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RESEARCH ARTICLE

The Impacts of Covid-19: An Econometric Analysis of Crude Oil Prices and Rice Prices in the World

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ABSTRACT

This study targeted to disclose the impact of COVID-19 on the relationship among world crude oil prices and world rice prices. It depended on data collected from different resources and covered the period extend from Jan. 2016 to May 2020. The data was divided into two periods: before COVID-19 from Jan. 2016 to Nov. 2019 and after the outbreak of COVID-19 from Dec. 2019 to May 2020. Engel-Granger Two Steps Procedure and ARDL bounds methods of analysis were used to analyze data before and after outbreaks of COVID-19, respectively. The result for the period before outbreaks of covid-9 revealed long-run co-integration among crude oil and rice prices series. Also, it recorded that the coefficient of adjustment parameter for rice showed negative (-0.349) and significant (critical t-value= -3.29), referring to the present of short-run relationship and meaning that model able to correct its past time instability. 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 rice prices. This result may be due to the consequences and lockdown of COVID-19. Consequently, these results may put down world food security situations.

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Introduction

In December 2019, Coronavirus disease (COVID-19) appeared in China and rapidly extended to other countries in the world (Li et al., 2020). Accordingly, in March 2020 World Health Organization (WHO) confirmed it as a pestilence (Remuzzi and Remuzzi, 2020). Different countries wanted to search for stopping the spread of COVID-19, using controlling travel and personally profitable activities (Guan et al., 2020). COVID-19 is mainly positively scattering economic hurting worldwide (Baldwin and Mauro, 2020). Following the announcement of COVID-19 infection, several big Japanese companies structured their workers to work from house in late February, later this practice is scattering speedily in other countries. Economically, this shuts and travel forbids decrease output straight in a manner that corresponding to short-term falls in employment (Baldwin and di Mauro, 2020). Numerous Southeast Asian exporting countries recently declared export restrictions to safeguard sufficient foods for local market (San Juan, 2020). This situation will inspire fear purchasing between importing countries. World fear purchasing together with export controls will merely end to increase commodity prices (Pascua, 2020).

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Several economists are starting to think about these outcomes. (Müller, 2020) wrote about a quantity of perspective in different areas of the economy.

(Maliszewska et al., 2020) suggested the prospective shock of COVID-19 on trade and Gross Domestic Product. Standard global computable general equilibrium model was used as method of analysis. It represents the shock as a demand (in case of remoteness among individual), underemployment of labor and capital, a fall in travel services and an increase in international trade costs. Gross domestic product decreases by 2%, 2.5% and 1.8% below the benchmark for the world, developing countries and industrial countries, respectively.

Other study examined the impact of the COVID-19 outbreaks and the crude oil disagreement among Kingdom of Saudi Arabia and Russia (Bildirici et al., 2020). The study appeared that crude oil prices have revealed remarkable and unexpected alteration.

Another study examined the impacts of world prices of rice and crude oil on inflation rate in Indonesia (Adam et al., 2016). Econometric methods of analysis were used. World rice prices and world oil crude prices affected positively dynamically Indonesia's inflation rate. Based on(Adam et al., 2018) directed to test the causal connection among rice price, exchange rate and crude oil price, covering period from Jan. 2000 to Sep. 2017. Data was analyzed by Vector autoregressive model. The result didn't show any long run connection among the series.

Almost semi of the residents in the world depends on rice (*Oryza sativa* L.) in their food and considers as staple food (Ansari et al., 2015). Economically, crude oil is considered as a vital product in world trade. It is essentially required for transportation, electric energy and production. Moreover, crude oil is considered as inputs in the field of agricultural production. It is utilized by way of transportation (Adam, 2016; Rafiq et al., 2009). Therefore, there is direct association among crude oil price and agriculture products prices, together with rice (Baumeister and Kilian, 2014; Adam et al., 2016; Sugden 2009).

