International Summit on Science Technology and Humanity
ISETH 2023
ISSN: 2615-1588 (online)

Estimating the Causal Relationship between Farmer Exchange Rate, Food Consumer Price Index and Inflation: ARDL Bounds and Toda-Yamamoto Approaches

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Abstract

The aim of this study is to investigate the causality between the exchange rate for farmers, the consumer price index for food, and inflation in five major cities in South Sulawesi, Indonesia. The Autoregressive Distributed Lag (ARDL) bounds testing and Toda-Yamamoto causality procedures are employed for analyzing monthly data from January 2015 to July 2022, allowing for the examination of both short-term and long-term effects. The empirical findings indicate a long-run equilibrium between the variables. The results reveal that in both the short run and long run, a 1% change in food prices results in approximately a 100% increase in the farmers' exchange rate. However, the Toda-Yamamoto causality test reveals that, except for a unidirectional causality relationship from the farmers' exchange rate to inflation in the food consumer price index, there is no significant causal relationship between the variables in the studied period and cities. This research contributes new insights into the interplay between inflation and the exchange rate for farmers, particularly in regions where agriculture is the primary source of income.

Keywords: Farmer, Exchange rate, Inflation, Consumer Price Index

Introduction

Modeling the relationship function between exchange rate and inflation is an important and ever interesting area of research. A good number of studies have been conducted in the context of connection between exchange rate and inflation by investigating the long-run and short-run dynamic inter-relationship as well establishing causal links with consumer price index. The studies have been pursued on the premises of developed, developing, and newly industrialized countries. Hence, the existing body of literature portrays that the exchange rate, inflation, and consumer price index have its direct bearing on economic development of the nations in general and every segment of the economy in particular. As pointed out by various research studies, exchange rate is a fundamental and indispensable aspect of economy (Henderson, 1949; Taylor, 2023; Yagubov et al., 2021). Using this instrument, a region can increase the production of goods and services thereby enhancing the income and economic growth. However, farmers exchange rates are more commonly used than exchange rates in places where agriculture is the primary source of income (Runtunuwu, 2020). The outcome of research works conducted by researchers (Ahdika et al., 2020; Akbar et al., 2019; Armayadi & Surentu, 2020; Bantilan et al., 2017; Yasin & Amin, 2021) for different periods using different types of econometrics models on dissimilar data set indicate that farmer exchange rate is a powerful aspect to influence the economics of region where agriculture is the primary source of income.

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Literature Review

Indonesian Farming Context

Indonesia, being an agricultural country, places significant importance on the agricultural sector as a key economic resource (Delgado & Siamwalla, 2018; Saripudin et al., 2020). A large portion of the Indonesian population relies on farming for their livelihoods (Sievanen et al., 2005). As the agricultural sector in Indonesia continues to grow, it is expected that the welfare of farmers would also improve (Valerio et al., 2022). However, various obstacles hinder the increase in farmer income and welfare, making it challenging to alleviate rural poverty (Saripudin et al., 2020; Valerio et al., 2022). This phenomenon is not unique to Indonesia but is also observed in other developing countries such as Malawi (Peters, 2006), Mozambique (Cunguara & Hanlon, 2012), and other developing countries (Ellis, 2000).

One indicator used to measure farmer welfare in Indonesia is the Farmer Exchange Rate (FER) indicator (Bantilan et al., 2017; Syaharuddin et al., 2021). The FER reflects the exchange rate faced by farmers, which includes the exchange rate of agricultural products consumed as well as the cost of production with goods and services (Elfira et al., 2022). Therefore, if the FER for farmers in Indonesia is high, it suggests that the purchasing power of farmers is relatively stronger. Assessing the value share paid by farmers can help determine the level of farmer welfare. If the percentage of the farmer's exchange rate is above 100, it indicates favourable farmer welfare. Moreover, ensuring the welfare of farmers is crucial for the sustainable production of rice and other food as essential staples for the Indonesian population. Thus, the FER serves as an indicator that can guide agricultural policy decisions. The FER represents the ratio of the price index received by farmers to the price index paid by farmers. Conceptually, it measures the substitutability of agricultural products produced by farmers with the goods or services consumed by farm households and the goods or services required for agricultural production.

Several factors influence the Farmer Exchange Rate (FER), including the Consumer Price Index (CPI), Gross Domestic Product (GDP), and rice prices. Previous research has shown that the CPI, which serves as an indicator for measuring farmers' well-being, has a negative impact on the FER (Jongwanich & Park, 2011). The low FER is primarily driven by high inflation in rural areas, where a significant portion of the population works in farming (Setiyowati et al., 2018). Rising inflation leads to increased prices for agricultural products (Njegovan & Simin, 2020). As these prices go up, many consumers hesitate to purchase agricultural goods, resulting in losses for farmers and a decline in their welfare. This decline in farmer welfare signifies a reduction in the average purchasing power of food farmers. According to the 2019 Indonesian Central Statistics Agency, a substantial 49.41% of poor households in Indonesia rely on the agricultural sector (Priyotomo et al., 2022). This percentage is significant, highlighting the importance of addressing farmer welfare. Given Indonesia's abundant natural resources, the country has the potential to become a leading exporter of rice and provide a prosperous life for farmers. The low level of farmer welfare in Indonesia has sparked the interest of researchers in studying the factors that influence the FER. A comprehensive understanding of these determinants will be valuable for planning development policies and improving future development programs.

