Price transmission of Arabica coffee (Coffea Arabica) between Sumatera Utara and major export destination countries in Asia and Australia

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Abstract. Increasing global coffee consumption is driving the increasing need for world coffee. Indonesia is a coffee producing country in the world where one of Indonesia's coffee production is produced in Sumatera Utara Province. This research was conducted to analyse the pattern of price transmission between the Sumatera Utara coffee export market and the Japanese, Singapore, Malaysia, Taiwan, Australia markets and to analyse whether there is an effect of coffee prices on other exporters' markets, importer's markets, import volumes and Indonesian Rupiah exchange rates against the US Dollar in the formation of coffee export prices on the Sumatera Utara exporter market. Based on statistical analysis using the Asymmetric Error Correction Model and Error Correction Model, it is known that the transmission pattern of coffee prices occurs symmetrically in the long run, whereas in the short term the price transmission occurs asymmetries. The formation of coffee export prices in the Sumatera Utara market in the long run is influenced by import prices in the Japanese and Malaysian markets, and the volume of exports, while in the short term is influenced by import prices in the Australian, Japanese, Malaysian markets, export volumes, and exchange rates Indonesian Rupiah against US Dollar.

1. Introduction
The growing coffee consumption phenomenon is driving an increase in world coffee needs. Consumption of beverages made from coffee bean extract worldwide reaches 2.25 billion cups per day [1]. Meanwhile according to the International Coffee Organization [2], world coffee needs in 2013 were in the range of 8.77 million tons. Coffee is a popular drink due to the unique and unique taste of coffee, besides the influence of traditional, historical, social and economic factors [3].

Indonesia is listed as one of the largest coffee producing countries in the world besides Brazil and Vietnam according to FAO data in 2014. This encourages Indonesia to place coffee as part of the main commodity of estate crops besides palm oil, rubber and cocoa. Noted the value of Indonesia's coffee export trade in 2016 through the 1.01 billion USD [4].

Sumatera Utara Province as one of the provinces in Indonesia, places coffee as one of the mainstay export commodities besides palm oil and rubber. This is supported by the potential of suitable and suitable areas for the development of coffee cultivation. The type of coffee that is widely cultivated in Sumatera Utara Province is a type of Arabica coffee.
Table 1. Data of province with the largest production of Arabica coffee in smallholders in Indonesia 2013 – 2017

| Province       | Year 2013 | Year 2014 | Year 2015 | Year 2016 | Year 2017 | Rata2 | (%) |
|----------------|-----------|-----------|-----------|-----------|-----------|-------|-----|
| Sumatera Utara | 49,052    | 49,143    | 49,565    | 50,313    | 50,416    | 49,698| 30.90|
| Aceh           | 42,079    | 44,423    | 41,847    | 41,309    | 42,294    |       |     |
| Sulawesi Selatan | 19,333   | 19,534    | 20,352    | 20,712    | 20,103    |       |     |
| Sumatera Barat | 15,068    | 15,111    | 15,127    | 15,109    | 15,114    |       |     |
| Jawa Barat     | 9,385     | 9,300     | 9,340     | 9,425     | 9,420     | 9,374 | 5.83 |
| Other Province | 24,008    | 25,314    | 24,159    | 23,776    | 24,114    | 24,274| 15.09|
| Indonesia      | 158,925   | 162,826   | 160,390   | 161,066   | 161,080   | 160,857| 100.00|

Source: Data Centres and Agricultural Information Systems, Secretariat General of the Ministry of Agriculture

Based on data Table 1 from the Secretariat General of the Ministry of Agriculture [5] it is stated that during the period 2013 - 2017 Sumatera Utara Province ranked first in Arabica coffee production with an average production of 49,698 tons per year and contributed 30.90% of the total national Arabica coffee production. The production capability of Sumatera Utara Province far exceeds the production of other provinces of Arabica coffee, making Sumatera Utara Province the largest producer of Arabica coffee in Indonesia.