This study enriches previous studies disclosure the impacts of COVID-19 on world economic, especially on the relation between world commodities prices. The study aimed to explore the effect of COVID-19 on the relationship between world crude oil prices and world rice prices. Reference to previous studies (effects of COVID-19 on economic), the significant of this study are: the nature of selected series (crude oil and rice) and their impacts on food security, besides, it analyzed data by an econometric analysis method.

Materials and Methods

Data Description

To highlight on the association among rice prices and the crude oil prices in the world, data of such series were collected for period extended from Jan. 2016 to May 2020 and analyzed using EVIEWS 9 program. Table 1 summarized information about the series.

Table 1. Variables description

Variable	Unit	Sources
- World crude oil average prices	(\$ bbl^{-1})	https://www.worldbank.org/en/research/ commodity-markets
- World Rice average prices	Rice, Thai 5% (\$ mt^{-1})	

Analysis Methods

The study designed to disclose the effect of COVID-19 on the relationship among world rice prices and world crude oil prices. The data was divided into two periods: Jan. 2016 to Nov. 2019 (before outbreak of covid-19) and Dec. 2019 to May 2020 (after outbreak of covid-19).

Engle-Granger test

Reference to the cointegration procedure, the following steps need to be carried out on the series under study (Emam and Hassan, 2002):

Unit root test

Unit root test is applied to examine the order of integration of the series. Numerous methods (among them is ADF test) can be utilized to inspect the existence of unit roots. The following regression equations are used by ADF test:

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

$$\Delta X_t = C_{t2} + \beta_t + ZX_{t-1} + e_{t2} \quad (2)$$

Where, b and z are ADF coefficients to be estimated, t is the time selected, C is the constant and B is the trend. Testing H_0: *X* has a unit root Against H_1: *X* has a stationary

If the t- Statistic of ADF coefficient larger than t- critical values, the series are stationary.

Engle-Granger two steps procedure

If the two series to be examined are both integrated (same order of integration), the next stage is to investigate whether they are cointegrated with each other, and this is done by using Engle- Granger Two Steps Procedure on the two series jointly. The two steps entail running Ordinary Least Square (OLS) regression as follows:

1- The first regression equation is

$$X_t = a_1 + B_1 Y_t + i_t \quad (3)$$

The equation simply calculates B_1 as the slope coefficient estimate (equation 3). It can also be done by calculating B_2 as the coefficient from equation 4 as follows:

$$Y_t = a_2 + B_2 X_t + z_t \quad (4)$$

2- An ADF test is run on the residuals (i_t and z_t) to investigate whether the series are integrated. If the ADF statistics, resulting from the second equation, are large and negative than the critical t- value (of order 1), then it is likely that the coefficient B_1 and B_2 exit and the series are cointegrated.

Cointegration Regression Durbin-Watson (CRDW) statistic represents another method for testing cointegration. If the results of the ADF and Engle- Granger Two Steps Procedure tests prove that each series is 1(1) and that the linear combination of them is 1(1), then the two series taken together are said to be cointegrated of order1, 1.

Error correction model (ECM)

If co integration test appears long-run association among the series, the ECM test can be used to evaluate the speed parameter of the short-run association between the series (Venujayakanth et al., 2017). The following is ECM equations:

$$\Delta(crude\ oil) = \Delta\ crude\ oil_{-1} + \Delta b_1 rice_{-1} + b_2\, U_{t-1} + V \quad (5)$$

$$\Delta(rice) = \Delta\ rice_{-1} + \Delta b_3 crude\ oil_{-1} + b_4 U_{t-1} + V \quad (6)$$

Where, b_4 represents the speed of adjustment and must be significant and negative to correct model disequilibrium. ECM viability was fixed by testing residual diagnostics tests. The tests were applied as follows:

Heteroskedasticity Test: Breusch-Pagan-Godfrey: In this test the null hypothesis: homoscedasticity and alternative hypothesis: heteroscedasticity. Accept of null hypothesis when P- value is more than 0.05 meaning that residual is homoscedasticity.

Residual Normality test: when Probability of Jarque- Bera statistic more than 0.05, then residual is normally distributed.

