

Analysis of Horizontal Integration of Corn Markets in West Nusa Tenggara

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Abstract: Corn is one of the leading commodities in the agricultural sector of West Nusa Tenggara (NTB) Province and exhibits price linkages across markets. This study aims to analyze the horizontal integration of corn markets and identify reference markets in NTB Province. The data used are secondary data on weekly retail-level corn prices from seven regencies/cities covering the period from January 2021 to December 2023. Market integration was analyzed using the Vector Error Correction Model (VECM), while reference markets were identified using Variance Decomposition. The results show that horizontal integration of corn markets in the long run occurs across six areas, namely Mataram City, East Lombok, Dompu, Sumbawa, Bima City, and Bima. In the short run, Tente Market in Bima Regency and Aikmel Market in East Lombok Regency each influence three other market areas. The results of the Variance Decomposition analysis indicate that Aikmel Market, Seketeng Market in Sumbawa Regency, and Tente Market serve as reference markets in the formation of corn prices in NTB. These findings provide information on inter-market price linkages that can serve as a consideration in formulating corn price stabilization policies in NTB Province.

Keywords: Market Integration, Corn, VECM, Variance Decomposition, Reference Market.

I. INTRODUCTION

The agricultural sector plays a critical role in ensuring food security in Indonesia. Beyond serving as a primary source of food, the sector provides substantial employment, particularly in rural areas, and makes a significant contribution to regional economic output as measured by the Regional Gross Domestic Product (RGDP). West Nusa Tenggara (NTB) Province is one of Indonesia's regions where agriculture constitutes a key component of the regional economy. In 2023, the agricultural sector contributed IDR 36.991 trillion, accounting for approximately 22% of the province's total RGDP of IDR 166.394 trillion. This contribution underscores the strategic importance of agriculture in supporting the regional economy of NTB Province.

Corn is one of the leading agricultural commodities in NTB Province. The crop is widely cultivated across the province and has considerable economic potential, particularly in terms of enhancing farmers' incomes and contributing to regional economic development. Trends in corn harvested area, productivity, and production in NTB Province over the 2021–2023 period are presented in Table 1.

Table 1. Trends in Corn Harvested Area, Productivity, and Production in West Nusa Tenggara (NTB) Province, 2021–2023

Year	Harvested Area (ha)	Productivity (tons/ha)	Production (tons)
2021	288.769,00	6,27	1.811.119,00
2022	334.015,40	7,57	2.531.492,46
2023	319.518,50	7,32	2.341.066,00

Source: Satu Data NTB 2024 (processed)

As shown in Table 1, the harvested area, productivity, and production of corn in West Nusa Tenggara (NTB) Province fluctuated during the 2021–2023 period. In 2021, corn production was recorded at 1,811,119 tons, increasing substantially to 2,531,492.46 tons in 2022. However, production subsequently declined to 2,341,066 tons in 2023. These fluctuations indicate that changes in corn production are closely associated with variations in harvested area and productivity. Although NTB Province has considerable potential for corn production, increasing output alone does not necessarily guarantee efficient marketing or stable prices. This is particularly relevant given the geographical and infrastructural conditions that characterize the distribution of corn across the province.

In this regard, the development of corn production in NTB Province continues to face challenges related to distribution and market access. Geographical conditions represent one of the major constraints, as corn-producing areas are distributed across different regions and islands with relatively limited accessibility. Sumbawa, Bima, and Dompu Regencies, which are major contributors to corn production, encompass extensive and predominantly hilly areas. Such geographical conditions may increase the time and transportation costs required to move corn from production areas to major trading centers. Furthermore, limitations in transportation infrastructure and distribution networks may reduce marketing efficiency and, consequently, affect the income received by corn farmers. Thus, the spatial distribution of production and the accessibility of markets are important factors in understanding the formation and movement of corn prices across regions.

These distribution and market-access constraints become particularly important because corn production is also characterized by seasonal fluctuations in supply. During the harvest season, when the volume of corn supplied to markets increases substantially, prices tend to decline. Conversely, when supply decreases outside the harvest season, corn prices tend to increase. This seasonal imbalance between supply and demand can contribute to price instability for farmers and other market participants. Consequently, understanding corn price movements requires not only consideration of production and distribution conditions but also an examination of how price changes in one market are transmitted to other markets.

Consistent with these conditions, corn prices in NTB Province exhibit both temporal and spatial variation, as reflected in monthly fluctuations and differences in prices across regions. Corn prices tend to increase from August to December, whereas during the early months of the year, prices tend to remain relatively stable or decline slightly. Such variations suggest the existence of inter-market price linkages that may influence the transmission of price changes across corn-producing and consuming areas. Therefore, examining the degree of market integration and identifying markets that play a central role in price formation are essential for understanding the dynamics of the corn market in NTB Province and for providing an empirical basis for policies aimed at improving market efficiency and stabilizing corn prices.

Regional price disparities are also evident in the marketing of corn in West Nusa Tenggara (NTB) Province. Bima Regency and West Lombok Regency record higher average corn prices than areas such as Bima City and Dompu. These price differences are associated with factors such as market accessibility, distribution costs, and geographical conditions. Although monthly price fluctuations tended to decline in 2023, regional price disparities persisted. Such price instability and spatial disparities continue to pose challenges for farmers and other market participants in NTB Province.

Against this background, the observed regional price disparities highlight the importance of examining the horizontal integration of corn markets in NTB Province. Effective market integration enables price changes in one market to be transmitted rapidly and efficiently to other markets. Conversely, weak market integration may result in persistent price disparities, an uneven distribution of marketing gains, and economic instability for farmers and other market participants. Therefore, analyzing market integration is essential for understanding the relationships among corn prices across markets, both in the short and long run.

