Ethiopian Journal of Economics

Volume 32 Number 1 April 2023

A Publication of
THE ETHIOPIAN ECONOMICS ASSOCIATION
(EEA)

VOLUME 32 NUMBER 1 April 2023

Published: September 2023

Can Ethiopia Reach a Lower-Middle-Income Status by 2025? A Framework of DSGE and VAR Models

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Article History: Received: 18 October 2022; Revised: 17 August 2023; Accepted: 02 October 2023

Abstract

Ethiopia has set the goal to be one of the Lower-Middle-Income (LMI) economies in the world by 2025. With that the target is to reach a GDP range of 147.5 to 578.4 bl. US$ and a GDP per capita range of 1,137 to 4,458 US$ by 2025. The present study asks whether Ethiopia is likely to reach these targets or not if the trends, dynamics, and volatility that have been experienced during the last decades persist. The out-of-sample forecast was analyzed using DSGE and VAR models, and the data set used in this study underwent a structural break test. Based on 1990-2018 data, the Nominal GDP of the Ethiopian economy is predicted to be 130.86 bl. US$ by the VAR model and 131.52 bl. US$ by the DSGE model in 2025. The 2004-2018 data gives a higher and above LMI margin predicted value of 164.84 bl. US$ and 169.69 bl. US$ for the VAR and DSGE models, respectively. Using the 2004-2018 data, the 2025 Nominal GDP in US$ is forecasted to be more than 164 bl, and the GDP per capita between 923 to 1,123 US$. Even though Ethiopia may surpass the target set in terms of Nominal GDP and come close to the GDP per capita target, still a lot necessity be done to make the goal of reaching the LMI status credible. Therefore, structural, financial and economic reforms, infrastructural investments and nurturing macro-economic balance, are among the policy measures that need to be taken to achieve a resilient LMI status by 2025.

Keywords: Ethiopia, LMI economy, 2025 forecast, DSGE, VAR
JEL Classification: C53; E37

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1. Introduction

Ethiopia was the second poorest country in the world at the beginning of the century. However, the country has registered an encouraging continuous growth over the last decades, facing but standing various shocks and macroeconomic difficulties and moved to the 17th poorest in 2018 (WB, WDI, 2018). The country is one of the fastest growing economies in the world with an average growth rate of 10.5 percent from 2004-2018 (yet, the average growth rate was 6.9 percent from 1991-2018), registering a record growth rate of 13.6 percent in 2004 (WB, WDI, 2020).

On one hand, the economic growth rate of 6.9 percent (1991-2018) and 10.5 percent (2004-2018) in Ethiopia has been confirmed by Ethiopian government institutions, the World Bank (WB), the International Monetary Fund and many other independent international organizations. The massive public infrastructural investments (such as hydroelectric, green energy, railway, etc.) had been launched primarily following the 15th of May 2005 Ethiopian general election, which many agreed the event changed the behavior of Ethiopian government in the economic sector. Furthermore, the First Growth and Transformation Plan (GTP I) leads to a large inflow of foreign direct investment, foreign borrowing, remittance and grant/aid. The above two explanations amplified the real GDP figures of the Ethiopian economy from 18.7 billion US$ in 2003 to 89.6 billion US$ in 2019 (WB, WDI, 2020). However, the above remarkable growth of 3.8 folds accompanied by numerous hitches such as GDP's underline incapability of income/output/resource distribution, the incoming projects have longer gestation period, weak institutions, illegal outflow of loan, grants, and foreign reserves through embezzlement (poses double burden on the economy as debt and social opportunity cost).

On the other hand, the report of double-digit economic growth figure has been disproved by the known Ethiopian Economist Alemayehu Geda (2018) as reported in https://newbusinessethiopia.com on 28th of June 2018. On the basis of the already exaggerated 7 percent Total Factor Productivity (TFP)[3], the expert estimated

[3] Hungary, Peru, Ethiopia, and Indonesia have the greatest aggregate productivities out of the 80 developing nations examined throughout the same period across different regions—Eastern Europe and Central Asia, Latin America, Africa, and Asia. The highest values among the countries surveyed are found in Moldova, Nicaragua, Ethiopia, and Indonesia, according to a comparison of average productivities in each area (Saliola & Seker, 2011). Technical advancement, technical efficiency change, and scale effect are the three components of TFP growth. According to Melaku's (2013) study, there are significant inefficiencies that account for at least 14% of the production variation among Ethiopian firms. After 2001/02, TFP showed stronger advancement, and the rise is

the economic growth was only 6-7 percent, not 10+ percent. Furthermore, the expert at the IMF's Finance and Development section based on the satellite images of the earth at night reveals economic growth in Ethiopia is exaggerated by 17 percent. However, the official data set of the IMF still confirms the double-digit economic growth in Ethiopia from 2004-2018 (IMF, 2018).

TFP's importance as a major source of growth in the last decade, compared to its negligible and sometimes negative contribution a decade before, demonstrates that the official GDP growth figure has a problem (Geda, 2008; Geda & Addis, 2014). This is due to the country's failure to implement meaningful technological and structural changes in its production methods, particularly in the agricultural sector, over the last decade, resulting in such unprecedented growth in factor productivity. It is also worth noting that TFP is calculated as a residual. Indeed, the jump in TFP from negative in 2002/03 to significant positive in 2003/04 (an unprecedented 14 percentage point jump) demonstrates the unrealistic nature of the officially reported growth figure. TFP in Ethiopia is more dependent on the vagaries of nature than on technology, and it has swung between negative and positive values. In the best of circumstances, it has historically remained below 1.5 percent (Geda & Addis, 2014).

Ethiopia's growth rate could not be accompanied by structural transformation. According to Table 1, the manufacturing and agriculture sectors contribute 6.8 percent and 32.5 percent, respectively, to the Gross Domestic Product (GDP) in 2020/21 (PDC, 2021; MoFED, 2012), and the agricultural sector employs approximately 75 percent of the population (World Bank, 2013). Indeed, the agricultural sector's contribution to GDP has declined from an average of 64.1 percent between 1991 and 2001 to 46.4 percent in 2011 and could fall to as low as 32.5 percent in 2020/2021, despite its contribution in terms of employment, foreign exchange earnings, and composition remaining largely unchanged. During this period, the contribution of the service sector and merchandise exports to GDP increased dramatically (World Bank, 2013). On the contrary, there was no discernible change in the industrial sector over the years.

mostly attributed to technical change. Due to the time invariant efficiency of the majority of industrial groupings, the impact of efficiency change is quite minimal. Additionally, because most industrial groups have constant returns to scale or little deviance from constant returns to scale, the scale effect is nil or extremely minor. The TFP in Ethiopia and LDCs in general include technical advancements, climate shocks (such as rainfall, drought, and famine), inefficiencies in productivity and institutions, statistical inconsistencies, and external sector rather than only technology or technical advancement.

Table 1: Composition of the Ethiopian Economy (in GDP)

Sectors of Ethiopian Economy	1991-2001	2001-2011	2020/21
Agriculture	64.1	47.7	32.5
Industry	8.7	13.0	29
Manufacturing	3.0	5.7	6.8
Services	27.3	39.3	39.5
Export of goods and services	4.1	12	13.3

Source: MoFED (2012), PDC (2021).

Non-primary goods accounted for a small share of total exports, while primary goods such as coffee, oilseeds, chat, gold, and flowers accounted for three-fourths of total export value in 2010/11. (PDC, 2021; MoFED, 2012). The structural composition of the Ethiopian economy in the remaining sectors has remained essentially unchanged for many decades. It is obvious that sustainable economic growth and structural transformation cannot be achieved without strong sectoral interdependence and changes in sectoral composition, especially in the early stages of development.

In Ethiopia, several plans, strategies, and policies, including the Structural Adjustment Program (SAP, 1996), the Sustainable Development and Poverty Reduction Program (SDPRP, 2002), the Industrial Development Strategy (IDS, 2003), the Plan for Accelerated and Sustained Development to End Poverty (PASDEP, 2005/06-2009/10), the Agricultural Development Led Industrialization (ADLI, 1993), the Growth and Transformation Plan (GTP I, 2010/11-2014/15) and GTP II (2015/16-2019/20) have been implemented to bring sustainable economic growth, industrialization and structural transformation, yet they are unsuccessful to in bringing the standard desired changes. The government is currently developing a Homegrown Economic Reform Agenda (HGERA, 2019) and a Ten-Year Perspective Development Plan (TYPDP, 2020/21-2029/30), in the hopes of changing the economy's sluggish structural composition.

Several efforts to structurally change the Ethiopian economy have resulted in a shift from an agricultural to a service-based economy, skipping the intermediate and vital sector of the economy, namely the industrial sector. The transition from agriculture to the service sector is not typical for Ethiopia, and it is unlikely to result in either sustainable growth or structural change in the economy.

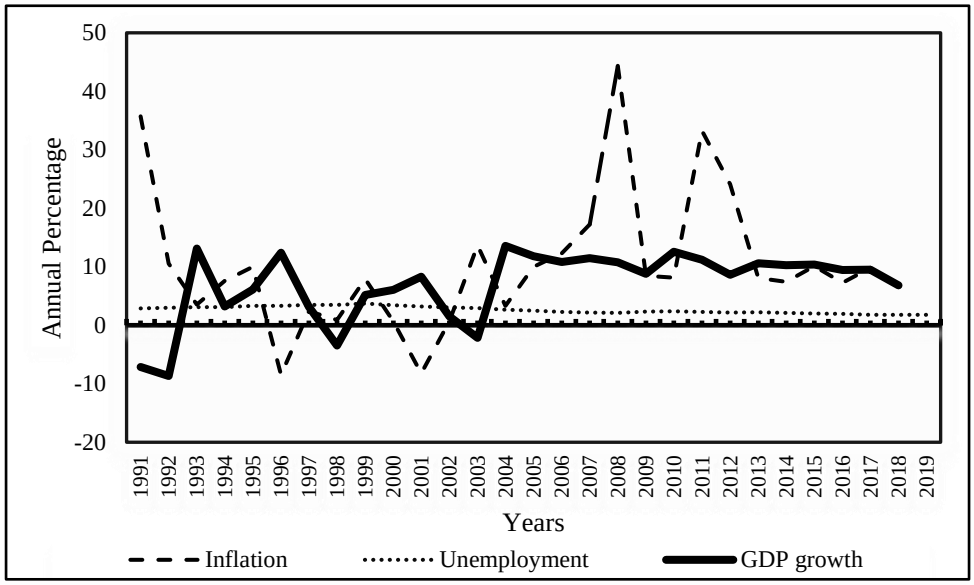
Figure 1 presents the inflation, unemployment and GDP growth trends in the economy. As reported in WB, WDI (2020) inflation reached an extremely high value of 44.4 percent in 2008, when the global economic downturn moderately hit the Ethiopian economy. After two years of single digit inflation, prices skyrocketed again to 33.3 percent in 2011, due to the Ethiopian currency devaluation of 2010. The unemployment level in Ethiopia remained high after the downfall of the Derg military regime in 1991 and increased further in the mid 1990's (WB, WDI, 2020). As Figure 1 presents, it showed a tendency to rise again in 2009-2010 may be due the global financial crisis. Since 2004, with the continuous achievement of double-digit economic growth, the employment rate slightly improved. The overall performance of the economy persuaded experts that Ethiopia could achieve the Lower-Middle-Income (LMI) economy status by 2025 as mentioned by MoFED (2010), WB (2013) and NPC (2016). According to UNDP (2018), the unprecedented sustained economic growth led some economists to assert that Ethiopia can achieve the aim to become LMI country by 2025.

Hence, upon the impressive performance of the economy relative to not only Africa at large, but also the world, Ethiopia has officially set the target to be listed in the LMI category by 2025 with a GDP in the range of 147.5 to 578.4 bl. US$ or 9.3 to 36.5 tr. ETB and a GDP per capita in the range of 1,137 to 4,458 US$[4]. By achieving this goal, Ethiopia is expected to pull millions of people out of poverty, improve life expectancy and reduce child and infant mortality.

It is worth reviewing studies that have been conducted on GDP forecasting to lay a foundational motivation for this study. Some of them are one-step ahead forecasts and did not emphasize dynamic forecasting. Also, most studies which grounded their forecasts on the Vector Autoregression (VAR) technique do not compare and evaluate their results against predictions by the Dynamic Stochastic General Equilibrium (DSGE) technique or other general equilibrium models.

[4] Own computation based on the GNI/GNP (Gross National Income/Gross National Product) per capita calculation of WB Atlas method data report from 1987 to 2018.

Figure 1: Trends of Macroeconomic Variables in Ethiopia



Source: NBE, 2022; WB, WDI, 2020

Abdul Razak, Khamis and Abdullah (2017) compare performance of Autoregressive Integrated Moving Average (ARIMA) and VAR models in the forecasting of Malaysian economic growth and suggest the best time series model from the two. The indicators used to measure economic growth are currency in circulation, exchange rate, external reserve, and reserve money. The forecast performances were appraised based on out-of-sample forecasts, using as error measurement the mean absolute percentage error. The study found out that the VAR model outperforms the ARIMA model based on the assessment of forecasting accuracy. The study by Bekana and Deressa (2017) has employed a VAR model to forecast the GDP of Ethiopia. However, their prediction is limited to a one-period-ahead forecast. In the study out-of-sample forecasts were produced for the Ethiopian GDP using the fitted model. The results for mean squared error, mean absolute error and Theils U statistic indicate that the estimated model is good enough to describe the data set. The paper by Trevor and Thorp (1988) presents three VAR models of the Australian economy. The forecasting performance of 1986-87 outcomes (on an ex-ante basis) is compared against three sets of private sector forecasts, the 1986-87 budget forecasts and the actual outcomes from the same period. The VAR forecasts perform at least as well or better than comparable forecasts of the private sector.

Among their conclusions, the detrending process is a key component of the quality of forecasting. The study objective of Patrick (2009) was to forecast GDP growth for the Baltic States Estonia, Latvia, and Lithuania. The forecasts were made based on a reduced VAR model which provided good results for horizons up to t+8 (Eight periods a head). Based on the findings it is possible to conclude that the model provided reliable estimates of future values of GDP for the assessed countries. The study suggests that the model should be appropriate to be applied to other countries of interest.

When trying to forecast Ethiopian GDP in 2025 from available data, we think it is appropriate to have more than one forecasting technique. Hence results from two or more methods should be evaluated for a more reliable and robust overall prediction. Due to limitation of resources, this study has employed a form of structural VAR and Small Open Economy (SOE) DSGE models to predict and evaluate the gross output level and income per capita projections of Ethiopia by 2025.

The first and second growth and transformation plans of Ethiopia from 2010 to 2020 (GTP I and GTP II) and the ensuing Homegrown Economic Reform Agenda all aim to transform the country from the low-income category to the next category of LMI by 2025. This study is meant to predict and evaluate the realization of the 2025 goal. More precisely, the present study inquires if Ethiopia is likely to meet its 2025 target if the trends, dynamics and volatility that have been experienced during the last decades endure. To the best of our knowledge, this question has not been investigated in detail. In fact, long run projections and estimations using DSGE and VAR models for Ethiopia are hardly available, but would seem to provide important guidance for policy interventions with appropriate measures. Recent outstanding, but potentially highly important events such as the expensive cost of living mainly caused by the climbing up of inflation to 20.16 percent in 2020 the first time since 2012, the COVID-19 crises, the unrest in different parts of the country and the disagreement with neighbouring countries may affect the prospects for Ethiopia's development in ways that are obviously not incorporated in this study's forecasts.

2. Materials and Methods

2.1 Data and Variables

The analysis was based on the seasonally adjusted quarterly time series data set for different indicators of the economy. Two time periods of the Ethiopian economy, i.e., 1990q1[5]–2018q1 and 2004q1–2018q1, have been used for forecast analysis of the 2025 goal. The structural break test reveals that 2002q2 and 2003q2 mark structural changes in the economy. These structural break points have been taken care of by incorporating dummy variables. Even though the first data set contain more observations, the period is also accompanied by structural changes in 2002q2 and 2003q2. Thus, doing the projection based on the 2004-2018 data set might better reflect the economic growth dynamics in the upcoming period.

Data[6] for the variables were collected from the National Bank of Ethiopia, the World Bank's World Development Indicators (WDI), the International Monetary Fund, and the United Nations. The variables used in this study follow the definition given by Salvatore (2013), Mankiw (2013), Dornbusch, Fischer and Startz (2011) and Romer (2012) and are described as follows:

[5] 'q' is measurement of time/date in terms of quarters.

[6] In this study various sources of data were consulted to acquire facts. The data compiled by the datasets such as WB: WDI, IMF and UN contain most comprehensive set of data on national, regional, and global estimates/indicators. The data series by this organizations are coming primarily from official national sources (Such as the NBE, CSA of Ethiopia, MoF of Ethiopia, MPD of Ethiopia as they report to the international organizations). Following the acquisition of data from national/official sources, international data sources go through several standardized procedures before publishing the data/information. To this end, the study employs both the national and international data sources for analysis.

Table 2: Description of Variables Used to Forecast the 2025 LMI Target of Ethiopia

Variable	Description	Measurement Unit
Nominal GDP (NGDP, y)	Monetary value of economic output/income.	Currency[7]
GDP per capita	Mean income (output) averaged for the whole population of a country.	Currency
Nominal exchange rate (e)	Several units of the domestic currency that can purchase a unit of a given foreign currency.	Currency
Inflation (π)	A sustainable increase in the general (average) price level of goods and service over a period.	%
Nominal interest rate (r)	Amount of interest rate per period, as a proportion of the amount lent, deposited, or borrowed.	%
Terms of trade (TOT, q)[8]	Ratio between a country's export prices and its import prices.	%

2.2 Model Specification

A wide range of methods are available to predict macroeconomic variables. A popular classification of forecasts is into judgment-based (qualitative) forecasting methods and model-based (quantitative) forecasts. The first group of methods mainly relies on a specific forecaster's ability to observe empirical regularities and irregularities in the economy which makes it difficult for an outsider to observe the model and data used (Robertson and Tallman, 1999). Such methods include executive opinions, Delphi methods, sales force estimates and consumer surveys. The second category relies on a statistical approach which paves the way to tracking sampling errors and to model performance evaluation. It includes VAR and DSGE

[7] Currency unit is measured in ETB and in the equivalent US$.

[8] In order to construct the terms of trade index, one must compare the export unit value indexes to the import unit value indexes relative to the base year 2000. Unit value indices are based on information provided by nations that meet UNCTAD's standards for data consistency, and they are augmented by UNCTAD's estimations, which are weighted using the previous year's trade values at the three-digit level of the Standard International Trade Classification. UNCTAD develops a set of average price indices at the three-digit product classification of the Standard International Trade Classification revision 3 using international and national sources, its commodity price statistics, and UNCTAD's secretariat estimates and calculates unit value indices at the country level using the current year's trade values as weights. This improves data coverage, especially for the most recent periods (WB, WDI, 2020).

models and many others like, exponential smoothing, trend projection, Autoregressive Moving Average (ARMA), ARIMA models, macroeconometric model and growth model. These quantitative forecasting methods are often classified into structural and non-structural ones, depending on how much 'structure' is provided by economic theory. These theoretical foundations may differ according to their view of the economy based on the assumptions they use and the components of the economy they emphasize. Some models focus only on the demand side of the economy, while others capture the supply constrained nature of developing economies, or are based on macroeconomic models such as the Real Business Cycle (RBC), New Keynesian (NK), Computable General Equilibrium, Global Macro, Applied General Equilibrium and Macroeconometric model.

The out-of-sample forecasts for 2025 in this study were analyzed and compared between DSGE and VAR models. On the theoretical grounds, VAR is a multivariate time series model, in which all the variables are considered as dependent. On the other hand, as Blanchard (2009) indicated the basic components of the standard open economy NK DSGE model comprises:

- the preferences of the households which capture intertemporal utility maximization,
- the technology capturing the relationship between different inputs and the output produced by profit maximizing monopolistically competitive firms,
- the monetary authority that employs different monetary policy instruments, and
- the economy's integration and interaction with international financial/asset markets.

2.2.1 VAR Model

VAR is a linear time-series technique that models the interrelationships between macroeconomic indicators assuming some variables as endogenous and others as exogeneous. One of the advantages of VAR modeling over DSGE is that, while a DSGE model provides an entire stochastic multivariate process, it places so many constraints on certain time series and are mostly rejected against less restrictive models such as VAR. VAR models became popular since their first use by Sims (1980) for macroeconomic analysis and are trying to achieve what Stock and Mark (2001) refers to as policy analysis, structural inference, forecasting and data description. Sims (1980, pp.16) identified the over-parameterization problem associated with large scale macro models when he argued that "if every variable is allowed to influence every other variable with a distributed lag of reasonable length,

without restriction, the number of parameters grows with the square of the number of the variables and quickly exhausts degrees of freedom". Over-parameterization is severe when the model has many variables with short time dimension. As Koop and Korobilis (2010) explain, all the solutions developed so far to overcome the problem of over- parametrization have one thing in common; that is, they are all based on the idea of shrinkage, i.e., restricting some of the elements of the coefficient matrix of the VAR model and the associated variance-covariance matrix to zero.

Furthermore, as Sims (1980), VAR is a stochastic process technique that can be used to display the linear interdependence of multivariate time series variables. This model generalizes the univariate auto regressive model by permitting many evolving variables. If the time series variables data are stationary in a level, estimations of the models proceed using the variables in a level; otherwise, the level of integration changes depending on the unit root test results. Then, a VAR model is used to forecast each variable from the lagged values of its own and the lagged value of other variables. Therefore, VAR expresses each variable as a linear function of its own past values, the past values of all other variables being considered, and a serially uncorrelated error term. One application of VAR in time series forecast is to test whether the lags of included variable have useful predictive content above and beyond others variables in the model. The lag length for the VAR model is determined using model selection criteria (Akaike, 1973; Lütkepohl, 2005).

A comprehensive p-th order VAR model is given by equation (1) (Robertson & Tallman, 1999):

$$y_{i,t} = \alpha_i + \beta_1 y_{i,t-1} + \cdots + \beta_p y_{i,t-p} + \varepsilon_{i,t} \qquad \textbf{(1)}$$

Where i is list of variables, α is constant, y at a given time depends on past values of y up to a lag length of p, β_ps' are coefficients of the lags and ε is an error term.

2.2.2 DSGE and The Small Open Economy Model

Until the mid-1970s the dominant paradigm in macroeconomics was Keynesian, in which short run fluctuations in economic activities are considered as caused by variations in aggregate demand. However, it was difficult to explain the stagflation that was closely linked to the oil price shock in the mid-1970s within the Keynesian paradigm, and thus contributed to the fading of this school and the rise of a new paradigm characterized by microeconomic foundations and supply side shocks.

The idea of DSGE was pioneered by Kydland and Prescott (1982) and Long and Plosser (1983) in their seminal contribution on the RBC model and it marks the rise of DSGE modeling. The typical RBC model is based on the neoclassical framework with 'microeconomic foundations' in the sense of optimization behavior of economic agents under flexible prices and the assumption of rational expectations. Being based on micro foundations has helped these models to overcome the criticism of Keynesian economics which does not have such foundations, whereas the rational expectations assumption enables them to address the Lucas critique, which says that estimated parameters may not be policy invariant such that using them for the future is invalid. The RBC models assume that markets always clear and economic fluctuations are the results of optimal inter-temporal decisions by economic agents and monetary variations cannot explain the fluctuations in aggregate variables. This has led to the conclusion that money is neutral and there is no need to use economic policy to correct the fluctuations (Snowdon & Vane, 2005). But the neutrality of money has faced serious challenges based on empirical evidence. The non-neutrality argument implies that prices and wages are not flexible, which led to the development in DSGE modeling that incorporate these issues.

Thus, New Keynesian short-run features were included into DSGE models. The new extended models have features of the RBC model, but include the NK assumption of imperfect competition and rigidities. In NK economics prices are rigid because of menu costs, aggregate demand externalities, coordination failure and staggered price contracts (Snowdon & Vane, 2005). Similarly, wages are also rigid because of efficiency wages, union power and staggered wage contracts. NK economists (such as Hicks) have thus given microeconomic foundations for rigidities introduced by J. M. Keynes (1936). Combining both households' and firms' optimization problems coming from the RBC approach with nominal and real rigidities, has provided a plausible explanation of short-run dynamic macroeconomic fluctuations and made macroeconomic models representative. The paper that first introduced this framework was Rotemberg and Woodford (1997). Remarkable changes have also been made in the specification and estimation of DSGE models (for example see, Goodfriend and King, 1997; Clarida, Gali and Gertler, 1999; Woodford, 2003; Mankiw, 2006; Goodfriend, 2007 and Gali and Gertler, 2007; Ohanian, Prescott and Stokey, 2009; Woodford, 2009; Tovar, 2009; Rochelle and Refet, 2010; Meeusen, 2011; Dotsey, 2013; Blanchard, 2016; 2017a; Nachane, 2017; Auclert, 2017; Christiano, Eichenbaum and Trabandt, 2018; Lindé, 2018; etc)

According to Tovar (2009, pp. 1) "DSGE models are powerful tools that provide a coherent framework for policy discussion and analysis. In principle, they

can help to identify sources of fluctuations, answer questions about structural changes, forecast and predict the effect of policy changes, and perform counterfactual experiments". Tovar further states that "Central Banks (CBs) have become increasingly interested in their usefulness for policy analysis. Aside these rapid advances, the use of DSGE models remain in the periphery of the formal policy decision making process in most CBs. It remains in CBs to be seen whether these models will be adopted in the core process of forecasting and policy analysis frameworks, or whether they will only be employed as a supplementary tool outside the core framework".

Since the DSGE models that are estimated from actual data have performed well, they have become popular in developed countries where they become the dominant macroeconomic models used to analyze monetary policies (Sisay, 2011). There is a large literature that tries to improve DSGE models by incorporating new assumptions, by linking the model with data and by extending it to developing countries. The progress can also be seen from the aphorism quoted in Chari (2010, pp. 2) "If you have an interesting and coherent story to tell, you can tell it in a DSGE model. If you cannot, your story is incoherent". Even though advancement of conventional macroeconomics has been attained in the last thirty years, the proponents of these models do not seem to be convinced and shaken by the criticisms. The tone of dissatisfaction regarding the progress is shared by many (see for example, Chari and Patrick, 2006; Chari and Patrick, 2008; Woodford, 2009; Blanchard, 2016; 2017a; Nachane, 2017; Auclert, 2017; Christiano, Eichenbaum and Trabandt, 2018; Lindé, 2018). Simultaneously, a considerable progress has been made in the past two decades which addresses few of the criticisms on DSGE.

DSGE Models can be estimated using various methods: for instance, the Generalized Method of Moments (GMM) has been employed by Clarida, Gali and Gertler (2000) for analysis. This method controls for endogeneity, omitted variable bias, error in measurement and heterogeneity potential (Caselli, Esquivel & Lefort, 1996; Bond, Hoefler & Temple, 2001). It also improves the effectiveness and consistency of simulations by Monte Carlo methods (Blundell & Bond, 1998). Orphanides (2001) and Ball and Robert (2002) used Ordinary Least Squares methods and made implausible identification assumptions in order to avoid an endogeneity bias. Full-information Maximum Likelihood Estimation (FMLE) has been employed by Fuhrer and Moore (1995), Leeper and Sims (1994) and Kim (2000). One problem in estimating DSGE models by FMLE, however, is that estimates of FMLE structural parameters are often at odds with additional information or observations. Recently, DSGE has also been estimated by Bayesian Methods (BM) since, they fit 'the

complete, solved DSGE model', avoid 'the dilemma of absurd parameter estimates,' and 'the weighting of the likelihood with the prior densities adds sufficient curvature in the posterior distribution to facilitate numerical maximization and identification' (Griffoli, 2010). Bayesian estimates of DSGE models based on likelihood have begun with the studies of Landon-Lane (1998), DeJong, Ingram and Whiteman (2000), Schorfheide (2000) and Otrok (2001). An and Schorfheide (2007) carried out analysis and estimation of a DSGE model by BM in a closed-economy framework. Lubik and Schorfheide (2007) used BM in a SOE framework to see the effects of exchange rate movement on CB's monetary policies, i.e., to investigate the hypothesis that CBs respond to exchange rates. de Walque and Wouters (2004), Lubik and Schorfheide (2006) and Rabanal and Tuesta (2006) used BM for multi-country DSGE estimates. The models can also be estimated using Moment Simulated Method (Francisco, 2011) and Indirect Inference Method (Le et al., 2012; Meenagh et al., 2019).

This study employed a NK SOE version of a DSGE model, that was developed by Gali and Monacelli (2005) and is increasingly used across the literature after its humble application by Lubik and Schorfheide (2007). The households, firms and CB decision-making processes that make up the DSGE model are listed as follows:

- The first order condition of the households' intertemporal utility maximization issue provides the economy's IS curve (demand or output gap Euler equation).
- The NK Phillips curve (or supply), which represents inflation dynamics, derived from the optimal price-setting decisions by profit maximizing monopolistically competitive firms.
- The Taylor-type interest rate rule is adopted from the target of monetary authority as a reaction function.

