Vertical Market Integration of Cooking Oil Commodities in Jember Regency: Vector Error Correction Model (VECM) Approach

Illia Seldon Magfiroh(✉), Intan Kartika Setyawati, Luh Putu Suciati, Rena Yunita Rahman, and Ahmad Zainuddin

Faculty of Agriculture, University of Jember, Jember, Indonesia
{illia.faperta,intan.faperta,suciati.faperta,rena.faperta, zainuddin91.faperta}@unej.ac.id

Abstract. The price of cooking oil in Jember Regency, has continued to fluctuate over the past few months. These changes in cooking oil prices certainly have implications for the decline in people's purchasing power and the producer's selling power. Prices at the producer level must be properly transmitted to the consumer level, and vice versa. Therefore, it is important to examine market integration of cooking oil in the Jember Regency. This study aims to analyze the vertical market integration from producers to consumers of cooking oil in Jember regency. This study utilized monthly time series data with a period of 53 series. The data collected was related to food price data at the producer and consumer levels in Jember regency. This research was conducted using the vector error correction model (VECM) to determine the market integration of producers and consumers. Based on the output of the VECM analysis, it was found that the market integration equation model of cooking oil producers and consumers did not have a long-term relationship. The results showed that the market of cooking oil producers and consumers has a short-term relationship or is integrated in the short term only.

Keywords: price · cooking oil · producer · consumer · VECM

1 Introduction

Food is one of the basic human needs related to human rights. Food availability is an obligation of all parties, both central and regional governments. The role of food in an economy is very strategic because food is a primary need for every human being. Although food demand is inelastic, changes in food prices and availability are sensitive issues. This sensitivity can be caused by market variables such as prices [1–4].

Food prices that continue to increase can lead to high inflation and price fluctuations. Changes in food prices can occur in each region and nationally. Changes in food prices also occurred in Jember Regency. In recent months, risks and uncertainties for consumers and producers regarding food prices have tended to increase. The price of main food, especially cooking oil as the main commodity in Jember Regency, has continued to fluctuate over the last few months. This can be caused by fluctuating demand and stock

Dafik (Ed.): ICCGANT 2022, APR 6, pp. 201–210, 2023.
https://doi.org/10.2991/978-94-6463-138-8_18

of cooking oil. In addition, the scarcity of cooking oil that had occurred in Indonesia also caused the price of cooking oil at the consumer level to become more expensive. The increase in the price of cooking oil at the consumer level is not always transmitted to the producer market. Based on this, it is important to study the integration of the cooking oil market in Jember Regency.

Food price transmission is very important in realizing stable and fair food prices for every economic actor. Prices at the producer level should be well transmitted to the consumer level, and vice versa prices at the consumer level should be well transmitted to the producer level. This price transmission is an important part in realizing the integration of the main food market (especially cooking oil) to make it more efficient. According to Ariyani (2012) [5], vertical market integration in food commodities can occur, if there are price changes at the producer and wholesale levels then followed by price changes at the consumer level. Between one market and another market will be interconnected, where price information will be obtained accurately, and this will make price movements efficient. Likewise, the food market in Jember must be integrated and efficient so that food prices, especially cooking oil, remain stable and do not fluctuate. Research related to food market integration, especially cooking oil, has been carried out by Manik et al. (2018) [6], Hafizah (2011) [7], Ardana and Sinaga (2020) [8], Arnanto et al. (2018) [9]. Previous research discussed the horizontal integration of the oil market. The novelty of this research is to discuss the integration of the cooking oil market with the scope of Jember Regency, East Java, Indonesia.

2 Research Method

This research utilized a descriptive-analytical method. The data used in this panellation was time series data in the form of monthly data on and cooking oil price at the producer and consumer levels from the East Java Central Bureau of Statistics and from the East Java Trade Office. The data used were 69 series from January 2017 to September 2022. The research location chosen was Jember Regency, East Java, Indonesia due to the recent increase in cooking oil prices in Jember Regency.

