

The impacts of COVID-19 on global trade: Nexus of wheat and crude oil

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Abstract: This study targeted to disclose the impact of COVID-19 on the world global trade, namely, the relationship between world crude oil prices and world wheat prices. It depended on data which was collected from different resources and covered the period extend from Jan. 2016 to Aug. 2023. The data was divided in to three periods: before COVID-19 (from Jan. 2016 to Nov. 2019), after outbreak of COVID-19 (from Dec. 2019 to Dec. 2020) and after recovering from epidemic outbreak (Jan. 2021 to Aug. 2023). Engel-Granger Two Steps Procedure and ARDL bounds methods of analysis were used to analysis data. The results for the period before and recovering from outbreaks of covid-19 revealed long run co-integration among crude oil and wheat prices series. While the result for the period after outbreaks of COVID-19 didn't discover any the long run relationship between world crude oil prices and world wheat prices. This result may be due to consequences and lockdown of COVID-19. Consequently, these results affect global food security situation.

Keywords: ARDL test, COVID-19, Crude oil, Wheat, World.

1. Introduction

The coronavirus disease 2019 (COVID-19) outbreak began in Wuhan, Hubei Province, China in December 2019 and rapidly spread throughout the nations worldwide [1]. It was caused by a novel coronavirus named as severe acute respiratory syndrome coronavirus 2 (SARS-CoV2). The World Health Organization (WHO) declared COVID-19 as a Public Health Emergency of International Concern (PHEIC) on January 30, 2020, and as a global pandemic on March 11, 2020, which is the second one in the 21st century followed by Swine flu in 2009 [2;3]. Globally, as of 5:43pm CEST, 17 May 2023, there have been 766,440,796 confirmed cases of COVID-19, including 6,932,591 deaths, reported to WHO [4]. Health systems and governments are planning and initiating different actions in battle with the COVID-19 epidemic. Using personal protection equipment, handwashing, social distancing and vaccines are the core strategies in nearly all health systems [5;6]. It has greatly affected billions of people worldwide for around 2 years and could have pushed 71-100 million people into extreme poverty due to the lockdown of cities and restrictions of traveling, gathering, and social distancing [7;8]. Subsequent the declaration of COVID-19 contagion, in late February numerous large Japanese companies organized their employees to labor from home, postponed this application is sprinkling quickly in additional nations. Economically, this technic (shuts and travel prevents) decline production straight in a way that matching to short-term reductions in employ [9]. Many Southeast Asian shipping countries stated exportation control to secure enough diets for internal market [10]. Accordingly, this condition will stimulate fear acquiring among importing nations. Global fear acquiring collected with export restrictions will lead to rise goods prices [11].

Numerous Economic experts are beginning to deliberate around these consequences. The study recorded about an amount of viewpoint in diverse economy parts [12].

Another study proposed the likely shock of COVID-19 on Gross Domestic Product and trade, using Standard global computable general equilibrium model as analysis method [13]. It signifies the shock as a request (in case of remoteness among individual), capital and labor underemployment of, a decrease in travel facilities and rise in global trade expenses. Gross domestic product declines by 1.8%, 2% and 2.5% beneath industrial countries, the benchmark for the global and developing countries, respectively.

Further study observed the influence of the COVID-19 outbreaks and the crude oil divergence between Russia and Saudi Arabia [14]. The study seemed that crude oil prices have discovered amazing and unpredicted variation.

Additional study observed the influences of world prices of crude oil and rice on Indonesia's inflation rate, using econometric methods of analysis [15]. Indonesia's inflation rate was affected positively animatedly by world crude oil and rice prices.

Other study aimed to reveal the effect of COVID-19 on the association between rice prices and crude oil prices at global level. It was divided into two periods: before and after outbreak of COVID-19 [16]. The result for the period before outbreaks of covid-9 discovered long-run co-integration between rice prices and crude oil series. Moreover, it documented that the coefficient of adjustment parameter for rice presented negative (-0.349) and significant (critical t-value= -3.29), denoting to the existing of short-run association, concluding that the model skillful to accurate its previous time variability. Whereas the outcome for the dated next outbreaks of COVID-19 didn't notice any the long run association among the series, concluding that this outcome may be owed to the consequences of lockdown of COVID-19. Therefore, the outcomes might lay miserable global food security circumstances [17]. About 66% and 16.6% of universal wheat production is used for food and feed, respectively. It cultivated on an area of 214 million hectares, producing 732.236 million tons in the world during 2018 [18].

