

Asymmetric price Transmission of the Groundnut market in Ethiopia. A NARDL Approach

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Abstract

Assessing market integration is essential for understanding the impacts of market expansion and liberalization initiatives. This research aims to analyze the spatial price transmission and market integration of significant groundnut markets in Ethiopia, utilizing monthly retail price data from September 2000 to August 2022. A combination of descriptive and econometric methods was employed for the analysis. The descriptive statistics indicated that consumption areas exhibited the highest nominal mean prices, with Dire Dawa and Addis Ababa reporting ETB29.89 and ETB28.69 per kilogram, respectively, whereas the producing regions showed the lowest average prices for groundnuts. The Augmented-Dickey Fuller test was used to test for the stationarity of individual price series and was confirmed by the KPSS test. All the price series data that were used tested for Unit Root. They were found to be non-stationary at levels but stationary after first difference at 1%, 5% and 10% significant levels. Johansen Co-integration test was used to test for long-run relationships between the market pair. It was found that all six market pairs were cointegrated at 5% level of significance. The Non-linear Auto Regressive Distributed Lag Model shows asymmetric price transmission in two market pairs, indicating quicker adjustments to price increases than decreases. The study implies the influence of geographical differences, distance, and production volume on market integration. This study provides significant contributions to the formulation of agricultural marketing policies and deepens our comprehension of market dynamics in Ethiopia.

Keywords: Groundnut, Market Integration Non-autoregressive distributed lag model, Price Transmission

1. Introduction

In countries where agriculture is the primary economic activity, particularly in the majority of sub-Saharan Africa, the agricultural sector and its related industries play a crucial role in fostering economic development and alleviating widespread poverty and food insecurity. In sub-Saharan African countries, among the crop types produced, groundnuts (*Arachis hypogaeas* L.) are an essential crop, and the fifth most widely cultivated crop in sub-Saharan Africa, following maize, sorghum, millet, and cassava FAO (2010) holds significant importance within the agricultural landscape of Ethiopia. Although it ranks as the second-most essential oilseed crop after sesame (Amare *et al.*, 2017), its primary production is concentrated in the eastern regions of the country. The 2020 cropping season witnessed an estimated production of 205,069

tons from approximately 113,515 hectares, with a productivity of 1.8 tons per hectare [1].

Strong connections to markets are being increasingly acknowledged for their role in poverty alleviation, food security, and rural community advancement within the agricultural sector. Organizations and development experts prioritize market interaction as a means to enhance agricultural output, foster economic growth, and diminish poverty and hunger among rural producers. This emphasis on market connections impacts food security, income levels, and overall productivity, creating a positive feedback loop that motivates small producers to invest in their businesses, enhance output quality, and diversify product lines [2].

Agricultural markets and access to market information are crucial for the effective engagement of smallholder farmers in agricultural markets [3]. Smallholder farmers, particularly those involved in groundnut production, encounter challenges in accessing vital market information, such as commodity pricing in local markets [4]. This limitation significantly impacts the farmers' ability to make informed and profitable trading decisions, inhibiting their capacity to exploit seasonal and spatial arbitrage opportunities. The absence of accurate market price information often compels smallholder farmers to accept the prices offered by buyers, thus compromising their marketing decisions.

In integrated markets, food commodities flow from surplus to deficit areas. Deficit areas, typically associated with high prices, create an incentive for traders to transport food from surplus to deficit areas [5]. Rational traders enter the market and capitalize on these arbitrage opportunities by increasing demand for the commodity in surplus areas while simultaneously boosting the supply of the commodity in deficit areas. This process continues until prices in both markets reach an equilibrium level, rendering trade unprofitable [6].

This study analyzes the process characterized as asymmetric, where the transmission of price changes varies depending on whether prices are rising or falling. It is frequently claimed that traders leverage their market power to implement pricing strategies that facilitate a swift and comprehensive pass-through of cost increases, while the transmission of cost reductions occurs more slowly and is less complete [7].

1.1. Asymmetry in Price Transmission

When the response of market at one level responds differently to a decrease and increase in price at a different level, then asymmetry exist. Asymmetry could exist in the magnitude or the speed of adjustment or both. In the former, short-run elasticities of price transmission differ according to the sign of the initial change while in the latter, long-run elasticity differ [8]. Asymmetry can also be classified as positive (when one price responds fully or quickly to an increase in another price as to a decrease, thus price movement that squeezes the margin is transmitted more rapidly and/or completely as the movement that stretches the margin). Otherwise, negative (when one price responds fully or quickly to a decrease in another price than to an increase; thus rapid and/or complete transmission to price movements that stretch the margin). This determines the direction of welfare transfer [9]. Asymmetry can also be considered to be vertical if determined along the food supply chain (e.g. from farm level to wholesale level) or spatial when determined between two geographically separated markets.

Asymmetric price transmission has long been associated with agricultural prices with the idea starting from Tweeten and Quance (1969) that used dummy variable to split input prices into increasing and decreasing input prices [10]. Following this, studies such as Acharjee et al., (2023) suggest that the price transmission pattern is symmetric in the short run but could be a mixture of symmetric and asymmetric in the long run [11]. This asymmetric

price behavior indicates that changes in retail prices do not get reflected fully at both farmgate and wholesale prices, and the transmitted prices may vary according to the retail prices based on their rising or falling pattern.

These studies, however, predated the development of cointegration and did not consider the problems related to nonstationary series [12]. Granger and Lee (1989) therefore incorporated the variable splitting technique into the error correction representation to correct for the problem of nonstationarity [13]. Since then, variants of this approach have been used extensively in applied work [14].

Other studies Abdulai (2000); Enders and Granger (1998) and Enders and Siklos (2001) also have captured asymmetry using threshold models, where price movements above or below certain thresholds trigger different response [15,16,17]. A number of potential causes but limited have been attributed to asymmetries in price transmission. Among studies addressing this issue include [8,14,18].