Farmer Exchange Rate, Food Consumer Price Index and Inflation

A group of scholars conducted their research on an individual region to find the casual relationship between farmer exchange rate, food consumer price index, and inflation. The experiment of employing Gini-coefficient for Nigerian farmer found that factors relate to consumer price index were major determinants of farmer's welfare (Agwu & Orji, 2013). The farmer exchange rate calculated in income function revealed that farmer exchange rate is very low (under 100) in one agricultural region center in Indonesia (Maharani et al., 2022). The different model was applied on Indonesian economy case to examine the consumer price index factor which has positive significantly affect the level of welfare farmers in Indonesia (Aulia et al., 2021). In other side, the farmer exchange rate influenced inflation was found in Indonesia for studies conducted in multiple regression analysis found that the farmer exchange rate had a positive and significant effect on the inflation rate (Yasin & Amin, 2021).

Method

Data Sources

The Statistics Indonesia Sulawesi Selatan Province database (https://sulsel.bps.go.id) provided monthly time series data (91 months) from January 2015 to July 2022 which is sufficient period to aid in the examination of the empirical model.

Autoregressive Distributed Lag Model (ARDL)

The study investigates both short- and long-term effects, as well as Toda-Yamamoto causality linkages (Toda & Yamamoto, 1995) between the variables. We adopt an Autoregressive Distributed Lag (ARDL) estimation technique with Bound cointegration test and error correction models (Pesaran et al., 2001).

To ascertain the sequence of integration of the series, we employed the Augmented Dickey-Fuller (ADF) unit root test to assess the stationarity of the variables. Here, the series is examined to see whether it has unit root features at their level, I (0), or at either of their first I (1) or second differences I (2). The possibility of a co-integration would be examined, nevertheless, if the series is integrated with the same sequence I(d) other than the I (0). Following Dickey and Fuller's AR (1) process, the stationarity of the variables is evaluated based on the following equation (Dickey & Fuller, 1979).

$$\Delta X_t = (\theta - 1)\, X_{t-1} + \mu_t \qquad (1)$$

Equating $\theta - 1 = \delta$ then Equation (1) turns to

$$\Delta X_t = \delta X_{t-1} + \mu_t \qquad (2)$$

Since the Dickey-Fuller model's stationary error term exhibits autocorrelation, the issue must be fixed by an adjustment procedure. This led Dickey and Fuller (1981) to include the lagged values of ΔX as an extra predictor in their model to form the Augmented Dickey-Fuller (ADF) unit root test is presented as the following.

$$\Delta X_t = \beta_0 + \beta_1 t + \delta X_{t-1} + \sum_{i=1}^{m} \gamma_i\, \Delta X_{t-i} + \mu_t \quad intercept, trend \qquad (3)$$

Where Δ is the difference processor, $\beta_0, \beta_1, \gamma_i$ are coefficient intercepts. The basic hypothesis for the ADF unit root test is the non-stationarity of the series denoted as $H_0: \delta = 0$, Series has a unit root (non-stationary);
$H_1: \delta < 0$, Series has not a unit root (stationary).

To find the long-term relationships, a co-integration test is examined once the order of integration is established via the stationarity test. If the series is integrated of order I (1) I (0), the cointegration tests (Engle & Bollerslev, 1986; Johansen, 1988), cannot be used. For evaluating cointegration relationships between series that are stationary at various levels, a Bounds testing methodology was developed (Pesaran et al., 2001). For the ARDL Bounds test, the predicted factor should be I (1), and the predictors could be I (0) or I (1) but not I (2) or more. Co-integration Bounds test is applied using an unrestricted error correcting model where the null hypothesis of absence of cointegration is tested; $H_0: \beta_1 = \beta_2 = \beta_3 = 0$. The Bounds test equation is described below.

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 X_{1t-1} + \alpha_3 X_{2t-1} + \sum_{n=1}^{k} \beta_n \Delta Y_{t-n} + \sum_{n=0}^{k} \rho_n \Delta X_{1t-n} + \sum_{n=0}^{k} \sigma_n \Delta X_{2t-n} + \mu_t \quad Generl\ equation\ for\ Bounds\ Cointegration\ test \qquad (3)$$

$$\Delta LNFER = \alpha_0 + \alpha_1 LNFER_{t-1} + \alpha_2 LNFood\_CPI_{t-1} + \alpha_3 LNINF_{t-1} + \sum_{n=1}^{k} \beta_{1n} \Delta LNFER_{t-n} + \sum_{n=0}^{k} \beta_{2n} \Delta LNFood\_CPI_{t-n} + \sum_{n=0}^{k} \beta_{3n} \Delta LNINF_{2t-n} + \mu_t \qquad (4)$$

