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## Article

# Asymmetric price transmission of Indonesian coffee

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## GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE

# Asymmetric price transmission of Indonesian coffee

Kamaruddin<sup>1</sup>, Raja Masbar<sup>2</sup>, Sofyan Syahnur<sup>3\*</sup> and Shabri A. Majid<sup>3</sup>

**Abstract:** Almost all previous studies of Asymmetric Price Transmission (APT) only focused on speed perspective. The study aims to investigate the effect of coffee prices in the global market on the Indonesian producer market in magnitude, speed, and direction perspectives. This study used the data of coffee prices at the producer level, coffee prices at the world market, and Indonesian GDP for the period 1980 to 2018. To examine the behavior of the APT, we use the NARDL model. The results show that there is a nonlinear co-integration of coffee prices between the global market and the Indonesian producer market. The APT occurs both in the long run and short run. The existence of the APT is not only in speed but also in magnitude and direction sides. The response of coffee prices in the producer market is higher and faster when the world coffee prices decrease. It indicates the failure to perform a perfectly competitive market structure in Indonesia. If the performance of the national economy is stable, Indonesian coffee producers are more likely to increase global coffee prices. However, in the Indonesian economic recession, coffee producers tend to suffer welfare loss due to the negative shock of world coffee prices. Therefore, policymakers should not only focus on economic growth but also has to make some policies assessing perfect competition in domestic agricultural markets.

**Subjects:** Applied Mathematics; Development Policy; Economics



Kamaruddin

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### PUBLIC INTEREST STATEMENT

The relationship between economic variables is not always linear in nature. This research report that relationships between coffee prices in the world market and the Indonesian producers' markets are nonlinear. There is asymmetric price transmission (APT) from the world market to the Indonesian producer's market. In this study, the existence of the APT is not only in speed but also in magnitude and direction sides. The response of coffee prices in the producer market is higher and faster when the world coffee prices decrease than they increase. This is an indication of the failure to perform a perfectly competitive market structure in Indonesia. Therefore, policymakers should not only focus on economic growth but also has to make some policies assessing perfect competition in domestic agricultural markets.

**Keywords:** world-producer coffee prices; asymmetric transmission; producer welfare; Shin's NARDL  
**JEL Classifications:** C54; E32

## 1. Introduction

The main purpose of this study is to examine whether coffee producer welfare is affected by Asymmetric Price Transmission (henceforth APT) from the world coffee prices to the coffee producer markets that occur in Indonesia. This study highlights the APT with a different pattern of price volatility from the magnitude, speed, and direction perspectives by employing Shin's Asymmetric Nonlinear Autoregressive Distributed Lags (NARDL) model (Shin et al., 2012). Shin et al. (2012) merely analyze the APT from the magnitude perspective with the NARDL model. Therefore, this study contributes to enrich the existing literature by examining the APT with a different pattern of price volatility from the magnitude, speed, and direction perspectives. Besides, this study also attempts to link the APT issue with the coffee producer welfare in which the Gross Domestic Product (GDP) is a control variable. It means that this study also examines the APT by using another basic approach to explore the APT not only in speed as they did, but also in magnitude and direction perspective. Therefore, this study contributes to enrich the existing literature by examining the APT with a different pattern of price volatility from the magnitude, speed, and direction perspectives.

Moreover, this study also attempts to link the APT issue with the coffee producer welfare in which the GDP is a control variable. Generally, coffee is the main tropical plant traded in the world regarding its half contribution of the total tropical commodities. Based on Food and Agricultural Organization data (2018), the highest coffee production is produced by several developing countries such as Brazil, Vietnam, Colombia, and Indonesia. In 2017, world coffee production was 9,327 million tons and Brazil's coffee production was 2.681 million tons as the largest coffee producing country in the world. Vietnam and Colombia produced 1.542 million tons and 754 thousand tons, respectively, while Indonesia's coffee production was 669 thousand tons or equal to 7% of world coffee production. The total coffee production of these four countries reached 61% of world coffee production. Nevertheless, evidence showed that the increase in coffee production particularly in Indonesia during 2000–2007 was not followed by an increase in coffee prices at the farm level. The price was relatively low compared to those of the other three countries and those of the world market. There is a strong indication that coffee price movements at the Indonesian producers' level are less responsive to the variation in coffee prices in the world market.

Especially for this commodity, FAO (2018) noted that producer prices in the Indonesian producer market have never experienced 60% of world prices. During 2000–2017, Indonesian producers faced abnormal prices conditions, particularly in 2004, 2009, 2014, and 2017. The ironic condition for producer prices happened in 2004 in which world prices increased by 25% from 1,415US \$/ton in 2003 to 1,774 US \$/ton and Indonesia producer prices fell by 2% from 661 US \$/tons in 2003 to 648US \$/ton in 2004. In 2014, world coffee prices increased by 44% from 3,076 US \$/ton in 2013 to 4,424US \$/ton in 2014 and the producer prices decreased by 7% from 1476US \$/ton in 2013 to 1429US \$/ton in 2014. This situation is caused by the low production capacity of Indonesia so that the effect of price increases on the world market may not reach the producer market as well as in some other countries (Krivonos, 2004; Worako et al., 2008). Therefore, we define this situation as the APT. The APT occurs when there is a different price response in one market as a positive price shock (there is an increase in prices) and a negative price shock (there is a decrease in prices) for the other markets. For instance, an increase in prices at the global market is followed by a slower reaction of increasing prices at the farm level or, when there is a decrease in prices at the global market, it is suddenly reacted by decreasing prices at the farm level (Krivonos, 2004; Shepherd, 2004; Mofya-Mukuka & Abdulai, 2013; Subervie, 2011; Worako et al., 2008). It means specifically that the APT creates welfare loss for the coffee producers in Indonesia. Empirically, three main factors cause the APT to occur, namely market

