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Symmetric and Asymmetric Effects of Foreign Direct Investment on Agriculture Sector Performance: Evidence from Ethiopia

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Abstract

This study examines the symmetrical and asymmetrical impacts of agricultural FDI on the performance of Ethiopia's agricultural sector. It uses multivariate time series data from secondary sources spanning 1981-2021. The data include agricultural real GDP, agricultural FDI inflow, and selected macroeconomic variables. Linear ARDL and non-linear ARDL (NARDL) econometric models were employed for analysis. Results from the asymmetric ARDL model indicate that positive FDI shocks have a significant and favorable effect on agricultural real GDP by 0.05% in the long run. However, negative FDI shocks were found to be statistically insignificant. In the short run, increases in FDI inflow during previous periods significantly reduced current agricultural real GDP, while decreases in FDI inflow also significantly diminished current agricultural production. According to the symmetric ARDL model, there was no significant relationship between the two variables in either the short or long term. The Granger causality test revealed a unidirectional relationship from FDI inflow to agricultural real GDP. In conclusion, agricultural FDI inflow significantly affects the performance of agricultural real GDP in the long run; however, its positive effect is not automatic in the short run. Therefore, attracting more FDI inflow to the agricultural sector is recommended to address financial and technological gaps in Ethiopia's agriculture sector.

Keywords: Agricultural real GDP, Asymmetric, Foreign direct investment, Linear ARDL, Non-linear ARDL, Symmetric.

1. Introduction

Agriculture is the dominant sector in the Ethiopian economy. It accounts 37.6% of GDP, 72% of exports and 66% of employment of the economy in 2021 (ATI, 2022). However, several factors such as population growth, environment and policy issues hindered the agriculture sector transformation (ibid). The cultivated land has been decreased due to the ever-increasing population. Environmental factors that include climate variability, declining soil fertility, increasing the incidence of pests and diseases severely affect the agricultural productivity (Devereux, and Sussex, 2000). The sector has shown little progress in agricultural technologies. Lack of robust policies in inputs such as land, investment and finance are the major factors that affect the performance of agriculture (Byerlee *et al.*, 2007).

In order to address the aformentioned challenges, various strategies that includes provision of agricultural technologies through extension package, encouragement of model farmers, introducing some policies measures such as land certification and investment policies have been taken as solutions in the country. Despite the existing efforts to transform agriculture, the sector has been contributed to the economy below its full potential. Recent development policies have emphasized the need for Foreign Direct investment (FDI) attraction as one of the possible interventions to transform the sector and improve its economic contribution. Besides, the government of Ethiopia has continuously promoted FDI as one of the strategies to achieve the goal of ensuring food security, import substitution and to realize the vision of becoming one of the middle-income countries by 2025 (Debebe and Bessie, 2022; PSI, 2022).

FDI can play a key role as a source of finance for the developing countries, creates economic integration in this business world, promotes international trade through access to foreign market, improves balance of payments and positive spill overs to domestic investments (UNCTAD, 2022). However, these positive outcomes depend on the strength of the backward and forward linkage of economic sectors, the level of institutional and human capital development, and the trade policies of the host country (Sabir *et al.*, 2019). Ethiopia attracts FDI with the support of foreign investment policy since 1990s to address to the country's financial and technological limitation in the agricultural sector (Haile and Asefa, 2006).

In Ethiopia, the potential impact of FDI on the agricultural performance has to be systematically weighted for the following reasons. First, the investments are undertaken in large areas of land and engage a large number of people directly or indirectly. Thus, it is crucial to investigate the impact of FDI due to its wider socio-economic impact. Second, the type of agricultural FDI has an implication on the food security of the host country. Thirdly, and most importantly it is essential 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 investments. FDI is among other several macro-economic variables that could affect the performance of agriculture sector (Ali *et al.*, 2010).

