RJOAS: Russian Journal of Agricultural and Socio-Economic Sciences
ISSN 2226-1184 (Online) | Issue 1(145), January 2024

UDC 332; DOI 10.18551/rjoas.2024-01.03

VOLATILE FOOD PRICES FORECASTING MODELS FROM LIVESTOCK PRODUCTS IN JAMBI PROVINCE OF INDONESIA

Afriani H., **Farhan Muhammad**, **Farizal**, **Darmawi Darlim**, **Firmansyah***
Faculty of Animal Science, University of Jambi, Indonesia
*E-mail: firmansyah_fapet@unja.ac.id

ABSTRACT
The method used in this research is a quantitative descriptive method using secondary data in the form of weekly data on prices of volatile food products from livestock in the form of beef, chicken meat, and chicken eggs for the period 2018 to 2021 sourced from the National Strategic Food Price Information Center. This research uses the Autoregressive Integrated Moving Average (ARIMA) model analysis, ARCH (Autoregressive Conditional Heteroscedasticy) model and GARCH (Generalized Autoregressive Conditional Heteroscedasticy) model analysis. The model for forecasting the price of volatile food products from livestock in the form of chicken meat, beef, and chicken eggs in traditional markets in Jambi Province, namely GARCH (1,1), has excellent performance. It is suggested that the GARCH (1,1) model can be used to forecast the prices of volatile food products from livestock in the form of chicken meat, beef, and chicken eggs in traditional markets in Jambi Province.

KEY WORDS
Volatile food, livestock products, price.

Much of the inflationary pressure in Jambi Province was contributed by food groups, including beef, chicken meat, and chicken eggs, which are basic necessities produced by livestock or what are usually called volatile foods or volatile components. The phenomenon of volatile food price fluctuations in livestock products is very interesting to research. Volatility of volatile food prices Livestock products in the form of beef, meat, and eggs have a negative impact. The negative effects of high or excessive price volatility if the government does not quickly anticipate these conditions will cause the risk of losses for producers and traders to be more significant. Especially when household consumers face volatile food price behavior livestock products in the form of beef, meat, and eggs tend to be more unstable, and price patterns also become more irregular during religious holidays in traditional markets.

According to Rakshit et al. (2021), predicting price volatility is essential for all stakeholders in the supply chain. According to Bórawski et al. (2021), high prices of agricultural products are a problem for consumers on the one hand and for food producers on the other hand. Issues with price volatility of agricultural products impact the decisions of consumers, traders, and producers (Bórawski et al., 2020). Research by Fakari et al. (2016) found that chicken meat price volatility is lower because the chicken meat market has a different market structure where there are only a few producers in the chicken market. According to Fakari et al. (2016), commodity price volatility depends on the market structure of each commodity. Commodities in weak markets with small producers (perfectly competitive markets) have higher commodity price volatility. In comparison, commodities in solid markets with large producers (imperfect competitive markets such as oligopoly and monopoly) have lower price volatility. Matošková (2011) suggests minimizing business losses due to price volatility by improving the information market system, strengthening the transparency and credibility of information provided in domestic and international markets, and strengthening institutional competence to ensure price stability in the food market.

Therefore, the process of forecasting the price of volatile food produced by livestock in the form of beef, meat, and eggs is critical because it has the aim of providing consumers with an idea of the price movements of volatile food produced by livestock and the price range of volatile food produced by livestock that will occur in the future, and is beneficial for consumer knowledge so that consumers do not just assume but can decide when is the right time to stock up or not.

METHODS OF RESEARCH

The method used in this research is a quantitative descriptive method using secondary data in the form of weekly data on prices of volatile food products from livestock in the form of beef, meat, and eggs from 2018 to 2021 sourced from the National Strategic Food Price Information Center. This research uses the Autoregressive Integrated Moving Average (ARIMA) model analysis, ARCH (Autoregressive Conditional Heteroscedasticy) model and GARCH (Generalized Autoregressive Conditional Heteroscedasticy) model analysis. Procedure analysis data covers stages following:

1. Test stationarity is carried out using Augmented Dickey-Fuller (ADF) at the same degree (level or different) until stationary data is obtained which is formulated as follows:

$$\Delta P_t = \propto_0 + \gamma P_{t-1} + \beta_i \sum_{j=1}^{m} \Delta P_{t-1} + \varepsilon_i$$

