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DETERMINANT OF RICE PRICE IN INDONESIA: A FOURIER ENGLE-GRANGER COINTEGRATION TEST

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ABSTRACT

The issue of food prices is a critical topic that need to be discussed. Food prices has implications on economic and society. In Indonesia, rice is the most widely comsumed staple. Unfortunately, the prices of rice are often unstable due various factors. This research investigates the relationship between exchange rate, money supply, and volatility of oil prices on rice prices in Indonesia.The research study used data from the period February 2008 to December 2022 based on data availability. All research data used are secondary data with time series type. Rice price data is sourced from the Food and Agriculture Organization (FAO), exchange rates and oil prices are sourced from the Federal Reserve Economic Data (FRED), and money supply is sourced from the Indonesia Economic and Financial Statistics (SEKI). This study uses the Fourier Engle-Granger (FEG) cointegration method as a novelty in looking at cointegration that has structural breaks and the FMOLS, DOLS, and CCR methods as analysis. The results found that the research variables were found to have cointegration in the rice price model. Furthermore, the exchange rate was found to have a significant negative effect (-0.454%, -0.420%, -0.456%) on rice prices. The money supply had a significant positive effect (0.640%, 0.627%, 0.639%), and the volatility of oil prices had a significant positive effect (0.024%, 0.031%, 0.026%) on rice prices. The results of this research have important policy implications for policymakers to control money circulation, maintain exchange rate stability, and use renewable energy alternatives.

Keywords: *exchange rate, fourier cointegration, money supply, rice price, volatility of oil prices*

BACKGROUND

Food prices have become a significant concern for policymakers and researchers across the country. It is essential to keep food prices stable without disrupting the macroeconomy. However, this is not always possible due to the dynamic changes in demand and supply, resulting in both scarcity and excess production (Lindawati et al., 2022). Indonesia is known as an agricultural country, with the majority of its population working in this sector (Rivai, 2022). It is also the largest producer of agricultural commodities. According to the Indonesian Central Statistics Agency, the agricultural sector contributed 13.05% to economic growth in Q2 of 2022. In Q2 of 2023, it is expected to contribute 13.35%, indicating a continued growth and contribution to the Indonesian economy.

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Rice is one of the primary commodities produced by the agriculture sector in Indonesia. It is the most widely consumed staple food by the Indonesian people and also a significant export commodity to neighboring regions like ASEAN. However, the price of rice often experiences periodic changes. Figure 1 illustrates the development of rice prices in Indonesia from 2008 to 2022. It can be observed that the cost of rice has been increasing significantly over the years. In February 2008, the price of rice was Rp 6,375, and by February 2012, it had risen to Rp 10,439, indicating a 38% increase in just four years and two months. During the COVID-19 pandemic, the price of rice rose to around Rp 14,000. This was due to the halt in people's activities, including the reduction of production activities by the producers (Hamulczuk & Skrzypczyk, 2022). Additionally, uncertain climate changes have caused unstable movements (Özdurak, 2016; Putra et al., 2021). If not resolved, price fluctuations will be a significant problem (Mgale et al., 2022).

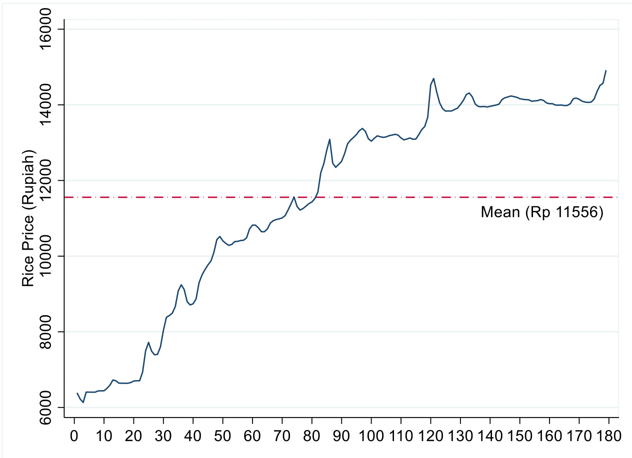

Figure 1. Rice price data in Indonesia for the period February 2008 to December 2022
Source: Food and Agriculture Organization (FAO)

Developing a strategy to control rice price increases is crucial and requires immediate attention. Research indicates that high food prices are influenced by factors such as exchange rates, money supply, and oil prices. The exchange rate plays a pivotal role in shaping import and export policies. When domestic production is high and the currency depreciates, exports tend to rise. Conversely, when the currency appreciates, imports increase. However, exchange rates are often volatile, leading to fluctuating costs (Köse & Ünal, 2024). Additionally, the money supply indicates people's purchasing power. As the money supply grows, so does consumer demand for rice, driving up prices (Adjemian et al., 2024). Oil prices are also a key factor, as energy is essential for modern agricultural activities, including operating machinery, irrigation, and transportation (Darwez et al., 2023). Global oil prices are unpredictable and unstable; when they rise, so do production costs. Frequent fluctuations in oil prices often lead producers to set higher prices to cover costs (Moussa et al., 2024).