Where α_0 is the constant term, $\alpha_1 - \alpha_3$ and $\beta_{1n} - \beta_{3n}$ are the coefficients, $\Delta LNFER$ is the natural logarithm of farmer exchange rate, $LNFood\_CPI$ is the natural logarithm of Food consumer price index and $LNINF$ is the natural logarithm of Inflation rate, μ_t is the white noise error term. For long-run analysis, the Autoregressive Distributed Lags (ARDL) method is used if the Bounds test is performed as a cointegration test. To investigate the long-run equilibrium, the level values of the series are employed, and the equation is described as.

$$\Delta LNFER_t = \alpha_0 + \sum_{n=1}^{k} \beta_{1n} \Delta LNFER_{t-n} + \sum_{n=0}^{k} \beta_{2n} \Delta LNFood\_CPI_{t-n} + \sum_{n=0}^{k} \beta_{2n} \Delta LNINF_{2t-n} + \mu_t \qquad (5)$$

When analysing economic linkages, lagged values of the variables should also be considered as predictors because past experiences and behaviours have an impact on economic behaviour in a present period. The ARDL approach is effective since it also considers the series' past values. However, the short-run analysis is carried out utilizing the series' 1st differences and the error correction term (ECT_{t-1}) where the equation for the short-term equilibrium is as follows.

$$\Delta Y_t = \alpha_0 + \sum_{n=1}^{k} \beta_{1n} \Delta LNFER_{t-n} + \sum_{n=0}^{k} \beta_{2n} \Delta LNFood\_CPI_{t-n} + \sum_{n=0}^{k} \beta_{3n} \Delta LNINF_{2t-n} + \delta ECT_{t-1} + \mu_t \quad (6)$$

Where α_0 is the constant term, $\beta_{1n} - \beta_{5n}$ are the coefficients, δECT_{t-1} is the error correction term while μ_t is the stochastic term. The decision is made that the short-term variations between the series vanish, and the series converge to the long-run equilibria once more if the coefficient of ECT_{t-1} (δ) is negative and-significant, further demonstrating the validity of the long-term analysis.

Toda – Yamamoto Causality test

Toda and Yamamoto's (1995) causality determines the causal linkages when the order of integration of the series is I (1), I (0). In this test, the level values of the series are employed for causation direction. It offers more information in this regard than the Granger causality test (if the series is non-stationary at level). The Toda-Yamamoto causality test is applied whether the variables' degrees of integration are the same and whether there's evidence of cointegration causeways in the indicators. No matter whether the series is stationary, stationary around the trend, or cointegrated, the test by Toda-Yamamoto (1995) exhibits an asymptotic $\chi 2$ distribution. The ideal lag length (p) is determined by the aid of the VAR model. By adding the highest integration degree of the series (s_{maxium}) to k, the Vector-Autoregressive model with ($k + s_{maxium}$) lag is estimated. The causal relationship between the independent factors of environmental taxes, urban population, use of renewable energy, and per capita GDP and the dependent variable of greenhouse gases in kilotons of CO2 emissions described by Toda and Yamamoto (1995) is as follows:

$$LNFER_t = \alpha_0 + \sum_{i=1}^{k} \beta_{1i} LNFER_{t-i} + \sum_{i=k+1}^{k+S_{maxium}} \beta_{2i} LNFER_{t-j} + \sum_{i=1}^{k} \delta_{1i} LNFood\_CPI_{t-i} + \sum_{i=k+1}^{k+S_{maxium}} \delta_{2n} LNFood\_CPI_{t-j} + \sum_{i=1}^{k} \Theta_{1i} LNINF_{t-i} + \sum_{i=k+1}^{k+S_{maxium}} \Theta_{2i} LNINF_{t-j} + \mu_t \quad (7)$$

$$LNFood\_CPI_t = \alpha_1 + \sum_{i=1}^{k} \beta_{1i} LNFood\_CPI_{t-i} + \sum_{i=k+1}^{k+S_{maxium}} \beta_{2i} LNFood\_CPI_{t-j} + \sum_{i=1}^{k} \delta_{1i} LNFER_{t-i} + \sum_{i=k+1}^{k+S_{maxium}} \delta_{2i} LNFER_{t-j} + \sum_{i=1}^{k} \Theta_{1i} LNINF_{t-i} + \sum_{i=k+1}^{k+S_{maxium}} \Theta_{2i} LNINF_{t-j} + + \mu_t \quad (8)$$

$$LNINF_t = \alpha_2 + \sum_{i=1}^{k} \beta_{1i} LNINF_{t-i} + \sum_{i=k+1}^{k+S_{maxium}} \beta_{2i} LNINF_{t-j} + \sum_{n=1}^{k} \delta_{1i} LNFER_{t-i} + \sum_{n=1+1}^{k+S_{maxium}} \delta_{2i} LNFER_{t-j} + \sum_{i=1}^{k} \Theta_{1i} LNFood\_CPI_{t-i} + \sum_{i=k+1}^{k+S_{maxium}} \Theta_{2i} LNFood\_CPI_{t-j} + \mu_t \quad (9)$$

Results and Discussions

De-trending data

Because we used monthly data in the analysis, we first de-trend the data to remove seasonality effects. Seasonality refers to the regular and predictable changes observed in a time series data that occur in a repeating pattern over a given period. These predictable fluctuations, which take place within a one-year period, are considered seasonal in nature. As the magnitude of the seasonal impact can vary across different series, it is beneficial to eliminate or adjust for these effects from the outset.