Beyond examining market integration, it is also important to identify the markets that function as reference markets in the formation of corn prices in NTB Province. Information on reference markets can provide insights into price dynamics and inter-market relationships across different regions. The findings of this study are expected to provide useful information for corn traders in making business decisions and to serve as an input for local governments and policymakers in formulating policies aimed at promoting corn price stability.

Based on the foregoing considerations, this study aims to analyze the horizontal integration of corn markets and identify reference markets for corn in West Nusa Tenggara Province. The study uses secondary data on weekly retail-level corn

prices from seven regencies/cities in NTB Province covering the period from January 2021 to December 2023. Market integration is analyzed using the Vector Error Correction Model (VECM), while the identification of reference markets is conducted using Variance Decomposition.

II. METHODS

This study employed a quantitative descriptive approach to analyze the horizontal integration of corn markets and identify the reference market in West Nusa Tenggara (NTB) Province. The data consisted of secondary weekly time-series data on retail-level corn prices from seven regions: Mataram City, West Lombok Regency, East Lombok Regency, Sumbawa Regency, Dompu Regency, Bima Regency, and Bima City, covering the period from January 2021 to December 2023. The data were obtained from the NTB Provincial Food Security Agency and the relevant regency-level agricultural agencies. Corn prices were measured in Indonesian rupiah per kilogram (IDR/kg).

Horizontal market integration was analyzed using the Vector Error Correction Model (VECM) with EViews 12 software. The analytical procedures included a stationarity test using the Augmented Dickey-Fuller (ADF) test, determination of the optimal lag length, a model stability test, the Johansen cointegration test, VECM estimation, the Granger causality test, and the Impulse Response Function (IRF). The VECM was employed to examine both short-run and long-run relationships among corn prices across markets, while the Granger causality test was used to determine the direction of causal relationships among regions. The IRF analysis was conducted to examine the responses of corn prices to price shocks originating from other regions.

The reference market was identified using Variance Decomposition analysis, which measures the contribution of price shocks in one region to the variability of prices in other regions. The results of this analysis were used to identify the markets that play a central role as reference markets in the formation of corn prices in NTB Province.

III. RESULT

A. Results of the Analysis of Horizontal Market Integration

1). Stationarity test

The stationarity test was conducted using the Augmented Dickey-Fuller (ADF) test at both the level and first-difference stages for the corn price data from the seven study areas: Mataram City, West Lombok, East Lombok, Sumbawa, Dompu, Bima Regency, and Bima City.

Table 2. ADF Stationarity Test at the Level for Corn Prices across Regencies/Cities

Region	Probability	Results of the Variable Test at the Level
Kota Mataram	0.3232	$P > 0.05$ (The data are non-stationary at the level.)
Lombok Barat	0.2079	$P > 0.05$ (The data are non-stationary at the level.)
Lombok Timur	0.0554	$P > 0.05$ (The data are non-stationary at the level.)
Sumbawa	0.6626	$P > 0.05$ (The data are non-stationary at the level.)
Dompu	0.4575	$P > 0.05$ (The data are non-stationary at the level.)
Kabupaten Bima	0.0623	$P > 0.05$ (The data are non-stationary at the level.)
Kota Bima	0.2453	$P > 0.05$ (The data are non-stationary at the level.)

Source: Processed Primary Data (2024)

Based on Table 2, the results of the Augmented Dickey-Fuller (ADF) stationarity test at the level indicate that all corn price variables across the study areas in West Nusa Tenggara (NTB) Province—namely Mataram City, West Lombok, East Lombok, Sumbawa, Dompu, Bima Regency, and Bima City—are non-stationary. This finding is indicated by the probability (p-value) exceeding 0.05 for all variables, suggesting that the data do not satisfy the stationarity condition at the level. Therefore, first-order differencing or higher-order differencing is required to achieve stationarity before the data can be subjected to further analysis.

Table 3. ADF Stationarity Test at the First Difference for Corn Prices across Regencies/Cities

Areas	Probabillity	Results of the Variable Test at the Level
Mataram	0.0000	$P < 0.05$ (The data are stationary at the first difference)
Lombok Barat	0.0000	$P < 0.05$ (The data are stationary at the first difference)
Lombok Timur	0.0000	$P < 0.05$ (The data are stationary at the first difference)
Sumbawa	0.0000	$P < 0.05$ (The data are stationary at the first difference)
Dompu	0.0000	$P < 0.05$ (The data are stationary at the first difference)
Kabupaten Bima	0.0000	$P < 0.05$ (The data are stationary at the first difference)
Kota Bima	0.0000	$P < 0.05$ (The data are stationary at the first difference)

Source: Processed Primary Data (2024)

The ADF test results indicate that all corn price variables are non-stationary at the level but become stationary after first-order differencing. This finding provides the basis for proceeding with the analysis of long-run relationships using the Johansen cointegration test and the Vector Error Correction Model (VECM).

2). Optimal Lag Length Determination

Optimal lag length determination is conducted to identify the appropriate number of lags to be incorporated into the model. Several criteria were considered, including Log Likelihood (LogL), Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Criterion (SC), and Hannan–Quinn Criterion (HQ).

The test results indicate that lag 0 is identified as optimal according to the FPE, AIC, SC, and HQ criteria. However, lag 0 was not selected because the Vector Error Correction Model (VECM) requires lagged terms to capture the dynamic relationships among variables. Therefore, lag 1 was selected as the minimum lag length for the VECM analysis.

