

## **Analysis of Market Integration between Mandailing Natal Rubber Auction Market and the International Crumb Rubber Market**

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### **Abstract**

The purpose of this research is to find out whether the price in the rubber auction market in Mandailing Natal Regency is integrated with the price of rubber in the international crumb rubber market (United States and Japan) and to find out how the influence of rubber prices in the international crumb rubber market (United States and Japan) on prices in the rubber auction market in Mandailing Natal Regency. The method of determining the research area was carried out by purposive sampling (deliberately). The selected research area was Mandailing Natal Regency, North Sumatra Province as the domestic market and the United States and Japan futures market as the international market. The data used in this study is time series data with a range of January 2018 to December 2022 with a total of 60 data used. The data analysis method used in this research is the Error Correction Model (ECM) and Price Transmission Elasticity, negative and the probability level is greater than the 95% confidence level (-0.095521) while the rubber auction market in the Mandailing Natal district and the Japanese market are imperfectly integrated where the probability value is greater than 0.05 (0.3999). The coefficient value of the rubber price coefficient at the Japanese market level is 0.082702 is positive. However, in the long term, the two markets are perfectly integrated with the rubber auction market in Mandailing Natal Regency. The transmission elasticity of the international price of crumb rubber and the price of crumb rubber in the rubber auction market in Mandailing Natal Regency is inelastic in the short and long term. However, in the long term, the transmission elasticity of the international price of crumb rubber and the price of crumb rubber in the rubber auction market is greater than in the short term.

**Keywords:** Rubber auction market, American rubber market, Japanese rubber market, market integration, price transmission elasticity.

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## Introduction:

The contribution of the plantation sub-sector to GDP is around 3.63 percent in 2020 or is in first place in the agriculture, livestock, and hunting and agricultural services sectors. This sub-sector is a provider of raw materials for the industrial sector, absorbs labour, and generates foreign exchange (BPS, 2017). Rubber is one of the plantation commodities that have an important role in economic activity. Indonesia is the world's largest rubber producer and exporter. Indonesia has the largest rubber plantations in the world in 2019 the total area of rubber plantations in Indonesia reached 3.6 million hectares with production reaching 3.63 million tons. Although Indonesia has the largest area in the world, Indonesia is the second-largest natural rubber producer after Thailand.

Indonesia's total natural rubber exports in the last thirteen years tended to fluctuate, ranging from -13.25 per cent to 18.05 per cent. In 2008 the total weight of exports reached 2.3 million tonnes with a total value of US\$ 6.06 billion, decreasing to 2.28 million tonnes in 2020 with a total value of US\$ 3.01 billion. Most of Indonesia's natural rubber production is exported to foreign countries and the rest is marketed domestically. In 2020, the top five importing countries for Indonesia's natural rubber are the United States, Japan, China, India and Korea. In the following, data is presented on the destination countries for Indonesia's natural rubber exports in 2020.

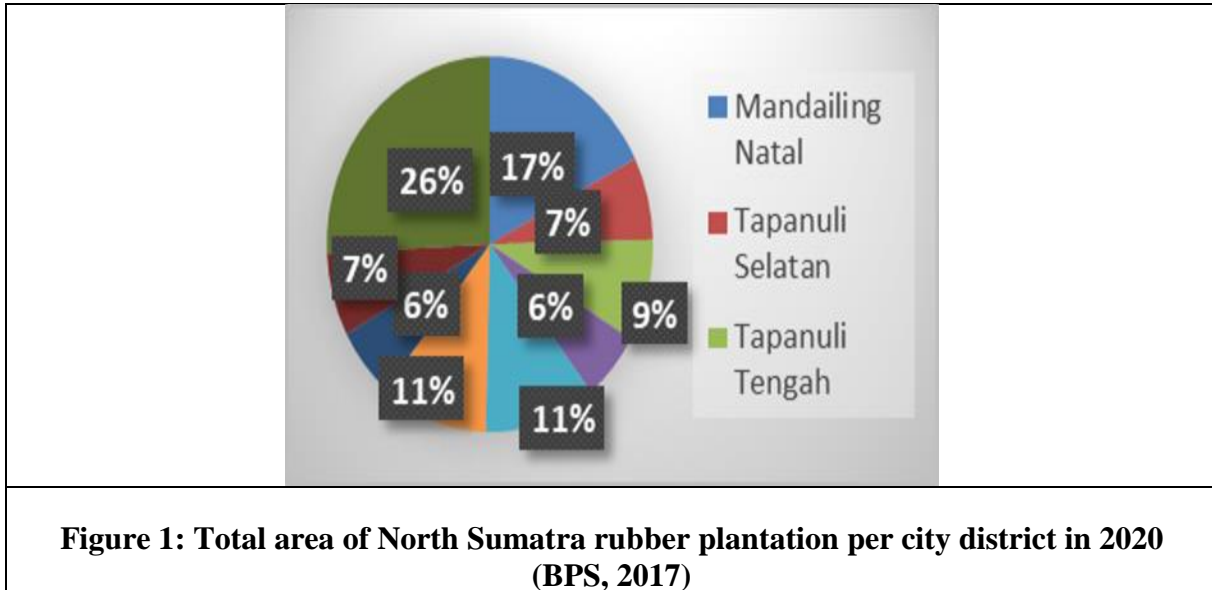
**Table 1: Indonesia's Natural Rubber Export Volume by Destination Country<sup>2</sup>**

No.	Export Destination Countries	Export Volume (Thousand Tonnes)	Export Value (US\$ Million)
1.	United States	449,68	606,64
2.	Japan	388,33	526,07
3.	China	329,99	406,92
4.	India	188,62	246,89
5.	Korea	149,64	189,48
<b>Total</b>		<b>1.506,26</b>	<b>1.976</b>

Based on the data above, it can be seen that Indonesia's total rubber export volume in 2020 reached 1,506.26 thousand tons with a value of US\$ 1,976 million. The largest export destination country was the United States with a total export volume of 449.68 thousand tons, while the lowest export destination country was Korea with 149.64 thousand tons.