In this regard, few empirical studies have been conducted by various researchers about the impact of FDI in Ethiopian economy. These studies can be systematically being grouped under two major categories. The first category focused on the nexus between FDI and 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 on each economic sector. The second category of studies emphasized on the effect of FDI on agriculture sector in Ethiopia (Weissleder, 2009; Persson, 2016). These studies had also limitations since they lack detail analysis and address specific localities. Therefore, the objective of this study is to explore the impact of FDI inflow on the agriculture sector performance in Ethiopia along with selected macro variables using symmetric and asymmetric approach. Besides, the study demonstrates the causal relationship between FDI inflow and agricultural performance using Granger causality test.

2. Method of Data Analysis

2.1. Data Description and Organization

Secondary data were gathered on the selected variables from formal sources such as Ethiopian Investment Commission (EIC), National Bank of Ethiopia (NBE), Food and Agricultural Organization (FAO) and World Development Indicators (WDI). The description, unit of measurement, the hypothesis and designation of the selected variables is presented in Table 1. The information were organized as multivariate time series data set stretching from 1981-2021. Agricultural GDP data was deflated with CPI index (consumer price Index) to transform to real values. To improve linearity and boost validity, data for some variables (real agricultural GDP, agricultural FDI inflow, gross fixed capital formation and credit to agriculture) were transformed using natural logarithm.

Table 1. Description of variables used in this study.

Selected variables	Designation	Description of variables	Unit of measurement	Hypothesis/ Expected sign
Agricultural real GDP	AGRGDP	An output in the agricultural sector made up of crops production, animal farm production, forestry, fishing and hunting in real terms.	Million Birr	
Foreign direct investment inflow in agriculture sector	FDIAG	Net inflows of foreign investments in agricultural sector.	Million Birr	+
Gross fixed capital formation	GFCF	Comprises machinery, plant, purchases of equipment, industrial buildings, construction of railways and roads.	Million Birr	+
Credit to agriculture	CRTA	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.	Million Birr	+
Trade openness	TOP	It is an export and import as a percentage of GDP.	Index	+
Real effective exchange rate	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	_
General Inflation rate	GIR	The rate of increase in price over a given period.	Index	_

2.2. Model Specification

For this study, symmetric ARDL and asymmetric ARDL (NARDL) model recently developed by Shin, Yu, and Greenwood-Nimmo (2014) were employed to assess the effect of FDI inflows on the agricultural real GDP. We specified ARDL model to capture the short run and long run effects. For further investigation, we also used NARDL model in order to decompose the total effect of FDI.

2.2.1. The Symmetric ARDL Model

The symmetric ARDL model was used to explore the symmetric association among the target variables (AGRGDP and FDIAG) with deterministic variables (GFCF, CRTA, TOP, REER and GIR). The optimal lag length was selected through VAR model using EVIEWS 10 software by AIC (Akaike information criteria) to capture the short run dynamics. The ARDL (p,q) model is expressed by the following equation as described by Pesaran *et al.*, (2001).

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

Where p and q the lag length selected

β_0 is constant term, $\beta_1 - \beta_7$ are elasticity coefficient of the variable, where all other variables are as previously defined in Table 1, LN is logarithm operator, ε_t is error term.

2.2.2. Asymmetric ARDL Model Specification

The Non-linear Autoregressive Distributed Lag (NARDL) 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:

$$LNFDIAG^{+} = \sum_{j=1}^{t} \Delta LNFDIAG_j^{+} = \sum_{j=1}^{t} max(\Delta LNFDIAG_j, 0) \quad (2)$$

$$LNFDIAG^{-} = \sum_{j=1}^{t} \Delta LNFDIAG_j^{-} = \sum_{j=1}^{t} min(\Delta LNFDIAG_j, 0) \quad (3)$$

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

$$\Delta LNAGRGDP = \beta_0 + \beta_1 LNAGRGDP_{t-1} + \beta_2^{+} LNFDIAG_{t-1}^{+} + \beta_2^{-} LNFDIAG_{t-1}^{-} + \beta_3 LNGFCF_{t-1} + \beta_4 LNCRTA_{t-1} + \beta_5 GIR_{t-1} + \beta_6 TOP_{t-1} + \beta_7 REER_{t-1} + \sum_{j=0}^{p} \theta \Delta LNAGRGDP_t + \sum_{j=0}^{q} (\theta_j^{+} \Delta LNFDI_{t-1}^{+} + \theta_j^{-} \Delta LNFDIAG_{t-1}^{-}) + \varepsilon_t \quad (4)$$

From equation 4, $\beta_2^{+} (\sum_{j=0}^{q} \theta_j^{+})$ 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. All variables are as previously defined in Table 1 and equation 1.