Table 4. Optimal Lag Length Determination for Corn Prices in West Nusa Tenggara (NTB)

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-6.545.085	NA	3.38e+33*	97.06792*	97.21857*	97.12914*
1	-6.508.640	6.857.031	4.07e+33	9.725.393	9.845.908	9.774.366
2	-6.476.856	5.650.507	5.29e+33	9.750.898	9.976.863	9.842.724
3	-6.449.868	4.517.972	7.43e+33	9.783.508	1.011.492	9.918.186
4	-6.408.630	6.475.839	8.56e+33	9.795.005	1.023.186	9.972.536
5	-6.375.856	4.806.882	1.14e+34	9.819.046	1.036.136	1.003.943
6	-6.347.500	3.868.452	1.66e+34	9.849.629	1.049.740	1.011.286
7	-6.294.435	66.82299*	1.72e+34	9.843.607	1.059.686	1.014.969
8	-6.248.859	5.266.471	2.07e+34	9.848.680	1.070.735	1.019.762

Source: Processed Primary Data (2024)

3). Model Stability Test

The stability test was conducted to determine whether the estimated model satisfies the stability condition. The results indicate that all characteristic roots have modulus values of less than one. Since all modulus values are below one, the model can be considered stable and is therefore suitable for further analysis, including the Vector Error Correction Model (VECM) and Impulse Response Function (IRF) analyses.

Table 5. Model Stability Test for Corn Prices across Regencies/Cities

Root	Modulus
-0.112957 - 0.202464i	0.231843
-0.112957 + 0.202464i	0.231843
0.144320	0.144320
0.021913 - 0.107291i	0.109506
0.021913 + 0.107291i	0.109506
0.073246	0.073246
-0.056869	0.056869

Source: Processed Primary Data (2024)

4). Johansen Cointegration Test

The Johansen cointegration test was conducted to examine the existence of long-run relationships among corn prices across the seven study areas. The test employed two approaches, namely the Trace Statistic and Maximum Eigenvalue Statistic. The results of the cointegration analysis are presented in Tables 6 and 7.

Table 6. Johansen Cointegration Test (Unrestricted Cointegration Rank Test)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.574332	4.957.456	1.346.780	0.0000
At most 1 *	0.498953	3.753.183	1.038.473	0.0000
At most 2 *	0.383137	2.778.795	7.697.277	0.0000
At most 3 *	0.371280	2.097.611	5.407.904	0.0000
At most 4 *	0.323413	1.443.273	3.519.275	0.0000
At most 5 *	0.292757	8.923.951	2.026.184	0.0000
At most 6 *	0.249131	4.039.985	9.164.546	0.0000

Source: Processed Primary Data (2024)

Table 7. Johansen Cointegration Test Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.574332	1.204.273	4.707.897	0.0000
At most 1 *	0.498953	9.743.886	4.095.680	0.0000
At most 2 *	0.383137	6.811.833	3.480.587	0.0000
At most 3 *	0.371280	5.543.378	2.858.808	0.0000
At most 4 *	0.323413	5.508.784	2.229.962	0.0000
At most 5 *	0.292757	4.883.965	1.589.210	0.0000
At most 6 *	0.249131	4.039.985	9.164.546	0.0000

Source: Processed Primary Data (2024)

Based on Tables 6 and 7, the probability values at each cointegration level are 0.0000, which are below the 0.05 significance level. These results provide evidence of cointegration among the corn price variables within the study system,

indicating the existence of long-run relationships among the markets. Accordingly, the corn price variables exhibit long-run interdependence, providing a basis for proceeding with the Vector Error Correction Model (VECM) analysis to further examine long-run relationships and short-run dynamics across regions.

5). Vector Error Correction Model (VECM)

a. Long-Run

The VECM estimation was conducted to analyze the long-run relationships among corn prices across the seven regions of West Nusa Tenggara (NTB) Province. The significance of the estimated coefficients was assessed by comparing the absolute value of the t-statistic with the critical t-value of 1.9775. A coefficient was considered statistically significant when the absolute t-statistic exceeded the critical t-value.

Table 8. Long-Run Horizontal Integration Analysis of Corn Prices in West Nusa Tenggara (NTB)

Cointegrating Eq:	CointEq1
MATARAM(-1)	1.000.000
BIMA(-1)	0.523638 (0.14385) [3.64016]
DOMPU(-1)	2.522.744 (0.43256) [5.83213]
KOTA BIMA(-1)	-1.197.459 (0.33119) [-3.61566]
LOMBOK BARAT(-1)	0.545278 (0.29451) [1.85149]
LOMBOK TIMUR(-1)	1.537.366 (0.29752) [5.16730]
SUMBAWA(-1)	-3.969.122 (0.36931) [-10.7475]
C	-1.241.532 -486.367 [-0.25527]

Source: Processed Primary Data (2024)

Based on Table 8, Mataram was used as the reference variable, with a normalized coefficient of 1.000000. The estimation results indicate that Bima, Dompou, East Lombok, and Sumbawa exhibit statistically significant long-run relationships based on their respective t-statistic values. Meanwhile, Bima City and West Lombok should be interpreted according to the signs and t-statistic values reported in the estimation results.

Overall, the VECM results indicate the existence of long-run relationships among corn prices across the study areas. These findings provide a basis for further examining the dynamics of short-run price movements using the VECM framework.

b. Short-Run

The short-run VECM analysis was conducted to identify the dynamics of corn price changes across regions and the adjustment mechanism toward long-run equilibrium. The estimation results are presented in Table 9.