Some of the potential causes of asymmetry discussed in literature include market power. Market power refers to the ability of an enterprise or a group of enterprises to raise and maintain price above or below a competitive level [19]. In non-competitive market structure where there is considerable degree of market power, market agents react quickly and/ or more completely to shocks that squeeze their marketing margin than to corresponding shocks that stretches them, resulting in positive asymmetry. Positive asymmetry is, however, not the only resulting effect of market power. Ward (1982) indicates that oligopolists can be reluctant to increase market prices for the risk of losing market share [20]. The positive asymmetry appears to be reasonable in pure monopoly while both positive and negative asymmetries are conceivable in the more common oligopolistic context [9].

Frey and Manera (2005) also present a comparable argument regarding tacit collusion in oligopolistic markets [18]. In this scenario, when wholesale prices rise, firms promptly raise their selling prices as a signal to their competitors, indicating their compliance with the tacit agreement. Conversely, when wholesale prices decrease, firms are cautious in adjusting their prices, as doing so may risk signaling a reduction in their profit margins and deviating from the agreement.

Adjustment/menu costs are another factor that contributes to the presence of asymmetry. These costs are incurred by firms when they decide to alter the quantities and/or prices of their inputs and/or outputs. When these costs are specifically related to price adjustments, they are referred to as menu costs [9]. Menu costs encompass various expenses such as the cost of modifying nominal prices, printing catalogues, dealing with inflation-related costs, and disseminating information regarding price changes. It is worth noting that these costs may exhibit asymmetry in relation to price increases and decreases.

2. Methodology

2.1. Study area and data sources

The Study was primarily examined four specific areas in Ethiopia: Oromia (Jima), Benishangul-Gumuz (Asosa), Amhara (Este), Central Ethiopia Regional State (Sawla), Diredawa, and Addis Ababa. These regions are part of the Twelve Regions of Ethiopia, with Addis Ababa serving as the nation's capital and Diredawa as a municipality. While Addis Ababa and Diredawa are considered consumption hubs, the four regions mentioned are recognized as significant groundnut production zones. Among them, Oromia Region stands as the largest groundnut producer, followed by Benishangul-Gumuz, according to the [21].

The markets that are studied in the Oromia region was Jima, while in the Amhara region was Este, BenishangulGumuz region was Asosa and SNNPR regions, Sawla markets was studied. These markets were surplus markets, and markets in deficit areas that were studied include the Diredawa market and the Addis Ababa market. The criterion for selecting these markets is based on net market positions (surplus and deficit), geographical distribution, data availability and the volume of trade or the importance of the market to the national Groundnut trade flow.

2.2. Source of Data

The study used secondary time series data that was collected from the Ethiopian Statistical Service (ESA) of Ethiopia, covering the period September 2000 -August 2022. The monthly retail prices that are deflated and seasonally adjusted to cater for inflation during the period of study were used.

2.3. Econometric Model

The examination of time series data involves several critical procedures, one of which is the verification of the stationarity of research variables, ensuring that none exhibit integration beyond the second order. Consequently, it is essential to analyze the unit root properties of the variables utilized in the study. The presence of multiple orders of integration within a variable can lead to misleading results. To assess the order of integration of the variables, we employed the Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) unit root tests prior to the application of the time series econometric model. Additionally, before investigating causality, it is crucial to evaluate the cointegrating relationships

among the variables. We implemented the Bounds cointegration test to determine whether any cointegration exists between the variables.

2.4. The Nardl Model

The study employed the NARDL approach to examine the asymmetric price transmission between markets experiencing surplus and those in deficit, specifically focusing on the relationship concerning groundnut prices.

The Non-linear ARDL model recently developed by Shin *et al.*, (2014) uses positive and negative partial sum decompositions allowing detecting the asymmetric effects in the long and the short-term [22]. Compared to the classical cointegration models, NARDL models present some other advantages. Firstly, they perform better for determining cointegration relations in small samples [23]. Secondly, they can be applied irrespective of whether the regressors are stationary at level or at the first difference (i.e. I(0) or I(1)). They cannot be applied however if the regressors are I(2). Therefore, the asymmetric NARDL framework of Greenwood-Nimmo and Shin, (2013) is particularly suitable for our research problem as it allows us not only to gauge the short- and long-run asymmetries, but also to detect hidden cointegration

$$\Delta P_{1t} = \theta_0 + \sum_{i=1}^n \rho_1 \Delta P_{1,t-1} + \sum_{i=1}^n \rho_2 \Delta P_{2,t-1} + \beta_2^+ ECT_{t-1}^+ + \beta_2^- ECT_{t-1}^- + \varepsilon_t$$

$$\Delta P_{2t} = \theta_1 + \sum_{i=1}^n \rho_1 \Delta P_{1,t-1} + \sum_{i=1}^n \rho_2 \Delta P_{2,t-1} + \beta_2^+ ECT_{t-1}^+ + \beta_2^- ECT_{t-1}^- + \varepsilon_t$$

$ECT_{t-1}^+ + ECT_{t-1}^- = ECT_t$, the standard symmetric VECM is nested in the AVECM and the F-test to test the null hypothesis of symmetry $H_0 : \beta_2^+ = \beta_2^-$. If this is rejected then price transmission process among the market is asymmetric [24].

The *F*-statistic value for the non-linear ARDL falls between the upper and lower bounds, it implies that the relationship between Change in price and its determinants is inconclusive. However, for the asymmetric NARDL, bounds test result shows that there is evidence of cointegration among Diredawa-Este, Diredawa-Jima, Diredawa-Sawla, Diredawa-Asosa, Addis ababa-Este, Addis ababa-Jima, Aaddisababa-Sawla and Adis ababa-Asosa Market.

3. Results and Discussion

Markets	Mean	Min	Max	CV (%)	Std. Dev.	Skewness	Observations
lnEste	22.83	2.36	113	91.02	20.87	1.49	276
lnJima	24.20	1.71	130	93.05	22.52	1.57	276
lnAsosa	13.49	1.39	77.91	85.84	11.58	1.91	276
lnDiredw	29.89	3.94	222.2	121.34	36.27	2.79	276
lnSawla	23.23	2.5	127.8	94.85	22.12	1.69	276
lnAdisababa	28.69	4.5	140	85.46	24.52	1.25	276

Source: Own computation from price data (2000-2022).

