**ADDIS ABABA UNIVERSITY**

**COLLEGE OF BUSINESS AND ECONOMICS**

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# The Impact of Foreign Direct Investment on the Performance of Agricultural Sector: The Case of Ethiopia

**By**

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## Acronyms and abbreviations

| | |
|---|---|
| ARDL | Autoregressive Distributed Lag |
| ATI | Agricultural Transformation Institute |
| CPI | Consumer Price Index |
| EIC | Ethiopian Investment Commission |
| FAO | Food and Agricultural Organization |
| FDI | Foreign Direct Investment |
| GDP | Gross Domestic Product |
| GFCF | Gross Fixed Capital Formation |
| IMF | International Monetary Fund |
| LLDC | Landlocked Developing Countries |
| MNE's | Multi National Enterprise’s |
| NARDL | Non-linear Autoregressive Distributed Lag (NARDL) |
| NBE | National Bank of Ethiopia (NBE) |
| PSI | Policy Studies Institute |
| R&D | Research and Development |
| SSA | Sub-Sahara Africa |
| UN | United Nations |
| UNCTAD | United Nations Conference on Trade and Development |
| UNICEF | United Nation International Chiltern’s Emergency Fund |
| USD | United State Dollar |
| VAR | Vector Autoregressive |
| VECM | Vector Error Correction Model |
| WDI | World Development Indicators (WDI) |
| WFP | Wold Food Program (WFP) |
| WIR | World Investment Report |

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## Abstract

*FDI in agriculture is one of the outward-looking strategies for the enhancement of agricultural production through availing capital and advanced technologies in developing countries including Ethiopia. Even if FDI inflow in Ethiopia was assumed to exist since the 1950s, there are limited studies on the impact of FDI inflow on the Ethiopian agricultural sector. The aim of this study is to examine the impact of agricultural FDI on the agricultural production performance in Ethiopia. Data from secondary sources over the year 1981-2021 for agricultural real GDP and agricultural FDI inflow along with selected macro variables was used in this study. Descriptive statistics and econometric models such as ARDL and NARDL were employed for the analysis of data. FDI inflow showed fluctuating trend across years, and floriculture followed by crop based and coffee based investments found to be the major sub-sectors in agricultural FDI inflow. Based on NARDL model analysis, a unit percent positive FDI shock had significant and favorable effect on the performance of agricultural real GDP by 0.05 % in the long run. However, a negative FDI shock was found to be statistically insignificant. In the short run, increase in FDI inflow during the past lagged period reduced the current agricultural real GDP significantly. In similar fashion, a decrease in FDI inflow in the past lagged period also significantly diminished the current agricultural production. In conclusion, agricultural FDI inflow significantly affects the performance of agricultural real GDP in the long run while its positive effect was not automatic in the short run. According to the ARDL model, no statistically significant effect in the short run while there was no any long run relationship between the two target variables. Based this finding attracting more FDI inflow to the agriculture especially in those sub-sectors that contribute to food supply in any possible way was recommended to address the financial and technological gap in the agriculture sector of Ethiopia.*

# 1. Introduction

## 1.1. Background and justification

Sub-Sahara Africa (SSA) countries usually face persistent food supply shock due to inefficient agriculture sector performance which in turn causes food price surge (WFP and UNICEF, 2022). Increasing food supply through intensifying agricultural investment in such region is one of the critical means to alleviate food supply shocks. Besides, promoting both domestic and foreign investments, along with other factors could be taken as better interventions for tackling economic shocks. Like many SSA countries, Ethiopia is threatened by high food supply shock due to limited domestic investment characterized by low income, low saving, limited capital accumulation, high poverty and weak capital market (FAO, 2016).

Agriculture is the dominant sector in the Ethiopian economy. It accounts for 37.57% of GDP, 72% of exports and 66% of employment of economy in 2021 (Agricultural Transformation Institute, 2022). The sector is the most prospected since the country is endowed with abundant resources and having diverse agro ecologies suited to agriculture. Moreover, the current Ethiopian ten years development plan (2021-2030) has laid out enhancing production and productivity of the agriculture sector and aspires to achieve 6.2% growth rate per annum in this sector.

For the last 5 years the agriculture sector on average scored 4.6% growth rate (NBE, 2022). However, Ethiopia cannot yet ensure food self-sufficiency. Furthermore, according to United Nations report, about 22 million Ethiopian people were looking for food aid 2022 (UN, 2021). The performance of agriculture in crop production as well as in livestock rearing lagged behind despite the presence of huge potential in the sector. About 95% of the agricultural commodities are still provided by smallholder farmers, which typically operate in small-scale with limited mechanization, technology adoptions and predominantly rain-fed (Lowder et al., 2021).

In Ethiopia, the agriculture sector faces several challenges that linked to population, environmental, technological and policy factors (ATI, 2022). The ever increase in population reduces landholding capacity of the farmers. The environmental factors involve climate variability, declining soil fertility, increasing pests and diseases (Devereux, and Sussex, 2000). The agriculture sector is still running with backward technologies. Lack of robust policies in inputs such as land, investment and finance are the major factors that affect the performance of the sector (Byerlee et al., 2007). In order to address the above challenges, various strategies such as provision of agricultural technologies through extension package, encouragement of model farmers, introducing some policy measures such as land certification and investment policy have been taken as solutions in the country (Shikur, 2020).

Despite the existing efforts to transform the sector, the contribution of agricultural sector to the national economy is below its potential. Recent developments in the agriculture sector have emphasized the need for Foreign Direct Investment (FDI) attraction as one of the potential interventions to transform the agriculture sector. Besides, the government of Ethiopia has persistently promoted FDI as one of the strategies to achieve the goal of ensuring food security, import substitution and becoming one of the middle-income countries by 2025 (Debebe and Bessie, 2022; PSI, 2022).

Foreign direct investment can play a key role as a source of finance for developing countries, creates economic integration, promotes international trade through access to foreign market, improves balance of payments and creates positive spill over effects to domestic investments (United Nations Conference on Trade and Development, 2022). However, these positive outcomes depend on the strength of backward and forward linkage of economic sectors, the level of institutional and human capital development, and trade policies of the host country (Sabir et al, 2019). On the other hand, studies also indicated that crowding-out and "land grabbing" are negatively associated with FDI that undercuts its growth effects (Wako, 2021).

In order to gain the opportunities of FDI for agriculture sector, Ethiopia attracts FDI in any way possible since 1950 (Mohammed, 1969). There are, however, various macro-economy variables as well as policies that should be considered along with FDI that might affect the agriculture sector as explained by Ali et al. (2010). The major macro-economic variables that are linked to the agriculture sector are inflation, exchange rate, lending to agriculture, interest rate and trade openness. Although some studies were conducted to assess the impact of FDI in agricultural sector as well as other economic sectors, past studies have limitation in regards to analyse these variables with sufficient empirical investigations and address limited region of the country. The main aim of this study is thus to examine the impact of FDI inflow in Ethiopian agriculture performance through investigating various macro variables related to agriculture sectors.

## 1.2. Statement of the Problem

The poor performance of the agricultural sector in SSA is one of the primary reasons for the current food supply shortage and food price inflation problems. The sector is, thus requires transformation through enhancing its capacity to alleviate food insecurity and supply deficit. Agricultural transformation entails a shift from highly fragmented, subsistence-oriented farms towards more specialized production and market supply to establish sustainable intensive crop and livestock production systems (Getachew, 2020).

Sustainable intensive production systems are capital-intensive that require more physical, human, intellectual and social capital in order to sustain and rebuild the natural capital embodied in land and water resources. Although access to finance is another determinant of agricultural transformation, many developing countries have limited financial capacity to fill the investment gap. For instance, commercial bank lending to agriculture is less than 10 percent in sub-Saharan Africa, while microfinance loans are usually too small and not suited to capital formation in agriculture (Da Silva and Mhlanga 2009). Besides, international aids and development assistances are unlikely to increase sufficiently to meet the investment needs in the short and medium terms (Hallam, 2011).

The aforementioned limitations of investments and financial support in agriculture sector drive FDI to be considered as a potential alternative to transform the sector in developing countries. The literature revealed that FDI inflow assisted with robust policies in East and Southeast Asia drives to social and economic transformation significantly (Sjöholm, 2014). Besides, Ethiopia is highly endowed with natural resources especially huge fertile land, ample water resources and cheap human labour which are not yet exploited. Resource endowments attract resource-seeking foreign investors since these resources were not available or not attainable at low cost in their home country. Such opportunities need evidence-based suitable policies and actions that enable the country to attract foreign investors for which analysing the current FDI scenario is crucial.

In realizing the above experience, FDI attraction has been one of the policy priorities in Ethiopian economic development. Ethiopia has exhibited limited advancement in the flow of FDI before 2010. However, the country showed significant increase of FDI inflow since 2010. Until recently, Ethiopia becomes one of the top five east African FDI destination countries among Mozambique, Kenya, Tanzania and Uganda (Awadhi and Byaro, 2022). She received $4.14 billion capital in 2016 from FDI inflow (UNCTAD, 2022). This huge amount of FDI inflow is obtained by the effort made by the government to attract more FDI and the then conducive environment of the country. However, FDI inflow began to slowdown in 2017 significantly due to domestic political instability and global economic slowdown (PSI, 2022).

SSA countries including Ethiopia are in state of macroeconomic instability, and thus attraction of FDI to economy is believed to be one of the major strategies that stabilize the macro-economic volatility. In this regards, FDI inflows has been raised in Ethiopia to alleviate the macro-economic instabilities (WIR, 2022). Although some studies conducted on impact of FDI on Ethiopian economic growth (Mohd and Muse, 2021, Gizaw, 2015, Menamo, 2014 and Kedir, 2012), such studies focused on aggregated economic performance and found to be inconclusive. The author hypothesized that investigating aggregate effect of FDI inflow masks the particular effect of FDI in the specific economic sector performance. This is due to the fact that each sector in some way has unique characteristics will respond differently to the FDI inflow.

Considering particular studies of FDI in relation to agriculture, very limited evidence are available. Some of these studies focused on agriculture sector are based on descriptive analysis that lacks detailed explanation while others are limited to specific localities (Weissleder, 2009; Persson, 2016). The impact of FDI on agriculture, however, needs to be investigated timely to comprehend the performance of the sector due to FDI intervention.

### 1.3 Objectives of the Study

The overall aim of this study is to investigate the impact of FDI inflow to the agriculture sector performance in Ethiopia. In line with the above overall aim, this study has the following specific objectives:

i) To analyse the trend of FDI in agriculture sector;
ii) To identify short run and long run linkage between FDI and agricultural growth;
iii) To identify the effects of other macroeconomic variables on the agricultural growth;
iv) To examine whether there is causality between FDI inflow and agricultural growth

## 1.4 Research questions

This study will specifically seek answers to the following research questions:

i. What does the trend of FDI inflow in the agriculture sector look like?
ii. To what extent does FDI inflow influence the agricultural sector of Ethiopia?
iii. To what extent do other selected macroeconomic variables influence the agricultural sector production performance?
iv. Is there a causal relationship between FDI inflow and agricultural growth?

## 1.5 Significance of the study

Ethiopia has been making efforts to increase agricultural production and productivity by implementing various agricultural strategic plans, which has been critical for achieving food security. A rise in demand for food becomes a challenge in Ethiopia due to population growth, urbanization, climate change, and high volatility in global food price. Moreover, the performance of the agriculture sector is not as expected despite its potential to contribute to the nation economy at large. Due to this fact, Ethiopia has been attracting FDI in to the agricultural sector for the last four decades to maximize the sector performance.

Since agriculture is an important sector in the Ethiopian economy, understanding the impact of agricultural FDI on the sector's performance is crucial for a number of reasons. Firstly, the investments are undertaken in large areas of land engages a large number of people directly or indirectly. Thus, it is necessary to investigate the effect of intervention of FDI since it has its own wider socio-economic impact. Secondly, the type of agricultural FDI has implication on the food security effort of the host country. For example, FDI on floriculture could have a negative impact on food security due to its competition of land used for food crops. Thirdly, and most importantly it is necessary to assess the benefits of this agricultural intervention by measuring the intended and unintended outcomes to improve the effectiveness of the existing and future foreign direct investments in agriculture sector.

There are also several macro and micro variables that should be investigated to comprehend the performance of agriculture sector linked with FDI intervention. However, few studies have been conducted in this regard. Thus, this study is vital to address this information gap so as to provide relevant evidences for future agricultural development plan.

## 1.6. Scope and limitation of the study

This study has temporal scope that examines the impact of agricultural FDI on the agriculture sector's performance using time series data that covers annual data running from 1981-2021. Such annual data is sufficient for the intended study although possible to include more observation which could not be possible due to nonexistence of tangible information.

The limitation of this study was presence of missing data values in few variables, but they were treated accordingly using backcasting and forecasting techniques.  Since time series models works with complete data, imputation has used to fill the missed data prior to the model analysis.

## 1.7. Research hypotheses

In this study, we hypothesize that agricultural FDI has significant effect on agricultural production in Ethiopia. This is being illustrated as follows:

$H_0$: Agricultural FDI inflow has no significant impact on agricultural production in Ethiopia.
$H_1$: Agricultural FDI inflow has a significant impact on agricultural production in Ethiopia.

## 1.8. Organization of this study.

The remaining part  of this thesis was organized as follows. The next chapter discussed theoretical, empirical and conceptual reviews of this study. Chapter three discusses the methodology and model specification for empirical analysis. Chapter four presents the descriptive and econometric analysis and interpretation of the results. Chapter five is dedicated for conclusion and recommendations.