North Sumatra is a province producing rubber plantation commodities. According to data from the Directorate General of Bonds, in 2020 the area of rubber plantations in North Sumatra will reach 369,392 hectares. Rubber is one of North Sumatra's people's quests based on 2020 North Sumatra BPS data (2017); 25 urban districts are centres of rubber production in North Sumatra. The following presents a diagram of the area of rubber plantations in North Sumatra by Regency/City 2020.

<sup>2</sup> Source: Indonesian Rubber Statistics 2020



Based on the data in Figure 1 above, the urban district that has the largest rubber planting area in North Sumatra in 2020 is the Mandailing Natal District with a total percentage of 17% of the total area of rubber plantations in North Sumatra. The entire rubber plantation area in Mandailing Natal Regency is a smallholder rubber plantation which is managed traditionally. In the process of marketing the production of rubber farmers in Mandailing Natal Regency, they market their products using an auction system. Farmers will sell their rubber to collectors who offer the highest bid price. The rubber auction process takes place once a week, namely around the market or weekend area.

The problem of rubber at the farmer level, especially Mandailing Natal Regency, is inseparable from the price issue. The price of rubber at the farm level is still very low, the price ranges from IDR 7,000-8,000/Kg in June 2022, this price is relatively low compared to the price of rubber at the provincial level which reaches IDR 10,000-11,000/Kg. The low price of community rubber in Mandailing Natal Regency is inseparable from the quality of the rubber produced by the farmers, who are so dirty that the rubber becomes damaged due to contamination of foreign materials into the sap, such as wood chips, stones and plastic. Also, farmers mix unsuitable coagulants, such as TSP fertilizer. The sap is stored in ponds for a long time, so the elasticity of rubber decreases causing low *bokar* (rubber processing materials) prices at the farmer's level (Simatupang and Situmorang, 1988).

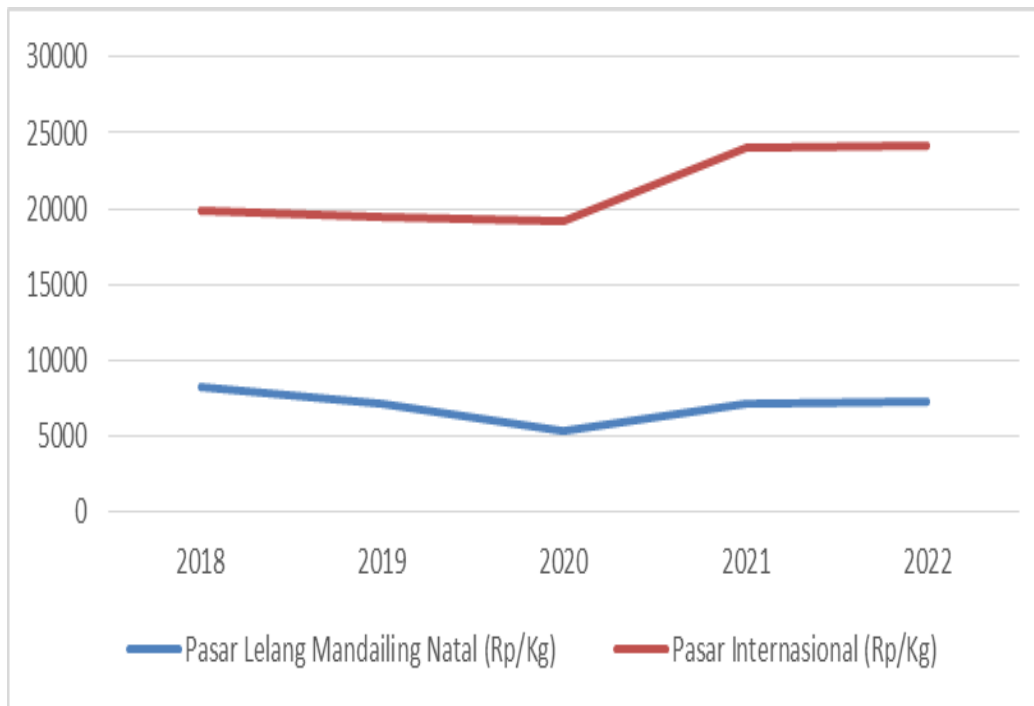
This is also similar to the issue of production quality; the reason for the low price of rubber in Mandailing Natal Regency cannot be separated from the condition of the rubber market, due to the long rubber supply chain. The longer the supply chain, the lower the price that will be received by farmers, because the greater the marketing costs that will be incurred in this condition, the level of marketing efficiency of rubber will be very high. The market will perform its function efficiently if it utilizes all available information such as price information on the reference market, and product availability.

As an export commodity, the price formation process for natural rubber in Mandailing Natal Regency cannot be separated from export destination countries such as the United States, Japan, and China. Based on data from Pramananda et al., (2022), 33.1% of rubber from North Sumatra was exported to Japan and 10% to the United States. In its journey, the price of rubber

in the domestic market (rubber auction market) will be closely related or integrated with the market prices of export destination countries. The domestic rubber market situation will be greatly influenced by the changes that occur in the world market. There is a dependence on the price of rubber in Mandailing Natal Regency on international rubber prices because most of the rubber production is still exported abroad. Besides that the world rubber price is the domestic reference price, so changes in world prices will be directly related to changes in domestic prices.

In recent years, the price of rubber in the market has always changed; this is inseparable from the state of world rubber. In recent years, various structural changes have occurred in the domestic and international markets. Developments in the finished goods industry, technology and optimization in the tire industry will increase consumption and require better and more consistent quality of natural rubber raw materials. Changes in the price of semi-finished goods and finished goods from rubber products, for example, namely crumb rubber, result in price changes for rubber raw materials (Malik et al., 2013).

