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Spatial Market Integration of Garlic in Indonesia

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Abstract

Garlic is one of the important horticultural commodities for Indonesian people. In 2020, Indonesia experienced a garlic deficit of 362.42 thousand tonnes. Indonesia's dependence on the international market causes garlic prices to tend to fluctuate. Integrated market information can help the government implement policies to reduce price fluctuations. The purpose of this study is to examine the development of garlic production, consumption, prices, and to analyze the spatial market integration of garlic in Indonesia. The data used is monthly time series data on garlic prices at the consumer level in 33 provinces for the period January 2014-December 2020. The analytical method used is Vector Error Correction Model (VECM). The results of the study show that there is a large gap between consumption and production of garlic, and the price of garlic fluctuates greatly. There has been a comprehensive long-term integration of the garlic market in Indonesia. This is indicated by the cointegration of all consumer market pairs. The consumer markets of Bali, Central Java, and East Java are price leaders. There are 212 pairs of integrated garlic consumer markets in the short term. This shows that the garlic market in Indonesia is more integrated in the long term.

Keywords
garlic; prices at the consumer level; spatial market integration

I. Introduction

Garlic is an important horticultural commodity for Indonesian people considering the variety and amount of its utilization (Ministry of Agriculture, 2018). In Indonesia, not all provinces can produce garlic because some areas are not suitable for planting garlic. This causes garlic production to catch up in only a few areas. Indonesia has an estimated garlic deficit of 362.42 thousand tons in 2020 (BPS, 2021). The huge gap between the production and consumption of garlic encourages garlic imports.

Figure 1 shows that the national garlic price is much higher and fluctuates compared to the international garlic price. The condition of Indonesia's territory which is an archipelagic country makes the prices of various basic commodities different in each province. In 2020, the average national garlic price is Rp. 25,081/kg. The lowest price is in South Kalimantan, which is Rp. 19,500/kg and the highest price is in North Maluku, which is Rp. 36,458/kg (PIHPSN, 2021). The high price difference between South Kalimantan and North Maluku, which reached Rp. 16,958/kg (86.96%), shows that trade relations between regions in Indonesia are less than optimal. Trade between regions indicates integration of the garlic market. Price disparities between regions that are too high may indicate that the garlic

commodity market is not yet efficient and market integration between regions is not well developed. This is contrary to the Law of the Republic of Indonesia Number 7 of 2014 concerning trade which explains that interregional trade activities aim to integrate the domestic market.

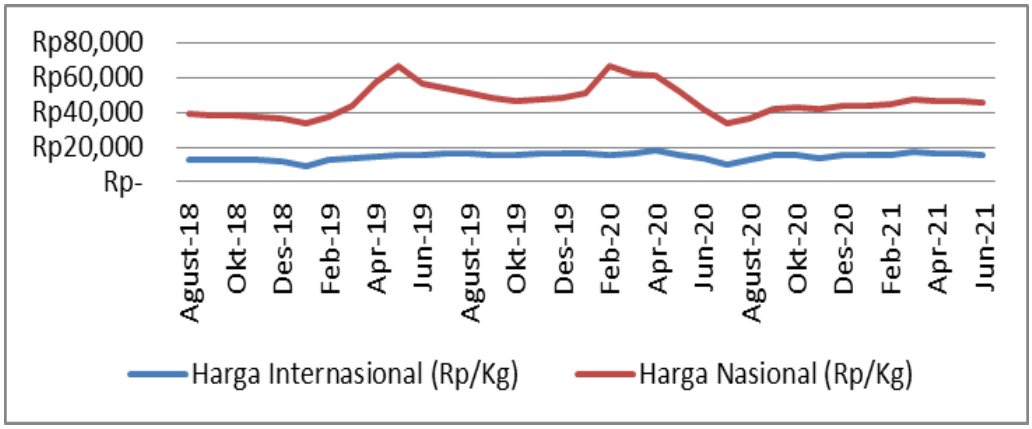

Figure 1. *National and International Garlic Prices for the Period August 2018 to June 2021*
Source: National PIHPS, 2021; ITC, 2021 (processed)