power, adjustment costs, and government intervention. Adjustment costs only cause APT in the short term if there is no abuse of market power by marketing agencies (Acharya et al., 2011; Rahmanta et al., 2020). However, when there is an abuse of market power, it will cause APT in the long term. In addition, government policies in the form of fixing prices can also lead to APT (Meyer & von Cramon-Taubadel, 2004).

In the last decade, there are some previous studies on APT between the coffee price at the world markets and the domestic markets (Khumaira et al., 2016; Mofya-Mukuka & Abdulai, 2013; Rahmanta et al., 2020; Subervie, 2011). However, not all of them investigate APT for coffee from global to producers market. Rahmanta et al. (2020) and Khumaira et al. (2016) do not focus on APT between the world market and producer market. They used AECM to investigate APT from Indonesian to importing countries. Their results show that APT only occurs in the short term due to cost adjustments. Only Subervie (2011) and Mofya-Mukuka and Abdulai (2013) focus on APT between the coffee price at the world markets and the producer markets. Subervie (2011) has used a threshold co-integration model to analyze the transmission of world coffee prices to coffee prices at the producer level in Africa. The results show that the price adjustment was an asymmetric transmission. Besides, Mofya-Mukuka and Abdulai (2013) has also found an asymmetric relationship between coffee prices at the world markets and coffee prices in Zambia and Tanzanian producers market by using the threshold error correction model (TVECM). All of these studies used the ECM model as a basic approach to analyzing the relationship between the two markets such that the results obtained only APT on the speed side. Therefore, this study focuses more on the APT not only on the speed but also on the magnitude and the direction perspectives.

This study, in contrast to previous studies, includes Gross Domestic Product (GDP) variable as a control variable. There is a strong indication from several previous studies which claim that the national economic condition represented by GDP has a strong effect on commodity prices (Ibrahim, 2015; Bekkers, et al., 2017). They found that changes in GDP had a positive and significant effect on changes in food prices in the global market and domestic market. Specifically, in the Asian region, Ibrahim (2015) found that when there was a 1% increase in GDP, it would increase food prices by 0.48% in the Malaysian domestic market. As part of foodstuffs, it is assumed that the price of coffee in the producer market will also be influenced by GDP. Hence, the GDP becomes a control variable in this study. Then, (Meyer & von Cramon-Taubadel, 2004) said that market reform and liberalization have the opportunity to change the pattern of price transmission from global markets to producer markets. After the market reforms, domestic prices adjust faster to changes in world prices. In addition, real prices and the share of prices received by farmers against global prices have also increased after this reform policy. However, in general, the response of coffee prices in the producer market is faster when there is a decline than when coffee prices increase in the international market. This condition is an indication of the APT asymmetric price transmission that causes a decline in welfare (Meyer & von Cramon-Taubadel, 2004). This situation occurs in several countries in the African region such as Kenya, Tanzania, and Ethiopia (Krivonos, 2004; Worako et al., 2008).

Specifically, this study uses the Asymmetric NARDL model formulated by Shin et al. (2012). The reason is that Shin's NARDL enables us to develop a stable model for the analysis of this study. However, this study does not merely analyze the APT on the speed side but also analyzes the APT on the magnitude and direction sides. Therefore, the Asymmetric NARDL model of Shin et al. (2012) is indeed modified in speed, magnitude, and direction sides of the APT. Afterward, this study analyzes the coffee producer welfare due to the APT which occurs in Indonesia. Specifically, the main purposes of this study are (i) to investigate the relationship between the volatility of coffee prices in the global market and the Indonesian producer markets; (ii) to examine the long run and short-run asymmetric

transmissions for the coffee price from the world market to the Indonesian producer market; and (iii) to explore how is the impact of the APT that occurs on Indonesian coffee producers.

The rest part of this study consists of reviewing the literature relating to the asymmetric transmission of world coffee prices and producer coffee prices in section 2. Discussion of the data, method, and the economic model used are provided in section 3. Finally, it intensively discusses the results in section 4 and the main conclusion of the study findings and policy recommendations presented in section 5.

## 2. Theoretical literature review

Meyer and von Cramon-Taubadel (2004) highlight three characteristics of the APT, which are; (1) spatial and vertical APT, (2) the magnitude of APT, and the speed of price adjustment, and (3) the positive and negative APT. The type of APT often discussed as the main topic of study is the magnitude of APT and the speed of APT adjustment. The APT magnitude denotes the responsive size to price changes at one particular market level caused by price changes of another market level. Then, the APT speed shows how long it takes time by one certain market level to adjust to the price change that occurs in other market levels.