Recently, the issues disturbing the variation of global cultivated product prices is energy prices which indicated by crude oil prices [19;20]. Economically, crude oil is reflected as an energetic product in the global trade [15]. Crude oil and its products are closely connected with the making, processing, conveyance, and transactions of greatest agricultural products [19]. The large fluctuations in crude oil prices can always affect the supply and demand balance of agricultural products, and then shocked the fluctuation of agricultural product prices [19]. Consequently, there is straight connotation between crude oil price and agriculture products prices ([15;16;21;22]).

This study enriches earlier studies discovery the influences of COVID-19 on global economic, particularly on the relation among world commodities prices. It pointed to discover the consequence of COVID-19 on the association among world wheat price and world crude oil prices. Reference to preceding studies (effects of COVID-19 on economic), the important of the study reflected to the nature of selected variables (wheat and crude oil) and their powers on food security.

2. Mathematical Model

2.1. Data Description

To focus on the relationship between wheat prices and the crude oil prices in the world. The data of such series were gathered and covered the period extended from Jan. 2016 to Aug. 2023 and analyzed using EViews 9 program. Table 1 summarized information about the series.

Table 1.
Variables description.

Variable	Unit	Sources
- World wheat average prices	(\$/mt)	https://www.worldbank.org/en/research/commodity-markets (accessed on 10 March 2023).
- World crude oil Prices	(bbl/\$)	

2.2. Analysis Methods

The study constructed to reveal the consequence of COVID-19 on the association between wheat prices and crude oil prices at global level. The data was split into three periods from: Jan. 2016 to Nov. 2019 (previous outbreak of covid-19), Dec. 2019 to Dec. 2020 (during outbreak of covid-19) and Jan. 2021 to Aug. 2023 (after outbreak of covid-19).

2.2.1. Graphical Analysis

Curves were drawn for the general index of the time series of the study to shed light initially on knowing the possibility of the equilibrium relationship between wheat prices and crude oil prices in the long term. Which is considered one of the simple analytical ways to find out this relationship, and it also allows for moving forward in conducting the joint integration test.

2.2.2. Cointegration Tests: Testing Long-Run Relationship

2.2.2.1. Unit Root Test

To test the order of integration of the series under study, ADF test is used [23;24]. The followings equations are applied:

$$\Delta X_t = C_{t1} + B_1 X_{t-1} + e_{t1} \quad (1)$$

$$\Delta X_t = C_{t2} + b_t + B_2 X_{t-1} + e_{t2} \quad (2)$$

Where, B_1 and B_2 are ADF coefficients to be valued, b is the trend, C is the constant, e is error term and t is the time selected. In testing the null hypothesis (H_0), X has a unit root against alternative hypothesis (H_1), X has a stationary. The variables are stationary if the t - statistic of the ADF coefficient is greater than t - critical values. The selection of the methods examining long run association be contingent on the series order; *Engle-Granger test* is applied when the series order is $I(1)$ and the ARDL test is noticed as operative for small observations of time series and used irrespective of the series order $I(0)$ and $I(1)$ but not $I(2)$ [25;26].

2.2.2.2. Engle-Granger test: Testing Long-Run Association

To conduct the cointegration test through Engle-Granger test, order of integration of the series must be specified first (same order of integration $I(1)$). Then, the Engle-Granger test can be directed [27]. The method includes the followings stages:

1. The regression equations are as follows:

$$X_t = a_1 + B_3 Y_t + z_{t1} \quad (4)$$

$$Y_t = a_2 + B_4 X_t + z_{t2} \quad (5)$$

where B_3 and B_4 are the slopes, coefficient estimate from Equations (4) and (5), respectively.

2. The ADF test is used on the residuals (z_{t1} and z_{t2}) testing whether the series are linked. If the ADF statistics are negative and greater than the critical t - value (of order 1), then it is predictable that the coefficient B_3 and B_4 exit (B_3 and $B_4 \neq 0$) and the series are cointegrated. Consequently, the series is joined of order 1,1.

3. Error correction model (ECM).

The ECM test is applied when cointegration test records long-run relationship between the series. It is used to amount the speediness parameter of the short-run association between the dual series [28]. The followings are the ECM equations:

$$\Delta(LW) = \Delta B_5 LW_{-1} + \Delta B_6 LC_{-1} + B_7 V_{1(t-1)} + U_1 \quad (6)$$

$$\Delta(LC) = \Delta B_8 LC_{-1} + \Delta B_9 LW_{-1} + B_{10} V_{2(t-1)} + U_2 \quad (7)$$

where B_5 and B_8 : coefficients of difference of lag dependent variable; B_6 and B_9 : coefficients of difference of lag independent variable; B_7 and B_{10} : speed of adjustment (necessity be negative and significant to

accurate model instability); W: world wheat prices; C: world crude oil prices; V_1 and V_2 : error correction terms; U_1 and U_2 : error terms; L= logarithm. Additionally, the ECM viability was checked by testing residual diagnostics tests.

