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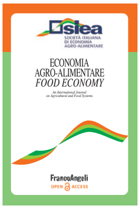

Asymmetric Price Transmission in the Cocoa Supply Chain in Indonesia

Ahmad Ridha[a,b], **Raja Masbar**[*,a], **Aliasuddin**[a], **Vivi Silvia**[a]

[a] Syiah Kuala University, Indonesia
[b] Samudra University, Indonesia

Abstract

This study investigates the asymmetric price transmission (APT) of global cocoa beans and cocoa pasta prices to farm prices. The cocoa pasta variable is a proxy for Indonesian processed cocoa industry products. We use monthly time series data from January 2007 to December 2020. The NARDL model was used to estimate the APT response behavior. The dummy variable (export cocoa bean tax) explains fluctuations in farm prices before and after the policy implementation. The results showed asymmetric cointegration between the global cocoa market and cocoa pasta prices moving towards farm cocoa prices in Indonesia. APT occurs in the short and long term with different significant levels for each variable. The increase (decrease) in the global market and cocoa pasta prices were transmitted asymmetrically in the short and long terms, except for the variable (PA-pos), which is not significant in the long term. We observe strong evidence of negative asymmetric price transmission. Negative price shocks (decreases) in global markets and cocoa pasta are more rapidly transmitted to farmer prices than positive price shocks. Adjustment prices occur in magnitude, speed, and sign. The high coefficient of negative asymmetric price transmission indicates the uncompetitive of Indonesia's supply-demand cocoa chain. At the same time, the cocoa bean export tax harms farm prices. The export tax policy has reduced farm prices by approximately 2.3%.

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* *Corresponding author*: Raja Masbar - Professor - Department of Economics - Syiah Kuala University - Banda Aceh City, 23111, Indonesia. E-mail: raja.masbar@unsyiah.ac.id.

Introduction

Price is the essential mechanism that links the various levels of the market. The study of vertical and horizontal price transmission allows for estimates of the market's entire activity (Vavra & Goodwin, 2005). The focus of this study was prompted partly by societal and political concerns about the food industry and distribution sector's concentration. These changes may impact the competitive position of market participants and price dynamics (Hassouneh *et al.*, 2015). The magnitude and speed of the coefficient are the market's ability to change prices and the intensity of competition in the agricultural marketing chain (Meyer & von-Cramon-Taubadel, 2004; Trestini & Penone, 2018).

Smallholder farmers in developing countries act as price takers, meaning they do not have a bargaining position on the price of their products (Jambor *et al.*, 2017). Many observers believe that intermediaries are more likely to cut prices than raise them. As a result, a rise in global prices may not be entirely passed on to farm prices, but a decrease in world prices is more likely to be fully passed on to farm prices (Usman & Haile, 2017). The discrepancy in the response of positive and negative shocks from upstream to downstream or vice versa is called asymmetric price transmission.

Asymmetric price transmission (APT) exists in agricultural markets, but the transmission differs based on commodities, countries, and market movements (Mclaren, 2015). APT can occur in the short and long term depending on the stochastic process that governs the price (Rezitis & Tsionas, 2019). Short-term APT is intended to compare the intensity of output price variations with positive and negative price changes in the input variables. Long-term APT is used to look at reaction time, the length of fluctuation, and the speed at which prices move toward an equilibrium level (Frey & Manera, 2007; Mclaren, 2015).

Two types of price transmission are horizontal and vertical. Horizontal price transmission is the large amount of disparate information that moves between markets. At the same time, vertical transmission is price movement along the supply chain (Vavra & Goodwin, 2005). Vertical transmission can describe the price adjustment mechanism between upstream and downstream markets (Chaudhry & Miranda, 2020). Price transmission relationships are typically characterized by price adjustments' speed, direction, and magnitude toward market shocks (Meyer & von-Cramon-Taubadel, 2004).

Several studies have investigated the asymmetric adjustment of vertical and horizontal price processes along supply and demand chains, and the results vary. Rezitis (2018), studies the vertical transmission among livestock and retail for various dairy products in Finland. Panagiotou (2021) tested the asymmetric vertical price transmission in the United States agricultural market, asserting that positive shocks to producers and distributors of prices are transmitted to retail at a more significant and faster rate than negative shocks in the long term. Korale *et al.* (2016) and Alam *et al.* (2016), found the presence of APT on the rice markets from upstream to downstream in Sri Lanka and Bangladesh. However, the opposite is not a rule.

Several works of literature examine horizontal price transmission, considering the relationship between domestic spot prices and global markets (Arnade *et al.*, 2017; Baffes & Gardner, 2003; Bekkers *et al.*, 2017). Several studies examine vertical price transmission (Acharya *et al.*, 2011). Some studies examine the transmission of future prices to the domestic spot market in agricultural commodities (Trestini & Penone, 2018). Many scientific studies have identified asymmetry in the adjustment of aggregate prices, which has prompted economists to study this phenomenon more in depth (Mclaren, 2015). Studying the transmission of commodity prices provides an outlook about the efficiency of markets and the welfare distribution of consumers and producers (Meyer & von-Cramon-Taubadel, 2004).