In general, there are some recent studies relating to the APT (Abdel-Latif et al., 2018; Adedeji et al., 2018; Alsamara et al., 2018; Amendola et al., 2019; Fousekis et al., 2016; Obeng, 2018; Rezitis & Tsionas, 2019; Sheikh et al., 2020). However, the price of coffee is still rarely discussed. There are two studies relating to APT between the price of coffee at the world markets and the producer markets of several countries such as those conducted by Subervie (2011), Mofya-Mukuka and Abdulai (2013), and Subervie (2011) used a threshold co-integration model to analyze the transmission of world coffee prices to producer coffee prices in Africa. The results of the study indicated that price movements are asymmetries. If the world coffee prices increased, it would not be necessarily transmitted to the producer price (farmers) of coffee. But, when the world coffee prices decreased, it was quickly followed by the decreased coffee prices of the producers in the market. This indicates that the failure of a perfectly competitive market structure. A further previous study Shepherd (2004) stressed that the agents and private actors at intermediate levels have market power which causes the price instability.

Mofya-Mukuka and Abdulai (2013) have also used the threshold error correction model (TVECM) to analyze the transmission of coffee prices before and after the policy reforms in Zambia and Tanzania. The results show that both before and after the policy reforms, the transmission of coffee prices between world markets and product markets is asymmetry. In Zambia, before policy reforms, producer prices responded slower when world prices increased compared to those of when world prices fell. In contrast, after the policy reforms, producer prices responded faster when world prices increased. In Tanzania, both before and after the policy reforms, producer prices responded faster when world prices rose than when world prices fell, even though before the policy reforms, the response was not as fast as after the policy reforms.

Several other studies (Ibrahim, 2015; Kumar, 2017; Shin et al., 2012) using the NARDL model did not focus intensively on the relationship between world coffee prices and producer coffee prices. They merely used the NARDL model to detect the existence of symmetric and asymmetric relationships. Moreover, Shin et al. (2012) conducted a study to examine the nonlinearity of a bivariate relationship between output and unemployment in the United States, Canada, and Japan. Then, Ibrahim (2015) estimates the presence or absence of asymmetry in food price behavior in Malaysia. Furthermore, Kumar (2017) examines the relationship between oil prices and gold prices in India using the NARDL model. All of them claimed that the relationships between independent variables and dependent variables are nonlinear. Therefore, the first hypothesis of this study is that the relationship between coffee prices at the global market and the Indonesian producer market is nonlinear cointegration in

nature. Differ from previous studies, this study uses Shin's Asymmetric NARDL model with a strong emphasis on the magnitude, speed, and direction sides of the APT of coffee from the world market to the Indonesian producers market. Therefore, the second hypothesis is that in the short-run and long-run transmissions for the coffee price between the world market and the Indonesian producer market are asymmetric in magnitude, speed, and direction perspectives.

### 3. Data and model specification

#### 3.1. Data

The various sources of the annual data from 1980 to 2018 are used in this study. Coffee price data at the producer level are obtained from the Food and Agricultural Organization (FAO), coffee prices at the world market are sourced from the World Trade Organization (WTO), while GDP is obtained from World Bank data. The annual data of the Coffee prices at the producer level, at the world market, and Indonesian GDP are expressed in US Dollar units. Because the range of data values among the variables used is very diverse, all data are transformed into logarithmic form. The consequences of all data transformed into a natural logarithm, the relationship between the independent variables and the dependent variable are expressed in a double log model. One of the advantages of this double log model is that the coefficients of estimation show constant elasticity. Therefore, in the long term, the effect of GDP and shocks of coffee prices in the global market on coffee prices in producer markets can be analyzed based on these coefficients.

#### 3.2. Model specification

The initial model framework of this study starts with the ARDL co-integration model which contains two data series which are prices of coffee at the Indonesian producer level (LI) and the coffee prices at the world market (LW) based on (Pesaran et al., 2001) expressed in the following formula:

$$\Delta LI_t = \alpha_0 + \alpha LI_{t-1} + \beta LW_{t-1} + \sum_{j=0}^{p-1} \alpha_j \Delta LI_{t-j} + \sum_{j=0}^{p-1} \beta_j \Delta LW_{t-j} + e_t \quad (1)$$

Then, the Indonesian GDP (LY) as a control variable is included in equation 1. Equation 1 can be represented as follows:

$$\begin{aligned} \Delta LI_t = & \alpha_0 + \alpha LI_{t-1} + \beta LY_{t-1} + \gamma LW_{t-1} + \sum_{j=0}^{p-1} \alpha_j \Delta LI_{t-j} \\ & + \sum_{j=0}^{p-1} \beta_j \Delta LY_{t-j} + \sum_{j=0}^{p-1} \gamma_j \Delta LW_{t-j} + e_t \end{aligned} \quad (2)$$

Equation 2 represents a linear co-integration relationship among Indonesian GDP, the price of coffee at the world market, and the price of coffee at the Indonesian producers market. In other words, the relationship among these variables is linear and symmetrical condition. If co-integration exists between these variables, the long-run relationship of them can be presented as follows:

$$LI_t = \rho_0 + \rho LY_{t-1} + \tau LW_{t-1} \quad (3)$$

where:  $\rho_0 = \alpha_0/\alpha$ ,  $\rho = \beta/\alpha$  and  $\tau = \gamma/\alpha$ .