It's indeed possible to integrate the decision-making process and the optimal choices of these economic agents to provide the basic model framework that describes the economy. In this study, the SOE model used is as follows:

Households: the consumption Euler equation showing the supply side of the economy can be rewritten as an open economy IS-curve:

$$y_t = E_t y_{t+1} - (R_t - E_t \pi_{t+1} - z_t) \qquad \textbf{(2)}$$

Where y is aggregate output, R is the interest rate, π is the inflation rate measured by the Consumer Price Index (CPI), z is the growth rate of an underlying non-stationary world technology process, and E is the expected value operator.

Firms: optimal price setting of domestic firms leads to the following an open economy modified Phillips curve:

$$\pi_t = \beta E_t \pi_{t+1} + \kappa y_t \quad \textbf{(3)}$$

Where the coefficient κ is a function of underlying structural parameters, such as labor supply and demand elasticities and the parameters capturing the degree of price stickiness.

Central Bank: monetary policy is represented by a Taylor-type interest rate rule which says that the CB adjusts the interest rate in response to the inflation rate (Taylor, 1993).

$$R_t = \psi \pi_t + u_t \quad \textbf{(4)}$$

Where Ψ represents monetary policy coefficient and u_t is an error term.

Nominal Exchange Rate: the nominal exchange rate e is included in the model based on the definition of CPI by assuming that comparative Purchasing Power Parity holds:

$$e_t = \gamma \Delta e_t + \pi_t^* \quad \textbf{(5)}$$

Where π* is an unobserved world inflation shock, and may also be interpreted as the misspecification, or deviations from Purchasing Power Parity and Δ shows a change in the value of e.

Terms of Trade: q can be determined as the relative prices which clears the international goods market and Δq is a change in the value of q. It is as follows:

$$\Delta q_t = \sigma q_t + \varepsilon_t \quad \textbf{(6)}$$

The five equations (2) to (6) above form a linear rational expectations model. It can be solved by different methods and a linear approximation a very common one. The log-linearized DSGE model is set in a state-space form, so that the observed variables are connected to model variables by measurement equations. Simultaneously, the state equations provide the reduced form of the DSGE model by relating current variables to their lags and the independent and identically distributed (i.i.d.) shocks. Then, the DSGE model is completed by specifying the process how the state variables evolve. The standard specification is as shown from equation (7) to equation (10).

$$z_{t+1} = \rho_z z_t + \xi_{t+1} \quad \textbf{(7)}$$

$$u_{t+1} = \rho_u u_t + \phi_{t+1} \quad \textbf{(8)}$$

$$\pi^*_{t+1} = \rho_{\pi^*} \pi^*_t + \theta_{t+1} \quad \textbf{(9)}$$

$$\varepsilon_{t+1} = \rho_\varepsilon \varepsilon_t + \delta_{t+1} \quad \textbf{(10)}$$

Where, z_{t+1}, u_{t+1}, π^*_{t+1} and ε_{t+1} indicated as first-order autoregressive processes.

The reduced form was obtained by solving the expectation terms in the structural form of the model using a suitable numerical technique. The frequently used numerical technique include Anderson-Moore Algorithm (AiM)[9] and the Kalman filter method to compute the value of the log-likelihood function in case the solution shows a unique convergence[10].

2.3 Pre- and Post-Estimation Tests

The pre- and post-estimation tests applied in this study include the serial correlation test (Breusch 1978; Godfrey 1978) to observe the interdependence of adjacent items, the Jarque-Bera normality (Jarque & Bera, 1980) test to check the data distribution, the Chow breakpoint test: the structural break tests have been done to identify any break inside the data series (Chow, 1960), and the cumulative sum test for parameter stability (Brown, Durbin & Evans, 1975). The data series went through a stationarity test and optimal lag length determination (Dickey and Fuller, 1979, 1981; Phillips and Perron, 1988; Akaike, 1973).

3. Results and Discussion

To estimate DSGE model and make it computationally operational, a value must be assigned to the parameters. The calibrations of the parameters presented in Table 3 are standard assigned values in the DSGE literature.

DSGE introduces a check for linearity in the model equations and not reports any non-linearity. All the data series in DSGE and VAR models must contain zero mean and be weakly stationary to appropriately use them in the analysis.

[9] See for example, Anderson and Moore's (1985), Blanchard and Kahn (1980); Klein (2000); Sims (2002) and Christiano (2002).
[10] See for example, Kalman (1960).

Furthermore, to conduct the analysis, the optimal lag length has been determined for each model estimation.

Table 3: Calibration of Parameters

Parameters	Description	Value	Source of Calibration
β	Discount factor	0.97	Gibbs, Hambur and Nodari (2018)
ψ	Monetary policy coefficient	1.23	Author's calculation[11]
κ	Elasticity and degree of price stickiness	0.15	StataCorp. (2019)
σ	Coefficient of nominal exchange rate equation	0.25	Author's calculation
γ	Coefficient of terms of trade equation	0.24	Author's calculation

Column one in Table 4 shows the WB's income group classification of countries in the world as four groups and columns two, three and four the corresponding Ethiopia's goal measured by GDP. Ethiopia's target in 2025 is to be one of the LMI countries by achieving the income level between 1,138 US$ to 4,458 US$ (or 71,745 ETB to 281,300 ETB). In other way, the lower bound of LMI country in terms of nominal GDP is 147.53 bl. US$ or 9.31 tr. ETB.

[11] It is computed according to the instructions below: DSGE's solve option puts the model without estimating parameters in state-space form; it is like iterate (0) but faster because it does not calculate standard errors. The use of solve for a given model's different parameter values is a valuable way to explore the theoretical properties of the model (StataCorp., 2019).

Table 4: Classification by Income Group and Ethiopia's Expected Target by 2025

Income Group[12]	GNI per capita[13] (2025 - US$) (World Standard)	NGDP[14] (2025 – bl. US$) (In Ethiopia)	NGDP[15] (2025 – tr. ETB) (In Ethiopia)
Low Income	≤ 1,137	≤ 147.53	≤ 9.31
Lower-middle Income	1,138 – 4,458	147.54 – 578.42	9.32 – 36.5
Upper-middle Income	4,459 – 13,952	578.43 – 1,810.26	36.6 –114.23
High Income	> 13,952	> 1,810.26	> 114.23

Source: Own computation, 2020

3.1 Predicting Nominal Gross Domestic Product (NGDP)

The DSGE and VAR models were estimated and quarterly prediction results were attained. Table 5 shows the predicted values of the Ethiopian NGDP measured in local currency (ETB) and US$.

The two data sets used in this study were subjected to a structural break test. The structural break test for the period 1990-2018 reveals breaks on the dates 2002q2 and 2003q3. However, the specification, diagnostics and goodness-of-fit analysis for structural breaks show no breaks for the data runs from 2004 to 2018. The structural break test in Figure 2 reveals a data break on 2002q2 in the model where NGDP (ETB) considered as dependent variable. Therefore, during the analysis the structural break point date has been taken care of by incorporating dummy variables, i.e., an

[12] In terms of income, the WB divides the world's economies into four income groups, i.e., high, upper middle, lower-middle, and low. The income classification is based on a measure of national income per person, or GNI per capita, calculated using the Atlas method. In 1978, the first World Development Report (WDR) introduced groupings of 'low income' and 'middle income' countries using $250 GNI per capita as threshold between the groups. In the 1983 WDR, the 'middle income group' was split into 'lower middle' and 'upper middle' groups, and in 1989 a 'high income' country definition was introduced. Since then, the thresholds to distinguish between the income groups have been adjusted for prices over time and the classification is updated each year on July 1st (WB, WDI, 2019).

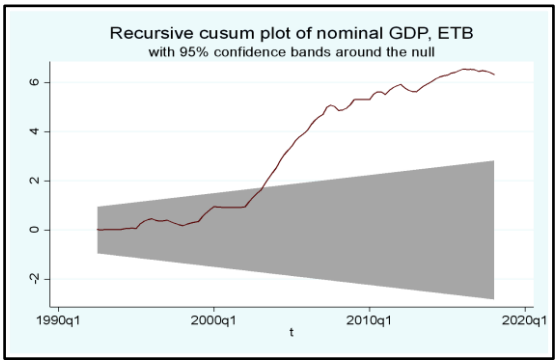
[13] Own computation and prediction based on the GNI per capita calculation of WB Atlas method data report from 1987 to 2018.

[14] The population of Ethiopia is projected to reach 129,749,455 in 2025 (United Nations, 2019).

[15] Exchange rate (/ETB per US$) was own prediction based on the VAR and DSGE analysis of this study. Accordingly, 1 US$ is expected to be exchanged by 63.10 ETB by end of 2025.

extra variable has been added in the right-hand side of the equation which contains a value of '0' before the break date and a value '1' after the break. The structural break test has also been conducted for the model of GDP per capita as dependent variable and the date 2003q3 was found as a breakpoint.

Figure 1: Structural Breakpoint Test for the Model NGDP (ETB) as Dependent Variable



Full sample:	1991q2 - 2018q1
Trimmed sample:	1995q3 - 2014q1
Estimated break date:	2002q2
Ho: No structural break	

Test	Statistic	p-value
swald	120.6500	0.0000

Sample: 1991q2 - 2018q1 Number of obs = 108
Ho: No structural break

Statistic	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
recursive	2.3389	1.1430	0.9479	0.850

Table 5 shows that the NGDP of the Ethiopian economy is predicted to reach 8.36 tr. ETB for the VAR model and 7.78 tr. ETB for the DSGE model in the q4 of 2025. Furthermore, the uses of 2004-2018 data in Table 6 gives a higher predicted value of 8.52 tr. ETB and 12.14 tr. ETB for the VAR and DSGE models, respectively. For the 1990-2018 data, the values in US$ were 130.86 bl. and 131.52 bl. for VAR and DSGE models, respectively. Using the 2004-2018 data, the NGDP values in US$ increased to 164.84 bl. and 169.69 bl., respectively. The VAR and DSGE modeling are performing alike in terms of producing a robust predicting value of NGDP (ETB) against the 2025 targets of the country. Based on the prediction results for the period 1990-2018 and compared them against the Ethiopia's expected nominal GDP by 2025 in Table 5, all show the target of the country in 2025 will hardly to be fulfilled.

Table 5: NGDP Prediction Using 1990-2018 Data[16]

Model	VAR		DSGE	
Quarterly Date	NGDP (tr. ETB)	NGDP (bl. US$)	NGDP (tr. ETB)	NGDP (bl. US$)
2018q2	2.29	84.69	2.29	85.09
2018q3	2.38	84.99	2.39	85.90
2018q4	2.48	85.43	2.49	86.79
2019q1	2.59	86.08	2.60	87.74
2019q2	2.71	86.93	2.70	88.76
2019q3	2.83	87.96	2.82	89.84
2019q4	2.96	89.15	2.94	90.97
2020q1	3.10	90.46	3.06	92.16
2020q2	3.25	91.88	3.18	93.40
2020q3	3.40	93.37	3.32	94.69
2020q4	3.56	94.92	3.45	96.03
2021q1	3.73	96.51	3.60	97.41
2021q2	3.91	98.11	3.75	98.84
2021q3	4.09	99.72	3.90	100.31
2021q4	4.28	101.33	4.06	101.83
2022q1	4.48	102.94	4.23	103.38
2022q2	4.68	104.54	4.41	104.98
2022q3	4.88	106.15	4.59	106.62
2022q4	5.10	107.78	4.78	108.30
2023q1	5.32	109.43	4.98	110.02
2023q2	5.54	111.10	5.19	111.78
2023q3	5.78	112.82	5.40	113.57
2023q4	6.02	114.58	5.62	115.41
2024q1	6.27	116.40	5.86	117.29
2024q2	6.54	118.27	6.10	119.20
2024q3	6.81	120.20	6.35	121.16
2024q4	7.10	122.20	6.61	123.15
2025q1	7.39	124.26	6.89	125.18
2025q2	7.70	126.39	7.17	127.26
2025q3	8.02	128.59	7.47	129.37
2025q4	8.36	130.86	7.78	131.52

Source: Own computation, 2020

[16] All values are in the 95 percent confidence bound.

The results in Table 5 and Table 6 show that the target for Ethiopia to reach 9.31 tr. ETB by 2025 appears not to be achieved except for some scenario results using the 2004-2018 data. In those cases, it is expected that the NGDP measured in the ETB exceeds 12 tr. and the NGDP measured in the US$ to exceed 164 bl. The year 2004 marks the time when the Ethiopian economy has been turning around for more than a decade to take on the growth truck of double-digit economic growth. This could therefore be the reason why the data set for 2004-2018 provides better predictive values than other data sets, such as 1990-2018. If this sustainable economic growth has repeated itself in the Ethiopian economy in recent years, it guarantees the achievement of the 2025 target of the LMI group.

Table 6: GDP Prediction Using 2004-2018 Data[17]

Model	**VAR**		**DSGE**	
Quarterly Date	**NGDP (tr. ETB)**	**NGDP (bl. US$)**	**NGDP (tr. ETB)**	**NGDP (bl. US$)**
2018q2	2.29	84.94	2.30	85.37
2018q3	2.39	85.67	2.42	86.66
2018q4	2.50	86.69	2.55	88.18
2019q1	2.60	87.96	2.69	89.87
2019q2	2.72	89.38	2.83	91.70
2019q3	2.84	90.89	2.99	93.66
2019q4	2.97	92.48	3.16	95.72
2020q1	3.10	94.15	3.34	97.88
2020q2	3.23	95.93	3.53	100.13
2020q3	3.38	97.83	3.74	102.46
2020q4	3.54	99.87	3.95	104.87
2021q1	3.70	102.04	4.18	107.35
2021q2	3.87	104.35	4.42	109.91
2021q3	4.06	106.79	4.67	112.55
2021q4	4.25	109.34	4.94	115.25
2022q1	4.45	112.00	5.23	118.04
2022q2	4.65	114.76	5.53	120.89
2022q3	4.87	117.61	5.85	123.83
2022q4	5.09	120.55	6.19	126.84
2023q1	5.31	123.58	6.54	129.93
2023q2	5.55	126.71	6.92	133.10

[17] All values are in the 95 percent confidence bound.

Model	VAR		DSGE	
Quarterly Date	**NGDP (tr. ETB)**	**NGDP (bl. US$)**	**NGDP (tr. ETB)**	**NGDP (bl. US$)**
2023q3	5.79	129.95	7.32	136.35
2023q4	6.05	133.30	7.74	139.69
2024q1	6.31	136.77	8.19	143.12
2024q2	6.59	140.36	8.66	146.63
2024q3	6.88	144.09	9.16	150.23
2024q4	7.18	147.96	9.69	153.93
2025q1	7.49	151.96	10.25	157.72
2025q2	7.82	156.11	10.85	161.61
2025q3	8.16	160.40	11.47	165.60
2025q4	8.52	164.84	12.14	169.69

Source: Own computation, 2020

Figure 3: The VAR Model Prediction[18] Values of GDP (in ETB) in a 95 Percent CI

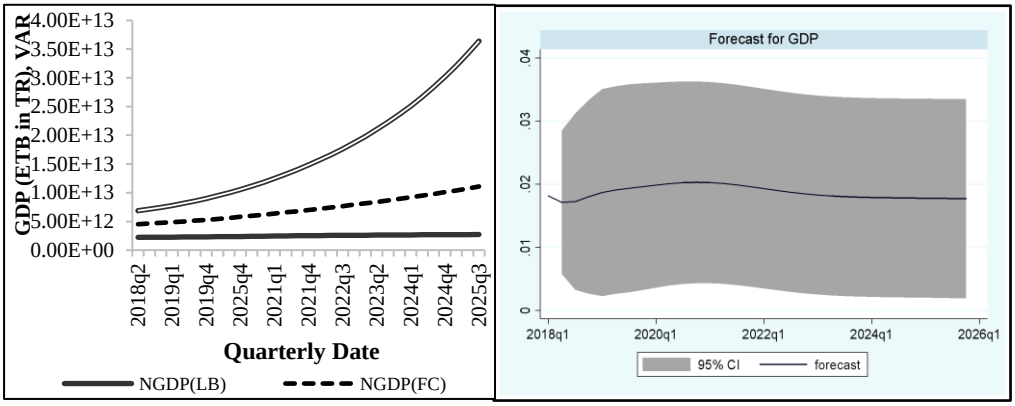
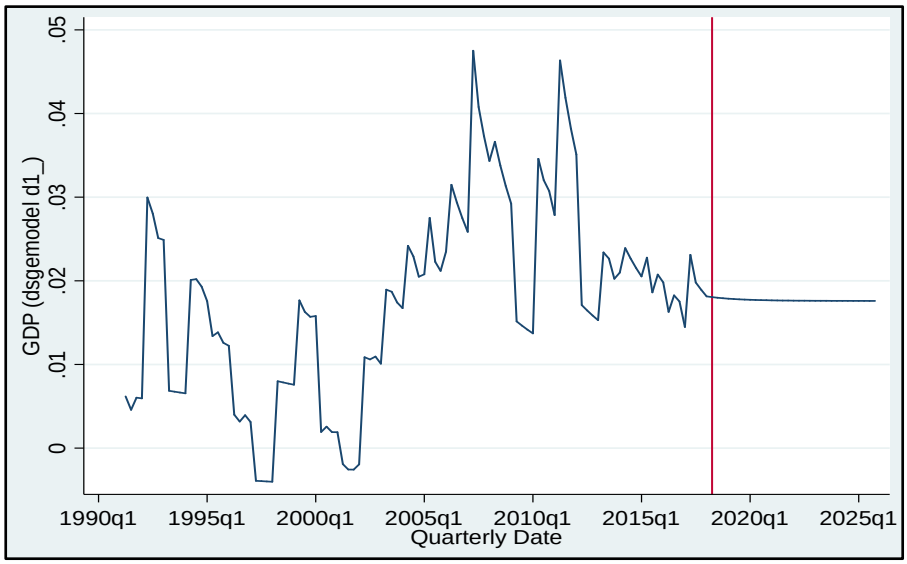


Figure 3 confirms that the out-off sample forecasts based on the VAR model entirely fall inside the 95 percent confidence interval. It indicates that the predicted results of GDP were in this interval with a 95 probability, if the assumptions of the model hold. The dynamic forecast in Figure 4 begins in the q2 of 2018. It shows the out-of-sample forecast for nominal GDP that employs a DSGE modeling.

[18] Based on 1990-2018 data series

Figure 4: The DSGE Model Forecast Values of GDP (ETB)



This study has also performed post-estimation diagnostics for the estimates. The autocorrelation, normality and stability test results are presented in Figure 5. The Lagrange-multiplier test revealed the absence of autocorrelation in the estimation process. Many of the Jarque-Bera test results confirm no normality in the data distribution except the pr(skewness)[19]. Regarding the stability of the VAR, all eigenvalues of the dynamic matrix lie inside the unit circle, which confirms the stability of the estimation procedures.

[19] Probability of skewness which is 0.2968 implying that skewness is asymptotically normally distributed (p-value of skewness > 0.05).

Figure 5: Autocorrelation, Normality, and Stability Diagnostics Tests for NGDP - US$

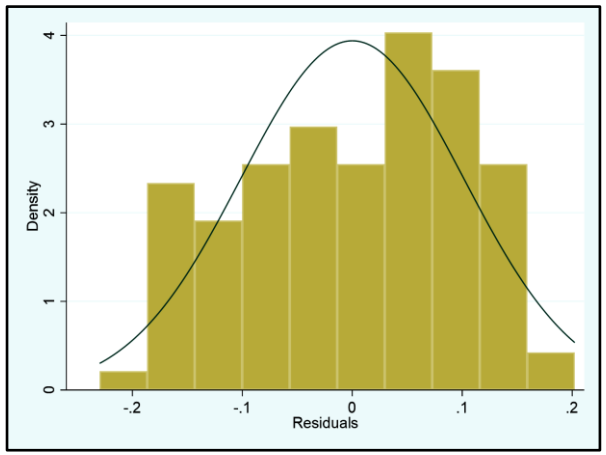
Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	15.5771	25	0.92684
2	7.6192	25	0.99967

H0: no autocorrelation at lag order

Jarque-Bera test

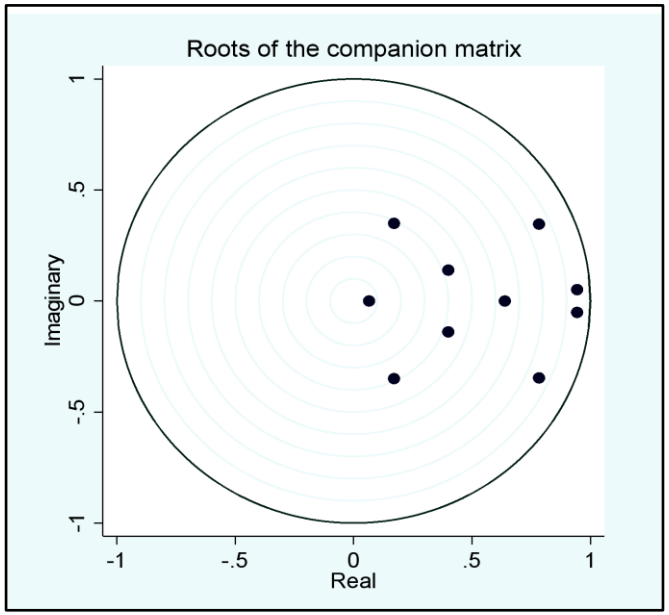
Equation	chi2	df	Prob > chi2
y1	8.979	2	0.01123
p	17.053	2	0.00020
R	47.950	2	0.00000
e	81.592	2	0.00000
q	25.994	2	0.00000
ALL	181.569	10	0.00000



Eigenvalue stability condition

Eigenvalue	Modulus
.94365 + .05127133*i*	.945042
.94365 - .05127133*i*	.945042
.782795 + .3464764*i*	.856046
.782795 - .3464764*i*	.856046
.6384549	.638455
.3994643 + .1392167*i*	.423028
.3994643 - .1392167*i*	.423028
.1702788 + .3497572*i*	.389005
.1702788 - .3497572*i*	.389005
.06497133	.064971

All the eigenvalues lie inside the unit circle.
VAR satisfies stability condition.

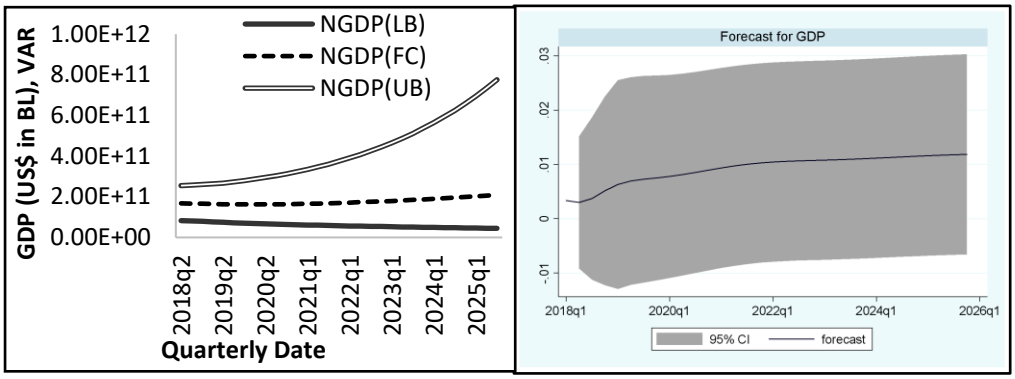



```
. sktest resid

                    Skewness/Kurtosis tests for Normality
                                                      ------- joint ------
    Variable |        Obs  Pr(Skewness)  Pr(Kurtosis) adj chi2(2)    Prob>chi2
-------------+-------------------------------------------------------------
       resid |        109      0.2960        0.0020        9.28          0.0097
```

Figure 6 confirms that out-off sample forecasts for the VAR estimation in 2018-2025 period entirely fall inside the 95 percent confidence bound. However, the results found are close to the lower margin of the LMI group. Thus, it requires a structural and sustainable growth in the economy to reliably apprehend the GDP range of the LMI category.

Figure 6: The VAR Model Prediction[20] Values of GDP (in US$) in a 95 Percent CI



3.2 Predicting GDP Per Capita for 2025

The predicted GDP per capita earning capacity of individuals for 2018-2025 in Ethiopia are presented in Table 7. Accordingly, the 2025 GDP per capita values using the 1990-2018 data series are 1072.3 and 923.2 US$ for the VAR and DSGE models, respectively. The 95 percent confidence band in the period 2004-2018 produces GDP per capita values of 1,122.57 and 1093.08 US$ for the VAR and DSGE models. The estimates based on the 2004-2018 period produced a better predicted value compared to the 1990-2018 period. Even though the GDP per capita value of 1,122.57 US$ was relatively close to the lower LMI margin of 1,138 US$, none of the predicted values confirms the country will achieve the goal of the LMI status before the end of 2025.

As the Ethiopian economy fails to reach even the bottom margin of the LMI range which is still quite low as compared with the upper margin of 4,458 US$, a strengthened growth and development are a head for Ethiopia to be in a reasonable interval of the LMI group.

[20] Based on 2004-2018 data series

Table 7: GDP Per Capita Prediction – US$[21]

Period	GDP per capita (1990-2018)		GDP per capita (2004-2018)	
Quarterly date	VAR model	DSGE model	VAR model	DSGE model
2018q2	773.6	773.86	773.97	775.81
2018q3	776.11	775.92	777.18	781.2
2018q4	780.56	778.44	782.76	788.03
2019q1	786.97	781.36	790.6	795.95
2019q2	794.94	784.64	800.17	804.7
2019q3	804.02	788.25	810.86	814.07
2019q4	813.8	792.13	822.19	823.93
2020q1	823.96	796.27	833.81	834.16
2020q2	834.33	800.64	845.53	844.67
2020q3	844.78	805.21	857.29	855.4
2020q4	855.29	809.96	869.09	866.29
2021q1	865.87	814.86	880.99	877.31
2021q2	876.54	819.91	893.04	888.43
2021q3	887.33	825.09	905.29	899.62
2021q4	898.24	830.38	917.75	910.87
2022q1	909.28	835.77	930.42	922.16
2022q2	920.4	841.25	943.25	933.49
2022q3	931.58	846.81	956.2	944.83
2022q4	942.75	852.44	969.21	956.2
2023q1	953.89	858.13	982.23	967.58
2023q2	964.95	863.88	995.22	978.97
2023q3	975.92	869.67	1,008.15	990.37
2023q4	986.78	875.51	1,021.02	1,001.78
2024q1	997.56	881.38	1,033.81	1,013.19
2024q2	1,008.27	887.29	1,046.55	1,024.60
2024q3	1,018.93	893.23	1,059.25	1,036.01
2024q4	1,029.58	899.19	1,071.92	1,047.42
2025q1	1,040.22	905.17	1,084.58	1,058.84
2025q2	1,050.89	911.17	1,097.24	1,070.25
2025q3	1,061.58	917.18	1,109.90	1,081.67
2025q4	1,072.30	923.21	1,122.57	1,093.08

Source: Own computation, 2020

[21] The values are presented in 95 percent confidence bound

As Figure 7 presents, the t-test for the forecast scenarios based on the 1991-2018 dataset for VAR and DSGE forecasting models show statistical differences value between the two forecasting models.

Figure 7: Significance Difference t-test Between DSGE and VAR (1990-2018)

ttest: varmodel – dsgemodel

	obs	Mean1	Mean2	dif	St Err	t value
varmodel - dsgemod~	31	912.298	839.942	72.355	8.689	8.35

However, in Figure 8 it has been presented, the t-test for the forecast scenario based on 2004-2018 data for VAR and DSGE forecasting models show no statistical differences between the two forecasting models. The t-test results reveals that the forecasting scenario based on the 2004-2018 dataset is producing more reliable and robust results over the forecasting scenario based on the 1991-2018 dataset.

Figure 8: Significance Difference t-test Between DSGE and VAR (2004-2018)

ttest : varmodel – dsgemodel

	obs	Mean1	Mean2	dif	St Err	t value
varmodel - dsgemod~	31	935.227	925.19	10.037	2.034	4.95

4. Conclusion and Policy Implications

Ethiopia has moved from the 2nd poorest country in the world at the beginning of this century to the 17th poorest in 2018[22], and the overall predictions of this study show that it will get closer to the goal of reaching the LMI status by 2025. DSGE & VAR models have been used, based on the quarterly time series data between 1990q1–2018q1, to evaluate, predict, & compare NGDP & per capita GDP values of the country by 2025. The prediction results in this study, particularly using the 1990-2018 prediction period, made clear that the 2025 goals of Ethiopia to reach a GDP of 147.5 US$ (or 9.3 tr. ETB) and a per capita GDP of 1,137 are not easily achievable with the current dynamics and trends of the economy. According to the predictions of this study Ethiopia's economy by 2025 will not reach even the lowest margin of the LMI range by many of estimation scenarios. The year 2004 is a reference point for the Ethiopian economy, as the average growth rate of the

[22] WB, WDI (2018)

economy was persistently more than 10 percent thereafter. In the case of prediction based on the 2004-2018 data set, the NGDP measured in the ETB become 12.14 tr. and the NGDP measured in the US$ reach 169.69 bl. But, even though the 2004-2018 data set produced exceeding above target predicted values than the 1990-2018 data set, the prospects of achieving a reasonable LMI value of GDP & GDP per capita (as a minimum an average US$ of 2797.5) by 2025 are not realizable.