Table 1: Nominal monthly groundnuts prices from 2000 to 2022, (ETB/kg)

Understanding price behavior in various markets has been closely linked to the concept of price variability. This variability can be attributed to a range of factors, including natural influences like weather fluctuations, as well as economic factors such as transportation expenses, market participants, and alterations in market structure. According to Table 1, Diredawa and Addisababa exhibited the highest nominal mean prices at 29.89 and 28.69 ETB per Kg respectively, whereas Asosa and Este showed the lowest mean prices at 13.49 and 22.83 ETB respectively. The high prices in both Diredawa and Addisababa were as a result of urban demand of groundnuts that outpaced supply [25]. The low prices recorded in Asosa, Sawla and Este can be attributed to the fact that the markets are located in the main groundnut growing regions across the country.

The variations in nominal groundnut prices in regions with both shortages and excesses are depicted in Figures (1) and (2) below. Prices in Diredawa and Addisababa were notably higher compared to those in the areas where groundnuts are produced, leading to a more distinct graphical representation. Overall, a consistent price pattern has been observed in all six markets, indicating that groundnut prices have moved in the same direction throughout the years. These findings support the conclusions of Lupiya, (2018) who demonstrated a national upward trend in groundnut prices. Upon visual examination, it is evident that prices have continuously increased, suggesting a potential spatial integration of markets in regions with both shortages and excesses.

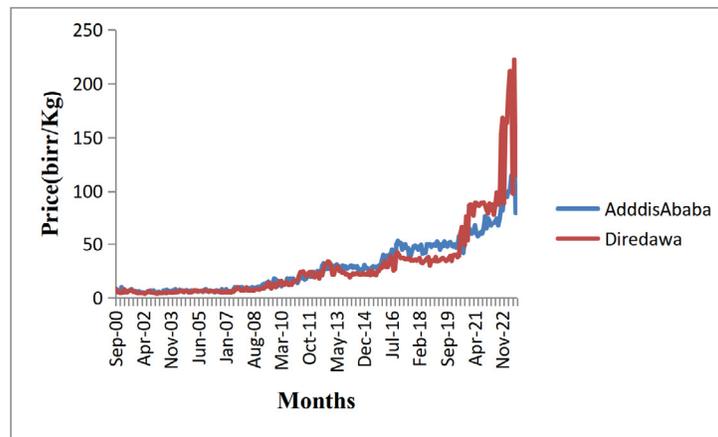


Figure 1: Groundnuts, nominal prices in deficit areas, 2000 to 2022, (Birr/KG)
Source: Own computation from price data

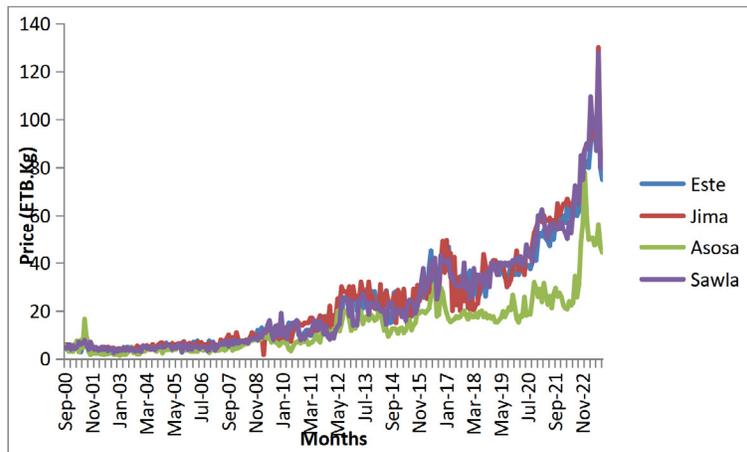


Figure 2: Groundnuts, nominal prices in surplus areas, 2000 to 2022, (Birr/KG)
Source: Own computation from Retail price data (2000-2022).

3.1. Stationarity Test Results

Price Series	ADF		KPSS	
	Level	First Difference	Level	First Difference
lnAddisAbaba	-0.22	-14.61***	1.90	0.23***

lnDiredawa	-0.23	-14.17***	1.85	0.25***
lnEste	-1.46	-15.27***	1.904	0.22***
lnJima	-0.42	-15.25***	1.88	0.28***
lnAsosa	-1.35	-22.36***	1.79	0.09***
lnSawla	-0.30	-17.21***	1.901	0.228***
Source: Own computation from Retail price data (2000-2022)				

Table 2: Unit Root Test for Retail Price (Birr/ Kg) of Selected Groundnut Market in Ethiopia at level and first difference result for the period 2000 to 2022

Note: For the ADF test; triple, double and single asterisks indicate statistical significance at 1, 5 and 10 percent level. On the other hand, triple, double and single asterisks for the KPSS show significance at all levels, two levels and one level respectively. The critical values for the ADF at 1, 5 and 10 percent levels are -3.465, -2.877 and -2.575 respectively. The critical values for the KPSS are 0.739, 0.463 and 0.347 at 1, 5 and 10 percent respectively.

Prices at the six markets were all stationary after the first difference. Since all variables were stationary after first difference, meaning that they were integrated of order 1, that is to say I (1). This is one of the conditions for testing co-integration that depicts the existence of a long-run relationship among the six groundnuts markets. Similarly, Kwiatkowski Philips Schmidt Shin (KPSS) found the same results with ADF tests. That is since the value of KPSS test statistics for the first difference of all market price series is smaller than the critical value at the 0.01 level of significance. We fail to reject the null hypotheses of stationarity at the 1% level of significance. This implies that the first differenced series of the all market are stationary.

4. Assymmetric cointegration test for Diredawa- Este market

4.1 F bound test

Upon verifying the order of integration, the next step involves

examining the cointegrating properties of the variables. We employed the Bounds cointegration tests, utilizing both F statistics and t statistics, to determine the presence of cointegration among the variables. The methodology of the tests is contingent upon the established upper and lower critical bounds. Specifically, if the empirical values of the F and t statistics surpass the upper bound, the null hypothesis is rejected, indicating that the variables are cointegrated. Conversely, if the values fall below the lower bound, it suggests a lack of cointegration among the variables. In cases where the values reside between the critical bounds, the results of the test remain inconclusive.