Table 9. Results of the Short-Run Horizontal Integration Analysis of Corn Prices in West Nusa Tenggara (NTB)

Error Correction:	D(Mataram)	D(Bima)	D(Dompu)	D(Kota Bima)	D(Lombok Barat)	D(Lombok Timur)	D(Sumbawa)
CointEq1	-0.153067 (0.04254) [-3.59818]	-0.178621 (0.07763) [-2.30093]	-0.075709 (0.02586) [-2.92860]	0.092145 (0.03397) [2.71289]	0.007837 (0.03848) [0.20364]	-0.122950 (0.04444) [-2.76652]	0.228531 (0.02943) [7.73798]
D(MATARAM(-1))	-0.291430 (0.08309) [-3.50759]	0.161157 (0.15162) [1.06290]	0.023836 (0.05050) [0.47198]	-0.004145 (0.06634) [-0.06249]	0.049898 (0.07516) [0.66375]	-0.114510 (0.08680) [-1.31923]	-0.176251 (0.05766) [-3.05553]
D(BIMA(-1))	0.027902 (0.04222) [0.66093]	-0.445797 (0.07704) [-5.78663]	0.062824 (0.02566) [2.44829]	0.000563 (0.03371) [0.01671]	-0.040612 (0.03819) [-1.06341]	-0.053196 (0.04410) [-1.20614]	-0.120488 (0.02931) [-4.11096]
D(DOMPU(-1))	0.235897 (0.14289) [1.65085]	-0.179416 (0.26076) [-0.68804]	-0.369286 (0.08668) [-4.25174]	-0.187426 (0.11309) [-1.64275]	-0.119522 (0.12897) [-0.92461]	0.435367 (0.14837) [2.91637]	-0.186369 (0.09827) [-1.19589]
D(KOTA BIMA(-1))	-0.184578 (0.10129) [-1.82231]	-0.338117 (0.18484) [-1.82928]	-0.055733 (0.06157) [-0.90526]	-0.309952 (0.08087) [-3.83262]	0.026956 (0.09280) [0.29049]	0.070468 (0.10582) [0.66594]	0.273808 (0.07032) [3.89376]
D(LOMBOK BARAT(-1))	-0.065972 (0.08387) [-0.78659]	-0.154414 (0.15305) [-1.00889]	0.065749 (0.05098) [1.28972]	-0.012112 (0.06697) [-0.18087]	-0.509450 (0.07587) [-6.71456]	-0.030321 (0.08762) [-0.34604]	-0.172097 (0.05823) [-2.95556]
D(LOMBOK TIMUR(-1))	0.107553 (0.07723) [1.39256]	0.200431 (0.14094) [1.42208]	0.069591 (0.04695) [1.49005]	-0.227402 (0.06167) [-3.68757]	-0.115870 (0.06957) [-1.65840]	-0.370101 (0.08092) [-4.58779]	-0.274767 (0.05362) [-5.12218]
D(SUMBAWA(-1))	-0.258173 (0.11909) [-2.16783]	-0.264393 (0.21733) [-1.21907]	-0.086823 (0.07239) [-1.19890]	0.153941 (0.09509) [1.61893]	0.178517 (0.10774) [1.65636]	-0.192326 (0.12442) [-1.54580]	-0.027824 (0.08266) [-0.33652]

Source: Processed Primary Data (2024)

The Error Correction Model (ECM) results indicate the existence of short-run relationships and price adjustment mechanisms toward long-run equilibrium across several regions in West Nusa Tenggara (NTB). The significance of the CointEq1 coefficient indicates that some regions are capable of responding to deviations from the long-run equilibrium.

The short-run relationships among regions vary in magnitude and are not uniformly observed across all markets. Mataram influences Sumbawa, while Bima influences Dompu and Sumbawa. Dompu, in turn, influences East Lombok, whereas East Lombok influences Bima City and Sumbawa. Although Sumbawa is one of the major corn-producing areas, its short-run price linkages with other markets are relatively limited. This pattern may be associated with the influence of large-scale buyers and national reference prices. Overall, these findings suggest that horizontal integration of corn markets in NTB is shaped by local market dynamics, distribution and logistics conditions, as well as inter-regional trading relationships.

6). Granger Causality Test

Based on the results of the Granger causality test, predictive relationships were identified among corn prices in several regions of West Nusa Tenggara (NTB). The relationship between Sumbawa and West Lombok was statistically significant, with a p-value of 0.0417. Meanwhile, Dompu and Bima exhibited a bidirectional relationship, with p-values of 0.0534 and 0.0467, respectively. However, several regional pairs, such as East Lombok and West Lombok, did not exhibit statistically significant predictive relationships. These findings indicate that corn price integration occurs across some regions, whereas other regions exhibit relatively limited price linkages.

7). Impulse Response Function

The figure below presents the Impulse Response Function (IRF), which illustrates how a shock or innovation in one regency/city affects other regions or the originating market itself over several periods.

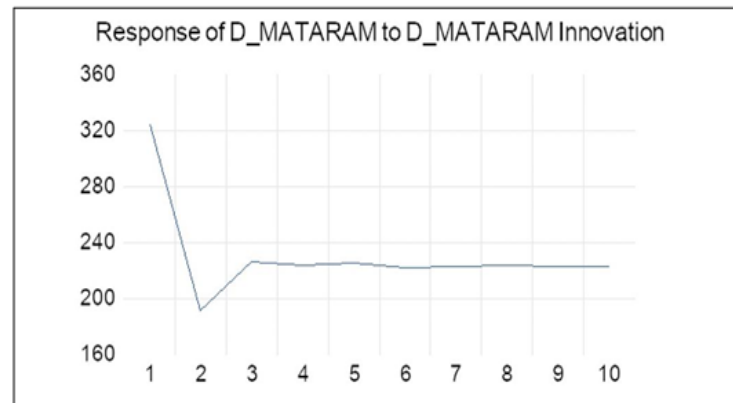


Figure 1. Response of the Mataram Corn Market to Its Own Innovation

The figure above illustrates the response of the Mataram corn market to its own innovation. A sharp decline is observed at the beginning of the period, from approximately 320 to 200, followed by a relatively stable response within this range through the end of the tenth period. This pattern indicates that the initial impact of the innovation on the Mataram market gradually dissipates and reaches a relatively stable level after the first period.