The concept of market integration is Related to the concept of price transmission. Market integration is a measure of the extent to which demand and supply shocks that arise in one region are transmitted to other regions (Fackler & Goodwin, 2001). Meanwhile, price transmission is a process where prices in one market affect prices in other markets (Lupiya, 2018). Price transmission is one of the integrated features of a market. In conclusion, if there is integration between the two markets, then the price transmission process will run well and price stabilization policies can be carried out regarding price movements (Firdaus & Gunawan, 2012). If the market is efficient, then prices in different markets must be integrated (Patil & Kerur, 2016). Implementation of price stabilization policies will be more effective in integrated markets than in non-integrated markets. In an integrated market, government intervention is channeled to other markets so that the implementation of price policies can be carried out at a lower cost (Agung & Daryanto, 2017).

Market integration into two groups, namely (1) horizontal (spatial) market competition refers to commodity prices that both move together by drying spatially different locations (Barrett, 1996); (2) Vertical market integration, namely the existence of a link between one marketing institution and other marketing institutions involved in one marketing channel (Erviana, 2019). This study focuses on the spatial market integration of garlic with the consideration that research on market integration has been carried out previously by previous researchers, but there has been no research on spatial market integration, especially on garlic commodities. The price used is the price of garlic at the consumer level with the consideration that prices at the consumer level fluctuate more as indicated by the national average coefficient of variation (CV) value of garlic prices at the consumer level of 0.28 in 2020. Study of market integration, the determinants of market integration are also important to study so that efforts to increase garlic market integration are the right targets. Based on the explanation above, the purpose of this study aims to:

1. Assess the development of garlic production, consumption, and prices in Indonesia.
2. Analyzing the integration of the spatial market for garlic in Indonesia.

II. Review of Literature

Market integration or integration is an indicator of marketing efficiency, especially price efficiency (Asmarantaka, 2009). Market efficiency relates to the extent to which markets limit costs and match supply to demand, whereas market integration describes how prices in different markets move together (Barrett, 1996). Market integration is a measure of the extent to which demand and supply shocks that arise in one region are transmitted to other regions (Fackler & Goodwin, 2001). A market that is said to be integrated if changes at one market level are channeled or transferred to other markets (Rahmawati, 2018). 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. Markets that are not integrated both spatially and intertemporally can indicate that marketing inefficiencies have occurred, resulting in price games and price distortions in the market (Adrianto, 2022).

Spatial market integration is the level of linkages between regional markets. Spatial market integration is described as market integration that occurs in markets that are geographically separated (Zahara, 2019). Spatial price analysis studies usually examine the co-movement in a time series of prices that are measured simultaneously at different places (Barrett, 2005). According to Firdaus and Gunawan (2012), spatial price integration can be defined as price transmission between markets which is reflected in price shifts in geographically different markets for the same commodity. If trade occurs between any two regions, then the price in the importing region equals the price in the exporting region plus the unit transportation costs incurred by moving between the two. If this holds true then the market can be said to be spatially integrated (Ravallion, 1986). The formation of market integration in a region aims to make the allocation of resources more efficient, encourage competition, and increase economies of scale in production and distribution between these regions (Nauly et al., 2021).

The concept of spatial market integration can be seen from the price relationship between geographically separated markets. This theory is explained by Tomek and Robinson (1990) with the Spatial Equilibrium Model. The basis of the concept is based on the development of excess supply and excess demand curves in trade between the two regions. This concept can also be used to estimate prices in the trading process, where prices are formed for each market and the number of commodities. In this concept, market division is divided into two groups. First, a potential surplus market (potential surplus market) and second, a potential deficit market (potential deficit market). A market that has excess consumption reserves is called a potential surplus market. The market that has a shortage of consumption reserves is called a potential deficit market. The occurrence of spatial market integration is one of the basic conditions for maximizing general welfare. In a spatially integrated market, signals are transferred between areas of surplus and deficit, the effect of which is the specialization of trade and production. As a result of the exchange of goods, services or information, there are adjustments in demand, supply and prices, which lead to an optimal allocation of resources, and indirectly also applies to the concept of sustainable development (Prus, 2019; Roman, 2020). Without spatial market integration, price signals would not be transmitted from areas of deficit to areas of surplus, prices would be more volatile, agricultural producers would fail to specialize according to long-run comparative advantage, and gains from trade would not materialize (Baulch, 1997; Chitete et al., 2021).