Furthermore, Kamaruddin *et al.* (2021), found an asymmetric price transmission between coffee prices in the international market to producers in Indonesia in the long term and short term. In addition, Fafchamps & Hill (2008) found that itinerant traders are the primary source of asymmetric price transmission from global markets to agricultural markets in Uganda. Bonjean & Brun (2011), confirm that the price of chocolate bars in France does not always react to fluctuations in global cocoa bean prices. High adjustment costs and stock management may partly explain this. In the 1970s, the boom in world cocoa bean prices was responded to quickly by the increase in the price of chocolate bars in France. On the other hand, the chocolate industry sector was very slow in responding to the drastic decline in world cocoa bean prices in the 1980s.

In the past, APT has reflected a failure of the market in microeconomics. Each external shock to the market price, either positive or negative, should result in a linear adjustment to the long-term market equilibrium (Frey & Manera, 2007). However, recent literature on APT can appear in perfectly competitive markets. Hence, it is inappropriate to deduce APT to reflect the market failure (Gizaw *et al.*, 2020). Because of the essence of this phenomenon, the researcher investigates what causes asymmetric price transmission. According to Meyer & von-Cramon-Taubadel (2004), market power, search costs, food adjustment costs, the trait of agricultural goods, and inventory storage can cause APT.

The typical explanation for price variations of agricultural products depends on the variations of market integration. The degree of market integration is a function of the magnitude of trading costs, which are often strongly influenced by government policies (Bekkers *et al.*, 2017). Indonesian government's policies have ratified export duties on cocoa beans since April 2010. Several studies have examined the impact of export taxes on domestic cocoa bean prices, such as Hasibuan & Sayekti (2018), Yudyanto & Hastiadi (2019) and Rifin (2015). The findings showed that the export duty had no significant effect on the price of cocoa beans at the farmers' level.

There is no research from all the studies above that analyzes the farmer's cocoa beans price in Indonesia through the asymmetric model. The cocoa pasta variable in the model is essential for explaining the relationship between the upstream and downstream sectors after the cocoa bean export tax is implemented. This model is significant to get more accurate analysis results.

Prices play an essential role in a market economy. Price volatility has severe implications for the economic well-being of various agents in the distribution management of agricultural products. Therefore, it is necessary to study price transmission to provide recommendations for policymakers. This research is noteworthy as price transmission will be seen from two sides, namely international cocoa bean prices (horizontal) and processed cocoa prices (vertical), combined in one analysis model.

The objectives of this study were (1) to examine the asymmetric price transmission of global cocoa bean and cocoa pasta prices to farmers' cocoa prices. (2) to determine the impact of the export tax policy on the fluctuations of cocoa farmers' prices

This paper contributes to the literature: (i) there are still few studies related to cocoa price transmission with asymmetric models in Indonesia. (ii) to fill the literature gap on the price transmission of processing cocoa industry products and farmers' cocoa prices in Indonesia, which is considered vital after the export tax implementation. Therefore, this paper can assist policymakers, academicians, and stakeholders, mainly related to the asymmetric price of cocoa in the domestic market.

The rest of the paper is organized as follows. Section 1 highlights the background. Section 2 is materials and methods. Section 3 is results and discussions, and Section 4 concludes the study.

1. Background

Indonesia is categorized as a developing country with a GDP per capita of USD 3,870 and the fourth most populous country globally (World Bank, 2020). The cocoa plantation sector plays an essential role in the Indonesian economy since it employs 900,000 farmers, with a cocoa production area of 1.6 million hectares. The people manage 87.4% of the plantation while large state-owned and private companies control the rest 12.6%. The average cocoa production is around 500,000 tons per year. Meanwhile, the number of exports of cocoa and its derivative products is USD 2 billion (BPS-Statistics Indonesia, 2021). It contributes to poverty reduction by providing employment and income in rural areas (Pratama *et al*., 2019).

The government implemented a cocoa revitalization program from 2009 to 2013 (known as the national movement for cocoa) to increase declining cocoa production and productivity. The decline in production was due to the oldness of trees and diseased cocoa plants. The average cocoa productivity in Indonesia is around 650 kg per hectare. It is still far from the ideal capacity, which can reach up to 1,500 kilograms per hectare. This program targets 450,000 hectares of land in 25 provinces in Indonesia through rejuvenation, intensification, farmer empowerment, disease control, and cocoa quality improvement (Ministry of Agriculture, 2015). The national movement for cocoa program also supports the availability of raw materials for the processed cocoa industry and improves the welfare of farmers by increasing production (Ariningsih *et al*., 2019; Pratama *et al*., 2019).

Cocoa commodities have been exported since the 1980s, especially dominated by cocoa beans (Hasnah *et al*., 2011). Since 2010, the Indonesian government has imposed a cocoa bean export tax to support the domestic cocoa processing industry's raw materials. After implementing the export tax, cocoa bean exports decreased dramatically, and processed cocoa exports showed an increasing trend yearly, especially pasta, butter, and cocoa powder (Rifin, 2015).

