Lecturer (PhD), University of Eswatini, Agricultural Economics and Management
*e-mail of the corresponding author: ademe@uniswa.sz
[2] Senior Researcher, Ethiopian Economic Association
Acknowledgments
We express our gratitude to African Economic Research Consortium (AERC) for providing us with the grant rendered to conduct the research that led to the writing of this article.

1. Introduction

Agricultural transformation is crucial for poverty reduction and improved food security in Sub-Saharan African (SSA) countries. The agricultural sector in this part of the world is characterized by mainly small-scale production, low productivity, low external input usage, and family labor orientation (World Bank, 2008). Therefore, inducing transformation towards improving agricultural productivity levels is often the aim of public investments and policies in many of these countries (Wiggins, 2014).

The government of Ethiopia has developed different policies and strategies over the past decades. First, in the mid-1990s, the government formulated a broad-based development strategy known as the Agricultural Development Led Industrialization Strategy (ADLI) as the major instrument for ensuring that the overall development of the country focused on the poor in general and the rural poor in particular. Second, the development policies and strategies pursued during the Sustainable Development and Poverty Reduction Program (SDPRP) (FDRE-MOFED, 2002). Third, the first Growth and Transformation Plan (GTP I) advances the important strategic directions pursued in the Plan for Accelerated and Sustained Development to End Poverty (PASDEP) (FDRE-MOFED, 2010/11). Fourth, the second Growth and Transformation Plan (GTP II), developed on the basis of GTP I, focused on modernization in the development of the agriculture sector, expansion of industrial development with a primary emphasis on light manufacturing, and a significant shift in export development (FDRE- MOFED, 2015/16).

Following these reforms, some success has been registered in different sectors of the economy, which has contributed to overall economic growth. The agricultural GDP growth rate was observed to be 6.6% per annum during the plan implementation period of GTP I (2010-2015). In terms of structural change, the share of agriculture and allied activities in overall GDP, which stood at about 42% at the beginning of the plan (2009/2010) declined to nearly 33.3% by the end of 2018/2019. Crop and livestock subsectors accounted for 27.4% and 7.9%, respectively. The decline in the share of agriculture is an indication of a structural shift from agriculture to industry and service sectors, as has already been noted (NPC, 2016). To understand why the share of agriculture declines in the Ethiopian economy, it is vital to conduct a study evaluating the performance of agricultural transformation in Ethiopia.

Structural changes in an economy entail that in the long run, the dynamics of sectoral shares are interrelated with each other and with economic growth

(Sepehrdoust and Adnan, 2012). The concept of sectoral linkage was developed from the theory of the "unbalanced growth model of Albert O. Hirschman". He indicated that each sector is linked with the rest of the economic system by its direct and indirect intermediate purchases of productive inputs and sales of productive outputs; these are backward and forward linkages. According to its system of linkages, each sector exerts 'push' and 'pull' forces on the rest of the economy. Unlike agriculture, the industrial sector is characterized by both strong backward and forward linkages and thus emerges as the main driver of development (Hirschman, 1958). However, the direction of causality linkage between sectors differs across countries (Sikhosana, 2015).

Identifying the causal linkages among sectors is an important policy input since the causal linkages will help to explain the direction of resource transfers between sectors (Subramaniam, 2010). This is because inter-sectoral linkages play a significant role in terms of assessing the degree of interdependence among sectors in an economy. Meaning, the capacity of the growth of one sector in motivating the growth of other sectors and guide policy makers to intervene that may enhance inter-sectoral linkages over time. In other words, it helps to provide inputs on inter-sectoral dynamics that could be useful to plan a favorable and suitable development strategy.

Although a few studies have been done on causal linkage among sectors in Ethiopia (Tadele, 2000; Kassahun, 2006; Degu, 2019 among others), they couldn't reflect the existing information since the contributions of agriculture, industry, manufacturing, and service sectors to the overall economic growth of Ethiopia vary with time. Moreover, there are serious limitations in evaluating the contemporary performance of agricultural transformation and the effectiveness of the overall agricultural transformation in Ethiopia. Having these concerns, this paper intends to assess the contemporary effectiveness of the overall agricultural transformation and analyze agricultural growth linkages across sectors in Ethiopia.

2. Empirical Literature Review

Economic theories and empirical literature describe economic linkages among sectors as backward and forward linkages or consumption and production linkages (Xinshen and Steven, 2007; Saikia, 2009). In the Ethiopian context, there are four interdependent sectors in the economy: agriculture, industry, manufacturing, and service sectors. The study tried to assess agricultural growth linkages across these sectors. The inter-relationship between agriculture and industry and/or the manufacturing sector could be expressed as follows: (1) Agriculture supplies food grains to industry to facilitate absorption of labour in the industrial sector; (2) Agriculture also supplies raw materials such as: unprocessed cotton, oil seeds, cereal crops, and coffee that are needed by the agro-based industries; (3) Industry supplies agricultural inputs, such as fertilizer, pesticides, and machinery, to the agriculture sector; (4) Agriculture generates surpluses of savings, which can be mobilized for investment in industry and other sectors of the economy (Saikia, 2009).This implies that the expansion of demand for agricultural inputs such as fertilizer, improved seeds, and machinery encourages industrial and service sector activities through backward linkages. Other sector activities could be stimulated by agriculture at the same time via forward linkages, such as the requirement to process agricultural products (Verner, 2001). Production linkages typically arise from the interdependence of the sectors to satisfy the needs of their productive inputs, whereas consumption linkages and demand linkages arise from the interdependence of the sectors to meet final consumption (Saikia, 2011).

Several studies have been done so far on agricultural growth linkages using different approaches. More complex formulations of multipliers can be constructed, including a semi-input-output multiplier using a full social accounting matrix (Haggblade and Hazell, 1989; Thorbecke, 1994; Xinshen et al., 2007; Saikia, 2011); econometric modeling and statistical causality tests (Alemu et al., 2003; Kassahun, 2006; Xinshen and Steven, 2007; Chebbi, 2010; João et al., 2014; Uddin, 2015); and CGE models with underemployed labour to permit demand-led growth in some sectors (Dorosh and Haggblade, 2003; Tadele, 2000). However, econometric modeling has been extensively used in most of the recent empirical studies (Saikia, 2009). Thus, this study used the econometric modeling approach that involves rigorous causality tests in the growth of various sectors. The functional forms and variables included are discussed in the subsequent sections.

3. Dataset and Research Methods

3.1 Dataset types and Sources

The study used secondary data retrieved from the World Bank (WB) and FAOSTAT databases (1981-2019) to assess the contemporary performance of the overall agricultural transformation and to evaluate the current agricultural growth linkages across other sectors in Ethiopia. Data pertaining agriculture value added (% of GDP), Manufacturing value added (% of GDP), Industry (including construction) value added (% of GDP) and service sector value added (% of GDP) belongs to WB databases. Data for agricultural productivity and level of production, and crop and livestock production indices were obtained from FAOSTAT databases.

The study used agricultural macroeconomic growth indicators to assess the contemporary effectiveness of the overall agricultural performance in Ethiopia. Agricultural performance indicators include: level and growth in agricultural GDPs; value added and share of growth in domestic output of an agricultural commodity; productivity (yield) and level of production; value added and share of growth in domestic output of an agricultural commodity that is sold nationally; value added and share of growth in agricultural exports in the regional and international exports for an agricultural commodity and employment generation. Other sectors of the economy were also used for comparison purposes.

3.2 Model Specification and Analytical Procedures

A model was designed to simulate Ethiopia's agricultural growth as a function of growth in four sectors (agriculture, services, industry and manufacturing) and their interactions with one another. The following endogenous growth model was established to evaluate the agricultural growth linkages across sectors:

Given four endogenous variables such as: agricultural, industrial, manufacturing and service sectors, the basic model can be mathematically expressed with the following form.

$$\boldsymbol{G_i = f(G_j, G_k, G_l, G_{i-1})} \quad \textbf{(1)}$$

Where the Gi is the growth of sector i, and i, j, k and l are stands for a natural log of agricultural, industrial, manufacturing and service sectors value added measured in U.S. Dollars, respectively (computed based on constant price, 2010). The above equation expresses the growth of a sector as a function of the other three sectors and its own previous year performance.

Vector Error Correction Model (VECM): Economic variables have short run behavior that can be captured through dynamic modelling. Vector Autoregressive is a statistical method used to analyze the relationship between several influencing variables. Vector Autoregressive (VAR) processes are popular in economics and other sciences because they are flexible and simple models for multivariate time series data. In econometrics they became standard tools when questioned the way classical simultaneous equations models were specified and identified and advocated VAR models as alternatives (Suharsono et al., 2017). VAR model estimation is actually a combination of several models of autoregressive (AR), where these models form a vector between the variables affect each other.