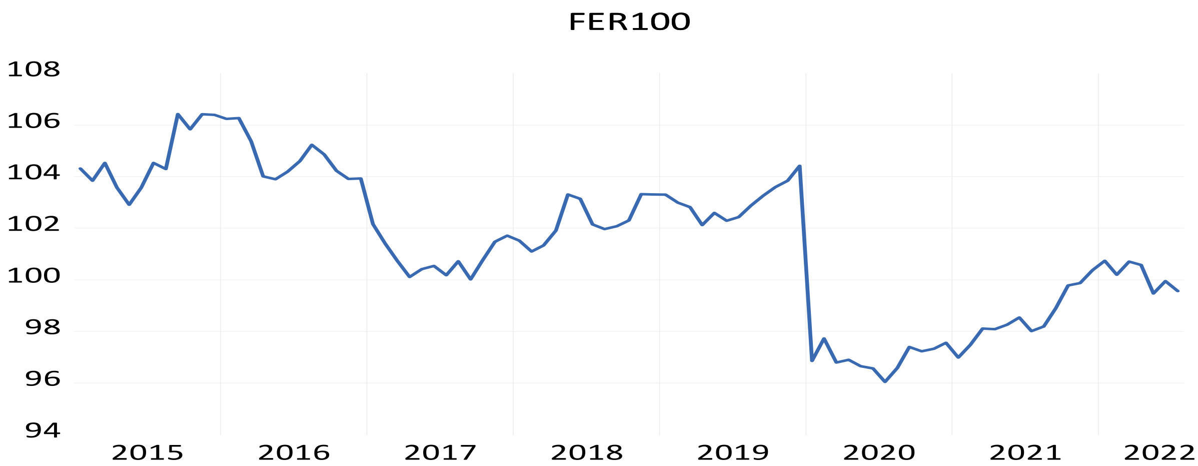

Figure 1. Series Graph of Farmer Exchange Rate

Source: Author's computation (2023)

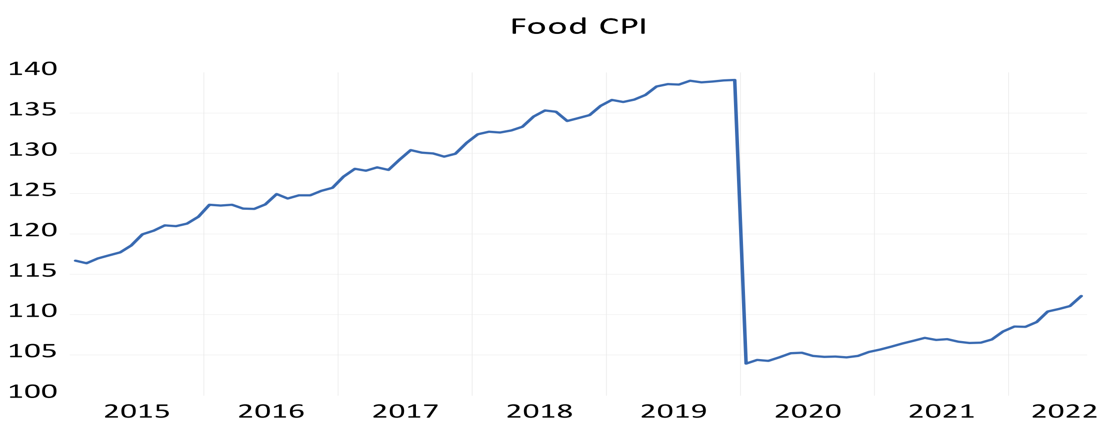

Figure 2. Series Graph of Food Consumer Price Index

Source: Author's computation (2023)

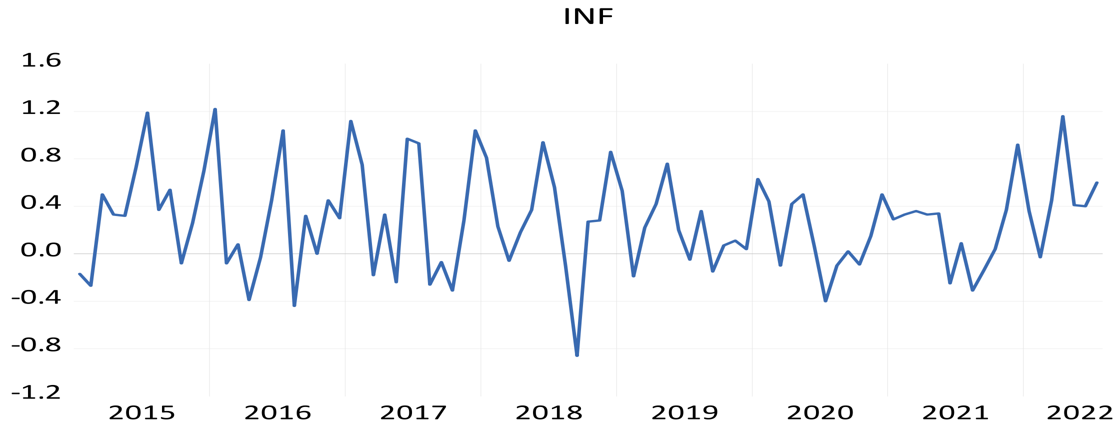

Figure 3. Series Graph of Inflation

Source: Author's computation (2023)