The estimated coefficient of the NARDL model will be spurious if variables are not cointegrated. This asymmetric cointegration technique under the nonlinear ARDL model has been proposed by [22]. They have recommended applying the joint null hypothesis of level variables and evaluating the bound test's critical values proposed by [26]. If the estimated value of F-statistics is obtained as more significant than the upper critical value, it confirms cointegration. If the F-value is closer to zero than the lower critical value, then there is no cointegration. If the F-value falls between the upper and lower critical values, then no conclusion can be drawn.

F-Bounds Test	Null Hypothesis: No levels relationship			
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	5.386920***	10%	2.63	3.35
K	2	5%	3.1	3.87
		2.5%	3.55	4.38
		1%	4.13	5
<i>Notes:</i> *** significant at 1% level.				
<i>Source:</i> Own computation from groundnut retail price data (2000-2022)				

Table 3: Results of Bounds Test for Diredawa- Este Market

Table above shows that the value of F-statistics is 5.386, which is greater than the critical value for 1%. The null hypothesis of no cointegration is rejected, which means the variables are cointegrating in the long term among the selected variables.

4.2. Assymetry test for Diredawa- Este market

From the Wald t test below the probability value is not significant so, we fail to reject the null hypothesis
Null hypothesis: there is no asymmetry
Alternative: there is asymmetry

Wald Test:			
Test Statistic	Value	Df	Probability
t-statistic	-1.124695	260	0.2618
F-statistic	1.264939	(1, 260)	0.2618
Chi-square	1.264939	1	0.2607

Restrictions are linear in coefficients
Source: Own computation from groundnut retail price data (2000-2022)

Table 4: Testing the presence of asymmetry for Diredawa - Este market

From the Wald t test above the probability value is not significant so, we fail to reject the null hypothesis. There is No asymmetry between this markets.

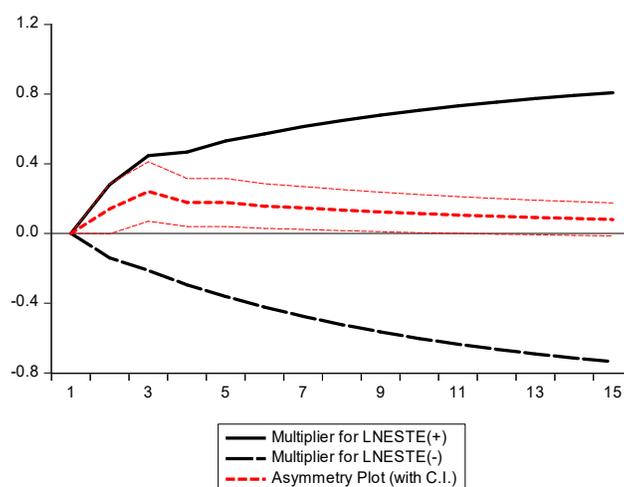


Figure 3: Shocks of asymmetric dynamic multipliers of Estet on Diredawat, using multiplier and the asymmetry identified with the NARDL model.

From The Figure above we can easily understand that:

1. The continuous dark line tells how Diredawa market corrects due to a positive change in Este market, and the dashed black line shows the adjustment of the dependent variable Diredawa over the horizon to a negative shock in Este.
2. The dashed line is the asymmetric plot, and it shows the difference between the dynamic multiplier of positive and negative changes in the regressor.
3. The asymmetry line lies within the upper and lower bands of the 95% confidence intervals. The zero line falls below the lower boundary of the 95% confidence intervals, indicating that their asymmetry is statically significant.
4. We can easily see that the dependent variable responds positively to a positive change and negatively to an adverse

change in the regressor. Also, we can see the response of Diredawa.

Getting positive or negative changes is more evident in the long run than in the short run, where it is virtually operating simultaneously. Furthermore, the scale of an increase resulting from a positive change is larger than the scale of decrease because of a negative change, and that variation is suggestive of the observed asymmetry already established in the Wald Test. So, there is no asymmetric relationship between Diredawa market and Este Market.

4.3. Assymetric Cointegration test for Diredawa-Jima Market

The Longrun Cointegration is presented in table below

F-Bounds Test	Null Hypothesis: No levels relationship			
	Value	Signif.	I(0)	I(1)
F-statistic	12.1796***	10%	2.63	3.35
K	2	5%	3.1	3.87

Notes: *** significant at 5% level.
Source: Own computation from groundnut retail price data (2000-2022)

Table 5: The bound test for Longrun cointegration of Diredawa-Jima Market

Table above shows that the value of F-statistics is 12.32693, which is greater than the critical value for 1%. The null hypothesis

of no cointegration is rejected, which means the variables are cointegrating in the long term among the selected variable.

Wald Test:			
Test Statistic	Value	Df	Probability
t-statistic	0.820218	266	0.4128
F-statistic	0.672757	(1, 266)	0.4128
Chi-square	0.672757	1	0.4121
Restrictions are linear in coefficients			
Source: Own computation from groundnut retail price data (2000-2022)			

Table 6: Testing the presence of asymmetry for Diredawa-Jima market

From the Wald t test above the probability value is not significant so, we fail to reject the null hypothesis. There is No asymmetry between this markets.

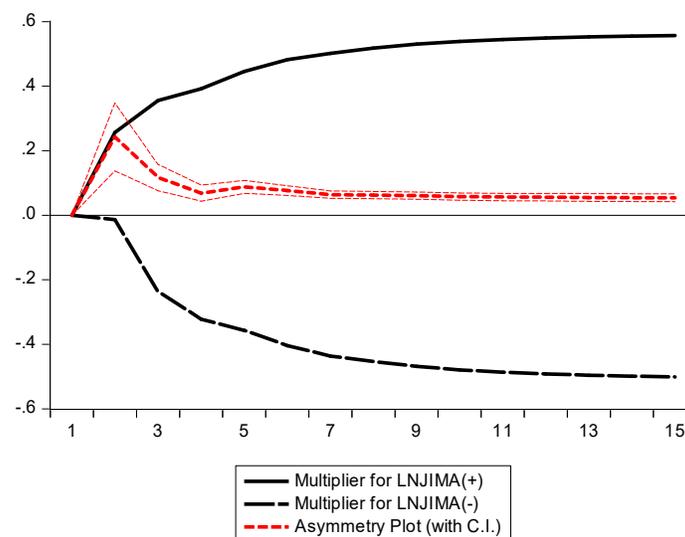


Figure 4: Shocks of asymmetric dynamic multipliers of Jimat on Diredawat, using multiplier and the asymmetry identified with the NARDL model.