The bound test was conducted following the NARDL model regression to determine the presence of long run relationship. Finally, the preliminary results are adjusted to Error Correction Model (ECM) (Nkoro and Uko, 2016) to estimate the speed of adjustment to the long run equilibrium of real agricultural GDP. Wald test was computed to explore the long (short) run asymmetry significance between the dependent and independent variable.

3. Results and Discussion

3.1. Descriptive statistics

The results of descriptive statistics for each variable are presented in Table 2. The highest average value was about 123,585 for agricultural real GDP and the lowest average value is agricultural FDI approximately 366 million birr. From the indexed values trade openness registered the lowest average (0.22) in the analysis of 41 observations. FDI inflow in agriculture sector scored an average value of 365.62 with standard deviation of 469.35. The variables such as real agricultural GDP and trade openness showed the highest (8,159.93) and the lowest (0.08) standard deviation, respectively. This implies that AGRGDP was found to be the most volatile while TOR was the least volatile variables.

Table 2. Descriptive statistics of variables.

	AGRGDP	FDIAG	CRTA	GFCF	GIR	TOP	REER
Mean	123585.52	365.6201	6559.368	193954.2	9.982794	0.222193	158.1279
Median	82532.28	137.8004	1884.800	17669.00	7.504031	0.217434	148.9784
Maximum	331309.33	1796.731	31823.62	1027047.	55.24131	0.361307	344.5183
Minimum	46452.46	0.500000	311.0000	195.0700	-11.82323	0.095692	93.78449
Std. Dev.	81599.33	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

3.2. Unit Root Test

Unit root tests were conducted using Augmented Dicky-fuller (ADF) and Phillips Peron (PPerron) tests in order to delineate the appropriate cointegration test and to specify the model. The unit root test indicated in Table 3 showed that general inflation rate was stationary at level I (0) while other variables were stationary at first difference I (1) and none of the variable was I (2). Therefore, we employed bound test cointegration along with ARDL or NADRL model for this study (Table 3).

Table 3. 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***

Note: * p<0.1, **p<0.05, *** p<0.01.

3.3. Symmetric ARDL

3.3.1. Bound Cointegration Test for ARDL

The statistical values of F-tests from bound test of cointegration for the ARDL model was below the lower bound I(0) at all specified levels of significance (Table 4). This indicated that the absence of long-term relationship between the variables.

Table 4. 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

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

3.3.2. Symmetric ARDL Model Estimation

The analysis of symmetric ARDL model revealed FDI inflow in the agriculture sector exerts a negative and insignificant impact on agricultural performance in the short run (Table 5). As indicated in Table 4 above, there was no long term relationship between the two target variables. The findings of this study do not support the previous study by Iddrisu *et al.*, (2015) who found negative impact of FDI inflow on the long run and the positive relationship in the short run with reference to Ghana.

The R^2 (0.96) and adjusted R-squared (0.95) of the linear ARDL model indicated that FDI inflow in agriculture sector and other variables was explained about 95% of variation in the agricultural GDP (Table 5).

Table 5. 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
Test statistics					
R-squared	Adjusted R-squared				
0.968140	0.958253				

Source: LNRGDPAG/LNFDIAG (2, 0) with fixed regressor (LNGFCF, LNCRTA, GIR, TOP, REER).

As indicated in Table 6, the post estimation test depicted that absence of heteroskedasticity and serial correlation in the linear ARDL model. Residuals were normally distributed as explained by Jarque-Bera normality test and Ramsey test verified no misspecification problem in the model (Table 6). The stability of the model was also confirmed by ARDL CUSUM and CUSUM-SQURE testes as indicated in Figure 1.