III. Research Method

To study the development of garlic production and consumption in Indonesia, annual time series data on national garlic production and consumption for the 2002-2019 period were used, sourced from the Ministry of Agriculture. To study price developments and to analyze the integration of the spatial market for garlic in Indonesia, monthly time series data on garlic prices in 33 provinces for the period January 2014-December 2020 were used, sourced from BPS. The reference provinces used are the 10 provinces with the highest amount of production and consumption of garlic, and the provinces where three major ports for imported garlic enter Indonesia, namely North Sumatra, West Sumatra, DKI Jakarta, West Java, Central Java, East Java, Bali, West Nusa Tenggara, East Nusa Tenggara, and North Sulawesi. Other provinces are assumed to be vassal provinces. The analytical method used to answer the first objective is descriptive analysis by presenting it in the form of reviews, tables, and graphs with the aim of facilitating the interpretation of the observation results. The analytical method used to answer the second objective is to use the Vector Autoregression (VAR)/Vector Error Correction Model (VECM) approach. The software used includes Microsoft Excel 2016 and Eviews 12. Here are some tests that will be carried out:

3.1 Data Stationarity Test

The data stationarity test can be carried out with the unit root test for each variable (Mubarokah, 2022). If the average changes over time and the variance are not sufficiently constant, then the series is not stationary (Patil & Kerur, 2016). Unit root test using the Augmented-Dickey Fuller (ADF) test. The data is said to be stationary if the ADF probability value obtained is less than the 5% significance level and the ADF test value is less than the critical MacKinnon value. The ADF test has the following equation:

$$\Delta P_t^i = \alpha_0 + \gamma P_{t-1}^i + \Sigma_{i=2}^{p} \alpha_i \Delta P_{t-1}^i + \varepsilon_t \quad \text{.....(1)}$$

where:

Δ	:	First-degree difference operator
P_t^i	:	Garlic consumer price in province i at time t (Rp/kg)
i	:	The garlic consumer market is analyzed in this study
t	:	Time period
$\gamma, \alpha_0, \alpha_i$	:	Model coefficients
ε_t	:	Model error

3.2 Optimal Lag Determination

The purpose of determining the optimal lag is to eliminate the autocorrelation problem in the VAR/VECM system. The length or size of the selected lag is the lag that produces the smallest criteria for Final Prediction Error (FPE), Akaike Information Criterion (AIC), Shwarz Information Criterion (SC), and Hannan-Quin Criterion (HQ), while for the Likelihood Ratio criteria (LR) the greatest value is chosen (Ayuningtyas, 2020).

3.3 Cointegration Test

The cointegration test is carried out to find out whether integration occurs in the long term (Ayuningtyas, 2020). Cointegration causes prices to move close together in the long term even though in the short term they move separately (Hidayanto, 2014). A cointegration test is needed to determine the model to be used. The VAR in the difference model is used when there is no cointegration between the variables while the VECM is used when there is

cointegration between the variables being analyzed. In cointegration testing using Eviews, decision-making is seen based on the value of the trace statistics results. If the trace statistic value > critical value, it means that there is a cointegration relationship or there is a long-term relationship between the variables being analyzed (Ayuningtyas, 2020). Integrated markets show lower price differences (Varela et al., 2012). Despite modest progress in some countries, the post-colonial state has been unable to establish rights-based political and economic systems of governance that would facilitate consolidation of state-building and promote economic development (Monga, 2019). Particularly, whether inflation is necessary or harmful form economic growth constitutes the basis of the matter in question (Eden in Wollie, 2018). The cointegration relationship that occurs between variables can be determined based on statistical tests, namely the trace statistic (λtrace) which is written in the following equation (Ayuningtyas, 2020):

$$\lambda_{trace}(r) = -T \, \Sigma \ln(1 - \lambda_i) \quad \text{……………………………………………………………(2)}$$

where:

T : Number of observations used

λ_i : Estimation of the i-th value of the eigenvalue order obtained from the Π matrix

r : Exponents indicating the sum of the cointegration vectors

3.4 Granger Causality Test

The causality test used in this study is the Granger Causality test. Causality analysis aims to determine the response of price changes in one market to other markets. The response to this change can go one way from one market to another, two directions from both markets or no mutual response between the two markets being analyzed (Rahmawati, 2018). Unidirectional occurs when one variable affects another while bidirectional occurs when the two variables influence each other (Zewdie, 2017; Bor, 2020). The market will be said to be dominant (leading) in price formation if price changes that occur in that market will be transmitted to other markets (Cahyaningsih, 2015; Rahmawati, 2018). Variables that do not have a causality relationship have a probability value greater than the critical value (0.05), while variables that have a causality relationship have a probability value smaller than the critical value.

3.5 VAR/VECM Estimation

VAR is a system of equations where each variable is a linear function of the lag of the variable itself and the lag of other variables. The VAR model is referred to as a non-structural model or a non-theoretical model (atheoretical). The formation of the VAR model is carried out in several stages, starting with stationarity tests and cointegration tests. If the stationary test concludes that the data is stationary at the level, then the ordinary VAR model (unrestricted VAR) is used. On the other hand, if the data is not stationary at the level but becomes stationary after differentiation, then cointegration testing must be carried out. If there is cointegration, the model used is VECM, but if there is no cointegration relationship, then the VAR model is used in the form of differentiation (VAR in difference) (Hidayanto, 2014). VECM is a restricted VAR model, used for variables that are not stationary at levels, and have the possibility to be cointegrated. In VECM there is also a speed of adjustment from the short term to the long term as indicated by the Error Correction Term (ECT) value (Mubarokah, 2022). Speed of adjustment is how long it takes for shocks in market i to be fully transmitted to market j (Varela et al., 2012). Adjustments towards long-term balance will be faster, if the ECT coefficient is greater and vice versa (Enders, 2008; Mubarokah, 2022).

IV. Discussion

4.1 Garlic Production, Consumption and Prices in Indonesia

Garlic is a vegetable commodity that is widely used as a cooking spice. Garlic plants grow very well in areas that provide subtropics with all-day sun for 17 hours in summer (Ministry of Agriculture, 2019). Generally, garlic in Indonesia is grown in the highlands. Several garlic centers such as Karo, Tegal, Tawangmangu, Selocepogo, Magelang, Batu, Ciwidey and Sembalun are medium and highland areas (>700 masl) (Hardjanto, 2014). In the 2017-2020, Central Java Province is the main garlic producing area which produces 95,073 tonnes of garlic (41% of national production). The main center for garlic production in Central Java Province is in Temanggung Regency. Another province which is a center for garlic production is West Nusa Tenggara which produces 78,424 tonnes of garlic (34% of national production). The main centers of garlic production in West Nusa Tenggara are East Lombok Regency and Bima City.