The volume and value of Sumatera Utara Arabica coffee exports each year varies according to world market demand. Fluctuations in the volume and value of Arabica coffee exports during the period 2012 - 2017 in more detail are presented in Table 2 below:

Table 2. Volume and value of Sumatera Utara Arabica coffee exports for the period of 2012 - 2017

| Year  | Export Value (USD) | Export Volume (Kg) | Export Price (USD/Kg) |
|-------|--------------------|--------------------|-----------------------|
| 2012  | 364,979,728        | 61,489,167         | 5,936                 |
| 2013  | 250,826,258        | 61,740,606         | 4,063                 |
| 2014  | 348,391,646        | 65,277,533         | 5,337                 |
| 2015  | 363,265,263        | 70,784,579         | 5,132                 |
| 2016  | 300,828,415        | 63,448,254         | 4,741                 |
| 2017  | 325,229,204        | 65,324,815         | 4,979                 |

Source: Indonesian Coffee Exporters Association, Sumatera Utara (data processed)

Data in Table 2 proves the highest export volume in 2015 and the lowest in 2012, but the fluctuations formed in export volumes do not reflect the same pattern as the fluctuations in export values.

Table 3. Average prices of world Arabica coffee in 2012 - 2015

| Year  | Export Price of Arabica Coffee (USD/Kg) |
|-------|----------------------------------------|
| 2012  | 4,111                                  |
| 2013  | 3,076                                  |
| 2014  | 4,424                                  |
| 2015  | 3,526                                  |

Source: Directorate General of Plantations
Based on data from Table 2 and Table 3 it can be seen that there is a close relationship between the export value of Sumatera Utara Arabica coffee with the price of Arabica coffee on the world market, where in the comparison of export values in 2012 with 2013 it can be seen that with higher world coffee prices in 2012 compared to 2013 made the export value in 2012 higher than the export value in 2013 although in 2013 the export volume was greater than the export volume in 2012.

There is a significant difference between the price of coffee in the Sumatera Utara Province market compared to the price in the market of the export destination country. This reflects the influence of the strengths of each market and the influence of the length of the marketing chain. Price fluctuations that occur are a picture of conditions of supply and demand movements that have an impact on prices on world markets both in terms of exporters and importers. The direct relationship between the two markets will form perfect integration, making symmetry transmission of prices possible. The asymmetries in the transmission of prices between the two markets indicate the possibility of differences in market power. This study aims to analyse the price transmission between the export prices of the Sumatera Utara market coffee with prices in several markets of the export destination countries, namely Japan, Singapore, Malaysia, Taiwan, Australia and to analyse whether there is an effect of coffee prices on exporters' markets and in the importer's markets, the volume of imports and the value of the rupiah against foreign currencies in the formation of coffee export prices in the Sumatera Utara exporter market.

2. Data and methods

2.1 Location and sample
This research was carried out deliberately where the research area was chosen based on consideration of its potential. Sumatera Utara Province in this case was chosen with consideration of its potential as the largest Arabica coffee producer area in Indonesia. This study uses secondary data based on time series (time series) over a period of 5 years, from 2014 to 2018. The data examined are monthly data concerning the volume of Sumatera Utara coffee exports, the export price of Sumatera Utara coffee, the price of imported coffee in the markets of Japan, Singapore, Malaysia, Taiwan and Australia, and the exchange rate of the Indonesia Rupiah against the US Dollar which will be collected from the Indonesian Coffee Exporters Association (AEKI) of Sumatera Utara, International Coffee Organization (ICO), Directorate General of Plantations, the Ministry of Trade, and other accountable sources.

2.2 Data analysis
Analysis of the data in this study is divided into two analyses, namely: 1) analysing the transmission patterns of prices that occur between the Sumatera Utara market and the markets of the export destination countries, and 2) testing the factors forming coffee prices on the export market in Sumatera Utara.