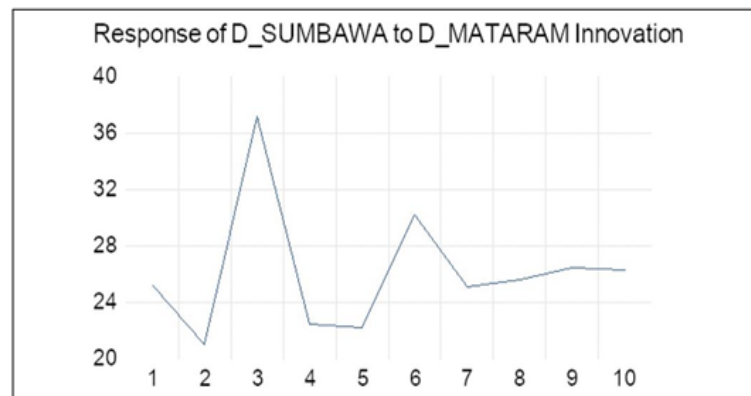


Figure 2. Response of the Sumbawa Corn Market to an Innovation in the Mataram Market

The figure above illustrates the response of the Sumbawa corn market to an innovation originating from the Mataram market. The initial response of Sumbawa was approximately 24, followed by a sharp increase to around 36 in the second period, indicating a substantial response during the early phase. Following this peak, the response fluctuated before eventually stabilizing at approximately 26 toward the end of the observation period. This pattern indicates that an innovation in the Mataram market has a relatively pronounced immediate effect on the Sumbawa market, although the magnitude of the effect tends to diminish and stabilize over time. The fluctuations in the Sumbawa market response further suggest dynamic price interactions between the two regions following an innovation originating in Mataram.

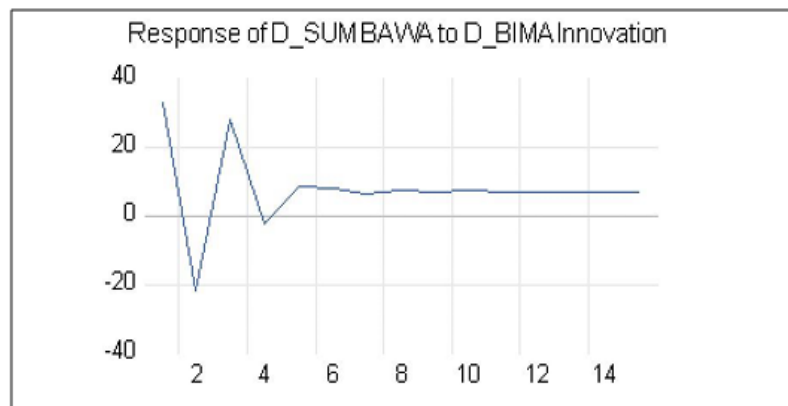


Figure 3. Response of the Sumbawa Corn Market to an Innovation in the Bima Market

The first graph illustrates the response of the Sumbawa corn market to an innovation originating from the Bima market. The response exhibits significant fluctuations during the initial periods, with the value declining sharply into negative territory before increasing to approximately 20 in the second period. Thereafter, the response gradually stabilizes and approaches zero after the fourth period. This pattern indicates that an innovation in the Bima market initially has a substantial impact on the Sumbawa market; however, the effect gradually dissipates and becomes negligible in the long run.

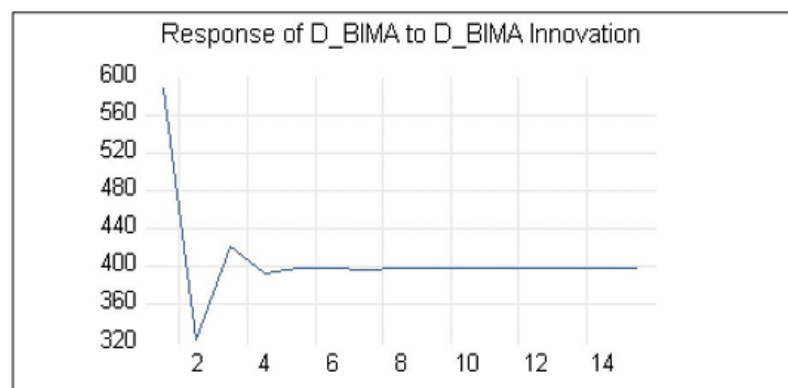


Figure 4. Response of the Bima Corn Market to Its Own Innovation

The figure above illustrates the response of BIMA to an innovation in itself. The initial response shows a sharp decline from approximately 560 to 380 in the first period, after which it stabilizes at around 360 until the end of the period. This indicates that the impact of an innovation in Bima itself diminishes rapidly and stabilizes at a certain level, with no major fluctuations over the long term.

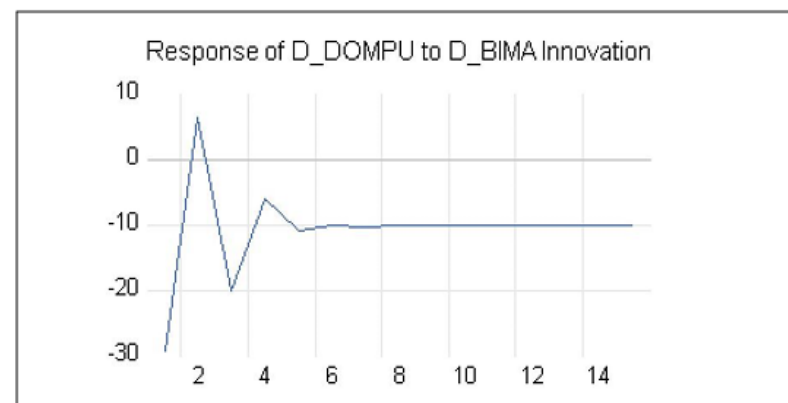


Figure 5. Response of the DOMPU Market to an Innovation in the BIMA Market

The figure above shows the response of DOMPU to an innovation in BIMA. Initially, the response of DOMPU shows a brief increase to approximately 8, but then declines sharply to a negative value of around -30 in the second period, followed by a slight recovery before eventually stabilizing at around zero. This indicates that an innovation in Bima has a direct and temporary impact on Domp, but its effect diminishes after several periods. Overall, the three graphs indicate that innovations in Bima have short-term impacts on other regions, but these effects do not persist in the long term..