Based on the graphs above, we can observe that the FER100 dataset, which represents the farmers' exchange rate, does not exhibit any seasonality effects. However, both the Food Consumer Price Index (Food CPI) and the Inflation rate (INF) display seasonality effects. Consequently, it is necessary to account for the seasonality in the Food CPI and INF data. Figure 4 demonstrates the presence of seasonality in both the Food CPI and the seasonality-adjusted series, Food_CPSA. Notably, the smoother trend is more pronounced in the Food_CPI series compared to the Food CPSA series. Therefore, we opted to use the Food_CPI series for the subsequent stages of analysis. Figure 5 illustrates both the INF series and its seasonality-adjusted series, INFSA. It is apparent that the sharp fluctuations in the INF series have been mitigated in the INFSA series, resulting in a smoother pattern. Consequently, we have chosen to utilize the INFSA series for the subsequent stages of analysis.

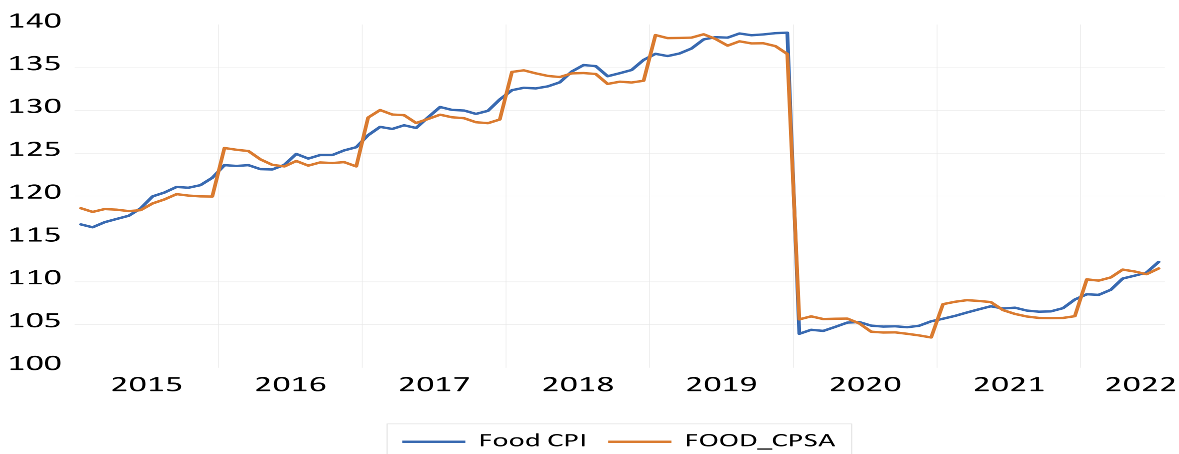

Figure 4. Adjusting the seasonality in Food CPI

Source: Author's computation (2023)