2.2.1 Analysis of price transmission patterns of Sumatera Utara market and export destination country markets. This analysis was carried out using the Asymmetric Error Correction Model (AECM) with the following model approach:

\[
\Delta PES = a_0 + \sum_{i=1}^{n} \beta_{1i} \Delta PES_{t-1} + \sum_{i=1}^{n} \beta_{12} \Delta PIT_{t-1} + \pi_1 ECT_{t-1} + \sum_{i=1}^{n} \beta_{21} \Delta PES_{t-1} + \sum_{i=1}^{n} \beta_{22} \Delta PIT_{t-1} + \pi_2 ECT_{t-1} + \epsilon_t
\]  

(1)

Where:
- PES = export price of Sumatera Utara coffee (USD/Kg)
- PES_t-1 = previous export price of Sumatera Utara coffee (USD/Kg)
- PIT = import price of main market destination country coffee (USD/Kg)
- ECT = Error Correction Term
\[ \alpha = \text{interception} \]
\[ \varepsilon = \text{error} \]

This method will describe the price fluctuations that occur in response to the price of the Sumatera Utara export market for price changes in the markets of the coffee export destination countries. Analysis through this model will separate the asymmetry patterns between long-term and short-term periods. Pattern symmetry or price asymmetry will illustrate the factors that influence price transmission.

2.2.2. Analysis of the effects of several factors in formation of Sumatera Utara coffee export price. The second analysis was performed using the Error Correction Model (ECM) with the long-term and short-term models as follows:

**Long Term Model**
\[
\ln P_{ES,t} = \alpha_1 + \alpha_2 \ln P_{ES,t-1} + \alpha_3 \ln P_{EB,t} + \alpha_4 \ln P_{IAU,t} + \alpha_5 \ln P_{IJ,t} + \alpha_6 \Delta \ln P_{IM,t} + \alpha_7 \ln P_{IT,t} + \alpha_8 \Delta \ln P_{IS,t} + \alpha_9 \ln V_{t} + \alpha_{10} \ln N_{T,t} + \varepsilon_t
\]  
(2)

**Short Term Model**
\[
\Delta \ln P_{ES,t} = \alpha_0 + \alpha_1 \Delta \ln P_{ES,t} + \alpha_2 \Delta \ln P_{EB,t} + \alpha_3 \Delta \ln P_{EV,t} + \alpha_4 \Delta \ln P_{IAU,t} + \alpha_5 \Delta \ln P_{IJ,t} + \alpha_6 \Delta \ln P_{IM,t} + \alpha_7 \Delta \ln P_{IT,t} + \alpha_8 \Delta \ln P_{IS,t} + \alpha_9 \Delta \ln V_{t} + \alpha_{10} \Delta \ln N_{T,t} + ECT_{t-1}
\]  
(3)

Where:
- \( P_{ES,t} \) = export price of Sumatera Utara coffee (USD/Kg)
- \( P_{ES,t-1} \) = previous export price of Sumatera Utara coffee (USD/Kg)
- \( P_{EB,t} \) = export price of Brazilian coffee (USD/Kg)
- \( P_{EV,t} \) = export price of Vietnamese coffee (USD/Kg)
- \( P_{IAU,t} \) = import price of Australian coffee (USD/Kg)
- \( P_{IS,t} \) = import price of Indonesian coffee (USD/Kg)
- \( P_{IJ,t} \) = import price of Japanese coffee (USD/Kg)
- \( P_{IT,t} \) = import price of Taiwanese coffee (USD/Kg)
- \( V_{t} \) = export volume of Sumatera Utara coffee (Kg)
- \( N_{T,t} \) = exchange rate of Indonesian Rupiah against the United States Dollar (IDR/USD)
- \( ECT \) = Error Correction Term

To find out the validity of the ECM model specifications, an Error Correction Term (ECT) coefficient test is performed. ECM model specifications are said to be valid if the ECT coefficient test results show a significant value.