# 2. Literature Review

## 2.1 Overview of FDI inflow

FDI is defined as a category of cross-country investment in which a firm or an entity based in one country establishes a lasting interest and a significant degree of influence over an enterprise into a firm or entity based in another country. In general, Dunning (1993) identified three possible FDI based on possible motives of foreign investors.

***Market seeking FDI***: refers to FDI focus on the host countries' demand and serves local and regional markets. The host country's market size, per capita income and market growth potential are important characteristics that drive of market seeking FDI.

***Resource/asset seeking***: refers to FDI targets to acquire natural resources that are not available at origin and available or cheap through FDI in the host country such as raw materials, skilled and unskilled labor and climate.

***Efficiency seeking FDI***: A kind of FDI occurs when Multi-national Firms' looks to invest in locations due to lower cost, efficient production process and economies of scale and so on the recipient country.

The volume of FDI in the world countries has shown growth due to the liberalization of trade and investment policies. Such growth accounted by a factor of ten for the last fifteen years at the time where international trade showed double increase on the same period (Ball et al., 2008). FDI flows in most countries showed progressive growth, for example, reached US$1.4 trillion in 2007 (UN, 2007). The trends of growth, however, vary in relation to geographical distribution of FDI countries. During the years of 2004 to 2006, FDI inflow in East and South Asian countries showed significant increase accounted for 49% followed by West Asia and central America accounted for 13 % and 7.5%, respectively (UN, 2007).

### 2.1.1 Overview FDI inflow to Africa

FDI inflow in Africa is very limited in spite of the continent's dire need for FDI due to the scarcity of capital investment (Marandu, 2019). The author was also illustrated that FDI inflows to Africa are concentrated regionally in South Africa and North Africa due to their natural resources endowment such as mining, oil and metals while East Africa and Central Africa have low levels of FDI inflow. Country-wise, the two main recipients of FDI in each sub-region are Angola and South Africa. In general, low and stagnant FDI inflow to Africa has been become an important agenda that needs attention as Africa received only 3% of the global FDI share between the years 2014 to 2018 in terms of total accumulated investment (Morgan, 2022).

The current global FDI inflow records $1.58 trillion in 2021 which was low as compared to $2.46 trillion in 2020 (UNICTAD, 2022). The Covid -19 pandemic and the recent war in Ukraine resulting uncertainty and downward pressure on FDI flow around the globe. According to UNICTAD (2022), African countries foreign direct investment riches $83 billion in 2021. This record was $39 billion in 2020 during the Covid -19 pandemic disruption. However, when we compare to the global share the investment inflow to Africa accounted for only 5.2% in 2021 which was 4.1% in 2020.

Various studies have been conducted on FDI inflow in Africa. The different factors that affects FDI in Africa was studied by Anyanwu (2011) while the determinants of FDI in ten SSA countries have been investigated by Jaiblai (2019). Another study by Sakyi (2017) examines the effect of FDI and trade by taking 45 African countries as benchmark over the period 1990-2014. In regional base, the impact of FDI in economic growth in East Africa was studied by Zekarias (2016). The drawbacks and challenges of FDI in Africa referring to deindustrialization of the continent infant industries as well as in grabbing of land and power was investigated by Wako (2021) , Lisk (2013) and Santangelo (2018).

### 2.1.2 Overview FDI inflow in Ethiopia

Some earlier documents indicate that FDI in Ethiopia was assumed to be appearing in 1950s focusing on in cotton plantation for domestic textile industries and export oriented coffee and citrus fruit productions (Mohammed, 1969). However, FDI is actively lay in ground in Ethiopian with the support of policy during in 1990s (Haile and Asefa, 2006). Currently, Ethiopia is found to be one of the top five FDI recipient countries followed by Kazakhstan, Mongolia, Turkmenistan and Uzbekistan, in that order among exceptionally landlocked developing countries (WIR, 2022). The above five countries has accounted for more than 71% of total FDI to the group. Ethiopia attracts averagely 661.85 million USD from 2011 until 2022, reaching maximum 1906.70 million USD in 2021 and record low of 151.90 USD million in 2011 (NBE, 2022).

According to UNCTAD (2022), manufacturing, agriculture and service are major sectors that attracted the highest shares of investment in Ethiopia. China has the large share of FDI in Ethiopia followed by Saudi Arabia, the United States, India and Turkey. China, for example, accounts for 53% of new FDI projects approved, with significant investments in manufacturing and service sectors (UNCTAD, 2022).

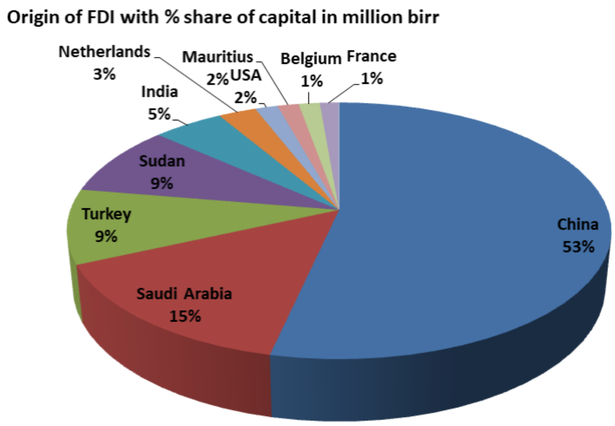



Figure 1. Source countries of FDI inflow to Ethiopia (Own analysis data source: EIC, 2022)

## 2.2. Basic definitions

**Agriculture sector:** an economic sector that encompasses crop, livestock production, fisheries and forestry for food and non-food products.

**Foreign direct investment (FDI)**: Investment from one country into another country (normally by companies rather than governments) that involves establishing operations or acquiring tangible assets, including stakes in other businesses.

**Absorptive capacity**: referred as an economy's capability to absorb the positive spill over benefits by foreign investors and apply it for local business. It is also defined as “the ability of a firm to recognize the value of new external information, assimilate it and apply it for business purposes” (Cohen and Leviathan, 1990). Absorptive capacity includes the strength of the backward and forward linkage of economic sectors, the level of institutional and human capital and trade policies of the host country, among other enabling conditions.

**Spill over:** is an economic event in one context that occurs because of something else in a seemingly unrelated context. For example, externalities of economic activity are non-monetary spill over effects upon non-participants.

### 2.3. Theoretical Framework on agricultural FDI

This paper examines FDI inflow in the agriculture sector nexus agricultural GDP in real values. The author found that literatures on the impacts of FDI inflow in the agriculture sector or food security are scarce. This study stands on the two basic theoretical foundations.

#### 2.3.1. The modernization theory

The modernization theory declared as fact that traditional societies gradually develop as they adopt modern practices (Janos, 1986). Considering agriculture sector in particular, this theory implies that adopting and customizing modern agricultural practices from foreign agricultural investments will lead domestic investors and gradually smallholder farmers to increase agricultural surplus by boosting their productivity. Although the agriculture sector is prominent for economic well-being in developing countries, it is operated with backward conventional farming method and hand labour (Skoet and Stamoulis, 2006). FDI in the agriculture sector serves as a channel to covey modern farming techniques (improved agricultural technologies, modern managerial and technical skills) from developed countries to least developed countries. By general assumption, foreign investors cultivate with higher level of technologies and bring positive externalities, which are not priced. Besides, the flow of foreign direct investment creates a wide opportunity for local farmers to introduce and adopt modern agricultural technologies.

#### 2.3.2. Dependency theory

Dependency theory was originated in 1949 by Hans Singer and Raúl Prebisch who stated that resources flow from a "periphery" of poor and under developed states to a "core" of wealthy states. Based on the above theory, FDI inflow entails host country become supplier of raw material, cheap labour for the investors' country and thus affects the developing countries in depletion of resources. Besides, foreign direct investment can deter economic development by widening income inequality, reducing consumer welfare and food security as explained by Mihalache-O'Keef and Li (2011). The proponents of this theory argue that foreign investment in the agriculture sector can reduce agriculture sector performance by hampering indigenous knowledge and entrepreneurship, interfering with domestic investment, by producing at an expensive price, repatriating profit to origin countries. Further multinational Firm's (MNF's) have the potential to influence local politics and economic condition (Dixon and Boswell, 1996; Heo and Hahm, 2007; Adams, 2009).

### 2.3.3 The direct impact – a neoclassical model

Economic production function is the most widely used approach in economic growth studies. The approach illustrate the relationship between aggregate production and factors of production usually, capital and labor (Solow, 1957). This function could be represented by the association between aggregate production and inputs using the following equations:

$$Y=A^*(K, L) \quad \text{(i)}$$

$$\Delta K_t = I_t - \alpha K_{t-1} \quad \text{( ii )}$$

Where Y denotes aggregate output, A is technology, K is capital input and L is labor input. The second equation depicts capital accumulation equation where $\Delta K$ represents change in capital accumulation $I_t$ is current investment and α denotes depreciation rate. As indicated in equation (ii), the change in capital accumulation of capital stock depends on directly on the current investment and inversely on the depreciation rate.

If all factors of production are paid their marginal products with the neoclassical assumption of constant returns to scale. The 'Solow' residual equation become:

$$\Delta lnY = \beta_k \Delta lnK + \beta_l \Delta lnL + \Delta lnA \quad \text{(iii)}$$

Where Y represents aggregate output, A is technology, K is capital input and L is labor, $\beta_k$ $and$ $\beta_l$ capital share and labor share of the output, respectively. $\beta_k + \beta_l = 1$ With the assumption of neoclassical theory technology assumed to be exogenous and not priced. As indicated in equation (ii) and (iii) there is a direct relationship between investment and the entire economic growth. The contribution of capital accumulation to economic growth or particularly sectorial growth determined by the capital share of national output in general sectorial output in particular. Hence, domestic and foreign investments both inject capital to the host country economy sectors including agriculture, which is the focus area of this study. The injected capital foster agricultural production growth in the short run while the country converges to steady state due to capital diminishing returns to scale in the long run.

### 2.3.4 The indirect impact- the new growth model

In contrast to neo classical theory, the new growth theory assumes that foreign direct investment is more impactful than domestic investment to the host country economy (Romer, 1987). According to this theory, this is due to the fact that the recipient countries dose not only obtaining capital but also technology, skill and expertise from FDI (Arrow, 1962). Moreover, these positive externalities of FDI has a potential to offset capital returns to scale of capital and boost aggregate production both in the short run and in the long run (Romer, 1986).

FDI in agriculture sector could raise the sector production performance in three ways by: Firstly, introducing new agricultural packages such as improved crop varieties, fertilizer packages, livestock husbandry packages, that can foster agricultural product and productivity. Secondly, adoption of new agronomic practice, farming techniques and modern methods that reduce pre and post-harvest losses (Lasbrey et al, 2018). Thirdly, applying irrigation in drought prone areas especially in developing countries that depends on rain fed agriculture (Songwe and Deininger, 2009).

### 2.3.5 Positive externalities of agricultural FDI

Another thought of FDI impact on economic sectors is positive externalities that stated by Forte & Moura, (2013). In addition to the potential capital injection and technology transfer benefits, FDI inflow can influence the entire economy including the agriculture sector through positive spill over effect. This includes indirect kill and managerial expertise and technology transfer to neighbourhood farmer's and domestic investors through demonstration or imitation (learning by watching), labour mobility , competition and integration with local firms in the form of back ward and forward linkage in the way that enhance productivity and production.

### 2.3.6 Negative externality of agricultural FDI

Dependency scholars widely advocate about the negative externalities emanates from the presence of multinational firms (MNF's) which brings negative effect on economic development in the long run (Perez, 1998). According to this theory, this MNF's investment favors its origin more than the recipient country. Agricultural FDI exerts negative spillovers such as displacement of local farmers to avail land for foreign investors, crowding out local investors and extensive use of chemicals that expose the environment to degradation that affect the economy in the long run (Cotula, 2009). In some of developing countries, there are special favors to MNF's that might not consider the local communities which in turn cause social conflicts and unrest so that agricultural FDI could not bring positive impact as expected (Görgen et al., 2009). These adverse impacts may escalate if there are weak administrative, regulatory, and governance arrangements associated with FDI.

## 2.4. Empirical reviews on FDI in relation to agriculture

Limited studies have been conducted on the impact of FDI on the agriculture sector performance and those existing studies show inconsistent findings. A study by Gunasekera and Newth, (2015) explored the impact of FDI inflow in African agricultural by Meta-analysis using dynamic Global Trade Analysis Project model (GDyn). This study revealed that FDI has a potential to increase African agricultural production along with land productivity improvement efforts in particular commodities, oil seeds, sugar, and cotton. Another literature from Tanzania by Msuya, (2007) concludes that smallholder farmers those are integrated into MNF's recorded a positive change in productivity and the author also suggests small holder strong institutional set up is necessary condition to benefit more from FDI inflow in Tanzania. In general, the above two studies recommended that FDI in agriculture could be effective if and only if the host country should make an effort that enhance land productivity and to establish strong institutions.

An empirical study by Oloyede (2014) was conducted using annual data from 1981 to 2012 for study of impact of FDI on agriculture. He found that FDI has a significant positive impact on the agriculture development both in the short run and in the long run. Similar study also undertaken by Iddrisu et al., (2015) in Ghana based on the annual data 1980-2013. In this study, FDI foster agricultural productivity in the short run while unlike to Oloyede (2014) he found that negative relationship in the long run.