2.2.3. Cointegration Tests: Testing Long-Run Association (ARDL Bounds Test)

1- Unit root test: [23;25] state the following equation to test the order of integration of the series under study, using the ADF test:

$$\Delta X_t = C_{t1} + B_{11}X_{t-1} + e_{t1} \quad (8)$$

$$\Delta X_t = C_{t2} + b_t + B_{12}X_{t-1} + e_{t2} \quad (9)$$

where B_{11} and B_{12} are ADF coefficients to be valued, b is the trend, C is the constant, e is error term, and t is the time selected. In testing the null hypothesis (H_0), X has a unit root against alternative hypothesis (H_1), X has a stationary. The series variables are stationary if the t -statistic of the ADF coefficient is greater than t -critical values.

2- The autoregressive distributed lag (ARDL bounds test): To test long-run association between the series, the ARDL model test was applied. The ARDL test is efficient for small observations of time series and used irrespective of the series order $I(0)$ and $I(1)$ but not $I(2)$. The following equations were used [24;29]:

$$\Delta X_t = C_1 + \sum_{t-1}^p a_1 \Delta Y_{t-1} + B_{13}X_{t-1} + B_{14}Y_{t-1} + E_1 \quad (10)$$

$$\Delta Y_t = C_2 + \sum_{t-1}^p a_2 \Delta X_{t-1} + B_{15}Y_{t-1} + B_{16}X_{t-1} + E_2 \quad (11)$$

where from Equations (10) and (11), a_1 , a_2 —coefficients of the difference of lag independent variables; B_{13} and B_{15} —coefficients of lag dependent variable; B_{14} and B_{16} —coefficients of lag independent variable, respectively; E_1 , E_2 —error terms.

ARDL tests were applied to assess the presence of long-run association among the series; with acceptance of null hypothesis, signifying no long-run association (null hypothesis: $B_{13} = B_{14} = 0$ against alternative hypothesis $B_{13} \neq B_{14} \neq 0$ in Equation (10). A comparable exam was used for the Y variable (dependent variable) (null hypothesis: $B_{15} = B_{16} = 0$ against alternative hypothesis $B_{15} \neq B_{16} \neq 0$ in Equation (11)).

The equations have lower and upper bound (two critical F-values) reflecting into justification the integrated order ($I(0)$ and $I(1)$) of the variables, respectively [29].

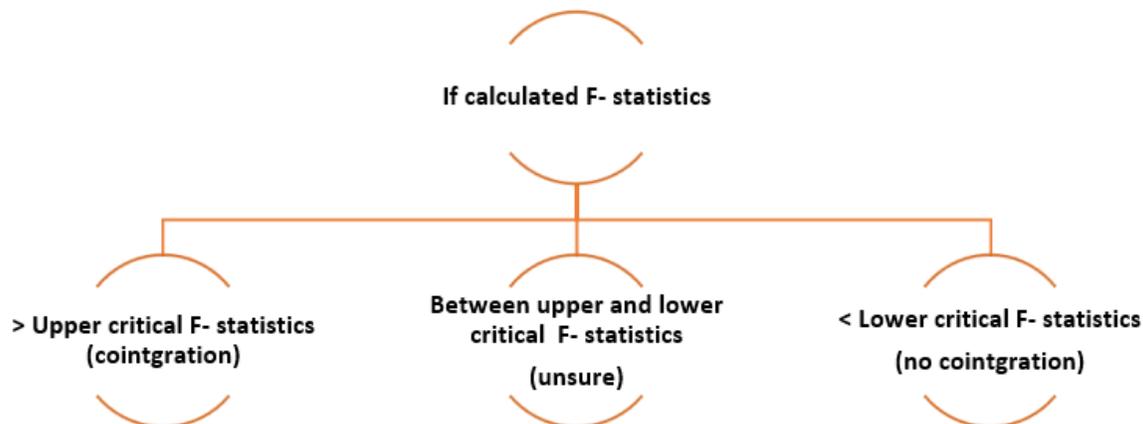


Figure 1.
Explanation scenario of bound test results.