According to Audina et al. (2021), the export benchmark price (HPE) of rubber in Indonesia will continue to follow international rubber price movements. This price movement occurred because the price of rubber on the international market is one of Indonesia's reference prices, including in the determination of HPE in Indonesia. The high price of rubber in the international market is suspected to be closely related to the price of rubber in the country, including in Mandailing Natal Regency. The following presents data on the movement of rubber prices in the domestic and international markets:



**Figure 2: Rubber prices in the auction and international market (Victor, 2023)**

Based on the data in Figure 2, it can be seen that the price of rubber at the level of the rubber auction market in Mandailing Natal Regency from the 2018-2021 period, the graph always moves to follow the price of rubber on the international market. From the 2018-2020 period, the price of rubber on the international market tends to be stable, where the price ranges

from Rp. 20,000/kg, while the price at the rubber grasshopper market in Mandailing Natal Regency in the 2018-2020 period experienced a significant decrease where in 2018 the price of rubber was Rp. 8,193/kg has decreased by 35% until 2020 when the price is IDR 5,258/kg. In the period 2020-2022, the price of rubber in both markets has increased, but from the graph of the increase in rubber prices in the two markets, it can be seen the difference where for prices on the international market the price increases are quite significant and fast, while for price movements in the auction market, the price increases are not too high and the price changes slowly.

In theory, price changes that occur abroad also affect domestic commodity prices, because the domestic and international markets are mutually integrated. An integrated market indicates an efficient marketing system, where there will be a positive correlation over time between prices in different market locations. Thus the transmission of information between various markets causes prices to move together in these various markets. However, based on the data in Figure 2, it can be seen that price movements between the two markets do not move together, that is, price changes at the international market level are not immediately followed by price changes at the auction market level. It takes some time for price movements on the international market to be followed by the auction rubber market in Mandailing Natal Regency.

The effect of international rubber prices on domestic rubber prices is that if there is a price change in the international market this will affect prices in the domestic market as well as affect prices on the rubber auction market in Mandailing Natal Regency, but sometimes increases and decreases in the price of crumb rubber occur in the market. International trade has a slow effect on the increase and decrease in prices in the rubber auction market in Mandailing Natal Regency.

### **Formulation of the problem:**

Based on the problems in the background above, several formulations of the problem in this study are formulated as follows:

- i. How is the price integration in the Mandailing Natal Regency rubber auction market with the price of rubber in the international crumb rubber market (United States and Japan,)?
- ii. How does the price of rubber in the international crumb rubber market (the United States and Japan) affect the price in the rubber auction market in Mandailing Natal Regency?

### **Research purposes:**

Based on the problems above, the objectives of this study are as follows:

- i. To find out whether the price in the rubber auction market in Mandailing Natal Regency is integrated with the price of rubber in the international crumb rubber market (the United States and Japan).
- ii. To analyze the influence of rubber prices in the international crumb rubber market (the United States and Japan) on prices in the rubber auction market in Mandailing Natal Regency.

## Research methods:

**Area determination method:** The method of determining the research area was carried out by purposive sampling (intentional). Purposive sampling is a sampling method based on certain criteria or objectives. The determination of the area was carried out in Mandailing Natal Regency, North Sumatra Province. Mandailing Natal Regency is the number one largest natural rubber production centre in North Sumatra province with a total planted area of 64,571 Ha or 17% of the total area of rubber plantations in North Sumatra Province

**Sampling Method:** The data used in this study is time series data with a range of January 2018 to December 2022 with a total of 60 data used.

## Data Types and Sources:

This study uses quantitative secondary data. The data used is time series data for the last 60 months. The secondary data used in this study were obtained from the Central Bureau of Statistics (BPS, 2017) of North Sumatra Province, the Association of Indonesian Rubber Companies which is also known as GAPKINDO, other relevant agencies and various literature related to this research. The types of data collected include rubber prices in the Mandailing Natal district auction market, and rubber prices in international markets (United States and Japan).

## Data analysis method:

To analyze the first formulation of the problem, namely to find out the integration between the Mandailing Natal regency rubber auction market and the international rubber market, an error correction model (ECM) was used.

**Stationarity Test:** The stationarity test is the most important stage in analyzing time series data to see whether there is a unit root that is contained between variables so that the relationship between variables in the equation becomes valid. Stationarity in the data is important because it will affect the results of the regression estimation. After all, if the regression results between these variables are not stationary, it will produce a spurious regression phenomenon. It is said that a false regression has a high R-squared and high t-statistical significance. The stationary test that is popularly used is the unit root test with the Augmented Dickey-Fuller Test method and for this, it is the reference inscribed by Cheung and Lai (1995). The equations in the ADF test are as follows:

$$Y_t = \Delta Y_{t-1} + u_t \text{ (tanpa Intercept)}$$

$$\Delta Y_t = \alpha + \Delta Y_{t-1} + \mu_t \text{ (dengan intercept)}$$

$$\Delta Y_t = \alpha_1 + \alpha_2 t + Y_{t-1} + \alpha_i \sum_{i=1}^m Y_{t-1} + \varepsilon_t$$

(Intercept with time trend)

Description:

$\Delta Y_t$  = Observed variable

$\alpha$  = intercept

The test criteria are:

If  $| \text{sig} | < | \alpha (0.05) |$  and if the absolute value of the ADF statistic is greater than the critical value in the first difference, it can be concluded that the data is said to be stationary at

degree one, and vice versa if the value is smaller, the degree of integration test needs to be continued until stationary data is obtained.

The determination of the optimal lag of the regressed variable in the equation is intended to avoid the possibility of residual autocorrelation in the data series. For the natural rubber price data series in this study using Akaike Information Criterion (AIC) analysis on a lag that has the smallest AIC value found in the Eviews 10 application.

**Data Cointegration Test:** The cointegration test is a follow-up test of the bik data stationarity test in level and difference I. The equation used in the cointegration test is as follows:

$$HKPL_t = \beta_0 + \beta_1 HKPA_t + \beta_2 HKPJ_t + e_t \dots$$

Description:

HKPL<sub>t</sub> = price of crumb rubber on the auction market at a certain time

HKPA<sub>t</sub> = price of crumb rubber in the US market at a certain time

HKPJ<sub>t</sub> = price of crumb rubber in the Japanese market at a certain time

bo = short run coefficient

β1 = long-term coefficient

**Test Criteria:** Johansen's cointegration test can be calculated from trace statistics. If Trace Statistics > Critical Value means there is cointegration and vice versa when Trace Statistics < critical value means there is no cointegration.