The data processing used was excel 2007 software and Eviews 7.0. The results of data processing are presented in the form of tabulations and graphs. The model used to analyze market integration was the VAR (Vector Autoregressive)/VECM (Vector Error Correction Model) model. The VAR/VECM model is a system of equations that shows each variable as a linear function of a constant and the lag value of the variable itself and the lag value of other variables in the system. Thus, the explanatory variables in the VAR/VECM model include the lag values of all the independent variables in the system. The VAR model of the market integration of cooking oil producers and consumers was as follows:

$$\begin{aligned} Pkon_t &= \alpha_1 + \delta_1 t + \phi_{11} Pkon_{t-1} + \cdots + \phi_{1p} Pkon_{t-p} \\ &+ \beta_{11} Ppro_{t-1} + \cdots + \beta_{1q} Ppro_{t-q} + \varepsilon_t \end{aligned} \tag{1}$$

and

$$\begin{aligned} Ppro_t &= \alpha_2 + \delta_2 t + \phi_{21} Ppro_{t-1} + \cdots + \phi_{2p} Ppro_{t-p} \\ &+ \beta_{21} Pkon_{t-1} + \cdots + \beta_{1q} Pkon_{t-q} + \varepsilon_t \end{aligned} \tag{2}$$

where $\mathrm{Pkon_t}$ is an nx1 vector of cooking oil prices at the consumer level of order one, generally denoted I(1); $\mathrm{Ppro_t}$ is the price of cooking oil at the producer level and εt is an nx1 vector of innovations [10]. In this study, the n studied amounted to 2 variables (food prices at the consumer level, respectively).

The specifications of the VECM model of cooking oil market integration at the producer and consumer levels are as follows:

$$\begin{aligned} \Delta \mathrm{Pkons_t} &= \varphi_1 + \delta_1 \mathrm{t} + \lambda_1 \mathrm{e_{t-1}} + \gamma_{11} \Delta \mathrm{Pkons_{t-1}} + \cdots + \gamma_{1p} \Delta \mathrm{Pkons_{t-p}} \\ &+ \omega_{11} \Delta \mathrm{Pprod_{t-1}} + \cdots + \omega_{1q} \Delta \mathrm{Pprod_{t-q}} + \varepsilon_{1t} \end{aligned} \tag{3}$$

and

$$\begin{aligned} \Delta \mathrm{Pprod_t} &= \varphi_2 + \delta_2 \mathrm{t} + \lambda_2 \mathrm{e_{t-1}} + \gamma_{21} \Delta \mathrm{Pprod_{t-1}} + \cdots + \gamma_{2p} \Delta \mathrm{Pprod_{t-p}} \\ &+ \omega_{21} \Delta \mathrm{Pkons_{t-1}} + \cdots + \omega_{2q} \Delta \mathrm{Pkons_{t-q}} + \varepsilon_{2t} \end{aligned} \tag{4}$$

Notes:

$\mathrm{Pprod_t}$ = vector containing the variable analyzed in the study (cooking oil price at producer level (IDR/kg))

$\mathrm{Pkons_t}$ = cooking oil prices at the consumer level (IDR/kg)

φ_x = intercept vector

$\gamma_{2p;}\ \omega_{2q}$ = vector of regression coefficients

t = time trend

γ_{2p} = αxβ' where b' contains the long-run cointegration equation $\mathrm{Pkon_{t-1}}$; $\mathrm{Ppro_{t-1}}$ in-level variable

λ_x = regression coefficient matrix indicating the presence of short-run integration

ε_t = error term

3 Results and Discussion

Research on market integration of producers and consumers of cooking oil uses cooking oil price data at the producer and consumer prices. All data used is data in the form of monthly data from January 2017 to September 2022 obtained from the Central Bureau of Statistics and the Ministry of Trade. The results of market integration analysis of producers and consumers of cooking oil were carried out using the VECM model. Before carrying out the VECM analysis, image analysis is carried out as shown in the Fig. 1.

The Fig. 1 shows that the price movements of cooking oil producers have the same trend as cooking oil consumers in Jember Regency. Despite having the same trend, data on cooking oil prices show that consumer prices fluctuate more than prices at the producer level. The existence of the same movements and trends may indicate that there is market integration between producer markets and consumer markets for cooking oil

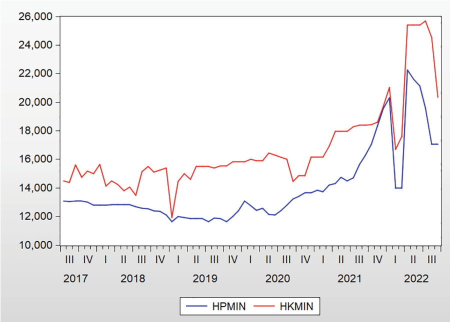

Fig. 1. Price graph of producers and consumers of cooking oil in Jember Regency

products in Jember Regency. However, this is needs to be proven first by using Vector Error Correction Model (VECM) analysis.