Reference to the reported F- statistics values three explanation scenarios are accessible (Figure 1); If the F- statistic is smaller than the lower bound of the critical values, the null hypothesis is accepted

(cointegration), higher than the upper bound of the critical values, the null hypothesis is rejected (no cointegration), and inside between the upper and lower bounds then the test is unconfident around integration among the series.

The cumulative sum (CUSUM) and the recursive coefficients methods were applied to exam the steadiness of the ARDL models estimates [25]. The estimated coefficients are steady if the residual is located within the 5% critical boundaries, indicating a 5% level of significance in Equations (10) where world wheat prices is dependent variable. If the Equations (10) have lower and upper bound (two critical F-values), it confirms the integrated order (1(0) and 1(1) of the variables [29]. Also, the result of recursive coefficients method indicated to Equation (11), the stability of the ARDL models evaluations.

To support the results of ARDL statistics, dynamic ordinary least squares (DOLS) and fully modified ordinary least squares (FMOLS) models were applied [29]. The FMOLS and DOLS model outcomes provide accurate estimations of long-run links among the series. Also, these methods have capability to suitably disclose the serial correlation problematic befalling among a series and its lag.

3. Results

The study planned to assess the outbreak of COVID-19 on association between world crude oil prices and world wheat prices. Therefore, the study offered in three portions relates to the period: before COVID-19 from Jan. 2016 to Nov. 2019 after outbreak of COVID-19 from Dec. 2019 to Dec. 2020 and Jan. 2021 to Aug. 2023 (after recovering from outbreak of covid-19).

3.1. Co-Integration Test Analysis (Jan. 2016 To Nov. 2019)

3.1.1. Graphical Analysis

As pre-test for cointegration, Figure 2 appeared that there may be long-run relationship between world crude oil price and world wheat price. This result leads further to conduct cointegration analysis.

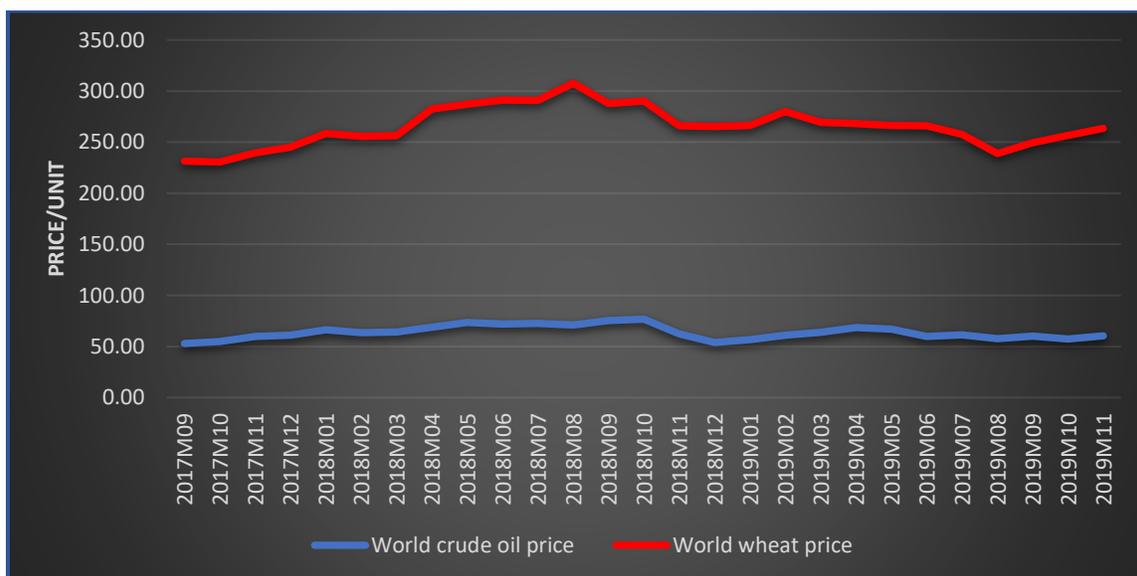


Figure 2. The trend lines of crude oil prices and wheat prices at global level (Jan. 2016 to Nov. 2019).

3.1.2. The Results of Unit Root Tests

The stationarity of world crude oil prices and world wheat prices series was estimated by unit root test (ADF). Table 2 presented that the series are stationary after achievement first difference 1(1), as the values of the ADF Statistics test were significant at 1% level. Since the two series had similar stationarity order 1(1), then Engle-Granger test was applied to exam the association between the two series.

Table 2.
Results of unit root test.