**Error Correction Model (ECM) test:** From the several methods above, if the data found is not stationary, but has cointegration, an adjustment is needed. These adjustments can be made with the ECM model (Rusdianasari, 2018), ECM has several uses, but the most important use for econometric work is in solving non-stationary time series data problems and pseudo-regression problems. The ECM model in this study can be written as follows:

$$\Delta Y_t = \alpha_0 + \alpha_1 \Delta X_t + \alpha_2 \Delta X_{t-1} + \alpha_3 ECT$$

In the model, the ECT coefficient values range from zero to one ( $0 < \alpha < 1$ ). The short-term coefficient of the ECM model equation is represented by the coefficient  $\alpha_1$ , while to obtain the magnitude of the long-term regression coefficient using the ECM model, the formula is used:

$$\text{Constant} = \alpha_0 / \alpha_3 \quad X_t = (\alpha_2 + \alpha_3) / \beta$$

If it meets the requirements, then the analysis can be continued using ECM with the following models:

$$\Delta HKPL = \alpha_0 + \alpha_1 \Delta HKPA + \alpha_2 \Delta HKPJ + \alpha_3 ECT + e$$

**Descriptions:**

ΔHKPL<sub>t</sub> = Change in the price of crumb rubber at the Mandailing Natal auction market at time t

ΔHKPA = Change in the price of crumb rubber in the United States market at time t

ΔHKPJ = Change in the price of crumb rubber in the Japanese market at time t

α<sub>0</sub> = short-term coefficient

β1 = long-term coefficient

$\alpha_1$  = adjustment speed.

**Test criteria:** The hypothesis is accepted if  $t \text{ count} > t \text{ table}$  at the 95% confidence level ( $\alpha = /<0.05$ ), meaning that the rubber auction market is integrated with the international market in the short term. The hypothesis is rejected if  $t \text{ count} < t \text{ table}$  at a confidence level of 95% ( $\alpha > 0.05$ ), meaning that the rubber auction market in the short term is not integrated with the international market.

To analyze the second problem formulation, namely to determine the effect of changes in rubber prices in the international market on the market price of Mandailing Natal rubber auctions, the concept of price transmission elasticity is used. The price transmission elasticity is the relative change in producer-level prices (Pf) to the relative changes in consumer-enhanced prices (Pr). The price transmission elasticity coefficient between rubber prices on the international market and rubber prices on the Mandailing Natal auction market in this study is defined as the percentage change in rubber prices on the international market to the percentage change in rubber prices on the Mandailing Natal auction market which can be seen in the equation below:

$$\text{Elasticity} = \frac{\frac{\Delta \text{HKPL}}{\text{HKPL}}}{\frac{\Delta \text{HKPI}}{\text{HKPI}}} = \frac{\Delta \text{HKPL}}{\Delta \text{HKPI}}$$

$$\text{Elasticity} = \frac{\% \Delta \text{HKPL}}{\% \Delta \text{HKPI}}$$

**Descriptions:**

$\% \Delta \text{HKPL}$  = Percentage change in the price of rubber on the auction market in Mandailing Natal Regency

$\% \Delta \text{HKPi}$  = Percentage change in rubber prices on the international market

**Criteria:**

$E_t = 1$ , then the sensitivity to price changes at the auction market level is the same as price changes at the international market level.

$E_t > 1$ , then the sensitivity to price changes at the auction market level is greater than price changes at the international market level.

$E_t < 1$ , then the sensitivity to price changes at the auction market level is smaller than price changes at the international market level.

**Operational Definition:**

- i. Market integration shows the relationship between commodity prices in one market and other markets. Heytens (1986) suggests that the price relationship in an integrated market is positively correlated over time, price changes in one market will be responded to by other markets with the same pattern of changes.
- ii. The export price of natural rubber is the sales price of natural rubber recorded at the Central Bureau of Statistics of North Sumatra.



### Operational Limitations:

- i. The price on the rubber auction market is the average price of rubber on the rubber auction market in Mandailing Natal Regency per month (Rp./Kg)
- ii. The price of rubber on the international market is the average price of SIR 20 on the market in the US market and the Japanese market per month. (Rp./Kg)
- iii. Market integration is carried out to analyze whether information on price changes that occur between the North Sumatra market and the international market is properly transformed or not.
- iv. To see market integration, it is analyzed using the EMC model, namely looking at long and short-term integration

### Results and Discussion:

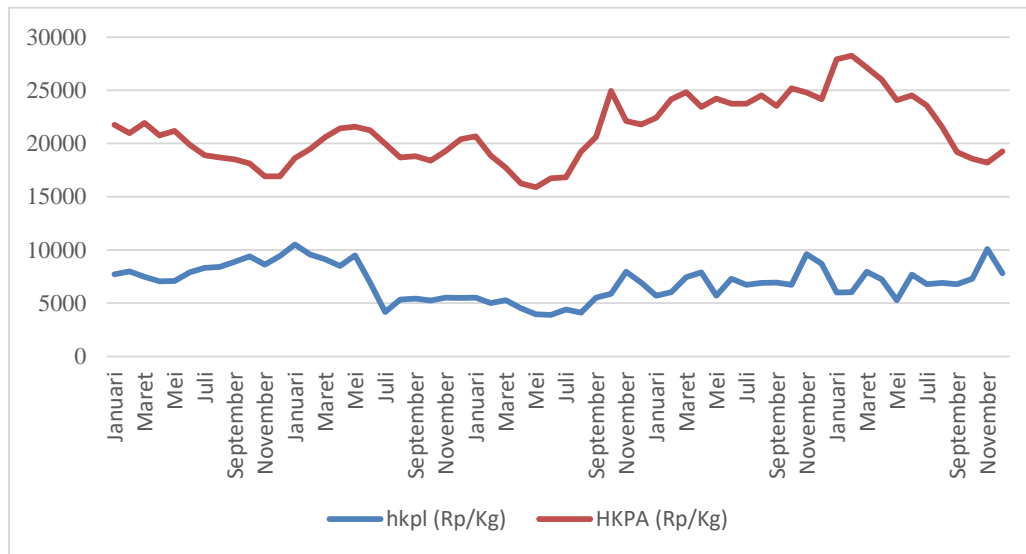
**Integration of Rubber Prices at the Auction and International Market Level:** The price of natural rubber commodities in the domestic market generally has a fairly high level of price fluctuation. One of the causes is the integration of the domestic market with the international market. This is understandable because the commodity of natural rubber is export-oriented so the price of Indonesian natural rubber is influenced and determined by price developments abroad. The level of integration of the natural rubber market can be measured in the domestic (domestic) market and the futures market as a reference market where this integration is also called spatial integration. This can be done because the physical price is a reference for futures prices, although this does not always happen. After all, not all futures prices react to changes in physical prices. In contrast, futures prices are future price signals for physical markets.