ARDL bounds test

ARDL model test is considered superior to other relevant tests; simple to run using OLS, regardless to the series order (I (0) or I (1) but not I (2)) and efficient for small sample. ARDL or bound test is used to estimate the long run association in addition to the short run dynamic relations between the series. The followings equations are used in this method (Pesaran, Shin et al. 2001):

$$\Delta Y_t = C_1 + \sum_{t-1}^{p} B_1\ \Delta X_{t-1} + a_1 Y_{t-1} + a_2 X_{t-1} + e_1 \quad (7)$$

$$\Delta X_t = C_2 + \sum_{t-1}^{p} B_2\ \Delta Y_{t-1} + a_3 X_{t-1} + a_4 Y_{t-1} + e_2 \quad (8)$$

ARDL tests the presence of long run connection between the series in the method wherever acceptance of null hypnosis meaning no long run relationship. H_1: $a_1 \neq a_2 = 0$ (equation 7) against alternative hypothesis $a_1 \neq a_2 \neq 0$. Also, the same test run for X variable as independent variable null hypnosis $a_3 = a_4 = 0$ (equation 8) against alternative hypothesis $a_3 \neq a_4 \neq 0$.

Each equation has lower and upper bound (two critical F-values) taking into account the integrated order (1(0) and 1(1) of the variables, respectively (Pesaran et al., 2001).

According to the calculated F- statistics values three interpretation scenarios were available (Figure 1). If the F-statistic is: lesser than the lower bound of the critical values null hypothesis is accepted (cointegration), larger than the upper bound of the critical values, the null hypothesis is rejected (no cointegration), and inside the upper and lower bounds then the test is unsure about integration between the series.

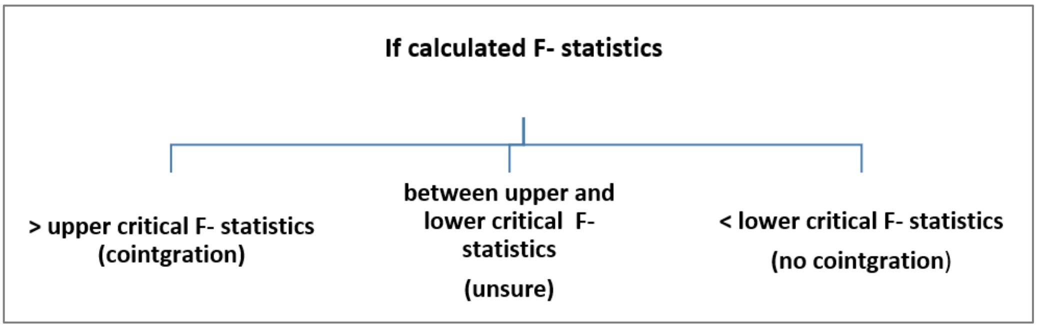

Figure 1. Interpretation scenario of bound test results. Source: Designed by Author.

Results and Discussion

The study designed to appraise the outbreak of COVID-19 on relationship among world rice prices and world crude oil prices. Accordingly, the results presented in two parts: first part concerns the period before COVID- 19 from Jan. 2016 to Nov. 2019 and the second one represents the period after outbreak of COVID-19 from Dec. 2019 to May 2020.

Co-Integration Test Analysis (Jan. 2016 to Oct. 2019)

The results of unit root tests

Using unit root test (ADF), stationarity of crude oil prices and rice prices series in the world was evaluated. Table 2 showed that all series are stationary after performing first difference 1(1), as the values of the ADF Statistics test were significant at 1% level. Since the two series had same stationarity order 1(1), then Engle- Granger test was used to test or to assess the relationship 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 crude oil prices	-2.472	-1.841	Nonstationary	-5.579*	-5.824*	Stationary
World Rice prices	-2.523	-3.635	Nonstationary	-5.194*	-5.130*	Stationary

Source: Author calculations based on collected data.
* At 1% level of significance.

Results of Engle-Granger test

The results of ADF test on the residuals (i_t and z_t in equations 3 and 4, respectively) presented in Table 3. ADF statistics are negative (-3.56 and-2.21) and statistically significant at 1% and 5% level. These results lead to accept the alternative hypothesis of integration, indicating the two prices series.