Time series	Intercept	Intercept and trend	Stationarity	Intercept	Intercept and trend	Stationarity
	at level			at first difference		
World wheat prices	-1.431	-2.417	Non stationary	-7.446*	-7.396*	Stationary
World crude oil prices	-3.196**	-2.574	Non stationary	-5.651*	-5.961*	Stationary

Note: * At 1% level of significance.

3.1.3. Results of Engle-Granger Test

The results of ADF test on the residuals (i_t and z_t in equations 3 and 4, respectively) offered in Table 3. ADF statistics are negative (-6.85 and -5.82) and statistically significant at 1% level. These results lead to accept the alternative hypothesis of integration, signifying that the series are cointegrated. This result matched with earlier study [16]. The study found that there is indication of long run association regarding rice prices and crude oil prices at world level before breakdown of COVID-19.

Table 3.
Cointegration test - Engle-granger test results-ADF residual.

	World crude oil prices	World wheat prices
World wheat prices**	-6.85*	
World crude oil prices**		-5.82*

Note: * and ** Indicate 1% level of significant and dependent variable, respectively.

3.1.4. Results of ECM

To forte the result of Engle-Granger test (long run association among world wheat prices and world crude oil prices), ECM was applied. To conduct ECM, lag selection should be specified. Table 4 indicates that lag 1 was selected. Table 5 illustrated results of ECM. The coefficient of adjustment parameter for crude oil prices (as dependent variable) showed negative sign (-0.235) and significant (critical t-value= -3.77), meaning that model able to correct its past time disequilibrium. Moreover, the coefficients of adjustment parameter for wheat prices (as dependent variable) were statistically insignificant, indicating that the model may be need more than one month to precise it's preceding time disequilibrium. To verify VECM adequacy, residual diagnostics pointers were used; Breusch-Pagan-Godfrey heteroscedasticity test, the serial correlation LM test, Breusch-Godfrey, and Jarque-Bera test. LM- statistics (lag 1) equal 6.50 with Prob.= 0.17, Chi-sq. equal 26.58 with Prob.=0.09 and Jarque-Bera test results records results statistics equals 4.67 with Prob. =0.323, respectively. These results of model adequacy led to accept null hypothesis no heteroskedasticity, no serial correlation of residuals and residual normal distribution, respectively.

Table 4.
Lag selection.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	131.2022	NA	1.10e-05	-5.742320	-5.662024	-5.712387
1	203.7355	135.3954*	5.23e-07*	-8.788242*	-8.547354*	-8.698442*

Note: Where * lag order selected by the criterion; logL—log lag variable; LR—sequential modified likelihood ratio (LR) test statistic (each test at 5% level); FPE—final prediction error; AIC—Akaike information criterion; SC—Schwarz information criterion; HQ—Hannan-Quinn information criterion; NA—not available.

3.2.2. Results of ARDL Tests

From Table 7, ARDL tests was directed for the price series, one is dependent and other is independent variable and via versa. To reveal the ARDL model adequacy, residual diagnostics were applied by Jarque-Bera, Serial Correlation LM Test Breusch-Godfrey and Breusch-Pagan- Godfrey Heteroskedasticity Test. Accordingly, the results appeared no serial correlation, no Heteroskedasticity and normal distribution of residual. Moreover, stability diagnostics were applied by means of A CUSUM test [31] and the recursive coefficients estimates (Imran, 2022) as showed in Figure 4 and 5, respectively. The results indicated that stability of the models.

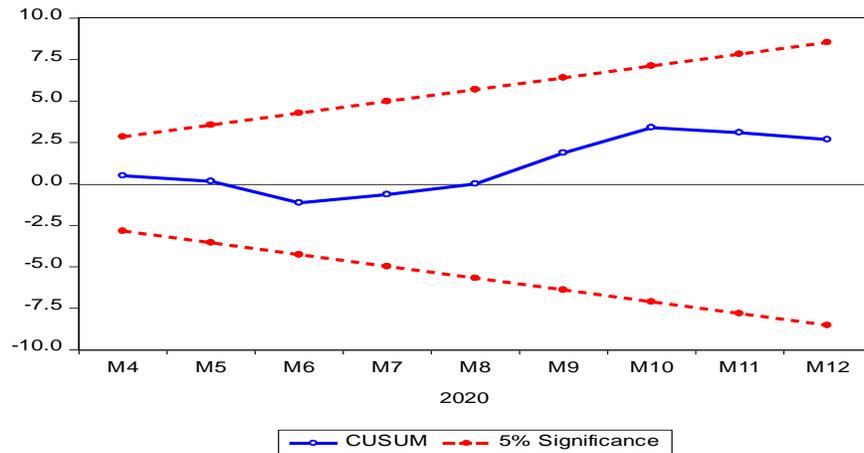


Figure 4.
Stability diagnostic (Wheat as dependent variable).