A panel data analysis of 55 developing countries over the period 1995-2009 examines the role FDI across sectors in food security. The study revealed that FDI in the agriculture sector improves food security by increasing food availability and utilization through rising agricultural production and productivity (Slimane et al, 2016). A study by Santangelo (2018) the effect of FDI in land called ‘land grabbing’ is heterogeneous with the origin of foreign investors. If the investment origin is from developed country it brings positive impact in the host country as well as it has positive externality due to home country institutional base for human rights and respects of farm land conduct. However, if the investor origin is from developing country FDI could drive adverse effect on food security by decreasing farming land due to institutional pressure of and they work in favor of policy objective their home country. The study concludes that the impact of FDI either it is positive or negative determined by the origin of MNFs.

Another study by Owutuamor and Arene, (2018) estimates the impact of Nigerian FDI inflow among other macro variables on agricultural growth based on annual time series data 1981 to 2014 by employing ordinary list squares (OLS) regression. They found that the share of agricultural inflow was very low as compared to other sectors and thus FDI in agriculture has positive insignificant effect on agricultural growth. The authors come to end that agricultural FDI alone will not lead to a sustainable growth in the sector unless it is blended with that the right proportion of local investment.

There are also very recent studies by Nyiwul and Koirala, (2022) and Dogan (2022) that investigate the direct and indirect impact impact of FDI on agriculture sector, respectively. The first authors analyzed the nexus between agricultural FDI and development of the agricultural, forestry and fishing sectors in developing countries using 16 developing countries annual data by employing panel vector auto regression approach. The findings of the study showed that the existence of positive and significant relationship between agricultural FDI and agriculture, forestry and fishing value add. In this study, the model illustrates the presence of cyclical effect among FDI and value addition in agriculture that remains positive up to five years. The study also indicated that there was strong bidirectional linkage in the middle of FDI inflow and agricultural value adds.

Doğan (2022) explores the indirect impact of agricultural FDI linking with food security applying 16 yearly data from 56 developing countries. He found that promoting the agricultural production and productivity is not the ultimate goal of the host country rather it is insuring food security. Some resource seeking FDI types mainly looking opportunities to enhance food security in the investor's country not always for domestic utilization. Despite there is a rise in agricultural production due to FDI involvement it does not means always contribute to food security. Over all, the empirical analysis indicated that although FDI has a positive significant impact on agricultural production it might decreases food security in the recipient country.

In the case of Ethiopia, various experts have conducted few empirical studies about the nature of FDI and its impact in the nation economy. These studies can be systematically be grouped under two major categories. The first category focused on the nexus of FDI on country's economic growth as a whole (Mohd and Muse, 2021, Gizaw, 2015, Menamo, 2014 Kedir, 2012). Such empirical studies, however, are inconclusive and mask the individual effect of FDI in each economic sector. The second category of studies emphasized on the effect of FDI on agriculture sector in Ethiopia by Weissleder (2009) and Persson (2016). The first author conducted her study based on descriptive analysis that lacks detailed explanation whereas the second author works limited on specific locations of Ethiopia.

To the best of our knowledge the symmetrical and asymmetrical impact of FDI inflow the agricultural production of Ethiopia has not been explored. To close this literature gap and to generate more detail empirical evidence, this study was conducted through analyzing the impact of FDI inflow on agricultural performance along with selected macro variables such as gross fixed capital formation, and credit to agriculture, trade openness, general inflation rate and real effective exchange rate using appropriate econometric methods.

### 2.5. Conceptual framework of the study

There are different potential factors that can drive the need of FDI inflow in agriculture sector. Such factors can be explained from two perspectives. The first one is the '*push factors*' that arises from the increased demand for food in developing countries like Ethiopia due to the ever-increasing population, vulnerability to global food price fluctuation ,the need for food self-sufficiency. The other perspective '*pull factors*' are the conducive environment for FDI such as the presence of diverse agro-ecology suited to agriculture, being endowed with abundant and cheap resource and higher need to expand large scale agro-processing and agro industry with backward and forward linkages in the foreign investors (Arezki et al., 2011; Deininger et al., 2011)

To feed the ever increasing population and to ensure food supply, the agricultural production and productivity should be increased significantly. There are two possible ways to boost production and productivity. The first option is increasing the productivity using improved packages with the existing arable land in a sustainable way. Alternatively, to expand the production area using those lands not cultivated so far. Out of the 34 % total arable land suited to agriculture in Ethiopia, only 14% are arable lands so far (FAO, 2023). This is an opportunity to enhance productivity either through intervention of domestic or foreign investors. Those lowland areas where water resource is available but with limited rainfall distribution can be applicable for agricultural FDI since there is a possibility to use technologies that requires high investment such as irrigation and mechanization.

One of the key constraints on agricultural production and productivity expansion in Africa is technology limitation. Increasing FDI inflow of foreign investment in food and agricultural sectors is crucial channel to convey improved technology, best practice and expertise from developed country that results productivity improvements. Agricultural technology adoption is a wide concept which encompasses new biological, chemical and mechanical technique including farm capital and inputs. Besides technology adoption level of developing countries also determined by the bases and absorption capacity of domestic investors farmer's knowledge, education, training, advises about the modern practice and institutional strength of agri-food sectors (Viatte, 2001).

Although FDI inflow is taken as a major variable that intended to be investigated in this study, there are also other macro variables such as gross fixed capital formation, credit to agriculture and, general inflation rate, general inflation and real effective exchange rate that affect agricultural performance. This is illustrated by the conceptual framework presented in Figure 2 below that depicts the FDI inflow-agriculture sector performance nexus keeping other macro variables as control variable.

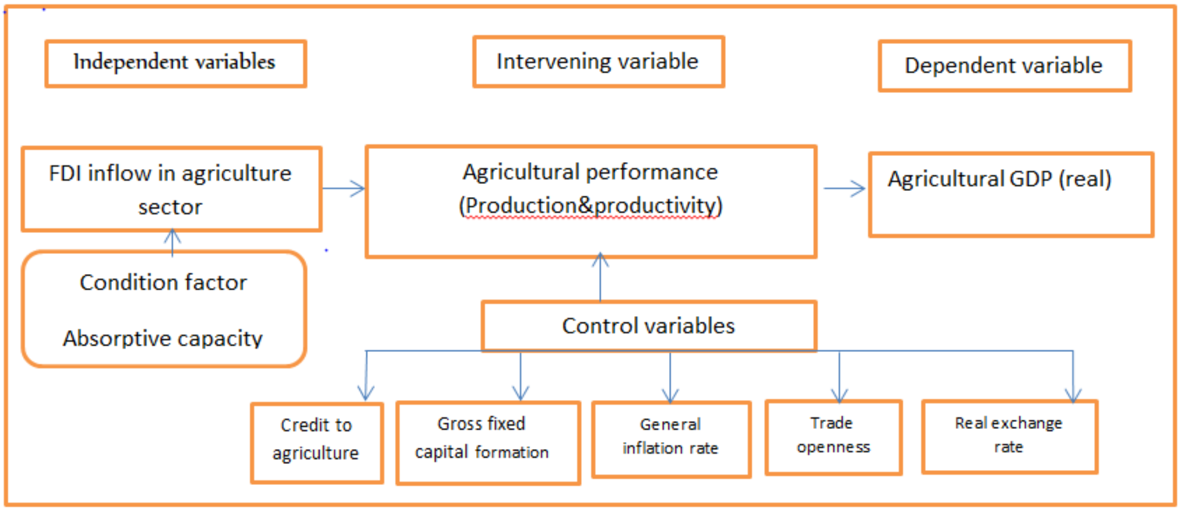



Figure 2. Conceptual framework of the study (own analysis)

As indicated in Figure (2) above, the nature of the relationship between FDI and agricultural performance is direct. FDI inflow in a large-scale farm with high technology investment and advanced managerial and technical skill directly enables a rise in agricultural product and productivity in the sector. Moreover, FDI could result in a positive spillover effect such as competition, linkage, skill, and imitation opportunities for domestic investors and small-scale arms depending on their absorption capacity. Thus, the indirect effect also harnesses the production to increase, and then its overall impact can be substantial.

# 3. Methodology

## 3.1. Description of variables and data source

Second party data were used to analyze the extent effect of FDI inflow on the agriculture sector performance. The data was gathered on the selected variables from well-known sources such as Ethiopian Investment Commission (EIC), National Bank of Ethiopia (NBE), Food and Agricultural Organization (FAO) and World Development Indicators (WDI). These variables were used to examine the significant relationship between FDI inflows to agriculture sector. The description, unit of measurement, data source and designation of the selected variables is presented in Table 1.

Table 1. Descriptions of variables

| No. | Selected variables | Description of variables | Expected sign | Unit of measurement | Data source | Variable designation |
|---|---|---|---|---|---|---|
| 1 | Agricultural real GDP (AGRGDP) | AGRGDP is an output in the agricultural sector is made up of crops production, animal farm production, forestry, fishing and hunting in real terms. | | Million Birr | WDI | LNRGDPAG |
| 2 | Foreign direct investment (FDI) inflow in agriculture sector | FDI is measured as FDI net inflows of foreign investments in agricultural sector. | + | » | EIC | LNFDIAG |
| 3 | Gross fixed capital formation (GFCF) | GFCF is made up of machinery, plant, purchases of equipment, industrial buildings, construction of railways and roads. | + | » | FAO | LNGFCF |
| 4 | Credit to agriculture (CRTA) | CRTA is the amount of loans provided by the private/commercial banking sector to producers in agriculture, forestry and fishing, including household producers, cooperatives, and agro-businesses. | + | » | NBE | LNCRTA |
| 5 | Trade openness (TOP) | TOP is export and import as a percentage of GDP | + | Index | » | TOP |
| 6 | Real effective exchange rate (REER) | REER An exchange rate is the rate at which one currency will be exchanged for another currency divided by a price deflator or index of costs. | _ | Average Birr/Dollar | » | REER |
| 7 | General Inflation rate (GIR) | GIR is the rate of increase in price over a given period of time | _ | Index | » | GIR |

### 3.2. Data organization and management

Data was organized as multivariate time series on annual basis spanning from 1981 to 2021 with a total of 41 observations. The real agricultural GDP value (in million Birr) and agricultural FDI inflow (in million Birr) were taken as dependent and independent variables, respectively. The variables such as credit to agriculture, gross fixed capital formation, general inflation rate, real effective exchange rate and trade openness were taken as control variables.

Time series models works if and only if the data is completed imputation was required to treat the missed values. Missed data for agricultural FDI inflow and gross fixed capital formation has filled with forecasting and by casting techniques. Agricultural GDP data was deflated with CPI index (consumer price Index) to transform to real values. To improve linearity and to boost validity, data for some variables (real agricultural GDP, gross fixed capital formation and credit to agriculture) were transformed to natural logarithm. The analysis of the study was conducted using STATA (17) and EViews 10 softwares.

### 3.3 Descriptive analysis

Descriptive analysis of data was conducted to understand the basic characteristics of the data. This analysis provides a brief summary and some outputs of the study.

### 3.4. Econometric analysis

#### 3.4.1. Stationary test

Standard regression techniques, such ARDL and NARDL require that the variables to be covariance stationary. To select the good fit models that explain the data, stationarity test was conducted for each variable. Then, those variables which are non-stationary at level were subjected to differencing to avoid estimating spurious regression. Finally, unit root tests were conducted using Augmented Dicky-fuller (ADF) and Phillips Peron (PPerron) test.

#### 3.4.2. Bound test of cointegration

The newly introduced bound test for cointegration developed by Pesaran et al (2001) was adopted since it is a novel approach to a solve the problem of testing the presence of long run relationship between the variables. Since the stationary test of the variable was found to be mixed I (0) and I (1), we employed bound test of cointegeration.

#### 3.4.3. Model specification

To assess the effect of FDI inflows in the agricultural real GDP, we used both symmetric Auto Regressive Distributed Lag (ARDL) and asymmetric ARDL or Non-linear ARDL(NARDL) models. The ARDL model was developed by Pesaran et al. (2001) while the NARDL model was relatively a recent model developed by Shin et al. (2014). The ARDL model was chosen due to its multiple advantages. First, the model performs better in determining cointegration relations in small observations (Romilly and Liu, 2001). Second, it allows displaying both static and dynamic effects of the independent variable(s) on the dependent variable. Third, it can be applied if the variables are stationary at level I (0) or stationary at first difference I (1) or mixed. On the other hand, the asymmetric ARDL (NARDL) model for two reasons. First, it allow to detect hidden cointegration between variables and, second, it enables to capture the dynamic effect of both positive and negative changes in an explanatory variable on a particular dependent variable that the ARDL fails to do.

***The symmetric ARDL model analysis***

To explore the symmetric association among FDI inflow in agricultural sector and agricultural real GDP with deterministic variables of gross fixed capital formation, credit to agriculture, trade openness, general inflation rate, real effective exchange rate. The optimal lag length was selected through VAR model using EVIEWS 10 software by AIC (acacia information criteria) as indicated below.