According to data from BPS-Statistics Indonesia, farmers' cocoa prices are around 40-65 percent of the world market price. Over the past five years, the average cocoa price for Indonesian farmers has been around Rp. 20,700/kg up to Rp. 33,000/kg. The price of cocoa beans also varies in each province.

Several factors that affect farmers' cocoa prices include the quality of the cocoa beans (Hasnah *et al*., 2011; Pratama *et al*., 2019), the currency exchange rate, and price fluctuations in the global market (Mukhlis *et al*., 2020; Rifin, 2015). Meanwhile, the presence of a solid intermediary agent (Mclaren, 2015), and the lack of a role for farmer cooperatives (Hasnah *et al*., 2011) can also drive prices inefficiently. In addition, the demand for the cocoa processing industry dramatically affects the price of cocoa beans in the domestic market. Therefore, the market connection between the domestic processed cocoa industry and the price of cocoa farmers is determined by the level of price transmission.

2. Materials and Methods

We examined the monthly price series for January 2007 to December 2020, available online. The data from the Statistics Indonesia (BPS), the International Cocoa Organization (ICCO), and the International Trade Center

(ITC). In addition, we use the export tax policy of cocoa beans as a dummy variable to observe the price fluctuations of cocoa beans at the farm level before and after the performance. This policy has been valid from April 2010 until now.

Table 1 - Descriptive Statistics (raw data are in US$/100kg)

Variables	Mean	Max	Min	Std. Dev
fp	169.79	230.76	103.15	29.38
gp	260.64	352.51	170.00	44.48
pa	235.78	400.57	55.56	92.30
lnfp	5.12	5.44	4.64	0.18
lngp	5.55	5.86	5.14	0.17
lnpa	5.36	5.99	4.02	0.51

Source: Author's elaboration.

Where *fp* = farmer's cocoa bean price, *gp* = global/international cocoa bean prices, *pa* = cocoa pasta price, and *ln* = the natural logarithms, respectively.

This paper applies the nonlinear autoregressive distributed lag (NARDL) model developed by Shin *et al.* (2014). NARDL is a dynamic and regression model with distributed lag used to analyze the relationship between dependent and independent variables. This model can capture the effects of regressor variables in a more flexible structure. Additionally, researchers can identify the time required to adjust the impact of shocks on the model. The NARDL specification analyses non-stationary and nonlinear issues in the context of an unrestricted error correction model (Panagiotou, 2021).

NARDL is a derivative of the standard ARDL linear cointegration model. In fact, in this model variable z_t is decomposed into (z_t^+) and (z_t^-) which is described by Shin *et al.* (2014) as follow:

$$z_t = z_0 + z_t^+ + z_t^- \tag{1}$$

where z_t^+ and z_t^- are partial sum positive and negative changes of independent variables.

$$z_t^+ = \sum_{j=1}^{t} \max\left(\Delta z_{it,j}^+, 0\right) \tag{2}$$

$$z_t^- = \sum_{j=1}^{t} \min\left(\Delta z_{it,j}^-, 0\right) \tag{3}$$

Therefore, the asymmetrical relationship in long term equilibrium is expressed as:

$$y_t = \varphi^+ z_t^+ + \varphi^- z_t^- + e_t \tag{4}$$

Where φ^+ and φ^- are asymmetric long term parameters and z_t is the vector kx1 of the decomposition of the regressors. Combining equation (4) with the ARDL model equation (*p,q*) as performed by Pesaran *et al.* (2001), the nonlinear ARDL model (*p,q*) becomes:

$$\Delta y_t = \alpha + \sum_{i=1}^{p} \beta_0 \Delta y_{t-i} + \sum_{i=0}^{q} \beta_1^+ \Delta z_{t-i}^+ + \sum_{i=0}^{q} \beta_2^- \Delta z_{t-i}^- + \varphi_0 y_{t-i}^+ + \varphi_1^+ z_{t-i}^+ + \varphi_2^- z_{t-i}^- + \varepsilon_t \tag{5}$$

The letters *p* and *q* capture the lag orders for the dependent variable (y_t) and the independent variables (z_t) in the distributed lag section. Substitute $z_{t,j}^+$ and $z_{t,j}^-$ variables in equations (2) and (3) similarly ($lngp^+$, $lngp^-$, $lnpa^+$, $lnpa^-$) to get the unrestricted as well as long- and short-term of the nonlinear autoregressive distributed lag, a dummy variable will be added to this model. The dummy variable consists of 0 and 1 (0 means before the export tax policy implementation and one after its performance). The lag order has been selected starting with max $p,q = 6$. The NARDL model as:

$$\Delta lnfp_t = \alpha + \sum_{i=1}^{p} \beta_0 \Delta lnfp_{t-i} + \sum_{i=0}^{q} \beta_1^+ \Delta lngp_{t-i}^+ + \sum_{i=0}^{q} \beta_2^+ \Delta lngp_{t-i}^- + \sum_{i=0}^{q} \beta_3^+ \Delta lnpa_{t-i}^+ + \sum_{i=0}^{q} \beta_4^+ \Delta lnpa_{t-i}^- + \varphi_0\, lnfp_{t-1} + \varphi_1^+\, lngp_{t-i}^+ + \varphi_2^- lngp_{t-i}^- + \varphi_3^+\, lnpa_{t-i}^+ + \varphi_4^-\, lnpa_{t-i}^- + du_{t-1} + \varepsilon_t \tag{6}$$