To acquire lessons for the future, authorities and policymakers should focus on the driving factors behind the forecasting scenarios that reports higher values in this study. Ethiopian economy needs to improve its all-encompassing performance to realize the goal of LMI status by 2025. The measures to be taken embraces infrastructural investments, generating sustainable finance, structural reforms, nurturing macro-economic balance which all may certainly contribute to further growth of GDP and GDP per capita.

Singular, but potentially highly important events such as the peace accord with neighboring Eritrea and Sudan, but also the COVID-19 disasters and the 2020 state of Tigray crisis may also affect the prospects for Ethiopia's development in ways that are obviously not incorporated in this study's forecast. It also must be recognized that GDP and GDP per capita are not be the sole and only measures of a country's level of development. Other criteria such as those of the human development index, economic vulnerabilities (measured by a country's initial macroeconomic fundamentals), the degree of a country's integration into the global financial system, the distribution of wealth and income, and the ecological footprint all need to be considered for an overall assessment a country's development. For instance, a reduction of poverty may be accomplished by a better distribution of income rather than a growth of GDP, and building a climate resilient green economy may not so much require growth of GDP, but rather a change of its composition. Such considerations and criteria, however, are beyond the scope of this study and it better be left to future to incorporate them.

Acronyms and Abbreviations

ARIMA	Autoregressive Integrated Moving Average
bl.	Billion
BM	Bayesian Methods
CB	Central Bank
CPI	Consumer Price Index
DSGE	Dynamic Stochastic General Equilibrium
ETB	Ethiopian Birr
FMLE	Full-information Maximum Likelihood Estimation
LMI	Lower-Middle-Income
NGDP	Nominal Gross Domestic Product
NK	New Keynesian
RBC	Real Business Cycle
SOE	Small Open Economy
TFP	Total Factor Productivity
tr.	Trillion
VAR	Vector Autoregression
WB	World Bank
WDI	World Development Indicator
WDR	World Development Report

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Agricultural Transformation Performance and Inter-Sectoral Linkages in Ethiopia

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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

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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.

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

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:

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

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 $\mu_t \sim$ 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 $(\beta_{N-1} \ldots \beta_2 - \beta_1 - I)\ Z_{t-N}$ 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; $i = 1, \ldots, N-1, \Gamma_i = -\left[I - \sum_{j=1}^{i} \beta_j\right]$; 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.

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

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

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

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

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

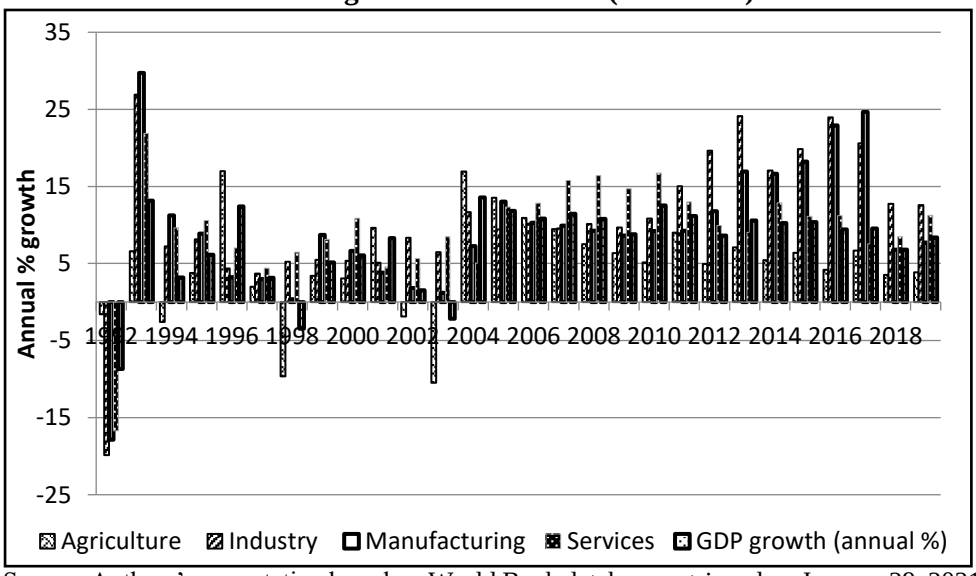
4.1 Agriculture Growth and Productivity Performance in Ethiopia

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.

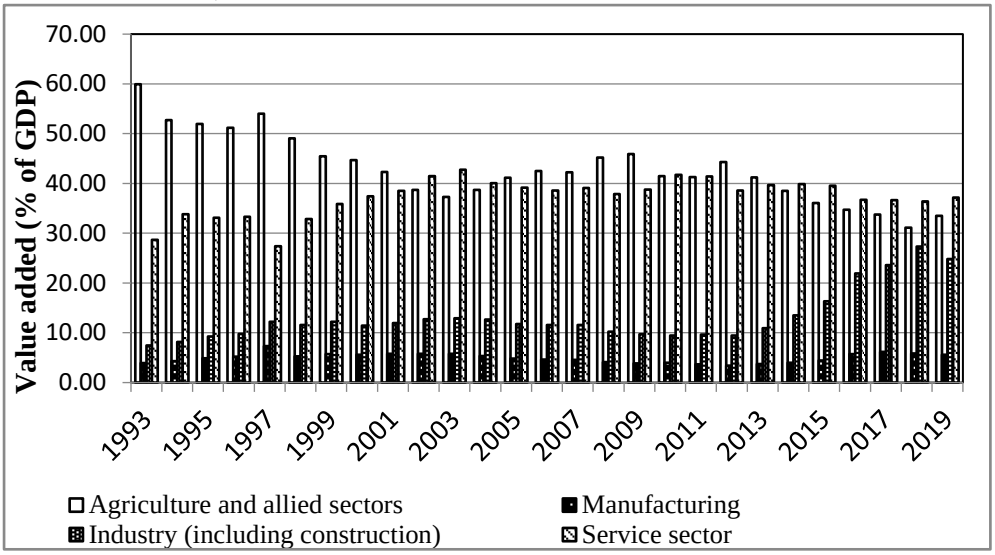
Generally, in the last 14 years (2004-2017), the overall GDP growth performance was built on fast and sustained growth achievements, averaging 10.7% GDP per annum. The agriculture value-added annual growth rate has declined, whereas the other sectors growth rates have shown remarkable growth achievements 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.

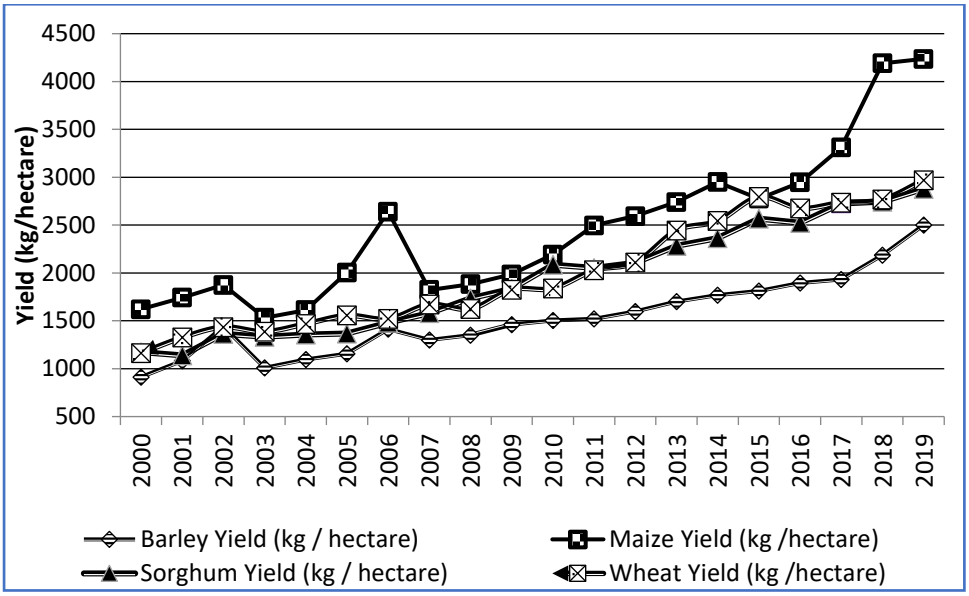
4.1.3 Agricultural productivity and level of production

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).

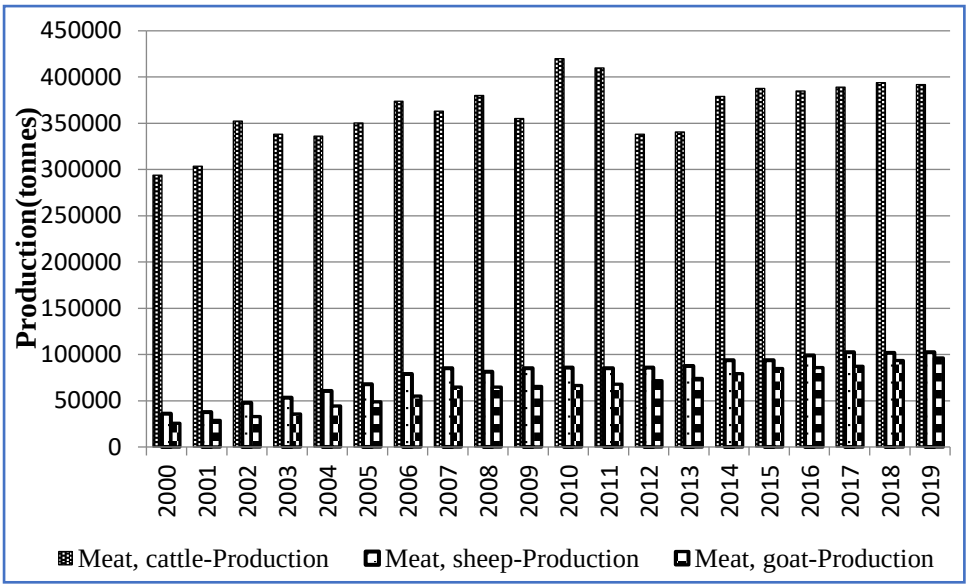


Source: Authors' computation based on FAO indices retrieved on 3-3-2021.

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)

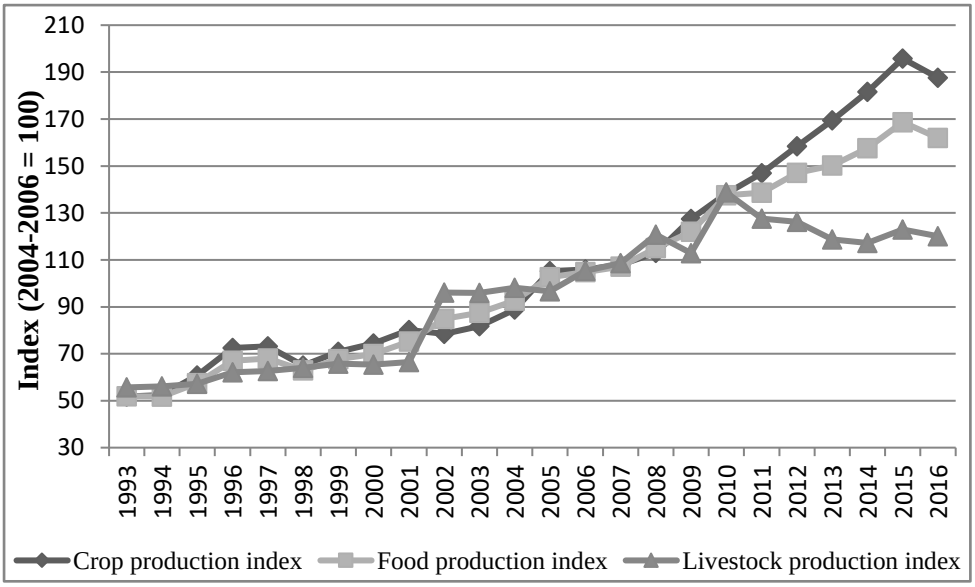


Source: Authors' computation based on FAOSTAT_data_3-3-2021.

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)



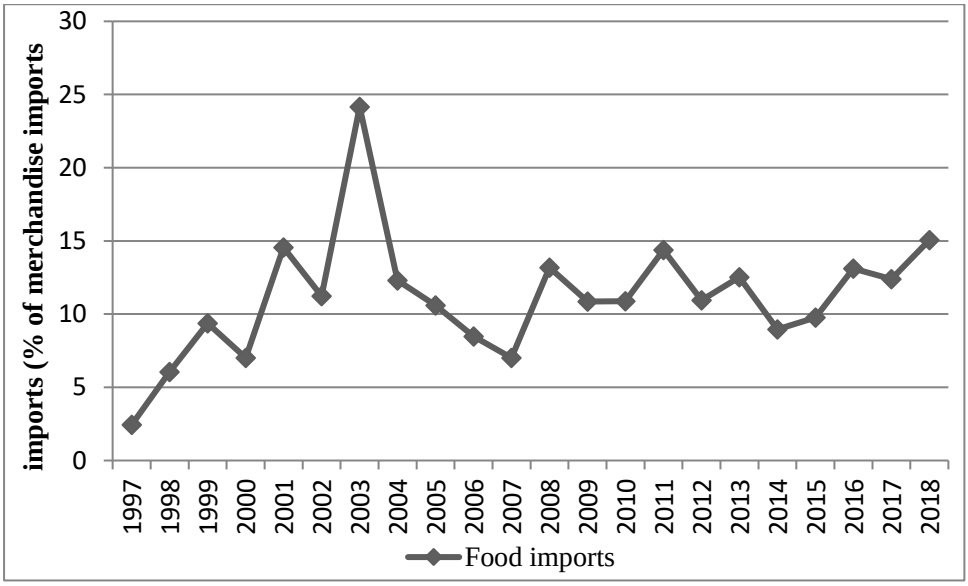
Source: Authors' computation based on FAO indices retrieved on 3-3-2021.

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).



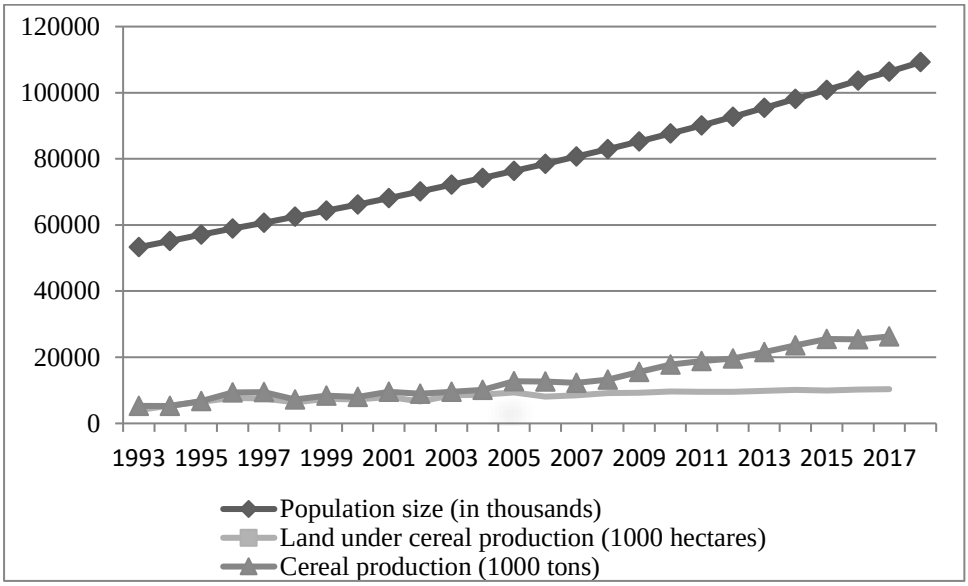
Source: Authors' computation based on World Bank database, retrieved on January 29, 2021.

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)



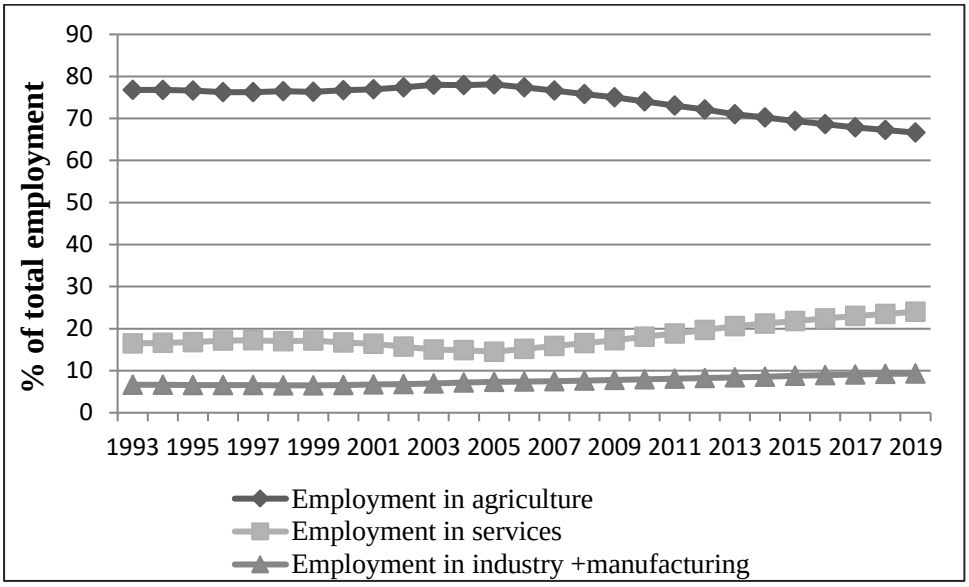
Source: Authors' computation based on FAOSTAT_data_3-3-2021.

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.

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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

(b) Jarque-Bera test

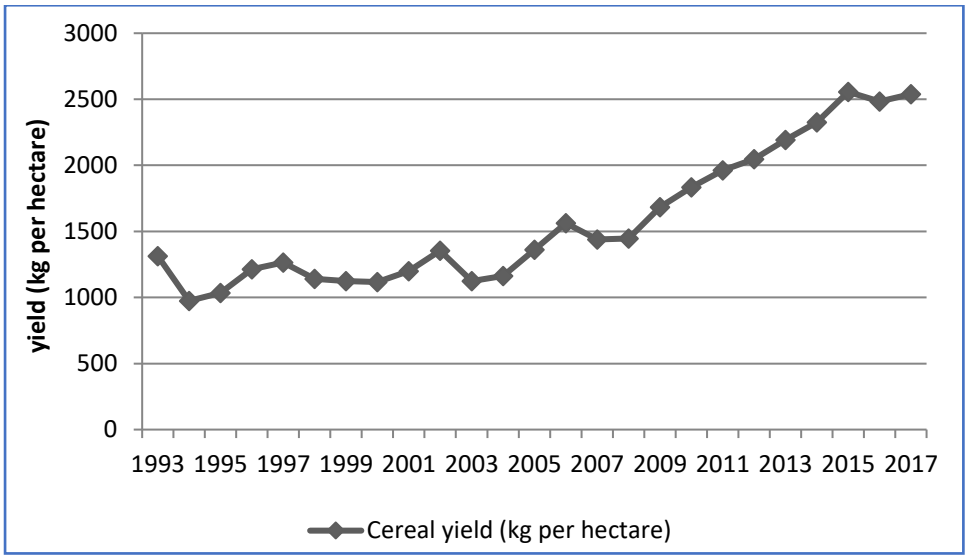
Equation	chi2	df	Prob > chi2
D_LN_AGR	0.405	2	0.81658
D_LN_IND	0.638	2	0.72675
D_LN_SER	1.067	2	0.58643
D_LN_MNF	0.307	2	0.85773
ALL	2.418	8	0.96545

(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

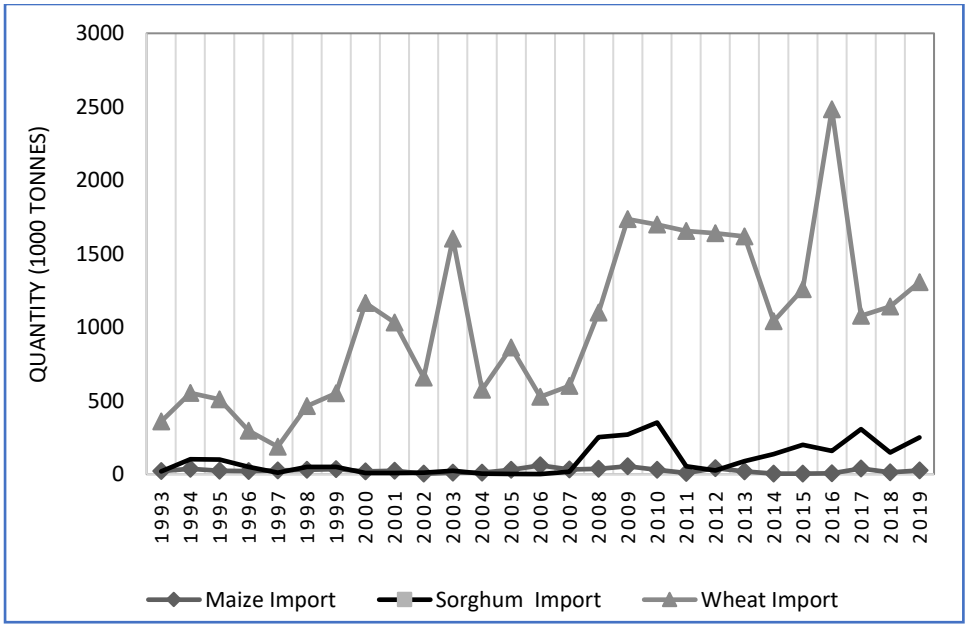
The VECM specification imposes 3 unit moduli.

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.

Dairy Enterprises' Market Participation Decisions and the Level of Value Addition: Evidence from Addis Ababa and Its Vicinity, Ethiopia

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Article History: Received: 31 October 2022; Revised: 19 May 2023; Accepted: 30 May 2023

Abstract

Ethiopia has ample potential and suitable agro-ecological conditions to establish dairy enterprises, and the enterprises contribute significantly to the economic, environmental, and quality-of-life, and well-being of individuals. Rapid urbanisation, rising income, and relatively high dairy product consumption per capita in the study area contribute to the sector's latent potential. However, little is being done to enhance the value addition of the milk production chain which in turn enhances value-added output. The attributes that influence dairy enterprises' decisions to penetrate the market and the degree of milk product value addition were examined in this study. A sample of 212 dairy enterprises was drawn from the study area's target population. The stated objectives have been achieved using both descriptive statistics and the Double-Hurdle econometrics model. The number of dairy cattle was a more significant factor in deciding whether to participate in the value addition of dairy products. Findings show that variables of interest in machinery and equipment, the volume of milk in the litter, access to credit services, and skills training had a positive and significant influence on the decision and the degree of value addition in the dairy production. The study also indicated that increasing milk volume, minimising the bureaucracy of credit service provision, and fostering low-cost technology and equipment innovation are vital to the success of a dairy enterprise. The study found that dairy enterprises stimulate substantial and diverse milk value additions.

Keywords: Decisions, VAM, double-hurdle model, micro and small enterprise, and dairy enterprise

JEL Classification: D22

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Acknowledgments

The authors would like to thank Bahir Dar University for allowing them to undertake this study and the Ethiopian Meat and Dairy Industry Development Institute (EMDIDI) for secondary data assistance. The authors are also grateful to the EMDIDI for providing them with the opportunity to study at the institution.

1. Introduction

Livestock is critical to Ethiopian economic development, accounting for one-quarter of national GDP and 40% of agricultural GDP (Kenea, 2019). Ethiopia's cattle population is more than 50 million, making it the largest in Africa and the seventh largest in the world (Bogale and Erena, 2022). Cattle have always been prized as a source of food, income, and social status. With an estimated 12 million cows and a conducive environment for dairy production, Ethiopia's livestock sub-sector is projected to provide 60-70% of the Ethiopian population's livelihoods (Shapiro et al., 2015). Dairy farming is an important aspect of Ethiopian livestock production, with unrealized potential due to a vast and diverse livestock population and dairy-friendly agroecology (Minten et al., 2020, Ayalew and Abatenhe, 2018). However, due to low per capita dairy consumption, the majority of the country is suffering from a persistent shortage of dairy products. According to the AGP-Livestock Market Development Project (2013), annual milk consumption is 19 litres per capita, well below worldwide standards.

The dairy sector seems to be on the verge of taking off, albeit most of its activities are concentrated in Addis Ababa, the surrounding territories, and other regional cities with big milk and dairy products markets. The average annual milk intake in the country is approximately 20 litters, but urbanization leads to an increase in that number (Dinkale, 2019). Although the nation has significant untapped potential in the dairy industry, the dairy sector is constrained by several factors, and the nation remains a net importer of milk and dairy products. Imports of dairy products are growing (Tadesse and Yilma, 2018). For example, between 2011 and 2015, the country spent an average of more than 15 million USD per year on imported dairy products, with the value increasing from about $13 million in 2011 to $18 million in 2015 (Tadesse and Yilma, 2018). The country has yet to realize its full potential in promoting and profiting from dairy production. In Addis Ababa, the average milk consumption per person is 50 liters per year (Mikru et al., 2021, Brasesco, 2019). Most dairy enterprises in and around most of the cities were established in the last 20 years in response to the rising market demand for fresh and processed milk (Kapaj and Deci, 2017, Vroegindewey et al., 2021, Alemu, 2019).

More than 80% of the milk produced in the country is marketed as raw milk or pasteurised milk with no added value (Wanjala et al., 2017). Milk holidays are an issue for dairy enterprises during the flush season since the shelf-life of raw and pasteurised milk is relatively short. Diversifying milk into different products will extend storage duration, resulting in greater benefits for enterprises and boosting the

value of dairy at each stage of production. However, because the cost of production and the selling price of raw milk are comparable, dairy firms do not benefit from milk sales. Product diversification and value addition may be two of the most beneficial practices for dairy enterprises. Value addition in the dairy industry can have a substantial impact on job creation and enterprise welfare. Value-added participation can help boost employment prospects and income generation. Dairy enterprises will be able to play a bigger part in combating poverty and fostering economic growth if they contribute more to value addition.

Facilitating market access and improving chain competitiveness and efficiency are important prerequisites for improving livelihoods (Bammann, 2019). The comprehensive identification of impediments to dairy value addition is crucial for increasing the profitability and productivity of dairy enterprises (Läpple and Thorne, 2019). Dairy firms must be robust enough to quickly change markets in order to maintain resilience. The city of Addis Ababa and its surroundings have the potential for dairy production, processing, marketing, and consumption; however, there is little information regarding dairy value addition. Besides, the dairy production system is not market-oriented, and milk produced by smallholders is primarily used for household consumption. This is due to inefficient dairy product marketing, which is characterized by long market chains, high margins, and poor marketing facilities and services. In the study area, dairy enterprises have limited access to market information and a less organized dairy marketing structure.

Despite the fact that the dairy enterprise is now facing the aforementioned challenges, very few studies have been conducted to analyse dairy enterprise market participation decisions and the amount of value added by dairy products in other areas (Hitihamu et al., 2021, Beyene et al., 2017b, Tegegn and Tamir, 2020, Tadesse et al., 2017a). Also, no study of this kind was undertaken in Addis Ababa and the vicinity to deal with the issues mentioned earlier. Therefore, the rationale for carrying out the study is based on the aforementioned concerns. Therefore, this study aims to fill the gap in the existing literature by adding new knowledge to the existing acquaintance on the determinants of dairy enterprises market participation decisions and the level of value addition of dairy products.

2. Methods

2.1 Description of the study area

This study was undertaken in Addis Ababa and the surrounding areas. Addis Ababa is the country's and Africa's primary political, economic, and cultural hub. It is the federal government's seat and home to several continental and international bodies, including the Africa Union and several countries' embassies. The city is divided into ten sub-cities, and the total population is projected to be 3,408,631, with 52.3% of the population being female (CSA, 2017).

Dairying in Addis Ababa and nearby is characterized by micro and small dairy enterprises and a few medium dairy-processing enterprises. In recent years, the demand for quality, value-added, and diversified dairy products has increased due to an increase in purchasing power, urbanization, population growth, and consumer awareness. In Addis Ababa, the top 10% of earners consumed 38% of milk, while the lowest income group consumed only 23% (Tadesse and Yilman, 2018).

2.2. Data Source and Type

Both primary and secondary data that have a qualitative and quantitative nature were employed to achieve the objective of this study. A semi-structured questionnaire was used to collect primary data from a representative sample of dairy enterprises. Secondary data relevant for this study was taken from the Ethiopia meat and dairy industry development institute (EMDIDI), the investment office, the micro and small enterprise agency, and the office of urban agriculture; those were located in the district of the study area, as well as from the Central Statistics Agency (CSA) and other published and unpublished sources.