Table 2. Optimal lag order

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -77.23406 | NA | 0.809546 | 5.464418 | 5.558714 | 5.493951 |
| 1 | -18.89832 | 104.6020 | 0.019118 | 1.717126 | 2.000014 | 1.805723 |
| 2 | -16.76587 | 3.529565 | 0.021865 | 1.845922 | 2.317404 | 1.993584 |
| 3 | -7.593037 | 13.91741 | 0.015496 | 1.489175 | 2.149249 | 1.695902 |
| 4 | -2.911622 | 6.457125 | 0.015127 | 1.442181 | 2.290847 | 1.707973 |
| 5 | -1.829074 | 1.343853 | 0.019205 | 1.643384 | 2.680643 | 1.968241 |
| 6 | 0.150935 | 2.184838 | 0.023377 | 1.782694 | 3.008546 | 2.166616 |
| 7 | 96.69142 | 19.31385* | 0.000794* | -3.220098* | -0.862691* | -2.481788* |

Own analysis

To capture the short run dynamics, we can write the linear ARDL (p,q) model associated with equation (1) as explained in Pesaran et al.(2001).

$$\Delta LNRGDP_t = \beta_0 + \sum_{j=1}^{p} \emptyset_j LNRGDPAG_{t-j} + \sum_{j=0}^{q} \beta_{2j} LNFDIAG_{t-j} + \beta_3 LNGFCF_t + \beta_4 LNCRTA_t + \beta_5 GIR_t + \beta_6 TOP_t + \beta_7 REER_t + \varepsilon_t \quad (1)$$

Where $\emptyset$ represent short run and long run dynamics

p and q the lag length selected

$\beta_0$ = Constant term

$\beta_1 - \beta_7$ = Coefficient of the variable

*Asymmetric ARDL model specification*

The non-linear ARDL allows to capture partial sum decomposition to implement non linearity by examining the possible asymmetric effects in the long run and short run. FDI variable was decomposed into positive and negative partial sums. The decomposed positive and negative sums imply an increase in LNFDIAG (with a positive superscript) and a decrease in LNFDIAG (with a negative superscript), respectively. We defined the partial sums for the foreign direct investment in agriculture sector as follows.

$$\mathrm{LNFDIAG}^{+} = \sum_{j=1}^{t} \Delta\mathrm{LNFDIAG}_{j}^{+} = \sum_{j=1}^{t} \max(\Delta\mathrm{LNFDIAG}_{j}, 0)$$
$$\mathrm{LNFDIAG}^{-} = \sum_{j=1}^{t} \Delta\mathrm{LNFDIAG}_{j}^{-} = \sum_{j=1}^{t} \min(\Delta\mathrm{LNFDIAG}_{j}, 0)$$
(2)

To explore the non- linear relationship between real agricultural GDP, we represent the analysis by the formulae

$$\Delta LNRGDPAG = \beta_0 + \beta_1 LNRGDPAG_{t-1} + \beta_2^{+} LNFDIAG_{t-1}^{+} + \beta_2^{-} LNFDIAG_{t-1}^{-} + \beta_3 LNGFCF_{t-1} + \beta_4 LNCRTA_{t-1} + \beta_5 GIR_{t-1} + \beta_6 TOP_{t-1} + \beta_7 REER_{t-1} + \sum_{j=0}^{p} \theta \Delta LNRGDPAG_t + \sum_{j=0}^{q} (\theta_j^{+}\, \Delta LNFDI_{t-1}^{+} + \theta_j^{-}\, \Delta LNFDIAG_{t-1}^{-}) + \varepsilon_t \quad (3)$$

From equation 3 $\beta_2^{+}(\sum_{j=0}^{q} \theta_j^{+})$ and $\beta_2^{-}(\sum_{j=0}^{q} \theta_j^{-})$ captures the long (short) run positive and negative impact of foreign direct investment in agriculture sector.

After employing the NARDL model, the bound cointegration test was resorted to determine the presence of long run relationship. Moreover, the analysis adjusted with Error Correction Model (ECM) (Nkoro and Uko, 2016) to determine the speed of adjustment to the long run equilibrium of real agricultural GDP. Wald test was also computed to explore the long (short) run asymmetry significance between the dependent and independent variable.

*Post-estimation tests*

Diagnostic tests were employed for post-estimation of ARDL and NARDL models whether there is some violation of classical regression assumptions: non-serial correlation, homoscedasticity, multicollinearity, linearity and specification, exists or not.

*Granger causality test*

Granger casualty test was used to verify the usefulness of FDI inflow in agriculture sector information to forecast the agriculture sector performance.

# 4. Result and discussions

## 4.1 Trend analysis of FDI inflow

### 4.1.1 FDI inflow in agriculture sector

FDI inflow in the agriculture sector of Ethiopia showed a fluctuating trend as depicted in the Figure 3 below Ethiopia has exhibited limited advancement in the flow agricultural FDI before 2004. Low capital inflow was registered in 1996 3.3 million birr while the sector recorded significant increase in FDI inflow in 2008 by attracting 1796.73 million birr capitals to the sector. This huge amount of FDI inflow was obtained by the effort made by the government to attract more FDI and the then conducive environment of the country (PSI, 2022). FDI inflow started to decline in 2017 largely due to domestic political instability and global economic dynamics (PSI, 2022).

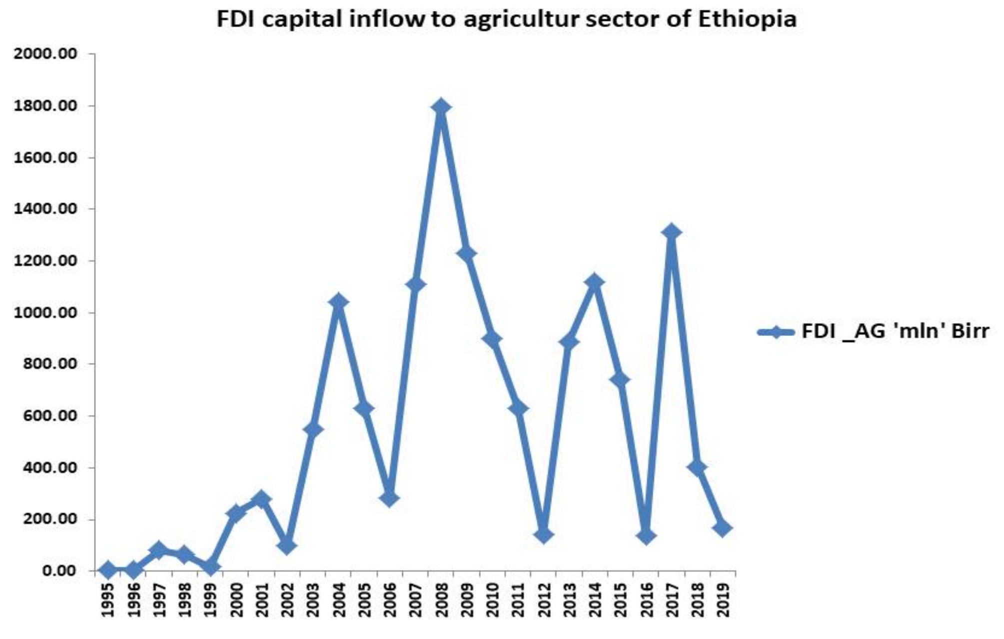



Figure 3. Trend line of agricultural FDI inflow to Ethiopia. (Own analysis data source: EIC, 2022)

### 4.1.2 Agricultural FDI inflow with sub –sector

In terms of sub-sector, the floriculture sub-sector accounts 2,923 million Birr capital inflow followed by crop and coffee based investments which account 2016 and 1226 million Birr capital, respectively (Figure 4). The large share in floriculture enables Ethiopia to become the sixth-largest international and the second-largest African rose exporter (Gelaye, 2023). The next larger investment on crops and coffee could imply that FDI might play in food security and export, respectively. The result also indicated that low investment was observed in poultry and cotton although they have huge potential in FDI inflow.

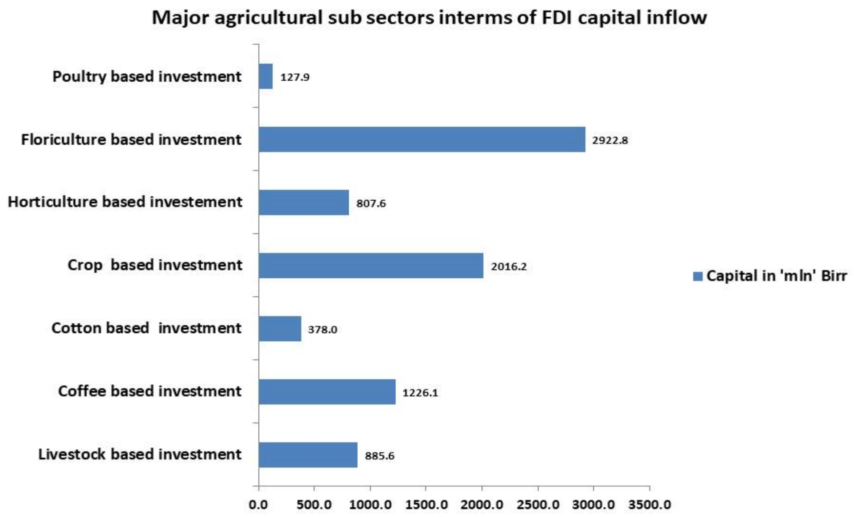



Figure 4. Sub-sector distribution of agricultural FDI. (Data source: EIC, 2022)

### 4.1.3 The contribution of FDI inflow to unemployment reduction

FDI inflow in Ethiopia created job opportunities to 74, 9810 peoples in which 394072 and 35, 5738 are permanent and temporary employment, respectively (Figure 5). This implies that FDI inflow has potential to reduce unemployment to the economy. Although the percentage of employee in agriculture was found to be smaller than the manufacturing and service sector, its contribution should not be underestimated. This is due to the fact that agricultural FDI is characterized by capital intensive that generate products with limited labor.

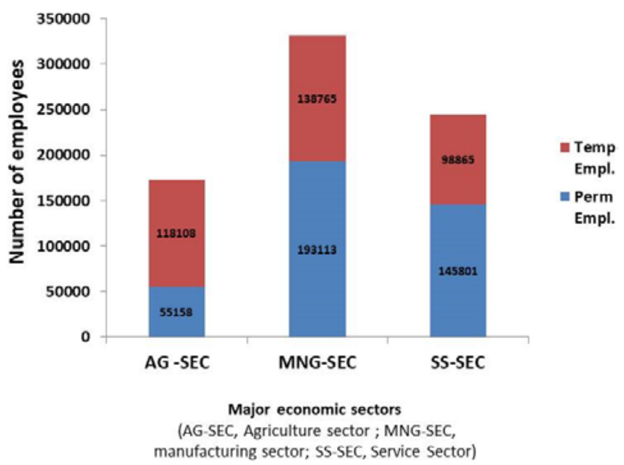



Figure 5. Employment opportunities created with FDI across major sectors (Own analysis data source: EIC, 2022).

### 4.2 .Descriptive statistics

The descriptive statistics the dependent and independent variables are presented in Table 3. The highest average value 12,358,552 million birr for agricultural real GDP and the lowest average value 0.22 trade openness index were found from analysis of 41 observations. Measure of dispersions indicated that the most volatile variable, real agricultural GDP scored the highest standard deviation 8,159.933 while the least volatile variable, trade openness recorded the least standard deviation, 0.08.

Measure of normality also showed that all variable except trade openness were found to be leptokurtic (kurtosis>3). This result also justified by Jarque-Bera test which showed similar result. Such variable were subjected to transformation for further analysis. Since the Skewedness of all variables was (> 0), the data sets were found to be asymmetric.

Table 3. Summary statistics

| | RGDPAG | FDIAG | CRTA | GFCF | GIR | TOP | REER |
|---|---|---|---|---|---|---|---|
| Mean | 12358552 | 365.6201 | 6559.368 | 193954.2 | 9.982794 | 0.222193 | 158.1279 |
| Median | 8253228. | 137.8004 | 1884.800 | 17669.00 | 7.504031 | 0.217434 | 148.9784 |
| Maximum | 33130933 | 1796.731 | 31823.62 | 1027047. | 55.24131 | 0.361307 | 344.5183 |
| Minimum | 4645246. | 0.500000 | 311.0000 | 195.0700 | -11.82323 | 0.095692 | 93.78449 |
| Std. Dev. | 8159933. | 469.3502 | 8328.230 | 317540.3 | 13.38992 | 0.080061 | 53.71830 |
| Skewness | 1.077977 | 1.245732 | 1.315605 | 1.547139 | 1.357280 | 0.139652 | 1.331705 |
| Kurtosis | 2.868336 | 3.637102 | 3.511172 | 3.889745 | 5.644401 | 1.756388 | 5.135315 |
| Jarque-Bera | 7.970178 | 11.29771 | 12.27363 | 17.70893 | 24.53456 | 2.775328 | 19.90777 |
| Probability | 0.018591 | 0.003522 | 0.002162 | 0.000143 | 0.000005 | 0.249658 | 0.000048 |
| Sum | 5.07E+08 | 14990.42 | 268934.1 | 7952124. | 409.2946 | 9.109915 | 6483.242 |
| Sum Sq. Dev. | 2.66E+15 | 8811584. | 2.77E+09 | 4.03E+12 | 7171.593 | 0.256391 | 115426.2 |
| Observations | 41 | 41 | 41 | 41 | 41 | 41 | 41 |

### 4.3 Regression line test

A regression line of the scatter plot of the dependent variable LNRGDPAG and the independent variable LNFDIAG indicated that the regression line does not resemble to straight line (Figure 6). This implies that the non-linear relationship between the dependent and independent variables.