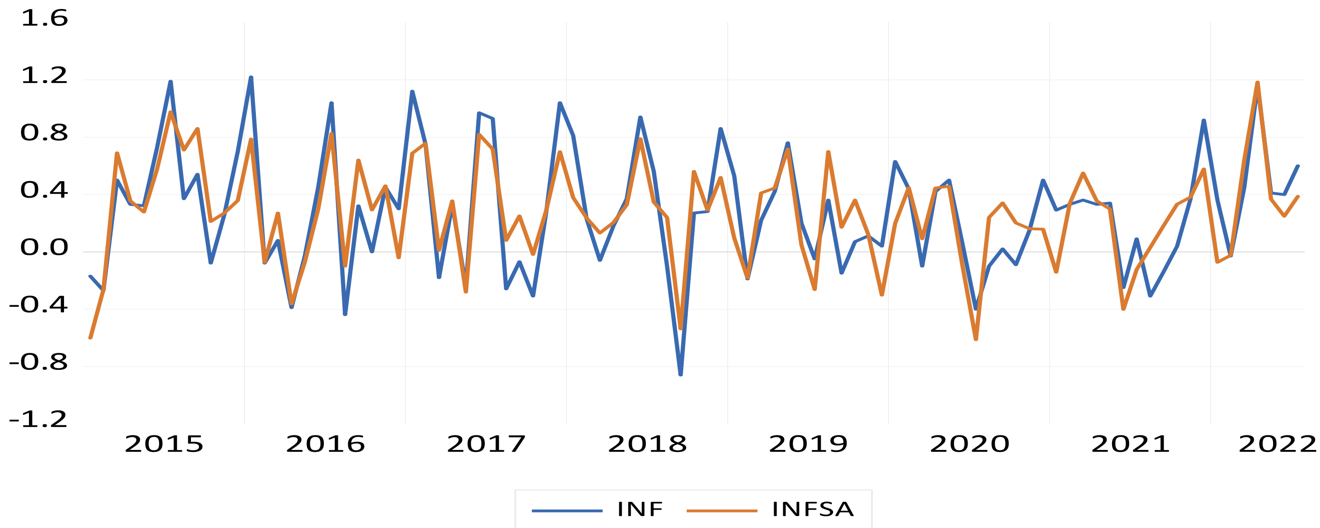

Figure 5. Adjusting the seasonality in INF

Source: Author's computation (2023

Stationarity Test Results

For each of the variables considered, the stationarity tests were assessed at both the level and 1st differences forms of all observed time series and each test is conducted with intercept and trend. To ascertain the absence of unit root traits in the series, we employed the ADF unit root test (Dickey & Fuller, 1979). Table 1 displays the level form stationarity test, and it reveals that seasonally adjusted inflation rate (INFSA) is stationarity (0.00 < 0.5) at level hence the order of integration for the series is I (0) while the other variables were found not to be stationary at level form. Upon taking the first difference, the results reveal that Food consumer price index (Food CPI), and Farmers exchange rate (FER) were found to be stationary since *prob values < 0.05* at 5% level of significance and the variables are integrated of order I (1), therefore, our series is I (1), (1) or (0). However, it is important to consider the assumptions of autocorrelation, heteroscedasticity when modelling time series data. On the other hand, the INF variable was already stationary at the level value and did not require differencing, hence the data is suitable for model estimation.

Table 1. Unit Root Test

Variables	**ADF Test (Prob)**	**Level: 1st**	**1st Difference**	**Order of Integration**
FER 100	0.38	Not stationary	Stationary	I (1)
FOOD_CPI	0.57	Not stationary	Stationary	I (1)
INFSA	0.00	Stationary	-	I (0)

Source: Author's Computation (2023)

ARDL Bounds Cointegration test

For evaluating cointegration relations between series that are stationary at various levels, Pesaran, Shin, and Smith (2001) developed a Bounds testing technique. For ARDL Bounds testing, the predicted factor is to be I (1) and the independent factors could be a mix of I (0) and I (1) but not I (2). Since the integration order of our data is I (1) for the dependent variable (FER), I (1) for independent variables (Food_CPI), and I (0) for (INFSA), it satisfies the criteria for ARDL Bounds cointegration. The Bounds cointegration test is employed to ascertain if distinct variables show a long-term equilibrium with one another i.e., the existence of long-term relationship between the dependent variable and the independent variables. The null hypothesis of "no Cointegration relationship" can be rejected if the *F-statistic* exceeds the upper and lower bound critical values and reports the existence of a cointegration relationship, otherwise reject. In Table 2, k stands for the number of predictor factors, and since our sample observation is 91 months, we interpret the critical values with a finite sample n=95, which is more appropriate for our real sample. The findings reveal that the null hypothesis of absence of co-integration is rejected because the resultant *F-statistic* (8.57) is larger than the 5% and 10% upper and lower bounds critical values.

Table 2. Bounds Cointegration

k	**F-statistics**	**Lower Bound**			**Upper Bound**		
		10%	5%	1%	10%	5%	1%
2	8,57***	3,26	3,94	5,407	4,24	5,04	6,78

Source: Author's computation (2023) ****shows significance at 1%*

ARDL Model Estimation Results

Since the Bounds estimation ascertained the presence of co-integration in the series, we estimate ARDL model for short-term and long-term equilibria. The long-run results in Table 3 reveals that Food consumer price index (Food_CPI) and Inflation (INFSA) have impact on farmers exchange rate (FER) in 5 big cities in South Sulawesi Region, Indonesia. The findings of the analysis reveal that Food Consumer Price Index (Food CPI) has significant positive (β = 1.00) impact on farmers exchange rate on the farmers' exchange rate (FER) over the study period. Specifically, a 1% increase in the Food CPI is associated with an average 100% increase in the FER, *ceteris paribus*. This result holds true for the five major cities in the South Sulawesi Region of Indonesia, from January 2015 to July 2022. Additionally, the analysis indicates that a 1% change in the seasonally adjusted inflation rate leads to a 6% increase in the farmers' exchange rate, all else being equal, however, it is important to note that this effect is statistically insignificant. These findings highlight the significant impact of the Food CPI on the farmers' exchange rate in the studied region, suggesting that changes in food prices have a substantial influence on the economic conditions of farmers. However, the relationship between the seasonally adjusted inflation rate and the farmers' exchange rate is not statistically significant, indicating that other factors may play a more prominent role in determining the exchange rate for farmers in this context.