From the figure above we can conclude the following points.

1. The continuous dark line tells how Diredawa market corrects due to a positive change in lnJima market, and the dashed black line shows the adjustment of the dependent variable lnDiredawa Market over the horizon to a negative shock in lnJima market.
2. The dashed line is the asymmetric plot, and it shows the difference between the dynamic multiplier of positive and negative changes in the regressor.
3. The asymmetry line lies within the upper and lower bands of the 95% confidence intervals. The zero line falls below the lower boundary of the 95% confidence intervals, indicating that their asymmetry is statically significant.
4. We can easily see that the dependent variable responds

positively to a positive change and negatively to an adverse change in the regressor. Also, we can see the response of Diredawa.

Getting positive or negative changes is more evident in the long run than in the short run, where it is virtually operating simultaneously. Furthermore, the scale of an increase resulting from a positive change is larger than the scale of decrease because of a negative change, and that variation is suggestive of the observed asymmetry already established in the Wald Test.

So, there is no asymmetric relationship between Diredawa market and Jimat Market

4.4. Assymetry Cointegration Test for Diredawa-Sawla Market

F-Bounds Test	Null Hypothesis: No levels relationship			
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	9.266***	10%	2.63	3.35

K	2	5%	3.1	3.87
		2.5%	3.55	4.38
<i>Notes: *** significant at 5% level.</i>				
Source: Own computation from groundnut retail price data (2000-2022)				

Table 7: Bounds test for nonlinear cointegration for Diredawa-Sawla Market

The cointegration test (Table 22) shows that the value of F-statistics is 9.266, which is greater than the critical value for 1%. The null hypothesis of no cointegration is rejected, which means the variables are cointegrating in the long term among the selected variables. Therefore, we can investigate Sawla market fluctuations in the NARDL cointegrating framework.

Wald Test:			
Test Statistic	Value	Df	Probability
t-statistic	-0.442352	265	0.6586
F-statistic	0.195675	(1, 265)	0.6586
Chi-square	0.195675	1	0.6582
Restrictions are linear in coefficients			
Source: Own computation from groundnut retail price data (2000-2022).			

Table 8: Testing the presence of asymmetry for Diredawa-Sawla market

From the Wald t test table above the probability value is greater than 5% which is not significant so, we fail to reject the null hypothesis. There is No asymmetry between this markets.

4.5. Assymmetric Cointegration test for Diredawa-Asosa Market

F-Bounds Test	Null Hypothesis: No levels relationship			
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	6.24542***	10%	2.63	3.35
K	2	5%	3.1	3.87
		2.5%	3.55	4.38
		1%	4.13	5
<i>Notes: *** significant at 1% level.</i>				
Source: Own computation from groundnut retail price data (2000-2022).				

Table 9: Bounds test for nonlinear cointegration for Diredawa-Asosa Market

The cointegration test (Table 24) shows that the value of F-statistics is 6.245425, which is greater than the critical value for 1%. The null hypothesis of no cointegration is rejected

Wald Test:			
Test Statistic	Value	Df	Probability
t-statistic	-1.855311	258	0.8853
F-statistic	0.020834	(1, 258)	0.8853
Chi-square	0.020834	1	0.8852
Restrictions are linear in coefficients			
Source: Own computation from groundnut retail price data (2000-2022).			

Table 10: Testing the presence of asymmetry for Diredawa-Asosa market

From the wald test table above the probability value is greater than the 5% significance we fail to reject the null hypothesis of no asymmetry and we conclude there is no asymmetry between the two markets.

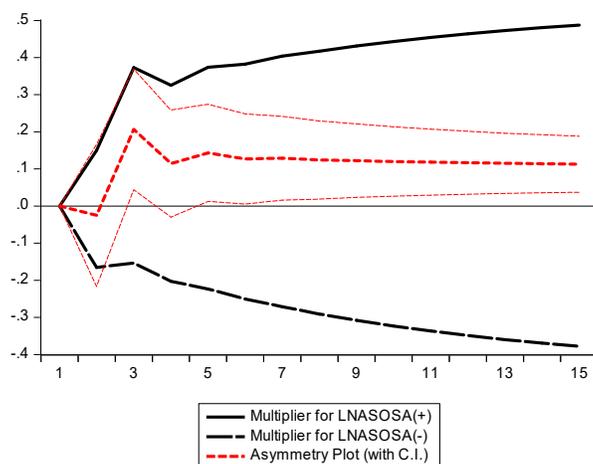


Figure 5: Shocks of asymmetric dynamic multipliers of Asosat on Diredawat, using multiplier and the asymmetry identified with the NARDL model

From The Figure above we can easily understand that:

1. The continuous dark line tells how Diredawa market corrects due to a positive change in Este market, and the dashed black line shows the adjustment of the dependent variable Diredawa over the horizon to a negative shock in Este.
2. The dashed line is the asymmetric plot, and it shows the difference between the dynamic multiplier of positive and negative changes in the regressor.
3. The asymmetry line lies within the upper and lower bands of the 95% confidence intervals. The zero line falls below the lower boundary of the 95% confidence intervals, indicating that their asymmetry is statically significant.
4. We can easily see that the dependent variable responds

positively to a positive change and negatively to an adverse change in the regressor. Also, we can see the response of Diredawa.

Getting positive or negative changes is more evident in the long run than in the short run, where it is virtually operating simultaneously. Furthermore, the scale of an increase resulting from a positive change is larger than the scale of decrease because of a negative change, and that variation is suggestive of the observed asymmetry already established in the Wald Test. So, there is no asymmetric relationship between Diredawa market and Asosa Market.