3. Results and discussion

3.1 Analysis of price transmission patterns between the Sumatera Utara market and the markets of export destination countries

Causality Test Results to analyse the pattern of the relationship between coffee prices in the Sumatera Utara market and the markets of the export destination countries are described in the following Table:
Table 4. Granger causality tests results

| Relation                  | Sum of Lag | F-Statistic | Probability |
|---------------------------|------------|-------------|-------------|
| Australia → Sumatera Utara| 1          | 1.41520     | 0.2392      |
| Sumatera Utara → Australia| 1          | 13.6666     | 0.0005 *    |
| Japan → Sumatera Utara    | 1          | 3.01803     | 0.0878      |
| Sumatera Utara → Japan    | 1          | 9.07928     | 0.0039 *    |
| Malaysia → Sumatera Utara | 1          | 0.13711     | 0.7126      |
| Sumatera Utara → Malaysia | 1          | 0.00618     | 0.9376      |
| Singapore → Sumatera Utara| 1          | 0.23296     | 0.6312      |
| Taiwan → Sumatera Utara   | 1          | 9.65556     | 0.0030 *    |
| Sumatera Utara → Taiwan   | 1          | 17.4048     | 0.0001 *    |

Note: * significant at 5% significance level

In Table 4 it can be seen that a one-way relationship occurs between Sumatera Utara market prices and Australian market prices, Sumatera Utara market prices with Japanese market prices, two-way relationships occur Sumatera Utara market prices with Taiwan market prices.

Table 5. Wald test results for coffee export prices in the Sumatera Utara market to prices coffee in the export destination market

| Relation                  | Variabel                  | F- statistic | Probability |
|---------------------------|---------------------------|-------------|-------------|
| Sumatera Utara → Australia| ΔPES_{t-1} = ΔPES_{t-1}  | 3.996666    | 0.0512      |
|                           | ΔPIAU = ΔPIAU             | 19.30409    | 0.0001      |
|                           | ECT = ECT                | 0.575810    | 0.4516      |
|                           | ΔPES_{t-1} = ΔPES_{t-1}  | 0.063140    | 0.8027      |
| Sumatera Utara → Japan    | ΔPIJ = ΔPIJ              | 6.073777    | 0.0173      |
|                           | ECT = ECT                | 0.049559    | 0.8248      |
|                           | ΔPES_{t-1} = ΔPES_{t-1}  | 6.750932    | 0.0123      |
| Sumatera Utara → Malaysia | ΔPIM = ΔPIM              | 1.920884    | 0.1720      |
|                           | ECT = ECT                | 2.021911    | 0.1614      |
|                           | ΔPES_{t-1} = ΔPES_{t-1}  | 4.788353    | 0.0335      |
| Sumatera Utara → Singapore| ΔPIS = ΔPIS            | 0.498296    | 0.4836      |
|                           | ECT = ECT                | 0.184831    | 0.6691      |
|                           | ΔPES_{t-1} = ΔPES_{t-1}  | 2.820245    | 0.0994      |
| Sumatera Utara → Taiwan   | ΔPIIT = ΔPIIT          | 4.780868    | 0.0336      |
|                           | ECT = ECT                | 0.472219    | 0.4952      |

The Wald Test results in Table 5 show that overall the pattern of coffee price transmission between the Sumatera Utara market and the markets of the export destination country occurs symmetrically in the long term, whereas in the short term the price transmission occurs asymmetry. The difference in patterns that occur can be caused by the influence of the distance between the exporting country and the importing country which will have an impact on the cost of shipping goods. Besides that Vietnam's presence as another coffee producer in the Asia and Australia region will have an influence on the Sumatera Utara market.
3.2 Analysis of factors in formation of coffee export prices in Sumatera Utara

Based on the results of statistical analysis of data using the Error Correction Model presented in Table 6, it is known that the formation of coffee export prices in the Sumatera Utara market for long-term conditions is only influenced by import prices in the Japanese and Malaysian markets, and export volumes.