Table 3. ARDL Long-run results

Variable	**Coefficiant**
FOOD_CPSA	1,00*** (0,00)
INFSA	0,06 (0,93)

Source: Author's computation (2023) *Note: *** shows significance at 1%*

In the short run, the results indicate a significant positive relationship, with a coefficient of -0.99. This implies that a 1% increase in food consumer prices leads to a substantial 99% increase in the farmers' exchange rate in Indonesia, *ceteris paribus*. Furthermore, the study reveals that this relationship between food prices and the farmers' exchange rate holds consistently in both the short-run and long-run. Regardless of the time frame, a 1% change in food prices is associated with an approximately 100% increase in the farmers' exchange rate. This suggests that changes in food prices have a strong and consistent impact on the economic conditions of farmers in Indonesia. Additionally, the constant term in the analysis, which captures the influence of factors other than food prices, shows a significant negative effect with a coefficient of -0.08. This indicates that a 1% change in these other factors results in an 8% decrease in the farmers' exchange rate, assuming all other variables remain constant. These findings highlight the significance of food prices in influencing the farmers' exchange rate in Indonesia. The results indicate that changes in food prices have a substantial and consistent impact on the economic conditions of farmers, while other factors not related to food prices also play a significant role in determining the farmers' exchange rate.

Intuitively, according to the co-integration error equation's one-period lag (CointEq (-1) *), the rate of change from short-term deviations to long-run equilibrium is negative (-0.45), and significant (*p-value* $0.0001 < 0.1$). This indicates that the system is convergent, and it takes a shorter period to compensate for variable divergence. The system also features an oscillating correction method, and when short-run deviations decrease, long-run co-integration relationships emerge. In other words, the short-run deviations (resulting from shocks in food consumer price and inflation) from the long-run equilibrium will be adjusted by 45 percent each year, which confirms a long-run relationship between the variables.

Table 4. ARDL Short-run results

Variable	Coefficiant
Constant	-0,08 ** (0,45)
D(FOOD_CPSA)	0,99 *** (0,00)
ECT_{t-1}	-0,45 *** (0,00)

*Source: Authors Computation (2023) Note: *** shows significance at 1%, ** shows significance at 5%*

Toda-Yamamoto Causality

There is always evidence of causality—either unidirectional or bidirectional—in the presence of co-integration (Granger, 1988). In this investigation, we analysed the Toda-Yamamoto causality test, which is appropriate whether the variables' degrees of integration are the same and whether there's cointegration linkage in the series. Irrespective of whether the series is stationary, stationary around the trend, or cointegrated, Toda-Yamamoto (1995) demonstrated that this test has an asymptotic $\chi 2$ distribution. Based on the findings presented in Table 5, it can be concluded that there is a one-way causal relationship between farmer exchange rate and inflation rate in 5 big cities, South Sulawesi Region, Indonesia between January 2015 – July 2022. These findings are consistent with Yasin - Amin's research (2021), which discovered a link between farmer exchange rates and inflation during the Covid epidemic in Indonesia. This study is also consistent with the previous finding in Russia (Kataranova, 2010) and in the United Kingdom (Kara & Nelson, 2003). However, neither of these studies particularly explained farmer exchange rates, instead referring to exchange rates in general. On the other hand, the findings of no causal link between the farmer exchange rate and the consumer price index. This conclusion contradicts with another finding: there is higher positive relationship between the exchange rate and CPI (Adetiloye, 2010). The previous study also generally explained exchange rates, instead referring to farmer exchange rates (Adetiloye, 2010).

Table 5. Toda-Yamamoto Causality Test

Variables		Chi-Sq
Cause	Effects	
Food_CPI	FER100	0.05 (0.97)
INFSA	FER100	1,37 (0.50)
FER100	FOOD_CPI	0.78 (0.67)
INFSA	FOOD_CPI	3.55 (0.16)
FER100	INFSA	5.42 (0.06) *
FOOD_CPI	INFSA	2.68 (0.26)

*Source: Author's Computation (2023) Note: *Statistically significant at 10%*

Diagnostics

To ensure the validity of the predicted model, various diagnostic checks were conducted. These include tests for normality using histograms, tests for heteroscedasticity using the Breusch-Pagan method, tests for serial correlation using the Breusch-Godfrey LM test, tests for functional misspecification using the RESET test, and tests for stability using CUSUM and CUSUMSQ charts. To evaluate the model specification, we conducted the optimum lag graph using Akaike information criterion. Figure 6 shows the AIC value of the smallest AIC values. Among them, the ARDL (1, 1, 0) model, which has the smallest AIC value is the best model for estimation. This suggests that the explanatory variables in the ARDL model are linearly related to the predicted factor, indicating that the equation's functional form is appropriately defined. Therefore, the linearity assumption of Ordinary Least Square estimation approaches is confirmed. We assessed the parameter strength of the model based on the Cumulative Sum (CUSUM) and Cumulative Sum of Square (CUSUMSQ) (Pesaran, 1997). In particular, CUSUM checks for systematic errors in parameter estimates, whereas CUSUMSQ looks for abrupt shifts in model stability. Because the plots fall inside the accepted region at a 95 percent confidence level, $Figure$ 7 show the stability of parameter estimates, hence, unbiased statistical inferences and policy recommendations can be inferred.