A. Time Series Data Analysis

1) *Stationary Test*

To analyze the movement of time series data and see the relationship between variables, it is necessary to test the stationarity of the data series. This test is carried out to see the consistency of the movement of time series data and to prevent spurious regression, which is a condition where a regression of one variable against another variable results in a high R^2 but there is no significant relationship economically. This often occurs when two or more time series data show strong trend characteristics over time.

To find out under which conditions the data can become stationary, the data is tested under several conditions. If the data series is stationary without differencing, then it is said to be condition I(0) or level. If the data series is stationary in the first derivative I(1), then it is said to be a condition (first differences) or integration of order 1. In general, if time series data must be derived "d" times to be stationary, then the data can be denoted in the form I(d) or integrated from order "d".

In this study, the stationarity test was carried out using the Augmented Dickey Fuller (ADF) test on level and first difference conditions, with intercept specifications with a trend or intercept without a trend. Testing price series using intercepts with or without trends (intercept and trend) shows the relationship with non-stationary data types (Random Walk Model/RWM). Testing with the assumption that there is an intercept/constant without a trend shows an RWM test with drift, while testing using an assumption that there is a constant/intercept with a trend shows an RWM test with a deterministic trend. This relates to price series which have the characteristics of a stochastic trend and a deterministic trend. The null hypothesis states that a unit root exists (and is not stationary), while the converse of the hypothesis states that a unit root does not exist (stationary). Based on McKinnon's absolute value and the statistical ADF value, the null hypothesis can either be accepted or rejected. If each variable's statistical ADF value is less than the McKinnon Critical Value in absolute terms, the data is stationary. Conversely, if the statistical ADF value exceeds the

Table 1. Unit Root Test Results with Intercept with Trend

Variable	Differenced	Intercept with trend				Conclusion
		ADF value test statistic	**1%**	**5%**	**10%**	
HKMIN	I(0)	−3.23	−4.11	−3.48	−3.17	Not Stationer
	I(1)	−7.30	−4.12	−3.49	−3.17	Stationer
HPMIN	I(0)	−0.61	−4.13	−3.49	−3.18	Not Stationer
	I(1)	−6.89	−4.14	−3.49	−3.18	Stationer

McKinnon critical value in absolute terms, the data are not stationary. The Table 1 displays the results of the stationarity test.

Based on the table of unit root test results, it is known that the variable producer prices and consumer prices for cooking oil are not stationary at the level. This is because the statistical ADF value of each variable such as the price of cooking oil at the producer and consumer levels is absolutely greater than the McKinnon critical value when the stationarity test is carried out using intercept criteria with trend. Because all variables show non-stationary conditions, it is continued with unit root testing on the first difference. The test results show that the null hypothesis that there is a unit root is rejected. This indicates that at the 1%, 5% and 10% significance level, all variables or data used are stationary at first difference, because the statistical ADF value is smaller in absolute terms when compared to the McKinnon critical value. Based on this, the VECM model can used.

2) *VAR Stability Test*
The results of the VAR stability analysis show that the VAR model used is a stable model so that further testing can be carried out with the VECM model.

3) *Optimum Lag Test*
The next crucial step is figuring out the ideal number of lags that may be incorporated into the model. The lag of the endogenous variables in the system of equations will be employed as exogenous variables, hence choosing the best lag is crucial while estimating the VAR/VECM model. The appropriate lag must be established to solve the autocorrelation issue in the VAR/VECM system. The values of the Akaike Information Criteria (AIC), Schwarz Criteria (SC), and Hannan-Quinn Information Criteria (HQ) may be used to calculate the length of the lag.

The amount or length of the lag that creates the least criteria is the lag that should be chosen. The system stability requirements are taken into account before determining the ideal lag duration. This study used the Akaike Information Criterion (AIC) scoring criteria to determine how long the lag was. The Table 2 shows the results of determining the ideal lag length.