2. The Autoregressive Integrated Moving Average (ARIMA) test uses the smallest Akaike Information Criterion (AIC) and Schwartz Criterion (SC) criteria. The ARIMA equation (Onour et al., 2011) is as follows:

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \ldots + \beta_p Y_{t-p} + \alpha_o e_t + \alpha_1 e_{t-1} + \alpha_2 e_{t-2} + \ldots + \alpha_q e_{t-q}$$

3. Model Test ARCH/GARCH (Autoregressive Conditional Heteroscedasticity) / (Generalized Autoregressive Conditional Heteroscedasticity). The first step to identify the ARCH/GARCH model is to see whether there is an ARCH error in the price movement data. GARCH Equation (Abdallah et al., 2020; Fasanya and Odudu, 2020; Tanaka and Guo, 2020; Komalawati et al., 2019) are as follows:

$$\sigma_t^2 = \alpha_0 + \alpha_1 e_{t-1}^2 + \ldots + \alpha_p e_{t-p}^2 + \lambda_1 \sigma_{t-1}^2 + \ldots + \lambda_q \sigma_{t-q}^2$$

or

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{P} \alpha_i e_{t-i}^2 + \sum_{j=1}^{P} + \lambda_j \sigma_{t-j}^2$$

4. ARCH-LM Heteroscedasticity Test. The ARCH-LM test (Lagrange Multiplier for Autoregressive Conditional Heteroscedasticity test) was carried out to see the effect of the presence of ARCH on the previously obtained model. Whether a model detects heteroscedasticity can be determined by looking at the F probability value and the Chi-square probability value, which are significant with a fundamental level of 5%;
5. Selection of the best model. The next stage after carrying out the ARCH-LM Heteroscedasticity test is estimating the parameters of the ARCH/GARCH model and selecting the best model. The variety forecast for the coming period is formulated as follows:

$$squared\ for h_t = \sigma^2 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 \varepsilon_{t-2}^2 + \ldots + \alpha_m \varepsilon_{t-m}^2 \text{ for ARCH}$$

or

$$h_t = k + \delta_1 h_{t-1} + \delta_2 h_{t-2} + \ldots + \delta_t h_{t-r} + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 \varepsilon_{t-2}^2 + \ldots + \alpha_m\ squared\ for \text{ for GARCH}$$

RESULTS AND DISCUSSION

The average price of chicken meat in the 2018-2022 period in traditional markets in Jambi Province is still normal because it is below IDR35,000/kg, which is the reference price for purchasing chicken meat at the consumer level. The average and minimum prices for chicken meat in traditional markets in Jambi Province were the lowest at the start of COVID-19, while the lowest maximum prices occurred during the COVID-19 period.

Table 1 – Description of Volatile Food Prices for Livestock Products in Jambi Province 2018-2022

No	Statistics	Volatile Food from Livestock Products		
		Chicken meat	Beef	ggs
1	Mean (IDR/kg)	32,723	123,997	21,697
2	Median (IDR/kg)	32,550	122,500	21,350
3	Maximum (IDR/kg)	48,650	142,500	27,350
4	Minimum (IDR/kg)	22,100	117,900	18,600
5	Std. Dev. (IDR/kg)	4,150	4,822	1,617

Beef has an average price in the 2018-2022 period in traditional markets in Jambi Province. normal because it is above IDR105,000/kg as the reference price for purchasing beef at the consumer level (Minister of Trade Regulation No. 07 of 2020). Reliable market information systems and up-to-date supply, demand, and stock information can help reduce price volatility (Paul et al., 2015). The volatility of tradable commodity prices is primarily determined by international markets and partly by exchange rate fluctuations and trade policies (Minot, 2014). Agricultural commodity price volatility can also directly relate to real income, especially in developing and least-developed countries (Gozgor & Memis, 2015).

What is the price data for volatile food products from livestock in Jambi Province from 2018 to 2022? Does it contain unit roots or not? Stationary test can be used. Results of the stationarity test for volatile food prices produced by livestock in traditional Jambi Province are presented in Table 2.