Previous studies regarding the three factors on food prices has been carried out using various methods. Studies in Nigeria found exchange rate factors using the NARDL method (Umar & Umar, 2022), money supply using the GARCH method (Fasanya & Olawepo, 2018), and oil prices having an impact on several agricultural commodities based on the VECM method (Nkowo et al., 2016). Furthermore, in Pakistan it was found that the exchange rate and money supply factors had an influence on food prices from the VECM method (Awan, & Imran, 2015) and Sarwar et al. (2020)

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found that oil prices have an asymmetric effect (NARDL) on food and non-food prices. Meanwhile in Saudi Arabia by Darwez et al. (2023) reveal that oil price volatility has a strong positive effect on food prices. The study was carried out using the NARDL approach. Taghizadeh-Hesary et al. (2019) found something similar with the Panel VAR approach in eight Asian economies. His latest research using a machine learning algorithm method found that a 28% increase in food prices stemmed from oil price volatility. In Türkiye, İnal et al. (2023) found that the exchange rate has a significant effect on food prices based on the FMOLS and DOLS methods.

Furthermore, studies on food prices, specifically rice prices in Indonesia, have been conducted by Ismaya & Anugrah (2018) using the GMM method. Their research concluded that a tight money supply and rising oil prices significantly (positively) impact food prices. Similarly, Hermawan et al. (2017) found that the exchange rate significantly affects rice prices using a multiple linear regression approach. These studies confirm that the exchange rate, money supply, and oil price volatility are strongly related to food prices. In Indonesia's case, the fluctuations in these factors are substantial, as illustrated in Figure 2.

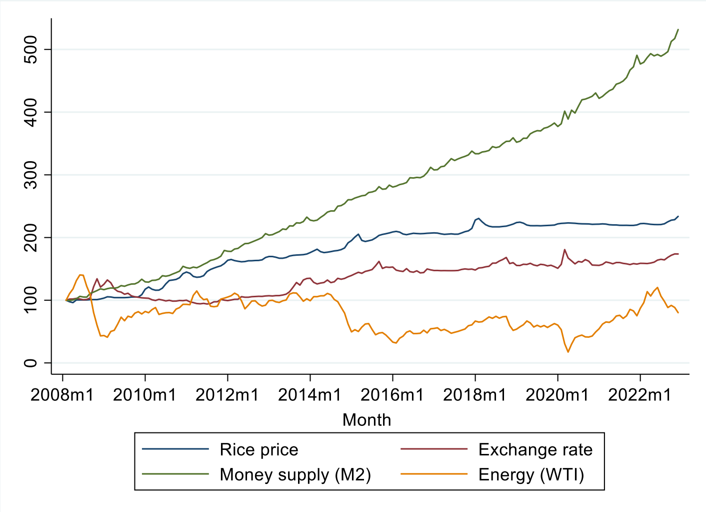

Figure 2. Development of Data on Index of Rice Prices, Exchange Rates, Money Supply, and Oil Prices (February 2028=100)

This research contributes in several ways. First, the study fills the gap in literature on the study of food commodities, especially rice prices with indicators of exchange rates, money supply and oil price volatility in Indonesia. These indicators are still analyzed separately. Second, this study analyzes in more depth using the latest cointegration method, namely Fourier Engle-Granger (FEG) and analysis methods from FMOLS, DOLS, and CCR. This method has the advantage of being able to analyze long and fluctuating data. Data will generally move in a trend, but data can also respond quickly to an event. These include policies, oil crises, pandemics, and even war. This factor has rarely been studied by previous researchers. As a result, the analysis results lead to bias, especially in long-term analysis. Meanwhile, the method has the advantage of having a reliable estimator when there are issues of endogeneity and serial correlation. Third, the issue of rice prices is still rarely researched in Indonesia. Thus, it is hoped that this study will obtain more precise results in terms of methods and analysis. The formulation of the research problem is whether the research variables have cointegration in the long term? How do these variables relate to the price of rice in Indonesia?

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RESEARCH METHODS

This research aims to examine the determinants that influence rice prices in Indonesia from the period February 2028 to December 2022. This sample was selected based on data availability. We used selected variables according to their significant influence on food prices. The variables studied are the exchange rate, money supply, and volatility of oil prices. The forms of research models include the following:

$$Rice_t = f(Exr_t, M2_t, VOP_t)$$

Where Rice shows the average national rice commodity price measured in Rp/Kg, Exr is the Rp exchange rate against the dollar, M2 is the money supply measured in billion rupiah, and VOP is the volatility of world crude oil prices based on West Texas Intermediate (WTI) which is measured in dollars per barrel. Volatility is extracted using the GARCH method. t is the time from February 2008 to December 2022. Rice price data is taken from the Food and Agriculture Organization (FAO), exchange rates and volatility of oil prices data are sourced from the Federal Reserve Economic Data (FRED), and money supply data is taken from the Indonesian Economic and Financial Statistics (SEKI). Table 1 presents the data sources and definition for this study. We transformed research data in the form of natural logarithms to reduce statistic problems such normality, heteroscedasticity and multicollinearity (Fachrurrozi et al., 2021; Zhou et al., 2021; Ikhsan et al., 2022; Fachrurrozi et al., 2022) and simplify interpret the estimation results (Raheem & Ogebe, 2017; Mahmood et al., 2019).