Table 2. Optimal Lag Criteria

Lag	LR	FPE	AIC	SC	HQ
0	NA	1.40e + 13	35.94615	36.01720	35.97382
1	113.8165	2.03e + 12	34.01469	34.22784*	34.09772
2	0.897248	2.29e + 12	34.13569	34.49094	34.27407
3	11.55443	2.10e + 12	34.04707	34.54441	34.24079
4	6.618274	2.11e + 12	34.04993	34.68938	34.29901

Based on the Table 2, it can be shown that the results of the optimum lag analysis using the Akaike Information Criteria (AIC) calculation obtained the optimum lag at lag 5. Thus, it can be concluded that the optimum lag used in the market integration model for cooking oil in producer markets and consumer markets is lag 5. This means that all the variables in this model influence each other not only in the current period, but these variables are interrelated up to the previous 5 periods.

4) *Cointegration Test*

Engel and Granger (1987) stated that cointegration refers to a few variables that are integrated to the same degree, so a cointegration test can be carried out. In this study all variables are cointegrated at degree or order 1 I(1). If the variables in a study are cointegrated at different degrees, then it can be said that these variables cannot be cointegrated.

If a system of equations has a cointegration connection, it is likely that the system also has an error correction model that depicts a short-term dynamic that is compatible with the long-term relationship. The Johansen test methodology is used in this study's cointegration testing. At the 5% level of significance, the Johansen test is performed by comparing the trace statistical value with the critical value and the highest eigenvalue with the critical value. There is a long-term connection or cointegration in the system of equations if the trace statistic or maximum eigenvalue is bigger than the critical value. The cointegration test results can be seen in Table 3.

The Johansen cointegration test will show whether the model shows cointegration or long-term integration. The results of the analysis show that the model used has a long-term relationship or cointegration. This means that in the long run, price changes at the producer level can be caused by price changes at the consumer level or vice versa.

5) *Granger Causality Test*

To find out the variables that affect changes in other variables, Granger Causality analysis can be carried out. This causality test is carried out by comparing the probability values at the significantly significant level at 1, 5 and 10 percent. If the probability value exceeds the real level, then H0 is rejected, and vice versa. The null hypothesis (H0) in this study is that there is no real interplay between the two markets being compared and on the contrary the alternative hypothesis (H1) shows that there is an interplay between the two markets being compared.

Table 3. Johansen Cointegration Test Results

hypothesis		Trace Statistic	Critical Value 5%	Mx-Eigen Statistic	Probability
H_0	H_1				
r = 0	r = 1	17.48512	25.87211	0.173613	0.3796
r = 1	r = 2	16.043610	12.51798	0.095820	0.0548

To confirm the transmission direction, causality testing is also done. Price shocks brought on by changes in demand (price transmission from downstream to upstream) will, in the event of vertical integration, have a different price transmission impact than shocks brought on by changes in supply. The Granger test technique is used for causality testing in this work.

If research utilizing the Granger test method demonstrates that there are two causal relationships (the price of cooking oil at the producer level affects the price of cooking oil at the consumer level, and vice versa), then actually the price of cooking oil has a reciprocal relationship from producers to consumers and vice versa. However, in the case of market integration for cooking oil, price changes are caused by demand shocks where prices at the producer level follow price changes that occur in the consumer market. The following are the results of causality testing using the Granger test.

According to Table 4, the price of cooking oil at the consumer level has a significant impact on the producer level pricing while the price at the producer level has little effect on the price at the consumer level. The consumer level prices shift first in this connection, which is one-way or hierarchical in structure, and then the producer market prices. Consumer prices control the direction of price change since they directly affect producer prices, which will vary in response to changes in consumer prices. This can be caused by market demand which will cause price changes at the consumer level and then be transmitted to the producer market. The cooking oil market fluctuates greatly because it is caused by fluctuations in the demand for cooking oil. In addition, in 2022 there will be price shocks at the consumer level where there is a surge in cooking oil prices at the consumer level which causes prices to become very expensive. This price shock was caused by the scarcity of cooking oil that occurred in Indonesia, so this condition also caused price shocks in Jember Regency.