2.3 Sample Size and Sampling Technique

2.3.1 Sample Size Determination

This study focused on micro, small, and medium dairy enterprises that were located in Addis Ababa and nearby. Therefore, all micro, small, and medium dairy enterprises in the study area constituted the sampling frame of the study. In sum, there were 484 dairy enterprises at the chosen site. So, the sample size was determined from the total number of dairy enterprises at a 95% confidence level with a 5% level of precision using Yamane's (1967) formula:

$$n=\frac{N}{1+N(e)^2}=\frac{484}{1+484(0.05)^2}=219$$

Where: n=sample size, N=total population (total number of dairy enterprises) e=level of precision.

2.3.2 Sampling Procedures and Technique

A multi-stage sampling technique was employed to select a sample of dairy enterprises. In the first stage of the study, Addis Ababa city and the surrounding towns such as Debire Zeit, Sebeta, and Sululta were purposely selected due to the presence of the largest number of dairy farms. In the second stage, stratified random sampling was employed to identify a sample dairy enterprise for data collection. The dairy enterprises from which a sample is to be drawn do not constitute a homogeneous group; they differ by amount of capital and number of employees. Due to this fact, stratified sampling is the best technique to obtain a representative sample. Then, the dairy enterprises were stratified into micro, small, and medium enterprises. Based on the amount of capital and employees they own; this then creates non-overlapping sub-populations or strata. The stratification is done to increase precision in the estimates of the characteristics of the whole population. In the final stage (third), the dairy enterprise was selected from each stratum using a simple random sampling technique.

Table 1: Sample distribution by study area and enterprise category

Categories of enterprises	Total population	Sampled enterprises	Addis Ababa		Debire zeit		Sebeta		Sululta	
			Sub total	Sampled	Sub total	Sampled	Sub total	Sampled	Sub total	Sampled
Micro DE	268	121	63	29	58	27	76	34	71	31
Small DE	170	77	45	21	33	15	54	24	38	17
Medium DE	46	21	19	9	5	2	12	5	10	5
Total	484	219	127	63	96	44	142	65	119	54

Source: Own computation, 2020

2.4 Econometric Model Specification

This study aimed to investigate the factors that determine the decision and level of value addition to milk (VAM) using the double-hurdle model. This model was chosen because it allows for the modelling of two parts: the first is the likelihood of achieving a value of 0 or 1, and the second is the value addition index of non-zero values. The double hurdle model formulated by Cragg (1971) by changing the conventional Tobit model has been used. There is a similarity between the double-hurdle and the extended Tobit models in the decision to participate and the degree of participation equations. The first hurdle relates to whether or not the dairy enterprises partake in VAM; the second is the degree of participation in VAM. This could be specified as:

$$D_{1i}^{*} = B_1 X'_{1i} + e_i \,; D_{1i} = \begin{cases} 1, if\ D1_i^{*} > 0 \\ 0, if\ \ D1_i^{*} \leq 0 \end{cases} e_i \sim \mathrm{N}(0,1) \qquad \textbf{(1)}$$

$$D_{2i}^{*} = B_2 X'_{2i} + \epsilon_i \,; D_{2i} = \begin{cases} D_{2i}^{*}, if\ D1_i^{*} = 1\ and\ D_{2i}^{*} > 0 \\ 0, else \end{cases} \epsilon_i \sim \mathrm{N}(0,1) \qquad \textbf{(2)}$$

This indicates that the observed degree of VAM (D_{2i}^{*}) is zero when there is zero censoring ($D_{2i}^{*} \leq 0$), inaccurate reporting, or some other random situation. The study rewrites equation 2 to make the procedures for seeing zero values clear (Jones and Wykes, 1989, Gao et al., 1995, Chi, 2017).

$$D_{2i} = D_{2i}^{*} = B_2 X'_{2i} + \epsilon_i\ if\ B_1 X'_{1i} + e_i\ > 0\ and\ B_2 X'_{2i} + \epsilon_i > 0 \quad (\mathbf{3})$$

$$(\text{when No} - \text{zero values imply} \Rightarrow \text{Partaking in VAM by diversification})$$

$$if\ B_1 X'_{1i} + e_i\ > 0\ and\ B_2 X'_{2i} + \epsilon_i \leq 0$$

$$(\text{when zero values imply } \Rightarrow \text{ Partaking in VAM by Specialization})$$

$$if\ B_1 X'_{1i} + e_i\ \leq 0\ and\ B_2 X'_{2i} + \epsilon_i > 0$$

$$(\text{when zero values imply } \Rightarrow \text{ a Random event/faulty report})$$

$$if\ B_1 X'_{1i} + e_i\ \leq 0\ and\ B_2 X'_{2i} + \epsilon_i \leq 0$$

$$(\text{when zero values imply } \Rightarrow \text{ No} - \text{Partaking to VAM})$$

A positive degree of VAM may be detected if an enterprise decides to participate in VAM and diversifies it, this is the first condition. The second circumstance that results in zero values is when a non-participant chooses to participate but does not diversify. Zero values might be detected if the enterprise does not participate and hence does not record any positive participation degree in the final equation. Assuming the error terms in equation 1 are independent; the stochastic specification can be written as:

$$\begin{pmatrix} e_i \\ \varepsilon_i \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & 0 \\ 0 & \sigma^2 \end{pmatrix}\right]$$

The double-hurdle model with independent error terms can be estimated using the following log-likelihood function, which is based on Adusah-Poku and Takeuchi (2019) and Mudemba et al. (2021) and is most commonly used in computer simulations.

$$LL = \sum\nolimits_0 \ln\left[1 - \phi(\beta_1 X'_{1i})\phi\left(\frac{\beta_2 X'_{2i}}{\sigma}\right)\right] + \sum\nolimits_+ \ln\left[\phi(\beta_1 X'_{1i})\frac{1}{\sigma}\varphi\left(\frac{D2_i - \beta_2 X'_{2i}}{\sigma}\right)\right]) \quad \textbf{(4)}$$

The contribution of all observations with an observed zero is related to the first term. It means that VAM and the participating degree yield zero observations. According to Chen et al. (2020) approach, all zeros are created solely by non-participating choices. The simplified form of the log-likelihood for independent error terms is:

$$LL = \sum_0 \ln[1 - \phi(\beta_1 X'_{1i})] + \sum_+ \ln\left[\phi(\beta_1 X'_{1i})\frac{1}{\sigma}\varphi\left(\frac{D2_i - \beta_2 X'_{2i}}{\sigma}\right)\right] \quad \textbf{(5)}$$

The additional term in the first term of equation 3, $\phi\left(\frac{\beta_2 X'_{2i}}{\sigma}\right)$ depicts what the double-hurdle model contributes. This additional term considers the possibility of observing zero-valued observation in the second stage. The second term in equation 3 accounts for the contribution of all observations having a non-zero degree of engagement in VAM decision making. The probability in the second term is the product of the conditional probability distribution and the density function arising

from the censoring rule and observing non-zero values (Wodjao, 2020). The former describes the possibility of meeting the VAM decision threshold in the instance at hand. The latter indicates the degree of witnessing a non-zero VAM participation degree.

Furthermore, the log-likelihood function of the double-hurdle model is equivalent to that of a truncated regression model and a univariate probit model (Ogeto et al., 2019, Wodjao, 2020) under the assumption of independence between the two error terms. Consequently, the log-likelihood function of the double-hurdle model may be maximized without losing information. It might be done by maximizing the two components: the Probit model and total data, then running a Tobit regression on the non-zero observations (Jones and Wykes, 1989).

2.5 Description of Variables

Outcome Variables

This study aimed to look into dairy enterprises' market participation decisions and the degree of milk value addition. This was investigated using two outcome variables: decision to participate and level of value addition to milk. The second outcome variable (level of value addition, which is a proxy for diversification) was derived from the data set using the product diversification index. The level of VAM is determined by choosing a dairy product diversity index that has a value between 0 and 1. The first step to compute the index is estimating the profit margin per litter of milk. Margin per litter (ML) was defined as a unit price minus variable cost (Horngren et al., 2016). There are three main different sources of variable cost: the raw milk, other raw materials (rennet, ferments, salt, rice, fruit, etc.), and packaging.

$$ML = \frac{Price\ per\ unit\ of\ product(P/UP)}{Liters\ of\ milk\ per\ unit\ of\ product(L/UP)} - \frac{Variable\ cost\ per\ unit\ of\ product(VC/UP)}{Liters\ of\ milk\ per\ unit\ of\ product(L/UP)}$$

The Herfindahl and Simpson indices were used to calculate the index, which is done as follows: Firs, the proportion of the 'ith' value added milk/dairy product could be computed as:

$$ML = \frac{P}{L} - \frac{VC}{L}$$

ML could be re-defined as the difference between income per litter of milk (IL) and variable cost per litter of milk (VCL).

$$ML = IL - VCL$$

Therefore, the value-added for a single product of milk could be computes as: Value added to milk for a single product (VAM) =Margin per litter of a product (MLi) times quantity of the product (Qi)

$$VAM_i = ML_i Q_i$$

Where 'i' indicate the specific milk product

Therefore, the total/Gross Value Added to Milk $(GVAM) = \sum_{i=1}^{n} ML_i Q_i = \sum_{i=1}^{n} VAM_i$

Then, the Herfindahl and Simpson indices were used to drive the index, which is done as follows: First, the proportion of the 'ith' value-added milk/dairy product could be computed as:

$$\mathrm{Pr_i} = \frac{ML_i Q_i}{\sum_{i=1}^{n} ML_i Q_i} = \frac{VAM_i}{\sum_{i=1}^{n} VAM_i}$$

Where ML=Margin per litter (ML); Q=quantity; VAM= Value Addition to milk; and Pri, the proportion of the 'ith' value-added milk/dairy product; and then the dairy product diversification index can be estimated as:

$$\mathrm{D_p^S} = \left(\sum_{\mathrm{i=1}}^{\mathrm{n}} \mathrm{Pr}\right)^2$$

The dairy product diversification index-Herfindahl Index approach is the sum of squares of all 'n' proportions and measures value addition to milk concentration. D_p^H takes the value of one when there is complete specialization and

approaches zero when the number of value-added dairy products shows perfect diversification. For direct interpretation, the Simpson Index (D_p^H) was executed as:

$$D_p^S = 1 - \left(\sum_{i=1}^{n} Pr\right)^2$$

The D_p^S Value has a direct relationship with diversification. The zero value of D_p^S indicates specialization, and moving toward one shows an increase in the number of value-added dairy products.

Table 2: Definition of variables and their expected signs

Variables Label	Variable Type
Dependent variables	
The decision to participate in VAM (1=Participation in VAM 0=otherwise)	Dummy
The extent of participation in VAM	Continuous between 0 and 1
Independent Variables	
Age of the enterprise manager	Continuous
Sex of the enterprise manager (1=male 0=otherwise)	Dummy
Family size of enterprise manager	Continuous
Education level of enterprise manager	Continuous
Experience of enterprise manager	Continuous
Ownership status (0= if the owner is manager 1=otherwise)	Dummy
Current Capital in 1000	Continuous
Number of employees	Continuous
Machinery & equipment (1=yes 0=no)	Dummy
Number of dairy cattle	Continuous
The volume of milk in litter per day	Continuous
Access to credit services (1=yes 0=no)	Dummy
Research & development (1=yes 0=no)	Dummy
Incentive (1=yes 0=no)	Dummy
Skill training (1=yes 0=no)	Dummy
Access to Market info. (1=yes 0=no)	Dummy

The explanatory variables of the study have been selected based on the economic theory, data availability and previous empirical studies (Lee, 2005, Marenya and Barrett, 2007, Knowler and Bradshaw, 2007, Kassie et al., 2010, Wollni et al., 2010). The detailed description of the variables, measurement units and their hypothesized direction of influence are presented in Table 2.

3. Results and Discussion

This section describes dairy enterprises' socioeconomic and demographic profiles. Then, a regression analysis was done to look at factors that influence dairy enterprises' decision to enter the market and their degree of engagement in VAM. Only 212 out of the total 219 sample sizes completed the survey questionnaire; hence, the analysis of the study is only pertinent to 212 enterprises.

3.1 Descriptive Statistics of Outcome Variable

Table 3 presents the descriptive statistics of outcome variables of dairy enterprises decision to participate in VAM activities and the degree of participation in VAM. Of the total dairy enterprises examined, 66.03 percent were involved in milk value addition (VAM), while 33.97 percent did not participate in the activity. Furthermore, the mean value of the degree of involvement in the VAM index was found to be 0.305, with a standard deviation of 0.146, implying that most dairy firms have an index that is closer to the mean owing to lower variation. The mean value indicates that dairy firms' engagement in the level of value addition or product diversification is quite low.

Table 3: Descriptive statistics of outcome variable

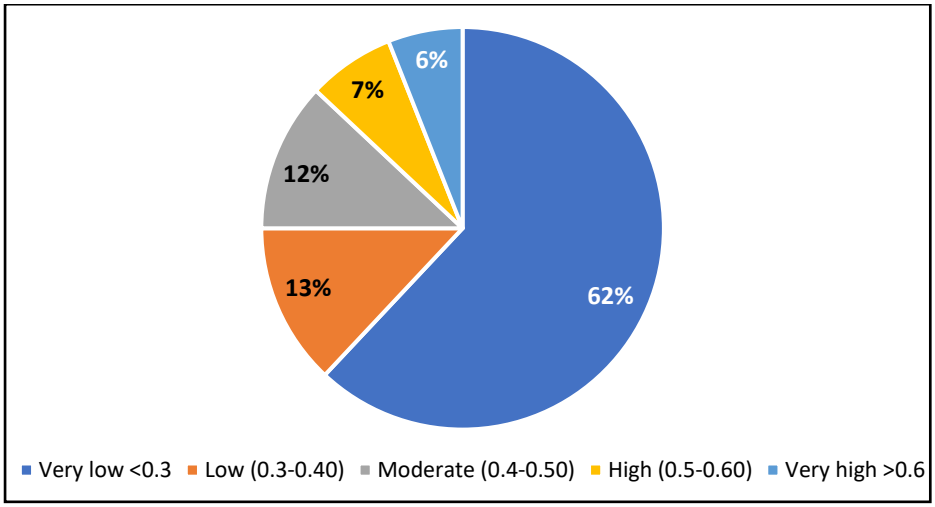
Variable	Category	Frequency	Percent
Decision to Participate to VAM	Participant (1)	140	66.03%
	Non-Participant (0)	72	33.97%
	Continuous	Mean	SD[3]
Degree of Participation to VAM		0.30546	0.14653

Source: own computation, 2020

[3] Standard Deviation

According to the given classification, 62 percent of the dairy enterprises examined had a very low degree of engagement in VAM, which is lower than the average of the sampled enterprises. The other 13 percent enterprises had also low participation index which is between 0.3 and 0.4. Only 25 percent of enterprises had a diversification degree greater than the sample's mean of 0.3.

Figure 1: Classification of degree of VAM



Source: Own computation, 2020
Source for classification: District Statistical Handbook, 2008; Hugli.

3.2 Socioeconomic and demographic profiles of dairy enterprises' manager

The result indicates that 48.7% of participant enterprises were managed by their owners, while 51.3% of the participant enterprises were managed by individuals who were not the owners of the enterprises. Similarly, out of the total non-participant enterprises, 73.6% were managed by the owners of the enterprise, while 26.4 percent of enterprises had managers who were not the owners of the enterprise. In terms of the gender of managers, 67.8% of participant dairy enterprises were run by male managers, while female managers led the remaining 32.2% of the enterprises. 52.9% of the non-participant dairy enterprises were led by male managers, while women managed 47.2% of non-participant enterprises. The chi-square test was done to check whether there was a statistically significant difference in gender and enterprise ownership status. The finding confirmed a statistically significant difference at 5% and 1% levels, respectively.

Table 4: Descriptive statistics of categorical variables

Variables	Category of partaking in VAM	%		%	Chi2 (1)
Sex	Participant	66.03	Female	32.14	4.624**
			Male	67.86	
	Non-participant	33.97	Female	47.22	
			Male	52.78	
Ownership status	Participant	66.03	Manager & Owner	48.57	12.1682***
			Manager	51.43	
	Non-participant	33.97	Manager & Owner	73.61	
			Manager	26.39	

***, **, significance level at 1% and 5% respectively

Source: Own computation, 2020

The average age of dairy enterprise managers who participated was 39.5 years, while the average age of non-participating the enterprises' managers was 32 years. It means that the enterprise managers who participated were 7.2 years older than the non-participants. On average, participant enterprises manager had higher level of education (13.1 year) and more work experience (9.6 years), whereas non-participants enterprise manager had lower level of education (10.2) and less years of work experience (5.9 years). This indicates that education and expertise are critical in adding value to milk products. The level of education and experience that dairy enterprise managers have may determine how well they are familiar with new technology and developments that can assist them run their businesses. It is also likely that it will influence decisions about the adoption of new technology and contribute to decision-making processes that can change the lives of businesses. Participant enterprises manager had an average family size of 2.7 members, whereas non-participant enterprises manager had an average family size of 2.2. The mean comparison test was carried out to determine whether there was a statistically significant difference in the mean age of enterprise managers, average level of education, average years of experience, and average family size. The result indicates that there was a statistically significant difference at the 1%, 1%, 1%, and 5% levels of significance, respectively.

Table 5: Descriptive statistics of continuous variables

Variables	Partaking in VAM status	Mean	Min.	Max.	t-test
Age	Participant	39.5214	21	62	-4.96***
	Non-participant	32.3056	21	45	
Family_size	Participant	2.7143	0	6	-2.22**
	Non-Participant	2.2222	0	6	
Education	Participant	13.4143	4	22	-7.83***
	Non-participant	10.1944	0	15	
Experience	Participant	9.6428	1	20	-7.25***
	Non-Participant	5.9861	1	10	

***, **, significance level at 1% and 5% respectively

Source: Own computation, 2020

3.3 Resources, Technology, and Institutional Service Access

It is believed that dairy cattle, milk volume, capital, employees, and machinery and equipment ownership will be the most significant resources required in the milk value addition task. The average number of dairy cows held by participating enterprises, as well as the volume of milk produced, was 17.1 cows and 341.6 litres, respectively, whereas those who did not participate had only 7.8 cows and produced an average of 139.4 litres of milk. This indicates that there is a greater and statistically significant difference between the two groups. Participants' milk production volumes ranged from 0 to 960 litres, whereas those who did not participate ranged from 0 to 32 litres.

Participants had an average current capital of 600,960 Eth. Birr and employed 14.3 people, whereas non-participants had an average financial capital of 124,900 Eth. Birr. Nonetheless, in terms of financial capital and employees, participating dairy enterprises had greater potential alternatives than non-participants (see Table 6). Furthermore, non-participants' current capital ranged from 40,000 to 282,660 Eth. Birr, whereas participants' current capital ranged from 100,000 to 3,000,750 Eth. Birr. This demonstrates that personnel and financial resources could influence the choice made by dairy enterprises in relation to the level of involvement in value addition.

Table 6: Descriptive statistics of access to resources and technology

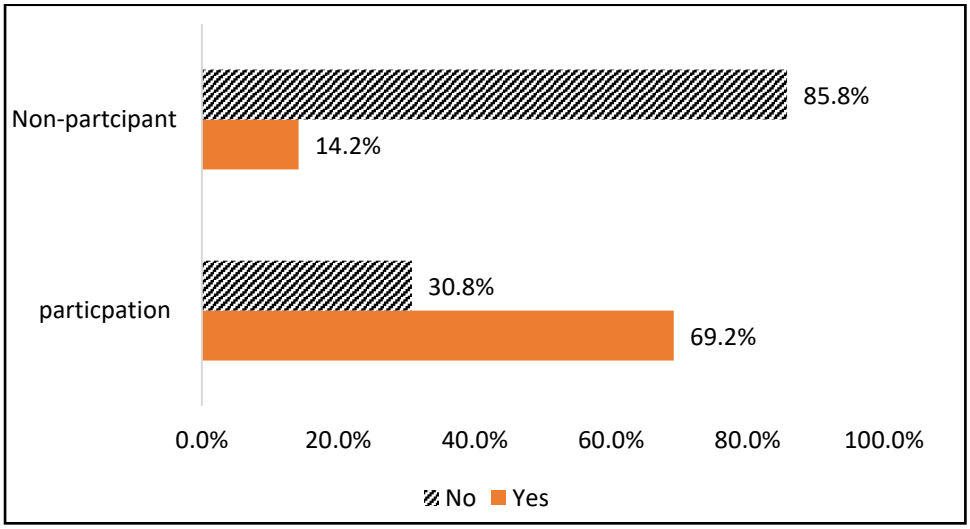
Variables	Partaking in VAM status	Mean	Min.	Max.	t-test
Dairy cattle	Participant	17.1	0	32	-7.022***
	Non-participant	7.8	2	19	
Volume of milk Per day	Participant	341.6	0	960	-6.792***
	Non-participant	139.4	30	320	
Capital (in 1000)	Participant	600.96	100	3000.75	-6.279***
	Non-participant	124.9	40	282.66	
Number of employees	Participant	14.3	2	52	-2.689***
	Non-participant	10.1	2	30	

***, significance level at 1%

Source: Own computation, 2020

Participants had better access to machines and equipment ownership and a more extensive selection of tools and equipment than enterprises that did not engage in value-adding work. 69.2% of participating dairy enterprises have access to machinery and equipment. In comparison, only 14.2% of non-participating dairy enterprises had access to machinery and equipment. This might suggest that having access to sophisticated machinery and equipment enables enterprises to add value to milk.

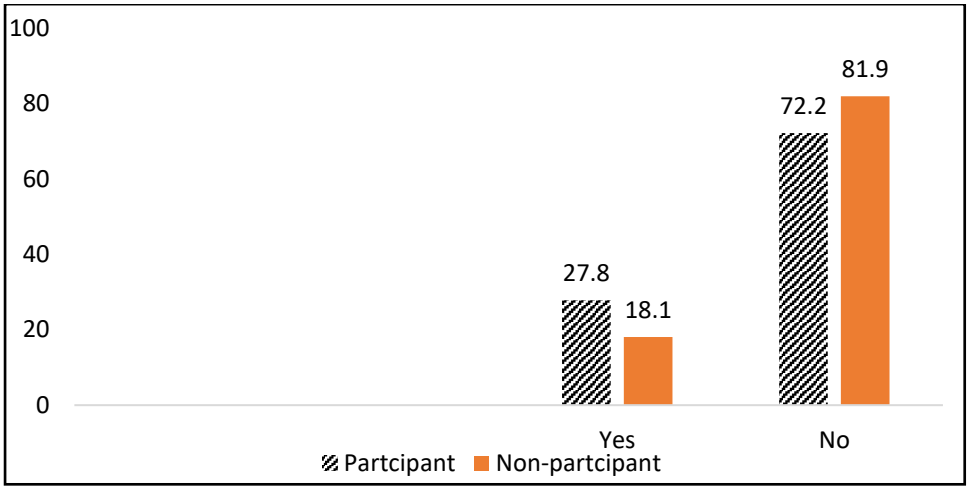
Figure 2: **Access to machinery & equipment**



Source: Own computation, 2020

Credit was an essential component of the dairy industry because it enabled enterprises to participate in activities that increased the value of milk and product diversification. The descriptive statistics indicated that 72.2% of participating dairy enterprises did not have access to credit, whereas the rest of the dairy enterprises (27.8% of them) had credit access. On the other hand, 81.9% of non-participant enterprises didn't receive loan access, while the remaining (18.9%) were offered credit. Dairy businesses must have access to various financial institutions from which they may get loans. Local moneylenders were the traditional source of financing for dairy farmers' companies when they needed more capital.

Figure 3: Access to credit service



Source: Own computation from 2020 survey

Ethiopia's dairy industry is among the fastest-growing in the world. An increase in the demand for value-added products, such as milk and dairy products, has led to a growth in the number of individuals seeking work. The government aims to minimize the quantity of milk and other imported dairy products, creating major pressure on national budgets.

Only 9.7 and 11.1 percent of individuals who did not engage in the milk value addition had access to different incentives and skills training. This contrasts with the 90.3 and 88.9 percent of non-participants who had no incentives and skills training access. On the other hand, participants who had access to incentives and skills training made up 50.7% and 65.77% of the total. In contrast, 49.3 percent and 34.3 percent of participants did not have access to the incentives or skills training. Compared to the total number of enterprises that participated in the study, only a tiny

percentage (11.2 %) of the dairy enterprises were interested in being involved in research and development activities to improve product quality and expand their product line.

Table 7: Institution and government support

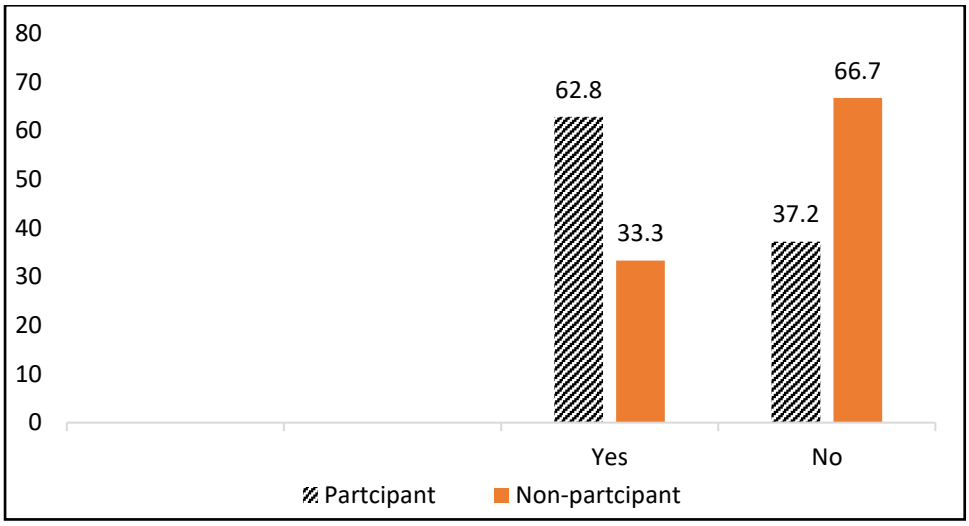
Variables	Category of partaking in VAM		%	Chi2(1)
Research & development	Participant	No	82.9	13.9185***
		Yes	17.1	
	Non-participant	No	100	
		Yes	0	
Incentive	Participant	No	49.3	34.3555***
		Yes	50.7	
	Non-participant	No	90.3	
		Yes	9.7	
Skills training	Participant	No	34.3	56.8871***
		Yes	65.7	
	Non-participant	No	88.9	
		Yes	11.1	

***, significance level at 1%

Source: Own computation, 2020

37.2 percent of the total participant diary enterprises did not have access to market information, compared to 62.8 percent of participants who had access to such information. Of the non-participant dairy enterprises, 66.7 percent were not provided with any media outlet about the market information. The remaining 33.3 percent of enterprises gained access to information. Exposure to direct market information enables the sale of milk and milk products through many transaction channels and gives a specific collection of advantages. With the backing of a well-organized market intelligence information system, all the dairy firms and traders can engage with one another and set a price for their goods.

Figure 3: **Access to market information**



Source: Own computation, 2020

3.4 Econometric Results

3.4.1 Determinants of the choice and degree of participation in VAM

The Double-Hurdle regression model was used to investigate the factors that influence dairy enterprises' decisions to take part in a market and their level of VAM. The likelihood ratio chi-square test result (LR chi2 = 225.23 and LR chi2 (14) = 291.09) indicates that at least one of the predictors' regression coefficients is not equal to zero, as shown in the table below. The null hypothesis states that all of the regression coefficients in the model are equal to zero. This indicates that the model succeeds in explaining the relationship between the dependent and at least one independent variable.