The variables $lngp^+$, $lngp^-$, $lnpa^+$, and $lnpa^-$ are partial sum positive and negative in *lngp* and *lnpa* as equations 2 and 3 above. (φ^+ and φ^-) is a vector of long term parameters to be estimated. $\sum_{i=0}^{q} \beta_i^+ \Delta z_{it-i}^+$ and $\sum_{i=0}^{q} \beta_i^- \Delta z_{it-i}^-$ the short term effect will be estimated coefficient for each of the first differences. (*du*) is dummy variable and (ε_t) is residual, Δ is difference operator of variables.

Wald's test was conducted to test the short term and long term asymmetry hypothesis. The short term symmetry of the null hypothesis (H_0: $\beta_i^+ = \beta_i^- = 0$), and the long term ($H_0$: $\varphi_i^+ = \varphi_i^- = 0$). The F statistics and critical values are used to explain the null hypothesis. If H_0 is rejected, there is an asymmetric price transmission. The error correction model of equation (6) as:

$$\Delta lnfp_t = \alpha + \sum_{i=1}^{p} \beta_0 \, \Delta lnfp_{t-i} + \sum_{i=0}^{q} \beta_1^+ \, \Delta lngp_{t-i}^+ + + \sum_{i=0}^{q} \beta_2^- \, \Delta lngp_{t-i}^- + \sum_{i=0}^{q} \beta_3^+ \, \Delta lnpa_{t-i}^+ + \sum_{i=0}^{q} \beta_4^- \, \Delta lnpa_{t-i}^- + du_{t-1} + \rho\xi_{t-1} + \varepsilon_t \quad (7)$$

The error correction term is (ξ_{t-1}) shows the speed of price adjustment towards long term equilibrium after a short term price shock.

The NARDL approach has several advantages: (1) it enables asymmetric and cointegration models in the same equation. (2) it can be applied to a small sample size. (3) it can be applied to the integrated variables I(0) and I(1), or a combination of the two (Shin *et al.*, 2014). Besides that, this model can also use lags on both the independent and dependent variables, which makes it a more flexible model.

3. Results and Discussions

Price fluctuations in global markets and the speed of transmission of export prices have an important influence on farmers' income (Mclaren, 2015). The fluctuations in farmers' cocoa bean prices (FP), world cocoa bean prices (GP), and Indonesia's cocoa pasta export prices (PA) can be seen in Figure 1.

Figure 1 - The natural logarithms of farm, global cocoa prices, and cocoa pasta

Source: Authors' elaboration on BPS, ITC, ICCO data (2021).

Fluctuations in the prices of these three commodities from 2007 to 2020 tend to have varied movements. The visual observation of the graph may have a cointegration relationship and asymmetric price transmission in the data.

As a starting point, ensure that none of the variables integrated order I(2). We use Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) for the unit root test. The optimal lag structure of the ADF is reached on the Schwarz information criterion (SIC). The optimal lag of the PP is selected on the Newey-West bandwidth with Bartlett weights. The null hypothesis is rejected if the critical value is greater than the statistical test (p-value less than the significant level). The findings are in Table 2.

Table 2 - Unit root tests

Variables	**ADF Test**		**PP test**	
	C	**C/T**	**C**	**C/T**
lnfp	0.027 (lag = 1)**	0.078 (lag = 1)*	0.129 (lag = 1)	0.303 (lag = 2)
lnpa	0.108 (lag = 1)	0.613 (lag = 1)	0.137 (lag = 5)	0.650 (lag = 5)
lngp	0.036 (lag = 1)	0.090 (lag = 1)	0.038 (lag = 2)	0.104 (lag = 1)
Dlnfp	0 (lag = 0)***	0 (lag = 0)***	0 (lag = 2)***	0 (lag = 4)***
Dlnpa	0 (lag = 0)***	0 (lag = 0)***	0 (lag = 3)***	0 (lag = 6)***
Dlngp	0 (lag = 0)***	0 (lag = 0)***	0 (lag = 3)***	0 (lag = 4)***