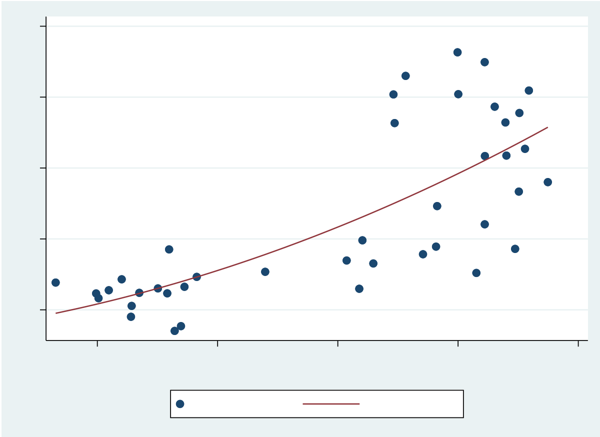


Figure. 6 Regression line of LNRGDPAG with LNFDI

### 4.3. Econometric analysis of the study

#### 4.3.1 .Unit root test

The unit root test indicated that general inflation rate was stationary at level I (0) while others variables were stationary at first difference I (1). Thus, the stationarity test of the selected variables for this study was found to be mixed I (0) and I (1) as well as none of the variable was I(2). In this study, therefore, ARDL or NADRL model were employed due to the mixed unit root (Shrestha, 2017).

Table 4. Unit root test of variables

| Variables | | Augmented Dickey–Fuller test | | Phillips and perron test | |
|---|---|---|---|---|---|
| | | Level I(0) | First difference I(1) | Level I(0) | First difference I(1) |
| LNRGDPAG | With intercept | 2.618733 | -4.608524*** | 2.353729 | -4.643808*** |
| | With intercept and trend | -0.819557 | -5.438864*** | -0.915626 | -5.416223*** |
| LNFDIAG | With intercept | -1.289267 | -7.906819*** | -1.438213 | -8.433996*** |
| | With intercept and trend | -0.124734 | -4.884175*** | -1.987527 | -9.615767*** |
| GIR | With intercept | -5.501894*** | | -5.521108*** | |
| | With intercept and trend | -6.003099*** | | -5.994009*** | |
| LNCRTA | With intercept | -0.245659 | -5.650539*** | -0.216077 | -5.614663*** |
| | With intercept and trend | -1.626088 | -5.666062*** | -1.710647 | -5.656155*** |
| LNGFCF | With intercept | -1.994121 | -3.544143*** | -1.482930 | -6.569875*** |
| | With intercept and trend | -2.133725 | -3.759881*** | -1.960587 | -6.664414*** |
| TOP | With intercept | -1.239028 | -6.320963*** | -1.237268 | -6.320963*** |
| | With intercept and trend | -0.519783 | -6.528559*** | -0.519783 | -6.527715*** |
| REER | With intercept | -2.370727 | -6.616016*** | 5.323457 | -7.344802*** |
| | With intercept and trend | -2.609540 | -4.524143*** | -2.644387 | -7.186133*** |

* p<0.1, **p<0.05, *** p<0.01,

#### 4.3.2. Cointegration test

In this study, bounds test approach was used to test long run cointegration by Pesaran et al. (2001) to detect the presence of the long run relationship among the variables. The statistical values of F-tests were 1.538519 and 29.14816 for the ARDL and NARDL models, respectively. Since the F-statistics values for NARDL models exceeds the upper bound at 10%, 5%, 2.5% and 1% level of significance, implying that the existence of cointegration in Non-linear ARDL models. In contrast, F –statistics values for ARDL models was below the lower bound at 10%, 5%, 2.5% and 1% level of significance that indicated the absence of long-term relationship between the variables.

Table 5. Bound cointegration test for symmetric ARDL model

| Test Statistic | Value | Signif. | I(0) | I(1) |
|---|---|---|---|---|
| F-statistic | 1.538519 | 10% | 5.59 | 6.26 |
| K | 1 | 5% | 6.56 | 7.3 |
| | | 2.5% | 7.46 | 8.27 |
| | | 1% | 8.74 | 9.63 |

(LGDPAG /LNMFDIAG (2, 7) with fixed regressors (LNMGFCF, LNCRTA, TOP, RER, and C, @ TREND)

Table 6. Bound cointegration test for asymmetric ARDL model

| Test Statistic | Value | Signif. | I(0) | I(1) |
|---|---|---|---|---|
| F-statistic | 29.14816 | 10% | 4.19 | 5.06 |
| K | 2 | 5% | 4.87 | 5.85 |
| | | 2.5% | 5.79 | 6.59 |
| | | 1% | 6.34 | 7.52 |

(LNGDPAG/LNMFDIAG_POS LNMFDIAG_NEG (2, 7, 7) with fixed regressors: (LNMGFCF LNCRTA GIR TOP RER C @TREND)

#### 4.3.3. The regression analysis for estimation

This part of the study presents and illustrates the output of model estimation by examining linear and non-linear impacts of FDI inflow in agriculture sector on agricultural performance The ARDL and NARDL model results are presented in Table 7, 9and 10, respectively and interpreted as follows.

***Symmetric ARDL model estimation***

The linear ARDL model estimate output indicated that FDI inflow in the agriculture sector exerts a negative and insignificant impact on agricultural performance in the short run. Besides, there was no long term relationship between the two target variables .Thus the bound test for long term cointegration was insignificant as indicated in table 5. This result was contradicts from the output of similar study by Iddrisu et al., (2015) who found that negative impact of FDI inflow in the long run while positively in the short run.

The $R^2$ and adjusted R-squared of the Linear ARDL model was 0.96 (.95%) which indicated that FDI inflow in agriculture sector and other variables was explained 95% of variation in the agricultural GDP. The remaining 5% attributed to the error term. The post estimation test depicted that absence of heteroscedasticity and serial correlation. Residuals were normally distributed as explained by Jarque-Bera normality test.Ramsey test verified no misspecification problem in the model. The stability of the model was also confirmed by ARDL CUSUM and CUSUM-SQURE testes as indicated in Figure 7 and 8, respectively.

Table 7. Symmetric ARDL model estimate

| Dependent variable | Regressors | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|---|
| LNRGDPAG | C | 4.134157 | 2.468675 | 1.674646 | 0.1048 |
| | @TREND | 0.015995 | 0.008817 | 1.814048 | 0.0800 |
| | LNRGDPAG(-1) | -0.286633 | 0.178639 | -1.604540 | 0.1194 |
| | LNFDIAG | -0.013037 | 0.018612 | -0.700504 | 0.4892 |
| | D(LNRGDPAG(-1)) | 0.118640 | 0.214461 | 0.553202 | 0.5844 |
| | LNGFCF | 0.011918 | 0.031631 | 0.376798 | 0.7091 |
| | LNCRTA | 0.006183 | 0.056802 | 0.108851 | 0.9141 |
| | GIR | -0.001338 | 0.001831 | -0.730458 | 0.4710 |
| | TOP | 0.104532 | 0.442078 | 0.236456 | 0.8147 |
| | REER | 0.000403 | 0.000692 | 0.582244 | 0.5649 |

LNRGDPAG/LNFDIAG (2, 0) with fixed regressors (LNGFCF, LNCRTA, GIR, TOP, REER**)**

R-squared 0.968140

Adjusted R-squared 0.958253

| Model diagnostics test | F-statistic | P-Value |
|---|---|---|
| Breusch-Godfrey Serial Correlation LM Test: | 0.623418 | 0.7098 |
| Heteroskedasticity Test: ARCH | 1.206249 | 0.3288 |
| Jarque-Bera Normality | 1.545007 | 0.461855 |
| Ramsey RESET Test | 1.749690 | 0.1923 |

* p<0.1, **p<0.05, *** p<0.01,

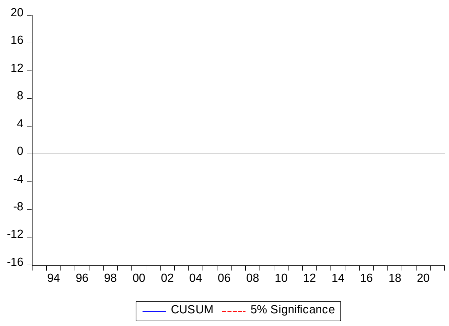



Figure. 7 Cumulative test for stability for ARDL

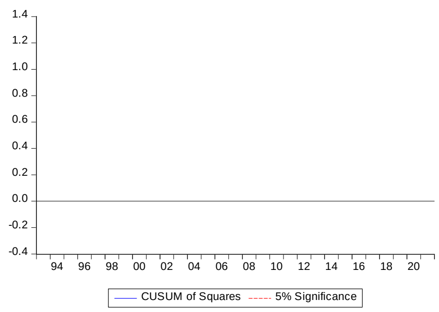



Figure 8. Cumulative square test for stability ARDL

### *Asymmetric ARDL model estimation*

The decomposed partial sum of FDI inflow in agriculture showed asymmetric coefficients as indicated in Table 8. The Wald test also justified the decomposed positive partial sum and the negative partial sum of LNFDIAG impact on the LNRGDP was unequivalent with 1% level of significance.

Table 8. Decomposed partial sum effect of LNFDIAG on LNRGDPAG

| Dependent variable | Regressors | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|---|
| LNRGDPAG | LNFDIAG_POS | 0.007824 | 0.023779 | 0.329026 | 0.7440 |
| | LNFDIAG_NEG | -0.103274 | 0.035116 | -2.940925 | 0.0056 *** |
| | C | 15.27741 | 0.075619 | 202.0322 | 0.0000*** |

* p<0.01p, **<0.05, ***p<0.001

Wald Test:
Null Hypothesis: LNFDIAG_POS= LNNFDI_NEG

| Test Statistic | Value | df | Probability |
|---|---|---|---|
| t-statistic | 8.414218 | 37 | 0.0000 |
| F-statistic | 70.79907 | (1, 37) | 0.0000*** |
| Chi-square | 70.79907 | 1 | 0.0000 |

* p<0.1, **p<0.05, *** p<0.01

The output of long run asymmetric ARDL estimates is presented in Table 9. The result showed that positive FDI inflows shock has favorable and significant effect on the agricultural GDP, indicating that a 1% increase in FDI inflow raise agricultural GDP on average by 0.050 %. This result was expected since FDI in agricultural sector could help to introduce new agricultural packages that could provide beneficial arrangement for the sector of the host country (Deininger et al., 2011). These findings were consistent with empirical studies by (Gunasekera and Newth, (2015) Dhahri and Omri (2020), Nyiwul and Koirala, (2022). The former authors revealed that growth in FDI capital inflow in agriculture sector of Africa enhance the sector's potential output. As explained by Linus and Niraj (2020) and Nyiwul and Koirala (2022), FDI inflow had a positive and significant effect on agricultural production. However, there was no statistically significant impact in negative shock of FDI inflow on agricultural GDP.

In addition to FDI inflow dynamics, the long run immediate past time shock in agricultural production reduced the current production significantly by -0.84% (Table 9). This condition might be due to price fluctuation issue if there is surplus production in the one-time past period which in turn cause fall in price of agricultural commodities and thus farmers lack the motivation to produce more in the current period as revealed by Xie and Wang (2017).

The short-run relationship showed interesting result that an increase in FDI inflow for consecutive six-time lagged period, except for period two, an increase in FDI inflow reduced the current agricultural GDP significantly (Table 10) Moreover, a decrease in FDI inflow for six successive past time lags to the current period also significantly diminished agricultural production. However, the elasticity coefficients for the positive partial sums effect were lower than the negative partial effect of FDI inflow. Such condition could reveal that the positive impact FDI in agriculture sector was not automatic in the short run.

FDI could hinder domestic investment (crowding out) and neighbor small-holder farmer's production. This might arise due to poor competitiveness of domestic investors or smallholder farmers as far as they produce with backward technologies. Bedsides, farmers might lose their farmland due to land acquisition for large-scale agricultural investments, also called land grabbing (Santangelo, 2018). Large scale agricultural investments in Ethiopia, for example, displaced over a million people based on the report by Davis et al., (2014) and Rahmato (2014). In the short run, 1% increase domestic investments such as gross fixed capita formation and credit to agriculture have a favorable and significant impact on agricultural GDP by 0.14% and 0.32%, respectively assuming other variables remain constant.

The measure of goodness of fit $R^2$ and adjusted R-squared of the non-linear ARDL model was 0.96 (.88%) which also indicate FDIAG_POS, FDIAG_NEG , CRTA , GIR GFCF,TOP and RERR can explain 88% of variation in the agricultural real GDP. The remaining 12% was attributed to the error term. The post estimation test depicted that absence of heteroskedasticity and serial correlation. Residuals were normally distributed and the Ramsey test provides no misspecification problem in the model. Besides, the NARDL CUSUM and CUSUM-SQURE testes in Figure 9 and Figure 10, respectively illustrated that the model stability. The above mentioned analysis justified that using asymmetric ARDL was appropriate for this study.