Table 8: Determinants of Decision and degree of partaking in VAM, Double-Hurdle Approach

Variables	Double-Hurdle (Probit regression) Outcome Variable-Decision to participant			Double-Hurdle (Tobit regression): Outcome Variable-Degree or extent of participation		
	Coeff.	Std. Err.	P>|Z|	Coeff.	Std. Err.	P>|t|
Age	0.1184	0.0421	0.005***	0.0023	0.0012	0.067*
Sex (male=1)	0.4655	0.4554	0.307			
Family size	-0.7332	0.2707	0.007***	-0.0165	0.0074	0.027**
Education level	0.3874	0.0976	0.000***	0.0256	0.0034	0.000***
Experience	0.2195	0.0933	0.019**	0.0086	0.0031	0.006***
Ownership Status (0=own 1=hire)	0.8345	0.4785	0.081*	0.041	0.0188	0.030**
Current Capital	0.0073	0.0021	0.001***	0.000011	0.000018	0.561
Number of Employee	0.0289	0.0256	0.259	0.0007	0.0009	0.441
Machinery & Equipment (1=yes 0=no)	1.0802	0.628	0.085*	0.1252	0.0227	0.000***
Number of dairy cattle	-0.1152	0.0668	0.085*	.	.	.
The volume of milk in the litter	0.0082	0.0032	0.011**	0.0002	0.0001	0.000***
Access to credit services (1=yes 0=no)	0.9747	0.5442	0.073*	0.0669	0.0201	0.001***
Research & development (1=yes 0=n)	1.1567	0.8363	0.167	0.0839	0.0271	0.002***
Incentive (1=yes 0=No)	-0.004	0.5131	0.994	0.0081	0.0216	0.706
Skills training (1=yes 0=No)	1.0132	0.5645	0.073*	0.0682	0.0199	0.001***
Access to Market info. (1=yes 0=No)	-0.5234	0.5493	0.341	0.0464	0.0202	0.023**
Intercept	-12.059	2.3471	0.000***	-0.4992	0.0531	0.000***
Sigma				0.1151	0.0073	
Log likelihood = -25. 722333	Log likelihood = 61.438462, Number of observations= 212, LR chi2 (14) = 291.09, Prob > chi2 = 0.0000, Pseudo R2 = 1.7305, Left–censored obs. (at D2<=0) =76, uncensored obs.=136, Right-censored obs. =0					
Number of observations= 212						
LR chi2 (16) = 225.23						
Prob > chi2 = 0.0000						
Pseudo R2 = 0.8141						

Note: ***, **, *: Implies statistical significance at 1%, 5%, and 10% levels,
Source: own computation, 2020

The managers' age has a positive and statistically significant influence on both the decision to engage in VAM and the level of VAM at 1% and 10% significance levels, respectively. All other things being equal, as the managers age increases, the likelihood of engaging in VAM and the degree of VAM increases. This means that older individuals are more eager to participate in the market than younger people. This indicates that older enterprise managers might have a broader knowledge base and range of abilities as a consequence of their experience. The findings of this study are congruent with those of Tadesse (2017), who revealed that age had a positive and significant influence on whether or not to engage in VAM. However, this finding contradicts the findings of Obanla (2018) and Lijalem (2019), who observed that age had a negative influence on the value addition to milk. The firm managers' family size had a negative and significant influence on their decision to enter the dairy market at the 1% level of significance and the degree that they participated in adding value to milk (VAM) at the 5% level of significance. Tegegn and Tamir (2020) also found that the family size of managers influences the decision to participate in a market and the extent of value addition to milk negatively.

The higher the level of education, the better equipped business owners are to grasp the numerous dairy products and their importance in the dairy sector. Education improves enterprise owners' skills to offer many types of value to their companies, and the more educated they are, the better positioned they are to manage their companies efficiently. Managers' levels of education have a positive and significant effect on their decision to participate in VAM and the extent to which they engage in value addition. This conclusion is consistent with the findings of Beyene et al. (2017a) and Tegegn and Tamir (2020). They found that levels of education had a positive and significant association with their involvement in milk value addition and the decision to participate. It was found that participants' decisions and degree of engagement in VAM were positively influenced by the number of years of experience they had worked in the dairy business and statistically significant. A one-year increase in experience leads to a higher possibility of entering the dairy market and the degree of VAM involvement.

Ownership status had a positive and statistically significant influence on the decision to engage in VAM and the level of value added to milk. This means that when competent managers are employed in the enterprise, the possibility of market participation and the degree of value addition to milk increase. In other ways, owner-managed enterprises are less likely to participate in VAM activities since dairy owners may not add as much value to milk as a professional manager does.

Financial capital influences the choice to participate in VAM at a 1% level of significance, but it has no effect on the amount of engagement. Besides, it was found that having access to various machinery and equipment had a favourable and statistically significant effect on whether or not people participated and how much they participated. Dairy businesses with access to machinery and equipment were more likely to take part in the VAM. This study revealed that the dairy firm could produce more types of dairy products if they had access to an additional spectrum of milk apparatus and equipment.

The greater the number of dairy cattle in an individual's herd, the less likely the dairy firm was to engage in VAM. This might be because larger dairy enterprises are compelled to give their cows a greater quantity of concentrated feed. Many dairy enterprises would prefer to invest in animal feed processing than in milk value addition. In contrast, the volume of milk produced was positively associated with the choice to participate in value-added milk (VAM) as well as the level of value addition, and these relationships were statistically significant at the 5% and 1% levels of significance, respectively. VAM may occur from an increase in milk production, which results in a higher volume, increasing the possibility that the milk will be processed into value-added commodities. Tadesse et al. (2017b) both confirmed the same result, however Ayyano et al. (2020) came to a different finding. Access to credit influences both the decision to engage and the ultimate amount of milk value addition. This indicates that firms with credit access were more likely to participate in VAM, allowing them to loosen financial liquidity limits. This conclusion is reinforced by Beyene et al. (2017a) and Ding et al. (2019), who both found comparable results in their separate studies.

Engaging in research and development increases the likelihood of participation and the extent of value addition to milk. Research and development had a positive and significant influence on how VAM participated at a statistical significance level of one percent. Skills training was also shown to have a positive and statistically significant influence on participation choices and the degree of VAM. Enterprises that have received skill training were more likely to participate in VAM than those that did not receive it, and enterprises with access to market information were more likely to engage in VAM than those that did not have access to it.

4. Conclusion and Policy Recommendations

4.1 Conclusion

The study attempted to identify the factors that influence involvement in dairy marketing value addition in Addis Ababa and the surrounding areas. It intended to detect dairy enterprise participation decisions and their impact on milk value addition or product diversification.

To that end, 212 dairy enterprises participated in this survey, with 66.03% participating and 33.97% not participating. The average age of participants was 37.07 years, and 57.08 percent of dairy enterprise owners managed the operations of their enterprises. It was also found that the average family size of managers was 2.55, and they had 12.32 years of education and 8.4 years of work experience. The mean values of them current capital, number of workers, amount of milk in litters per day, and number of dairy cows in the study area were 439.27 ETB, 12.87, 272.93, and 13.97, respectively.

Providing proper services to dairy enterprises can assist them in producing value-added dairy products. 27.83% of participants in the study used credit services, 36.79% used incentives, 47.17% used skills training, and 52.83% used market information. Furthermore, 11.32% of enterprises conduct research and development related to the enhancement of dairy value addition.

Access to cutting-edge machinery and equipment, the amount of milk stored per litre, financing services, and skills training all promote dairy firms' participation in milk value-addition activities. On the contrary, the number of dairy animals had a modestly adverse effect on the decision to join VAM. This might be because a dairy farm with a bigger number of cows needs a significant amount of high-concentration feed in order for their animals to have increased milking production.

4.2 Recommendations and Policy Implications

The study advises that decision-makers, stakeholders, and dairy enterprises devote special attention to the dairy industry in order to increase dairy value addition. It suggests the following areas as crucial intervention to increase VAM participation in the industry:

Dairy enterprises should be promoted and expanded for better economic benefit and to adopt new technologies for advancing value addition to milk.

Financial institutions including banks and microfinance institutions should review their entire processes to establish an atmosphere that would encourage dairy firms to solve their financial issues and take part in dairy market value addition. Financial institutions need to expand their access to credit services and shorten their provision periods to be able to take part in VAM.

Consistent efforts should be made by the government or other stakeholders in order to provide machinery and processing equipment for chilling and processing milk for dairy enterprises that are suitable for milk value addition.

To improve milk value addition and subsequently marketable supplies for better market participation, a strategy should be designed to provide technical skill training for the enterprises to improve and diversify dairy products.

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Private Sector Development in Ethiopia

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Article History: Received: 07 December 2022; Revised: 16 August 2023; Accepted: 29 September 2023

Abstract

The role of the private sector in driving sustainable and inclusive growth, poverty reduction, and creating jobs is indispensable. In order to effectively use the opportunities available for sustainable development and transformation of the Ethiopian economy and to further leverage the private sector, it is important to examine the structure and performance of private sector development, identify important bottlenecks and challenges, and further investigate its contribution to the economy. A time series Autoregressive Distributed Lag (ARDL) model was employed using secondary data collected from various official sources from 1991 to mid-2021. The result shows that in response to successive policies and strategies, an increment trend in private sector investment project was observed from 2003 onwards. However, the majority of the investment has been carried out by domestic investors. The implementation rate of projects in all development plan periods has been very low and showed a decline in agriculture sector investment from 2000 onward. Although promising signals indicate that the industry sector has begun to emerge over the last few years, with less participation of domestic private investors in the manufacturing sub-sector and no or little agriculture sector investment, this indicates a less nascent structural change to the productive sector of the economy. The result further shows domestic private sector investment has not yet been channelled into the productive sector and export market, which has a trickle-down effect towards industrialization and structural transformation of the economy and plays a less satisfactory role in employment generation, export, and economic growth of the country. The ARDL model revealed that the real effective exchange rate and credit have positive and significant effects both in the short and long runs. On the other hand, government expenditure and real interest rate were found to be positive and significant only in the long run. The results suggest that macroeconomic policies should be aligned with country's the comparative advantage. To this end, encouraging a high-value export-led

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manufacturing sector and thereby strengthening Ethiopia's overseas purchasing power (improving the negative real effective exchange rate), undertaking government expenditure on capital investment (such as preferably on physical infrastructure and the development of industrial parks), and providing adequate financial services will leverage private sector investment in Ethiopia.

Key words: Privet sector investment, trends, challenges, ARDL model, Ethiopia.
JEL Classification: 0.2 & 1.6

1. Introduction

The role of the private sector in driving sustainable and inclusive growth, poverty reduction, and creating jobs in developing countries is indispensable. For instance, a report by the European Commission (EC) revealed that the private sector provides approximately 90% of jobs in developing countries (EC, 2014). The sector is also important in contributing to the growth of gross domestic investment and allocating resources efficiently (Nwakoby and Bernard, 2016). The private sector is, thus, identified as an essential stakeholder in fighting poverty, creating employment opportunities, ensuring long-term economic growth, and hence providing a pathway towards inclusive economic growth and transformation of the economy.

In Ethiopia, the private sector plays a leading role in the structural transformation process towards industrialization and hence, has been given much emphasis by the Government of Ethiopia (GoE) over the last two decades. This was noticed in several national policy documents, including the Industrial Development Strategy (IDS) (2002); Sustainable Development and Poverty Reduction Program (SDPRP) (2002/2003-2004/2005); Plan for Accelerated and Sustained Development to End Poverty (PASDEP) (2005/2006-2009/2010); Growth and Transformation Plan I (GTP-I) (2010/2011-2014/2015); and Growth and Transformation Plan II (GTP-II) (2015/2016-2019/2020). Particularly, during GTP-I and II periods, the government recognized the key role of private sector development in the process of economic development of the nation and spurred its engagement in the productive sectors of the economy. In response to this, various administrative, institutional, and policy reform measures have been taken to leverage the private sector's involvement in the productive sector of the economy, particularly, in the manufacturing sector (MoFED, 2010; PDC, 2016).

In response to the 2018 political reform in the country, the Ethiopian government introduced some restructuring measures to stimulate the performance of major economic sectors and made changes in institutional arrangements. In connection to with this, the government formulated a three-year Home-Grown Economic Reform (HGER) interim plan that emphasized the role of private sector development in sustaining the economic growth trajectory of the country. HGER serves as a bridge between the GTP–II and the Ten Years' Development Plan (TYDP) (2021-2030). The TYDP aims to sustain the rapid economic growth achieved during GTP-I and GTP-II by addressing key strategic pillars: ensure quality economic growth and shared prosperity; improve productivity and competitiveness; undertake institutional transformation; strengthen the technological capability and digital economy; ensure private sector leadership in the economy; ensure equitable participation of women and children; enhance access to justice and efficient civil services; build a climate-resilient green economy; and strengthen regional peace building and economic integration. The plan gives due consideration to private sector development, aiming to strengthen their participation in key productive sectors in the years to come. However, the potential role of the private sector in sustainable development and the structural transformation of the economy were not fully optimized until recently.

Despite policy support over the last two decades, the contribution of the private sector to the national economy, as compared to the public sector is less satisfactory. The economic growth that the county registered in the last decade has been largely driven by public investments such as transport, energy, and social services (EEA, 2015; WB, 2016b). Consequently, the share of public investment in GDP increased from 5 percent in the early 1990s to an average of approximately 15 percent in 2018/2019 (Mulu, 2019). According to the World Bank, Ethiopia recorded the third-highest public investment but the sixth-lowest private investment in the world. Such types of huge public investment might complement private sector development or have "crowding in" effects due to the expansion of crucial infrastructure. At the same time, it might also create "crowding out" effects due to the shortage of loanable funds and foreign exchange at the central bank (WBa, 2016). Therefore, to identify the key macroeconomic determinants of private investment in the country, more information is required on these factors.

Ethiopia's private sector is predominantly characterized by small-scale, informal, and service-oriented businesses mostly operating in domestic markets where returns are high and quick. The sectoral distribution of the domestic private sector shows that investors are not vigorously entering the productive sectors

(manufacturing and agriculture) and the export market, which are critical pathways toward industrialization and structural transformation. Instead, most domestic private investors are increasingly concentrated in the service sector and/or domestic market (Mulu, 2019). For instance, during the GTP-I period, from a total 123 operational domestic private investment projects that received investment licenses from regions, 88 (71%) projects were engaged in the service sectors, 21 (17%) projects in the manufacturing sector, and 14 (11%) projects in the agriculture sector (NPC, 2016). This indicates a need to identify weaknesses and constraints hindering the domestic private sector from robustly entering the productive sectors, improve the country's export trade competitiveness, and build its capacity for resilience to shocks.

According to Ambachew (2010) and Amanu (2020), the main factors influencing Ethiopian private sector development include: domestic market size, return to capital, resource availability, degree of trade openness and liberalization, infrastructural facilities, macroeconomic and political instability, incentive packages, and infrastructural and institutional facilities. Furthermore, studies by Kolli (2010), Mulu (2019), Solomon (2001), and TAK-IRDI (2016) outlined weaknesses of the role of private sector development and its role in economic transformation in Ethiopia in the short run. In contrast, there are virtually no specific nationally representative studies that extensively explored the long-term trends, challenges, and policy options and examined the role of the private sector in the economic development process over the last three decades, thereby directing future needed policy intervention in Ethiopia. In response, this study aims to examine the structure and performance of private sector development from 1991/1992 to 2020/21, identify important bottlenecks and challenges, and further investigate its contribution to the economy over the last three decades, and propose implementable policy recommendations to play a more pronounced role in the national economy.

2. Materials and Methods

In this section, the data sources for the study, data acquisition approaches, methods of data analysis, and model justification and specification are discussed sequentially:

2.1 Data Type and Sources

The main data used for the study were collected from various official sources, such as the National Labor Force Survey, Primary Manufacturing Survey, Enterprise Survey, Phone Survey, World Development Indicators of the World Bank, and Ethiopian Investment Commission (EIC) databases. In addition, annual reports of the Central Statistical Agency (CSA), National Bank of Ethiopia (NBE), Planning and Development Commission (NDC), and Ministry of Finance (MoF) were consulted.

An extensive desk review of existing policies, strategies, programs, and plans for private sector development in Ethiopia was conducted. This review was performed to evaluate the effectiveness of policies, strategies, programs, and plans designed to promote private sector investment over the last three decades. The study also consulted various development plans namely: IDS (2002), PASDEP (2005/2006–2009/2010), GTP I (2010/2011-2014/2015), GTP II (2015/2016-2019/2020), and TDPP (2020/2021-2029/2030). Furthermore, pertinent sources, such as academic journals and books, annual reports, and policy brief papers, relevant to the study were critically reviewed.

2.2 Method of Data Analysis

To address the objectives of the study, a combination of descriptive and econometric analyses was applied. The theoretical framework and econometric model specification are explained and specified in subsequent sections:

Theoretical framework: This study considered two macroeconomic theories, namely: the multiplier and acceleration theories of investment, as a theoretical framework. Multiplier theory considers investment to be a multiplier effect of the growth of the national economy (Nipun, 2018). The theory states that when the national economy of a nation increases, investment is expected to increase. This theory is silent about the effects of induced investment. In reality, the investment might not instantaneously respond to the change in the national economy, or it might also induce growth rather than have the resultant effect. The acceleration principle, on the other hand, explains more about the implications of induced investment. It tells more about how total output or income can bring about additional investment spending. Put simply, this explains why an increase in national income often leads to a disproportionate increase in investment spending. Indeed, it describes why the amount of investment in an economy does not depend on the absolute level

of business activity but on whether the activity level is increasing or decreasing. Subsequently, it clarifies that if there is a change in the national income or output of an economy, then, it tends to induce a change in investment. The acceleration posits that a small change in national income or output in such an economy will lead to a greater (accelerated) change in investment in the economy. It describes the accelerated effect on investment of a small change in the demand for or output, that is, an increase in sales of consumer goods in such an economy (Nipun, 2018). Following Ayeni (2020), for this study, macro variables that determine private investment or the nature of the response of investment are introduced to simple accelerated theory. Based on both theoretical and empirical literature, private sector investment in this particular study is explained as follows:

$$TPI_t = f(LTPI, RGDP, UNEMPT, REER, GOVEX, TOT, CREDIT, INFL, RIR)$$

Where: TPI=Total Private Investment, LTPI = lagged value of TPI, RGDP = Real gross domestic product, UNEMPT = Rate of Unemployment, REER= Real Effective Exchange Rate, GOVEX = Government Expenditure, TOT = Terms of Trade Index, CREDIT = Credit provided to private sector, INFL= Inflation, and RIR = Real Interest Rate.

Autoregressive Distributed Lag (ARDL) Model Justification and Specification: The ARDL model proves to be a suitable method to estimate the influence of time lag effects of explanatory variables in multivariate time series analysis (Pesaran 2001). Unlike the competing VAR models, the ARDL model treats the parsimonious lags of the right-hand variables as an independent variable (Pesaran and Shin, 1999). For this reason, the only cointegration and error-correction method that allows some of the independent variables to be nonstationary (I (1)) and some to be stationary (I (0)) is the ARDL bounds testing approach. In other words, the ARDL approach to cointegration has the advantage of avoiding the classification of variables (the independent variables) of interest into I(0) or I(1), and unlike conventional cointegration tests, there is no need for unit root or stationary pretesting (Pesaran et al., 2001). Therefore, to estimate the long-term relationship between private investment and repressors, the ARDL model is selected for the study. ARDL model involves two stages. In the first stage, it examines whether there is a long-run relationship between the variables under investigation. Second, it estimates the coefficient of the short-run relations and the associated Error Correlated Models 6.

In order to put the dependent and independent variables on the same level and to make the econometric estimation robust, the differencing of all variables

involved has proven to be crucial. Therefore, differenced values imply changes in the variables, and interpretations of coefficient estimates become more logical. Moreover, the tabulated F values (Pesaran and Shin, 2009) have upper and lower bounds, where the upper bound assumes that all the variables are I(1) stationary and the lower bound assumes that all the variables are I(0) stationary. Therefore, examining whether a variable is I(1) or I(0) stationary, which requires differencing, helps to come up with a conclusion in the case where the calculated F-statistics lie within the upper and lower bounds. Based on what has been brought up earlier, the ARDL model for constraints on private sector investment is given as follows:

$$\begin{aligned}\Delta lnTPI = \beta_0 &+ \sum_{i=1}^{j} \beta_1 \, \Delta lnTPI_{t-j} + \sum_{i=1}^{k} \beta_2 \, \Delta lnRGDP_{t-k} \sum_{i=1}^{m} \beta_3 \, \Delta lnUEMPT_{t-m} \\ &+ \sum_{i=1}^{q} \beta_4 \, \Delta lnREER_{t-q} + \sum_{i=1}^{z} \beta_5 \, \Delta lnGOVEX_{t-z} \\ &+ \sum_{i=1}^{f} \beta_6 \, \Delta lnTOT_{t-f} + \sum_{i=1}^{h} \beta_7 \, \Delta lnCREDIT_{t-h} \\ &+ \sum_{i=1}^{l} \beta_8 \, \Delta lnINFL_{t-l} + \sum_{i=1}^{n} \beta_9 \, \Delta lnRIR_{t-n} + \mu_1 lnTPI \\ &+ \mu_2 lnRGDP + \mu_3 lnUEMP + \mu_4 lnREER + \mu_5 lnGOVEX \\ &+ \mu_6 lnTOT + \mu_7 lnCREDIT + \mu_8 lnINFL + \mu_9 lnRIR + e_i\end{aligned}$$

Where TPI: Total private investment (the dependent variable) measured in million USD, RGDP: Real Gross Domestic Product (a proxy for demand conditions in the economy); GOVEX: Government Expenditure on investment (a proxy for public investment); UEMPT: Unemployment Rate (proxy for factor availability); CREDIT: Credit to private sector (proxy for liquidity constraints); INFL: Rate of inflation (proxy for macroeconomic uncertainties/instability); REER: Terms of Trade Index (proxy for export competitiveness); TOT: Terms of Trade (proxy for trade balance; RIR; and Real Interest Rate (proxy for demand for saving)

β1, β2, β3, β4, β5, β6 and β7, β8 and β9 are short-run coefficients to be estimated, μ0, μ1, μ2, μ3, μ4, μ5, μ4, μ5, μ6, μ7 and μ9 are long-run coefficients, and t spans from 1991/1992 to 2020/21 time periods.

To determine whether there is a long-run relationship among the variables in co-integrating equation (1), the null hypothesis of no long-run relationship (i.e. H0: the long run coefficients are jointly equal to zero) against the alternative hypothesis of a long-run relationship (i.e., H1: the long-run coefficients are jointly different from zero) using the F-statistic (Wald test) test. The decision rule is that if the computed F-statistic is greater than the upper critical bound, and then the null hypothesis can be rejected, suggesting co-integration. On the other hand, if the computed F-statistic is less than the lower critical bound, the test fails to reject the null hypothesis, and it can be concluded that there is no co-integration. Given the case where the test statistic lies within the lower and upper critical bounds, conclusive inference can only be made once the order of the integration of the underlying regressors is known (Pesaran et al., 1999).

3. Results and Discussions

The results of the study are discussed and presented in the following order. First, policies and programs aimed at promoting private sector development and their challenges and effectiveness are thoroughly discussed. Second, factors that hinder private sector participation in different sectors over the last three decades were analyzed. In the third part, the contribution of private investment to the Ethiopian economy over the last three decades was described. Finally, the long- and short-run relationships between key macroeconomic determinants and private investment were estimated, inspected, and interpreted.

3.1 Private-Sector Development in Ethiopia

Over the last three decades, the government of Ethiopia has been implementing various policies and strategies. It started with the Industrial Development Strategy (IDS), which is also in practice to date. Subsequently, a five-year Sustainable Development and Poverty Reduction Program (SDPRP) was implemented from 2002/2003-2004/2005. Then, a Plan for Accelerated and Sustained Development to End Poverty (PASDEP) was implemented from 2005/2006 to 2009/2010, which was sequentially followed by the Growth and Transformation Plan-I (GTP-I) (2010/2011 to 2014/2015) and the Growth and Transformation Plan-II (GTP-II) (2015/2016 to 2019/2020). Currently, based on GTP I and GTP II progress evaluation results and the Home-Grown Economic Reforms (HGER) policy direction, the government designed and implemented the

Ten-Year Development Plan (TYDP) in 2020/2021 to be implemented until 2029/2030.

In 2002, the government of Ethiopia implemented the first five-year development plan called the Sustainable Development and Poverty Reduction Program (SDPRP) (2002/2003- 2004/2005). During the year, the government designed and implemented a comprehensive separate strategy known as the Industrial Development Strategy (IDS). The strategy recognized the private sector as an engine for fostering industrialization and augmenting structural transformation process of the economy. The strategy clearly stated that the government tasks for promoting private sector development: (i) creating a conducive business environment at all levels for all, ii) providing direct support to strategically selected subsectors of private sector investment such as: textile and apparel, meat, agro-processing industries, construction, and Micro and Small Enterprises (MSEs). In addition, IDS provides a range of support programs (such as economic incentives and capacity building) for cluster development in the above priority areas of private investment in Ethiopia (FDRE, 2002).

The PASDEP (2005/2006 to 2009/2010) builds on policy support initiatives in the SDPRP and IDS aiming for the development of the private sector for the structural transformation and industrial development of the country. The plan envisaged creating a conducive business environment for private sector investment by providing multifaceted support, undertaking various reforms (such as institutional, regulatory, and financial sectors), and strengthening the complementary role of the government with greater domestic and foreign private participation. The plan considers private sector development as a key for realizing the development of the industrial and export sectors of the economy. The plan identified key sectors for private sector investment participation that include (i) agricultural and rural sector, (ii) infrastructure, construction, power generation, and downstream telecommunication services, and (iii) social sectors such as private primary and secondary schools in urban areas, technical and vocational training, and higher education, as well as opportunities in the private provision of health care services. As outlined in the plan, the role of the government is to support and fill the gaps that could not be adequately covered by the private sector and maintain macroeconomic stability, stable exchange rate, and lower inflation rate, which are integral parts of private sector development in Ethiopia (MoFED, 2006).

In GTP-I (2010/2011 to 2014/2015), the government aimed to ensure macroeconomic stability to create a conducive investment environment for the private sector development such as: enabling the manufacturing industry to play an

active role in the economy, revising the investment code to encourage further private sector investment, undertaking privatization of government-owned industries to the private sector, maintaining international competitiveness, and providing support and create enabling environment for private sector engagement on productive subsectors particularly manufacturing subsectors. It also aimed to provide direct support on capacity-building programs such as twinning programs, benchmarking kaizen, industrial input supply, and skill development programs for the private manufacturing industry sector. Moreover, the plan clearly states boosting government investment in the development of industrial parks with the aim of transferring to private investors with utmost transparency and accountability (MoFED, 2010).

Under GTP-II (2015/2016-2016), the plan builds on the GTP-I and recognizes private sector development as a key for creating employment jobs and enhancing income on a sustainable basis. The plan also clearly explains the vision to become a leader in light manufacturing (sub) sector in Africa. The plan gives special attention to utilizing opportunities available for sustainable development and transformation of domestic investors. To this end, the plan envisages redirecting domestic private investors from service and construction subsectors toward manufacturing and providing institutional support for the transition of small manufacturing enterprises to medium and large scales. The development of aggressive industrial parks and agro-processing zones in different parts of the country contributed to addressing the bottlenecks related to production and logistic constraints and thereby, enhance the productivity, quality, and competitiveness of both domestic and foreign investors. In addition, the plan aims to create conducive environment for Foreign Direct Investment (FDI) and attract investment in the key sectors of the economy (manufacturing). To this end, the revision of investment regulation was endorsed and approved by parliament and the council of Ministers in 2012 (PDC, 2016). In contrast to PASDEP, GTP-I and II placed less emphasis on balanced private sector investment in the productive sector of the economy (both agriculture and industry).

The ongoing TYDP (2020/2021 to 2029/2030) took private sector-led economic growth as one of the strategic pillars. It aims to create a conducive investment atmosphere and incentivize domestic investors aiming to strengthen their participation in the key productive sectors of the economy; building strong and market-led public-private partnerships to ensure the establishment of an inclusive and pragmatic market economy; enhancing the provision of quality infrastructure to attract quality FDI inflow to the county; identifying and optimizing new sources of

growth; empowering and stimulating private sector investment in strategic key areas that provide inclusive growth, and emphasizing public-private partnerships on problem-solving innovations and research activities for inclusive growth and assuring sustainable development. Moreover, the plan also aims to strengthen the role of FDI in industrial parks to make Ethiopia's growth momentum more sustainable in the years to come (PDC, 2020).

3.1.1 Structure and Performance of Private Sector Investment across Development Plans

According to Ethiopian Investment Commission (EIC, 2021), a total of 113,127 private sector investment projects[4] were registered across all regional states and city administrations between 1991/2002 and mid-2021. Among the projects, the majority of the investment is owned by domestic private investors 94.75% (107,189 projects), and the remaining 5.25% (5,938 projects) is owned by foreigners. Out of the total investment projects registered, 7.87% or 8,901 projects are in the implementation (construction) stage, 43,363 projects or 38.33% have launched operations, while the remaining 59,400 projects or 52.5% are pre-implementation (licensed investment) projects by mid-2021. This means that less than half (46%) of the total registered private investment projects are converted into actual investments, indicating the slow pace of implementation of private sector investment projects over the past three decades.

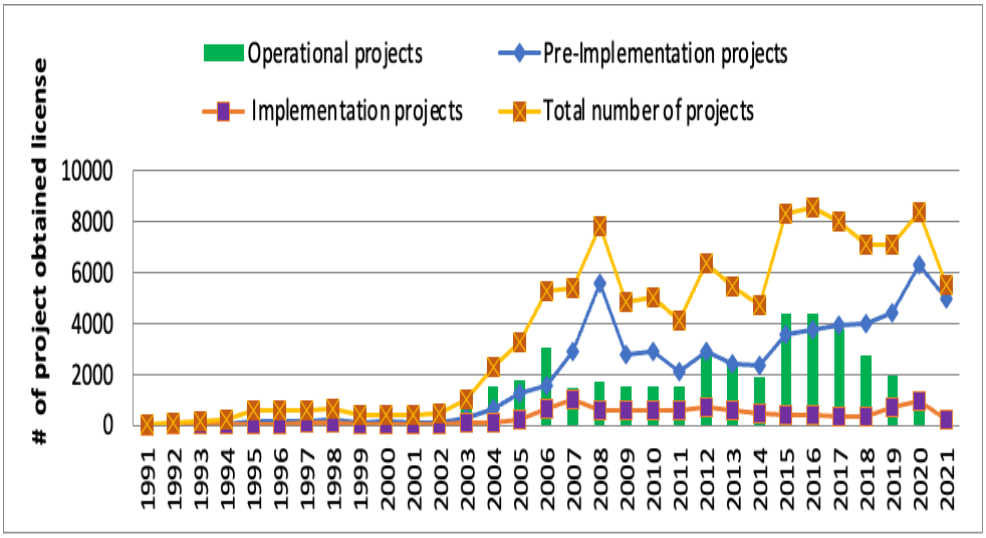
Figure 1 below shows the trends in total private sector investment projects under four different project stages over the last three decades. In response to the IDS in 2002, which clearly states the government's commitment to encouraging private sector investment in Ethiopia, a large number of investment projects (both domestic and foreign investment) have been increasing from 2003 onwards. However, the number of operational projects has been very low and has declined over recent years (from 2015 onwards).