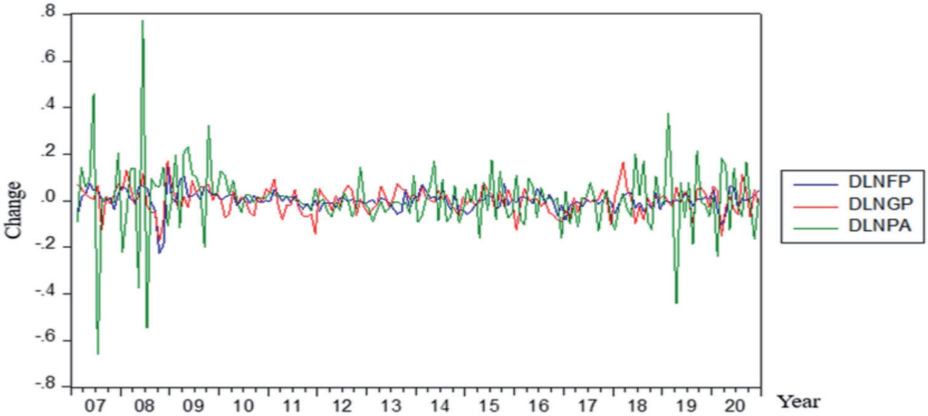
Notes: (D) is the first difference operator. (C) is constant. (C/T) is constant and linear trend. (*, ** and ***) indicate significant at 10%, 5%, and 1%, respectively.

Source: Authors' elaboration.

Figure 2 shows price movement after data changes to the first difference relatively more stable. The output in Table 2 shows that rejecting the null hypothesis of non-stationary price series in levels for all variables except (lnfp) in the ADF test is significant at 5% level. Therefore, tests on first differences I(1) show that all variables are significant at 1% level. This finding allowed us to run a cointegration test.

The cointegration test (Table 3) shows that the value of F-statistics is 19.525, which is greater than the critical value for 1%. The null hypothesis of no cointegration is rejected, which means the variables are cointegrating in the long term among the selected variables. Therefore, we can investigate cocoa price fluctuations in the NARDL cointegrating framework. Accordingly, we estimate equation (5), and the maximum lag order considered is six.

Figure 2 - First difference in the natural logarithms of the Indonesia cocoa supply chain



Source: Authors' elaboration on BPS, ITC, ICCO data (2021).

Table 3 - Bounds test for nonlinear cointegration

F-Statistics	**5% level**		**1% level**		**Conclusion**
	I(0)	**I(1)**	**I(0)**	**I(1)**	
19.525***	2.56	3.49	3.29	4.37	co-integration

Notes: *** significant at 1% level.

Before concluding the estimation results, various diagnostic tests were carried out to ensure the NARDL model was valid (Table 4, part c). The coefficient value of R2 (0.649) shows that 64.9 percent of the price variation of cocoa farmers is affected by the prices in the global market (GP) and cocoa pasta price (PA).

The normality of the residual term uses Jarque-Bera (JB) test. The Breusch-Godfrey serial correlation LM for the autocorrelation and heteroscedasticity tests used ARCH statistics. The NARDL model is well specified because the residuals are normally distributed. There is no heteroscedasticity and no serial autocorrelation in the models.

The asymmetric test using the Wald test shows an asymmetric relationship in price transmission on all variables except the PA-pos variable in the long term. Therefore, the nonlinear autoregressive distributed lag approach used in this research can provide more extensive and accurate information. The lag selected models are (2, 3, 1, 6, 4). The model estimation results, long-run equilibrium, and diagnostic tests, respectively, are presented in Table 4.

Table 4 - The NARDL estimation and diagnostic results

Variables	Coefficient	t-stat	Probability
Part A. Short-term asymmetric			
C	0.021**	2.491	0.038
D(LNFP(-1)	0.158**	2.019	0.045
D(LNFP(-2)	-0.150**	-2.008	0.047
D(LNGP_POS)	0.202**	1.940	0.054
D(LNGP_POS(-1)	-0.211**	-2.021	0.045
D(LNGP_POS(-3)	0.222***	2.528	0.013
D(LNGP_NEG)	0.307***	3.374	0.001
D(LNGP_NEG(-1)	0.318***	3.473	0.000
D(LNPA_POS(-1)	0.071*	1.931	0.056
D(LNPA_POS(-4)	-0.122***	-3.230	0.001
D(LNPA_POS(-6)	0.063*	1.923	0.056
D(LNPA_NEG(-4)	0.135***	3.638	0.000
DU	-0.023***	-2.287	0.025
Part B. Long-term relations			
D(LNGP_POS)	0.323*	1.802	0.073
D(LNGP_NEG)	0.629***	5.293	0.000
D(LNPA_POS)	0.079	0.761	0.448
D(LNPA_NEG)	0.178**	1.967	0.051
Part C. Statistics and diagnostics			
ECT	-0.992***	-11.018	0.000
R^2	0.649		
Jarque-Bera (J-B)	0.042		0.979
Serial Correlation LM test	0.435		0.804
Heteroskadisticity (ARCH)	4.607		0.100
W_{LR}PA	0.659		0.418
W_{LR}GP	6.568***		0.012
W_{SR}PA	3.794**		0.053
W_{SR}GP	9.444***		0.002
Cusum	Stable		
CusumSQ	Stable		

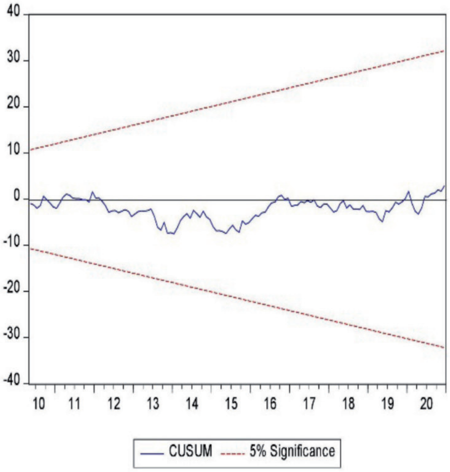
Notes: *, ** and *** indicate significant at 10%, 5%, and 1% level, respectively. W_{LR} is Wald test for long term. W_{SR} is Wald test for short term.