Let Z_t denote the column vector that contains the four-sector series at time t with N-lags. We can specify the VAR (N) model as:

$$Z_t = \beta_1 Z_{\mathrm{t-1}} + \beta_2 Z_{\mathrm{t-2}} + \ldots + \beta_N Z_{\mathrm{t-N}} + \mu_t \quad \textbf{(2)}$$

Where Z_t is a (nx1) vector of stochastic I (1) variables, βi (i=1,..., N) is n x n matrix of parameters, μ is a vector of deterministic component (i.e., a constant and trend), and μ_t ~ IN $(1, \mu)$ is a vector of error term and t = 1,..., T (T is the number of observation).

The above model can be re-parameterized to give a vector error correction model (VECM). That is, adding and subtracting (β_{N-1}...$\beta_2 - \beta_1 - I$) $Z_{\mathrm{t-N}}$ from Equation 2 (I being the identity matrix) results the following specification.

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \cdots + \Gamma_{N-1} \Delta Z_{t-N+1} + \pi Z_{t-N} + \mu_t \quad \textbf{(3)}$$

Simplifying Equation (3) gives

$$\Delta Z_t = \sum_{i-1}^{N-1} \Gamma_i \Delta Z_{t-i} + \pi Z_{t-N} + \mu_t \quad \textbf{(4)}$$

Where; $\mathrm{i} = 1, \ldots, \mathrm{N} - 1, \Gamma_i = -\left[I - \sum_{j=1}^{i} \beta_j\right]$; Γ_i is allowed to vary without restriction.

$$\pi = -\left[I - \sum_{j=1}^{N} \beta_j\right]$$

If there is any long run relationship (i.e., cointegration among the variables) we can rewrite Equation (4) to come up with the following VECM specifications.

$$\Delta AGR_t = \alpha_1 + \sum_{i-1}^{N} \delta_i \Delta AGR_{t-i} + \sum_{i-1}^{N} \rho \Delta X_{jt-i} + \gamma ETC_{t-1} \quad \textbf{(5)}$$

$$\Delta IND_t = \alpha_2 + \sum_{i-1}^{N} \delta_i \Delta IND_{t-i} + \sum_{i-1}^{N} \rho \Delta X_{jt-i} + \gamma ETC_{t-1} \quad \textbf{(6)}$$

$$\Delta MNF_t = \alpha_3 + \sum_{i-1}^{N} \delta_i \Delta MNF_{t-i} + \sum_{i-1}^{N} \rho \Delta X_{jt-i} + \gamma ETC_{t-1} \quad \textbf{(7)}$$

$$\Delta SERV_t = \alpha_4 + \sum_{i-1}^{N} \delta_i \Delta SERV_{t-i} + \sum_{i-1}^{N} \rho \Delta X_{jt-i} + \gamma ETC_{t-1} \quad \textbf{(8)}$$

Where, ΔAGR_t, ΔIND_t, ΔMNF_t and $\Delta SERV_t$ are the lagged first difference of agriculture, industry manufacturing and service sectors, valued added at constant price respectively; ΔX_{jt-i} is a vector of the first differences of the explanatory variables; α is constant term and ETC_{t-1} represents the error correcting term (speed of adjustment to the long run equilibrium); and N is the parsimonious lag of variables under consideration.

If there is only one cointegrating vector and if the endogenous and exogenous variables are identified in the long run analysis, we can develop the VECM by conditioning on the exogenous variables. In this case, only the error correcting terms of the endogenous variables appear in the error correction model. The coefficient of the lagged error correction term (ECTt-1) is a short-term adjustment coefficient and represents the proportion by which the long-term disequilibrium in the dependent variable being corrected in subsequent period (Erjavec and Cota, 2003).

3.3 Pre and Post Estimation Tests

Unit Root Test: the first step to do is testing to ensure stationary properties of the variables. Thus, Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests were used to assess the stationarity and unit-root characteristics of variables. The Dickey-Fuller (DF) test might seem reasonable to test the existence of a unit root in the series using the most general form of model (Dickey and Fuller, 1979; 1981). The Phillips-Perron test is similar to the ADF test, but it is a bit more advanced. It helps to check if the data points are changing in a predictable way. If the data points are changing in a predictable way, then the time series is stationary. If the data points are changing in an unpredictable way, then the time series is non-stationary (Phillips and Perron, 1988).

Optimum Lag Selection: The determination of the number of lags (orders) to be used in the VAR model can be determined based on the criteria of Akaike Information Criteria (AIC), Schwarz Information Criteria (SC), or Hannan Quinn (HQ). The lag to be chosen in this research model is the model with the smallest HQ value. In this stage, we also tested the stability of the VAR model. The determination of optimum lag and VAR stability is done before going through the cointegration test stage.

Cointegration Test: The concept of cointegration is basically to see the long-term balance among the observed variables. Thus, after the evaluation of the univariate properties of the time series, the next step is to determine the level of cointegration between variables. Two or more integrated one variable are said to be co-integrated if there exists a linear combination of them that is stationary (Engle and Granger, 1987). This study used the Johanson co-integration technique. Unlike the Engle-Granger methodology, the Johanson methodology allows for testing the presence of more than one cointegration vector. In addition to this, it allows one to estimate the model without restricting the variables to endogenous and exogenous a priori (Johansen and Juselius, 1992).

Granger Causality Test: Granger causality tests are widely used to investigate causal relationships between variables. The Granger causality test is a statistical hypothesis test for determining whether one variable affects another. Granger (1969) approached the question of whether x causes y is to see how much of the current y can be explained by past values of y and then to see whether adding lagged values of x can improve the explanation. y is said to be Granger-caused by x if x helps in the prediction of y, or equivalently if the coefficients on the lagged x's are statistically significant. Note that two-way causation is frequently the case; x Granger causes y and y Granger causes x.

$$Y_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i Y_{t-i} + \sum_{i=1}^{n} \beta_i X_{t-i} + \varepsilon_t \quad \textbf{(9)}$$

$$X_t = \alpha_0 + \sum_{j=1}^{n} \alpha_i Y_{t-j} + \sum_{j=1}^{n} \beta_j X_{t-j} + \varepsilon_t \quad \textbf{(10)}$$

Post Estimation Tests: Major VECM post estimations tests such as normal distribution of disturbances (Jarque-Bera test), residual autocorrelation (Lagrange-multiplier test) and VEC stability condition (eigenvalue stability condition) were made.

3.4 Description of Variables

The following are descriptions of variables used based on World Bank national, and OECD National Accounts data files:

Agriculture Value Added (AGR): Agriculture corresponds to International Standard Industrial Classification (ISIC) divisions 1-5 and includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources.

Industrial Value Added (IND): Industry corresponds to ISIC divisions 10-45. It comprises value added in mining, construction, electricity, water, and gas. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. Annual growth rate for industrial value added based on constant local currency. Aggregates are based on constant 2010 U.S. dollars.

Service Sectors Value Added (SERV): Services correspond to ISIC divisions 50-99 and they include value added in wholesale and retail trade (including hotels and restaurants), transport, and government, financial, professional, and personal services such as education, health care, and real estate services. Also included are imputed bank service charges, import duties, and any statistical discrepancies noted by national compilers as well as discrepancies arising from rescaling. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. Annual growth rate for value added in services based on constant local currency. Aggregates are based on constant 2010 U.S. dollars.

Manufacturing Value Added (MNF): Manufacturing refers to industries belonging to ISIC divisions 15-37. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources and expressed constant 2010 U.S. dollars. Annual growth rate for manufacturing value added based on constant local currency. Aggregates are based on constant 2010 U.S. dollars.

4. Results and Discussions

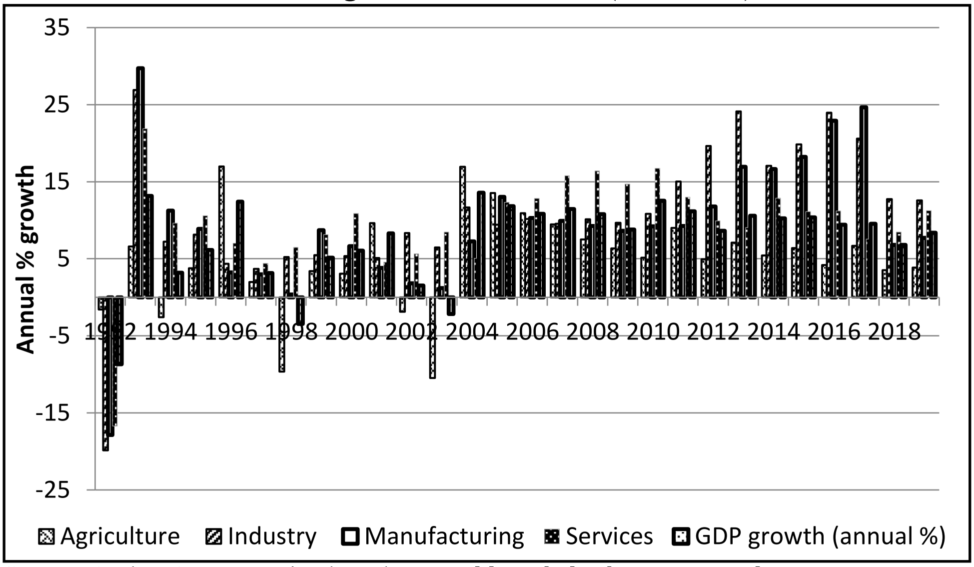
4.1 Agriculture Growth and Productivity Performance in Ethiopia

Indicators such as agricultural growth, agricultural yield, farm resource productivity, agricultural mechanization, and intensification could be constructed to measure agricultural productivity. This set of indicators will give an indication of the efficiency of resource use, which could affect agricultural trade and profitability, which in turn reflect agricultural growth performance.