Table 2 – Results of Stationarity Test for Volatile Prices of Livestock Food Products

No	Province	Test Equation (Trend & Intercept)	t-Statistics	Augmented Dickey-Fuller test statistics Test critical values		Prob.*
1	Chicken meat	Levels	-5.34176	1 % Level	-3.457984	0.0000
2	Beef	1st Difference	-14.29209	1 % Level	-3.458104	0.0000
3	Eggs	1st Difference	-10.40593	1 % Level	-3.457984	0.0000

The results of the unit-roots test showed that data on the price of volatile food produced by livestock in the form of beef and eggs in Jambi Province for the period 2018-2022 was stationary at the level of 1st difference, while the price of chicken meat was stationary at the level levels.

After determining the AR and MA orders, we continue to select the ARIMA model for the price of volatile food produced by livestock based on the smallest AIC and SC values and the largest R-squared and Adjusted R-squared. ARIMA model results for volatile food produced by livestock in traditional markets in Jambi Province can be seen in Table 3. There are various ARIMA models for the price of volatile livestock food products at traditional Jambi Province markets. Based on the smallest AIC and SC values and the largest R-squared and Adjusted R-squared, the ARIMA model for the price of volatile food produced by livestock, namely ARIMA (1,0,1) for chicken meat, ARIMA (1,1,1) for beef, and ARIMA (12,0.6) for eggs. These three ARIMA models have significant probabilities.

Table 3 – ARIMA Model Results for Volatile Food from Livestock Products

Volatile Food from Livestock Products	ARIMA models	AIC	S.C	R-Squared	Adjusted R-Squared	Prob*
Chicken meat	ARIMA (1,0,1)	18.28653	18.34472	0.713158	0.709497	0.00000
Beef	ARIMA (1,1,1)	18.28331	18.34167	0.244653	0.234969	0.00000
Eggs	ARIMA (12,1,6)	15.33219	15.40514	0.233129	0.219964	0.00000

After determining the ARIMA model for the price of volatile food produced by livestock in Jambi Province, the ARCH heteroscedasticity test was continued for the ARIMA model. If the results of the ARCH heteroscedasticity test show that the F-statistic and Obs*R-squared results are not significant, then it can be concluded that it is free of heteroscedasticity so that the ARIMA model can be used as a model for forecasting future prices. On the other hand, if the F-statistic and Obs*R-squared are significant, it can be concluded that there is heteroscedasticity, so that the ARIMA model cannot be used as a model for forecasting future prices. Heteroscedasticity test results on the ARIMA model for volatile food produced by livestock in Jambi Province are presented in Table 4.

Table 4 – Heteroscedasticity Test ARIMA Model for Volatile Food from Livestock Products

Volatile Food from Livestock Products	ARIMA models	F-statistic	Prob. F(1.235)	Obs*R-squared	Prob. Chi-Square(1)	Conclusion
Chicken meat	ARIMA(1,0,1)	0.018520	0.8919	0.018675	0.8913	Heteroscedasticity Free (Can Predict)
Beef	ARIMA (1,1,1)	0.345322	0.5573	0.347750	0.5554	Heteroscedasticity Free (Can Predict)
Eggs	ARIMA (12,1,6)	5.011454	0.0261	4.948574	0.0261	There is Heteroscedasticity (Unable to Predict)

The results of the ARCH heteroscedasticity test in the ARIMA model for the price of volatile livestock food in traditional markets in Jambi Province that are not significant or free of heteroscedasticity or have no ARCH effect in the ARIMA model are chicken and beef. Based on these results, it can be concluded that the ARIMA model can be used to predict future prices for chicken and beef. This research found that the price of volatile food produced by livestock in traditional markets in Jambi Province that are significant or not free of heteroscedasticity or there is an ARCH effect in the ARIMA model based on the heteroscedasticity test are eggs. So, it can be explained that the ARIMA model cannot be used to predict the future price of eggs. This (eggs) must be continued into the ARCH/GARCH model for volatile food commodities produced by livestock.

ARCH/GARCH model analysis for volatile food from livestock products in traditional markets in Jambi Province all (chicken meat, beef, and eggs) GARCH model (1.1) because the probability value is significant. For chicken meat, the GARCH (1,1) model with AR(1) and MA(1) and a probability value of 0.000. Next, for beef, the GARCH (1,1) model with AR(1) and MA(1) and a probability value of 0.000. Then, for eggs, the GARCH (1,1) model with AR(12) and MA(1) MA(6) and a probability value of 0.000. In detail, the results of the ARCH/GARCH model analysis for volatile food produced by livestock in traditional markets in Jambi Province (chicken meat, beef, and eggs) are presented in the following Table 5.