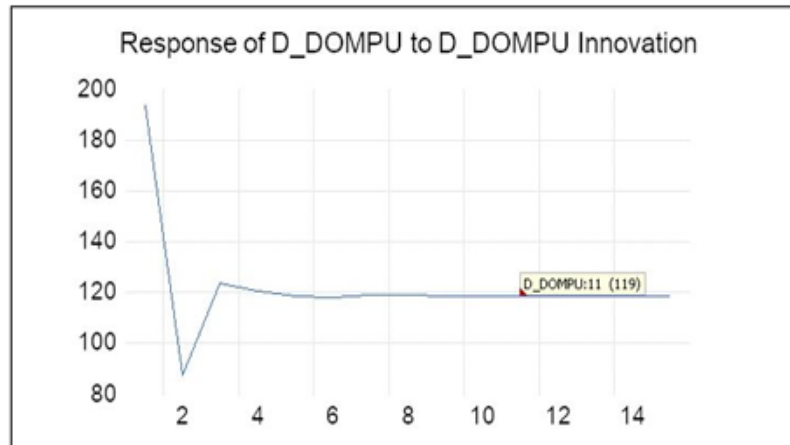


Figure 6. Response of the Corn Market in DOMPU to an Innovation in Itself

The figure above shows the response of DOMPU to an innovation in itself. In the initial period, there is a sharp decline from approximately 180 to 120, followed by stabilization at around 119 until the end of the period. This indicates that the impact of innovation on DOMPU decreases significantly during the initial period and subsequently reaches a stable level without substantial changes in the long term.

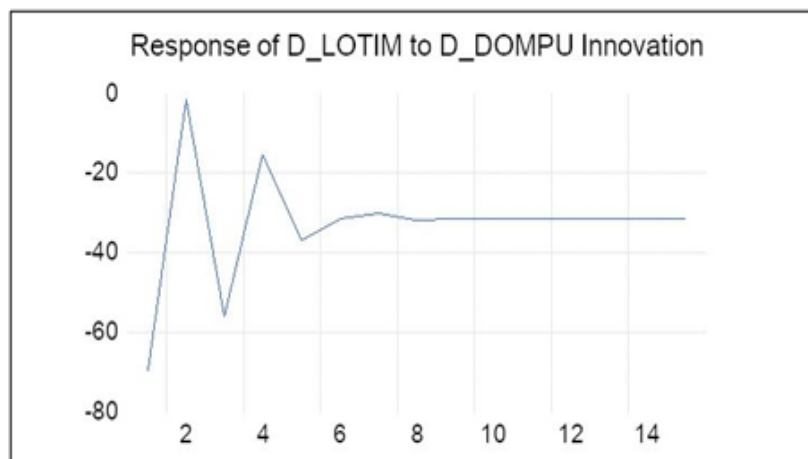


Figure 7. Response of the LOTIM Market to an Innovation in the DOMPU Market

The figure above illustrates the response of EAST LOMBOK to an innovation in DOMPU. Initially, the response of EAST LOMBOK fluctuates sharply, moving from 0 to a positive value of approximately 20, then declining sharply to a negative value of around -40. After fluctuations during the first few periods, the response of EAST LOMBOK stabilizes at around -40 and shows no significant changes through the 15th period. This pattern indicates that an innovation in DOMPU has a substantial and fluctuating initial impact on EAST LOMBOK, but eventually reaches a stable negative level in the long term. The stable negative response of EAST LOMBOK to an innovation in DOMPU indicates a persistent influence in the opposite direction between the two variables..

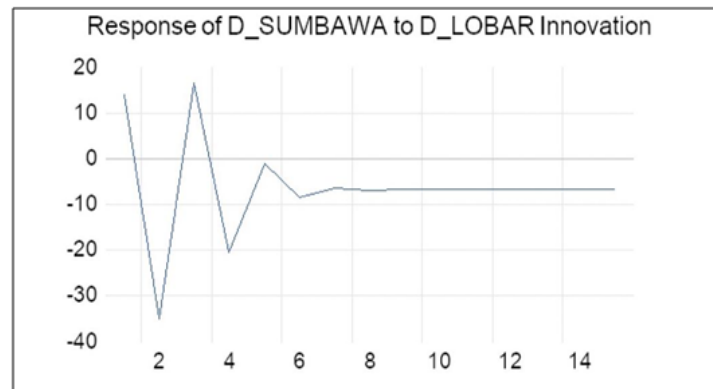


Figure 8. Response of the SUMBAWA Market to an Innovation in the LOBAR Market

The figure above illustrates the response of SUMBAWA to an innovation in WEST LOMBOK. The initial response experiences significant fluctuations, with the value increasing positively to approximately 10 before declining sharply to around -35. After several initial periods, the response stabilizes at around zero. This indicates that an innovation in West Lombok has a relatively fluctuating short-term impact on Sumbawa, but the effect gradually diminishes and becomes insignificant in the long term.