4.1.1 Growth in Agricultural GDPs

An obvious indicator of agricultural growth performance is the growth rate of agricultural GDP. Performance towards this target could be simply measured using trends in the agriculture GDP growth rate. To give more relevant narratives, the study considered the value- added percentage growth of other sectors of the economy, such as industry, manufacturing, and service sectors, for the purpose of comparison, as indicated in Figure 4.1.

Figure 4.1: Value added annual growth (%), agriculture, industry and manufacturing and service sectors (1992-2019).



Source: Authors' computation based on World Bank database, retrieved on January 29, 2021.

The value-added annual growth rate of the agricultural sector is fluctuating over the study years due to the nature of the production system (mainly rain fed) and not being fully supported by technology. During the years 1992, 1995, 1998, 2000, and 2003, the growth performance of the agricultural sector was found to be negative, and the overall GDP growth became negative since the agriculture sector took the lion's share during that time. These periods were the drought periods (1995, 1998, 2000, and 2003) and border conflict between Ethiopia and Eritrea (1990-1993) (Getachew, 2018), which probably caused lowest growth rate in the agriculture sector. In 2004, the agricultural sector's GDP growth started to recover significantly. It is to be recalled that the government has followed expansionary monetary and fiscal policies by launching various megaprojects since 2004.

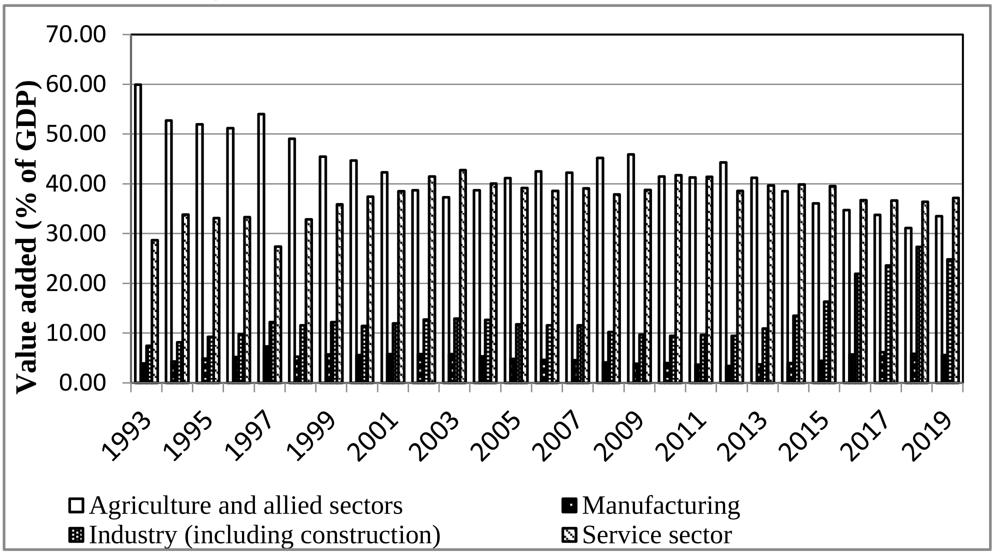
Generally, in the last 14 years (2004-2017), the overall GDP growth performance was built on fast and sustained growth achievements, averaging 10.7% GDP per annum. The agriculture value-added annual growth rate has declined, whereas the other sectors growth rates have shown remarkable growth achievements in the years 2010-2017. These periods were the growth and transformation plan implementation periods (GTP I and half of GTP II). However, the growth rate in both sector failed to continue in the years 2018 and 2019, showing the poor performance of the growth plan's implementation.

4.1.2 Share of Sectoral Value Added to GDP Growth

Figure 4.2 below indicates the sectoral value-added percentage GDP shares in Ethiopia (1993-2019). Agriculture is the biggest contributor to the economies of low-income countries like Ethiopia. The agriculture sector was dominant before 2001 and covered more than 42.34% of the value-added percentage of GDP. Starting in the years 2002-2004, the service sector took the lead in value-added percentage of GDP, while the industry sector fluctuated and did not show significant changes in value added percentage of GDP (nearly 12%) between the years 2001-2007. The agriculture sector has overtaken the manufacturing sector to lead the value-added percentage of GDP again between 2004-2010.

The percentage value added in GDP of the agricultural sector has been declining since from 2012, whereas in 2013/2014, the service sector came to lead the value-added percentage of GDP in Ethiopia. This may be due to the fact that different services such as education and training, banking and insurance, health institutions, transport services, trade, telecommunication infrastructure, hotels, and tourism services are expanding alarmingly during those periods. A decline in the share of agricultural value added could also be an indicator of the growth of other sectors, such as the industrial sector. The industry sector value added in GDP observed improvements beginning in 2012, with a small difference observed in the agriculture sector by the year 2018 (27.31%). The share of value added in the manufacturing sector, however, remains stagnant despite improvements all over the study periods and remains less than 6% of GDP.

Figure 4.2: Sectoral value-added percentage GDP shares in Ethiopia (1993-2019)



Source: Authors' computation based on World Bank database, retrieved on January 29, 2021.

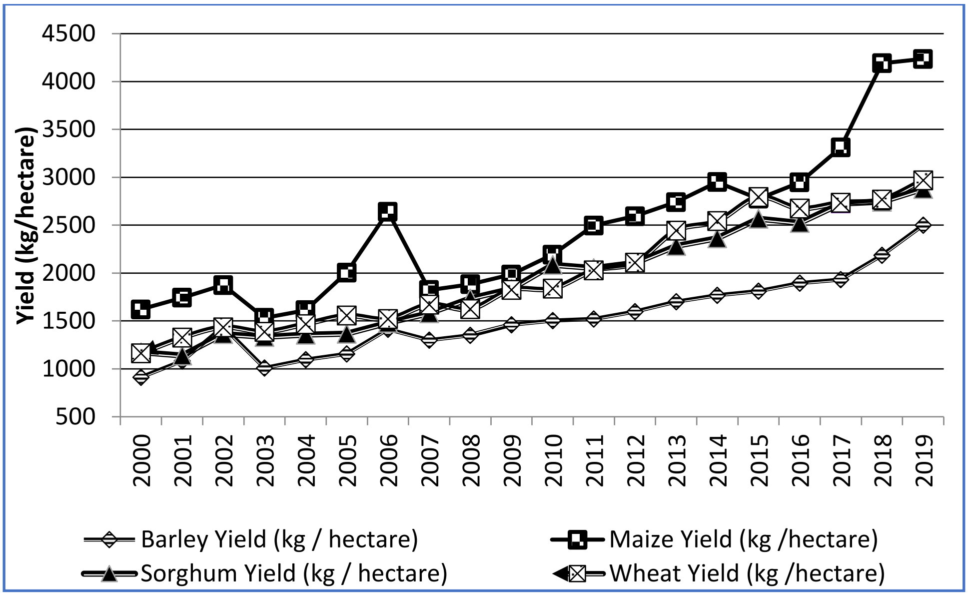
4.1.3 Agricultural productivity and level of production

Increasing the quantity of production and yield is an evident way to speed up agricultural growth. It is therefore necessary to monitor the levels and trends of technical progress in agricultural production in Ethiopia.

Major crops yield

Considering yield as one of the performance indicators, the trends of the four major food crop productions, such as barley, wheat, maize, and sorghum, are presented here. Trends in the average yield of cereal production experienced the most serious decline in the years 2000, 2003, and 2007 (see Appendix Figure 1). It should be noted that those years were the drought periods mentioned above. The big picture arising from the above trend indicated that agriculture yield growth in Ethiopia could be rain-fall dependent. The trends in the yield of the four crops and the overall cereal production during the years 2008-2015 have shown relatively appreciable improvements.

Figure 4.3: Patterns of major cereal crops yield (hg/ha) in Ethiopia (2000-2019).