Based on the data phenomenon of this study, there is a possibility of a non-linear relationship between the coffee prices at the world market and the coffee prices at the Indonesian producers market. Therefore, equation 2 can be redeveloped by adopting the NARDL model as formulated by Shin, Yu, and Greenwood-Nimmo (2014) as follows:

$$\begin{aligned} \Delta LI_t = & \delta_0 + \delta LI_{t-1} + \pi LY_{t-1} + \theta LW_{t-1}^+ + \theta LW_{t-1}^- \\ & + \sum_{j=0}^{p-1} \lambda_j \Delta LI_{t-j} + \sum_{j=0}^{q-1} \pi_j \Delta LY_{t-j} + \sum_{j=0}^{r-1} \theta_j \Delta LW_{t-j}^+ + \sum_{j=0}^{s-1} v_j \Delta LW_{t-j}^- + e_t \end{aligned} \quad (4)$$

In [equation 4](#), this study tries to identify the shock of coffee prices at the world market by differentiating it into positive shock ( $LW^+$ ) and negative shock ( $LW^-$ ). Now, [equation 4](#) represents a nonlinear co-integration relationship between the coffee prices at the world market and the coffee prices at the Indonesian producer market, when it rejects the null hypothesis  $\delta = \pi = \theta = v = 0$  through the Bound test. In other words, these variables have an asymmetric relationship. The long-run relationship form of the co-integration of these variables in this study can be depicted as follows:

$$LI_t = \lambda_0 + LY_{t-1} + \sigma LW_{t-1}^+ + \omega LW_{t-1}^- \quad (5)$$

where:  $\lambda_0 = \delta_0/\delta$ ,  $\lambda = \pi/\delta$ ,  $\sigma = \theta/\delta$ ,  $\omega = v/\delta$  and.

Moreover, to prove the APT in magnitude perspective, we follow the procedure from Adedeji et al. (2018) in which they use the Wald test for testing whether long-run symmetric relation exists among the variables with the hypothesis that  $\sigma = \omega$  and short-run symmetric with the hypothesis  $\theta_j = v_j$ . Furthermore, to prove the asymmetric transmission from the speed side, it can be denoted by the appearance of positive and negative shocks of the coefficients simultaneously in the same lag period. If they appear simultaneously in the same lag period, there will be symmetric in speed perspective. On the contrary, if they do not appear all together in the same lag period, it means asymmetric transmission in speed perspective. Then, to examine the asymmetric transmission in the direction side, it can be demonstrated by comparing the signs of the positive and negative shocks of the coefficients. If the signs of the coefficients are the same, it denotes that there is no asymmetric transmission. In contrast, if the signs are different, it means that will be asymmetric transmission in direction.

Besides, several steps are followed in this study before estimating [equations 4 and 5](#); (i) the stationary of the data is first tested using the Augmented Dickey-Fuller (ADF) and Lee and Stracizichi Lagrange Multiplier (LSLM) tests to obtain the structural break. This stationary test does not require all stationary data at the level I (0) or at the first difference I (1), but the important thing of stationary data is not at the second difference I (2); (ii) before interpreting the estimation results and performing estimates by using the NARDL models, several statistical diagnoses are employed. Jarque-Bera statistics and the LM statistics are used for checking the error normality and the autocorrelation of data, respectively, and ARCH statistics are used for the heteroscedasticity test. We follow Ibrahim (2015) and Adedeji et al. (2018), to adopt the general-to-specific procedure to arrive at the final specification of the NARDL model by trimming insignificant lags. These results are represented at the lower panel in [Table 2](#); (iii) The next step is a co-integration test among the variables to show the relationship of all variables long run (the dependent variable and independent variables), particularly after making the shock on the independent variables). In this case, we follow Narayan (2005) who uses lower and upper bound for the co-integration test. In addition, the other accuracy tests of the model used are CUSUM and CUSUMSQ tests to look into the stability of the model utilized in this study. They are performed to the NARDL model which is presented in [Figure 4](#); (iv) Then, determining the formulation of the long-run relationship in [equation 5](#) is based on the estimated coefficients in [equation 4](#); (v) Finally, the asymmetric transmission test is conducted by using the Wald test.

#### 4. Empirical results and discussion

The descriptive statistics analysis concerning the main variables used in this study, [Table 1](#) shows that the average price of coffee at the world market during the study period (1980–2017) was 2916 USD/ton while the average price of coffee at the Indonesian producer market was only 1393 USD/ton. Indonesia's GDP, in general, has increased with an average value of 335 billion USD



**Table 1. Descriptive statistics of world coffee price, Indonesian producer coffee prices, and Indonesian GDP**

| Statistic indicators | World Prices (LW) | Producer Prices (LI) | GDP (LY) |
|----------------------|-------------------|----------------------|----------|
| Mean                 | 2916              | 1393                 | 335      |
| Max                  | 1357              | 578                  | 72       |
| Min                  | 5976              | 2855                 | 1015     |
| Std.Dev              | 1002              | 517                  | 317      |
| No. Obs              | 38                | 38                   | 38       |

Source: Data sources from the Food and Agricultural Organization (FAO), the World Trade Organization (WTO), and World Bank (2018).

during 38 years of observed data. Specifically, [Table 1](#) shows the descriptive statistics of the main variables used in this study are as follows:

Based on the descriptive statistics analysis, it continues with the first step of the model used, the ADF and LSLM tests. They are used to know the stationary condition of all observed variables of this study. In this study, the hypothesis that the price series are nonstationary is tested using both the Augmented Dickey-Füller (ADF) test and the LSLM structural break unit root test suggested by Lee and Strazicich (2003). In particular, the LSLM procedure searches the overall possible breakpoints to test for the structural breaks and accounts for the fact that the breakpoints are dependent on the data. The AIC values were employed to determine the appropriate lag length which varied across the series. [Table 2](#) presents the results of the unit root tests. Both the ADF and the LSLM tests indicate that all the series are non-stationary at levels, but stationary at first differences. As shown in [Table 2](#), the identified structural break for the Indonesian producers coffee process was the year 1986, which coincides with the completion of economic reforms in the agricultural sector. For World prices, the revealed structural break was in 2009, as the impact of the 2008 global financial crisis on commodities prices includes coffee prices. For GDP, a structural break occurred in June 1998, it is coinciding with the impact of the Asian financial crisis. Subsequently, the Durbin-Watson (DW) values confirmed the absence of autocorrelation in this study.

Accordingly, we estimated Equation (2) and (4) for ARDL and NARDL models respectively. The preferred specification is chosen by grid search of better lags starting with  $\max p = q = 4$  were finally used for the estimation. We adopt the general-to-specific procedure to arrive at the final specification of the NARDL model by trimming insignificant lags as in Ibrahim (2015) and Adedeji et al. (2018). One of the

**Table 2. Stationarity tests**

| Variables | ADF     |                 |  | LSLM             |         |                 |
|-----------|---------|-----------------|--|------------------|---------|-----------------|
|           | Level   | 1st differences |  | Structural break | Level   | 1st differences |
| LI        | -1.9867 | -2.1035***      |  | 1986             | -2.6165 | -5.6706***      |
| LY        | -0.0671 | -6.0067***      |  | 1998             | -2.5081 | -11.8194***     |
| LW        | -2.3567 | -6.4355***      |  | 2009             | 3.6919  | -6.4522***      |

Note:\*\*\*indicate significant at 1%

advantages of a general to the specific procedure in NARDL model estimation is the results can remove insignificant lags. The estimation results are represented in [Table 3](#) which is completed with several results of diagnostic statistics. Based on the P-values of the Jarque-Bera test (J-B test), the Lagrange Multiplier test (LM test), and the ARCH test, the data of this study appear to be statistically normal, and free from autocorrelation and heteroscedasticity problems.

Based on the estimated results in [Table 3](#), we examine the cointegrating and long-run equations for both models, ARDL and NARDL presented in [Table 4](#). The critical values are taken from Narayan's critical values table simulated for the bound test. Based on the result, it shows that the F-statistics value of the ARDL model is between lower and upper bound so that we can not conclude whether the co-integration or no co-integration among variables in the ARDL model. However, the F-statistics value of the NARDL model is above 6.250 (95% upper bound). It means that the rejection of the hypothesis is done. This underlines that the existence of the long-run co-integration between the variables, and suggesting the asymmetric nature of the relationship in the respective time horizon (long-run or short-run). These findings represent that a nonlinear co-integration is formed between the world coffee prices and the coffee prices at the Indonesian producer market by involving Indonesian GDP as a control variable. This also underlines that the further analysis of this study refers to the estimation results of the NARDL model.

According to the stability model tests of the NARDL model by using CUSUM and CUSUMSQ, they show that the path lines of the estimation model are inside the borderlines with a 5% significance level. This denotes that the NARDL model is stable and it does not need to continue with the correlogram assessment of the residual squared test. [Figure 1](#) presents the CUSUM and CUSUMSQ for stability model tests of the NARDL model as follows:

The further analysis of this study is the long-run relationship based on the estimation results of the previous NARDL model which is represented in [Table 5](#). Based on [Table 5](#), the coffee price at the Indonesian producer market, in the long run, is highly volatile as indicated by the constant value of estimation coefficient of about  $-8.957$ . Moreover, if there is a change (increase or decrease) of Indonesian GDP by 1%, it will result in a change (increase or decrease) in the coffee price at the Indonesian producer market by 0.68% in the long run. The other important thing of this study is that the price changes at the world market are separated into the positive shocks as an increase coffee price and the negative shocks as a decrease in coffee price to examine the impact of these changes on the producer coffee prices in Indonesia. The positive shocks are represented by the LW\_Positive coefficient and negative shocks are represented by the LW\_Negative coefficient. The results denote that, in the long run, when there is an increase in coffee price at the world market by 1%, it will increase the coffee price at the level of Indonesian coffee producers by 0.32%. Meanwhile, when there is a decrease in the coffee price by 1% at the world market, it will reduce the coffee price at the producer market by around 0.90%. The difference of the LW\_Positive and LW\_Negative coefficients, in the long run, highlights an important point of this study that there is a strong indication of an APT from the world coffee price to the coffee price of the Indonesian producer level. Therefore, to explore it more deeply, it is indeed necessary to perform an APT test.

The asymmetric test can be classified into long-run and short-run asymmetric tests. In the short run, an asymmetric transmission can be analyzed in terms of direction, magnitude, and speed sides. Meanwhile, in the long run, the APT is merely examined in terms of direction and magnitude sides.

In the short run, based on [Table 4](#), there is a difference in sign of the positive and the negative shock coefficients of coffee prices at the world market. At this point, the sign of positive shock coefficient is negative and the sign of negative shock coefficient is positive. This means that there is a strong APT in the direction side between the coffee prices at the world market and the Indonesian producer market.