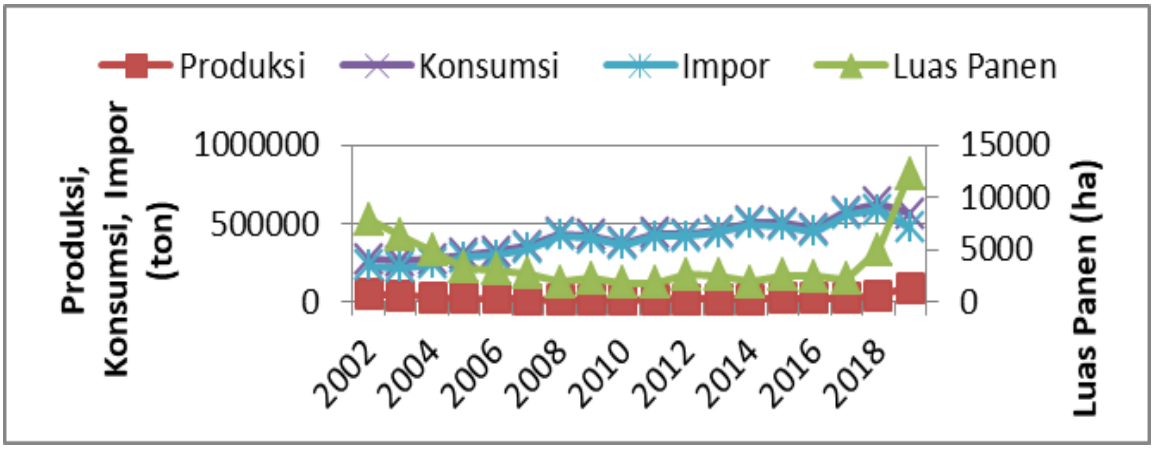

Figure 2. *Production, Consumption, Import, and Harvested Area of Garlic in Indonesia for the 2002-2019 Period*

Source: Ministry of Agriculture, 2020; BPS, 2021 (processed)

Figure 2 shows that from 2002-2005 there was a decrease in garlic production, in 2006-2017 production fluctuated, and in 2018 it rose again until 2019, but it is still far from the total consumption of garlic. Garlic consumption in 2002 was 269,229 tons and tended to increase to 561,686 tons in 2019. In the 2002-2019 period, the average garlic production was 25,970 tons and the average consumption was 429,314 tons, meaning that Indonesia experienced a garlic deficit of 403,344 tonnes (93.95%). This shows that there is a large gap between the consumption and production of garlic. This gap shows the magnitude of the shortage of garlic supply in Indonesia so that the government imports garlic. In the 2002-2019 period, the volume of Indonesian garlic imports had the same trend as garlic consumption, which tended to increase. The low production of garlic in Indonesia is due to the narrow planting area and low productivity. Trade liberalization is also one of the factors causing garlic production to continue to decline. This is reinforced by the existence of government policies issued in the Regulation of the Minister of Finance of the Republic of Indonesia No. 49/PMK.010/2022 concerning the determination of import duty rates within the framework of the ASEAN-Hongkong, People's Republic of China free trade agreement (ASEAN-Hongkong, China Free Trade Agreement). In this policy, the import duty rate for garlic is 0%. This encourages more and more imported garlic to circulate in Indonesia and causes Indonesian garlic farmers to fall even further.

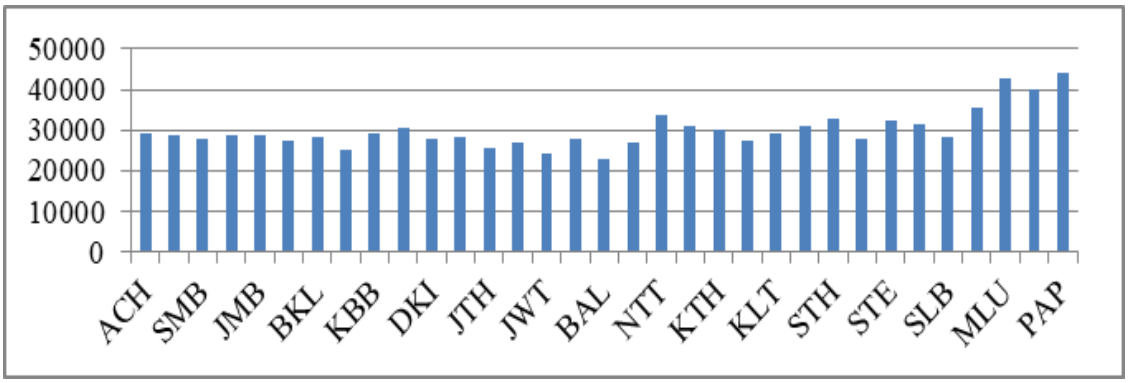

Figure 3. *The Average Price of Garlic in 33 Provinces in Indonesia for the 2014-2020 Period*
Source: BPS, 2015; BPS, 2016; BPS, 2017; BPS, 2018a; BPS, 2019a; BPS, 2020c; BPS, 2021a (processed)