In order to answer the first research objectives, we used a Fourier Eagle-Granger (FEG) cointegration method by Yilanci (2019). Conventional cointegration uses the null hypothesis that there is no relationship only between variables without being influenced by other factors such as technological changes, economic crises, oil price shocks, and political changes. This phenomenon is commonly known as a structural break. Currently, most data movements are affected by this problem. If this element is overlooked, the resulting analysis can be misleading (Ike et al., 2020). The problem of structural breaks also applies to cointegration. According to Gregory & Hansen (1996), if long-term cointegration has structural breaks, the strength of the cointegration test becomes weakened, as in Eagle-Granger cointegration (1987). This shows that conventional cointegration may have potential bias. Although conventional cointegration is expected to occur, if there is a structural break then cointegration is not identified (Faisal et al., 2019). Consequently, long-term analysis cannot be carried out. Currently there are several cointegration tests which include structural elements of breaks such as Gregory & Hansen (1996) with 1 break and Hatemi-J (2008) with 2 breaks. Both methods capture the structural break problem with a dummy variable approach and assume that the break time is unknown. However, almost all previous studies conducted tests for unknown structural breaks using the Zivot & Andrew (1992) approach.

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Table 1. Data Sources and Measurement

Variables	Abrreviation	Definition	Source	Expect Sign
Rice price	Rice	National average retail rice price in Rp/Kg	FAO	
Exchange rate	Exr	National currency (Rp) to US Dollar spot exchange rate for Indonesia	FRED	+/-
Money supply	M2	Broad money in billion Rupiah	SEKI	+
Volatility of oil prices	VOP	Spot crude oil price WTI in USD/barrel	FRED, Extracted using GARCH	+

The stationarity testing literature has been deepened to detect elements of structural breaks in a model. Becker et al. (2006) introduced in depth the stationary testing of models with unknown structure breaks. Previous literature explains that the gap problem can be done using Perron's (1989) approach, namely including dummy elements. In addition to Becker et al. (2006), there are Fourier stationarity tests such as Enders & Lee (2012) and Rodrigues & Taylor (2012). Based on this understanding, this research uses fourier-based Engle-Granger cointegration analysis by Yilanci (2019). The aim is to find cointegration of data that has unknown structural breaks. This method has the following advantages, First, it captures structural breaks in the data so that it is useful in economics. Second, it can accurately present non-linear relationships between variables. Third, it is more robustness when there is data complexity. However, this cointegration method is very complex and requires computational burden because the fourier optimal selection will be more than conventional methods. The form of cointegration regression is as follows:

$$y_{it} = d(t) + \beta' x_t + u_t$$

Where $t = 1,2, \ldots, T$. y_{it} is an independent variable in scalar, and x_t is a vector $(m\ x\ 1)$ of independent variables. $d(t)$ is a deterministic function on *t* which is used as a Fourier expansion with a single-frequency component. The form $d(t)$ is as follows:

$$d(t) = \alpha_0 + \gamma_k sin\left(\frac{2\pi kt}{T}\right) + \delta_k cos\left(\frac{2\pi kt}{T}\right)$$

Where α_0 adalah constant, T indicates the number of observations, and k represents the Fourier Frequency. From equations (1) and (2) it can be substituted into equation (3) as follows:

$$y_{it} = \alpha_0 + \gamma_k sin\left(\frac{2\pi kt}{T}\right) + \delta_k cos\left(\frac{2\pi kt}{T}\right) + \beta' x_t + u_t$$

To test the null hypothesis of cointegration, the researcher used the same stationary as Yilanci (2023) procedure, namely Augmented Dickey Fuller (ADF) on the residual. The form of autoregression estimation is as follows:

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$$\Delta\hat{u}_t = \rho\hat{u}_{t-1} + \sum_{i=1}^{p} \theta_i \hat{u}_{t-i} + e_t$$

Where $e_t \sim i.i.d(0, \sigma^2)$, while computing the t-statistic for the stationarity test (equation (5)) is used to see the null hypothesis (no cointegration). The notation $\hat{\rho}$ is an Ordinary Least Square (OLS) estimator and $se(\hat{\rho})$ is the standard error of $\hat{\rho}$. The decision to reject the null hypothesis if it is below the significance level α.

$$\tau_{FEG} = \frac{\hat{\rho}}{se(\hat{\rho})}$$

Cointegration is a statistical technique that helps estimate long-term relationships between variables. For second research objective, the Full Modified OLS (FMOLS), Dynamic OLS (DOLS), and Canonical Cointegrating Regressions (CCR) methods are commonly used for this purpose. The FMOLS method is an estimator for estimating the long term. This method has quite good efficiency compared to the OLS method (Hdom & Fuinhas, 2020). The DOLS method is an estimator that includes lag and lead elements so that the level of efficiency estimation is better (Ibrahiem & Hanafy, 2020). Meanwhile, CCR is an efficient asymptotic estimator where the residuals are free from autocorrelation problems (Raihan & Tuspekova, 2022). Even though all three have different methods, they all have the same advantages, namely this method avoids endogeneity and serial correlation problems, and produces unbiased long-term estimates (Waheed et al., 2018). The systematics of the research process is shown in Figure 3.