Table 6. Diagonsitic test s of the linear ARDL model.

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

Note: p<0.1, **p<0.05, *** p<0.01.

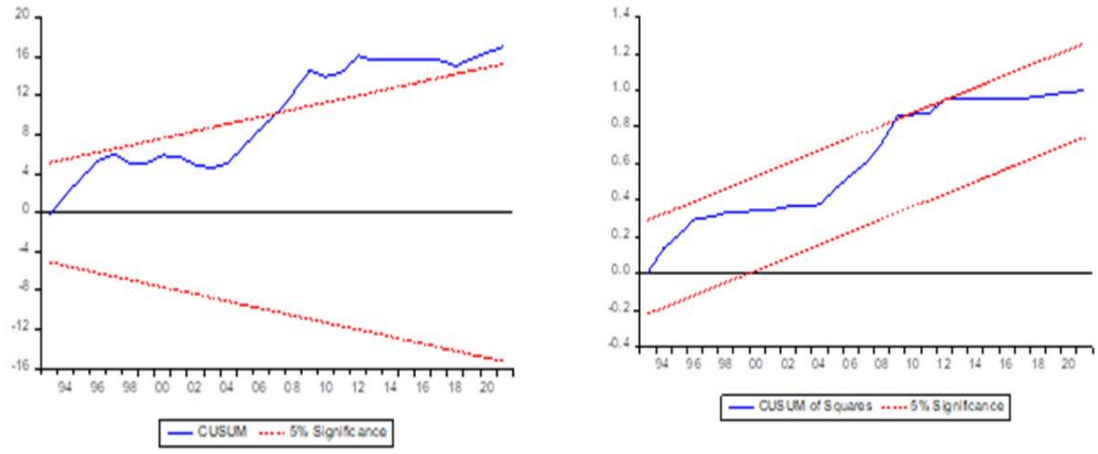

Figure 1. Cumulative sum test of stability for ARDL at 5% significance level.

3.4. Asymmetric ARDL (NARDL)

3.4.1. Bound cointegration test for NARDL

The NARDL model related bound test of cointegration showed the existence of long run cointegration in non-linear ARDL model with the F-statistics value of 29.14 that exceeded the upper bound at all specified level of significance (Table 7).

Table 7. 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

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

3.4.2. Asymmetric ARDL Model Estimation

In the long run, an increase in FDI inflow showed a positive significant effect on the agricultural performance (Table 8). This implies that a 1% increase in FDI inflow raises agricultural GDP on average by 0.050%. Such positive relationship between FDI inflow and AGRGDP could be due to the fact that the intervention of FDI would bring the introduction of new agricultural packages with improved technologies. Moreover, It will transfer knowledge and skill, improves infrastructure and boost related industries and improve export opportunities that could provide beneficial arrangement for the sector of the host country (Deininger *et al.*, 2011). The above finding was consistent with empirical studies by Gunasekera and Newth (2015), Dhahri and Omri (2020), Nyiwul and Koirala (2022) who demonstrated that the growth in FDI capital inflow in agriculture sector of Africa's country considered in their study enhance the agricultural performance. 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 8). This condition might be due to price fluctuation, surplus production in the one-time past period might cause fall in price of agricultural commodity under consideration and thus farmers lack motivation to produce more in the current period (Xie and Wang, 2017). Moreover, it might be reduced due to supply chain disruption during past time surplus and risk aversion behavior of the farmers.

However, agricultural performance declined for consecutive six-time lagged period with an increases as well as a decrease of FDI inflow in the short run (Table 8). Moreover, 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 of FDI in agriculture sector was not automatic in the short run.

Regarding other macro variables, an increase of domestic investments such as GFCF and CRTA by 1% had a favorable and significant impact on agricultural GDP by 0.14% and 0.32%, respectively, in the short run (Table 8). These internal investments enhance technology generation and dissemination, supply chain and market access as well as financial access for farmers in the short run.