4.6. Asymmetry Cointegration Test for Addisababa-Este Market

F-Bounds Test				
Null Hypothesis: No levels relationship				
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	14.57028***	10%	2.63	3.35
K	2	5%	3.1	3.87
		2.5%	3.55	4.38
		1%	4.13	5

Notes: *** significant at 1% level.
Source: Own computation from groundnut retail price data (2000-2022)

Table 11: Bounds test for nonlinear cointegration for Addisababa-Este Market.

The cointegration test (Table 26) shows that the value of F-statistics null hypothesis of no cointegration is rejected. is 14.57028, which is greater than the critical value for 1%. The

Wald Test:			
Test Statistic	Value	Df	Probability
t-statistic	1.401188	265	0.1623
F-statistic	1.963328	(1, 265)	0.1623
Chi-square	1.963328	1	0.1623

Restrictions are linear in coefficients
Source: Own computation from groundnut retail price data (2000-2022)

Table 12: Testing the presence of asymmetry for Addisababa-Este market

From the wald test table above the probability value is greater than the 5% significance we fail to reject the null hypothesis of no asymmetry and we conclude there is no asymmetry between the two markets.

4.7. Assymetry Cointegration Test for Addisababa-Jima Market

F-Bounds Test				
Null Hypothesis: No levels relationship				
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	10.27831***	10%	2.63	3.35
K	2	5%	3.1	3.87
		2.5%	3.55	4.38
		1%	4.13	5
Notes: *** significant at 1% level.				
Source: Own computation from groundnut retail price data (2000-2022)				

Table 13: Bounds test for nonlinear cointegration for Addisababa-Jima Market

The cointegration test (Table 28) shows that the value of F-statistics null hypothesis of no cointegration is rejected. is 10.27831, which is greater than the critical value for 1%. The

Wald Test:			
Test Statistic	Value	Df	Probability
t-statistic	3.705808	266	0.0003
F-statistic	13.73301	((1, 266))	0.0003
Chi-square	13.73301	1	0.0002
Restrictions are linear in coefficients			
Source: Own computation from groundnut retail price data (2000-2022)			

Table 14: Testing the presence of asymmetry for Addisababa-Jima market.

From the table above the wald test table the probability value is less than the 5% significance we reject. The null hypothesis of no asymmetry and there is asymmetry between the two markets.

4.8. Assymetry Cointegration Test for Addisababa- Sawla Market

F-Bounds Test				
Null Hypothesis: No levels relationship				
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	22.670***	10%	2.63	3.35
K	2	5%	3.1	3.87
		2.5%	3.55	4.38
		1%	4.13	5
Notes: *** significant at 1% level.				
Source: Own computation from groundnut retail price data (2000-2022)				

Table 15: Bounds test for nonlinear cointegration for Addisababa- Sawla Market

The cointegration test (Table 30) shows that the value of F-statistics null hypothesis of no cointegration is rejected. is 22.67000, which is greater than the critical value for 1%. The

Wald Test:			
Test Statistic	Value	Df	Probability
t-statistic	4.063520	269	0.0001
F-statistic	16.51219	((1, 266))	0.0001
Chi-square	16.51219	1	0.0000
Restrictions are linear in coefficients			
Source: Own computation from groundnut retail price data (2000-2022)			

Table 16: Testing the presence of asymmetry for Addisababa- Sawla market

From the table above the wald test table the probability value is less than the 5% significance we reject. The null hypothesis of no asymmetry and there is asymmetry between the two markets. These results are similar to those of Asymmetric effect of financial development and energy consumption on environmental

degradation in South Asia New evidence from non-linear ARDL analysis [27]. Also, found long- and short-run asymmetric relationships between producer milk price and most retailer dairy product prices in Hungary [28].

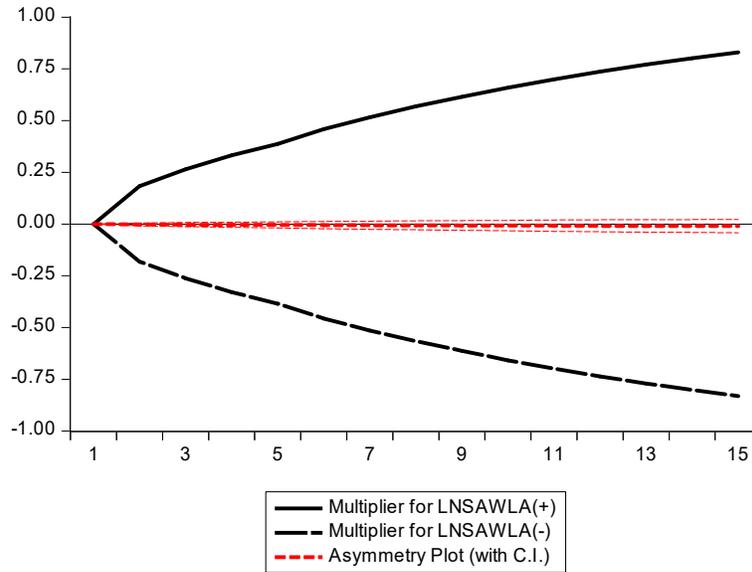


Figure 6: Shocks of asymmetric dynamic multipliers of Sawlat on Addisababat, using multiplier and the asymmetry identified with the NARDL model

From the above figure the red broken line (Assymetry plot) is on the zero line so, it clearly indicate the existence of asymmetry between the two market.

4.9. Assymetry Cointegration Test for Addisababa- Asosa Market

F-Bounds Test				
Null Hypothesis: No levels relationship				
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	11.0055***	10%	2.63	3.35
K	2	5%	3.1	3.87
		2.5%	3.55	4.38
		1%	4.13	5

Notes: *** significant at 1% level.
Source: Own computation from groundnut retail price data (2000-2022)

Table 17: Bounds test for nonlinear cointegration for Addisababa- Asosa Market

The cointegration test (Table 16) shows that the value of F-statistics is 11.0055, which is greater than the critical value for 1%. The null

hypothesis of no cointegration is rejected

Wald Test:			
Test Statistic	Value	Df	Probability
t-statistic	-0.578827	269	0.5632
F-statistic	0.335041	((1, 266))	0.5632
Chi-square	0.335041	1	0.5627

Restrictions are linear in coefficients
Source: Own computation from groundnut retail price data (2000-2022)