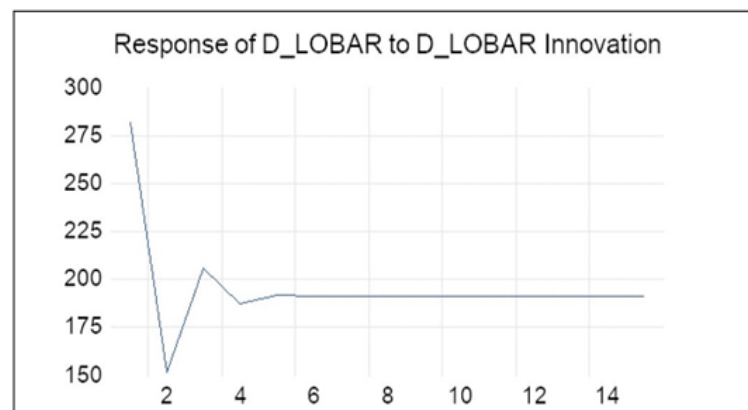


Figure 9. Response of the Corn Market in LOBAR to Its Own Innovation

The figure above illustrates the response of West Lombok to its own innovation. The initial response shows a sharp decline from approximately 275 to 175 in the first period, followed by a slight increase and subsequent stabilization at around 200 until the end of the observation period. This indicates that the impact of innovation in West Lombok on its own market diminishes rapidly and reaches an equilibrium at a relatively stable level in the long term. The response suggests that the initial innovation in West Lombok has a significant impact on the West Lombok market; however, its effect remains relatively stable after the initial period, without substantial fluctuations over the long term.

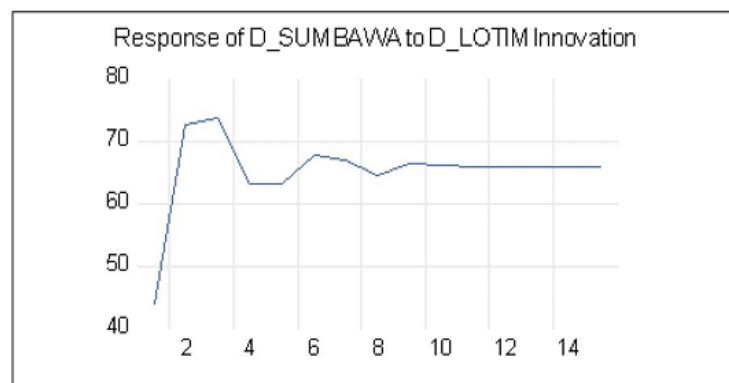


Figure 10. Response of the SUMBAWA Market to an Innovation in the EAST LOMBOK Market

The figure above shows that the response of SUMBAWA to an innovation in EAST LOMBOK increases sharply in the first period, reaching approximately 70, followed by a slight decline and subsequent fluctuations before eventually stabilizing at around 60. This indicates that an innovation in East Lombok has a significant initial impact on Sumbawa; however, the effect gradually diminishes and reaches a stable level in the long term.

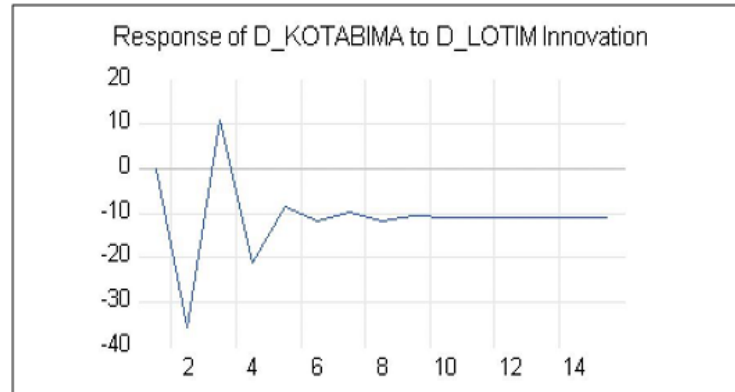


Figure 11. Response of the SUMBAWA Market to an Innovation in the EAST LOMBOK Market.

The figure above shows the response of KOTA BIMA to an innovation in EAST LOMBOK. The initial response exhibits sharp fluctuations, beginning with a decline to approximately -10, followed by an increase to around 10, and then a further decline to approximately -20 before stabilizing near zero. This indicates that an innovation in East Lombok has a fluctuating short-term impact on KOTA BIMA; however, the effect gradually diminishes over time.

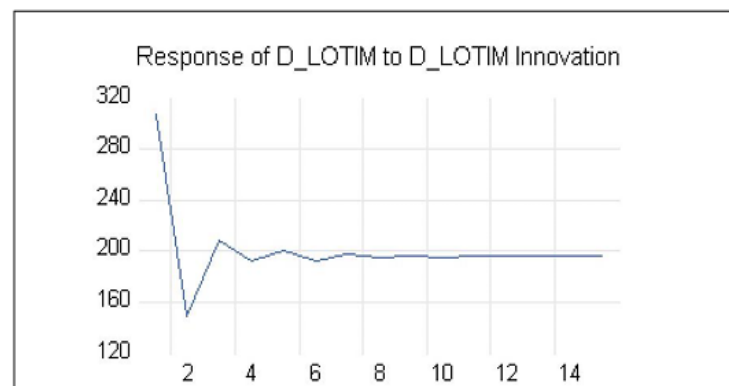


Figure 12. Response of the Corn Market in LOTIM to Its Own Innovation

The figure above shows that the response of EAST LOMBOK to its own innovation declines significantly in the first period, from approximately 280 to 180, followed by a slight increase and then stabilization at around 200 until the end of the observation period. This indicates that the initial innovation in East Lombok has a substantial impact on its own market; however, after the initial period, the response reaches a stable level without major fluctuations in the long term.

Innovations in corn markets across various regencies/cities in West Nusa Tenggara (NTB) exhibit significant short-term impacts, both on their own markets and across regions. The initial responses are generally characterized by fluctuations or sharp declines, followed by stabilization in the long term. This indicates that although an innovation in one market generates a relatively substantial direct impact, its effect tends to diminish over time and eventually reaches an equilibrium. The relationships among markets are dynamic, with several regions, such as Dompu and East Lombok, as well as Mataram and Sumbawa, exhibiting significant fluctuations before stabilizing. Overall, these patterns indicate strong linkages among the corn markets in these regions; however, the effects are temporary and do not persist in the long term.