In this study, the measurement of the level of integration between the rubber auction market and the international market was carried out using the error correction model (EMC) method where in the calculation stage three stages of the stationarity test, data cointegration test and error correction model test were carried out. From the data obtained regarding the development of rubber prices in the reference market (US and Japanese markets) and the rubber auction market

**Integration of Rubber Prices in the Mandailing Natal District Auction Market with the United States Market:** The United States is the largest export destination for national rubber. In 2020, the volume of natural rubber exports from the United States was recorded at 449.68 thousand tons. This shows that the state of rubber prices in the United States market will greatly impact market conditions at the national level. As much as 10% of rubber production in North Sumatra in 2022 will be exported to the United States. The United States is the second largest export destination country for North Sumatra rubber after Japan. With these data that the American market is the destination for rubber exports in the province of North Sumatra, it can be stated that the two markets have a reciprocal relationship in the movement of rubber prices at the local and international levels. Before the ECM testing between the two markets, the following shows a comparison of natural rubber prices on the auction market and the United States market.

From the results of searching the data obtained, the highest price at the Batanghari Regency Rubber Auction Market only reached Rp. 10,525.-/kg, namely in November 2022, while the price of natural rubber in the United States market reaches Rp. 28,258.93,-/kg in February 2022. From these data, it can be seen that the highest price will be in 2022 but in a different month, this indicates that the integration of rubber prices between the two markets is

still very low, adjusting to changes in rubber prices on the market America needs a few months to be transformed in the auction market.



**Figure 3: Pattern of Price Developments (Victor, 2023)**

Based on the pattern of price developments in the chart above, it can be seen that in 2018 the price of rubber on the American market has decreased while the price of rubber on the auction market has experienced an increasing trend. For the next period, the price trend in the American market gradually increased, while in the auction market, the line pattern of price developments decreased. This indicates that the price change trend in the American market is not immediately followed by the auction market in Mandailing Natal Regency, where the price change trend requires several periods to be followed by the rubber auction market.

To find out how the integration between the two markets is, an error correction model test will be carried out between the two markets. For more details, the results of the integration test analysis for the two markets are presented below:

**Stationarity Test:** From the results of the ADF test it is known that at the H0 level, it cannot be rejected (data not stationary), but at the first difference level H0 is rejected (stationary data). The ADF test results for each variable can be seen in Table 2 below:

**Table 2: ADF Test Results (Augmented Dickey-Fuller Test)<sup>3</sup>**

Level	Variables	Statistical ADF T Value	MacKinnon's Critical Value			Sig	AIC
			1%	5%	10%		
	HKPL	-2,982742	-3,546099	-2,91173	-2,59355	0.0424	16,96879
	HKPA	-1,65269	-3.546.099	-2,91173	-2,59355	0,4497	17,24908
First Difference	HKPL	-8,20082	-3,550396	-2,91355	-2,59452	0.000	17,00304
	HKPA	-6,58859	-3,548208	-2,91263	-2,59403	0.00	17,29344

<sup>3</sup> Source: Secondary Data Processed 2023

The results of the ADF test in Table 2 above show that each variable has an optimal lag of 10 which is seen based on the smallest AIC criterion. At the level, the variable price of rubber in the United States market and the price in the rubber auction market in Mandailing Natal Regency has a smaller value than the Mckinnon critical value (data not stationary), but at the first difference level, the price of rubber in the United States market and the price in the auction market rubber in Mandailing Natal Regency is stationary. The results of the ADF test are in line with the results of research by Malik et al., (2013) which states that the Singapore rubber price variable and the rubber price at the Mandailing Natal auction market are stationary at the first difference level.

From the results of the ADF test for the rubber price variable on the auction market in Mandailing Natal Regency, the United States rubber market shows that these two variables have passed the ADF test, so the next test stage is the cointegration test.

**Co-integration Test:** The cointegration test is a test of the linear combination of non-stationary variables to analyze long-term relationships. From the results of the Coentigration test on the research variables, the following results are obtained:

**Table 3: Co-integration Test results for Rubber Prices at the Auction Market and the American Market<sup>4</sup>**

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.168043	16.74868	15.49471	0.0322
At most 1 *	0.099492	6.078176	3.841466	0.0137
Trace test indicates 2 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

The results of the Johansen cointegration test above show that the cointegrated variables, init can be seen with a trace statistic value that is greater than the critical value of 5% and 1%. Cointegrated variables where the value of the trace statistic and the maximum eigenvalue reject H0 to the level of significance ( $\alpha = 5$  percent) are two cointegration equations. which means that the price of rubber in the auction market of Mandailing Natal Regency, in the long run, is influenced by the price of rubber in the international market, namely the United States rubber market.