Table 9. Asymmetric ARDL model long run estimation

| Dependent variable | Regressors | Coefficient | Std. Error | t-Statistic | Prob.* |
|---|---|---|---|---|---|
| LNRGDPAG | C | 25.71767 | 2.089530 | 12.30787 | 0.0000 *** |
| | @TREND | 0.030452 | 0.038636 | 0.788191 | 0.4472 |
| | LNRGDPAG(-1) | -0.840102 | 0.153302 | -5.480045 | 0.0002*** |
| | LNFDIAG_POS(-1) | 0.050412 | 0.022998 | 2.192017 | 0.0508* |
| | LNFDIAG_NEG(-1) | 0.034467 | 0.048959 | 0.703989 | 0.4961 |

(LNGDPAG/LNMFDIAG_POS LNMFDIAG_NEG (2, 7, 7) with fixed regressors: (LNMGFCF LNCRTA GIR TOP RER C @TREND**)**

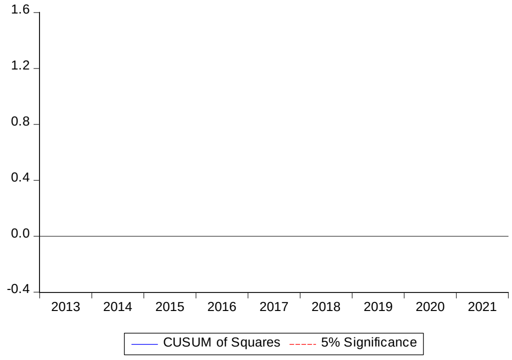
* p<0.1, **p<0.05, *** p<0.01,

Table 10. Asymmetric ARDL model short run estimation

| Dependent variable | Regressors | Coefficient | Std. Error | t-Statistic | Prob.* |
|---|---|---|---|---|---|
| LNRGDP | D(LNRGDPAG(-1)) | 0.812665 | 0.120601 | 6.738472 | 0.000*** |
| | D(LNFDIAG_POS(-1)) | -0.030167 | 0.013601 | -2.217932 | 0.0485** |
| | D(LNFDIAG_POS(-3)) | -0.024901 | 0.013644 | -1.825115 | 0.0952* |
| | D(LNFDIAG_POS(-4)) | -0.081409 | 0.011608 | -7.013134 | 0.000*** |
| | D(LNFDIAG_POS(-5)) | -0.047866 | 0.012221 | -3.91655 | 0.0024*** |
| | D(LNFDIAG_POS(-6)) | -0.036207 | 0.011838 | -3.058611 | 0.0109** |
| | D(LNFDIAG_NEG(-1)) | 0.096235 | 0.032356 | 2.974277 | 0.0126** |
| | D(LNFDIAG_NEG(-2)) | 0.090405 | 0.035323 | 2.559365 | 0.0265** |
| | D(LNFDIAG_NEG(-3)) | 0.150098 | 0.033084 | 4.536871 | 0.0008*** |
| | D(LNFDIAG_NEG(-4)) | 0.141845 | 0.032434 | 4.373308 | 0.0011*** |
| | D(LNFDIAG_NEG(-5)) | 0.028655 | 0.019408 | 1.476488 | 0.1679 |
| | D(LNFDIAG_NEG(-6)) | 0.0569 | 0.020956 | 2.715223 | 0.0201** |
| | LNGFCF | 0.141369 | 0.076282 | 1.853238 | 0.0908* |
| | LNCRTA | 0.321629 | 0.035076 | 9.16961 | 0.000*** |
| | GIR | -0.001213 | 0.000864 | -1.402712 | 0.1883 |
| | TOP | -2.98176 | 0.39574 | -7.534639 | 0.000*** |
| | REER | 0.000115 | 0.000631 | 0.182742 | 0.8595 |
| | CointEq(-1)* | -1.835121 | 0.175527 | -10.45493 | 0.000*** |

(LNGDPAG/LNMFDIAG_POS LNMFDIAG_NEG (2, 7, 7) with fixed regressors: (LNMGFCF LNCRTA GIR TOP RER C @TREND
* p<0.1, **p<0.05, *** p<0.01,

| | | |
|---|---|---|
| R-squared | 0.965021 | |
| Adjusted R-squared | 0.888066 | |
| Model diagnostics tests | F-statistic | P-Value |
| Breusch-Godfrey Serial Correlation LM Test: | 2.451836 | 0.2455 |
| Heteroskedasticity Test: ARCH | 1.052966 | 0.3130 |
| Jarque-Bera Normality | 0.714800 | 0.699493 |
| Ramsey RESET Test | 0.453109 | 0.519 |



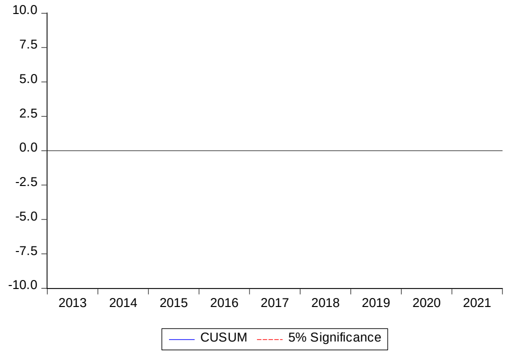




Figure 9.Cumulative test for stability of NARDL

Figure 10. Cumulative square test for stability.

### *Dynamic multiplier in asymmetric ARDL output*

The multiplier graph for FDI inflow (LNFDIAG) indicates the speed of adjustments to the new long run equilibrium for any positive and negative shocks (Figure 11). The black break line indicates the non-linear adjustment of RGDPAG to negative shocks while the solid black line shows adjustment to positive shock. The red break line indicates the difference between both negative and positive shocks. Error Correction Term (ECT) of vector error correction model (VECM) was -1.83 which found to be negative coefficient and significant at 1% (Table 10). This implies that there was oscillatory convergence to long run equilibrium since the value is within the value between -1 and -2 and the error correction process fluctuates around the long-run value .Similar result was reported by Loayza and Ranciere, (2006), Narayan and Smyth, (2006) and Ho and Saadaoui, (2021) in different asymmetric analysis studies.

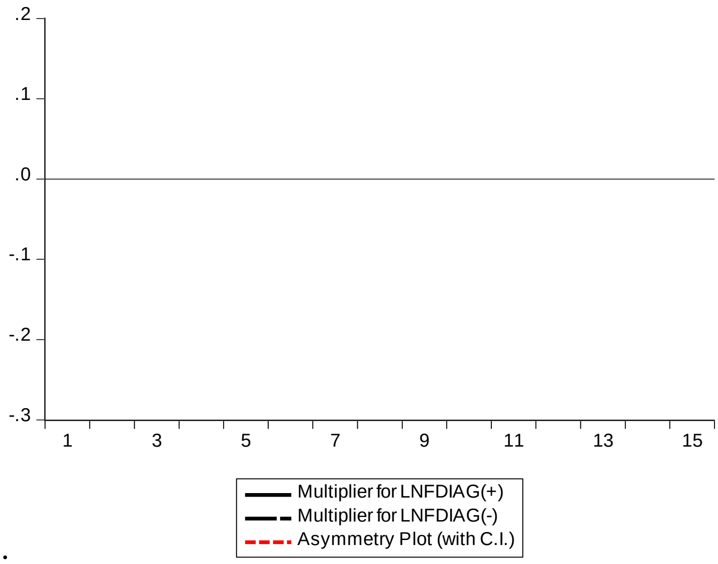



Figure 11. Dynamic multiplier graph of FDI inflow (LNFDIAG)

***Wald test for asymmetry***

The asymmetric Wald test was conducted as presented in (table 11). The analysis revealed that the existence of asymmetry both in the long and short run which were significant at 10% and 1%, respectively. Implying that dynamics of agricultural FDI (Increase or decrease) has unequevalent effect both in the short run and in the long run .Thus, the finding further corroborates the use of non-linear method for this analysis is appropriate.

Table 11 .Wald test to examine long-run asymmetries and short-run asymmetries.

| Asymmetric test | | F-stats | P-value |
|---|---|---|---|
| LNFDIAG | Long-run | 0.015945 | 0.063070* |
| | Short-run | 62.95 | 0.000*** |

* p<0.1, **p<0.05, *** p<0.01,

***Granger causality test***

Granger causality test was employed to examine the direction of causality among the variables selected for this study. Bidirectional causality was observed only for GIR to AGRGD while LNFDIAG depicted unidirectional causality running from LNFDAG to LNRGDPAG (Table 12). By implication, an increase or decrease in FDI inflow can serve as information to forecast the future value of agricultural GDP. This result was in agreement with the study conducted by (Wardhani, and Haryanto, 2020). In this study, the Granger causality test also showed that the existence of unidirectional relationship from positive shock and negative shock of LNFDIAG to agricultural GDP with the 5% and 10% level of significance, respectively (Table 13).

Table 12. Granger causality test

| | LNGDPAG | LNMFDIAG | GIR | LNCRTA | LNMGFCF | TOP | RER |
|---|---|---|---|---|---|---|---|
| LNRGDPAG | | 0.45330 | 3.12389* | 4.02057 ** | 5.13485** | 1.47004 | 0.23873 |
| LNFDIAG | 15.7570*** | | 1.73453 | 2.01264 | 4.12676** | 4.57314*** | 1.25534 |
| GIR | 3.15468* | 0.01337 | | 0.35633 | 3.41994** | 5.53741*** | 4.39288** |
| LNCRTA | 0.27004 | 3.22158** | 5.00106** | | 0.73399 | 2.26393 | 0.03947 |
| LNMGFCF | 1.87334 | 2.75817* | 2.51584* | 31.7105*** | | 1.04745 | 1.11459 |
| TOP | 3.12159* | 0.21193 | 1.60834 | 3.94954** | 1.57017 | | 2.79351* |
| REER | 3.89750* | 3.20198** | 2.15390 | 3.88634* | 3.39802** | 0.74025 | |

* p<0.1, **p<0.05, *** p<0.01,

Table 13. Granger causality test for the decomposed LNFDIAG

| Null Hypothesis: | Obs | F-Statistic | Prob. |
|---|---|---|---|
| LNFDIAG_POS does not Granger Cause LNRGDPAG | 28 | 9.11007 | 0.0473 ** |
| LNRGDPAG does not Granger Cause LNFDIAG_POS | | 0.25880 | 0.9619 |
| LNFDIAG_NEG does not Granger Cause LNRGDPAG | 39 | 2.99769 | 0.0919* |
| LNRGDPAG does not Granger Cause LNFDIAG_NEG | | 2.81225 | 0.1022 |

* $p<0.1$, ** $p<0.05$, *** $p<0.01$,

# 5. Conclusions and Recommendations

## 5.1 Conclusions

In Ethiopia, attracting FDI inflow in the agricultural sector is believed to be a potential intervention to enhance agricultural production and productivity. Hence, it is crucial to assess the impact of the FDI intervention to the agriculture sector performance considering other linked macro variables. This study attempts to explore the symmetric and asymmetric impacts of agricultural FDI in the sector performance over the period of 1981-2021. Those variables selected as an important factors for analyzing FDI impact on agriculture includes gross fixed capital formation, credit to agriculture, general inflation rate, trade openness and real effective exchange rate.

Agricultural FDI in Ethiopia follows a fluctuating trend and a yearly capital inflow varied between 3.3 to 1796.73 million birr among 1995 and 2019. Among the sub-sectors, floriculture followed by crop-based investment and coffee have large share of capital inflow. Floriculture accounts 2922.8 million birr while crop-based and a coffee-based investment attributes 2016.2 and 1226.1 million Birr, respectively.

The symmetric model reveals that FDI inflow in the agriculture sector exerts a negative and insignificant impact on agricultural performance in the short run. The study also indicates that there is no long run relationship between the two target variables. According to asymmetric model analysis, an increasein FDI inflow has profound significant effect on the agricultural real GDP in the long run. On the other hand, no statistically significant impact was detected about a decrease in FDI inflow on agricultural real GDP. The short-run relationship portrays an increase in FDI inflow in the past lagged period reduces the current period agricultural real GDP significantly. In similar fashion, a decrease in FDI inflow during the past period also significantly diminishes agricultural production. However, the elasticity coefficients for the positive partial sums effects are lower than the negative partial sum effects of FDI inflow.

Symmetric model analysis shows that there is no other macro variables significantly affect the agricultural real GDP. However, the asymmetric model analysis indicates that in the short run 1% increase in gross fixed capital formation and credit to agriculture have favorable and significant impacts on agricultural real GDP by 0.14% and 0.32%, respectively assuming other variables remain constant.

According to the granger causality test, unidirectional causality was obtained running from foreign direct investment to real agricultural GDP. The decomposed positive partial sum and negative partial sum of FDI inflow granger cause agricultural real GDP with the 5% and 10% level of significance, respectively.

## 5.2. Recommendations

This study found that agricultural FDI inflow significantly affects the performance of agricultural real GDP positively in the long run. An implication of this finding is that the government should maintain attracting more FDI inflow in order to sustain and promote the potential benefit from the intervention. Moreover, it is vital to enhance the absorptive capacity of the country's economy that enables to absorb the positive spillovers from FDI inflow. The need for attracting more FDI inflow is due to its crucial role in addressing the financial and technological gap which is the major challenges of the country.

In light of the results obtained from the empirical analysis of this study, there is recommended that further research can be undertaken on factors that determine FDI inflow to agriculture sector. There is also a need for assessing the impact agricultural FDI on improving food security of Ethiopia.