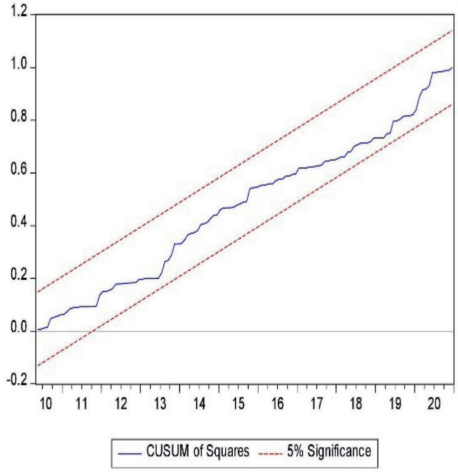
The error correction term (ECT) values are statistically negative and significant, indicating an adjustment towards price equilibrium in the model. The high ECT value indicates a high speed of adjustment to the long term equilibrium and vice versa. The ECT value is -0.992, significant at 1% level. The high value of ECT proves the existence of convergence from short term to long term balance. Meanwhile, this value indicates the rapid adjustment of farmers' cocoa prices due to the well-developed transportation and communication infrastructure.

Other reasons related to the high-speed adjustment can be presented as follows: First, infrastructure development to support the distribution of agricultural products in Indonesia. In the last decade, the development has been carried out on a large scale, integrating rural areas into broader markets in cities. Thus, the link between these regions can reduce logistics costs (McCawley, 2015; Sandee, 2016). It can also reduce the costs incurred by marketing agents, and the prices received by farmers can be higher. Second, farmers can obtain as much information as they can access on the internet. Farmers can find the accurate and up-to-date price of cocoa beans traded in domestic cocoa trading centers, thus reducing their chance of being manipulated. According to Nabhani *et al.* (2015), information technology has made it easier for farmers to increase transactions and access information about the latest market needs.

In order to analyze the structural stability of estimated models, the CUSUM (cumulative sum) and CUSUM-SQ (cumulative sum of squares) tests are used. The results are presented in Figure 3. It indicates that it does

Figure 3 - Cusum and Cusum-SQ





not cross the determined bounds. It demonstrates the stability of the estimated coefficient because CUSUM and CUSUM-SQ are at a significance level of 5% in determining bounds.

Price Transmission of the Global Market and Pasta Cocoa Prices to Farm Price

The NARDL estimation results show that in the long term (Table 4, part B), a 1% rise in the global market prices will fall farmers' cocoa prices by 0.32%. Otherwise, a 1% fall in the global market prices will reduce farmers' prices by 0.63%. The difference in the magnitude of the price transmission coefficient is doubled.

In the short term (Table 4, part A), all variables significantly affected the cocoa farmers' price when the positive (negative) shocks were significant at 10, 5, and 1% level. Price transmission is asymmetric in the short term due to the response to price increases (decreases) at different lags. The negative shock is larger in magnitude than the positive shock. 1% price increase in global price (GP-Pos) makes farmers' price increase 0.20%, for a 5% significant level. Meanwhile, a 1% decline in global prices (GP-neg) will reduce farmers' cocoa prices by 0.31%, for a 1% significant level.

The results of pasta cocoa (Table 4, part B) In the long term, a 1% decrease in cocoa pasta prices (PA-neg) brings down the farm price by 0.17%. On the other hand, the increase in the price of cocoa pasta (PA-pos) is not transmitted to farmers' prices, and this can be seen from the probability value being insignificant (greater than 10% significant level). Meanwhile, in the short-term (Table 4, part A), a 1% positive price shock for pasta cocoa (PA-pos) will increase farmers' cocoa prices by 0.07%. Meanwhile, negative price shocks (PA-neg) were transmitted to farmers' cocoa prices by 0.14%.

Characteristics of price movements in the cocoa distribution chain indicate a lag time and asymmetries. The decline in global market prices and the price of cocoa pasta spread to farmers' prices more quickly. On the other hand, slower transmission is channelled to farmers' prices when there is a positive shock (price increases). This difference can be seen from the magnitude of the coefficient, speed, and sign. Overall, the empirical findings indicate that global cocoa bean prices are the main driver of farm-level prices.