**Error Correction Model:** The model that includes adjustments to make corrections for these imbalances is the Error Correction Model (ECM). The Error Correction Model (ECM) used in this study is the Engle-Granger Error Correction Model (ECM). The results of the ECM analysis using the Engle-Granger model obtained the regression coefficient for the short term between the American rubber price variable and the rubber price at the auction market in Mandailing Natal Regency. From the test results using the eviews 10 program, the following results are obtained

<sup>4</sup> Source: Primary Data Processed 2023

**Table 4: ECM analysis results between rubber prices at the auction market and the American market<sup>5</sup>**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<b>D(HKPA)</b>	-0.095521	0.112608	-0.848258	0.3999
<b>ECT(-1)</b>	-0.271985	0.091134	-2.984440	0.0042
<b>C</b>	-6.982104	150.0870	-0.046520	0.9631

Then the ECM equation between rubber prices in the short run can be written as follows:

$$\Delta HKPL = -6.982104 - 0.0955\Delta HKPA - 0.2719\text{ect}$$

Based on the ECM equation above, it can be seen that the coefficient values of the two markets where the coefficient value of rubber prices at the US market level is negative. This indicates that in the short term, the results of the regression coefficient obtained are known between the international rubber market, namely the United States and the Mandailing Natal District Rubber Auction Market, it is not perfectly integrated. This is because the coefficient value is negative and the probability level is greater. From the 95% confidence level (-0.095521) and a probability value greater than 0.05 (0.3999), this indicates no integration in the short term between the rubber auction market and the American market.

The ECT coefficient is between -0.2 to 0.271 and the probability value is less than 0.05 at the 95% confidence level. This indicates that the model used for the short-term equation is valid to use. ECT shows the speed of adjustment seen from the absolute value of ECT, which is interpreted as an imbalance between the actual price and the long-term equilibrium level.

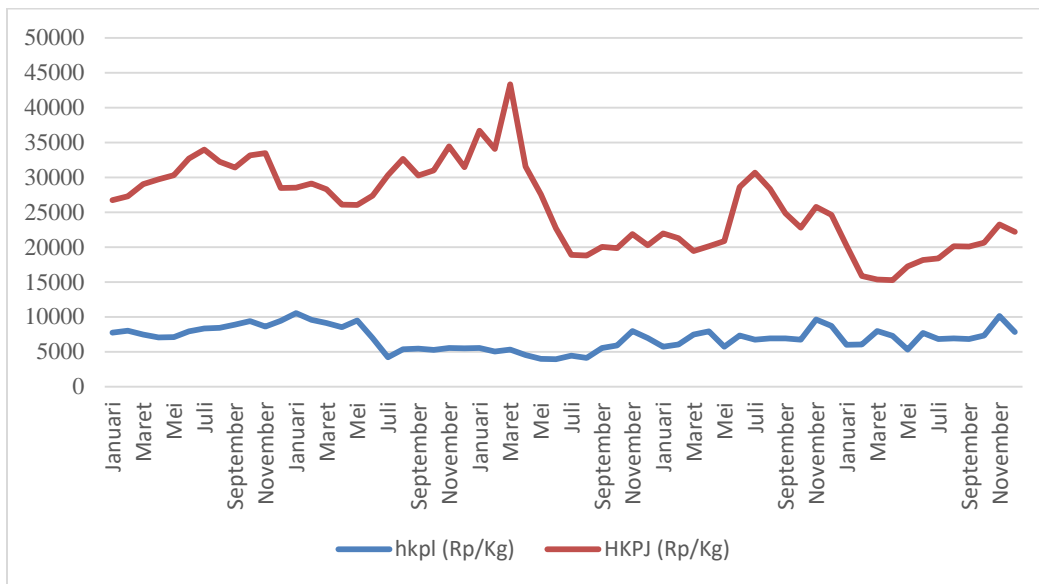
The larger the coefficient indicates the faster the adjustment towards long-term balance and vice versa. The ECT value of -0.271 indicates that changes in rubber prices on the American market take approximately 27 days to be transformed in the Mandailing Natal District rubber auction market. These results are to what was revealed by the Chair of the North Sumatra Branch) that price changes on the international rubber futures exchange market take approximately 20 days to be followed by price changes at the farm level. This is due to the long rubber supply chain and the process of processing farmer rubber (Bokar) into SIR20 and ready to be traded on the international market. With these constraints, changes in world rubber prices do not necessarily follow price changes at the auction market level, especially in Mandailing Natal Regency.

In the short term, there may be an imbalance (disequilibrium). This imbalance often occurs in economic behaviour. This means that what economic actors want (desired) is not necessarily the same as what happened. There are differences in what economic actors want and what happens, so adjustments are needed. The possibility of the market being integrated in the short term is very small but the market will remain integrated in the long term. This means that conditions in the primary market may not affect secondary prices from one period to another precisely. But for certain periods and on average these conditions are a determining effect, if this happens then price changes in the primary market will be reflected proportionally in the secondary market.

<sup>5</sup> Source: Secondary data processed in 2023

**Integration of Rubber Prices in the Mandailing Natal District Auction Market with the Japanese Market:** Japan is the main export destination for North Sumatran rubber. It was recorded that in 2022 as much as 30% of North Sumatra’s rubber production was exported to Japan. The Japanese futures market commonly called TOCM (Tokyo Commodity) is the second-largest futures exchange market in the world. Where this is the movement of commodity prices on the TOKOM futures exchange market will cause price movements in its follower markets such as the rubber market in Mandailing Natal Regency.

Natural rubber price movements in the auction market and the Japanese market have the same pattern, namely price movements tend to fluctuate. These price changes are due to supply and demand which varies from time to time. The following is a graph of price developments in both markets.



**Figure 4: Price Movements in the Madina Regency Rubber Auction Market and the Japanese Futures Exchange Market (BPS, 2017)**

From Figure 4 it can be seen that price movements in both markets where the trend of price movements in the rubber auction market in Mandailing Natal Regency and the Japanese market has almost the same pattern of movement where in the 2018 period the price of rubber in both markets has an increasing trend and in the 2019 period it has decreased where the lowest decline was in July for the auction market while in the Japanese market occurred in April, after the price decline, then the price of rubber on the Japanese futures exchange market continued to increase, so the highest increase occurred in April 2020, while for the movement of rubber prices on the market auction pattern data where the price changes that occur are not too large or tend to be stable.