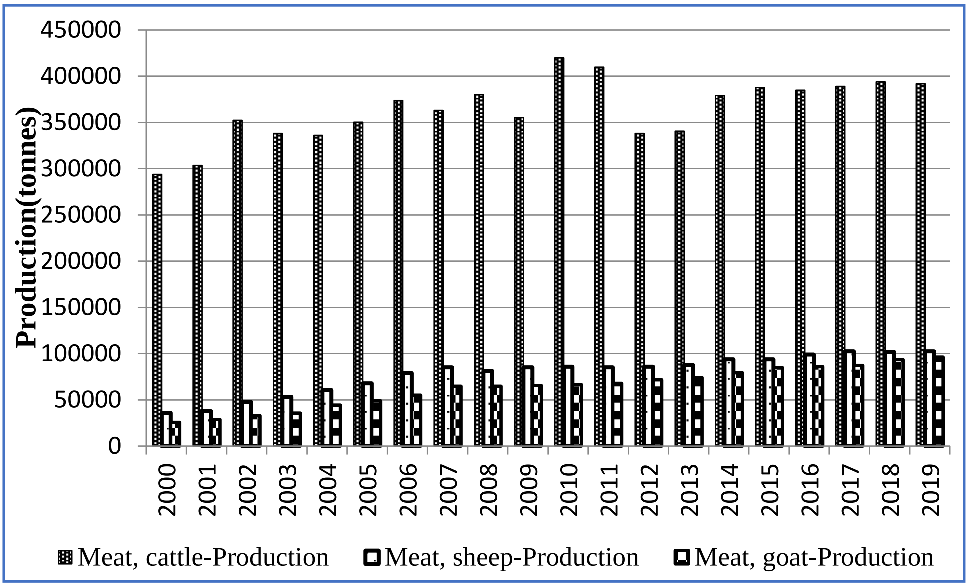


Source: Authors' computation based on FAO indices retrieved on 3-3-2021.

Meat production

Ethiopia is said to possess the largest livestock population in Africa. Despite its potential, the livestock sub-sector has remained undeveloped. Given the population growth, rising income, increased urbanization, and high demand for meat in Ethiopia, the level of production over the last decades has shown almost steady growths, as shown in Figure 4.4. This is due to the fact that the production system is subsistent or not commercial, constraints on animal feed and nutrition, inadequate management practices, a lack of processing and packaging, etc. In 2010 and 2011, cattle meat production was the highest as compared to other periods. The observed changes might be due to the agricultural transformation since these periods were the beginning of implementing the first Growth and Transformation Plan (GTP I) in Ethiopia. However, cattle meat production has declined for two consecutive years (2012 and 2013), indicating the poor performance of the agricultural growth and transformation plan.

Figure 4.4: Meat production in Ethiopia (2000-2019)

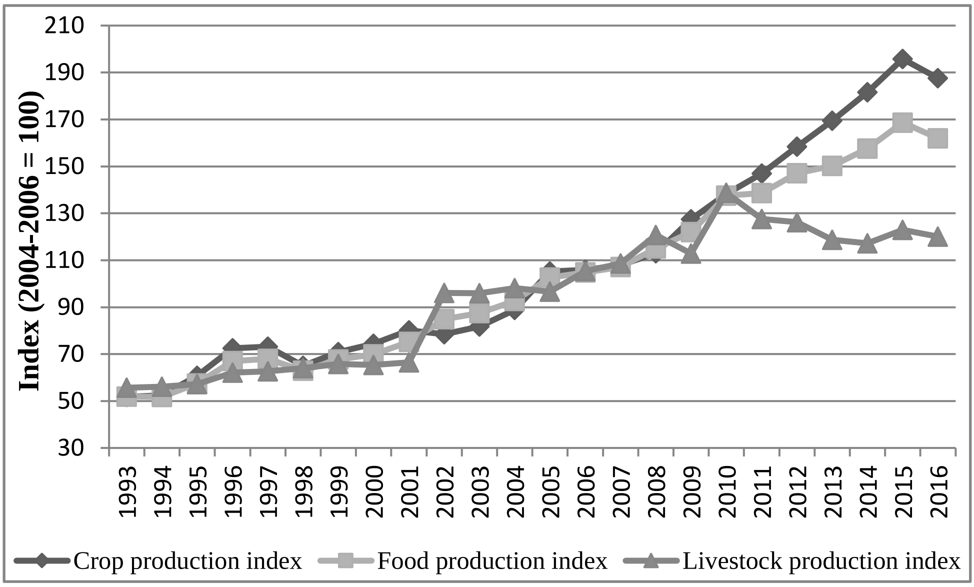


Source: Authors' computation based on FAOSTAT_data_3-3-2021.

Crop and Livestock Production Indices

The production index, as shown in Figure 4.5, shows a coinciding increment of indices for both crop, livestock, and food productions from years 1993-2010 relative to the base period 2004-2006. However, the livestock production index dropped beginning in 2010, whereas the others kept on increasing up to 2015. The crop production index grew substantially from an index of 55.67 (in 1993) to the maximum index of 195.79 (in 2015) and then decreased by -8.18% in 2016. The food production index also grew from 51.77 (in 1993) to the maximum index of 168.7 (in 2015) and then declined by -6.81% in 2016.

Figure 4.5: The pattern of agricultural production indices in Ethiopia (1993-2016)



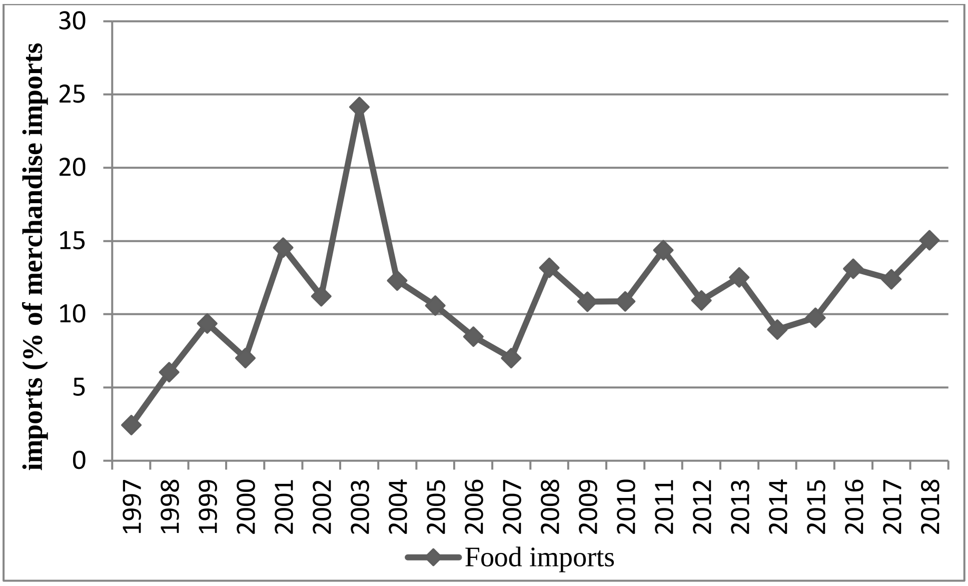
Source: Authors' computation based on FAO indices retrieved on 3-3-2021.

4.1.4 Trends in Food Imports

Food imports might be other indicators of agricultural performance in meeting the food needs of an economy. Despite improvements in domestic food crop production beginning in 2007, as shown in Figure 4.3 above, food crop imports have shown increments. This is an indication of the gap between domestic food production and the rise in population size.

As indicated in Figure 4.6, the extent of food imports, expressed as a percentage of merchandise imports, has shown increasing and decreasing trends over different time periods. The highest food imports have been observed in 1997/1998 and 2003, when the lower cereal yield and lower agricultural GDP growth were perceived as a result of drought in these periods, as presented in Figures 4.1 and 4.3. It seems that the size of food imports has to do with the performance of domestic agricultural production, in which food imports tend to decline during good harvest years and rise during drought years (see cereal yields in Appendix Figure 1). Among the major food crops imported, wheat constitutes the largest followed by sorghum in volume as well as value in Ethiopia (see Appendix Figure 2).

Figure 4.6: Trend of food crops imports in Ethiopia (1997- 2019).



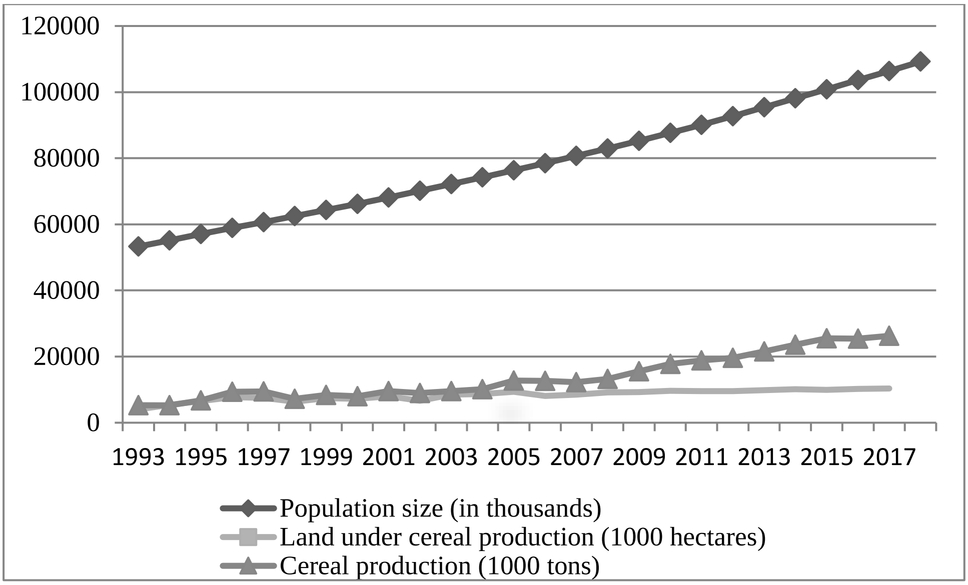
Source: Authors' computation based on World Bank database, retrieved on January 29, 2021.