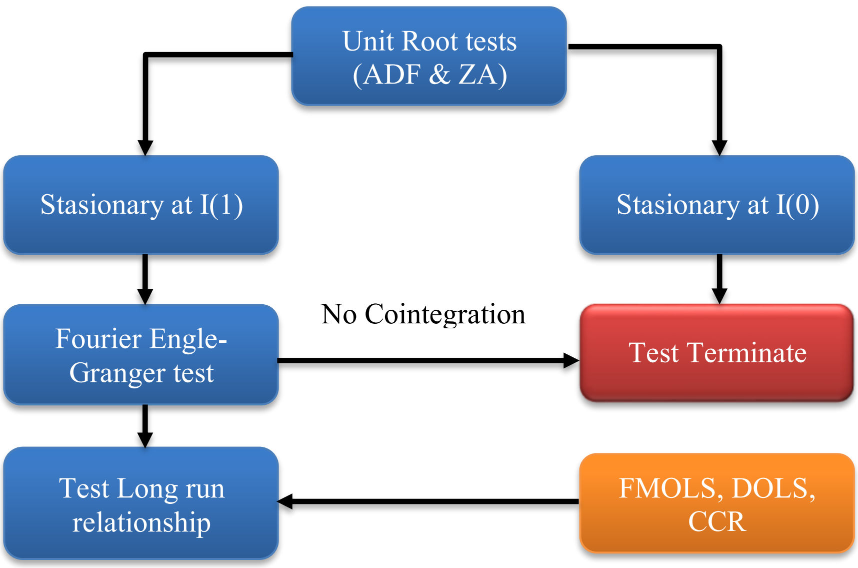

Figure 3. Systematics of the Research Process

RESULT AND DISCUSSION

Statistics Descriptive

Before starting the analysis, the researcher presents the research data in Table 2 in the form of descriptive statistics in natural logarithms. The average movement of rice prices is 9,322 with a standard deviation of 0.267. Similarly, the rupiah exchange rate (Exr) has an average of 9.388 with a

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standard deviation of 0.193. The money supply (M2) has an average of 15,201 with a standard deviation of 0.466, while volatility of oil prices (VOP) has an average of 4.22 with a standard deviation of 0.357. The descriptive statistics demonstrate that the money supply and oil prices fluctuate more often than the other two variables. Lastly, based on Jarque-Berra, it can be observed that the data is not normally distributed.

Table 2. Descriptive Statistics

Variable	Mean	Min	Max	Std. dev	Jarque-Berra
Rice	9.322	8.721	9.609	0.267	29.19***
Exr	9.388	9.048	9.703	0.193	20.05***
M2	15.201	14.282	15.958	0.466	11.33***
VOP	4.22	2.806	4.896	0.357	9.862***

Information: *** mean level of significance at 1%.

Unit Root Test

The next step is to check if it is stationary. Researchers used two stationary approaches, namely Augmented Dickey-Fuller (ADF) and Zivot-Andrews (ZA). Both approaches aim to achieve the same goal, but Zivot-Andrews is a more advanced version of ADF that is capable of estimating structural breaks in data. Table 3 presents the findings of the study, which indicate that all variables are not stationary at both ADF and ZA levels. However, testing at the first difference level shows that all variables are stationary with a significance level of 1%, which was also confirmed by ZA. In Table 2, the structural breaks are also presented. Structural breaks fall into two categories: known and unknown. If the structural break is known, it is assumed that this period causes a significant shift in the data. However, identifying the structure breaks in a time series is challenging due to data fluctuations (see Figure 2). To minimize errors in pinpointing the exact structural breaks, we utilize a break structure derived from statistical computing results. Most statistical software packages already include features for identifying such structural breaks. The rice price and exchange rate show a time break in July 2010, the money supply shows a break in June 2011, and the volatility of oil prices breaks in October 2014. These findings demonstrate that the Eagle-Granger method can be implemented.

Table 3. Unit Root Test

Variable	ADF	Zivot-Andrews	Time Break
Level / I(0)			
Rice	-2.587	-3.350	2010M07
Exr	-1.018	-3.662	2013M07
M2	-1.675	-4.106	2011M06
VOP	-2.310	-4.048	2014M10
First Difference / I(1)			
Rice	-8.286***	-8.271***	2012M02
Exr	-12.723***	-10.997***	2015M10
M2	-17.082***	-8.531***	2020M03
VOP	-9.644***	-9.293***	2020M05

Information: *** mean level of significance at 1%.