According to the official figures from the EIC (2021), private sector investment registered a total capital inflow of 617.3 billion birr from 1991/2002 to mid-2021, of which 238-billion-birr capital (38.57%) invested during GTP-II periods, which is the leading of all development plan periods, followed by the capital invested 159.2 billion birr (25.79%) during GTP-I and 115.8 billion birr (18.76%)

[4] According to project stage of development, private sector investment projects are classified into different status; pre-implementation (licensed projects), implementation (under-construction), and operational projects (EIC, 2021)

during PASDEP periods respectively. However, the capital invested in private sector investment decreased to 51.9 billion birr (8.41%) at the beginning of the TYDP period. This implies that the total capital invested by private sector investment is leading during the GTP-II period in response to the policy direction that placed much emphasis on directing private sector investment toward manufacturing sector of the economy.

Figure 1: Operational status of private sector investment projects, 1991/1992-2021

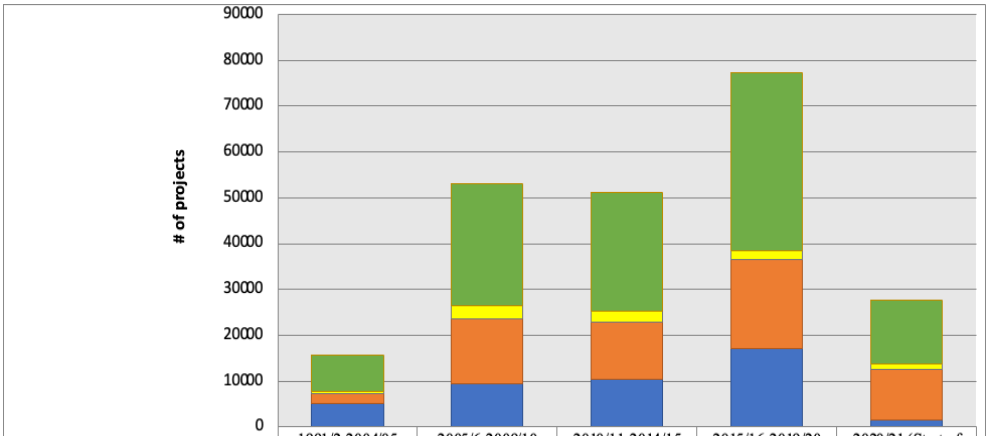


Source: EIC, data accessed on September 2021

Figure 2 shows private sector investment flow by the status of projects across development plans. The first period spanning 1991/2002 to 2004/2005, which constituted both the SDPRP and IDS, was a period of the beginning of private sector investment inflow in which from a total of 7,828 projects, 7.61% (5,034 projects) were operational during the periods. Subsequently, during the PASDEP periods (2005/2006 to 2009/10), from a total of 26,560 projects, 9,421 or 10.48% of the projects were operational. In the third period, GTP-I (2010/2011 to 2014/2015) registered 25,942 projects, of which only 9.76% (10,340) were operational projects. The fourth period, during GTP-II (2015/2016 to 2019/2020), registered a total of 17,114 projects, of which only 5.07% of the projects were operational during the period, which is the maximum compared to all five-year development plans. Finally, the last period is the beginning of the current TYDP (2020/2021 to 2029/2030), registering a total of 13,885 projects, of which 8.05% (1454 projects) are operational.

This shows that the implementation rate of the projects is higher during GTP-II and has shown improvement across all plans over time but is still very low compared to the number of licensed projects in all plan periods.

Figure 2: Private sector investment inflow across development plans



	1991/2-2004/05 (SDPRP & before)	2005/6-2009/10 (PASDEP)	2010/11-2014/15 (GTP-I)	2015/16-2019/20 (GTP-II)	2020/21 (Start of TYDP)
Total # of projects.	7828	26560	25942	38912	13885
# of implemented projects	593	2773	2469	1948	1118
# of pre-implementation projects	2169	14265	12491	19383	11092
# of operation Projects	5034	9421	10340	17114	1454

Source: EIC, data accessed on September 2021

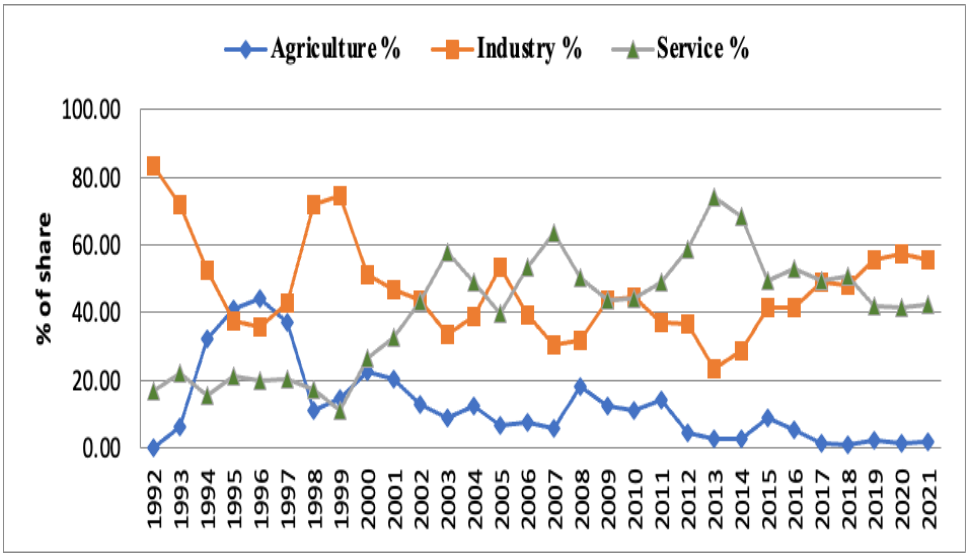
3.1.2 Performance of Private Investment across the Main Sector and Subsectors

Private sector investment inflow contributes to the development endeavor of the country peroxide by the amount of capital invested among the main subsector of the economy over the last thirty-one years (1991/1992 to mid-2021). Out of 43,363 operational investment projects, 21,984 projects (50.70.04%) are service sector investments, 18,556 projects (42.79%) are industry projects, and the remaining 2,823 projects (6.51%) are agriculture sector investment projects (EIC, 2021). This shows that the majority of private sector investment has been made mainly in the non-productive sector of the economy over the last three decades.

Figure 3 shows the trends of the operational number of project shares across the main sector of the economy from 1991/1992 to mid-2021. The total number of operational projects of the service subsector led from 2005/2006 to 2017/2018 and subsequently declined from 2018 to 2021. The industry subsector took the lead starting in 2018 and showed incremental trends from 2013 onwards. However, the agricultural subsector share depicts declining trends over time that span from 1996

to mid-2021. This shows that the majority of operational private investment projects are from service or industry sector with lower investment projects in the agriculture sector over the last years. This might be policy support starting GTP-I and GTP-II plans, which have placed much emphasis on the manufacturing industry and hence resulted in good progress in shifting private investment inflow from the service sector to the industry. However, balanced policy support for the productive sector between manufacturing and agriculture sectors is crucial in the years to come.

Figure 3: Private sector investment inflow subsectors

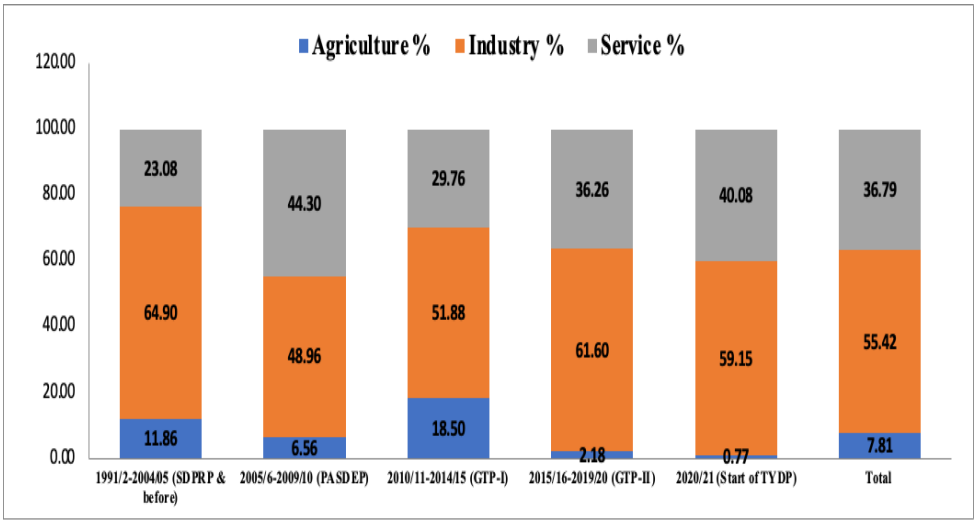


Source: EIC, data accessed on September 2021

Figure 4 below shows the sectoral distribution of the invested capital share of investment projects across the successive development plans. Out of a total of 617.3-billion-birr capital investment made over the last three decades, the industry sector took the leading share with 342.1-billion-birr capital (55.42%), followed by service with 227.1 billion birr (36.79%) and agriculture sector with 38.2 billion birr (7.81%), with a leading similar sector rank in all development plans showing lower investment inflow to the agriculture sector over the three decades. This partly depicts the effectiveness of GTP-I and GTP-II policy support to redirect private sector investment toward productive sector (industry). As a result, most private sector investment seems to channel towards the industry sector over the ten years. Although the performance of the industry has been impressive during the GTP-II, the figure suggests substantial declining trends of agricultural investment with increment trends

of an operational project in the service sector during the periods. The result suggests that there are some promising signals which the industry sector might have begun to emerge with no or little agriculture sector investment which indicates the less nascent structural change in the productive sector of the economy.

Figure 4: Sectoral breakdown of investment projects (capital invested share) across development plans



Source: EIC, data accessed on September 2021

The creation of employment opportunities by private sector investment projects has increased for temporary or casual works. However, permanent employment opportunities have declined in recent years. Private sector investment projects, which started operation, created a total of 941,496 (23.9%) permanent employment and 2,997,196 (76.1%) temporary job opportunities from 1991/1992 to mid-2021. Looking at the share of employment in the major sector of the economy (i.e. agriculture, industry, and service), out of the total employment opportunities, 57.27% (225,576 jobs) was created by the service sector, 24% (945,671 jobs) by industry, while the remaining 737,261 employment jobs or 18.72% was created by the agriculture sector (EIC, 2021). This shows that the majority of employment opportunities are created by the service sector, while the industry and agriculture are contributed less over the last three decades which shows the infancy stage of the productive sector of the country.

According to the EIC secondary data, the trends of the share of permanent and temporary employment opportunities created by private sector investment

projects over the three decades. The results show a declining pattern in the share of permanent employees from 1994to mid-2021, except for an increase in 2013, while temporary employees show increasing trends (the highest in 1992 and lowest in 2013), which is contrary to the government plan. The most relevant type of employment is permanent, since human capital skills and technological know-how are provided by permanent rather than temporary workers, and therefore due attention and incentive schemes should be given to private sector investors to opt for permanent forms of employment rather than temporary employment in the years to come.

Based on the EIC data from the past three decades, the largest agriculture sub-sector investment is found in the agriculture, hunting, and forestry subsector (95.91%) and distantly followed by the fishing subsector for both domestic and foreign investments over 1991/2 to mid-2021. The result suggests that less or no private sector investment (domestic and foreign) in the fishing sub-sector, which is one of the comparative advantages of exploitable fish potential in response to the development of various dams including the Great Renaissance Dam (GERD) of Ethiopia. On the other hand, the private sector investment sectoral share of capital invested within the industry sector from 1991/1992 to mid-2021. The total capital invested by foreign investors in the manufacturing subsector took the leading share (85.57%), followed by the construction subsector (11.09%), whereas the remaining few foreign investors engaged in electricity, mining, and quarrying subsectors. However, the total capital invested by domestic investors took the leading in mining and quarrying (84.51%), followed by the construction subsector, while the remaining few domestic investors engaged in electricity and manufacturing subsectors. This suggests that domestic private investors' engagement in the manufacturing subsector remained less satisfactory despite GTP I and GTP II policy attention and incentives given to redirect the private sector toward manufacturing sector since the sub-sector would spearhead and transform other industry sectors of the economy This might be because domestic private investors lack industrial knowledge, technical and managerial skills and experience in operating large manufacturing industries. Therefore, the participation of domestic private investors in the manufacturing subsector has been limited in recent years.

The EIC data on the sectoral share of capital invested by private sector investment within the service sector from 1991/1992 to mid-2021. The leading two service subsectors in terms of invested capital in operational projects by both foreign and domestic investors are real estate, which includes machinery and equipment, rental and consultancy services (61.36%), hotels, and restaurants (25.53%). The

other three subsectors have a share of 0.7 to 5.3 percentage points. This indicates that private sector investment (both domestic and foreign) has been lopsided more towards a few service subsectors, which might be due to the lower level of start-up capital requirement, technical and managerial capability, the lower payback period of capital return, and associated risks compared to those in the service sector. In addition, the concentration of the private sector on a few service subsectors might be due to the short-term profit maximization motives of firms.

3.2 Sectoral Composition of Private Sector Investment

The data obtained from the EIC cover private capital investment in major economic activities over the last three decades (1991/1992-mid-2021) in Ethiopia. For this study, the data were organized considering three major sub-sectors, namely: the agricultural, industry (manufacturing) and service main sectors of the economy. The data were further examined for each subcomponent of the sectors to unpack and characterize and evaluate the overtime performance of private sector investment in the country.

3.2.1 Capital Investment by Private Sector on the Subsector of the Economy

The service sector was the most important sub-sector to attract capital investment over the last three decades (1991/1992-mid-2021), followed by the manufacturing sector. Among the various major service sector investments, capital invested in real estate, machinery and equipment, rental and consultancy services stand first, followed by hotels and restaurants. The average capital invested in mining and quarrying is the leading from industry sub-sector due to huge investment requirement compared to other investment in the industrial sector. While the agricultural sector has been considered the leading sector toward economic growth and development and backed by all the development policies thus far, the average capital investment in the sector is by far smaller than investment in subcomponents of the service sector such as Hotels and rent. Although it is not possible to draw any implication at this level, it clearly shows a divergence of the policy directives and what has exactly been happening on the ground (Table 1).

The results in Table 1 above and Figure 5 below also provide a glimpse of the resource allocation of the country over the last three decades. Even in the service sector, the most important sector from the societal perspective, such as education and health, had been given less priority to invest in. Generally, private sector investment

in Ethiopia seems more focused on less risky and high-turn of return investment sectors than high impact and long-term societal welfare.

Table 1: Average capital investment by subsector in billion birr (1991/1992-mid-2021)

Subsectors Sectors	Capital (in billion birr)		
	Domestic	**Foreign**	**Total**
Agriculture, hunting & forestry	35.1	11.1	46.2
Fishing	0.0	2.0	2
Agriculture total	35.1	13.1	48.2
Manufacturing	0.2	110.6	110.8
Construction	32.9	13.8	46.7
Mining and quarrying	183.6	0.5	184.1
Electricity	0.6	0.0	0.6
Industry total	217.2	124.9	342.1
Education	9.4	0.4	9.8
Health and social work	11.1	1.0	12.1
Hotels and restaurants	55.6	2.4	58
Other community, social and personal service activities	1.8		1.8
Real estate, machinery & equipment, rental & consultancy services	133.6	5.7	139.3
Tour Operation, Transport and Communications services	3.8	0.7	4.5
Wholesale, retail trade and repair service	1.6		1.6
Service total	216.9	10.2	227.1
Total	469.2	148.2	617.4

Source: EIC data accessed on September, 2021

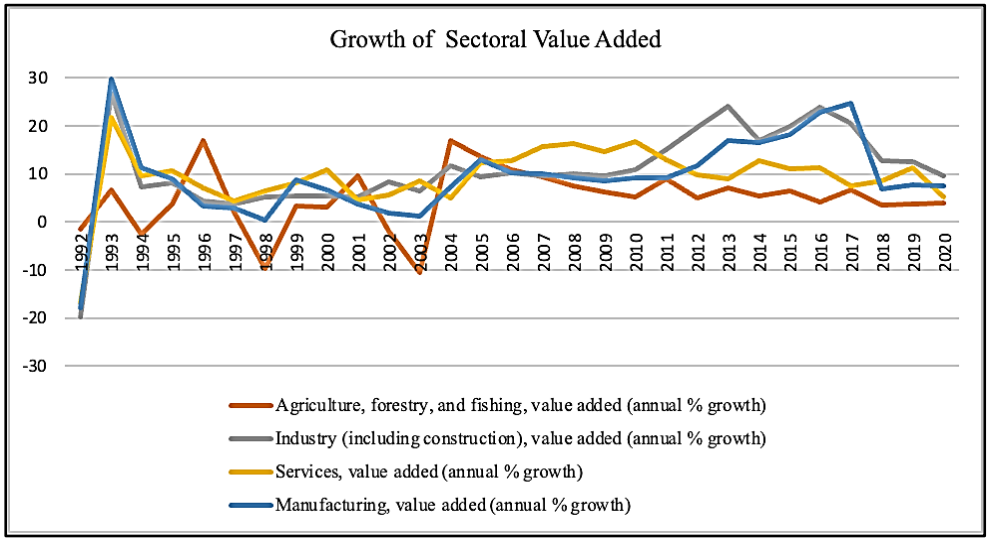
3.2.2 Evolution of Sectoral Value Added

The overtime trend of annual growth of sectoral value added is mixed. Immediately after the regime change (1992), all the sectors showed a boom except the agricultural sector. Of course, the economic recovery effort by the current government could be the major push factor for the sharp rise. Although there was a consistent and almost identical change in value added growth during the 1994-2004 period, for the industrial service and manufacturing sector, the agricultural sector exhibited larger swings. The unhealthy fluctuation in the agricultural sector value added could be linked to policies such as agricultural development-led

industrialization, which were resource shifts and extensive but sporadic interventions in the sector because of market liberalization and privatization.

Figure 4 above shows that after 2005, the change in agricultural sector value added declined gradually, and the pattern depicted trends similar to those of the service sector. However, the industrial sector overtook the service sector starting 2011 onward. The pictorial view depicted in Figure 5 is consistent with policy directives such as GTP I and GTP II, where much focus is given to enhance value-added activities in the manufacturing sector. Nonetheless, the value-added growth in the agricultural sector remained stagnant, while it still contributed to the lion's share of GDP of the country. Moreover, in recent years (starting in 2017), the value-added growth of all sectors exhibited declining and mixed patterns.

Figure 5: Percentage growth of sectoral value added



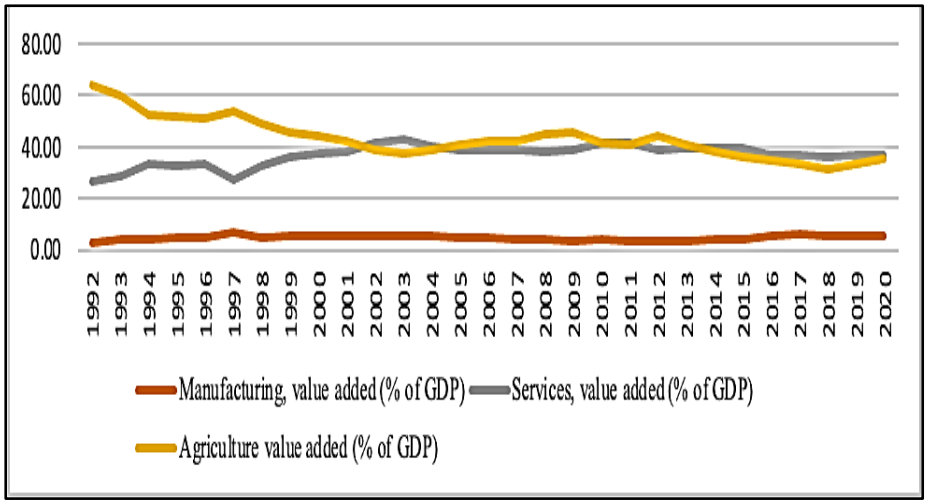
Source: Own computation (NBE and WB data 2020)

3.2.3 Evolution of GDP Composition

In this subsection, the manufacturing sector is given due attention, as the relative development of this section is sluggish, in contrast to the government plan. The sectoral distribution of growth of each sector in percentage shows heterogeneity over time (Figure 5). However, the percentage contribution of the main sector's value addition tells a very different story (Figure 6). The manufacturing sector's contribution to the overall value added (% GDP) is stagnant throughout the period covered. On the other hand, the service sector has been competent with the agricultural sector, which is against the structural pathways of the economy, in which the share of the agricultural sector was expected to decline while the manufacturing sector competed with the service sector.

The converging pattern of the agricultural and service sector over the last three decades clearly shows that the economy is burdened with pure consumption. Unless the consumption demand from the service sector (demand) is backed by equivalent output (supply), it becomes distortionary and consequently economically unstable.

Figure 6: Sectoral Value Added



Source: Own computation (NBE and WB data 2020)

3.3 Long-Run and Short-Run Deriving Forces of Private Investment

The advantage of the ARDL approach over other multivariate time series techniques is that estimation of the short and long-run coefficients does not require any form of prior stationarity of the right-hand side variables (Pesaran et al., 2001).

However, there are a series of steps to be followed before determining the final model specification. Accordingly, prior to running the ARDL model specified, parsimonious lag for each series was determined using Akaike Selection Criterion (AIC) optimum lag length determination criteria. Accordingly, ARDL (3 1 1 1 0 0 11 0) was found to be the appropriate specification. Furthermore, the robustness of the model was tested using the Ramsay Regression Specification Error Test (RSET) for variables, and the model was found to be the most robust.

Given that the data are short, the ARDL model fitted using the AIC to capture the long-run effect of the selected regressors. In addition, consistency of the long-run relationship was tested using the Pesaran/Shin/Smith (2001) ARDL Bounds Test approach, and the result was found to be significant (F 7.494), which is much higher than the critical values at the 5% significance level (I-1 critical value = 3.12). This test result implies that we can confidently reject the null hypothesis, meaning that there is a significant long-run relationship between private investment and the regressors.

The estimated ARDL model revealed that out of eight explanatory variables, four variables have a significant long-run relationship with private investment. In the long run, Real Effective Exchange Rate (REER), Government Expenditure (GOVEX), Credit provided to the private sector (CREDIT) and Real Interest Rate (RIR) have a positive significant effect on private investment in Ethiopia (Table 2).

Real effective exchange rate is found to be significant at 10% significance level. Real effective exchange rate is a measure of competitiveness of domestic products in the international market a one percent increase in competitiveness index of the country results in a 0.25 increase in private sector investment and hence it is important to look at the change (improvement) in real effective exchange while dealing with exchange rate policies

Theoretically, government expenditure crowds out private investment in the short term but crowds in the effect of private investment in the long-run (Laopodis, 2001). Consistently, the long-run coefficient estimates of government expenditure revealed that there is a positive and significant causal relationship between government expenditure and private investment. This implies that government expenditures on infrastructure developments (such as transport, energy and social services) will not have instantaneously stimulated effects and will not create a shortage of loadable funds for private sector investment (Ayeni, 2020; WBa, 2016). Therefore, the long-run result is theoretically, empirically, and practically consistent.

Credit is proved to be a source of capital to boost private investment in an economy. In line with the result reported by Solomon (2021), the long run estimates

of credit offered to private investment revealed that there is a positive and significant effect. A one percent increase in credit increases private investment by about 0.12 percent. This result shows more attention should be given to the provision of credit service in order to realize the potential of private sector investment contribution to the country's economy.

Table 2: Estimated long and short-run coefficients using the ARDL (3 1 1 1 0 0 11 0 1)

Variables	Coefficient	Std. Err.
Long run dynamics		
Lagged value of Total Privet Investment, TPI (L1)	-1.967***	0.404
Real GDP (RGDP)	0.001	0.004
Unemployment Rate (UEMPT)	-2.086	2.903
Real Effective Exchange Rate (REER)	0.246**	0.083
Government Expenditure (GOVEXP)	0.945*	0.437
Terms of Trade (TOT)	0.019	0.049
Credit provided for privet sector (CREDIT)	0.121**	0.039
Inflation rate (INFL)	-0.162	0.108
Real Interest Rate (RIR)	0.276*	0.134
Short run Coefficients		
TPI		
L1.	0.491	0.298
L2.	0.493*	0.264
lnRGDP (L1)	0.049	0.002
ln UNEMP(L1)	-9.099	10.16
lnREER (L1))	0.484*	0.264
lnCREDIT (L1)	1.127**	0.360
lnINFl (L1)	0.193	1.617
_cons	0.670	0.425

Note: ***, ** and * are significant at the 1%, 5% and 10% levels, respectively
Source: Model Result

Real exchange rate if found to have a positive and significant effect on private investment. Since real interest rate is the difference between inflation and the

bank interest rate, its value is negatively worsening overtime due to the fact that inflation is usually higher than the bank interest rate. Therefore, the result of the study is in line with the reality on the ground. The implication is that the higher the real exchange rate in its absolute value, improves private investment. Meaning that investors prefer to reinvest the profit they make as well as their savings rather than depositing it in the bank. However, it is very crucial to cut a balance between the savings from most of the society where the marginal propensity to consume is too high. For this parcel of the society, an increase in real interest rate will discourage saving, thereby investment.

Once the long-run cointegrating model has been estimated, the third step is to model the short-run dynamic parameters within the ARDL framework. Thus, the lagged values of all level variables (a linear combination is denoted by the error-correction term, ECMt-1) are retained in the ARDL model. Table 2 presents the results of the estimated Error-Correction Model (ECM) of the private sector investment model using the ARDL technique. The result shows lagged value of total investment (L2), real effective exchange rate (REER), and credit has positive effect on private investment.

The autoregressive short-run effect of private investment was found to be significant, implying that there is a positive spillover effect of last-year's investment on the present. This result is in line with rational expectation theory, where investors are rational and do have information about the industry. Hence, the more vibrant industry in the last period stimulates investment in the current period.

Consistent with Ayeni (2020), real effective exchange rate is found to have positive and significant effect on private investment in the short run. This result is consistent with economic theory, which implies the real effective exchange rate increases the overall competitiveness and hence stimulates private investment (Romer, 1996). Exchange rate policies are important to bring instantaneous changes in private investment, as well as sustain and stimuli economic activity in the long run. Similarly, the short run result shows credit has positive and significant effect on private investment in the short run and suggesting rectifying financial services boost private investment in the upcoming years.

3.4 Challenges and Constraints of Private Sector Investment in Ethiopia

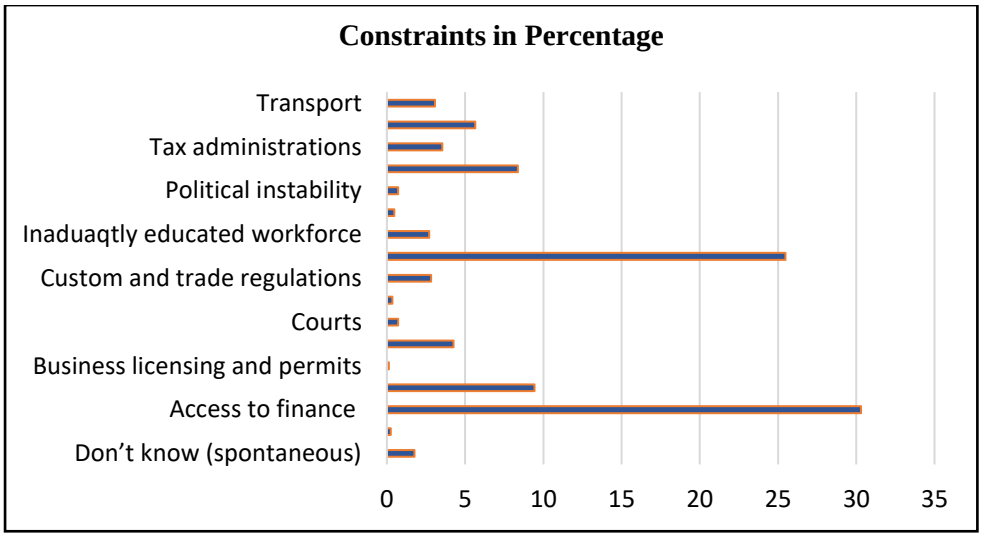
This section examines the main challenges and constraints of private sector development in Ethiopia. A series of economic reforms have burnished and promoted the country's profile among the international private sector keen to tap

Ethiopia's competitive labor force, emerging domestic market, and regional trade access (FDRE, 2020). The government aims to expand the role of private sector investment by providing various policies and strategies to support the development of industrial parks to encourage FDI inflow to the country. In response, the country's exports, job opportunities, and transfer of knowledge and technology have been improving over time (WB, 2021). However, the government made much investment in industrial parks to be transferred to private sector investors and attempted to rectify various constraints and challenges, which would limit both competitiveness and capacity of resilience to various shocks in private sector investment.