Table 5 – ARCH/GARCH Model Results for Volatile Food from Livestock Products

Volatile Food from Livestock Products	ARCH / GARCH models	Variables	Coefficient	Std. Error	z-Statistics	Prob.
Chicken meat	GARCH(1,1)	AR(1)	0.650413	0.058912	11.04037	0.0000
		MA(1)	0.570764	0.067458	8.461031	0.0000
Beef	GARCH (1,1)	AR(1)	0.079204	0.009734	8.136875	0.0000
		MA(1)	-0.467620	0.062481	-7.484214	0.0000
Eggs	GARCH (1,1)	AR(12)	-0.149098	0.062784	-2.374754	0.0176
		MA(1)	0.409580	0.090863	4.507692	0.0000
		MA(6)	-0.112622	0.046692	-2.412022	0.0159

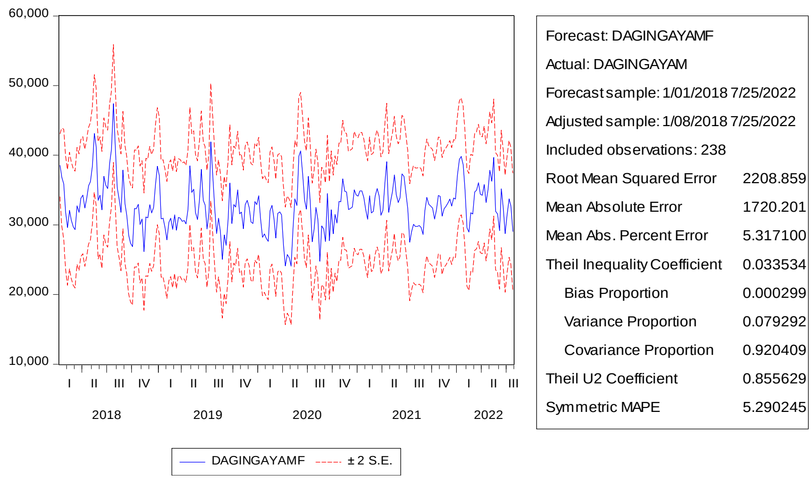
ARCH/GARCH model analysis for volatile food produced by livestock in traditional markets in Jambi Province only beef and eggs GARCH model (1.1), while chicken meat has an ARCH model (1.0). The GARCH (1,1) model with MA(1) and a probability value of 0.000 for beef and eggs. Meanwhile, for chicken meat, the ARCH (1.0) model has AR(2) AR(9) and MA(1) MA(9), and the probability value is 0.000.

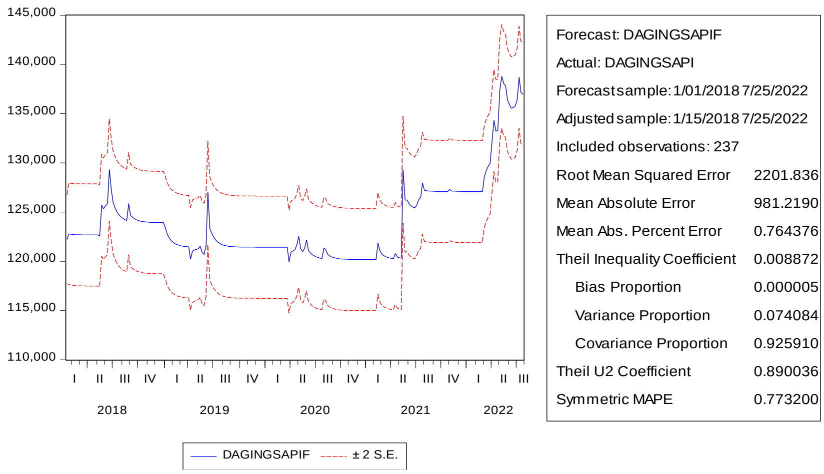
After determining the ARCH/GARCH model for the price of volatile food produced by livestock in traditional markets in Jambi Province, the ARCH LM heteroscedasticity test was continued. Results of the ARCH LM heteroscedasticity test on the ARCH/GARCH model for the price of volatile food produced by livestock in traditional markets in Jambi Province are not significant, as seen from the value of Prob. F and Prob. Chi-Square is greater than the 5% or 0.05 significance level. This result means that the GARCH (1,1) model is heteroscedasticity free, which means the residual variance is constant; in other words, there is no ARCH effect for all volatile food commodities produced by livestock. Based on these results, it can be concluded that the GARCH (1,1) model can be used to predict the future price of volatile food products from livestock (chicken meat, beef, and eggs) in traditional markets in Jambi Province. The results of the ARCH LM heteroscedasticity test in the GARCH (1,1) model for the price of volatile food produced by livestock at traditional markets in Jambi Province are presented in Table 6.