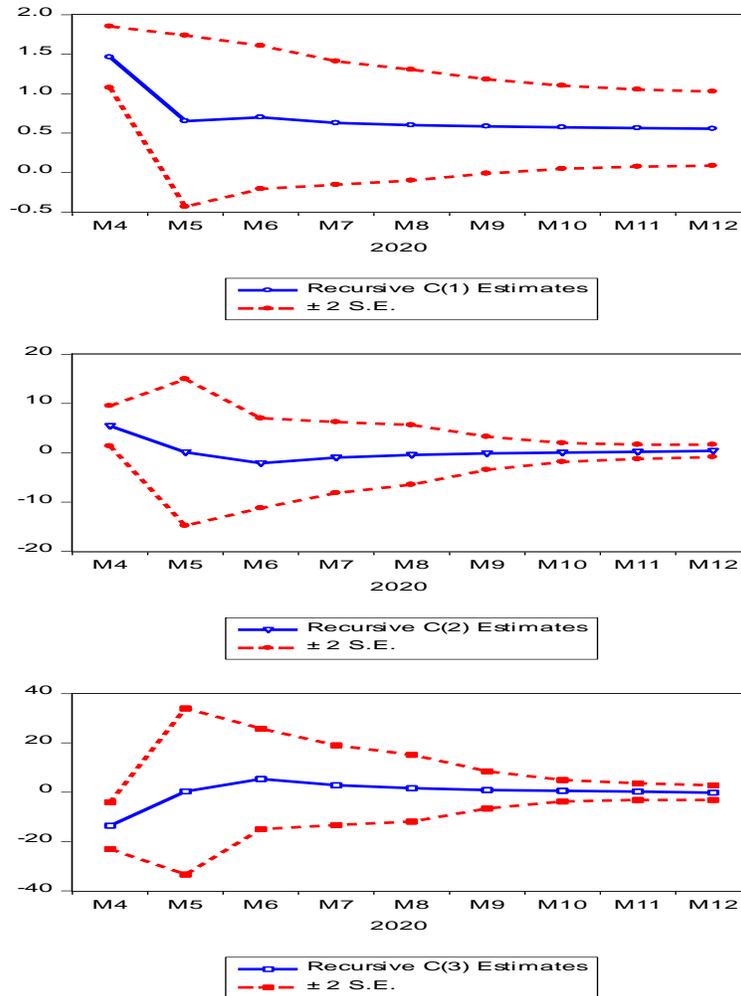


Figure 5. Stability diagnostic (Crude oil as dependent variable).

Moreover, stability diagnostics were applied by means of CUSUM test [31] and the recursive coefficients estimates [32] as shown in Figure 4 and 5., respectively. The tests indicated that stability of the models.

Table 7.
Results of ARDL tests.

Model 1		Model 2	
Wheat (Dependent variable)		Crude oil (Dependent variable)	
Selected ARDL model (1, 0)		Selected ARDL model (1, 0)	
Independent V.	Coefficient	Independent V.	Coefficient
World wheat prices (-1)	0.895 (0.002)	World crude oil prices (-1)	0.556 (0.042)
World crude oil prices	0.026 (0.737)	World wheat prices	0.373 (0.571)
C	0.215 (0.649)	C	-0.176 (0.908)
- R-squared	0.71	- R-squared	0.43
- Adj. R-squared	0.65	- Adj. R-squared	0.30
- F- statistics	11.046 Prob. 0.004	- F- statistics	3.359 Prob. 0.081
- Serial Correlation LM Test: Breusch-Godfrey 0.434 Prob. 0.66		- Serial Correlation LM Test: Breusch-Godfrey 1.354 Prob. 0.28	
- Breusch-Pagan- Godfrey Heteroskedasticity Test: 0.072 Prob. 0.93		- Breusch-Pagan- Godfrey Heteroskedasticity Test: 0.635 Prob. 0.55	
- Jarque-Bera: 0.101 Prob. 0.60		- Jarque-Bera: 3.654 Prob. 0.16	

Note: Figures between () are Probability.