**Table 3. The Estimation result of ARDL and NARDL models**

| Variables              | ARDL model  |         | NARDL model |         |
|------------------------|-------------|---------|-------------|---------|
|                        | Coefficient | P Value | Coefficient | P Value |
| Constant               | 0.670127    | 0.5669  | -6.726503   | 0.0230  |
| LI(-1)                 | -0.721177   | 0.0008  | -0.750970   | 0.0000  |
| LY(-1)                 | -0.211240   | 0.0043  | 0.513881    | 0.0006  |
| LW(-1)                 | 1.250820    | 0.0006  | -           | -       |
| LW_P(-1)               | -           | -       | 0.327001    | 0.0491  |
| LW_N(-1)               | -           | -       | 0.755129    | 0.0003  |
| DLI(-1)                | 0.510895    | 0.0179  | 0.466341    | 0.0051  |
| DLI(-2)                | -           | -       | -           | -       |
| DLI(-3)                | -           | -       | -0.485381   | 0.0002  |
| DLI(-4)                | -           | -       | -           | -       |
| DLY                    | 0.726755    | 0.0013  | -           | -       |
| DLY(-1)                | -           | -       | -0.798358   | 0.0012  |
| DLY(-2)                | 0.648595    | 0.019   | -           | -       |
| DLY(-3)                | -           | -       | -           | -       |
| DLY(-4)                | 0.381107    | 0.047   | -0.354395   | 0.0371  |
| DLW                    | 0.532897    | 0.0013  | -           | -       |
| DLW(-1)                | -0.486107   | 0.0512  | -           | -       |
| DLW(-2)                | -0.458328   | 0.0206  | -           | -       |
| DLW(-3)                | -0.256294   | 0.071   | -           | -       |
| DLW(-4)                | -0.375529   | 0.0262  | -           | -       |
| DLW_P                  | -           | -       | -           | -       |
| DLW_N                  | -           | -       | 1.078196    | 0.0001  |
| DLW_P(-1)              | -           | -       | -0.307404   | 0.0764  |
| DLW_N(-1)              | -           | -       | -           | -       |
| DLW_P(-2)              | -           | -       | -           | -       |
| DLW_N(-2)              | -           | -       | -0.710079   | 0.0017  |
| DLW_P(-3)              | -           | -       | -           | -       |
| DLW_N(-3)              | -           | -       | -           | -       |
| DLW_P(-4)              | -           | -       | -1.018462   | 0.0000  |
| DLW_N(-4)              | -           | -       | 0.967198    | 0.0002  |
| R <sup>2</sup>         | 0.79        |         | 0.88        |         |
| R <sup>2</sup> adjusts | 0.67        |         | 0.80        |         |
| F-Stat                 | 6.327203    | 0.0002  | 11.05131    | 0.0000  |
| J-B                    | 0.832840    | 0.6594  | 1.045618    | 0.5928  |
| LM(1)                  | 0.293310    | 0.5881  | 2.260577    | 0.1327  |
| LM(2)                  | 0.328292    | 0.8486  | 4.170534    | 0.1243  |
| LM(3)                  | 7.716450    | 0.0523  | 4.242749    | 0.2364  |
| LM(4)                  | 8.028615    | 0.0905  | 5.891435    | 0.2074  |
| ARCH(1)                | 1.198914    | 0.2735  | 0.230902    | 0.6309  |
| ARCH(2)                | 0.704108    | 0.7023  | 1.40864     | 0.4944  |
| ARCH(3)                | 0.767318    | 0.8573  | 1.896087    | 0.5943  |

(Continued)

**Table 3. (Continued)**

| Variables | ARDL model  |         | NARDL model |         |
|-----------|-------------|---------|-------------|---------|
|           | Coefficient | P Value | Coefficient | P Value |
| ARCH(4)   | 2.224431    | 0.6946  | 2.216733    | 0.6960  |
| $W_{LR}$  | -           | -       | 47.87327    | 0.0000  |
| $W_{SR}$  | -           | -       | 3.168334    | 0.0930  |

Note: J-B is the Jarque-Bera test for error normally, LM(n) where n = 1,2, 3,4 is the LM test for error autocorrelation up to the lag order given in the parenthesis, and ARCH(n) where n = 1,2, 3,4 is the ARCH test for autoregressive conditional heteroskedasticity up to the lag order given in the parenthesis.

**Table 4. The result of the co-integration test**

| Model specification | F Statistic | 95% lower Bound* | 95% upper Bound* | Conclusion     |
|---------------------|-------------|------------------|------------------|----------------|
| ARDL                | 5.72624     | 4.428            | 6.250            | no conclusion  |
| NARDL               | 12.51528    |                  |                  | co-integration |