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FEG Cointegration Result

Table 4 shows the results of the FEG cointegration test developed by Yilanci (2019). We used the bootstrapping method on 500 models and with optimal k = 1 to obtain proper accuracy. Based on this table, there is a significant cointegration relationship at the 5% level. This indicates that the exchange rate, money supply, and volatility of oil prices together influence rice prices in the long run. Thus, these findings reject the null hypothesis where there is no cointegration relationship.

Table 4. Fourier Engle-Granger (FEG) Cointegration Test

Model	t-stat	Min SSR	Critical value 5%	Critical value 1%
Rice = f (Exr, M2, VOP)	-4.885**	0.018	-4.796	-5.354

Information: ** mean level of significance at 5%.

Long Run Estimation Result

After knowing the stationary test and cointegration test, the next stage is to estimate the long-term price of rice. Researchers used three methods, namely FMOLS, DOLS, and CCR as a form of comparison and reliability. Table 5 shows the estimation results for the three methods.

Tabel 5. Long-run Estimation on Rice Price

Variable	FMOLS	DOLS	CCR
Exr	-0.454***	-0.420***	-0.456***
	(-5.20)	(-5.60)	(-5.23)
M2	0.640***	0.627***	0.639***
	(23.58)	(28.52)	(23.69)
VOP	0.024**	0.031**	0.026**
	(1.96)	(2.53)	(1.99)
Sin	-0.499***	-0.043***	-0.050***
	(12.00)	(-3.09)	(-3.00)
Cos	-0.982***	-0.095***	-0.099***
	(-12.00)	(-14.61)	(-11.09)
Constant	3.846***	3.731***	3.875***
	(6.34)	(7.08)	(6.40)

Information: ** and *** mean level of significance at 5% and 1%, also () is z-hit.

The exchange rate variable has a significant negative relationship with rice prices at the 1% level, with coefficients ranging from -0.420 to -0.456. This means that a 1% increase in the exchange rate will cause rice prices to fall by approximately 0.420% to 0.456%. These findings are consistent with those of Hermawan et al. (2018), Fasanya & Olawepo (2018), and İnal et al. (2023), but differ from Teena Lakshmi & Shivakumar (2018). The impact of the exchange rate on rice prices is indirect. Hermawan et al. (2018) explain that exchange rates are closely linked to trade policies designed to boost agricultural productivity. For instance, during a long dry season that reduces rice production, implementing a food import policy can help control domestic food prices. However, the effect of importing is only temporary (Samal et al., 2022; Köse & Ünal, 2024). Prolonged imports can

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disadvantage local farmers, who struggle to compete with more efficient and cheaper foreign production. İnal et al. (2023) suggest that a stronger currency encourages consumers to prefer higher-quality goods at lower prices, which can increase demand for rice and ultimately drive rice prices higher in the long term. Therefore, it is necessary to emphasize exchange rate stability, reduce food imports (especially rice), and use local food so that rice prices remain stable in the long term (Umar & Umar, 2022; İnal et al, 2023).

Furthermore, the money supply showed a positive relationship with rice prices and was significant at the 1% level. The estimated coefficients ranged from 0.627 to 0.640, indicating that a 1% increase in the money supply would raise rice prices by approximately 0.627% to 0.640%. This effect is stronger than those of the other two variables studied. This finding is consistent with the studies of Ismaya & Anugrah (2018), who also observed a strong positive correlation between the money supply and rice prices. The amount of money in circulation is often linked to income. When there is a significant increase in the money supply, people have more cash to purchase essential items. This change in the money supply affects the demand for goods; as the money supply increases, so does income, shifting the demand curve and leading to higher prices. Ismaya & Anugrah (2018) attribute this to an excess money supply. Hermawan et al. (2018) reported that Indonesians tend to spend nearly 20% of their income on rice. Therefore, when people have more money, rice is likely to be a top purchasing priority. Therefore, the money supply needs to be controlled so that rice prices remain stable in the long term (Rivai, 2022).

Lastly, the volatility of oil prices was found to have a positive and significant effect at the 1% level. An increase in oil price volatility by 1% is expected to raise rice prices by approximately 0.024% to 0.026%. This finding is consistent with studies by Sarwar et al. (2020) and Darwez et al. (2023). Indonesia, being a net importer of crude oil, relies heavily on imports to meet its domestic energy needs. The frequent fluctuations in oil prices impact all sectors, including agriculture, which relies on machinery for production. Most agricultural sectors use machinery that runs on oil (Aydoğan & Vardar, 2019). These machines are essential for producing various goods, including rice. As oil is a significant cost factor, increased oil price volatility leads to higher rice prices. Although the impact may seem small, the rise in oil prices is crucial. Darwez et al. (2023) highlight that this volatility severely affects the supply chain, leading producers to raise output prices. This, in turn, can result in losses for farmers and increased costs for consumers. Oil fluctuation conditions are still occurring and causing price uncertainty, so it is necessary to look for other energy alternatives such as renewable energy and environmentally friendly technology to reduce production costs which are increasing all the time (Nwoko et al., 2016; Taghizadeh-Hesary et al., 2019).