Figure 3 shows that the province with the highest average garlic price in the 2014-2020 period was Papua (PAP), which was Rp. 44,191/kg. Meanwhile, the province with the lowest average price was Bali (BAL), which was Rp. 22,887/kg. In the 2014-2020 period, garlic price disparities between provinces in Indonesia show high figures. The difference between the lowest and highest prices of garlic in Indonesia is 93.08%. As the largest garlic producer in Indonesia, the average price of garlic in Central Java (JTH) is Rp. 25,654/kg. This price is still relatively low when compared to the average national price of Rp. 30,027/kg. The province with the most volatile garlic price was DKI Jakarta province with a CV (Coefficient of Variation) of 38.76%. Meanwhile, the province with the most stable price was West Java with a CV value of 19.53%. When viewed from the value of the coefficient of variation, it indicates that the price of garlic fluctuates highly and is unstable.

4.2 Spatial Market Integration of Garlic in Indonesia

a. Stationarity Test and Optimum Lag Test

Testing stationarity at the level or I (0) level, there are 16 out of 33 consumer level garlic price data that are not stationary at the level at the 5% level. Failure to fulfill the assumption of stationarity at level or I(0) causes all variables to be tested at the first difference level or I(1). At the first difference level, all garlic price data is stationary at the 5% significance level, so the cointegration analysis can be continued. Of the 10 reference provinces used, the optimum lag that produced the most was lag 1 (163 market pairs). This means that the variables in the model influence each other not only in the current period but these variables influence each other up to 1 previous period.

b. Cointegration Test

The results of Johansen's co-integration test can see whether or not there is spatial integration of garlic in Indonesia (Rahmawati, 2018). The test results show that all reference provinces have co-integration relationships with other provinces or have significant long-term relationships. The existence of spatial integration indicates that price changes in one consumer market are reflected as price changes in geographically different consumer markets. Integration between garlic consumer markets in the long term in Indonesia is thought to occur due to the flow of information related to prices in the market so that this information can be transmitted from one market to another. One of the reasons for this condition is the growing development of technology in the dissemination of information that can be accessed easily, quickly and for free online via a smartphone. Several websites that provide information related to agricultural commodity prices include the Market and Basic

Needs Monitoring System (SP2KP), the Strategic Food Price Information Center (PIHPS Nasional), and the Central Bureau of Statistics (BPS). This is in line with research by Hidayanto (2014), Lupiya (2018), Bacud et al. (2019), Asmara and Ardhiani (2010), and Mubarokah (2022), which state that the two markets can be integrated due to factors other than trade, for example because there is good information flow due to supporting telecommunications infrastructure.

c. Causality Test

In the 317 market pairs tested, 174 market pairs (54.89%) had a one-way relationship, 41 market pairs (12.93%) had a two-way relationship, and 102 market pairs (32.18%) had no relationship. The consumer markets of Bali, Central Java and East Java are the price leaders (leading) because these three provinces most influence the prices of other follower provinces. While other provinces are price followers (following). This is thought to occur because the three provinces are one of the garlic center provinces in Indonesia and the locations of these provinces tend to be close together. In addition, Central Java and East Java are the provinces with the highest consumption of garlic in Indonesia. East Java Province is also one of the provinces to import garlic into Indonesia which will be distributed to other regions. Therefore, if the government is going to make a policy to control garlic prices, then the market that must be the main concern is the consumer market that is the price leader, namely Bali, Central Java and East Java. So that the policies taken can be implemented quickly and at a lower cost.

d. VECM Estimation

Table 1 shows that 212 market pairs (66.88%) have short-term relationships or are integrated in the short term, and 105 other market pairs (33.12%) have no relationships or are not integrated in the short term. East Java is the only reference province that is integrated with all of its follower provinces in the short term. Meanwhile Central Java and Bali are integrated in the short term with 31 other provinces. The integration of these three provinces with most of the participating provinces is in line with the results of the Granger Causality test which states that the three provinces are the leading price leaders which have a lot of influence on prices in the following provinces. This is in line with Nauly et al., (2021) which states that provinces which are the main production centers have a more integrated relationship than other provinces.