Table 3. Cointegration Test - Engle-Granger test results-ADF residual

	World rice prices	World crude oil prices
World crude oil prices	-2.21**	
World rice prices		-3.56*

Source: Author calculations based on collected data.
* And ** indicate 1% 5% level of significant, respectively.

Results of ECM

To strength the result of Engle-Granger test (long run association among crude oil prices and rice prices in the world), ECM was applied. Table 4 illustrated results of ECM. The coefficient of adjustment parameter for rice showed negative sign (-0.349) and significant (critical t-value= -3.29), meaning that model able to correct its past time disequilibrium. Also, the results convey that the coefficients of adjustment parameter for crude oil (as dependent variable) was statistically insignificant; concluding that the model may be need more than one month to accurate it is preceding time imbalance. In order to verify VECM adequacy, serial correlation of residuals LM and residual heteroskedasticity tests were tested. LM- statistics (lag 1) equal 1.37 with Prob.=0.85and Chi-sq. equal 23.89 with Prob.=0.16, respectively. These results of model adequacy lead to accept null hypothesis no serial correlation of residuals and no heteroskedasticity.

Table 4. Results of ECM

Error Correction	D (Rice)	D (Crude oil)
CointEq1	-0.349 [-3.29]	0.024 [0.68]
D (Rice (-1))	0.409 [2.78]	-0.015 [-0.31]
D (crude oil (-1))	-0.099 [-0.21]	0.152 [0.96]
C	0.510 [0.26]	0.5130 [0.77]
ECM residual serial correlation LM tests:		
Lags	LM-Stat	Prob.
1	1.37	0.85
VEC Residual Heteroskedasticity Tests:		
	Chi-sq	Prob.
	23.89	0.16

Source: Author calculations based on collected data.
Figures between [ ] are critical t-values.

Co-Integration Test Analysis (Nov. 2019 to May 2020)

The unit root tests results

Unit root test results (ADF) recorded that world crude oil and world rice price series are stationary at level 1(0) and after performing first difference 1(1), respectively (Table 5). Consequently, the two series hadn't same stationarity order (1(0) and 1(1)), accordingly, ARDL Bounds Test was chosen to evaluate the relationship between two series.

Table 5. Results of unit root Test (ADF)

Time series	Intercept	Intercept and trend	Stationarity	Intercept	Intercept and trend	Stationarity
	at level			at first difference		
World crude oil prices	-3.587**	-3.926***	1(0)	-	-	-
World rice prices	-0.954	-2.586	Nonstationary	-2.665	-28.025*	1(1)

Source: Author calculations based on collected data.
*, ** and *** at 1%, 5% and 10% level of significance, respectively.

Results of ARDL tests

ARDL tests was conducted for the price's series, one is dependent and other is independent variable and via versa (Table 6). To disclose the ARDL model adequacy residual diagnostics were run using Breusch-Pagan- Godfrey Heteroskedasticity Test, Jarque-Bera and Serial Correlation LM Test Breusch-Godfrey, Accordingly, the results appeared no serial correlation, no Heteroskedasticity and normal distribution of residual. Also, stability diagnostics was run using A CUSUM test (Zhai et al. 2013). The test appeared the steadiness of the cumulative sum of the recursive residuals, concluding that stability of the model (Figure 2&3).

Table 6. Results of ARDL tests

Model 1			Model 2		
Rice (dependent variable) Selected ARDL model (1, 0)			Crude oil (dependent variable) Selected ARDL model (1, 0)		
Independent V.	Coefficient		Independent V.	Coefficient	
World rice prices (-1)	-0.009 (0.97)		World crude oil prices (-1)	0.184 (0.50)	
World crude oil prices	-2.763 (0.01)		World rice prices	-0.283 (0.03)	
C	606.214 (0.009)		C	171.276 (0.02)	
- R-squared	0.91		- R-squared	0.92	
- Adj. R-squared	0.86		- Adj. R-squared	0.88	
- F- statistics	19.37	Prob. 0.009	- F- statistics	22.23	Prob. 0.007
- Serial Correlation LM Test: Breusch-Godfrey 1.800	Prob. 0.18		- Serial Correlation LM Test: Breusch-Godfrey 0.097	Prob. 0.76	
- Breusch-Pagan Godfrey Heteroskedasticity Test: 3.480	Prob. 0.18		- Breusch-Pagan Godfrey Heteroskedasticity Test: 2.449	Prob. 0.29	
- Jarque-Bera: 0.633	Prob. 0.73		- Jarque-Bera: 0.412	Prob. 0.81	