The Paths of Asymmetric Adjustment

The difference in magnitude (GP-Pos and GP-Neg) and (PA-pos and PA-neg) becomes the essential point in this paper. There is sturdy proof of asymmetric price transmission (APT) on the price in the farmer's cocoa bean market both in the long and short term, so asymmetric testing is needed. Asymmetric price transmission testing is carried out using the Wald test.

The results of the Wald test (Table 4, part C) show an asymmetrical relationship between the global market (GP-pos and GP-neg) and farmers' prices in the long and short term, significant at 1% level, respectively. Meanwhile, APT of the cocoa pasta (PA) only occurs in the short term and is significant at 5% level, while in the long term, it does not exist (p-value greater than 10% critical value).

The Export Tax of Cocoa Beans in Indonesia

This study uses the cocoa bean export tax as a dummy variable (DU). The DU coefficient is -0.023, significant at 1% level (Table 4, part A). The direction of the coefficient is negative, which explains that the export tax policy has reduced the cocoa price of farmers by 2.3%. It is different from the studies of Neilson *et al.* (2013) and Rifin (2015), which stated that the tax policy on cocoa bean export did not negatively affect farmers' cocoa bean prices using a linear approach.

Export taxes change domestic markets by affecting prices, production volumes, consumption, trading, and the well-being of producers and consumers. Consumers benefit from lower prices, but domestic producers lose (Liefert & Westcott, 2016). Implicitly, the export tax is a government stimulus to secure the supply of raw materials for the domestic cocoa processing industry at a lower price (Yudyanto & Hastiadi, 2019).

The real profits of the export tax are in terms of capacity building for the processing industry, increased competitiveness, the availability of employment, and government revenue (Hasibuan & Sayekti, 2018; Liefert & Westcott, 2016).

Discussion

The price transmission model of the global market and the prices of processed cocoa to farmers' prices are presented to understand the mechanism behind price transmission in Indonesia. In this case, the response of negative price shocks is more significant than positive shocks. So it is called "negative asymmetry price transmission". The price of cocoa in the global market is the primary determinant of farmers' cocoa prices, both short and long term. Meanwhile, the price of cocoa pasta will provide a quick response to farmers' prices if there is a negative shock.

The findings of the present investigation are partially in accordance with Mukhlis *et al.* (2020), Rifin (2015), and Tsowou and Gayi (2019) as they study Indonesian cocoa beans with the linear model. Their research found the transmission of global cocoa prices to farm prices in Indonesia's supply chain in the long term. The results of our study can confirm the above analysis. Negative price shocks are transmitted more strongly to farmer cocoa prices than positive shocks in the long and short term. It causes a disparity in the response received by the market at the producer level. Our study is unique because it uses an asymmetric model to separate positive and negative price shocks.

Some studies have found that the role of uncompetitive behavior of traders and adjustment costs causes asymmetric price transmission (Meyer & von-Cramon-Taubadel, 2004; Rezitis & Tsionas, 2019). In line with many studies, the price transmission from the world market to the domestic agricultural market is incomplete, especially in developing countries where marketing channels and intermediary agents are too numerous and ineffective (Cutts & Kirsten, 2006; Mofya-mukuka & Abdulai, 2013; Subervie, 2011). In addition, the low quality of cocoa beans and farmers' bargaining position cause the price received to be inadequate (Hasnah *et al.*, 2011; Sianipar & Widaretna, 2012). According to Hasnah *et al.* (2011), the lack of cooperation between farmers and village cooperatives and the lack of farmer associations are the main factors influencing price volatility in Indonesia.

Another interesting result is that the magnitude of the coefficient for cocoa pasta (PA) is smaller than the global price (GP), both in the short and long term. Meanwhile, the producers (farmers) are indirectly forced to supply the domestic cocoa processing industry through the export tax. Due to the lack of linkage between the domestic cocoa processing industry sector and cocoa farmers, the price of cocoa beans at the farm level is highly vulnerable to falling prices in the global market. It impacts farmers' well-being and causes the supply of cocoa beans to dwindle (Ariningsih *et al.*, 2019; Hasnah *et al.*, 2011). The cocoa processing industry necessitates a significant investment. High processing, manufacturing, and distribution concentrations can lead to non-competitive environments and asymmetric price transmission (Niemi & Liu, 2016; Rezitis, 2018; Walters, 1975). According to Bonjean and Brun (2011), the processing industry and distributors often use their market power to manipulate prices, which causes prices to be sent out unequally.

Based on several pieces of literature, there are several causes for price asymmetry in the cocoa processing industry sector and farmers' cocoa prices in Indonesia, among others. Firstly, there is a large number of intermediary agents. The imbalance of power of agents in the supply chain causes asymmetric price transmission because agents with market power can delay price adjustments (Mclaren, 2015; Meyer & von-Cramon-Taubadel, 2004). Meanwhile, the geographical spread of farmers and economies of scale in the agricultural market is characterized by market forces from the demand side (Gizaw *et al.*, 2020).