CONCLUSION AND SUGGESTION

The purpose of this research is to analyze the macroeconomic data related to rice prices in Indonesia using a novel method called FEG cointegration. The testing process includes stationary tests and cointegration tests. The results of stationarity testing using ADF and Zivot indicated that all variables were stationary at level I(1), which makes it possible to perform the Engle-Granger cointegration test. The FEG cointegration test disproved the null hypothesis and showed that there was a long-term relationship between the exchange rate, money supply, and volatility of oil prices on rice prices in Indonesia.

Based on the findings with FMOLS, DOLS, and CCR estimates, it has been observed that the exchange rate has a significant negative impact at the 1% level. If the exchange rate increases by 1%, the price of rice will fall by around 0.420% to 0.456%. The variable of money supply has shown a positive sign on the price of rice and it has been statistically proven that it significantly affects the 1% level. Impact of the money supply increases by 1%, there will be an increase in the price of rice by 0.627% to 0.640%. On the other hand, oil price volatility has shown a positive sign at the 5% significance level. Increasing volatility of oil prices by 1% will push rice prices from 0.024% to 0.026%. Out of the three variables studied, the money supply has the greatest impact followed by the exchange rate and oil price volatility.

Based on these findings, policymakers need to take several measures such as stabilizing the Indonesian Rupiah currency. Control as an emphasis on domestic rice prices by reducing imports and placing more emphasis on domestic resources. Controlling the circulation of money in society by implementing monetary policy steps to increase interest rates. This step was taken to reduce the level of demand and maintain price stability in the market. Selanjutnya, shifting the dependence on fossil energy to renewable energy. Additionally, measures should be taken to enhance the efficiency and productivity of the agricultural sector through investments in modern farming techniques and technologies. This will make the economy more environmentally friendly, protect the environment for the future, and reduce the effects of oil price fluctuations on the economy and various sectors. Implementing these policies can help mitigate the volatility of rice prices and ensure food security. The research primarily focuses on analyzing the factors that affect rice prices in Indonesia using the FEG approach and FMOLS, DOLS, CCR estimator. However, it must be noted that this research has certain limitations. Future studies should aim to develop a rice price model using the ARDL method, which can produce both short-term and long-term estimates. This will help in generating precise estimates that can be used as a reference for policy decisions. Additionally, future research must include variables related to technology and investment in the agricultural sector, incorporate the impact of COVID-19 as a dummy variable, and retest prices of other agricultural commodities.

REFERENCES

Adjemian, M. K., Arita, S., Meyer, S., & Salin, D. 2024. Factors affecting recent food price inflation in the United States. Applied Economic Perspectives and Policy, 46(2), 648–676. https://doi.org/10.1002/aepp.13378

Awan, A. G., & Imran, M. 2015. Food price inflation and its impact on Pakistan’s economy. Food Science and Quality Management, 41, 61–73. https://core.ac.uk/download/pdf/234684073.pdf

Aydoğan, B., & Vardar, G. 2020. Evaluating the role of renewable energy, economic growth and agriculture on CO2 emission in E7 countries. International Journal of Sustainable Energy, 39(4), 335–348. https://doi.org/10.1080/14786451.2019.1686380

Becker, R., Enders, W., & Lee, J. 2006. A stationarity test in the presence of an unknown number of smooth breaks. Journal of Time Series Analysis, 27(3), 381–409. https://doi.org/10.1111/j.1467-9892.2006.00478.x

Darwez, F., Alharbi, F., Ifa, A., Bayomei, S., Mostfa, E., Lutfi, A., Haya, M. A., & Alrawad, M. (2023). Assessing the Impact of Oil Price Volatility on Food Prices in Saudi Arabia: Insights From Nonlinear Autoregressive Distributed Lags (NARDL) Analysis. ECONOMICS - Innovative and Economics Research Journal, 11(2), 5–23. https://doi.org/10.2478/eoik-2023-0056

Hdom, H. A. D., & Fuinhas, J. A. 2020. Energy production and trade openness: Assessing economic growth, CO2 emissions and the applicability of the cointegration analysis. Energy Strategy Reviews, 30. https://doi.org/10.1016/j.esr.2020.100488

Enders, W., & Lee, J. (2012). The flexible Fourier form and Dickey-Fuller type unit root tests. Economics Letters, 117(1), 196–199. https://doi.org/10.1016/j.econlet.2012.04.081

Engle, R. F., & Granger, C. W. J. 1987. Co-Integration and Error Correction: Representation, Estimation, and Testing. Econometrica, 55(2), 251–276. https://doi.org/10.2478/ats-2018-0019