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## Annex

### VAR Lag Order Selection Criteria

Endogenous variables: LNRGDPAG LNFDIAG
Exogenous variables: C
Date: 05/15/23 Time: 06:56
Sample: 1981 2021
Included observations: 34

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -77.23406 | NA | 0.809546 | 5.464418 | 5.558714 | 5.493951 |
| 1 | -18.89832 | 104.6020 | 0.019118 | 1.717126 | 2.000014 | 1.805723 |
| 2 | -16.76587 | 3.529565 | 0.021865 | 1.845922 | 2.317404 | 1.993584 |
| 3 | -7.593037 | 13.91741 | 0.015496 | 1.489175 | 2.149249 | 1.695902 |
| 4 | -2.911622 | 6.457125 | 0.015127 | 1.442181 | 2.290847 | 1.707973 |
| 5 | -1.829074 | 1.343853 | 0.019205 | 1.643384 | 2.680643 | 1.968241 |
| 6 | 0.150935 | 2.184838 | 0.023377 | 1.782694 | 3.008546 | 2.166616 |
| 7 | 96.69142 | 19.31385* | 0.000794* | -3.220098* | -0.862691* | -2.481788* |

### ARDL model estimation

Dependent Variable: LNRGDPAG
Method: ARDL
Date: 05/10/23 Time: 12:38
Sample (adjusted): 1983 2021
Included observations: 39 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): LNFDIAG
Fixed regressors: LNGFCF LNCRTA GIR TOP REER C @TREND
Number of models evalulated: 20
Selected Model: ARDL(2, 0)
Note: final equation sample is larger than selection sample

| Variable | Coefficient | Std. Error | t-Statistic | Prob.* |
|---|---|---|---|---|
| LNRGDPAG(-1) | 0.832008 | 0.188662 | 4.410051 | 0.0001 |
| LNRGDPAG(-2) | -0.118640 | 0.214461 | -0.553202 | 0.5844 |
| LNFDIAG | -0.013037 | 0.018612 | -0.700504 | 0.4892 |
| LNGFCF | 0.011918 | 0.031631 | 0.376798 | 0.7091 |
| LNCRTA | 0.006183 | 0.056802 | 0.108851 | 0.9141 |
| GIR | -0.001338 | 0.001831 | -0.730458 | 0.4710 |
| TOP | 0.104532 | 0.442078 | 0.236456 | 0.8147 |
| REER | 0.000403 | 0.000692 | 0.582244 | 0.5649 |
| C | 4.134157 | 2.468675 | 1.674646 | 0.1048 |
| @TREND | 0.015995 | 0.008817 | 1.814048 | 0.0800 |

| | | | |
|---|---|---|---|
| R-squared | 0.968140 | Mean dependent var | 16.17210 |
| Adjusted R-squared | 0.958253 | S.D. dependent var | 0.598187 |
| S.E. of regression | 0.122222 | Akaike info criterion | -1.149395 |
| Sum squared resid | 0.433211 | Schwarz criterion | -0.722841 |
| Log likelihood | 32.41320 | Hannan-Quinn criter. | -0.996351 |
| F-statistic | 97.91557 | Durbin-Watson stat | 1.899259 |
| Prob(F-statistic) | 0.000000 | | |

# Bound test of cointgration  for ARDL model

| F-Bounds Test | | Null Hypothesis: No levels relationship | | |
|---|---|---|---|---|
| Test Statistic | Value | Signif. | I(0) | I(1) |
| | | | Asymptotic: n=1000 | |
| F-statistic | 1.538519 | 10% | 5.59 | 6.26 |
| k | 1 | 5% | 6.56 | 7.3 |
| | | 2.5% | 7.46 | 8.27 |
| | | 1% | 8.74 | 9.63 |
| | | | Finite Sample: n=40 | |
| Actual Sample Size | 39 | | | |
| | | 10% | 5.915 | 6.63 |
| | | 5% | 7.135 | 7.98 |
| | | 1% | 10.15 | 11.23 |
| | | | Finite Sample: n=35 | |
| | | 10% | 5.95 | 6.68 |
| | | 5% | 7.21 | 8.055 |
| | | 1% | 10.365 | 11.295 |

| t-Bounds Test | | Null Hypothesis: No levels relationship | | |
|---|---|---|---|---|
| Test Statistic | Value | Signif. | I(0) | I(1) |
| t-statistic | -1.604540 | 10% | -3.13 | -3.4 |
| | | 5% | -3.41 | -3.69 |
| | | 2.5% | -3.65 | -3.96 |
| | | 1% | -3.96 | -4.26 |

**Post estimation test for ARDL**

| Test | F-statistic | P-Value |
|---|---|---|
| Breusch-Godfrey Serial Correlation LM Test: | 0.623418 | 0.7098 |
| Heteroskedasticity Test: ARCH | 1.206249 | 0.3288 |
| Normality | 1.545007 | .461855 |
| Ramsey RESET Test | 1.749690 | 0.1923 |

| Breusch-Godfrey Serial Correlation LM Test: | | | |
|---|---|---|---|
| F-statistic | 0.623418 | Prob. F(6,23) | 0.7098 |
| Obs*R-squared | 5.455388 | Prob. Chi-Square(6) | 0.4869 |

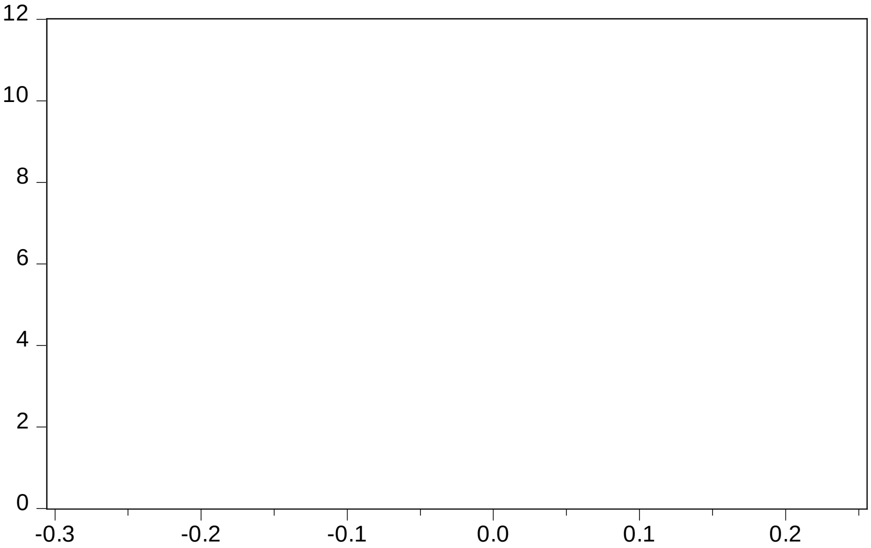
| Heteroskedasticity Test: Breusch-Pagan-Godfrey | | | |
|---|---|---|---|
| F-statistic | 1.206249 | Prob. F(9,29) | 0.3288 |
| Obs*R-squared | 10.62301 | Prob. Chi-Square(9) | 0.3024 |
| Scaled explained SS | 7.460563 | Prob. Chi-Square(9) | 0.5893 |

LNGFCF LNCRTA GIR TOP REER C

Omitted Variables: Powers of fitted values from 2 to 3

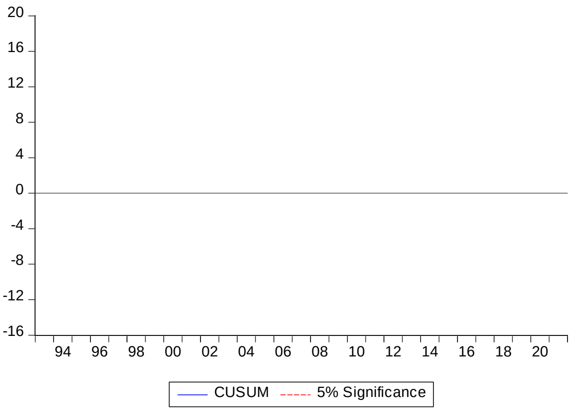
| | Value | df | Probability |
|---|---|---|---|
| F-statistic | 1.749690 | (2, 28) | 0.1923 |

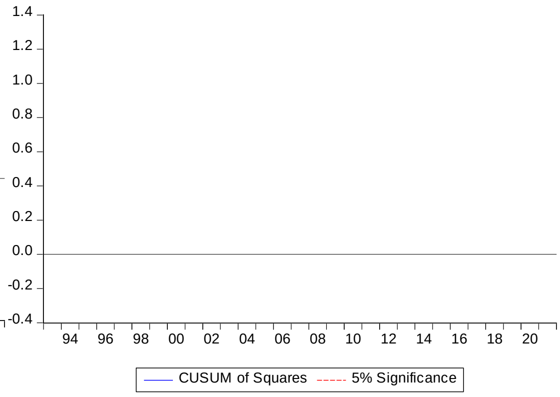
Jarque-Bera




Series: Residuals
Sample 1983 2021
Observations 39

| | |
|---|---|
| Mean | 7.31e-16 |
| Median | 0.013495 |
| Maximum | 0.232109 |
| Minimum | -0.292349 |
| Std. Dev. | 0.112667 |
| Skewness | -0.417796 |
| Kurtosis | 3.502553 |
| Jarque-Bera | 1.545007 |
| Probability | 0.461855 |




**Decomposed partial sum effects**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| LNFDIAG_POS | 0.007824 | 0.023779 | 0.329026 | 0.7440 |
| LNFDIAG_NEG | -0.103274 | 0.035116 | -2.940925 | 0.0056 |
| C | 15.27741 | 0.075619 | 202.0322 | 0.0000 |

Wald Test:
Null Hypothesis: LNFDIAG_POS= LNFDI_NEG

| Test Statistic | Value | df | Probability |
|---|---|---|---|
| t-statistic | 8.414218 | 37 | 0.0000 |
| F-statistic | 70.79907 | (1, 37) | 0.0000 |
| Chi-square | 70.79907 | 1 | 0.0000 |

Bound test of cointegration fo NARDL model

## Bound test of cointgretion for NARDL model

| F-Bounds Test | | Null Hypothesis: No levels relationship | | |
|---|---|---|---|---|
| Test Statistic | Value | Signif. | I(0) | I(1) |
| F-statistic | 29.14816 | 10% | 4.19 | 5.06 |
| k | 2 | 5% | 4.87 | 5.85 |
| | | 2.5% | 5.79 | 6.59 |
| | | 1% | 6.34 | 7.52 |

| t-Bounds Test | | Null Hypothesis: No levels relationship | | |
|---|---|---|---|---|
| Test Statistic | Value | Signif. | I(0) | I(1) |
| t-statistic | -10.45493 | 10% | -3.13 | -3.63 |
| | | 5% | -3.41 | -3.95 |
| | | 2.5% | -3.65 | -4.2 |
| | | 1% | -3.96 | -4.53 |

Assymetric ARDL model

Sample (adjusted): 1989 2021
Included observations: 33 after adjustments
Number of always included regressors: 5
Number of search regressors: 20
Selection method: Stepwise forwards
Stopping criterion: p-value forwards/backwards = 0.5/0.5

| Variable | Coefficient | Std. Error | t-Statistic | Prob.* |
|---|---|---|---|---|
| C | 25.71767 | 2.089530 | 12.30787 | 0.0000 |
| @TREND | 0.030452 | 0.038636 | 0.788191 | 0.4472 |
| LNRGDPAG(-1) | -0.840102 | 0.153302 | -5.480045 | 0.0002 |
| LNFDIAG_POS(-1) | 0.050412 | 0.022998 | 2.192017 | 0.0508 |
| LNFDIAG_NEG(-1) | 0.034467 | 0.048959 | 0.703989 | 0.4961 |
| D(LNFDIAG_POS(-6)) | -0.036207 | 0.011838 | -3.058611 | 0.0109 |
| D(LNRGDPAG(-1)) | 0.812665 | 0.120601 | 6.738472 | 0.0000 |
| TOP | -2.981760 | 0.395740 | -7.534639 | 0.0000 |
| D(LNFDIAG_NEG(-4)) | 0.141845 | 0.032434 | 4.373308 | 0.0011 |
| LNCRTA | 0.321629 | 0.035076 | 9.169610 | 0.0000 |
| D(LNFDIAG_NEG) | 0.054899 | 0.020310 | 2.703004 | 0.0205 |
| GIR | -0.001213 | 0.000864 | -1.402712 | 0.1883 |
| D(LNFDIAG_NEG(-3)) | 0.150098 | 0.033084 | 4.536871 | 0.0008 |
| D(LNFDIAG_NEG(-6)) | 0.056900 | 0.020956 | 2.715223 | 0.0201 |
| D(LNFDIAG_POS(-3)) | -0.024901 | 0.013644 | -1.825115 | 0.0952 |
| D(LNFDIAG_POS(-5)) | -0.047866 | 0.012221 | -3.916550 | 0.0024 |
| D(LNFDIAG_POS(-4)) | -0.081409 | 0.011608 | -7.013134 | 0.0000 |
| D(LNFDIAG_NEG(-2)) | 0.090405 | 0.035323 | 2.559365 | 0.0265 |
| LNGFCF | 0.141369 | 0.076282 | 1.853238 | 0.0908 |
| D(LNFDIAG_NEG(-1)) | 0.096235 | 0.032356 | 2.974277 | 0.0126 |
| D(LNFDIAG_POS(-1)) | -0.030167 | 0.013601 | -2.217932 | 0.0485 |
| D(LNFDIAG_NEG(-5)) | 0.028655 | 0.019408 | 1.476488 | 0.1679 |
| CointEq(-1)* | -1.835121 | 0.175527 | -10.45493 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.998673 | Mean dependent var | 16.27391 |
| Adjusted R-squared | 0.996140 | S.D. dependent var | 0.594818 |
| S.E. of regression | 0.036954 | Akaike info criterion | -3.523568 |
| Sum squared resid | 0.015022 | Schwarz criterion | -2.525897 |
| Log likelihood | 80.13888 | Hannan-Quinn criter. | -3.187882 |
| F-statistic | 394.2770 | Durbin-Watson stat | 2.615205 |
| Prob(F-statistic) | 0.000000 | | |