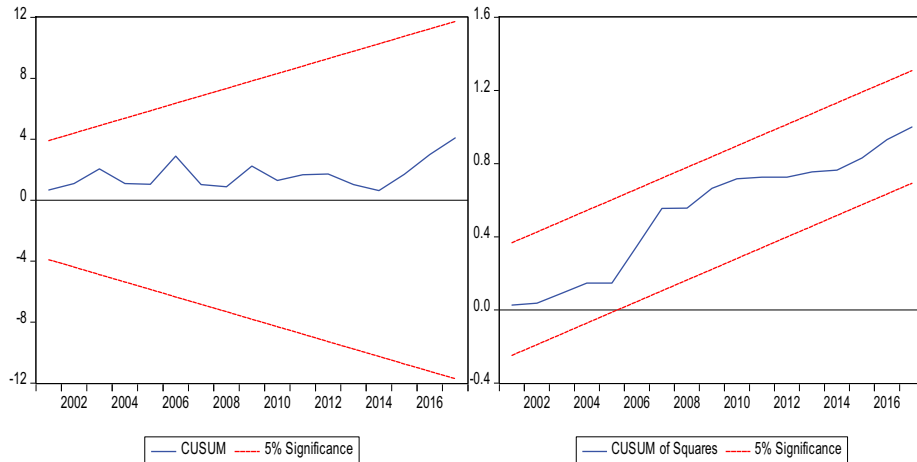
Notes: \*The critical values of co-integration decision are based on Narayan (2005), given the small sample size.

This condition denotes that the coffee price at the Indonesian producer market decreases in the short run when the coffee price at the world market increases. The APT in the speed side is indicated by differences in time response with the positive shock coefficient (DLW\_P) or negative shock coefficient (DLW\_N) of coffee prices at the world market during the lag period. The positive shock coefficient of DLW\_P does not exist, but the negative shock coefficient of DLW\_N exists and it is significant. Moreover, the only positive shock of DLW\_P (-1) exists and it is significant, while the negative shock of DLW\_N(-1) does not exist. Furthermore, the negative shock of DLW\_N(-2) exists and it is significant, while the positive shock of DLW\_P(-2) does not exist. This shows strong evidence that there is an APT in terms of speed side between the price of coffee at the international market and at the Indonesian producer market in the short run. This result indicates that the speed of adjustment in price at the Indonesian producer market occurs faster when the coffee price at the world market decreases compared to the increasing coffee price at the world market.

In magnitude perspective, APT in the short run also appears as indicated by the size of positive and negative shock coefficients which differ significantly based on the F Statistic and P-Value of the Wald test result in Table 6. The important thing related to the APT is that it matters in terms of the magnitude, speed, and direction in the short run. The main cause of the formation of coffee APT in the short term in Indonesia is the adjustment cost (Khumaira et al., 2016; Rahmanta et al., 2020)

In the long run, the signs of positive and negative shock coefficients of coffee prices at the world market are the same, both of which have the same sign, namely positive (see Table 5). It means that there is no APT on the direction side. In other words, the direction of coffee price changes at the Indonesian producer and the world market has a similar movement. Moreover, from a magnitude perspective, there is an APT of the coffee price from the world market to the Indonesian producer market. This result is based on the significant P-Value of the long-run Wald test result (see Table 6). The APT on the magnitude side is very detrimental for Indonesian producers because the positive shock coefficient is smaller than the negative shock coefficient.

**Figure 1. CUSUM and CUSUMSQ for stability model test of NARDL.**



**Table 5. Long-run relations**

| Variables   | Coefficient | P-Value |
|-------------|-------------|---------|
| Constant    | -8.957092   | 0.0251  |
| LY          | 0.681826    | 0.0001  |
| LW_Positive | 0.322891    | 0.0585  |
| LW_Negative | 0.896604    | 0.0001  |

This condition denotes that there has been a failure to establish a competitive market in Indonesia due to the existence of strong market power in the domestic market.

Based on the previous empirical description, it can be summarized the results of the APT analysis in the following Table 7. In the short run, there is an APT in terms of direction, speed, and magnitude sides which have an impact on the welfare loss of coffee producers in Indonesia. In the long run, there is no APT in terms of direction side so that the directional movement of the coffee price at the Indonesian producer market is the same as its direction at the world market. However, there is only an APT in terms of magnitude side which has an impact on the welfare loss of coffee producers due to the smaller response of coffee prices at the Indonesian producer market when the world coffee prices increase compared to the world coffee prices decrease.

Based on Tables 5, 6, and 7, there is strong evidence that there is a negative APT for Indonesian coffee producers. In addition, GDP, positive shocks, and negative shocks to coffee prices in the global market have a positive and significant effect on changes in coffee prices in the producer market in the long term. However, because each coefficient value is smaller than 1, it indicates that market demand is an inelastic condition so that the impact on producer welfare is not too

**Table 6. Long-run and short-run asymmetric tests**

| Variables               | F-statistic | P-value |
|-------------------------|-------------|---------|
| Wald Test <sub>IR</sub> | 47.87327    | 0.0000  |
| Wald Test <sub>SR</sub> | 3.168334    | 0.0930  |

**Table 7. The characteristics, indicators, and results of APT tests**

| Period    | Characteristics of APT | Indicators of APT  | Conclusion |
|-----------|------------------------|--|------------|
| Short-run | Direction              | Different in sign between the DLW_P(-n) coefficients and DLW_N(-n) coefficients (Table 3)  | Asymmetric |
|           | Speed                  | DLW_P(-n) coefficient and DLW_N(-n) coefficient do not exist with the same lag (Table 3)   | Asymmetric |
|           | Magnitude              | Wald test result is significant (Table 6) and DLW_P(-n) coefficients are smaller than DLW_N(-n) coefficients (Table 4)                       | Asymmetric |
| Long run  | Direction              | The same sign of LW_Positive(-1) coefficient and DLW_Negative(-1) coefficient (Table 5)  | Symmetric  |
|           | Magnitude              | Wald test result is significant (Table 6) and the Magnitude of LW_Positive coefficient is smaller than the LW_Negative coefficient (Table 5) | Asymmetric |

large. A 1% change in GDP will cause a 0.68% change in producer prices. This means that the national economy still plays a role in the price of coffee in the producer market. Furthermore, a positive shock coefficient of 0.3 indicates that an increase in coffee prices in the international market by 1% will increase coffee prices in the producer market by 0.32%. The negative shock coefficient of 0.89 indicates that a 1% decline in coffee prices in the global market will cause a decline in coffee prices by 0.89%.