From Figure 4, it can be interpreted that the pattern of price movements between the two markets has a relatively similar pattern where the two markets have integration with one another. However, for more details on how the linkage or integration of the two markets follows, a test is carried out using an error correction model to find out how the markets are integrated into the long and short term.

**Test the stationarity of the data:** From the test results using the eviews 10 program, the following results are obtained:

**Table 5: Test Results (Augmented Dickey-Fuller) ADF Rubber Auction Market and Japanese Market<sup>6</sup>**

Level	Variable	Statistical ADF T Value	MacKinnon's Critical Value			Sig	AIC
			1%	5%	10%		
Level	HKPL	-2,982742	-3,546099	-2,91173	-2,59355	0,0424	16,96879
	HKPJ	-1,95303	-3,546,099	-2,91173	-2,59355	0,3064	17,24908
Frist Difference	HKPL	-8,20082	-3,550399	-2,91355	-2,59452	0,000	17,00304
	HKPJ	-7,93732	-3,548208	-2,91263	-2,59403	0,00	17,29344

In table 5 above, at the level by entering the intercept and trend, it shows the test results at the level level I (0), all variables contain a unit root, so they are not stationary. Then the test is continued at the first difference or I (I), which results in all variables no longer containing a unit root or is stationary because each ADF statistical value is smaller than its critical value. Thus all the variables used are stationary at degree 1 or I (10).

**Co-integration Test:** From the results of the Co-integration test on the research variables, the following results are obtained:

**Table 6: Co-integration Test results for Rubber Prices at the Auction Market and the Japanese Market<sup>7</sup>**

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0,336798	27,99454	15,49471	0,0004
At most 1 *	0,069458	4,175323	3,841466	0,0410
Trace test indicates 2 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

The results of the Johansen cointegration test above show that the variables are cointegrated. This can be seen by the trace statistic value which is greater than the critical value of 5% and 1% (27.99454 > 15.49471) and the probability value is less than 0.00 (0.0004 < 0.05). Cointegrated variables where the value of the trace statistic and the maximum eigenvalue reject H0 to the level of significance ( $\alpha = 5$  per cent) are two cointegration equations which mean that the price of rubber in the auction market of Mandailing Natal Regency in the long term is influenced by the price of rubber in the international market, namely the Japanese futures market.

**Error Correction Model:** The following presents the data from the Error Correction Model (ECM) test using the Engle-Granger model. The results of the ECM analysis using the Engle-

<sup>6</sup> Source: Secondary Data Processed 2023

<sup>7</sup> Source: Primary Data Processed 2023

Granger model obtained the regression coefficient for the short term between price variables on the rubber auction market in Mandailing Natal Regency and the Japanese futures market.

**Table 7: ECM Analysis Results between Rubber Prices at the Auction Market and the Japanese Market<sup>8</sup>**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(HKPJ)	0.082702	0.047431	1.743616	0.0867
ECT(-1)	-0.269451	0.089380	-3.014667	0.0039
C	3.658279	147.6489	0.024777	0.9803

Then the ECM equation between rubber prices in the short run can be written as follows:

$$\Delta HKPL3.658279 + 0.082702\Delta HKPJ - 0.269451\text{ect}$$

Based on the ECM equation above, it can be seen that the coefficient values of the two markets where the coefficient value of rubber prices at the Japanese market level is positive and the probability level is greater than the 95% confidence level ( $0.0867 > 0.05$ ). This indicates that in the short term, the rubber market is imperfectly integrated. So it can be concluded that there is integration in the short and long term between the Mandailing Natal district rubber auction market and the rubber market on the Japanese stock exchange, the ECT coefficient is between -0.2 to 0.269 and the probability value is less than 0.05 at the 95% confidence level this indicates that the model used for short-term equations is valid to use. The ECT value of -0.269 indicates that changes in rubber prices in the Japanese market require approximately 26 days to be transformed in the Mandailing Natal Regency rubber auction market.

These results are in line with Malik et al. 's research (2013) which states that the ECM equation above shows the integration of the Singapore rubber market and the Jambi Province rubber auction market in the short-term and long-term are strongly integrated (according to the criteria used), which means fluctuations in rubber prices in the market.

The price movement of natural rubber in the auction market is in the same direction as the development of rubber prices in the Japanese futures market. Rubber price movements in the world futures market are transmitted to the domestic market (border prices and wholesale prices) through market mechanisms. This price movement is integration, but there is no known price co-integration relationship between the physical natural rubber market in Mandailing Natal and the Japanese rubber futures market.

The market is said to be integrated into the short run if price changes that occur in the reference market are directly and completely transferred to prices in the domestic market. The imperfect integration of rubber prices between the auction market and the Japanese futures exchange market indicates that the level of market efficiency is not yet good. An efficient market is where prices can always fully reflect the available information and no trader can profit and control the information in a monopolistic market form. In other words, an efficient commodity futures market can provide signals on prices in the spot market and eliminate losses so that profits can be guaranteed in the trading process. Markets between regions are fully integrated if the prices of different markets move together and the price differences between the markets are equal to transfer costs which include transportation costs and transaction costs.

<sup>8</sup> Source: Secondary Data Processed 2023

Based on these results it can be concluded that shocks originating from the Japanese commodity futures market in the short term responded positively to entering the long-term period the response decreased to a negative direction. But overall the response given to shocks is the same, increasing at the beginning of the period and decreasing at the end of the period and the magnitude of the dynamic response is relatively small. This means that the response to natural rubber price shocks on the Japanese futures market is small or not strong in influencing the prices that are formed.

**The elasticity of Rubber Price Transmission Between the Auction Market and the International Market:** Market problems that are still being faced to date indicate that agricultural markets are asymmetrical (asymmetrical market) where the price transmission elasticity of agricultural commodities is small so that price increases at the consumer level cannot be enjoyed by producers. Price transmission analysis is an analysis that can describe the extent of the impact of changes in the price of goods at one market level on changes in the price of these goods at other market levels. With this understanding, the elasticity of rubber price transmission can be defined as the magnitude of the influence of price changes in the US and Japanese futures markets on rubber prices in the auction market of Mandailing Natal Regency.