Table 8. Asymmetric ARDL model estimation.

Dependent variable	Regressors	Coefficient	Std. Error	t-Statistic	Prob.
Long run					
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
Short run					
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***
Test statistics					
R-squared	Adjusted R-squared				
0.965021	0.888066				

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

The measure of goodness of fit R^2 and adjusted R-squared of the non-linear ARDL model was 0.96 (0.88%), indicated that FDIAG_POS, FDIAG_NEG, CRTA, GIR GFCF, TOP and REER 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 and serial correlation (Table 9). 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 2 illustrated that the model stability. The above mentioned analysis justified that using asymmetric ARDL was appropriate for this study.

Table 9. Diagnostics tests of the NARDL model.

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

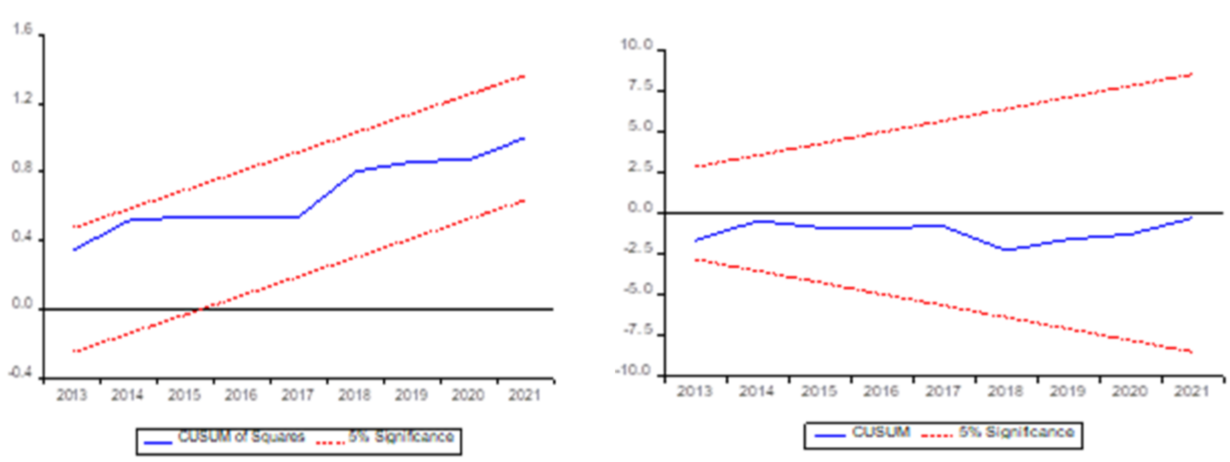

Figure 2. Cumulative sum test of stability for NARDL at 5% significance level.

3.4.3. Asymmetric Test for NARDL Model Test

We used Wald test to verify the significance of asymmetry for the NARDL model. The Wald test revealed the existence of significant asymmetry both in the long and short run, which was at 10% and 1% significance level, respectively (Table 10). This implying the dynamics of agricultural FDI (increase or decrease) has inequivalent effect both in the short and in the long run. Thus, this result further corroborates the use of non-linear method for this analysis is appropriate.

Table 10. 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***

Note: * p<0.1, **p<0.05, *** p<0.01,

3.4.4. Dynamic Multiplier Graph

The graphical representation of the multiplier for FDI inflow indicated the speed of adjustments to the long run equilibrium for any positive and negative shocks (Figure 3). The solid black line shows the adjustment agricultural real GDP to a positive shock in FDI inflow, while the dotted black line shows the adjustment of agricultural real GDP to a negative shock. The asymmetric line, represented by the red dotted line indicates the difference between the positive and negative shocks in FDI inflow. The value of error correction term of the model was -1.83 at 1% significance level (Table 8). This implies that there was oscillatory convergence to the long run equilibrium since the value is within the value between -1 and -2. Similar result was reported by Loayza and Ranciere, (2006), Narayan and Smyth, (2006) and Ho and Saadaoui, (2021) in their respective topics of asymmetric analysis.