B. VECM Analysis

The following step is to estimate the integration equation using the VECM after counting the number of cointegrated vectors (Vector Error Correction Model). Although time series data is frequently not stationary at a level, or termed data stationarity, Engle-Granger (1987) in Widarjono (2012) [11] asserts that a linear combination of two or more nonstationary data becomes stationary, this is what is known as cointegrated. A long-term link between the variables in the VAR system is what is meant by cointegration.

Table 4. Causality Test Results with the Granger Method

Null Hypothesis:	Obs	F-Statistic	Probability
HPMIN does not Granger Cause HKMIN	58	0,562597	0,7548
HKMIN does not Granger Cause HPMIN		6,070124	0.0481

Table 5. Long Term Market Integration

Cointegration Equation	Cooking Oil Price Variable		
	HPMIN	HKMIN	C
Cointegration 1	1.000000	1.085236 (0.20271) [5.35371]	2943.369

In order to demonstrate a theoretical link between variables, the VECM model is applied to time series data that are stationary at the difference and cointegrated levels but not at the level.

The VECM model, often known as a limited VAR model, is a non-structural VAR model. This is because VECM still permits dynamic changes in the near term while limiting the long-term behavioral interaction between the existing variables such that it converges into a cointegration relationship. Because any divergence from the long-term balance will be eventually fixed by modifications, this cointegration concept is referred to as error correction.

In this study it has been known that cointegration occurs in the integration model in the market for cooking oil producers and consumers. The presence of cointegration in the system suggests that the producer and consumer markets for cooking oil have a long-term structural link. The Table 5 displays the long-term connection in the market for cooking oil.

The Table 5 shows that the cooking oil market at the consumer level has a significant influence on the price at the producer level of 1.085. This means that every 1 percent price increase at the consumer level will cause an increase in the price of cooking oil at the producer level by 1.08, and vice versa if there is a decrease in prices at the consumer level it will be transmitted by a decrease in prices at the producer level. In addition to long-term output, VECM also shows short-term analysis results as Table 6.

Based on the output of the VECM analysis, it is known that the market for producers and consumers of cooking oil has a short-term relationship. The short-run relationship that occurs is consumer prices which will affect producer prices in lag 2. This suggests that price changes in the consumer sector will have a 0.488 magnitude transmission to producer pricing. Accordingly, a price change at the consumer level of 1% will result in a price change at the consumer level of 0.488%, and vice versa. Consumer price adjustments from the prior era also have an impact on current pricing. This implies that in calculating price adjustments at the consumer level at this time, the prior price changes

Table 6. SHORT Term Market Integration

Error Correction:	**D(HPMIN)**	**D(HKMIN)**
CointEq1	0.077876	0.439636
	(0.16345)	(0.16672)
	[0.47644]	[2.63691]*
D(HKMIN(−1))	0.119225	0.026394
	(0.03517)	(0.03987)
	[0.50698]	[0.11003]
D(HKMIN(-2))	0.488814	−0.550717
	(0.22781)	(0.23237)
	[2.14573]*	[−2.37004]*
D(HPMIN(−1))	−0.178610	−0.068921
	(0.24319)	(0.24806)
	[−0.73445]	[−0.27785]
D(HPMIN(−2))	−0.021604	0.127141
	(0.23161)	(0.23625)
	[−0.09328]	[0.53817]
C	145.0875	124.9942
	(176.522)	(180.054)
	[0.82192]	[0.69421]

that took place in the cooking oil consumer market in Jember Regency will be utilized as a reference. These results are consistent with research [7] and [9] which shows that consumer prices for cooking oil will affect changes in cooking oil prices at the producer level.

4 Conclusion

Cointegration occurs in the integration model in the market for cooking oil producers and consumers. The existence of cointegration in the system indicates that there is a long-term structural relationship between the producer and consumer markets of cooking oil. The market for cooking oil producers and consumers has a short-term relationship. The short-run relationship that occurs is consumer prices which will affect producer prices in lag 2. This indicates that price changes that occur in the consumer market will be transmitted to producer prices. The government needs to carry out a policy of controlling the price of cooking oil at the consumer level by improving the cooking oil trading system and conducting regular market operations.

Acknowledgment. We thank the Institute for Research and Community Service (LPPM), University of Jember for the financial support for this study or research through a group research grant with Decree No 14970/UN25/KP/2022.

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