Table 18: Testing the presence of asymmetry for Addisababa- Asosa market

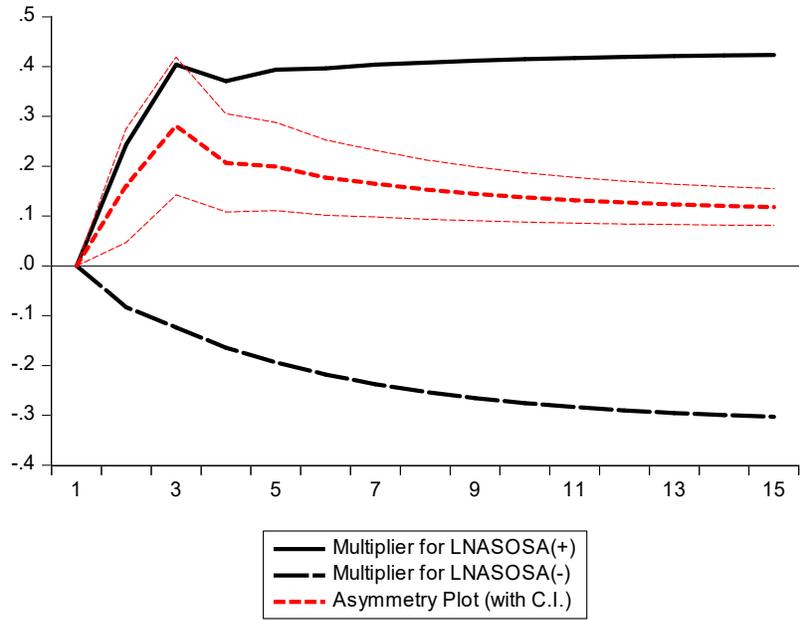


Figure 7: Shocks of asymmetric dynamic multipliers of Asosat on Addisababat, using multiplier and the asymmetry identified with the NARDL model.

From the asymmetric Dynamic Multiplier Graphs above the following conclusion was made.

1. The continuous dark line tells how Addisababa market corrects due to a positive change in Asosa market, and the dashed black line shows the adjustment of the dependent variable lnAddisababa over the horizon to a negative shock in Asosa.
2. The dashed line is the asymmetric plot, and it shows the difference between the dynamic multiplier of positive and negative changes in the regressor.

4.10. Asymmetric Dynamic Multipliers

In order to explore whether the estimated coefficients are stable

in the short and long term Das *et al.*, (2023) the Cumulative Sum of Error Forecast (CUSUM) test is applied to verify stability (Pesaran *et al.*, 2001) [29]. The results are shown in Figure11 with a 5% confidence band, and all the values in the sample are identified considering the Price transmission of the Different market for 2022. The stability of the parameters of NARDL model is examined using CUSUM and CUSUMSQ stability approach introduced by [30]. If the blue lines cross upper or lower bounds, it implies that parameters are not stable in the model. Since the blue lines in both graphs are within lower and upper bounds, we can infer that parameters of the estimated model are stable.

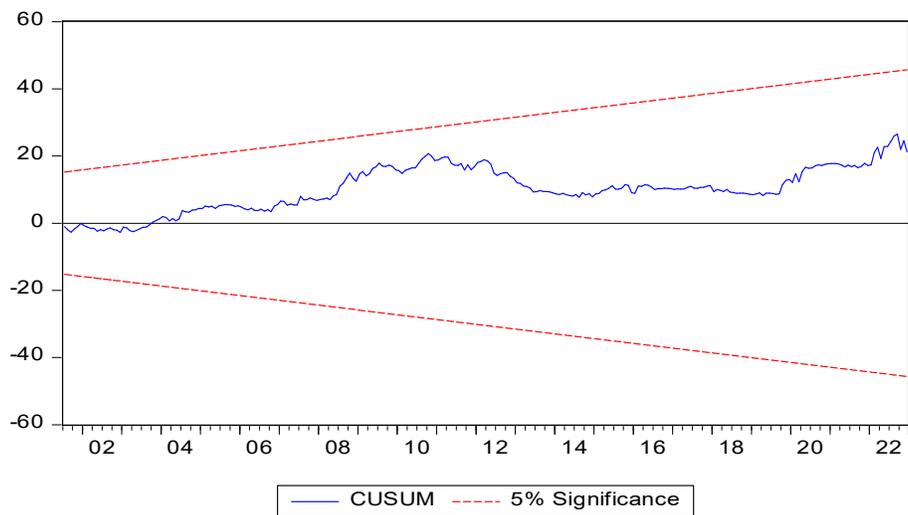


Figure 8: The Cumulative Sum of Error Forecast (CUSUM) test to estimate the Stability of NARDL model

From the above fig, It indicates that it doesnot cross the determined bounds. It demonstrates the stability of the estimated coefficient because CUSUM is at a significance level of 5% in determining bounds.

Direda- Este			Direda -Jima			Direda –Sawla			Dire– Asosa		
Var.	Coef	t-stat	Var.	Coef	t-stat.	Vari	Coef.	t-stat	Var	Coef.	t-stat
C	0.23	2.45	C	0.326	5.05	C	0.347	5.81	C	0.028	1.03
$\Delta LnDir_{t-1}$	-0.148	-3.74	$\Delta LnDir_{t-1}$	-0.197	-5.06	$\Delta LnDir_{t-1}$	0.519	9.11	$\Delta LnDir_{t-1}$	0.547	9.52
$\Delta LnDir_{t-2}$	0.14	2.88	$\Delta LnDir_{t-2}$	-0.284	-4.90	$\Delta LnDir_{t-2}$	0.282	4.98	$\Delta LnDir_{t-2}$	0.369	6.52
$\Delta LnEst_{t-1}$	0.13	2.66	$\Delta LnJim_{t-1}$	0.158	4.20	$\Delta LnSaw_{t-1}$	0.199	5.56	$\Delta LnAso_{t-1}$	0.031	0.71
$\Delta LnEst_{t-2}$	-0.32	-5.38	$\Delta LnJim_{t-2}$	0.151	3.87	$\Delta LnSaw_{t-2}$	0.198	5.25	$\Delta LnAso_{t-2}$	-0.104	-2.69
ECT_{t-1}^+	0.28	3.79*	ECT_{t-1}^+	0.80	5.37	ECT_{t-1}^+	1.005	7.18**	ECT_{t-1}^+	0.553	2.89**
ECT_{t-1}^-	0.16	2.1	ECT_{t-1}^-	0.76	4.62	ECT_{t-1}^-	0.998	6.27	ECT_{t-1}^-	0.449	2.02
Tests for asymmetry			Tests for asymmetry			Tests for asymmetry			Tests for asymmetry		
F-test	Prob.		F-test	Prob.		F-test	Prob.		F-test	Prob.	
1.674	0.19		0.672	0.412		0.195	0.658		0.335	0.885	
Wald t			Wald t			Wald t			Wald t		
-0.265	0.20		0.820	0.412		-0.442	0.658		-1.855	0.885	