The bound tests results for the two (1 and 2) ARDL models were documented (Table 8). Model 1, the bound examined F-test for the coefficients of wheat (one lag period) and crude oil (independents variables). Also, in model 2, the bound scan F-test for the coefficients of crude oil (one lag period) and wheat (independents variables). F- statistic are 0.618 and 1.373 for model 1 and 2, respectively, which are lesser than lower bound of the bounded critical F-statistic, signifying there are no evidence of long run association concerning world wheat prices and world crude oil prices throughout the period from Dec. 2019 to Dec 2020. These outcomes might be owed to the drawbacks of COVID- 19. This result coincided with previous study [16]. [16] found that there are no indication of long run association concerning global rice prices and crude oil prices after breakdown of COVID-19.

Table 8.
Results of bounds test: ARDL.

Dependent- independent	F- statistic of bound test		
World wheat prices – world oil prices	0.618		
World oil prices- world wheat prices	1.373		
-Significance:	1%	5%	10%
- Lower Bound:	4.94	3.62	3.02
- Upper Bound:	5.58	4.16	3.51

3.1.3. Long-Run Confirmation Results

The results of ARDL model contest with of FMO and DOL (Table 9). Long -run relationship didn't notice among world wheat prices and world crude oil prices during the period extending from Dec. 2019 to Dec.2020. Several former studies applied FMOLS and DOLS with to reinforce the outcomes of ARDL model [24,33,34].

Table 9.
Long-run results evidence.

Dependent-Independent	ARDL	FMOLS	DOLS
LW-LC	0.026 (0.74)	0.139 (0.47)	0.052 (0.76)
LC-LW	0.373 (0.57)	0.630 (0.50)	0.068 (0.96)

Note: LW-World wheat prices. LC- World crude oil prices; L = logarithm; ARDL—autoregressive distributed lag; FMOLS—fully modified ordinary least squares; DOLS—dynamic ordinary least square.

3.3. Co-Integration Test Analysis (Jan. 2021 To Aug. 2023)

3.3.1. Graphical Analysis

As pre-test for cointegration, Figure 3 appeared that there may be long-run relationship between world crude oil price and world wheat price. This result leads further to conduct cointegration analysis.

3.3.2. The Results of Unit Root Tests

The stationarity of world crude oil prices and world wheat prices series was estimated by unit root test (ADF) for the period from Jan. 2021 to Aug. 2023. Table 10 offered that the series are stationary after attainment first difference 1(1), as the values of the ADF Statistics test were significant at 1% level.

Table 10.
Results of unit root test.

Time series	Intercept	Intercept and trend	Stationarity	Intercept	Intercept and trend	Stationarity
	at level			at first difference		
World wheat prices	-1.775	-0.674	Non stationary	-3.936*	-4.235*	Stationary
World crude oil prices	-2.377	-1.877	Non stationary	-4.997*	-5.045*	Stationary

Note: * At 1% level of significance.

3.3.3. Results of Engle-Granger Test

The results of ADF test on the residuals (i_t and z_t in equations 3 and 4, respectively) offered in Table 11. ADF statistics are negative (-3.85 and 3.99) and statistically significant at 1% level. These results lead to accept the alternative hypothesis of integration, suggesting that the series are cointegrated. This result concluded that there is indication of long run association regarding wheat prices and crude oil prices at world level after relieve breakdown of COVID-19.

Table 11.
Cointegration test - Engle-granger test results-ADF residual.

	World crude oil prices	World wheat prices
World wheat prices**	-3.85*	
World crude oil prices**		-3.99*

Note: * and ** Indicate 1% level of significant and dependent variable, respectively.

3.3.4. Results of ECM

To forte the result of Engle-Granger test (long run association among world wheat prices and world crude oil prices), ECM was applied. To conduct ECM, lag selection should be specified. Table 12 indicates that lag 2 was selected. Table 13 illustrated results of ECM. The coefficients of adjustment parameter for wheat prices and crude oil prices (as dependent variable) were statistically insignificant, indicating that the model may be need more than one month to precise it's preceding time disequilibrium. To verify VECM adequacy, residual diagnostics pointers were used; Breusch-Pagan-Godfrey heteroscedasticity test, the serial correlation LM test, Breusch-Godfrey, and Jarque-Bera test. LM- statistics for lag 1 and 2 equal 0.83 with Prob.= 0.93 and 0.66 with Prob.= 0.96, respectively. Chi-sq. equals 26.74 with Prob.=0.64 and Jarque-Bera test results records results statistics equals 4.75 with Prob. =0.31, respectively. These outcomes of model fittingness led to accept null hypothesis no heteroskedasticity, no serial correlation of residuals and residual normal distribution, respectively.