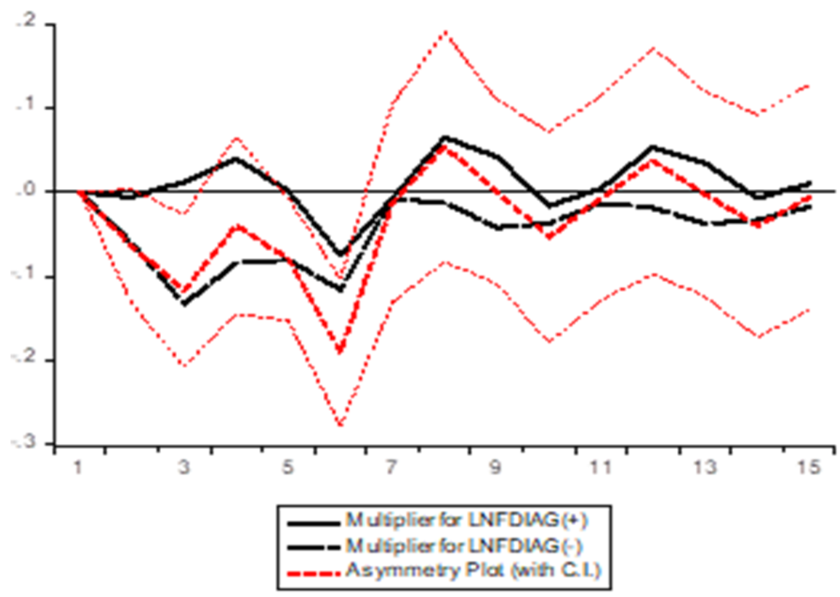

Figure 3.
Dynamic multiplier graph of FDI inflow (LNFDIAG).

3.5. 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 AGRGDP whereas LNFDIAG depicted unidirectional causality running from LNFDAG to LNAGRGDP (Table 11). By implication, an increase or a decrease in FDI inflow can be used as a primary 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 partial sum and negative partial sum of LNFDIAG to agricultural GDP with the 5% and 10% level of significance, respectively (Table 12).

Table 11. Granger causality test.

	LNGDPAG	LNMFDIAG	GIR	LNCRTA	LNMGFCF	TOP	RER
LNAGRGDP		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	

Note: * p<0.1, **p<0.05, *** p<0.01.

Table 12. 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

Note: * p<0.1, **p<0.05, *** p<0.01,

4. Conclusion and Recommendation

This study attempts to explore the symmetric and asymmetric impacts of FDI inflow on the performance of agricultural sector over the period of 1981-2021 in Ethiopia. Other macro variables such as gross fixed capital formation, credit to agriculture, general inflation rate, trade openness and real effective exchange rate were taken as a control variable to investigate more the effect of FDI inflow on agriculture performance. The symmetric model reveals that FDI inflow in the agriculture sector exerts a negative and insignificant impact on agricultural performance in the short run. Besides, the ARDL model indicated that the absence of long run relationship between the two target variables. According to asymmetric model analysis, positive FDI inflow shock has profound significant effect on the agricultural real GDP. However, the negative FDI shock did not show a significant impact on agricultural real GDP. On the other hand, the short-run relationship portrays an increase in FDI inflow in the past lagged periods reduced the current agricultural real GDP significantly. In similar fashion, a decrease in FDI inflow during the past periods also significantly diminished agricultural production.

An implication of this finding is that the government should devote more attention to attracting FDI inflow to the agriculture to enhance its economic contribution. The country should create an investment-friendly environment that consistently attracts foreign investment. This could be achieved through tax incentives, reducing bureaucratic hurdles, and improving infrastructure in rural areas. Reducing over-reliance on foreign investments is also crucial. Promoting domestic investments better access to credit for smallholder farmers and public agricultural spending could provide a buffer against the impacts of negative FDI shocks. Moreover, it is vital to investigate in detail the impact of other macro variables which are related to FDI inflow to capture the holistic determinants of agriculture sector.

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