Source: Author calculations based on collected data.
Figures between ( ) are Probability.

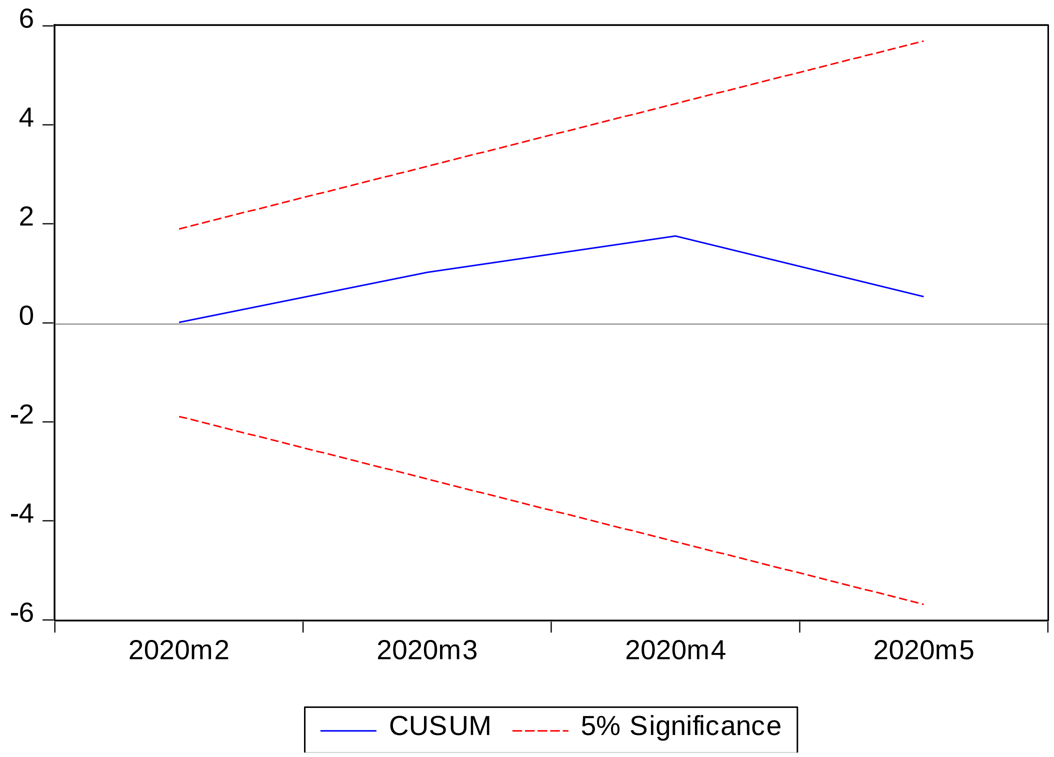

Figure 2. Stability diagnostic (world rice prices as dependent variable). Source: Author calculations based on collected data.