Second is the ineffectiveness of Indonesia's farm cooperatives. According to Boer *et al.* (2019) and Hasnah *et al.* (2011), cooperatives can help strengthen ties between farmers and industry. This institution has the potential to minimize the role of intermediaries significantly. Furthermore, an inclusive value chain can improve farmers' cocoa farmers' welfare and price stability. Above all, coaching and training from cultivation through post-harvest management can be conducted with a cooperative role to provide additional incentives.

Furthermore, export taxes have a negative effect on farm cocoa prices in Indonesia. The coefficient value is -2.3%, indicating that the policy direction is unfavorable for farmers. Export taxes should be maximized to improve farmer welfare and ensure a sustainable supply of cocoa beans in Indonesia (Yilmaz, 2006)using a computable general equilibrium (CGE. According to Klasen *et al.* (2013), improving welfare will provide a competitive advantage while positively contributing to smallholder livelihoods and long-term rural economic growth.

4. Conclusions

This study investigates the asymmetric price transmission (APT) of cocoa pasta prices (PA) and global cocoa bean prices (GP) on farmers' prices in Indonesia. Furthermore, adding export tax policy as a dummy variable makes the asymmetric equation function more reliable. The NARDL model is used for estimation, explaining the long-term and short-term asymmetric relationship.

The results show that the price of domestic cocoa beans is integrated with the global cocoa market and cocoa pasta as a proxy for Indonesian processed cocoa. We find strong evidence of negative asymmetric price transmission in the cocoa supply chain. Negative price shocks (drops) in global markets and cocoa pasta are more quickly passed on to farmers' prices than positive price shocks are.

The increase and decrease in the global cocoa market and cocoa pasta prices were transmitted asymmetrically in short and long terms, except for the variable (PA-pos). The increase in the price of cocoa pasta in the long term does not affect the farmgate price. The high coefficient of magnitude asymmetric price transmission shows Indonesia's supply-demand cocoa chain is uncompetitive.

The export tax policy has reduced the cocoa price for farmers by 2.3%. Therefore, the ministry of agriculture needs to make some breakthroughs to stabilize the price of cocoa beans in the domestic market. The asymmetric model's export tax variable (DU) results can strengthen previous research used with another approach.

The existence of negative asymmetric price transmission is very detrimental to the income of cocoa farmers in Indonesia, most of whom are small farmers with low incomes. The potential trespass of market power by intermediary agents may have led to widening gross margins (i.e., the price gap between intermediaries and farmers). The possibility of a high loss of farmer welfare requires government intervention.

In the end, further research can develop in diverse directions. For example, investigate the transmission of cocoa bean prices between countries. Moreover, adding intermediary agents in the vertical and horizontal price transmission models will be more effective in seeing how their role influences the prices.

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Ahmad Ridha
Department of Economics - Syiah Kuala University - Banda Aceh City, 23111, Indonesia
Department of Economics - Samudra University - Aceh, 24415, Indonesia.
E-mail: ahmad.ridha@unsam.ac.id
Holds a degree in Agriculture Economy (Indonesia, 2006) and a Master's Degree in Economics, Syiah Kuala University (Indonesia, 2011). A PhD scholar in Economics with a major in Agricultural Economics at the Faculty of Economics and Business, Syiah Kuala University, Indonesia. His research interest in Agricultural Economics, Natural Resouces Economics, and Microeconomics. Currently, lecturer at the department of development economics, Samudra University, Indonesia.

Raja Masbar
Full Professor at Department of Economics - Faculty of Economics and Business - Syiah Kuala University - Banda Aceh City, 23111, Indonesia
Email: raja.masbar@unsyiah.ac.id
He holds a Master's and a Ph.D from the University of Kentucky, Lexington, USA, in 1984 and 1990, respectively. His research interest and lectures are in Microeconomics, Econometrics, Time Series Analysis, Agricultural Economics. He is teaching at the Master and Doctoral program of the Economics Department, Syiah Kuala University.

Aliasuddin
Associate Professor - Department of Economics - Faculty of Economics and Business - Syiah Kuala University - Banda Aceh City, 23111, Indonesia
E-mail: aliasuddin@unsyiah.ac.id
Aliasuddin is Associate Professor at the Faculty of Economics and Business, Syiah Kuala University, Indonesia. Holds a Master's Degree in Economics from Syiah Kuala University, Indonesia (1997). Received Ph.D from University Putra Malaysia (2009). His research interest and lectures are in Microeconomics, Econometrics, Natural Resouce Economics, Environmental Economics, International Economics and Time Series Analysis. He also has been a facilitator for planning and budgeting, especially for the district and municipality board of planning since 1998. He also has been a consultant for regional planning since 1998. He has several experiences in planning.

Vivi Silvia
Associate Professor - Department of Economics - Faculty of Economics and Business - Syiah Kuala University - Banda Aceh City, 23111, Indonesia
Email: vivisilvia@unsyiah.ac.id
Vivi Silvia is Associate Professor at the Faculty of Economics and Business, Syiah Kuala University, Indonesia. She holds a Master's Degree in Economics from Syiah Kuala University (1997) and has a PhD in Economics, Syiah Kuala University (2016). Her research interests and lectures are in Microeconomics, Public Economics and Agricultural Economics.