Adisab- Este			Adisab -Jima			Adisab-Sawla			Adisab – As		
Var.	Coef	t-stat	Var.	Coef	t-stat.	Vari	Coef.	t-stat	Var	Coef.	t-stat
C	0.14	4.38	C	0.958	10.07	C	0.68	9.13	C	0.951	10.7
$\Delta LnAds_{t-1}$	0.47	7.60	$\Delta LnAds_{t-1}$	-	1.03	$\Delta LnAds_{t-1}$	0.468	8.24	$\Delta LnAds_{t-1}$	0.495	8.25
$\Delta LnAds_{t-2}$	0.17	2.84	$\Delta LnAds_{t-2}$	0.017	1.15	$\Delta LnAds_{t-2}$	0.122	2.19	$\Delta LnAds_{t-1}$	0.245	4.31
$\Delta LnEst_{t-1}$	0.07	1.66	$\Delta LnJim_{t-1}$	0.306	-1.34	$\Delta LnSawl_{t-1}$	0.270	6.98	$\Delta LnAso_{t-1}$	0.039	0.54
$\Delta LnEst_{t-2}$	0.065	1.40	$\Delta LnJim_{t-2}$	0.017	-2.73	$\Delta LnSawl_{t-2}$	0.253	8.09	$\Delta LnAso_{t-2}$	-0.174	-2.83
ECT_{t-1}^+	0.76	9.37	ECT_{t-1}^+	0.53	-1.73*	ECT_{t-1}^+	0.662	11.2**	ECT_{t-1}^+	-0.37	2.6**
ECT_{t-1}^-	0.73	7.85	ECT_{t-1}^-	0.48	-0.10	ECT_{t-1}^-	0.618	9.20	ECT_{t-1}^-	-0.047	9.2
Tests for asymmetry			Tests for asymmetry			Tests for asymmetry			Tests for asymmetry		
F-test	Prob.		F-test	Prob.		F-test	Prob.		F-test	Prob.	
1.963	0.16		13.73**	0.003		16.512*	0.001		7.43	0.563	
Wald t			Wald t			Wald t			Wald t		
1.401	0.16		3.705	0.003		4.063	0.001		-0.578	0.563	

Table 18: Results of Asymmetry Vector Error Correction Model

ECT_{t-1}^+ and ECT_{t-1}^- measures adjustment to positive shocks and negative shocks respectively. Positive shocks are events that increase price of Groundnut in the surplus and deficit markets while negative shocks are events that decrease the price of groundnut in the deficit and surplus markets. Wald test was conducted to test the existence of asymmetry.

5. Conclusion

It is undeniable that comprehending the behavior of agricultural prices is crucial for the development of a viable Agricultural Development Plan and a sustainable food security policy. Throughout the years, numerous governments have endeavored to attain market efficiency by implementing diverse agricultural sector policies and programs. Their ultimate objective has been to ensure the availability of food from surplus to deficit areas, while also aiming to achieve positive welfare impacts from policy initiatives and address the disparities between deprived and affluent regions that arise from ecological variations and other factors. Despite such efforts, agricultural development policies in Ethiopia have concentrated much attention on increasing agricultural productivity while research on market price analysis has been relegated to the background. The purported ability of the market participants to influence the conduct of the market resulting in a full and faster transmission of cost increases to consumers than the contrary cost decreases makes it necessary to study the nature of market price linkages in Ethiopia.

The study sought to acquire knowledge about the state of Groundnut markets in Ethiopia in the last decade. Using monthly Retail Groundnut prices data between 2000 to 2022 the study examined: the variation and trends within Groundnut prices in Six markets under study, price linkages among Surplus and deficit markets in Ethiopia between 2000 to 2022, whether price transmission between Surplus and deficit markets are symmetric or asymmetric and the extent to which Groundnut markets in Ethiopia are spatially integrated.

A descriptive analysis of the data shows that the market with the highest average values for monthly Retail prices was Diredawa while the lowest value was Asosa. The variability in Groundnut market prices as determined by the coefficient of variation was on the average approximately 95.6 percent. The high fluctuations in mean Retail prices indicate that Groundnut prices were unstable. Also, the seasonal variation indicates that prices generally decline rapidly in the four months after the new crop harvest which comes in May for the all parts of the Ethiopia. A trend analysis in all the six markets shows that prices were lowest in May and highest in April. The annual trend also shows a general increase in price of groundnut over the years with a cyclical pattern in every six years that is 2017, 2018, 2019, 2020, 2021 and 2012.

All the price series showed econometric integration of the order I (1) meaning that similar stochastic processes generated these series. The test for cointegration using the Johansen Maximum Likelihood tests reveals that all the six market pairings were

cointegrated. The market pairs examined showed that their prices series do not diverge at equilibrium thus exhibiting spatial price linkage. The results complement earlier studies of market integration in the Ethiopian market, which potentially can be attributed to the non-interventionist role of the government, improvement in communication infrastructure and the different degrees of self-sufficiency that create arbitrage between the maize markets.

The adjustment mechanism between the Groundnut markets after a shock was characterized by asymmetry where traders responded faster to shocks that squeezed their marketing margin than those that stretched them. Two out of the six markets pairs, InAddisababa-InJima and InAddisababa-InSawla, market exhibited positive asymmetry in price transmission even though the remaining markets show faster adjustment to price increases compared to price decreases, they are not statistically significant [31].

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