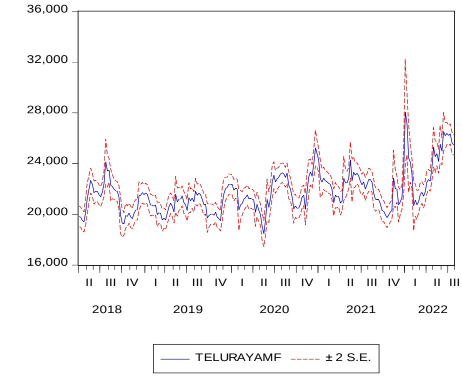
Table 6 – Heteroscedasticity Test ARCH/GARCH Model for Volatile Food from Livestock Products

Livestock Products	ARCH / GARCH models	F-statistic	Obs*R-squared	Prob. F(1.235)	Prob. Chi-Square(1)	Conclusion
Chicken meat	GARCH (1,1)	0.238861	0.6255	0.240649	0.6237	Heteroscedasticity Free (Can Predict)
Beef	GARCH(1,1)	0.031171	0.8600	0.031433	0.8593	Heteroscedasticity Free (Can Predict)
Eggs	GARCH (1,1)	0.157123	0.6922	0.158421	0.6906	Heteroscedasticity Free (Can Predict)

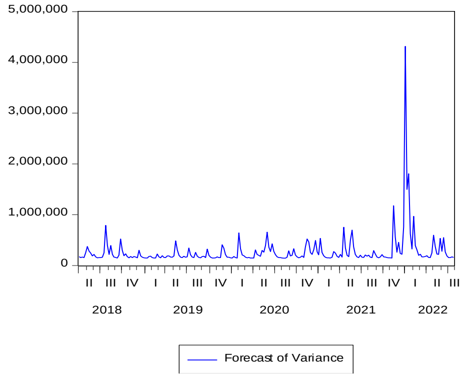
Chicken meat in traditional markets in Jambi Province has a MAPE value of 5.32% or <10%. So, these results can conclude that the model for forecasting the price of chicken meat in traditional markets in Jambi Province can be said to have excellent performance. Research by Burhani et al. (2013) is based on time series data for daily price data for chicken meat in Indonesia for the period February 2003-2013. The best model for forecasting the volatility of chicken meat prices using ARCH-GARCH analysis is ARCH (1).







Forecast: TELURAYAMF	
Actual: TELURAYAM	
Forecast sample: 1/01/2018 7/25/2022	
Adjusted sample: 4/02/2018 7/25/2022	
Included observations: 226	
Root Mean Squared Error	516.2440
Mean Absolute Error	339.1993
Mean Abs. Percent Error	1.536121
Theil Inequality Coefficient	0.011827
Bias Proportion	0.000997
Variance Proportion	0.000985
Covariance Proportion	0.998018
Theil U2 Coefficient	0.879388
Symmetric MAPE	1.541824



The results of the beef price forecasting model evaluation in traditional markets in Jambi Province turned out to have a MAPE value of 0.76% or <10%. This model for forecasting beef prices in traditional markets in Jambi Province can be said to have an excellent performance.

Chicken eggs in traditional markets in Jambi Province had a MAPE value of 1.54% or <10%. This model for forecasting the price of chicken eggs in traditional markets in Jambi Province can be said to have an excellent performance. Research by Larasati et al. (2016) concluded that the best GARCH model of the increase in basic food prices (9 essential commodities) was used to predict one year into the future. The conclusion is the GARCH model can be used as a forecasting model because it has a high level of validation (comparing predicted prices with original prices).