4.1.5 Cereal production, land size and population growth

A common narrative hold that increasing farm size inevitably accompanies agricultural development and economic growth. An extensive literature review addresses the inference that formal land titling may be a necessary condition for increasing investments in land and the efficient allocation of land (Galiani and Schargrodsky, 2010; Ali et al., 2011). However, in Ethiopian, farmer land sizes are too small and there is no title for the land. Farm size aggregation as well as land privacy were recommended by different political elites, but the government's stand has been continued without flexibility in amending the constitution using the legal and regulatory environment.

As indicated in Figure 4.7, the land size under cereal production showed steady improvements over the study periods. Small farm sizes under rain-fed conditions have reinforced subsistence production, in which production activities are guided by home consumption requirements. Despite improvements in crop production, it is unable to feed the large population growth. The total population of Ethiopia has more than doubled during the past two decades, from 53.29 million in 1993 to 109.2 million in 2018, with an average growth rate of 2.8%.

Figure 4.7: Trends of total population, cereal production and land under cereal production (1993-2018)



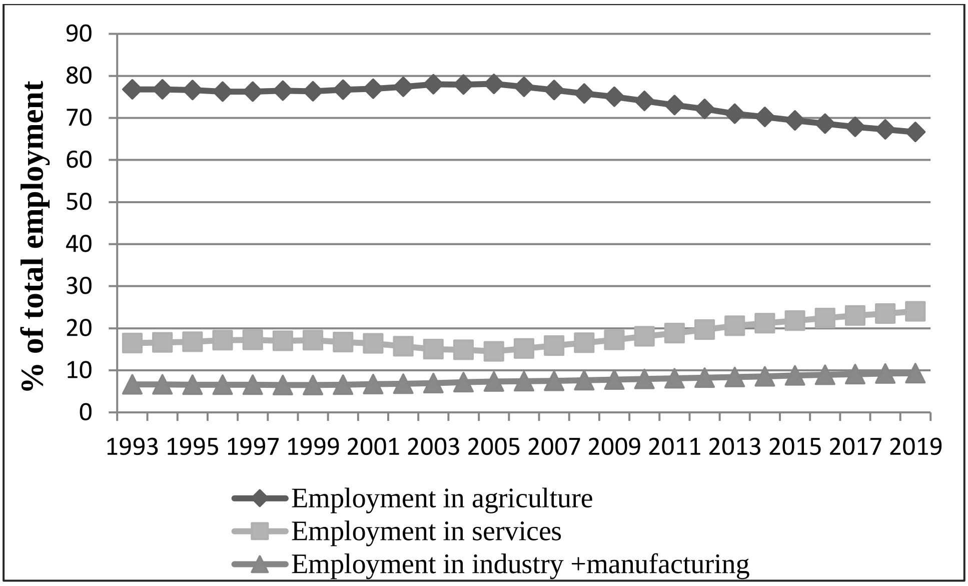
Source: Authors' computation based on FAOSTAT_data_3-3-2021.

4.1.6 Employment Contributions

Agricultural Development Led Industrialization (ADLI) (1994) and growth and transformation plans such as GTP I (2010) and GTP II (2015/2016) of Ethiopia set out agriculture as a primary stimulus to increase output, generate employment and income for the people, and as the springboard for the development of the other sectors of the economy. In spite of these various efforts, meaningful structural changes are not depicted in terms of employment generation, as indicated in Figure 4.8.

The agriculture sector continued to be the main source of employment throughout the period in Ethiopia. Beginning from 2006 to 2019, employment generation in agriculture declined with few changes, whereas the service sector rose in small amounts. The decline in agriculture's share of employment might be due to cases where agricultural labour productivity grows extremely slowly relative to labour productivity in other sectors (Anderson, 1987). Employment generation in the industry sector has remained quite low even though the government has taken several programmes to promote urban employment, such as the Micro and Small Enterprises (SMEs) Development Strategy and (the Integrated Housing Development Programme (IHDP).

Figure 4.8: Patterns of sectoral employment contributions-Ethiopia (1993-2019).



Source: Authors' computation based on World Bank Database, retrieved on January 29, 2021.

4.2 Regression Analysis

4.2.1 Unit Root and Multivariate Cointegration Tests

In order to check the stationarity of data series, we employed two different unit root tests: Augmented Dickey Fuller and Phillip-Perron, and results for both of these tests are presented in Appendix Table 1. Due to the non-stationary nature of the data, the stability conditions for Vector Auto Regression (VAR) are not met, implying that the Wald test statistics for Granger causality are invalid. In such a case, the cointegration approach and vector error correction model (VECM) are recommended to investigate the relationship between non-stationary variables. Thus, after applying the first difference, all variables appear to be stationary. The first difference implies that all variables are integrated in order one I(1).

Once it is confirmed from the unit root tests that all the series are integrated at the same order I(1), we then proceed further to estimate a multivariate Johansen and Juselius (1990) cointegration test to analyze the equilibrium relationship between agricultural (LN_AGR), industrial (LN_IND), manufacturing (LN_MNF) and service (LN_SER) sectors valued added GDPs. The Johansen co-integration test applied to determine the appropriate lag length and check the stability of the VAR is presented in Appendix Table 2. The lag length is selected using the Akaike Information Criterion (AIC), the Schwarz Information Criterion (SIC), and Hannan-Quinn Information Criterion (HQIC). Thus, the result shows that there should be four lag in VAR analysis that means three lag should be used in VECM.

The results in Appendix Table.3 indicate that both trace statistic (λ trace) and maximum eigenvalue (λ max) statistic indicate that there is one cointegrating equation among LN_AGR, LN_IND, LN_MNF and LN_SER in the long-run.

4.2.2 Long-Run Estimates and Speed of Adjustment Coefficients (ECt-1)

Having established a long-run equilibrium relationship between agricultural (LN_AGR), industrial (LN_IND), manufacturing (LN_MNF) and service (LN_SER) valued added variables, it is also important to analyze the speed of adjustment that brings back the equilibrium relationship in the long-run. For this purpose, we employed the vector error correction model (VECM) and the results of normalized cointegration coefficients and error correction terms in the VECM model.

The speed of adjustment parameters (alpha) or the estimated coefficient (ECt-1) in the VECM model in Table 4.2 indicates that the four ECt-1 coefficients make up the long run disequilibrium adjustment vectors for the model. The coefficients of ECt-1 can be interpreted as adjustment coefficients measuring the relative importance of a deviation from equilibrium for a given endogenous variable. The result shows these coefficients to be negative and statistically significant at 1% and 5% significance levels. This confirms the model converges to the steady-state since the values of the speed of adjustment parameters are all negative and absolute value less than 1. The coefficient of the ECt-1 has a negative sign and is highly significant for all the variables, confirming further that the variables in the system have a long-run relationship. For instance, the estimated coefficient of ECt-1= -0.2723 implies that about 27% of the short-run deviations from the agriculture sector will be adjusted each year to the long-run equilibrium level of the agriculture sector. The same is true for the other three sectors.

Since the study focused on the agricultural sector, it is selected to be normalized, as shown in Table 4.1 below. Based on the beta (β) parameters of the cointegrating vector of Johansen normalization restriction, the long run relationship between sectoral value-added percentage GDP shares in Ethiopia can be presented in the following equation:

$$LN\_AGR_t = 4.7135\, LN\_IND_t - 4.418\, LN\_MNF_t - 0.3463 LN\_SER_t + 6.2893$$

The restricted cointegrating beta (β) coefficients normalized to the agricultural sector indicated the existence of a strong positive relationship between the industrial sector and the agricultural sector in the long-run. For instance, a 1% increase in value added percentage GDP shares of the industrial sector leads to a 4.7% increase in agricultural sector value added percentage GDP shares, holding all other variables that affect the agricultural sector constant. The positive signs in the long-run relationships imply the existence of strong forward and backward relationships between the industrial and agricultural sectors. This positive relationship (between the agricultural and industrial sectors) actually contradicts the view of traditional economic growth theory. It does not necessarily mean that the theory is meaningful because the contribution of the agriculture sector in generating demand for the industrial sector has become more pronounced in recent years in Ethiopia. The intention is to indicate that the agriculture-industry linkage has been playing an important role in determining the overall growth of the economy, contributing 33.5% of the GDP share and 66.6% of employment generation by the year 2019, and that the positive linkages will continues in the long-run.

The linkage between the agriculture sector and the industrial sector is two-way and mainly involves backward and forward linkages. The forward relationship represents the effect of agricultural outputs on the industrial sector. For instance, in the Ethiopian case, agriculture supplies food grains to industry to facilitate the absorption of labour in the industry sector. Agriculture also supplies inputs like raw cotton to cottage industries, oil seeds and grains to agro-processing industries, and beer to brewery industries. In a backward relationship, industry supplies industrial inputs, such as fertilizer, pesticides, machinery, etc. to the agriculture sector. The growth of agriculture and industry has triggered an interest in structural changes in Ethiopia, so these significant long-run linkages are crucial issues for government policies.