Table 1. The Results of the VECM Estimation of the Short-run Relationship of Consumer-Level Garlic Prices between Reference Provinces and Follower Provinces in Indonesia

Pulau	SMU	SMB	DKI	JWB	JTH	JWT	BAL	NTB	NTT	SLU
Sumatera	2	4	7	6	10	10	10	1	4	3
Jawa	2	4	2	3	4	5	5	5	3	0
Bali Nusa Tenggara	1	1	2	1	3	3	2	2	1	1
Kalimantan	1	1	3	3	4	4	4	1	0	3
Sulawesi	4	4	5	5	6	6	6	3	3	5
Maluku Papua	3	3	4	4	4	4	4	1	4	3
Total	13	17	23	22	31	32	31	13	15	15

e. Speed Adjustment

In VECM there is a speed of adjustment from the short term to the long term which is indicated by the Error Correction Term (ECT) value. The ECT coefficient value is a speed adjustment to measure how quickly the response variable adjusts to return to a long-term

equilibrium condition after a shock occurs in the independent variable. The ECT coefficient value must be <1, negative and significant. A response variable is said to have a high-speed adjustment if the absolute value of the ECT coefficient is >0.200, moderate if the absolute value of the ECT coefficient is between 0.100-0.200, and low if the absolute value of the ECT coefficient is <0.100 (Jubaedah, 2011; Jojo, 2021). Based on the speed adjustment grouping, it shows that 188 market pairs meet the ECT requirements. Of the 188 market pairs, 112 market pairs have high-speed adjustments, 56 market pairs have moderate speed adjustments, and 20 market pairs have low-speed adjustments.

Central Java as the reference province has a high-speed adjustment with most of its followers (22 provinces). This means that when there is a shock to the price of garlic in Central Java, the price of garlic in the 22 participating provinces will experience price adjustments quite quickly. This is thought to have happened because Central Java is a province of garlic production centers and one of the provinces that has the highest consumption level of garlic in Indonesia. This is also to the results of the Causality test which shows that Central Java is one of the leading provinces in price because this province has a lot of influence on prices in follower provinces. North Sulawesi, which is integrated with Gorontalo, is one of the market pairs that have a high-speed adjustment value with an ECT coefficient of -0.715. This means that when a shock occurs in North Sulawesi, garlic prices in Gorontalo return to equilibrium at a rate of 71.5% per month, and it takes 1 month for the system to fully balance or recover from the shock in the long term. This shows that Gorontalo can be said to be quick to respond to price shocks originating from North Sulawesi. The high-speed adjustment between North Sulawesi and Gorontalo is thought to have occurred due to the close distance between the two provinces. This is in line with Gitau and Meyer (2018), and Rivera and Helfand (2001) which state that market pairs that are close to one another are integrated, have lower transaction costs, and price differences are quickly corrected compared to markets that are farther apart.

V. Conclusion

The results of the study show that in the period 2002 to 2019 there is a sizeable gap between consumption and production of garlic in Indonesia. The price of garlic in Indonesia tends to fluctuate. There has been a comprehensive long-term integration of the garlic market in Indonesia. This is indicated by the cointegration of all consumer market pairs. The consumer markets of Bali, Central Java and East Java are price leaders. There are 212 pairs of integrated garlic consumer markets (66.877%) in the short term. This shows that the garlic market in Indonesia is more integrated in the long term. Central Java Province as the reference province has a high-speed adjustment with most of its follower provinces (22 provinces). In an effort to stabilize garlic prices, intervention from the government is needed. One way this can be done is by increasing the intensification and extensification programs in order to increase garlic production and productivity. As the leading garlic price region, price changes in the Provinces of Bali, Central Java and East Java will be transmitted to other regions. Therefore, priority intervention from the government should be focused on stabilizing the price of garlic in the leading province so that price fluctuations from one province do not spread to other provinces, and the costs incurred are lower. Suggestions for further research are that it can be done by adding reference provinces and research analysis periods. Apart from that, it can also be examined regarding the integration of the spatial market for garlic at the producer level in Indonesia, so that it will provide an overview related to the condition of the garlic market in Indonesia.

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