CONCLUSION

The model for forecasting the price of volatile food products from livestock in the form of chicken meat, beef, and chicken eggs in traditional markets in Jambi Province, namely GARCH (1,1), has excellent performance. It is suggested that the GARCH (1,1) model can be used to forecast the prices of volatile food products from livestock in the form of chicken meat, beef, and eggs in both traditional markets in Jambi Province.

REFERENCES

1. Abdallah MB, Farkas MF, and Lakner Z. 2020. Analysis of Meat Price Volatility and Volatility Spillovers in Finland. Agricultural Economics – Czech, 66, 2020 (2): 84–91. https://doi.org/10.17221/158/2019-agricecon.
2. Bórawski P., Perkowska A., Guth M., Parzonko A., Rokicki T., and Dunn JW 2021. Price volatility of milk and dairy products in Poland after accession to the EU. Agricultural Economics – Czech, 67, 2021 (3): 111–119. https://doi.org/10.17221/459/2020-agricecon.
3. Bórawski P., Guth M., Truszkowski W., Zuzek D., Bełdycka-Bórawska A., Mickiewicz B., Szymańska EJ, Harper JK, Dunn JW 2020: Milk price changes in Poland in the context

of the Common Agricultural Policy. Agricultural Economics – Czech, 66: 19-26. https://doi.org/10.17221/178/2019-agricecon.

4. Burhani, FJ, A. Fariyanti and S. Jahroh. 2013. Analysis of Price Volatility of Beef Beef and Broiler Chicken in Indonesia. Agribusiness Forum: Agribusiness Forum, 3(2), 129-146.
5. The phases are IO and Odudu TF. 2020. Modeling returns and volatility spillovers among food prices in Nigeria. Journal of Agriculture and Food Research. 2 (2020) 100029:1-17. https://doi.org/10.1016/j.jafr.2020.100029
6. Fakari, B., Aliabadi, MMF, Mahmoudi, H., and Kojori, M. 2016. Volatility Spillover and Price Shocks in Iran's Meat Market. Custos e @gronegócio on line - Vol.12, No.2 – Apr/Jun – 2016: 84-98.
7. Gozgor G & Memis C. 2015. Price volatility spillovers among agricultural commodity and crude oil markets: Evidence from the range-based estimator. Agricultural Economics – Czech, 61, 2015 (5): 214-221. https://doi.org/ 10.17221/162/2014-agricecon.
8. Komalawati., RW Asmarantaka., R. Nurmalina, & DB Hakim. 2019. Modeling Price Volatility and Supply Response of Beef in Indonesia. Tropical Animal Science Journal, August 2019, 42(2):159-166. https://doi.org/10.5398/tasj.2019.42.2.159.
9. Larasati EN, P. Hendikawati, and Zaenuri. 2016. Volatility Forecasting Analysis of Nine Basic Materials Using the GARCH Method with the R Program. UNNES Journal of Mathematics 5 (1) Page: 91-99.
10. Matošková D. 2011. Volatility of agrarian markets aimed at price development. Agricultural Economics – Czech, 57, 2011 (1): 34-40. https://doi.org/10.17221/143/2010-agricecon.
11. Minot N. 2014. Food price volatility in sub-Saharan Africa: Has it increased? Food Policy 45 (2014) 45-56. http://dx.doi.org/10.1016/j.foodpol.2013.12.008
12. Onour IA, Bruno S. Sergi. 2011. Modeling and forecasting volatility in the global food commodity prices. Agricultural Economics-Czech, 57, 2011 (3): 132-139. https://doi.org/10.17221/28/2010-agricecon.
13. Paul, R.K.; SP Bhardwaj, DR Singh, A. Kumar, P. Arya and KN Singh. 2015. Price Volatility in Food Commodities in India- An Empirical Investigation, International Journal of Agricultural and Statistical Sciences, Vol.11, No.2, pp.395-401.
14. Rakshit, D., R. K. Paul and S. Panwar. 2021. Asymmetric Price Volatility of Onions in India. Indian Journal of Agricultural Economics. Volume 76, Number 2, April-June 2021:245-260.
15. Tanaka T & Guo J. 2020. International price volatility transmission and structural change: a market connectivity analysis in the beef sector. Humanities And Social Sciences Communications (2020) 7:166:1-13. https://doi.org/10.1057/s41599-020-00657-x.