The long-run linkage between the manufacturing and agricultural sectors was negative and significant. The results also suggest that, in the long run, a 1% increase in the service sector will result in a 4.4% decline in the agricultural sector. Moreover, the long-run effect of the service sector on the agricultural sector is not significant. This implies that the expected long-run relationships in terms of resource transfer from the service sector to the agricultural sector are not significant. A possible explanation for non-significant sectoral interdependency is due to underutilization of their resources, and therefore, a sector can increase its output without affecting the other sector negatively (Subramaniam, 2010).

Table 4.1: Restricted cointegrating beta (β) coefficients normalized to agricultural sector

Beta (β)	(β) Coefficients	Std. Err.	T-statistics	P-value	[95% Conf. Interval]	
LN_ AGR_ce1	1	.	.	.	.	.
LN_IND_ce1	-4.7135	0.6260	-7.53	0.000	-5.940	-3.4865
LN_MNF_ce1	4.4186	0.5302	8.33	0.000	3.3794	5.4577
LN_SER_ce1	0.3463	0.2664	1.30	0.194	-0.1759	0.8685
_cons	-6.2893	.	.	.	.	.

Source: Authors' Computation based on World Bank Database, retrieved on January 29, 2021.

4.2.3 The short-run estimation

Table 4.5 presents the short-run estimates (standard errors in parenthesis) for the Ethiopian sectoral economy. The short run coefficients contained in "Γ" are collected from the row coefficients of the lagged differences (LD). The lagged differences were due to the fact that some sectors did not have an immediate effect on other sectors or themselves. The model estimates confirmed how sectoral growth is affected by the past values of the same sector and other sectors of the economy. The result shows that all sectoral growths are influenced by their own past growths, either positively or negatively. As indicated by Subramaniam (2010), the signs of differences might be due to changes in the structure, technology, fluctuations in demand, product cycles, expansion and contraction adjustment speeds, time to build, planning, inventory management, technological progress, and other shocks peculiar to the sector.

The short-run estimation result indicated in the second row of (D_LN_AGRt-2) confirmed that agricultural sector value added influenced the growth of agriculture and all other sectors of the economy. This means the dynamic linkages play a significant role in determining the impact of agriculture on other sectors. In this instance, the value-added growth of the latter two years agricultural sector (t-2) negatively influenced its own performance and positively influenced all other sectors. Agriculture is negatively associated with its own performance due to the fact that most agricultural products in Ethiopia are contributed by small-holder subsistent farmers who cannot satisfy their basic needs. The other reason might be forcefully manipulated due to changes in the structure and direction of linkages between agriculture and the rest of the economy by different regimes in the country.

For instance, the direction of causality in the Derg regime was deliberately controlled by a centrally planned economy to run from agriculture to manufacturing and industrialization and EPRDF turned its back on liberal thought in favour of the developmental state and the inculcation of import substitution industrialization in the industrial policy menu of EPRDF.

The agricultural sector is also negatively linked to a one-year lag in the industrial sector and positively linked to the manufacturing sector. One of the most striking features of developing countries is a weak linkage between agriculture and industry since agriculture cannot experiment with new inputs such as fertilizers and machinery (Abdelmalki and Mundler, 1995, as cited by Kafando, 2018). In Ethiopia, these production inputs (fertilizers and machinery) were provided through imports rather than being produced in the country, which created a negative linkage between agriculture and industrial sectors. The other reason for the negative relationship (between the agricultural and industrial sectors) is the view of the traditional economic growth theory, which predicts that as the economy grows, the significance of the agricultural sector will diminish as resources, such as land, labor, and capital, are transferred to more efficient sectors, such as the industrial sector. This might also be convincing since Ethiopia recorded consecutive averages of 10.7% GDP in the last 14 years (2004-2017). Moreover, the industrial sector competes with the agricultural sector through resources (land, skilled labor and capital), and such competition for resources establishes a negative relationship as well.

The agricultural sector is positively linked with the first-and second-lagged service sectors. This indicated that investments in some special services such as transport and communication, storage, the building of rural roadways, banking and financial facilities, trade and hotels, social services such as education, hospitals, and other infrastructure, etc. increase agricultural growth. The result also depicted that the agricultural and service sectors have shown a positive linkage with the industrial sector in the short-run. This shows positive shocks or progress in the agricultural and service sectors do have a positive impact on the industrial sector. A negative shock to the agricultural sector would also result in a decline in industrial sector growth. For instance, during the period of agricultural shocks in Ethiopia, all other sectors have declined quite similarly to agriculture (see Figure 4.1 above).

The industrial sector has been positively and significantly linked with its past (two-years-lagging) performance. This could be due to the fact that investors would be attracted by the progress of the industrial sector and encouraged to invest in it. The short-run relationship between the industrial and manufacturing sectors is found to be negative since they compete for similar resources such as agricultural outputs, land, labour etc. since their differences are in the size of production and the size of labour used in some instances. Moreover, the industrial sector is positively and significantly associated with the service sector since the industry is the most service-intensive sector.

The manufacturing sector is associated with its past performance and the agricultural sector only. Its own performance was negatively linked with the second lag, whereas it became positive with the first lag. The second lag of manufacturing sector was negatively linked with its own performance, and the sign of linkage reversed in the first lag. This is an indication of positive and negative shocks in the sector. The previous year's positive performance of the manufacturing sector brought positive linkages to the existing growth of the sector, whereas the negative shock also had in a negative effect on the growth of the sector. It is to be recalled that the manufacturing sector in Ethiopia is highly dependent on imported sources for its raw material requirements due to shortages, seasonal supply, and poor quality of domestic products (UNDP, 2017). However, the short-run error correction model of the manufacturing sector indicated the existence of a positive and significant linkage with the agricultural sector. The manufacturing sector, like the industrial sector, consumed agricultural outputs as an input, so a positive forward relationship is expected.

As depicted in Table 4.5, the service sector is positively and significantly affected by the lagged value of the agricultural sector. This implies higher productivity in the agricultural sector, which indicates that the sector is utilizing the service sector very efficiently, particularly facilities such as education, marketing, finance, insurance, and transportation. Therefore, a strong positive relationship between the agricultural and service sectors is expected.

Table 4.2: The short-run VECM results of inter-sectoral linkages in Ethiopia (1981-2019)

Explanatory variables	Dependent variables			
	D_ LN_AGRt	**D_ LN_INDt**	**D_ LN_MNFt**	**D_ LN_SERt**
D_ LN_AGRt-1	0.1774	-0.1219	-0.1204	0.0522
	(0.1233)	(0.1222)	(0.1614)	(0.1358)
D_ LN_AGRt-2	-0.3869***	0.4671***	0.5140***	0.3109**
	(0.1294)	(0.1282)	(0.1694)	(0.1424)
D_ LN_INDt-1	-1.3364***	0.1023	-0.7402	-0.6135
	(0.3627)	(0.3596)	(0.4749)	(0.3994)
D_ LN_IND t-2	-0.2817	0.7522**	-0.3105	0.1905
	(0.3603)	(0.3572)	(0.4718)	(0.3968)
D_ LN_MNt-1	0.5468*	0.5014	1.1825***	0.6258*
	(0.3172)	(0. 3145)	(0.4153)	(0.3492)
D_ LN_MNFt-2	-0.1328	-1.3153***	-1.0028***	-0.8325***
	(0.2329)	(0.2308)	(0.3049)	(0.2565)
D_ LN_SERt-1	0.8671***	-0.0368	0.0363	0.4565
	(0.3259)	(0.3231)	(0.4268)	(0.3589)
D_ LN_SERt-2	0.8092**	0.8163**	1.5962***	0.8036**
	(0.3303)	(0.3274)	(0.4325)	(0.3637)
ECt-1	-0.2723***	-0.1406**	-0.4026***	-0.1807**
	(0.0658)	(0.0652)	(0.0861)	(0.0724)

Note: "*", "**" and "***" denote the estimates are significant at 10%, 5% and 1%, respectively; Standard errors are in parenthesis and the rest are coefficients; ECt-1= coefficient of error-correction term.

Source: Authors' Computation based on World Bank Database, retrieved on January 29, 2021.

The VECM post-estimations, such as normal distribution of disturbances, residual autocorrelation, and VEC stability condition, were made as indicated in Appendix Table 4 (a), (b) and (c). One of the problems in statistics is the autocorrelation among the variables. The Lagrange-multiplier test result indicated no problem with autocorrelation except for the second lag. The second test was the Jarque-Bera test of statistics against the null hypothesis that the disturbances in a VEC model are normally distributed. The result that the null hypothesis of normal distribution is not rejected implies the model has no problem with specification. The last test was checking the eigenvalue stability condition in a vector error-correction model. The test result suggests that all the eigenvalues lie in a single unit circle, which is the result of the correct specification of the cointegrating rank of the matrix. The VEC model stability result also indicated that there is a real root at about 0.83, which implies that the predicted cointegrating equation is probably not stationary.