Selection Summary

**Post estimation tests**

Breusch-Godfrey Serial Correlation LM Test:

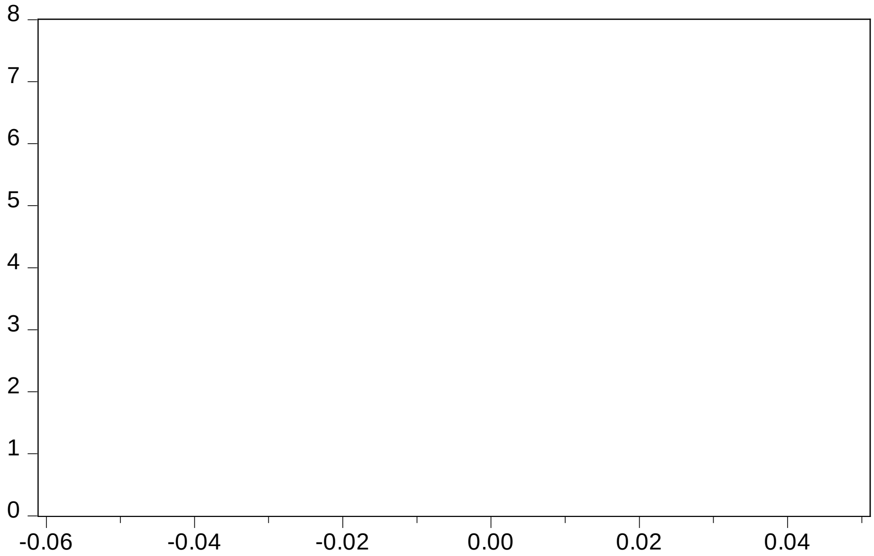
| | | | |
|---|---|---|---|
| F-statistic | 2.451836 | Prob. F(5,3) | 0.2455 |
| Obs*R-squared | 26.51210 | Prob. Chi-Square(5) | 0.0001 |

Heteroskedasticity Test: ARCH

| | | | |
|---|---|---|---|
| F-statistic | 1.052966 | Prob. F(1,30) | 0.3130 |
| Obs*R-squared | 1.085078 | Prob. Chi-Square(1) | 0.2976 |

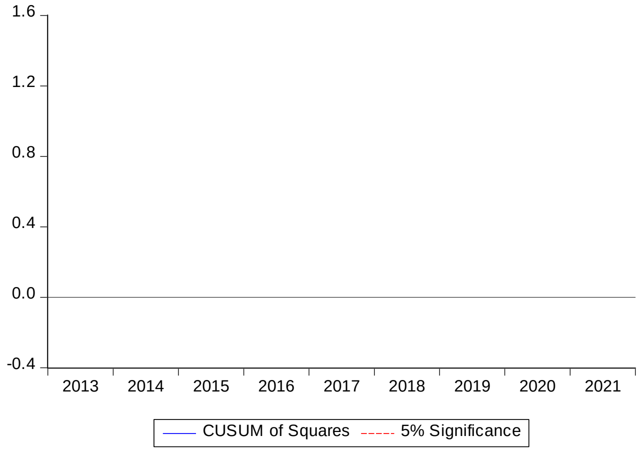
Omitted Variables: Squares of fitted values

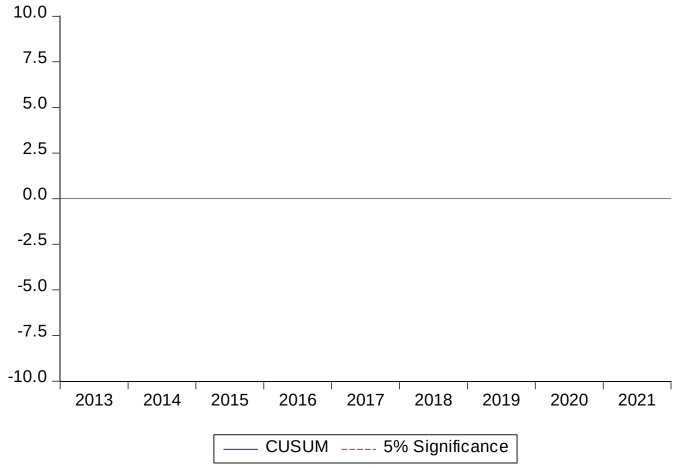
| | Value | df | Probability |
|---|---|---|---|
| t-statistic | 0.673134 | 8 | 0.5198 |
| F-statistic | 0.453109 | (1, 8) | 0.5198 |



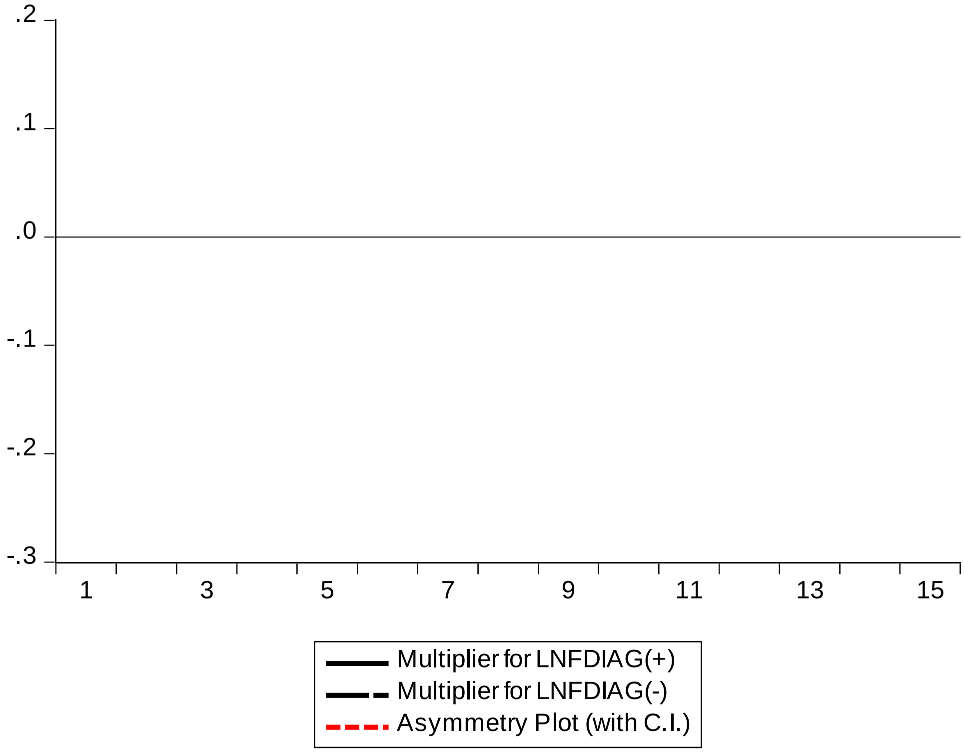

Series: Residuals
Sample 1989 2021
Observations 33

| | |
|---|---|
| Mean | 5.38e-15 |
| Median | 0.001021 |
| Maximum | 0.044478 |
| Minimum | -0.050460 |
| Std. Dev. | 0.022136 |
| Skewness | -0.337806 |
| Kurtosis | 3.251801 |
| Jarque-Bera | 0.714800 |
| Probability | 0.699493 |






Multiplier graphh



| Null Hypothesis: | Obs | F-Statistic | Prob. |
|---|---|---|---|
| LNFDIAG_POS does not Granger Cause LNRGDPAG | 28 | 9.11007 | 0.0473 ** |
| LNRGDPAG does not Granger Cause LNFDIAG_POS | | 0.25880 | 0.9619 |
| LNFDIAG_NEG does not Granger Cause LNRGDPAG | 39 | 2.99769 | 0.0919* |
| LNRGDPAG does not Granger Cause LNFDIAG_NEG | | 2.81225 | 0.1022 |

Pairwise Granger Causality Tests
Date: 05/21/23 Time: 11:54
Sample: 1981 2021
Lags: 1

| Null Hypothesis: | Obs | F-Statistic | Prob. |
|---|---|---|---|
| LNFDIAG_NEG does not Granger Cause LNRGDPAG | 39 | 2.99769 | 0.0919 |
| LNRGDPAG does not Granger Cause LNFDIAG_NEG | | 2.81225 | 0.1022 |

**STATA also replicate the almost the same result as depicted in the following page**

```
. nardl LNRGDPAG LNFDIAG if tin(1981,2021),p(2) q(7) deterministic( GIR TOP REER LNGFCF LNCRTA ) horizon(40) resid
> ual
```

Regression results (variables renamed):

| Source | SS | df | MS |
|---|---|---|---|
| Model | .417792037 | 23 | .018164871 |
| Residual | .015680078 | 10 | .001568008 |
| Total | .433472115 | 33 | .013135519 |

| | | |
|---|---|---|
| Number of obs | = | 34 |
| F(23, 10) | = | 11.58 |
| Prob > F | = | 0.0002 |
| R-squared | = | 0.9638 |
| Adj R-squared | = | 0.8806 |
| Root MSE | = | .0396 |

| _dy | Coefficient | Std. err. | t | P>\|t\| | [95% conf. | interval] |
|---|---|---|---|---|---|---|
| _y | | | | | | |
| L1. | -1.832809 | .1836399 | -9.98 | 0.000 | -2.241984 | -1.423633 |
| _x1p | | | | | | |
| L1. | .0692393 | .0200659 | 3.45 | 0.006 | .0245297 | .1139489 |
| _x1n | | | | | | |
| L1. | .0056987 | .0303533 | 0.19 | 0.855 | -.0619327 | .0733301 |
| _dy | | | | | | |
| L1. | .8130675 | .1543489 | 5.27 | 0.000 | .4691568 | 1.156978 |
| _dx1p | | | | | | |
| --. | .0026441 | .010995 | 0.24 | 0.815 | -.0218542 | .0271424 |
| L1. | -.0388054 | .0247444 | -1.57 | 0.148 | -.0939394 | .0163286 |
| L2. | -.0034719 | .0267516 | -0.13 | 0.899 | -.0630782 | .0561344 |
| L3. | -.0247792 | .0241751 | -1.02 | 0.330 | -.0786447 | .0290863 |
| L4. | -.0839517 | .0223454 | -3.76 | 0.004 | -.1337404 | -.0341629 |
| L5. | -.0480622 | .015843 | -3.03 | 0.013 | -.0833626 | -.0127618 |
| L6. | -.039233 | .0143812 | -2.73 | 0.021 | -.0712764 | -.0071897 |
| _dx1n | | | | | | |
| --. | .045886 | .0204202 | 2.25 | 0.048 | .0003868 | .0913851 |
| L1. | .1119036 | .0376208 | 2.97 | 0.014 | .0280792 | .195728 |
| L2. | .1023249 | .0440543 | 2.32 | 0.043 | .0041659 | .2004839 |
| L3. | .1646825 | .0343765 | 4.79 | 0.001 | .0880869 | .2412782 |
| L4. | .1542506 | .0308447 | 5.00 | 0.001 | .0855244 | .2229769 |
| L5. | .0341578 | .0207899 | 1.64 | 0.131 | -.0121649 | .0804805 |
| L6. | .063189 | .0195771 | 3.23 | 0.009 | .0195685 | .1068094 |
| GIR | -.0013278 | .0009482 | -1.40 | 0.192 | -.0034405 | .000785 |
| TOP | -2.957705 | .4404033 | -6.72 | 0.000 | -3.938985 | -1.976425 |
| REER | -.0000794 | .0005099 | -0.16 | 0.879 | -.0012156 | .0010568 |
| LNGFCF | .1817104 | .0622506 | 2.92 | 0.015 | .0430073 | .3204134 |
| LNCRTA | .3206608 | .0468975 | 6.84 | 0.000 | .2161667 | .425155 |
| _cons | 25.43842 | 2.37764 | 10.70 | 0.000 | 20.14071 | 30.73613 |

(7 missing values generated)

Asymmetry statistics:

| | Long-run effect [+] | | | Long-run effect [-] | | |
|---|---|---|---|---|---|---|
| Exog. var. | coef. | F-stat | P>F | coef. | F-stat | P>F |
| LNFDIAG | 0.038 | 9.984 | 0.010 | -0.003 | .03529 | 0.855 |
| | Long-run asymmetry | | | Short-run asymmetry | | |
| | | F-stat | P>F | | F-stat | P>F |
| LNFDIAG | | 8.64 | 0.015 | | 66.07 | 0.000 |

Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

| Cointegration test statistics: | | |
|---|---|---|
| | t_BDM = | -9.9805 |
| | F_PSS = | 51.8669 |

| Model diagnostics | stat. | p-value |
|---|---|---|
| Portmanteau test up to lag 15 (chi2) | 9.083 | 0.8731 |
| Breusch/Pagan heteroskedasticity test (chi2) | .02546 | 0.8732 |
| Ramsey RESET test (F) | .4089 | 0.7517 |
| Jarque-Bera test on normality (chi2) | .8277 | 0.6611 |

```
Cointegration test statistics:    t_BDM =      -9.9805
                                  F_PSS =      51.8669
```

| Model diagnostics | stat. | p-value |
|---|---|---|
| Portmanteau test up to lag 15 (chi2) | 9.083 | 0.8731 |
| Breusch/Pagan heteroskedasticity test (chi2) | .02546 | 0.8732 |
| Ramsey RESET test (F) | .4089 | 0.7517 |
| Jarque-Bera test on normality (chi2) | .8277 | 0.6611 |