The result of various empirical studies shows that the private sector faces key challenges which prevent it from playing a much greater role in driving economic growth and job creation (Kifle and Atilaw, 2018). In addition, the ongoing COVID-19 pandemic and political unrest, which are causing instability in different parts of the country, are adversely affecting private sector investment, with direct impacts on consumer demand decline, contracted product markets, the blocking of foreign Revenue and importing valuable inputs have access to finance and are vital to private sector development (FDRE, 2020). Therefore, in exploring the contemporary challenges and constraints of private sector investment in Ethiopia, this study explored different datasets namely: the Enterprise Survey (2015), Primary Manufacturing Survey (2020), and Phone Survey Data (2020/2021). Based on these survey results and from the critical empirical reviews of previous studies, the main constraints and challenges of private sector development in Ethiopia identified by the present study are indicated as follows:

Limited access to finance services: As shown in Figure 7, the enterprise survey of WB (2015) showed that from the 848-enterprise survey interviewed, 30.31% of the respondents reported that access to finance was the main constraint encountered during the establishment of private sector investment in Ethiopia. Similarly, access to finance was also found to be a leading constraint of private sector investment in a more recent primary manufacturing survey of the WB (2020). Inefficient financial markets increase the reliance on internal funds or informal sources by connecting firms that are creditworthy to a broad range of lenders and investors. A firm's ability to access financial markets to undertake investments and other operational requirements appears to be a prominent obstacle. The sources of a firm's financing and the features of their financial transactions by excessive dependence on internal funds may indicate potentially inefficient financial intermediation. Ethiopia's government exerts a variety of control mechanisms over the banking sector that constrains firms' access to finance.

Figure 7: Constraints of private sector investment during the establishment of businesses



Source: Author's estimate from Enterprise survey (2015).

As shown in Figure 7, the main problem related among Ethiopian enterprises to access finance was related to the loan problem. Based on the estimated result obtained using primary manufacturing survey (2020) data, approximately 51.13 respondents reported that they faced loan problems during the establishment of the manufacturing industry. The loan related problems include insufficient permitted loans, inability to fulfill loan requirements, high interest rates, short loan durations, bureaucracies, and long loan procedures. This finding identified low percentage of firms financed by banks in Ethiopia. Since commercial banks generally serve Ethiopia's largest firms and regionally focused microfinance institutions tend to micro-scale enterprises, the needs of the "missing middle" of small and medium-sized enterprises largely go unmet. This was also reported by Dalberg (2019) and FDRE (2020). For instance, starting in 2014, Ethiopia shows that mixed signals of constrained access to finance characterized by a rise in the saving rate, increasing the supply of funds for lending, and as a result, private bank lending to private sector investment has risen by 22 percent annually. However, survey results revealed that the bulk of investments continue to be self-financed or served by the black market. Although improvement in the financial landscape has made significant progress for the development of private sector investment, finance remains a notable weakness and has been characterized by low domestic savings mobilization, underdevelopment of capital markets and insufficient credit to key sectors (Tyson, 2021).

Lack of Physical Infrastructure: This includes electricity, transport, and water supply, which are prerequisites for competitiveness and growth in the private sector investment. The quality of physical infrastructure efficiently connects private businesses to markets for inputs, products, and technologies, reduces the cost of production, and enhances the competitiveness of business in local and international markets. As shown in Figure7, according to the enterprise survey of the WB (2015), approximately 25.4% of interviewed private sector investors replied that electricity is the second constraint that hinders the establishment of private sector investments.

Furthermore, according to a primary manufacturing survey of WB (2020), approximately 7.15% of interviewees reported that they faced a shortage of electricity and water supply in the manufacturing industries and hence, hindered the full capacity operation of the businesses. An inadequate electricity supply can increase costs, disrupt production, and reduce the profitability of businesses. A variety of indicators shows unreliable access to electricity as a constraint on economic activity. According to Abdisa (2018), frequent and prolonged electricity power outages harm employment, productivity, and export earnings in all private sector developments. Specifically, electric power distribution and generation are the binding constraints on private sector investments in Ethiopia. The distribution of electric power either remains incomplete or has been degraded due to poor maintenance and results in low availability and frequent outages, which interrupts production and raise costs for firms that rely on a steady, predictable power supply. Ethiopia has embarked on an expansion of power generation capacity with projects scheduled for completion in the next few years, but the obsolescence of transmission and distribution infrastructure continues to compromise reliable supply.

Transport is another physical infrastructure that hinders the development of private sector investment. Based on the enterprise survey of the WB (2015), approximately 3.07% of Ethiopian firms report that transportation is one of the constraints for private sector investors. Ethiopia's current state of transport and logistics performance imposes an additional layer of costs to firms seeking to export and generate foreign exchange rates. The inefficiency of transport services imposes additional costs on firms and may act as barriers to private sector investment. Moreover, based on the World Bank's Logistics Performance Index, which considered infrastructure, timeliness, customs, and logistics quality, Ethiopia is ranked last compared to Kenya, Rwanda, and Uganda. Much of this index shows poor road quality and connectivity (WB, 2021). Ethiopia's road network also lags far behind its comparators, with the average rail density of its comparators exceeding Ethiopia by more than twelve times. According to Nakamura et al. (2019) and Iimi

et al. (2019), Ethiopia's export transit has taken 42 days, far exceeds Rwanda and Uganda, and is twice as long as Kenya. Underlying this delay, the long inland distance to the Djibouti port delays the document preparation of port handling and customs clearance processes, which are also longer and costlier. Consequently, these notable constraints are due to the long bureaucratic process involved and the existing legal arrangement among constraints that hinder the private sector.

Ethiopia has abundant water and sanitation resources; nevertheless, much of Ethiopia's private sector investments face challenges in terms of water supply and access to safe drinking water. For many manufacturing industries, water is also an important input in the manufacturing process. Interruptions in the water supply can have serious adverse effects on firms' operations. In the absence of absolute scarcity in much of the country, the technical cost of withdrawals primarily drives the price of provision (WB, 2021). In surveys of the manufacturing sector, water insufficiency does not appear to be a significant constraint when compared to other potential issues in terms of percentage reports.

Access to land: According to the enterprise survey data of WB (2015) in Figure 7, the private sector investors interviewed, approximately 9.4% of the respondents replied that access to land discouraged private sector investment. Access to land was challenged by inadequate support from the government side, followed by poor implementation and enforcement of the policy at all levels and inadequate access to land. In Ethiopia, reforms to land policies are related to land certification campaigns that introduced land use rights through long-term leases, as well as permission to rent, transfer of usage rights, and bequests.

Land continues to account for the bulk of the government's dispute resolution activities and processes taking a long time and has more cost of transferring land between parties and the reliability and transparency of its administrative processes. The government should pay compensation if the land is given for private sector investment as a form of leases but often complain that the compensation paid has been reported to be unfair and inadequate, as a result, would be a source of conflict and instability (Stebek, 2015). Specifically, the Ethiopian government's development of industrial parks throughout the nation has recently solved land for large, foreign-owned factories and other manufacturing industries to improve land constraints facing private investors in the country (FDRE, 2020). However, it is not sufficient for domestic private sector investors and those who engaged in micro and medium enterprises. The study identified challenges of enhancing tenure security to facilitate the emergence and coalescence of a strong private sector investment. In connection to this, Stebek (2015) notes that Ethiopian

land governance faces challenges in the availability, transferability and affordability of land access for business activities.

The practice of informal market: Formal private business exists and operates inside the bounds of government regulations. The effect upon practices in the informal market influenced the competitiveness of formal firm. According to the estimated result of the enterprise survey data of WB (2015) (Figure 7), approximately 8.37 percent of respondents reported that informal market practice adversely affects formal private business. The practice of informal marketing activities and inadequate regulatory tax systems may affect the development of formal private businesses. Thus, these adversely influence market opportunities for formal businesses. Formal firms can impose additional costs of production compared with a business engaged informally and could not compute in the market. Moreover, financial inefficiencies of the labor force from formal firms may affect the growth of business. Consequently, it creates more opportunities for informal business. According to Amha (2019), firms from the formal sector do not develop faster than firms from the informal sector.

Tax-related issues: Tax rates and poor administration system are the main obstacles hindering development of privet sector investment in Ethiopia. According to World Enterprise Survey of WB (2015) result findings, the main reasons were high tax rates (5.66%) and poor tax administration (3.54%) (Figure 7). The result attested those investors were challenged by inadequate support from the government side related to tax rates and tax administration. Moreover, poor implementation and enforcement of the policy at all levels were also found to be a challenge negatively influencing private sector investment. Thus, good governance in areas of taxation is a fundamental issue to create a conducive business environment. Formal businesses pay taxes and are supposed to comply with regulations, and tax administration and regulations safeguard the general public's interest while remaining transparent and not imposing the administration process on private sector investment. Gizachew et al. (2021) and Nikus (2021) also confirmed that the reformation of tax administration and regulations should be undertaken to improve private sector investment in the productive sector of the economy.

Corruption: The finding showed that corruption is also the main challenge and constraint in private sector investments in Ethiopia. Corruption in response to lack of transparency and regulations ensuring accountability of the regulatory environment is critical to the success of private-sector investor operations. When these rules are obscured or bent due to corruption, firms may limit their full capacity operation. The result of the enterprise survey of the WB (2015) shows

only approximately 4.25% of the respondents replied that corruption is an obstacle for the establishment of the private sector. Private investments' investors are requested to pay a bribe to obtain selected services when they request a construction permit while trying to secure a government contract or during meetings with tax officials. This act creates an unfavorable business environment by undermining operational efficiency and raising the costs of production. Corruption and bribes are common and quite high and add to the bureaucratic costs of obtaining the required permits and licenses. This can be an obstacle to the development of private sector investments. This is due to lack of institutional capacity and poor system. Based on this finding, the present analysis flags corruption as problematic but not a binding constraint on private sector investment in Ethiopia.

Inadequately educated workforce: Despite improvement in the overall educational coverage over the last years, results pointed out that lack of adequate qualified educational professionals in the labor market affects private sector investment in Ethiopia. There has been a significant improvement in formal education in Ethiopia. Accordingly, secondary education has risen steadily to reach approximately 40 percent (WB, 2020). Meanwhile, the young workforce accounts for a growing portion of human capital. The World Bank Enterprise survey (2015) result shows 2.71% of the responses was related to the problem of quality of educated workforce (see in detail Figure 7). The respondents reported that the supply of labor from college and university graduates lacks the required technical knowledge and skills. Therefore, private sector investors remain dissatisfied with the availability of quality-educated workers in the labor market. According to MoE (2019), most graduates lack soft skills such as teamwork, creativity, and initiative. These problems discourage private businesses' ability to innovate and grow, which is basically due to weak linkages between industry and universities.

Custom and trade regulations: Customs and trade regulations include issues related to policies and conditions, profit taxation, protection of property rights, and business regulation. They are also the main challenges and constraints in private sector investments in Ethiopia. Involvement in international trade permits private sector investment to expand, raise standards for efficiency, import materials at lower cost, and acquire updated and better technologies. However, trading requires firms to deal with customs and trade regulations and is necessary to obtain export and import authorizations. Customs and trade-related constraints can often delay the timely delivery of goods and services to the international market. According to the World Bank (2021), compliance costs for imports in Ethiopia are more than double compared to Sub Saharan Africa (SSA). However, exports are about the same as

SSA. Border compliance costs are much lower than SSA. Overlapping institutional setup and lack of coordination create conflicting authorities across different government structures and have brought complaints from private businesses that rely on the well-coordinated administration of regulations and procedures. From the World Bank enterprise survey results, approximately 2.83% of private-sector investors replied that they faced obstacles to customs and trade regulations (see Figure 7). Efficient custom and trade regulations enable businesses to export and import goods directly. Delays in clearing customs for exports and imports create additional costs to the firm. These can interrupt production, interfere sales, and affect supplies or merchandise.

Shortage of foreign exchange: Based on survey results of WB (2020), the shortage of foreign exchange was one of the obstacles that hindered the full operation of manufacturing industries. Approximately 3.76% of interviewers reported that shortage of foreign exchange is one of the constraints that adversely affects the operation of manufacturing industries. The survey results revealed that the constraint related to shortage of foreign currency has pushed import-reliant businesses to break production and even close their doors due to stock-out products. The manufacturing sector mainly imports most raw materials through international trade. Burdensome regulations and span systems of tracking, certifications, and licensing add further costs, such as lengthy stoppages of operations and frequent business closes. Consequently, the shortage of foreign exchange adversely affects firm activity, goals, and factors of production. This shows that government foreign exchange services do not keep pace with the demand for imports in private sector investors in Ethiopia.

The time and opportunity costs associated with securing foreign exchange create additional costs for firms. Domestic private investors are obliged to purchase foreign exchange from the black market by incurring higher costs. Additional reports reveal that firms exert greater pressure on government offices to obtain hard currency, whether through lobbying or bribes or looking at the black market. Not surprisingly, firms operate within government-designated priority sectors, and foreign-owned firms have independent access to foreign currency. Recently, one of the causes of shortage of hard currency in Ethiopia is due to the gradual overvalues the Ethiopian birr against the U.S. dollar.

4. Conclusion and Recommendations

The study assessed the structure and performance of private sector development and identified the key constraint and challenges, and explored its

contribution to the economy using secondary data and evidence from the past three decades. ARDL model was employed to analyze the long- and short-run driving forces of private sector investment. The study analyzed various policy measures designed by the government in response to promoting private sector investment in the country. The result shows an increment trend of the private investment projects (domestic and foreign) has been observed over recent years. However, the majority of investment is owned by domestic than foreign investors. Besides, the implementation rate of projects has been very low across all plans and has particularly declined in recent years. During the last three decades, private sector investment capital flow has been mainly made in the service sector with a minimal investment flow in the agriculture sector, but there are some promising signals in the industry sector which has begun to emerge over the last recent years (since 2018).

The top three leading sub-sectors in terms of capital inflow (both domestic and foreign) made by the private sector over the last three decades are real estate (machinery and equipment, rental and consultancy services) from service, mining, and quarrying from industry, and agriculture and hunting and forestry from the agriculture sector. Similarly, in terms of employment creation, the service sector remains the major contributor, followed by industry and agriculture in their respective order. However, the trends of permanent employment share declined over time. Ethiopia's domestic private sector investors mainly concentrated on real estate and its associated services (from service), mining-and quarrying (from industry), and with less participation in agriculture, hunting, and forestry (from agriculture) subsectors over the last three decades. This implies domestic private sector has not yet vigorously entered productive sectors (agriculture and manufacturing) of the economy. Most domestic private sector investment is concentrated in the service sector primarily due to a lack of industry knowledge, limited access to input markets, technical and managerial skills, experience in operating large manufacturing industries, and the short-term profit maximization motives of firms. Hence, the private sector plays less satisfactory role in the employment generation, export, and output growth of the country. In response to the policy support during GTP I and II, impressive progress of shifting private investment inflow from the service sector to the industry has been made over the last recent years, but less participation of domestic private investors in the manufacturing sub-sector, less participation of FDI, and no or little agriculture sector investment indicating less nascent structural change in the productive sector of the economy. This suggests scale-up the policy supports given to the manufacturing sector during GTP I and II to the agriculture sector

with more balanced policy support between the manufacturing and agriculture sectors are crucial during the current TYDP periods.

Private sector investment in the productive sector (industry and agriculture sectors) has a trickled down effect of boosting industrial competitiveness and accelerating structural transformation and is thereby, inextricably linked with a reduction in poverty and the unemployment rate from the economy. To this end, the government has to provide much policy support for the productive sector in general (agriculture and industry sectors) and particularly special support for some subsectors that the economy needs most (such as the manufacturing sector). The government should also scale up the policy support given to manufacturing industry during GTP I and II to agriculture sector during TYDP periods. For the productive sector to play the expected transformative role in the economy, the government has to introduce various incentive schemes (for both domestic and foreign investors) to be able to provide quality goods and services and maintain international export standards. The incentive schemes could target tax incentives, export promotion, employment/skills training, incentives for creating permanent employment opportunities, incentives for the adaptation and transfer of foreign technologies (to domestic firms).

The study found out the main constraints and challenges hindering private sector investment includes inadequate physical infrastructure (that is, electricity, transport and logistics, and water supply services), lack of input markets (that is, restricted access to financial services, limited access to land, lack of technically skilled labor force), weak institutional framework (that is, ineffective regulatory environments, malpractice in the informal market, corruption, custom, trade, and tax-related issues), and political instability that lead social unrest in different parts of the county. The results suggest that manufacturing firms have been hit the hardest by the pandemic in several channels which include the reduction of demand, shortage of raw materials and intermediate goods, restricted movement of workers, and absence from the workplace due to prolonged containment measures which lead to the forced closure of business and market place. Therefore, the government should also quickly address the constraints to improve private sector development through designing various short and long-term strategies to allow a much greater role for the private sector in driving economic growth and job creation in Ethiopia.

For the private sector to play the expected transformation role in the economy, the government should undertake the following main activities: create enabling business environment through providing a range of incentive schemes in the priority sector of the economy; resolve the bottlenecks through better functioning

of input market (labor, land and capital) through undertaking reforms in the financial sector, enhancing coordination within and between different layers of the government, and improving skillfully human resource shortages through continual capacity building training; providing quality physical infrastructures and supplying modern, affordable and sustainable energy, providing and facilitating required raw materials and machineries, strengthening inclusive Public-Private-Partnerships by providing preferential support for accessing raw material inputs, technologies, and financial services, and creating enabling business environment in the industrial parks; and ensuring consistent management strategies to minimize corruption, minimizing the violent uprisings by strengthening ways for ensuring peace and stability and build up the confidence of private sectors, and minimizing bureaucratic inefficiencies in the government and financial institutions.

The ARDL model result shows real effective exchange rate and credit have positive significant effect on private investment both in the short and long run. This result implies exchange rate fluctuation and accessibility of financial services are time unbounded constraints of private sector investment and hence financial sectors reform should be undertaken in view of leveraging private sector investment in the upcoming years.

Consistent improvement in real effective exchange rate of the country improves private sector investment. This is because improved real effective exchange rate means private investors have a consistent market and thereby improves their competitiveness on the international market. This is also an indicator of consistent market demand for domestic products in international markets, which is an incentive for private investors. Therefore, it is imperative to focus on production of exportable goods and services. This can be achieved through encouraging investment in high-value export-led manufacturing sector which is crucial to reverse the negative significant effect of currency devaluation and strengthen oversees purchasing power in the years to come. To this end, government should provide various economic incentives for the domestic investors engaged in productive sectors will help produce excess supply to improve the trade balance of the country.

Government expenditure has a positive significant effect in the long run but not in the short run. This is a good indicator that the government expenditure will augment private sector investment in the future. However, such government expenditure should be made priory on capital investment (such as physical infrastructure and development of parks), which naturally takes time to take effect. Therefore, it is helpful to focus on high-impact physical infrastructure and development of parks to stimulate private sector investment in Ethiopia.

Real interest rate has a significant positive effect in the long run but not in the short run. This is a good flag that an increase in real interest rate encourages saving and thereby private investment. The effect of real interest rate can be seen from two directions: the depositor and the borrower perspective. The policy measure that aims to improve real interest rate should maintain the tradeoff between saving and investment. To this end, the government should adjust real interest rate in such a way that encourages saving and private sector investment in the years to come.

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Impact of Nutrition-Sensitive Agriculture on Rural Women Welfare: A quasi-experimental design

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Article History: Received: 30 June 2023; Revised: 04 September 2023; Accepted: 02 October 2023

Abstract

Women's welfare, defined as a state of being happy, healthy and prosperous which can be measured in terms of food and non-food consumption, is a top development target in Ethiopia. Various initiatives are being carried out to promote women's welfare, including nutrition-sensitive agriculture (NSA) interventions. The nutrition-sensitive agriculture interventions are being undertaken in the country's most vulnerable area. The study examined the impact of NSA interventions on the welfare of rural women. A multi-stage sampling technique was employed to select 94 participant and 166 non-participant women, for a total of 260 representative households. The study employed descriptive statistics as well as the propensity score matching (PSM) approach to attain its stated objective. The study's findings indicated that the intervention had a significant and positive influence on women's welfare. Thus, the sustained and wider dissemination of the nutrition-sensitive agricultural intervention would require building the capacity of key actors and institutionalizing the scheme in the regular, publicly supported extension program.

Key words: welfare, impact, nutrition sensitive agriculture and PSM
JEL Classification: D60

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1. Introduction

Women are the primary providers of home welfare in rural communities via nutrition and dietary improvement (K. Smith, 2017). Women's welfare can be improved when they engage in on-farm activities, notably backyard horticulture crop cultivation and small stock (chicken) raising. However, programs for productive development and the delivery of extension services usually ignore them. The poor social position of women, which is a result of ingrained cultural restrictions, might make morbidity and problems with food intake worse (Lange, Gherissi, Chou, Say, & Filippi, 2019). According to Quisumbing (2020), if men and women had equivalent social standing, the under-three child underweight rate would fall by almost 13%. Numerous programs for women's empowerment aim to reduce socio-cultural barriers and lessen their detrimental effects on women household's welfare. Such efforts have a variety of effects on rural women's families, including greater access to nutritious food.

It is really concerning to see how many people nationwide lack access to adequate food and nourishment, especially women and children. In Ethiopia, more than 38%, 23%, and 9% of children under five are stunted, underweight, or wasted, respectively (CSA, 2020). The percentage of undernourished women among women of reproductive age was 22 percent (Biswas, Rahman, Khanam, Baqui, & Ahmed, 2019). To improve the wellbeing of rural women, the Ethiopian government is collaborating with a number of non-governmental organizations (NGOs). The government's goal is to improve the nutritional condition of those who lack access to food, particularly small children and mothers who are capable of carrying children. Feed the Future Ethiopia is a five-year flagship multi-sector nutrition intervention effort financed by USAID (Idd, 2017).

Development partners are pushing nutrition-sensitive agriculture (NSA) solutions to address the problems associated with malnutrition (Di Prima, Wright, Sharma, Syurina, & Broerse, 2022). In order to combat malnutrition and a lack of micronutrients, nutrition-sensitive agriculture (NSA) strives to provide a variety of food sources that are nutritionally dense and rich (Junuthula, Kumari, & Srinivasan, 2022). NSA is a widely used strategy that allows for a lot of adaptability to match certain biophysical and sociocultural circumstances. Improved nutrition for the poor is a goal of the NSA, particularly for mothers and small children. Food for people living throughout the world can be made affordable and accessible, diversified and sustainable, and nutrient-dense through NSA-based agricultural production (Junuthula, Kumari, & Srinivasan, 2023).

However, very little has been done to provide evidence that shows how NSA intervention affects welfare outcomes and the difficulties encountered. In Ethiopia, nutritionally sensitive agriculture is a relatively recent phenomenon that has not received much in-depth study. NSA intervention may help to lower welfare insecurity since it enables households to enhance their standard of living. Some empirical studies have been carried out by various scholars to assess the impact of NSA in Ethiopia. Mucheye (2021) investigated the impact of nutrition-sensitive agriculture on women's empowerment. Gizachew (2019) studied the influence of NSA intervention on income outcomes in a similar way. These empirical studies, however, concentrated on certain regions and variables, such as income and empowerment, which didn't reflect the welfare of rural women and on the traditional impact assessment procedures. Therefore, this study uses propensity score matching (PSM) to examine the impact of NSA intervention on the welfare of rural women. It also addresses the issue caused by quasi-experimental designs in agricultural research and development activities. Households who participate in the program may differ from non-participants in a number of ways, which can lead to inaccurate results in traditional impact assessment approaches. It also contributes to the field by doing a quality check on various matching algorithms and controlling for unobservable factors using a sensitivity analysis.

2. Literature Review

Agriculture is critical to global employment, revenue, and food security. Global actions aim to increase rural household welfare and encourage a smallholder-led agricultural revolution through improved agricultural practices, improved seed variety and fertilizer application, mechanization, and technology uptake (Chandra, Dargusch, McNamara, Caspe, & Dalabajan, 2017; D'Annolfo et al., 2021). This is critical for food security as well as welfare security. However, the adoption of improved agricultural technology interventions is sluggish due to obstacles such as adverse weather, liquidity, culture, risk aversion, and infrastructure limitations (Balana & Oyeyemi, 2022; Havemann, Negra, & Werneck, 2022). Farmers' adoption behavior is mostly impacted by subjective conditions and information offered (Zeweld, Van Huylenbroeck, Tesfay, & Speelman, 2017). Over the past few decades, global progress in food and nutritional security has been significant (Naylor et al., 2021; WHO, 2020). However, challenges remain, with malnutrition being a major concern. Undernutrition accounts for over 45% of fatalities among children under five, 1.9 billion obese adults, and 462 million underweight children (Dukhi, 2020;

Padhani, Das, Akhtar, Ismail, & Bhutta, 2022). This dismal data clearly demonstrates the intensity of the hunger issues faced by both children and adults. Given the detrimental implications of malnutrition, the United Nations has established many goals to tackle the problem through the promotion of NSA-related good practices across the world (Di Prima et al., 2022). The 2014 Second International Conference on Nutrition (ICN) assessed nutrition developments since 1992 and highlighted the need for nutrition-sensitive agricultural practices for food and welfare security(Meldrum, Padulosi, Lochetti, Robitaille, & Diulgheroff, 2018).

Nutrition-sensitive agriculture (NSA) is an approach that promotes food and welfare security by placing nutritionally rich and diversified food sources on the table to combat malnutrition and micronutrient deficiencies (Ruel, Quisumbing, & Balagamwala, 2018). The intervention aims to improve maternal and child nutrition while also empowering women. It is intended for mothers with children aged three to twelve months, and the intervention provides women access to agricultural training and inputs (such as equipment, seeds, and poultry) to promote small-scale agriculture and increase nutrient-rich food production. More crucially, the NSA approach pushes development agents to consider agricultural initiatives through the perspective of nutrition. NSA has become a globally adopted technique that allows for extensive adaptation to meet the particular bio-physical and socio-cultural characteristics of the target groups. The primary goal of NSA-based agricultural production is to make food abundant and accessible, diversified and sustainable, and healthy (Junuthula et al., 2023). The NSA strategy aims to dramatically improve poor people's nutrition, particularly that of mothers and small children (Nguyen et al., 2022). Agriculture impacts three key determinants of nutrition: food access, healthy environment, and adequate care practices. Food access refers to affordable, nutrient-dense foods available on farms and markets (Maestre, Poole, & Henson, 2017). Healthy settings ensure effective resource management, while care practices focus on women's empowerment, labor, and income (WHO, 2018). Welfare security is a complex issue that goes beyond food availability and variety. NSA intervention's simplified impact pathways specify six outcomes for agriculture and nutritional interventions: on-farm availability, food diversity and safety, market food environment, income, women's empowerment, nutrition knowledge and norms, and natural resource management practices (Di Prima, Wright, Sharma, Syurina, & Broerse, 2020). These outcomes lead to improved diet and health, ultimately improving food and welfare security.

Agricultural interventions aiming at enhancing food and nutrition security usually focus on food production and consumption at the household level.

Developing household technical capacity for agricultural intensification and diversification is crucial to accomplishing this goal (De Roest, Ferrari, & Knickel, 2018). A favorable strategy should support long-term intensification and diversification to enhance NSA. Increasing production per unit of land or animal, as well as integrating complementing enterprises, are examples of how NSA might be accomplished (Pinillos, 2018). Increased access to crop and livestock inputs and services should be made possible with assistance. Households that can combine animal raising with crop production, particularly backyard vegetable and fruit cultivation, benefit nutritionally (De Roest et al., 2018). Producers of mixed crops and animals must be encouraged to undertake on-farm diversification. The increased and diversified output of nutrient-dense foods is critical for food and welfare security as well as market surpluses. The NSA intervention focuses on nutrient-dense food consumption for women of reproductive age (15–49 years) and children under two years of age (Bird, Pradhan, Bhavani, & Dangour, 2019; Gizachew, 2019). Other members of the family, however, might also engage in this pattern.