5. Conclusion and Policy Implications

5.1 Conclusion

The ambition of agricultural transformation cannot take place without integrated and synergistic linkages with other sectors of the economy. In the context of Ethiopia, there are four interlinked sectors: agriculture, industrial, manufacturing, and service sectors. Thus, recognition of agricultural transformation is basically linked with these sectors, so that the intention of transforming one sector cannot be implemented without the corresponding transformation of the other. Based on the evaluation of different indicators to assess the performance of the agricultural sector, the desired plan of agricultural transformation couldn't achieve what was expected in terms of sustainability, productivity, or yield, inducing technical change, food self-sufficiency, and expansion of agro-industries.

In order for agricultural transformation to be sustainable, it needs to be practically linked to other sectors of the economy. Results of the VECM show that there is a sectoral relationship in terms of value added among the agricultural, industrial, manufacturing, and service sectors in Ethiopia. The analysis of the long-run relations confirmed that the different sectors of the Ethiopian economy moved together over the sample period and, for this reason, their growth was interdependent. For instance, the industrial sector has a positive effect on the performance of the agricultural sector in the long run. This is due to the fact that the growth in the industrial sector enhances the supply of inputs (such as machinery, fertilizer, and chemicals) to the agriculture sector, thereby encourages agricultural activities to grow. However, in the short-run, the industrial sector has a negative effect on the performance of the agricultural sector, and the agricultural sector in turn positively affects the value added in the industrial sector. The long-run linkage between the manufacturing and agricultural sectors was negative and significant whereas, the long-run effect of the service sector on the agricultural sector is not significant. This implies that the expected long-run relationships in terms of resource transfer from the service sector to the agricultural sector are not significant, or it might indicate the underutilization of its resources.

The VEC model's short-run estimates confirmed how sectoral growth is affected by the past values of the same sector and other sectors of the economy. The agriculture sector in the short-run is negatively associated with its own performance. It might be due to the forcefully manipulated structural changes practiced in different periods and under different regimes in the country. Moreover, due to the fact that most agricultural products in Ethiopia are contributed by small-holder subsistence farmers who cannot satisfy their basic needs. The result also indicates that agriculture's value added has a significant association with all other sectors of the economy in different time lag periods.

5.2 Policy Implications

The agriculture sector has gone through different economic reforms. Recent policy initiatives relating to the agricultural sector include agricultural transformation in view of maintaining agriculture as a major source of economic growth through a structural shift from food production to commercial crops. The sector will also serve as a springboard to bring about structural transformation in the long run through its contribution to industrial growth. Given the existing economic policy of the country and inter-sectoral linkages, the following important policy implications are drawn.

The declining agricultural share of GDP cannot be merely an indicator of structural transformation since the sector is still the pillar of the economy, as confirmed by analysis. Based on the different performance indicators discussed in the analysis, agricultural transformation couldn't accomplish as what was expected. This calls for policy amendments to some extent. A common narrative holds that increasing farm size inevitably accompanies agricultural development and economic growth. However, Ethiopia still practiced the Maresha and hoe cultivation systems. This requires immediate priority to replace traditional farming with mechanized farming and the utilization new technologies. This can be achieved by increasing farm size, either by aggregating the fragmented land use patterns through cooperative schemes by changing the existing land policy following legal environments.

The presence of short-run and long-run cointegrating relationships between sectors provides evidence that there are two processes that separate the long-run from the short-run responses of the Ethiopian economy. Accordingly, this is an important scenario for macroeconomic policy, taking into account the possible long-run interdependences between agriculture and other sectors of the economy. In this regard, policymakers should pay more attention to the problem of transferring resources from agriculture to other sectors and vice versa.

The negative short-run agriculture–industry linkage indicates the agricultural sector should enhance its use of industrial inputs such as agricultural machinery, fertilizers, and other chemicals. Thus, there should be an action plan so as to effectively increase technology adoption and strengthen the relationship between agriculture and industry in Ethiopia.

References

Alemu, Z. G., Oosthuizen K. and van Schalkwyk H. D. (2003). Contribution of agriculture in the Ethiopian economy: a time-varying parameter approach. *Agrekon*, 42:1, 29-48.

Anderson, K. (1987). On why agriculture declines with economic growth. Agric. Econ., 1: 195 207. Elsevier Science Publishers B.V., Amsterdam- Printed in The Netherlands.

Chebbi, H. E. (2010). Agriculture and economic growth in Tunisia. China agricultural Economic review, 2 (1), 63-78.

Degu, A. A., (2019). The causal linkage between agriculture, industry and service sectors in Ethiopian economy. *American Journal of Theoretical and Applied Business*, 5(3), pp.59-76.

Demekech G., Fisseha M., Getnet Z., Kindie T. and Melkamu A. (2010). Multi-stakeholder linkages in rural innovation process in Amhara region, Ethiopia. Working Document Series, 137.

Dickey, D. A., and Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, 74, 427-431.

________. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica*, 49 (4), 1057-1072.

Engle, R., & Granger, C. W. (1987). Co-Integration and Error Correction: Representation, Estimation, and Testing. *Econometrica*, 55 (2), 251-276.

Erjavec, N., and Cota, B. (2003). Macroeconomic Granger causal dynamics in Croatia: evidence based on a vector error correction modeling analysis. Ekonomski pregled, 54 (1-2), 139-156.

Federal Democratic Republic of Ethiopia (FDRE) Ministry of Finance and Economic Development (MOFED). (2002). Ethiopia: Sustainable Development and Poverty Reduction Program, Addis Ababa, Ethiopia.

Federal Democratic Republic of Ethiopia (FDRE) Ministry of Finance and Economic Development (MoFED). (2010/11). Growth and Transformation Plan I (GTP I), Addis Ababa, Ethiopia.

________. (2015/16). Growth and Transformation Plan II (GTP II), National Planning Commission, Addis Ababa, Ethiopia.

Getachew A. M. (2018). Drought and its impacts in Ethiopia. Weather and Climate Extremes 22 (2018), Pp 24–35.

Granger, C. W. (1969). Investigating causal relations by econometric models and cross spectral methods. *Econometrica*, 37(3): 424–438.

Haggblade, S., and Hazell P. B. R. (1989). Agricultural Technology and Farm-non-farm Growth Linkages. Agricultural Economics 3: 345-364.

Hirschman A. (1958). *The Strategy of Economic Development*. Yale University Press. Pp. xiii, 217.

João, G., Gilson Pina & Marta C. N. Simões. (2014). "Agriculture in Portugal: linkages with industry and services," GEMF Working Papers 2014-04, GEMF, Faculty of Economics, University of Coimbra.

Johansen S, Juselius K. (1990). Maximum likelihood estimation and inference on cointegration – With applications to the demand for money. Oxford Bulletin of Economics and Statistics, 52(2): 169–210.

________. (1992). Some structural hypothesis in a multivariate cointegration analysis of the PPP and the UIP for the U.K. *Journal of Econometrics* 53 (1992): 211-44.

Kafando N. C. (2018) Does the Development of the Agricultural Sector Affect the Manufacturing Sector? In: Shimeles A., Verdier-Chouchane A., Boly A. (eds) Building a Resilient and Sustainable Agriculture in Sub-Saharan Africa. Palgrave Macmillan, Cham.

Kassahun, T. (2006). Dynamic Sectoral Linkages in the Ethiopian Economy: A preliminary Assessment. Addis Ababa: Ethiopian Economic Association /Ethiopian Economic Policy Research Institute.

Phillips, Peter C. B. and Perron P. (1988). Testing for a Unit root in time series regression. Biometrika, 335-346.

Saikia, D. (2009). Agriculture-Industry Inter-linkages: Some Theoretical and Methodological Issues in the Indian Context. Institute for Financial Management and Research, MPRA Paper No. 27820, posted 04 Jan 2011 08:12 UTC.

________. (2011). Analyzing inter-sectoral linkages in India. *African Journal of Agricultural Research*, 6 (33), 6766-6775.

Sepehrdoust, H., & Adnan, Q. M. (2012). An empirical study of inter-sectoral linkages and Economic growth. Trends in Applied Sciences Research, 7: 494-504.

Sikhosana N, T. A. (2015). Inter-sectoral linkages and Agricultural growth in Swaziland for the period 1971-2011. *Journal of Economics and Sustainable Development*, 6, 218-228.

Subramaniam, V. (2010). Agricultural Intersectoral Linkages and their Contribution to Economic Development" (2010). University of Kentucky Doctoral Dissertations. 771. https://uknowledge.uky.edu/gradschool_diss/771.

Suharsono, A., Aziza A. and Pramesti. W. (2017). Comparison of Vector Autoregressive (VAR) and Vector Error Correction Models (VECM) for Index of ASEAN Stock Price. AIP Conference Proceedings 1913, 020032 (2017).