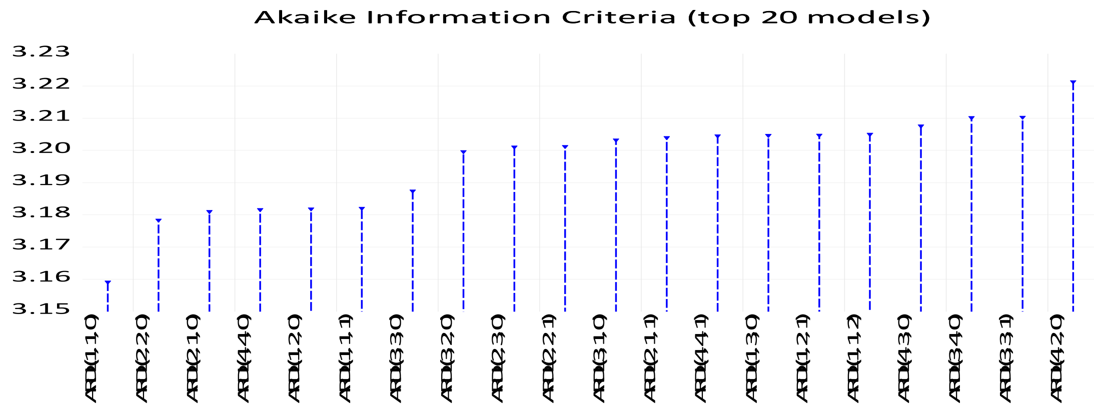

Figure 6. Akaike Information Criteria (Top 20 Models)

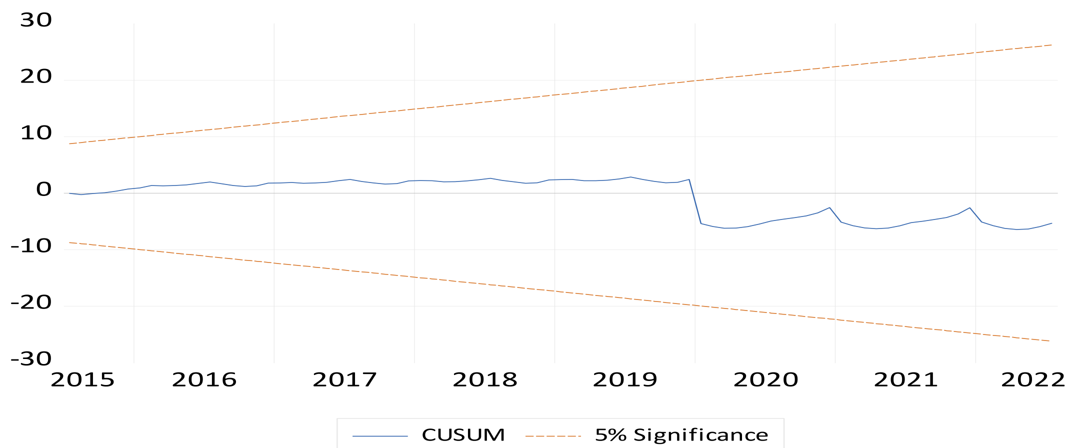

Figure 7. CUSUM Graphs

Conclusion

This study aimed to investigate the relationship and causality between the exchange rate for farmers, the consumer price index for food, and inflation in five major cities in South Sulawesi, Indonesia. The analysis utilized monthly time series data spanning from January 2015 to July 2022, totaling 91 months. To ensure robustness and reliability, the study employed various econometric techniques, including tests such as the ADF unit root test, ARDL Bounds test, ECM, and Diagnostic tests. The main objective was to examine both the short-term and long-term effects of the predictors on the exchange rate for farmers. The findings demonstrate the existence of a long-run equilibrium relationship among the farmers' exchange rate, the food consumer price index, and the inflation rate. Specifically, the results reveal a significant positive impact of the food consumer price index on the farmers' exchange rate in the five major cities of the South Sulawesi Region, Indonesia. In the short run, the study identifies a significant positive effect of the food consumer price index on the farmers' exchange rate. Notably, the analysis highlights that both in the short-run and long-run, a 1% change in food prices leads to an approximately 100% increase in the farmers' exchange rate. Furthermore, the constant term, which represents factors other than food prices, has a significant negative effect on the farmers' exchange rate. Regarding causality, the study identifies a one-way causal relationship between the farmers' exchange rate and the inflation rate. This implies that changes in the farmers' exchange rate have a causal impact on inflation, but not vice versa.

Based on these findings, it is recommended that policymakers in the South Sulawesi Region, Indonesia, pay close attention to the dynamics between the farmers' exchange rate, the food consumer price index, and inflation. Policies that aim to stabilize food prices and support farmers in managing exchange rate fluctuations could contribute to overall economic stability and improved living conditions for farmers. Additionally, efforts should be made to address factors other than food prices that affect the farmers' exchange rate to create a more favourable environment for agricultural producers.

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