The difference between the effect of increasing and decreasing coffee prices in the global market on coffee prices in producer markets is a strong indication of an increase or decrease in producer welfare. If the increasing effect is greater than the decreasing effect, the producer's welfare increases. On the other hand, if the decreasing effect is greater than the increasing effect, the producer's welfare decreases. The result of this study shows that the decreasing effect is greater (0.89%) than the increasing effect (0.32%). In the long term, coffee producers have the opportunity to experience a decline in welfare if GDP does not change. However, like GDP, in general, continued to increase during the study period, the difference of coefficient values (0.89%-0.32% = 0.57%) had denoted a little impact on the welfare of Indonesian coffee producers. It means that Indonesian coffee producers are more prosperous when there is an increase rather than a decrease in coffee prices in the international market.

In sum, this condition indicates that there has been a failure to establish a competitive market in Indonesia. Therefore, policymakers need to make various efforts as a stimulus to stabilize the formation of a competitive market in Indonesia in the particular coffee market. These findings are in line with the research results of Subervie (2011) in which the price adjustments are asymmetric. If

an increase in world coffee prices, it is not necessarily transmitted to the coffee prices of producers (farmers). But, if a decrease in coffee prices at the world market is rapidly transmitted to coffee prices at the producers (farmers). This result also deals with the Mofya-Mukuka & Abdulai' findings (2013) in which the producer price responses are slower when the world prices increase than the world prices fall for the case of Zambia. However, this result contradicts the case of Tanzania where producer price responses are faster when the world prices increase than the world prices fall. The critical finding of this study shows that the negative APT for Indonesian coffee producers, in the long run, underlines an indication of the failure to perform a perfectly competitive market structure. This is caused by the third party in which agents at the coffee market play an important role and misuse the market power which affects the price instability at the coffee producer level. As a result, if the national economy tends to be unstable due to economic shocks, Indonesian coffee producers tend to suffer losses due to this negative price asymmetry.

## 5. Summary and conclusion

Almost all previous studies of Asymmetric Price Transmission (APT) only focus to speed perspective. This study is the first to analyze the APT with a different pattern of coffee prices volatility in magnitude, speed, and direction perspectives by using Shin's Asymmetric NARDL model. The study aims to investigate the relationship between coffee prices in the global market and the Indonesian producer market. We also explore the APT in magnitude, speed, and direction perspectives of the coffee of the two markets by including GDP as a control variable. The first important finding of this study shows that there is a non-linear co-integration between the coffee prices at the world market and the Indonesian producer market. This is highly supported by Bound test results. It means that Shin's Asymmetric NARDL model enables us to obtain a strong relationship between the coffee prices volatility in the global market and the producers market. The second essential point is that the coffee price transmission from the global market to the Indonesian producer market both in the short-run and long-run is asymmetric. In the short run, there is an APT concerning the magnitude, speed, and direction. This situation is caused by adjustment costs at some value channel of the domestic market.

In the long run, there is an APT in terms of magnitude based on the coefficients of positive and negative shocks of coffee prices at the world market. For Indonesian coffee producers, there is a negative APT as indicated by the coefficient of the positive shock of world coffee prices which is smaller than the negative shock coefficient. The coffee price response at the producer market is higher when the world coffee prices decrease compared to the world coffee prices increase. If the performance of the national economy is stable, Indonesian coffee producers are more likely to increase global coffee prices compared to decrease. However, in the Indonesian economic recession, coffee producers tend to suffer welfare loss due to the negative shock of world coffee prices.

This situation is caused by some players use market power in the domestic market. The negative APT for coffee producers, in the long run, denotes a strong indication of the domestic market failure to perform a perfectly competitive market structure in Indonesia. It means that the coffee farmers in Indonesia tend to suffer welfare loss due to the negative shock of world coffee prices, especially if the condition of the national economy is a recession as an impact of the economic shocks. Therefore, governance should not only focus on economic growth, but governance also has to make some policies assessing the welfare of coffee producers. In sum, one of the efforts to keep a high coffee price level at the coffee producers is that the policymakers need to provide a stimulus for the stability of the competitive market structure by reducing monopsony power in the domestic coffee market.

We realize the limitation of this study is that it only examines the APT between the global market and the producer market in Indonesia. The result of this study denotes that, for coffee commodities, the APT between the global market and the producer market exists in Indonesia. There is market power in domestic marketing channels between producers and collectors of coffee

commodities or between collectors and exporters of coffee commodities. Market power owned by collectors and exporters causes the APT. Therefore, further study is needed to involve the transmission of coffee prices between the exporter's market and the collector's market.

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