Fachrurrozi, K., Fahmiwati, Hakim, L., Aswadi, & Lidiana. 2021. Pengaruh kemiskinan dan pengangguran terhadap kriminalitas di Indonesia di tahun 2019. Jurnal Real Riset, 3(2), 173–178. https://doi.org/10.47647/jrr

Fachrurrozi, K., Masbar, R., Aliasuddin, & Seftarita, C. 2022. Energy-growth-globalization (EGG) nexus in N-11 countries. Heliyon, 8(9), e10522. https://doi.org/10.1016/j.heliyon.2022.e10522

Faisal, F., Sulaiman, Y., & Tursoy, T. 2019. Does an asymmetric nexus exist between financial deepening and natural resources for emerging economy? Evidence from multiple break cointegration test. Resources Policy, 64(April), 101512. https://doi.org/10.1016/j.resourpol.2019.101512

Fasanya, I. O., & Olawepo, F. 2018. Determinants of food price volatility in Nigeria. Agricultura Tropica et Subtropica, 51(4), 165–174. https://doi.org/10.2478/ats-2018-0019

Gregory, A. W., & Hansen, B. E. 1996. Tests for cointegration in models with regime and trend shifts. Oxford Bulletin of Economics and Statistics, 58(2), 555–560. https://doi.org/10.1111/j.1468-0084.1996.mp58003008.x

Hatemi-J, A. (2008). Tests for cointegration with two unknown regime shifts with an application to financial market integration. Empirical Economics, 35(3), 497–505. https://doi.org/10.1007/s00181-007-0175-9

Hamulczuk, M., & Skrzypczyk, M. 2022. European union agri-food prices during covid-19 and their selected determinants. Problems of Agricultural Economics, 371(2), 5–27.

Hermawan, W., Fitrawaty, F., & Maipita, I. 2017. Factors Affecting the Domestic Price of Rice in Indonesia. Jejak, 10(1), 155–171. https://doi.org/10.15294/jejak.v10i1.9133

Hdom, H. A. D., & Fuinhas, J. A. (2020). Energy production and trade openness: Assessing economic growth, CO2 emissions and the applicability of the cointegration analysis. Energy Strategy Reviews, 30. https://doi.org/10.1016/j.esr.2020.100488

Ibrahiem, D. M., & Hanafy, S. A. 2020. Dynamic linkages amongst ecological footprints, fossil fuel energy consumption and globalization: an empirical analysis. Management of Environmental Quality: An International Journal, 31(6), 1549–1568. https://doi.org/10.1108/MEQ-02-2020-0029

Ike, G. N., Usman, O., & Sarkodie, S. A. 2020. Fiscal policy and CO2 emissions from heterogeneous fuel sources in Thailand: Evidence from multiple structural breaks cointegration test. Science of the Total Environment, 702, 134711. https://doi.org/10.1016/j.scitotenv.2019.134711

Ikhsan, I., Fachrurrozi, K., Nasir, M., Elfiana, E., & Nurjannah, N. 2022. Energy-Growth Nexus in Indonesia: Fresh Evidence from Asymmetric Causality Test. International Journal of Energy Economics and Policy, 12(1), 396–400. https://doi.org/10.32479/ijeep.11837

İnal, V., Canbay, Ş., & Kırca, M. 2023. Determinants of Food Prices in Türkiye: Fourier Engle-Granger Cointegration Test. Journal of Economic Policy Researches, 10(1), 133–156. https://doi.org/10.26650/jepr1132061

Ismaya, B. I., & Anugrah, D. F. 2018. Determinant of Food Inflation: the Case of Indonesia. Buletin Ekonomi Moneter Dan Perbankan, 21(1), 81–94. https://doi.org/10.21098/bemp.v21i1.926

Köse, N., & Ünal, E. (2024). The effects of the oil price and temperature on food inflation in Latin America. Environment, Development and Sustainability, 26(2), 3269–3295. https://doi.org/10.1007/s10668-022-02817-2

Lindawati, Emalisa, & Zulfida, I. 2022. Analysis of rice supply determinants in North Sumatera. IOP Conference Series: Earth and Environmental Science, 977(1). https://doi.org/10.1088/1755-1315/977/1/012056

Mahmood, H., Maalel, N., & Zarrad, O. 2019. Trade openness and CO2 emissions: Evidence from Tunisia. Sustainability (Switzerland), 11(12). https://doi.org/10.3390/su10023295

Mgale, Y. J., Timothy, S., & Dimoso, P. 2022. Measuring Rice Price Volatility and Its Determinants in Tanzania: An Implication for Price Stabilization Policies. Theoretical Economics Letters, 12(02), 546–563. https://doi.org/10.4236/tel.2022.122031

Moussa, R. K., Ousseini, B., & Taha, C. K. 2024. Asymmetric effects of oil prices on inflation in Côte d'Ivoire. Resources Policy, 90(August 2023), 104842. https://doi.org/10.1016/j.resourpol.2024.104842