Table 6. Results of ECM statistical analysis long-term models of coffee export price formation factors in Sumatera Utara

| Variable | Coefficient | Std. Error | t-Statistic | Probability |
|----------|-------------|------------|-------------|-------------|
| C        | 0.862961    | 0.722286   | 1.194765    | 0.2380      |
| PES(-1)  | 0.836282    | 0.109351   | 7.647712    | 0.0000      |
| PEB      | -0.219420   | 0.123374   | -1.778497   | 0.0817      |
| PEV      | -2.31E-07   | 2.33E-06   | -0.099315   | 0.9213      |
| PIAU     | -0.034025   | 0.025618   | -1.328134   | 0.1904      |
| PIJ      | -0.235938   | 0.093425   | -2.525426   | 0.0149      |
| PIM      | 0.405021    | 0.184431   | 2.196056    | 0.0330      |
| PIS      | 0.037101    | 0.033283   | 0.099315    | 0.9213      |
| PIT      | 0.034154    | 0.046760   | 0.888466    | 0.3787      |
| VI       | 4.30E-08    | 2.19E-08   | 0.966928    | 0.3551      |
| NT       | -2.88E-05   | 3.99E-05   | -0.721342   | 0.4742      |

R-squared | 0.720442 | Mean dependent var | 2.632373 |
Adjusted R-squared | 0.662201 | S.D. dependent var | 0.294662 |
S.E. of regression | 0.010509 | Akaike info criterion | -0.526092 |
Sum squared resid | 1.405914 | Schwarz criterion | -0.138754 |
Log likelihood | 26.31970 | Hannan-Quinn criter. | -0.374891 |
F-statistic | 12.36999 | Durbin-Watson stat | 1.287781 |
Prob (F-statistic) | 0.000000 |

Table 7. Results of ECM statistical analysis short-term models of coffee export price formation factors in Sumatera Utara

| Variable | Coefficient | Std. Error | t-Statistic | Probability |
|----------|-------------|------------|-------------|-------------|
| C        | 0.014143    | 0.010509   | 1.345812    | 0.1850      |
| D(PES(-1)) | 0.182377 | 0.065642   | 2.778379    | 0.0079      |
| D(PEB)   | 0.353466    | 0.110258   | 3.216682    | 0.0492      |
| D(PEV)   | -7.70E-07   | 7.15E-07   | -1.077881   | 0.1867      |
| D(PIAU)  | -0.035545   | 0.009467   | -3.754535   | 0.0005      |
| D(PIJ)   | -0.198841   | 0.043089   | -4.614620   | 0.0000      |
| D(PIM)   | 0.370449    | 0.109958   | 3.368990    | 0.0015      |
| D(PIS)   | 0.026711    | 0.015930   | 1.676805    | 0.1004      |
| D(PIT)   | 0.015781    | 0.014755   | 1.069549    | 0.2904      |
| D(VI)    | 3.78E-08    | 9.17E-09   | 4.117911    | 0.0002      |
| D(NT)    | -0.000132   | 4.04E-05   | -3.271069   | 0.0020      |
| ECT      | 0.845876    | 0.074640   | 11.33273    | 0.0000      |

R-squared | 0.862874 | Mean dependent var | 0.089666 |
Adjusted R-squared | 0.830084 | S.D. dependent var | 0.189667 |
S.E. of regression | 0.078141 | Akaike info criterion | -2.078602 |
Sum squared resid | 0.280880 | Schwarz criterion | -1.652304 |
Log likelihood | 72.27947 | Hannan-Quinn criter. | -1.912550 |
F-statistic | 26.31445 | Durbin-Watson stat | 0.991966 |
Prob (F-statistic) | 0.000000 |
As for the short-term conditions of the formation of the export price of coffee in the Sumatera Utara market is influenced by import prices in Australia, Japan, Malaysia, export volume, and the exchange rate of the Indonesian Rupiah against the US Dollar. The details are presented in Table 7.

Differences in factors that influence the formation of coffee prices in the Sumatera Utara market that occur between long-term and short-term conditions are estimated by the presence of Vietnam as another coffee producer in Asia and an alternative coffee exporter for Asia and Australia.

4. Conclusions
The pattern of transmission of coffee prices between the Sumatera Utara market and the markets of the export destination countries occurs symmetrically in the long term, whereas in the short term the price transmission occurs asymmetrically.

The formation of coffee export prices in the Sumatera Utara market in the long term is influenced by import prices in the Japanese and Malaysian markets, and the volume of exports, while in the short term is influenced by import prices in the Australian, Japanese, Malaysian markets, export volumes, and exchange rates Indonesian Rupiah against US Dollar.

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