Tadele, F. (2000). Measuring sectoral interdependence in Ethiopia: a social accounting matrix (SAM) approach. *Ethiopian Journal of Economics*, IX.

Uddin, M. M. (2015). Causal Relationship between Agriculture, Industry and Services Sector for GDP Growth in Bangladesh: An Econometric Investigation. *Journal of Poverty, Investment and Development*, 18, 124-130.

UNDP. (2017). A case study of growing manufacturing industry in Ethiopia.

Verner, N. M. (2001). Inter-sectoral dynamics and economic growth in Ecuador. The World Bank Latin America and the Caribbean Region Economic Policy Sector Unit.

Wiggins, S. (2014). African Agricultural Development: Lessons and Challenges. *Journal of Agricultural Economics,* 65(3), 529-556.

Xinshen D., Belay F., Haggblade S., Alemayehu S., Kassu W., Bingxin Y. (2007). Agricultural growth linkages in Ethiopia: Estimates using fixed and flexible price models, IFPRI Discussion Paper No. 00695.

Xinshen, D. & Steven Haggblade, B. F. (2007). Agricultural Growth Linkages in Ethiopia: Estimates using Fixed and Flexible Price Models. Washington: international food policy.

________. (2007). Agricultural Growth Linkages in Ethiopia: Estimates using Fixed and Flexible Price Models. Washington: international food policy.

Appendix

Appendix Table 1: Augmented Dickey Fuller (ADF) and Philips-Perron stationary test results

Variables	Level				First difference				I(d)
	ADF		Philips-Perron		ADF		Philips-Perron		
	test-statistic	P-value	test-statistic	P-value	test-statistic	P-value	test-statistic	P-value	
LN_AGR	0.670	0.9892	0.722	0.9892	-5.508	0.0000	-5.508	0.0000	I(1)
LN_IND	3.861	1.0000	2.435	1.0000	-3.148	0.0232	-3.148	0.0232	I(1)
LN_MNF	2.281	0.9989	2.342	0.9989	-3.725	0.0038	-3.725	0.0038	I(1)
LN_SER	2.327	0.9990	1.297	0.9990	-3.717	0.0039	-3.717	0.0039	I(1)

Note: I(d) – integrated of order "d"; ADF=Augmented Dickey Fuller; LN_AGR= natural log of agricultural valued added; LN_IND= natural log of industrial valued added; LN_MNF= natural log of manufacturing valued added and LN_SER= natural log of services sector valued added.

Source: Authors' Computation based on World Bank Database, retrieved on January 29, 2021.

Appendix Table 2: VAR Lag Order Selection Criteria.

Lag	LogL	LR	FPE	AIC	HQIC	SBIC
0	190.68	NA	1.4e-10	-3.84925	-11.2529	-11.1325*
1	208.821	36.283	1.3e-10	-12.1262	-11.1386	-10.5367
2	239.142	60.641	5.6e-11	-12.8503	-11.7623	-10.6791
3	256.068	33.853	6.0e-11	-12.9185	-11.5743	-10.0096
4	282.602	53.066*	4.1e-11*	-14.0366	-11.9686*	-9.92244

Note: - "*" indicates lag order selected by the criterion.

Source: Authors' Computation based on World Bank Database, retrieved on January 29, 2021.

Appendix Table 3: Summary of Johansen co-integration test

Rank	Eigen value	Trace Test			Maximum Eigen statistic		
		Trace statistic	Critical Values 5%	1%	Maximum statistic	Critical Values 5%	1%
0	-	75.2611	53.12	60.16	51.4791	28.14	33.24
1	0.78986	23.7820*1*5	34.91	41.07	15.1504	22.00	26.81
2	0.36815	8.6316	19.96	24.60	5.9587	15.67	20.20
3	0.16520	2.6729	9.42	12.97	2.6729	9.24	12.97

Note: "*" indicates that the trace and the maximum eigenvalue statistic are smaller than the 5% critical value. That means the rejection of null hypothesis of no co-integration at 5% level of significance.

Source: Authors' Computation based on World Bank Database, retrieved on January 29, 2021.

Appendix Table 4: VEC Post Estimation Specification Tests

(a)

Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	22.3259	16	0.13298
2	26.5376	16	0.04692
3	19.6944	16	0.23430
4	22.9373	16	0.11542

H0: no autocorrelation at lag order

(c)

Eigenvalue stability condition

Eigenvalue	Modulus
1	1
1	1
1	1
.8266149	.826615
-.7053486	.705349
.4628101 + .5299i	.703553
.4628101 - .5299i	.703553
.1869309 + .6584786i	.684498
.1869309 - .6584786i	.684498
-.2193338 + .6379507i	.674602
-.2193338 - .6379507i	.674602
.4853972	.485397

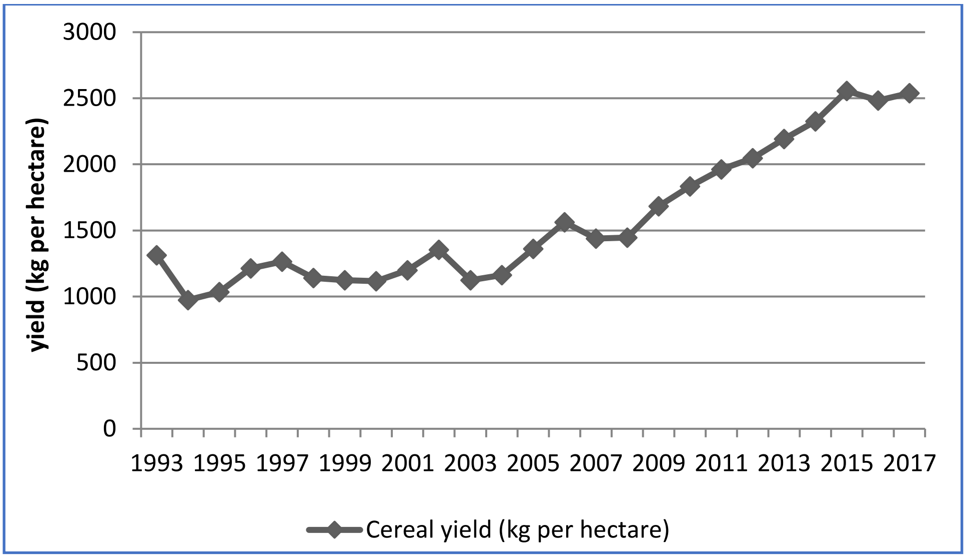
The VECM specification imposes 3 unit moduli.

(b)

Jarque-Bera test

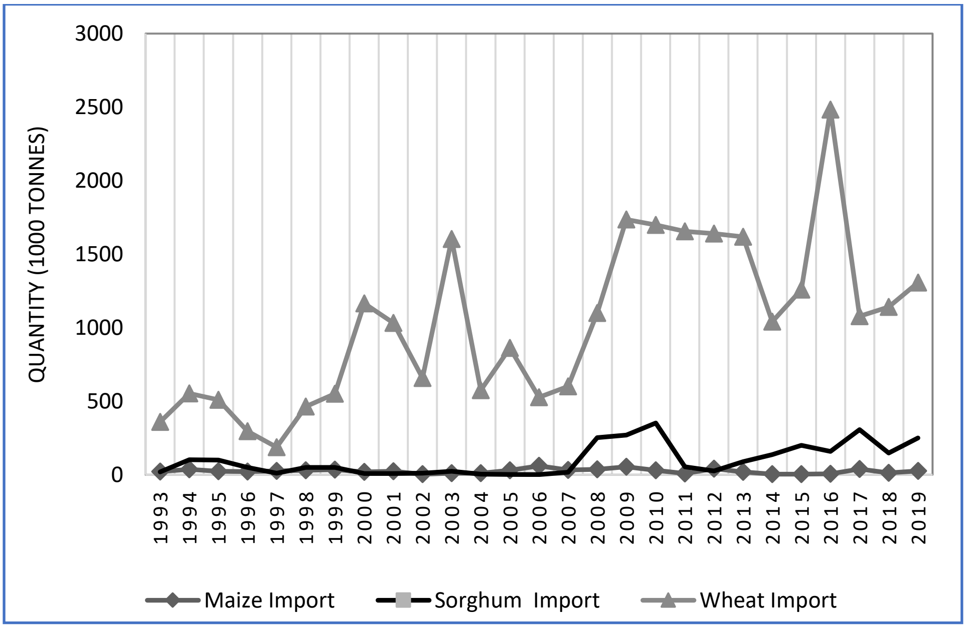
Equation	chi2	df	Prob > chi2
D_LN_AGR	0.405	2	0.81658
D_LN_IND	0.638	2	0.72675
D_LN_SER	1.067	2	0.58643
D_LN_MNF	0.307	2	0.85773
ALL	2.418	8	0.96545

Appendix Figure 1: Cereal yield in Ethiopia (1993- 2019).



Source: Authors' computation based on World Bank database, retrieved on January 29, 2021.

Appendix Figure 2: Trend of major food crops imports in Ethiopia (1993- 2019).



Source: Authors' computation based on World Bank database, retrieved on January 29, 2021.