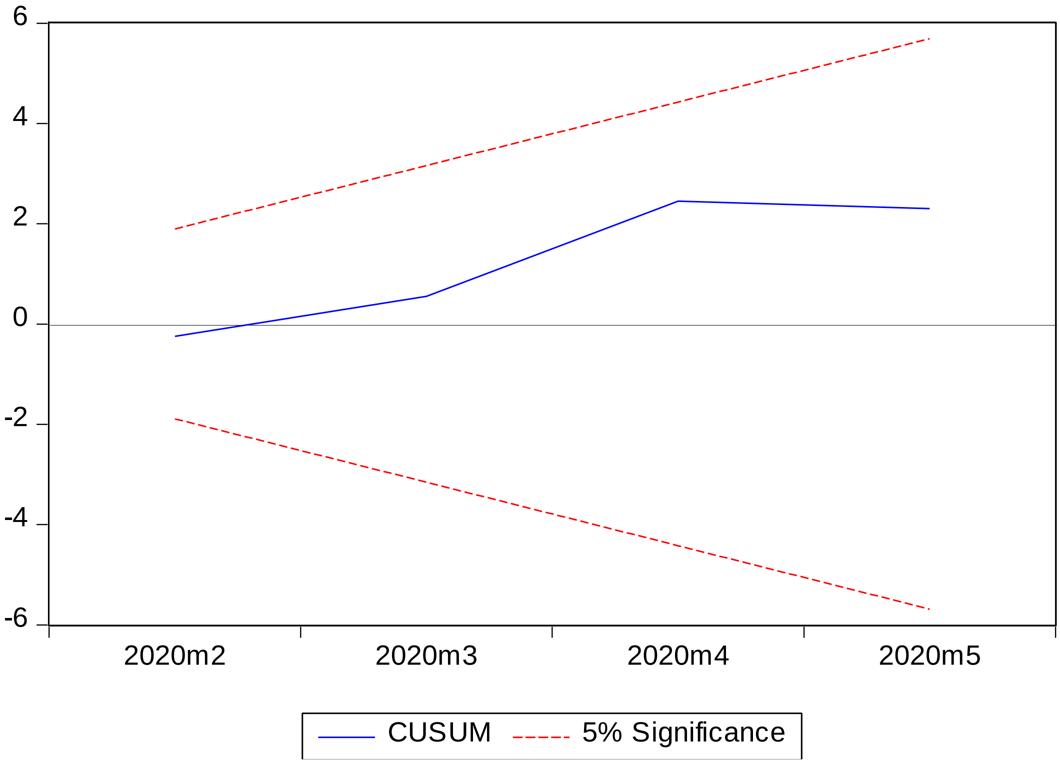

Figure 3. Stability diagnostic (world crude oil prices as dependent variable). Source: Author calculations based on collected data.

Table 7 recorded the bound tests results for the two (1 and 2) ARDL models. Model 1, the bound examined F-test for the coefficients of rice (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 rice (independents variables). F- statistic are 1.311 and 0.129 for model 1 and 2, respectively, which are lesser than lower bound of the bounded critical F-statistic, indicating there are no proof of long run relationship between world rice prices and world crude oil prices during the period from Nov. 2019 to May 2020. These results may be due to the consequences of COVID-19.

Table 7. Results of Bounds Test: ARDL

Dependent- independent		**F- statistic of bound test**	
World rice prices-world oil prices		1.311	
World oil prices-world rice prices		0.129	
-Significance:	1%	5%	10%
- Lower Bound:	4.94	3.62	3.02
- Upper Bound:	5.58	4.16	3.51

Source: Author calculations based on collected data.

Conclusion

The study aimed to disclose the influence of COVID-19 on the relationship among world crude oil and world rice prices. It depended on data collected from different resources related to study subject and covered the period extend from Jan. 2016 to May 2020. The data was divided in to two periods: before COVID- 19 from Jan. 2016 to Nov. 2019 and after outbreak of COVID-19 from Dec. 2019 to May 2020. Engel-Granger Two Steps Procedure and ARDL bounds methods of analysis were used for the period before and after outbreaks of COVID-19, respectively. The result for the period before outbreaks of COVID-19 revealed long run co-integration among crude oil and rice prices series. Accordingly, it recorded that the coefficient of adjustment parameter for rice showed negative (-0.349) and significant (critical t-value= -3.29), indicating that the model able to correct its past time disequilibrium. While the result for the period after outbreaks of COVID-19 didn't discover long run relationship between crude oil and rice. This result may be reflecting to lockdown of COVID-19. Accordingly, these results may lay down world food in insecurity position.

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