Table 12.
Lag selection.

.	LogL	LR	FPE	AIC	SC	HQ
0	43.23250	NA	0.000219	-2.748833	-2.655420	-2.718949
1	75.41917	57.93602*	3.36e-05	-4.627945	-4.347706*	-4.538294
2	80.93070	9.185872	3.05e-05*	-4.728713*	-4.261647	-4.579295*

Note: Where * lag order selected by the criterion; logL—log lag variable; LR—sequential modified likelihood ratio (LR) test statistic (each test at 5% level); FPE—final prediction error; AIC—Akaike information criterion; SC—Schwarz information criterion; HQ—Hannan–Quinn information criterion; NA—not available.

Table 13.
Results of ECM.

Error correction	D(World wheat prices)	D (World crude oil prices)
CoIntEq1	0.277 [-2.02]	0.149 [-0.93]
D(Wheat (-1))	0.483 [-2.31]	0.070 [-0.29]
D(Wheat (-2))	-0.053 [-2.31]	0.525 [-1.90]
D(crude oil(-1))	-0.211 [-1.09]	-0.039 [-0.17]
D(crude oil(-2))	0.083 [-0.42]	-0.372 [-1.63]
C	0.003 [-0.26]	0.010 [-0.67]
ECM residual serial correlation LM tests: Lags 1 LM-Stat 0.83 Prob. 0.93		
Lags 2 LM-Stat 0.66 Prob. 0.96		
VEC Residual Heteroskedasticity Tests: Chi-sq 26.74 Prob. 0.64		
- Jarque-Bera: 04.75 Prob. 0.31		

Note: Figures between $[-]$ are critical t -values.

4. Conclusions

The study pointed to reveal the effect of COVID-19 on the connection between wheat and crude oil prices at global level. The data was collected from different various resources linked to study subject and roofed the period from Jan. 2016 to Aug. 2023. The data was separated in to three periods: earlier COVID- 19 from Jan. 2016 to Nov. 2019, after outbreak of COVID-19 from Dec. 2019 to Dec. 2020 and recovering from outbreak from Jan. 2021 to Aug. 2023. Engel-Granger Two Steps Procedure and ARDL bounds methods were applied as methods of analysis. The results for the period earlier outbreaks of COVID-19 discovered long run co-integration between world wheat prices and world crude oil prices series. In addition, it noted that the coefficient of adjustment parameter for wheat showed negative (-0.349) and significant (critical t -value= -3.29), concluding that the model gifted to accurate it's past time disequilibrium. While the result for the period after outbreaks of COVID-19 didn't notice long run association among wheat prices and crude oil prices. This outcome might be due to lockdown of COVID-19. Reference to the recovering period from outbreak, the results discovered long run co-integration between world wheat prices and world crude oil prices series. Also, it recorded that the coefficients of adjustment parameter for wheat and crude oil showed positive and insignificant, concluding that the model powerless to accurate it's past time disequilibrium. From the results, there are long run relationship between wheat and crude price at global level before and after recovering from outbreaks of COVID 19. While the result appeared no long run relationship between wheat and crude oil at worldwide level due to lockdown. Consequently, these result may direct affect world food security situation.

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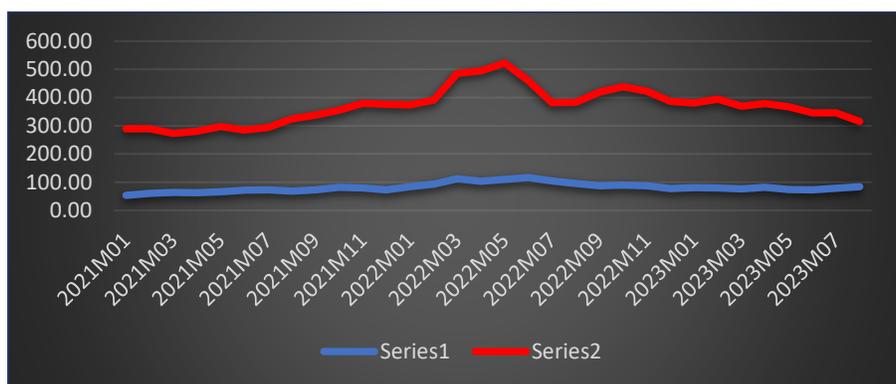


Figure 6. The trend lines of crude oil prices and wheat prices at global level (Jan. 2021 to Aug. 2023).