Nwoko, I. C., Aye, G. C., & Asogwa, B. C. 2016. Effect of oil price on Nigeria's food price volatility. Cogent Food and Agriculture, 2(1). https://doi.org/10.1080/23311932.2016.1146057

Nwoko IC, & Aye GC. (2022). Crude oil price and food price volatility: A conceptual analysis. International Journal of Scientific Research Updates, 4(1), 108–115. https://doi.org/10.53430/ijsru.2022.4.1.0067

Özdurak, C. 2021. Major Determinants of Food Price Volatility in Turkey: Inflation Surge Aftermath of 2016. SSRN Electronic Journal, 2016(Figure 1). https://doi.org/10.2139/ssrn.3904157

Perron, P. 1989. The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis. Econometrica, 57(6), 1361–1401. https://doi.org/10.2307/1913712

Putra, A. W., Supriatna, J., Koestoer, R. H., & Soesilo, T. E. B. 2021. Differences in local rice price volatility, climate, and macroeconomic determinants in the indonesian market. Sustainability (Switzerland), 13(8). https://doi.org/10.3390/su13084465

Raheem, I. D., & Ogebe, J. O. 2017. CO2 emissions, urbanization and industrialization: evidence from a direct and indirect heterogeneous panel analysis. Management of Environmental Quality: An International Journal, 28(6), 851–867. https://doi.org/10.1108/MEQ-09-2015-0177

Raihan, A., & Tuspekova, A. 2022. The nexus between economic growth, renewable energy use, agricultural land expansion, and carbon emissions: New insights from Peru. Energy Nexus, 6(March), 100067. https://doi.org/10.1016/j.nexus.2022.100067

Rehman, F. U., & Khan, D. 2015. The Determinants of Food Price Inflation in Pakistan: An Econometric Analysis. Advances in Economics and Business, 3(12), 571–576. https://doi.org/10.13189/aeb.2015.031205

Rivai, A. 2022. The monetary policy impact on agricultural growth and food prices. International Journal of Research in Business and Social Science, 11(9), 158–165. https://doi.org/10.20525/ijrbs.v11i9.2234

Rodrigues, P. M. M., & Robert Taylor, A. M. 2012. The flexible fourier form and local generalised least squares de-trended unit root tests. Oxford Bulletin of Economics and Statistics, 74(5), 736–759. https://doi.org/10.1111/j.1468-0084.2011.00665.x

Samal, A., Ummalla, M., & Goyari, P. 2022. The impact of macroeconomic factors on food price inflation: an evidence from India. Future Business Journal, 8(1). https://doi.org/10.1186/s43093-022-00127-7

Sarwar, M. N., Hussain, H., & Maqbool, M. B. 2020. Pass through effects of oil price on food and non-food prices in Pakistan: A nonlinear ARDL approach. Resources Policy, 69(September), 101876. https://doi.org/10.1016/j.resourpol.2020.101876

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Vol 8 (3): 699-711, November 2024

Taghizadeh-Hesary, F., Rasoulinezhad, E., & Yoshino, N. 2019. Energy and Food Security: Linkages through Price Volatility. Energy Policy, 128(November 2018), 796–806. https://doi.org/10.1016/j.enpol.2018.12.043

Teena Lakshmi, B., & Shivakumar, K. M. 2022. An Econometric Analysis of Food Inflation in India. Economic Affairs (New Delhi), 67(3), 301–306. https://doi.org/10.46852/0424-2513.3.2022.22

Ulussever, T., Ertugrul, H. M., Depren, S. K., Kartal, M. T., & Depren, Ö. 2023. Estimation of Impacts of Global Factors on World Food Prices: A Comparison of Machine Learning Algorithms and Time Series Econometric Models. Foods, 12, 873.

Umar, U. A., & Umar, A. 2022. Effects of Exchange Rate on Food Inflation in Nigeria: A Non-Linear ARDL Approach. Gusau International Journal of Management and Social Sciences, 5(1), 195–209.

Waheed, R., Chang, D., Sarwar, S., & Chen, W. 2018. Forest, agriculture, renewable energy, and CO2 emission. Journal of Cleaner Production, 172, 4231–4238. https://doi.org/10.1016/j.jclepro.2017.10.287

Yilanci, V. 2023. The Determinants of Forest Products Footprint: A New Fourier Cointegration Approach. Forests, 14(5). https://doi.org/10.3390/f14050875

Yilanci, V. 2019. A Residual-Based Cointegration test with a Fourier Approximation. In MPRA (Issue 95395). https://mpra.ub.uni-muenchen.de/95395/

Zhou, J., Ma, Z., Wei, T., & Li, C. 2021. Threshold effect of economic growth on energy intensity—evidence from 21 developed countries. Energies, 14(14), 1–12. https://doi.org/10.3390/en14144199

Zivot, E., & Andrews, D. W. K. 1992. Futher Evidence on the Great Crash, the Oil-Price Shock, and the Unit-Root Hypothesis. Journal of Business & Economic Statistics, 10(3), 251–270