Empowering women is also critical for poverty reduction and welfare enhancement. There is a link between empowerment and better nutritional results (Baba, Kearns, McIntosh, Tannahill, & Lewsey, 2017). Women have been prioritized as beneficiaries of agricultural and nutrition programs. Autonomy, independence, ownership, self-awareness, agency, communal action, power redistribution, self-determination, participation, dignity, social inclusion, and choice are all facets of agricultural and nutritional empowerment. Women's empowerment comprises income, resource ownership, knowledge, and decision-making. NSA intervention affects these factors at varying rates and intensities, as measured by the Women Empowerment in Agriculture Index (FAO, 2018). Nutrition-based agricultural interventions have recently begun to include gender issues in their plans. This is due to women's importance in food production and consumption as well as their vulnerability to hunger and malnutrition. Children who receive inadequate care and feeding practices are more vulnerable to the detrimental impacts of malnutrition, which appear as stunting, wasting, and underweight, along with other deficiencies induced by malnutrition (De & Chattopadhyay, 2019). This improves people's well-being, prompting actions like NSA to attain the intended welfare benefits. To achieve this development goals, governments, donor institutions, and development organizations are increasingly supporting nutrition-sensitive agriculture.

3. Method

3.1 Theoretical Framework

The total consumption (food and non-food) spending is used as a measure of individual women's welfare to evaluate the influence of nutrition-sensitive agriculture on it. In order to investigate how NSA affects household welfare, Skoufias, Unar, and González-Cossío (2008) theoretical approach was applied. Let our utility function, which is composed of three factors: food consumption, non-food consumption, and leisure, be separable in its arguments. This assumption leads the study to develop the utility function as given below.

$$U = (fc, nfc, L) \quad \textbf{(1)}$$

and the budget constraint will be

$$Pffc + Pnnfc + WL = \mho + W\Omega \quad \textbf{(2)}$$

Where fc stands for food consumption, nfc stands for non-food consumption, and L stands for leisure from the utility function. Pf is the price of food consumption, Pnf is the price of non-food consumption, and W is the price of time in the budget constraint. In the same equation, $\mho$ represents non-labor income, and Ω represents time endowment.

Women households seek to maximize utility $U = (fc, nfc, L)$ while adhering to the budget constraint $Pffc + Pnnfc + WL = \mho + W\Omega$. This leads to the following specification of the Lagrangian function (equation):

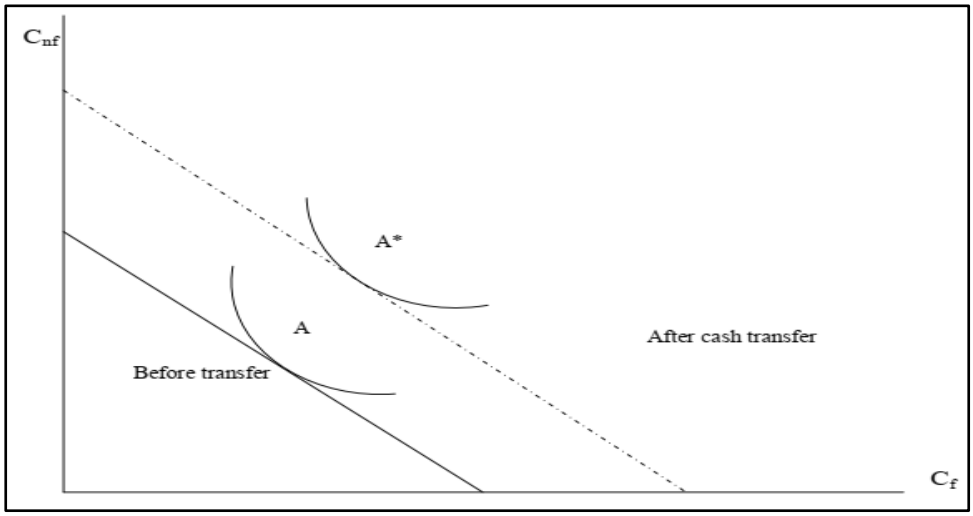
$$L = U = (fc, nfc, L) + \lambda(Pffc + Pnnfc + WL - \mho - W\Omega) \quad \textbf{(3)}$$

Let's now employ graphical analysis to examine what transpires when a household implements a nutrition-sensitive agricultural intervention. The intervention of NSA N results in a parallel shift of the original budget line by $\frac{N}{pf}$ to the new dotted budget line to the right, as shown in Figure 1 below, and its impact on welfare is summed up by the shift of the optimal point from initial A to post-intervention A*. From Figure 1, it can be inferred that the intervention will probably lead to an increase in both food and non-food consumption. Mathematically, the first-order criteria describing the optimal choice of food and nonfood intake and leisure

after the intervention are provided by the same ratio as those given above before the intervention at point A*.

At the equilibrium, at point A*, the maximization problem will yield:

$$\frac{Uf}{Unf} = \frac{Pf}{Pnf}, \frac{UL}{Uf} = \frac{W}{pf} \; and \; \frac{UL}{Unf} = \frac{W}{pnf} \qquad \textbf{(4)}$$



The theoretical framework provides illustration of how NSA initiatives have raised household welfare. This shows that interventions will enhance the welfare of households. The technique described above shows that consumption expenditure (total consumption expenditure) may be employed as a stand-in for welfare in empirical studies. In other words, general consumer spending might stand in for the health of a home.

3.2 Method of Analysis

The analysis was done using descriptive statistics and propensity score matching method. Descriptive statics, such as percentages, mean, standard division, frequency, t-test, and cross-tabulations used to describe the socio-economic and plot-level factors (pre-intervention) influencing rural women household NSA participation in the program and then summarized by using inferential statics.

3.2.1 Propensity score matching (PSM) method

The NSA lacks a baseline survey and does not use randomization to determine participation. In other words, households that are eligible for selection are deliberately chosen based on their knowledge of the intervention and level of social security. Additionally, the baseline survey was not carried out before the NSA intervened in the study area. Thus, PSM uses observable characteristics of individuals in the sample to generate a control group that is comparable to the treated group conditional on identified exogenous factors, but different regarding the intervention status, here participation in NSA. There is a presumption of no unobserved heterogeneity differences between the control and treated group in PSM. To achieve the stated objectives, propensity score matching, which is often used to analyze the impact of a program, was utilized. Prior to the NSA intervention, it was presumed that socioeconomic and plot-level attributes were equivalent. The application of PSM entails five phases (Caliendo & Kopeinig, 2008). These involve evaluating the PSM, selecting a matching process, establishing if there is overlap (common support), estimating matching quality (effects), and doing a sensitivity analysis. The estimation of the propensity score is the first stage in the PSM technique. Conditional matching may only be done on P(X) rather than X when P(X) = Prob(D=1|X), which is the likelihood of participation in the program conditional on X (Rosenbaum and Rubin ,1983). These authors argue that if results without intervention are independent of participation given X, then they are also independent of participation given P(X), reducing a multidimensional matching issue to a single-dimensional problem. Choosing which model to use for the estimate and which variables to include in this model are both critical phases in calculating the propensity score.

For the binary treatment situation, the study assesses the likelihood of beneficiary vs. non-beneficiary using either logit or probit models that frequently produce similar findings. This is relevant to the choice of the kind of model to be employed. As a result, it is not a serious issue. However, the logit model is more popular for the estimation process (Caliendo & Kopeinig, 2008). The logit model was employed in this work to estimate the propensity score in order to fully exploit this advantage. The conditional independence assumption (CIA) dictates that the outcome variables be independent of treatment conditional on the propensity score. Thus, the matching method is based on identifying a set of variables X (covariates) that may effectively fulfill this condition. (Caliendo & Kopeinig, 2008). Basically, grasping economic theories, having a deeper grasp of earlier research, and being

cognizant of institutional settings are all important guidelines for selecting the appropriate variables (Sianesi, 2004; J. A. Smith & Todd, 2005). The second stage in PSM is selecting among a variety of matching estimators after estimating the propensity score. It is possible to use a variety of PSM matching estimators (algorithms).

To get over the shortcomings of "nearest neighbor" matching and the danger of poor matches when the closest neighbor is far away, caliper and radius matching are utilized. In order to prevent poor matches and increase matching quality, caliper matching imposes a tolerance limit on the maximum propensity score distance. Caliper matching involves selecting a member of the comparison group as a matching partner for a treated individual who falls within the caliper (propensity range) and has the lowest propensity score. (Caliendo & Kopeinig, 2008). However, caliper matching does have the disadvantage of making it challenging to choose a suitable tolerance level in advance (J. A. Smith & Todd, 2005).

A common support condition is used to ensure that any combination of traits found in the treatment group may also be seen in the control group (White & Sabarwal, 2014). The average treatment impact on the treated and the population is only defined in the zone of common support; so, imposing common support is the third critical PSM step (Caliendo & Kopeinig, 2008; Kintamo, 2018). The area between the lowest and highest propensity scores of the treatment and comparison groups is known as the "common support region." This zone is established by removing observations with propensity scores that are lower than the minimum and higher than the maximum of the treatment and comparison groups, respectively (Abebe, Chalchisa, & Eneyew, 2021; Caliendo & Kopeinig, 2008).

Since our conditioning is based on propensity scores rather than all variables in both treated and comparison groups, the matching technique must be able to balance the distribution of different variables, which is the fourth crucial stage in PSM (Caliendo & Kopeinig, 2008; King & Nielsen, 2019). Although there are numerous ways for verifying, they are all basically implied to compare data before and after matching and determine whether there is still a difference after conditioning on propensity scores. If there are discrepancies, it shows that the matching failed and that remedial action is required. (Caliendo & Kopeinig, 2008; Shiba & Kawahara, 2021). There are several indicators that verify the quality of matching. The stratification test, the t-test, joint significance, pseudo-R2, and standardized bias are among these.

The last stage in PSM implementation would be to test the sensitivity of the estimated results (Caliendo & Kopeinig, 2008; Shipman, Swanquist, & Whited,

2017). The CIA, on which the matching method is based, states that the evaluator should consider all elements that influence the participation decision and outcome variables at the same time. This is the basis for this approach. However, since the data on the distribution of the untreated outcome for treated groups and vice versa are uninformative, this assumption is basically untestable. (Becker & Caliendo, 2007; Caliendo, Mahlstedt, & Mitnik, 2017). With matching estimators and the assumption that the observables have been chosen correctly, treatment effects are estimated. However, a hidden bias may develop if unobserved variables influence both the treatment assignment and the outcome variable at the same time, rendering the CIA incorrect. As a result, average treatment effect on the treated (ATT) estimates are biased (Corbacho, Philipp, & Ruiz-Vega, 2015; P. R. Rosenbaum & Rosenbaum, 2002). Testing the robustness of findings to deviations from the identification assumption is crucial since matching estimators are not robust against hidden biases. But using non-experimental data makes it hard to gauge the scope of selection bias. So, through sensitivity analysis, this issue may be solved (Caliendo & Kopeinig, 2008). It is advised that the Rosenbaum bounding technique be used to test the sensitivity of the estimated ATT to divergence from the CIA (P. R. Rosenbaum & Rosenbaum, 2002).

3.3 Data collection, Sample Size and Sampling Technique

3.3.1 Data collection

The cross-sectional data used in this study was gathered from primary sources. Using a structured questionnaire and a household level survey, primary data on the socioeconomic factors, agricultural characteristics, plot level features, resource ownership of the households, and other variables pertinent to the study were gathered. For ease of understanding between enumerators and respondents, a structured questionnaire produced in English was translated into Amharic. Then, in 2022, a household level survey was carried out on a sample of 260 households, of which 94 were farmers who engaged in NSA and the remaining 166 did not engaged in NSA, serving as a treatment group and a control group, respectively.

3.3.2 Sample Size Determination

Ethiopia has eleven regional administrative states, each subdivided into zones, districts, and kebeles[2]. The study was conducted in the Farta district of the

[2] The lowest administrative unit

South Gondar zone of Amhara Regional State. The total number of women targeted at the selected site was 745. So, the sample size was determined from the total number of women at a 95% confidence level with a 5% level of precision using Yamane's (1967) formula:

$$n=\frac{N}{1+N(e)^2}=\frac{745}{1+484(0.05)^2}=260$$

Where: n=sample size, N=total population (total number of dairy enterprises) e=level of precision.

3.3.3 Sampling Technique and Procedures

The NSA project implementing district was purposively selected from South Gondar Zone in consultation with South Gondar Agriculture Development Office. The district contains both participant and non-participant women with similar socioeconomic features, which are relevant to measure the extent of changes realized due to the NSA intervention. Multi-stage sampling procedures were employed to select the district, kebeles, and women. In the first stage, Farta district was purposefully selected because it is one of the beneficiary districts of the NSA intervention program. In the second stage, four kebeles were purposefully selected among the total of 31 kebeles due to their vulnerability to drought and as beneficiaries of the intervention. In the third stage, the total number of 745 women in the four selected kebeles was stratified into two strata: NSA intervention participant and non-participant women among the sample frame, which are listed down as participant and non-participant in the March 2021–2022 agricultural season in each selected kebele's administrative office. In the fourth stage, representative samples were selected from each kebele using the systematic random sampling technique by the constant k number of intervals, where k = N/n = 3, based on the probability proportional to sample size. Finally, 260 (166 non-participant and 94 participant) sample households were selected. Women of reproductive age, including mothers and caretakers with children under the age of two, were included in the formal, structured questionnaire interviews. Finally, two plots of information were taken from each female-headed household. The following table shows the sampling distribution of households by Kebele.

Table 1: Proportional Distribution of Samples by Kebeles

Kebeles	Total Number of women in kebeles			Sample size from each kebele $n_i 3 = {}^{N_i}/_{N} * n$		
	Participant	Non-participant	Total	Participant	Non-participant	Total
Worken	65	101	166	20	38	38
Awuzet	80	108	188	25	40	65
Sahirna	73	118	191	23	44	67
Kolay Dengorse	81	119	200	26	44	70
Total	299	446	745	94	166	260

3.4 Description of variables included in PSM

Table 2: Definition and Measurement unit of variables

Variables	Description	measurement unit
Household level characteristics		
hhsize	Size of household's members	number
headsex	Gender of household head	dummy
headage	Age of household head	years
headed	Education level of household head (1=male 0=otherwise)	dummy
maritalstatus	Marital status of household head (1=married 0=otherwise)	dummy
dependratio	The ratio of dependent household members to non-dependent	number
livestock	Total number of livestock	TLU
extvisit	Numbers of extension visit per year	number
shock	Households affected by health shock (1=yes 0=no)	dummy
radio	Radio ownership (1=yes 0=no)	dummy
Plot level characteristics		
plotdist	Plot distance from homestead	minutes
irrigation	Plots irrigate (1=irrigated 0=Otherwise)	dummy
poor	Soil type (1=poor 0=0therwises)	dummy
fair	Soil type (1=fair 0=0therwises)	dummy
good	Soil type (1=good 0=0therwises)	dummy
steep	Terran nature (1=steep 0=0therwises)	dummy
moderate	Terran nature (1=moderate 0=0therwises)	dummy
flat	Terran nature (1=flat 0=0therwises)	dummy
Intervention		
NSA	Nutrition sensitive agriculture4	dummy
Outcome		
totalexp	Total consumption expenditure	Birr

[3] Where n_i is sample size in i[th] kebele, N_i is total population of the household in i[th] kebele and N is total population of households in the selected kebeles.

[4] NSA intervention is a nutrition-sensitive investment which intends to ensure better nutrition. The participants received training, advice, seed and poultry that can help them to improve their production and consumption.

4. Results and Discussion

4.1 Descriptive statistics

The results and discussion part provide a full explanation of the study's findings, which are described below in two sub-sections. Women's socioeconomic and plot-level characteristics related to rural women's welfare are discussed in the first part. The next parts deal with the impact of NSA intervention on welfare outcomes.

Table 3 revealed that participant women's average family size was less than that of non-participant women, and the entire sample average family size is close to 5, which is similar to the national average of 5 (UN, 2017). The t-test indicated that there were statistically significant differences. The mean age of participant women was 52 years, whereas non-participant women had an average age of 54.9 years, and no statistically significant difference was found for this covariate. The mean dependence ratio of participant women was 1.28, while non-participant women had a dependency ratio of 1.87, indicating that on average, one economically independent household member supports 1.28 dependents for participant women and 1.87 dependents for non-participant women. Women who participated in the program received visits from extension officers 4.15 times a year on average, whereas women who did not participate received 1.47 visits from extension development agents. The t-test result revealed a statistically significant difference in extension visits between the two groups. In terms of livestock ownership, participant women outnumbered non-participant women by a statistically significant margin. Finally, the average yearly total spending of non-participating women was birr 8552.9, whereas participant women spent birr 10,229.61. This suggests that the average spending of the participant women was more than that of their counterpart, with a statistically significant difference.

Table 3: Descriptive statistics of continuous variables

Variables	Non-Participant			Participant			P-value
	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	
hhsize	166	5.33	2.115996	94	4.45	1.89	0.000***
headage	166	54.92	15.44906	94	52.05	16.07	0.156
dependratio	166	1.87	1.110816	94	1.28	0.98	0.000***
extvisit	166	1.47	2.567163	94	4.15	3.75	0.000***
livestock	166	1.97	1.74	94	2.69	2.41	0.005***
totalexp	166	8613.231	3902.61	94	10,375.14	3680.99	0.000***

*** 1% level of significance
Own computation (2022)

Table 4 below showed that 48% of participant women and 34% of non-participant women were literate. The chi2 test revealed that there is a statistically significant difference in education status. The percentage of married women was 80% among participants and 72% among non-participants, with no discernible difference between the two. In addition, 57% of non-participant women and 61% of participant women reported having suffered health shocks at least once during the study period. Twenty-two percent of participant women and 20% of non-participant women had radios that enables them to get access for various sources of information.

Table 4: Descriptive statistics of household level dummy variables

Variables	No-Participant			Participant			P-value
	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	
headedu	166	0.34	0.48	94	0.48	0.50	0.099**
maritalstatus	166	0.72	0.45	94	0.80	0.40	0.180
shock	166	0.57	0.50	94	0.61	0.49	0.838
radio	166	0.22	0.41	94	0.20	0.40	0.236

** 5% level of significance
Own computation (2022)

Table 5 shows that the average distance of farm plots from home for participant and non-participant women was 19.5 and 21.7 minutes, respectively. This suggests that non-participant women plot sites further away than participant women.

Table 5: Descriptive statistics of plot level continuous variables

Variables	Participant			Non-Participant			P-value
	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	
plotdist	332	21.71	22.1	188	19.24	19.54	0.212

** 5% level of significance
Own computation (2022)

Table 6 shows that only 7% and 9% of plots were irrigated by participant and non-participant women, respectively, implying that the most of plots cultivated by both participant and non-participant women relied on a rainfed farming system. Furthermore, 45% of plots had fertile soil, 40% possess good soil fertility, and 15 percent had poor soil quality. In terms of plot terrain, 67% of plots had a moderate

slope, while 17% had a flat slope. The slopes of the remaining 16% of plots were steeper.

Table 6: Descriptive statistics of plot level dummy variables

Variables	Participant			Non-Participant			P-value
	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	
irrigation	332	0.07	0.26	188	0.09	0.29	0.201
poor	332	0.15	0.35	188	0.07	0.26	0.014**
fair	332	0.40	0.49	188	0.48	0.50	0.075*
good	332	0.45	0.50	188	0.45	0.50	0.889
steep	332	0.16	0.37	188	0.11	0.32	0.157
moderate	332	0.67	0.47	188	0.77	0.42	0.020**
flat	332	0.17	0.38	188	0.12	0.33	0.096*

*** 1%, ** 5%, * 10% level of significance

Own computation (2022)

4.2 Impact of NSA on Women Welfare (PSM Result)

The model found that there exists a close socio-economic and plot level character similarity between the NSA participant and the non-NSA participant (control) women. The outcome variables that are being tested for the changeover NSA intervention were annual consumption expenditure of women. It is customary to run the multicollinearity and heteroskedasticity tests in most of economics related research studies. However, these tests were not conducted in the present study. The reasons for this include, the fact that heteroskedasticity error terms have little influence on the estimated intervention impact in propensity score matching (Williams, 2012). And also no multicollinearity test conducted as there is one explanatory term per estimation (Gujarati & McGraw-Hill, 2004).

The probability of participation is predicted on the basis of the selected parameters that represent meaningful observable differences between participants and non-participants women. When single observables are examined, it is found that household size, head age, dependency ratio, plot distance have a negative significant influence on decision to participate in NSA while head education, marital status, irrigation access, extension visit, livestock holding, level of soil fertility, and terrain nature all had positive significant influence on households' participation decisions in the NSA program (see Table 7 in the appendices).

To match the treated and its comparison group, the propensity score of women was computed based on their individual characteristics. The propensity score results indicated that the required balancing property of the distribution of propensity scores is satisfied. Most of participant women and non-participant women had a common support region, only two participant women were outside the common support region and therefore discarded from the matched sample (see table 8 in the appendices). The main aim of checking the common support region was to identify the households that were in the same range of observable socio-demographic, economic, and plot-level characteristics in the two groups (see table 9 in the appendices).

The radius caliper (RC) matching with band width 0.25 was chosen as the most desirable matching estimator since it fulfils the three desirable criteria, i.e., the equal means test, which is referred to as the balancing test (Dehejia & Wahba, 2002). Thus, the average treatment effect of the program on the treated was estimated for the matched households on the basis of this robust matching estimator. It was the after-matching phenomenon that indicated that the tests of whether there was a significant difference between the characteristics of the participant and non-participant women after balancing them based on their propensity score through the radius caliper 0.25 of the matching estimator. However, in principle, there must not be any significant difference between those covariates after matching processes. Accordingly, the T-values also revealed that, from a total of 14 covariates, 13 became insignificant after matching, while 11 of them were significant before matching (see table 10 in the appendices).

This matching process can equalize features between the treated and matched comparison groups. As a consequence, the findings may be utilized to evaluate the impact of NSA participation across groups of households with comparable observable characteristics. All of the above tests indicate that the matching method used is suitable for the data at hand. As a result, the study proceeds to estimate the average treatment impact on the treated (ATT) for the sample households.

4.3 Average Treatment Effect on the Treated

The impact estimate demonstrated that participation in NSA had significant effects on welfare in the study area since the average treatment effect on the treated after matching is positive and the t-calculated is more than the 5% critical value of 1.96. The higher impact of the NSA on welfare found in stud study might be

attributed to the fact that households in the study area were completely targeted. Furthermore, the average treatment effects on the treated (ATT) of welfare are 1623.4 birrs per year (10267.04 birrs for treated group and 8643.6 birrs for the controlled group), and the positive difference, as well as the t-calculated 3.10, indicated that nutrition-sensitive agriculture programs had a statistically significant positive impact on women welfare (see Table 11 in the appendices). Similar studies by Gizachew (2019) and Mucheye (2021) confirms that the NSA intervention have had positive, although at varying degrees, influence on women empowerment, productive resource ownership, dietary varieties and welfare. The study confirmed that participation in the NSA improves welfare via reducing the likelihood that a household has become very low caloric intake as well as enhancing women's non-food consumption spending.

4.4 Sensitivity Analysis Results

To estimate the extent to which such selection on unobservable may bias our inferences on the effects of the program, sensitivity analysis was conducted. One strategy to address this problem is the Rosenbaum and Rubin (1983) approach, which allows the analyst to decide how strongly an unobserved variable may affect selection in the treatment. If there are unobserved variables that simultaneously affect selection into treatment and the outcome variable, a hidden bias might arise to which matching estimators are not robust (Rosenbaum & Rubin, 1983). The result of this study indicates that the inference of the effect of the program is not varying though the participants and non-participants women have been allowed to differ in their odds of being treated up to (maximum value of gamma 2 with 0.25 increments) in terms of unobserved covariates. Therefore, it can be concluded that our impact estimates of welfare were insensitive to unobserved selection bias and were the result of pure effect of the program which is participating in the program (see Table 12 in the appendices).

5. Conclusion and Policy Recommendation

5.1 Conclusion

This study examined how the NSA intervention impacted welfare outcomes of rural women. The study area's socio-demographic, economic, and plot-level factors that determine women's ' decision to participate in NSA were investigated. The study

relied heavily on primary data collected from 260 randomly selected sample households from four kebeles, with 166 non-participants and 94 participant women. As a result, data on women welfare were collected from both participant (treatment) and non-participant (control) households using plot-level cross-sectional data and analyzed using descriptive statistics as well as econometric approaches.

Impact evaluation based on treatment-control comparisons can be inaccurate due to selection bias, but propensity score matching can be used to acquire accurate estimates due to the difference between matched participants and non-participants being attributable to the therapy. Significant and robust differences are found for nutrition-sensitive agriculture between matched participants and non-participants based on the quality check of standardised differences and the control of the unobservable by Rosenbaum's bounds. So, the nutrition sensitive agriculture program had brought a significant positive effect on women welfare. The significant impact of NSA on women welfare might be because participant households in the study area had been full targeted.

5.2 Recommendation

The empirical findings led to the following recommendations:

The intervention had a positive impact on welfare this will mainly require a special attention by policy makers and concerned bodies and it should be scaled up to the other areas.

Since the implementation of the program is limited to districts where development agents and NGOs operates, for wider implementation of the intervention, the NSA approach should be incorporated in the regular extension programs with the required resources.

The NSA program initially assumed full family targeting for the poor of beneficiaries in order to fill the gap of welfare. However, the finding indicates that participant households were not full family targeted and there by decrease the welfare they have gotten from the program. Therefore, a special attention should be given by a concerned body.

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Appendices

Table 7: logit regression to predict propensity scores of participations conditional on selected variables

Variables	cofe	P-val
hhsize	-0.455***	[0.000]
headage	-0.014*	[0.050]
headedu	0.416*	[0.091]
maritalstatus	1.050***	[0.001]
dependratio	-0.532***	[0.000]
shock	0.438*	[0.096]
irrigation	1.017**	[0.015]
extvisit	0.309***	[0.000]
livestock	0.215***	[0.000]
plotdist	-0.012**	[0.032]
fair	0.766	[0.334]
good	0.910**	[0.029]
moderate	0.621*	[0.070]
flat	0.936**	[0.048]
Constant	-0.290	[0.689]
Observations	520	

*** 1%, ** 5%, * 10% level of significance

Own computation (2022)

Table 8: distributions of estimated propensity score for participant and non-participant

	Variable	Obs	Mean	Std. Dev.	Min	Max
Non-participant	_pscore	188	0.231143	0.218726	0.004136	0.977853
Participant	_pscore	332	0.5833097	0.250255	0.049054	0.9902

Own computation (2022)

Table 9: The Common Support Region

psmatch2: Treatment assignment	psmatch2: Common support		Total
	Off support	On support	
Untreated	0	332	332
Treated	2	186	188
Total	2	518	520

own computation (2022)

Table 10: Tests of covariate matching quality

Variable	Unmatched	Mean		t-test	
	Matched	Treated	Control	t	p>t
hhsize	U	4.4468	5.3313	-4.77	0.000***
	M	4.4409	4.7985	-1.89	0.060*
headage	U	52.053	54.928	-2.01	0.045**
	M	51.978	51.888	0.06	0.955
headedu	U	.44681	.34337	2.34	0.020**
	M	.44086	.51481	-1.43	0.154
maritalstatus	U	.79787	.72289	1.90	0.058*
	M	.7957	.80056	-0.12	0.907
dependratio	U	1.2785	1.8673	-6.07	0.000***
	M	1.2842	1.4092	-1.35	0.178
shock	U	0.5531	0.56627	-0.29	0.773
	M	0.55435	0.60479	-0.98	0.328
irrigation	U	.10638	.06024	1.90	0.058 *
	M	.09677	.09712	-0.01	0.991
extvisit	U	4.1489	1.4759	9.62	0.000 ***
	M	4.0753	3.4521	1.59	0.114
livestock	U	2.6983	1.972	3.98	0.000***
	M	2.6903	2.5361	0.65	0.518
plotdist	U	19.245	21.711	-1.25	0.212
	M	19.355	19.924	-0.27	0.790
fair	U	.04255	.01205	2.23	0.026**
	M	.04301	.03686	0.30	0.763
good	U	.90426	.80723	2.94	0.003 ***
	M	.90323	.90227	0.03	0.975
moderate	U	.77128	.6506	2.89	0.004***
	M	.76882	.78213	-0.31	0.759
flat	U	.12766	.08434	1.58	0.114
	M	.12903	.12012	0.26	0.795

* if variance ratio outside [0.75; 1.33] for U for M

*** 1%, ** 5%, * 10%

own computation (2022)

Table 11: Average Treatment effect on the treated

Variable Sample	Treated	Controls	Difference	S.E.	T-stat
totalexp unmatched	10375.1	8613.2	1761.9	360.7	4.88***
ATT	10342.5	8910.3	1432.2	461.9	3.10***

*** 1%,

own computation (2022)

Table 12: Sensitivity analysis with ROSENBAUM'S bounds

Gamma	sig+	sig-	t-hat+	t-hat-	CI+	CI-
1	0	0	8748.35	8748.35	8664.09	9030.19
1.25	0	0	8432.93	8466.01	8958.82	9381.23
1.5	0	0	8187.24	8348.34	8928.82	9662.83
1.75	0	0	8290.12	8580.18	8940.35	9925.11
2	0	0	8337.63	8789.86	8774.81	9157.4

sig+ - upper bound significance level

sig- - lower bound significance level

t-hat+ - upper bound Hodges-Lehmann point estimate

t-hat- - lower bound Hodges-Lehmann point estimate

CI+ - upper bound confidence interval (a= .95)

CI- - lower bound confidence interval (a= .95)

Own computation (2022)