The magnitude of price transmission elasticity is indicated by the coefficient  $\beta_1$  in the ECM equation results obtained. To obtain a long-term equation that has a balance, the short-term equation is adjusted by the coefficient  $\alpha_2$ . The magnitude of price transmission elasticity can be seen from the  $\beta_1$  coefficient of the long-run equation. The coefficient of price transmission elasticity in the short and long term can be seen in Table 8 below:

**Table 8: Rubber Price Transmission Elasticity<sup>9</sup>**

No.	Market	Elasticity	
		Short-term	Long-term
1.	America's Market	-0.095521	0.146164
2.	Japan's Market	0.082702	0.212422

From Table 8 above, it is known that the level of elasticity of price transmission from the two markets in the long term and short term is in the inelastic criteria where the elasticity value of the two markets is less than 1 where the rate of change in prices at the international market level is greater than the rate of change in prices in level. For more details, the following briefly describes the level of elasticity between the two markets and the rubber auction market:

**The elasticity of rubber price transmission in the auction market and the American market:** Table 8 above shows the coefficient of rubber price transmission elasticity in the auction market in Mandailing Natal Regency in the short term (coefficient  $\alpha_1$  in the ECM equation) is -0.095521. This means, in the short term a 1% change in the price of rubber in America will cause a change in the price of rubber on the auction market in Mandailing Natal Regency by -0.095521%, while in the long term, the price transmission elasticity of rubber in the auction market in Mandailing Natal Regency is 0.146164 (coefficient  $\beta_1$  in the equation ECM) which means, in the long run, a 1% change in the price of rubber in America will cause a change in the price of rubber on the auction market by 0.14%. From the table above it can also be seen

<sup>9</sup> Source: Secondary Data Processed 2023



that the transmission elasticity of rubber prices in the auction market to rubber prices in America both in the short and long term is inelastic ( $\beta_1 < 1$ ).

**The elasticity of rubber price transmission in the auction market and the Japanese market:**

Table 8 above shows the coefficient of rubber price transmission elasticity in the Japanese market in the short run (coefficient  $\alpha_1$  in the ECM equation) 0.082702. This means, in the short term a 1% change in the price of rubber in the Japanese market will cause a change in the price of rubber in the Mandailing Natal Regency auction market by 0.082702%, while in the long run, the price transmission elasticity of rubber in the Mandailing Natal Regency auction market is 0.212422 (coefficient  $\beta_1$  in the equation ECM) which means, in the long run, a 1% change in the price of rubber in Japan will cause a change in the price of rubber on the auction market by 0.212422%. From the table above it can also be seen that the transmission elasticity of rubber prices in the rubber auction market to rubber prices in Japan both in the short and long term is inelastic ( $\beta_1 < 1$ ).

The results of the analysis show that the transmission elasticity of rubber prices is inelastic because  $E < 1$ , thus the rate of change in rubber prices at the international market level is greater than the rate of change in rubber prices at the farmer level or the rubber auction market in Mandailing Natal Regency. Philip (2008) states that if at the consumer level (International Market) there is a price increase then it will pass on the price increase experienced at the consumer level to farmers (Rubber Auction Market) imperfectly, in other words, farmers receive lower price increases compared to price increases that consumers pay for. Price transmission like this does not benefit farmers (rubber auction market) as producers because the price increases that occur at the international market level cannot be enjoyed by the rubber auction market (farmers) by that time.

Alamsyah (2014) added that if the value of price transmission elasticity is less than one ( $E_t < 1$ ), it is called inelastic, where the rate of change in prices at the international market level is greater than the rate of change at the rubber auction market level in Mandailing Natal Regency, which is low, reflecting inefficient marketing where price changes that occur at the consumer level are not entirely passed on to farmers. This pattern of price transmission occurs in monopsony markets where traders can control the purchase price of farmers. In the marketing of agricultural products, if the price transmission from the primary market (producers) is low, it is an indicator that the market structure formed is oligopoly, and reflects monopsony or oligopsony power exercised by the secondary market. Instability on the supply side is a phenomenon that occurs due to high price fluctuations in the agricultural sector. Agricultural produce can be caused by perishable agricultural products, in the short term when low prices cannot reduce production or increase demand.

**Conclusion:**

Based on the results of research on the integration of rubber prices between the Mandailing Natal Regency rubber auction market and the international rubber market, the following results are obtained:

- i. The international rubber market, namely the United States and the Mandailing Natal Regency Rubber Auction Market, are not integrated into the short term, this is because the coefficient value is negative and the probability level is greater than the 95% confidence level (-0.095521) and the probability value is greater than

0.05 (0.3999). The coefficient value of the rubber price coefficient at the Japanese market level is 0.082702 is positive and the probability level is greater than the 95% confidence level ( $0.0867 > 0.05$ ). This indicates that in the short term, the rubber market is imperfectly integrated. However, in the long term, the two markets are perfectly integrated with the rubber auction market in Mandailing Natal Regency.

- ii. The transmission elasticity of international crumb rubber prices and the price of crumb rubber in the rubber auction market in Mandailing Natal Regency is inelastic in the short and long term. However, in the long term, the transmission elasticity of the international price of crumb rubber and the price of crumb rubber in the rubber auction market is greater than in the short term.

### Recommendations:

The integration of the international crumb rubber market and the rubber auction market in Mandailing Natal Regency is imperfect, so what needs to be done is:

- i. **For traders and farmers:** Imperfect market integration can be used as a reference for determining prices in the future so that they can calculate price conversions at the farmer level after taking into account dry rubber content, transportation costs, quality and cleanliness/rubber.
- ii. **For policymakers:** By knowing market integration and the amount of price transmission, the government can mitigate price volatility by implementing a price stability policy by implementing a valid base price and trying to make Indonesian rubber exports not only focus on legal materials but more on products.
- iii. In this study, integration is only viewed from the price point of view, so to strengthen the description of the spatial integration of the natural rubber market between the physical market in Indonesia and the world futures market it should also be carried out based on the flow of goods, trade transaction costs and trade transaction volume.

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