C. Determination of the Reference Market

The reference market is a market that has a dominant influence on price formation in other regions, such that changes in its prices can serve as a reference for surrounding markets. Kustiari et al. (2018) employed variance decomposition to identify the reference market based on the contribution of price shocks to price variability in other markets.

In this study, variance decomposition is used to analyze corn price interactions across seven regencies/cities in West Nusa Tenggara (NTB). This method measures the influence of price shocks originating from each region, both from the market itself and from other regions, thereby providing an overview of the level of market integration and the potential existence of a reference market for corn prices in NTB.

Table 10. Varian decomposition Mataram

Period	S.E.	Mataram	Bima	Dompu	Kota Bima	Lombok Barat	Lombok Timur	Sumbawa
1	3.234.771	1.000.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	3.852.721	9.517.363	0.005694	0.192829	0.132092	0.404268	0.386440	3.705.048
3	4.554.967	9.262.887	0.005694	0.472009	0.361279	0.537055	0.570065	5.425.031
4	5.104.155	9.288.713	0.005880	0.371673	0.295196	0.359376	0.618289	5.467.583
5	5.607.535	9.303.508	0.005508	0.385894	0.247385	0.325743	0.581857	5.418.528
6	6.073.730	9.309.962	0.004703	0.374859	0.222675	0.318603	0.559829	5.319.692
7	6.501.132	9.254.121	0.004309	0.396372	0.203680	0.326229	0.651755	5.986.641
8	6.904.485	9.258.822	0.004115	0.391638	0.192090	0.325071	0.662587	5.836.733
9	7.284.574	9.246.460	0.004031	0.390769	0.179969	0.322330	0.668691	5.969.476
10	7.646.428	9.240.560	0.004126	0.340854	0.170729	0.321511	0.679306	6.025.589
11	7.991.410	9.235.647	0.004159	0.325347	0.161258	0.318686	0.684055	5.966.028
12	8.322.368	9.235.281	0.004237	0.309363	0.155384	0.318417	0.689355	5.987.647
13	8.640.575	9.232.492	0.004447	0.304280	0.149585	0.317371	0.693585	6.117.928
14	8.947.500	9.231.548	0.004346	0.297480	0.146295	0.316533	0.697475	6.141.817
15	9.244.210	9.228.529	0.004138	0.291386	0.139998	0.315749	0.700633	6.162.137

Source: Processed Primary Data (2024)

The table above presents the results of variance decomposition for the MATARAM variable over 15 periods. This decomposition illustrates the contribution of each variable to the forecast error variance of MATARAM. In the initial period (Period 1), MATARAM accounts for 100% of its own variance, with no contribution from other variables. However, over time, the influence of other variables becomes apparent, particularly SUMBAWA, whose contribution increases to approximately 6% by Period 15. Other variables, including BIMA, DOMPU, KOTA BIMA, WEST LOMBOK, and EAST LOMBOK, also contribute to the variance of MATARAM, although their contributions remain relatively small compared with SUMBAWA. Overall, MATARAM remains the dominant factor in explaining its own variance, although the influence of other variables increases over time.

Table 11. Varian decomposition Bima

Period	S.E.	Mataram	Bima	Dompu	Kota Bima	Lombok Barat	Lombok Timur	Sumbawa
1	590.3026	0.949218	99.05078	0.000000	0.000000	0.000000	0.000000	0.000000
2	693.1645	0.945031	93.45562	2.619603	0.444139	0.684441	0.002269	1.848095
3	819.0165	1.028655	93.41417	2.214657	0.389343	0.575929	0.028725	2.216575
4	913.9590	1.281223	93.41417	2.144657	0.388343	0.575929	0.028725	2.216575
5	1001.865	1.323566	93.56510	1.970869	0.328698	0.566177	0.024106	2.221486
6	1083.568	1.348662	93.40662	1.996533	0.285139	0.563462	0.028887	2.310782
7	1158.643	1.361115	93.51663	1.947205	0.251230	0.563267	0.028887	2.339137
8	1229.335	1.375136	93.57062	1.906623	0.227387	0.560495	0.027392	2.332743
9	1296.258	1.388276	93.57062	1.898826	0.207387	0.560495	0.028822	2.344899
10	1359.818	1.386276	93.57062	1.870076	0.190627	0.560495	0.027392	2.344899
11	1420.538	1.384276	93.57062	1.870076	0.190627	0.560495	0.027392	2.344899
12	1478.771	1.395779	93.57062	1.855703	0.168588	0.558881	0.029276	2.339917
13	1534.807	1.396779	93.57062	1.841056	0.156052	0.558317	0.028776	2.389997
14	1588.976	1.391779	93.57062	1.831074	0.147516	0.557936	0.027792	2.410618
15	1641.130	1.406385	93.57062	1.829059	0.140092	0.557567	0.027796	2.422103

Source: Processed Primary Data (2024)

The table above presents the results of the variance decomposition of the BIMA variable over 15 periods. The variance decomposition provides an overview of the contribution of each variable to the forecast error variance of BIMA over time. In the first period, BIMA explains nearly all of its own variance (99.05%), but its contribution gradually decreases as the number of periods increases. Other variables, particularly SUMBAWA, begin to make small contributions to the variance of BIMA over time, while the influence of other variables, such as MATARAM, DOMPU, and EAST LOMBOK, also increases gradually. This indicates that BIMA remains dominant in explaining its own variance, although the influence of other variables on its forecast becomes slightly more significant in the long term.

Table 12. Varian decomposition Domp

Period	S.E.	Mataram	Bima	Domp	Kota Bima	Lombok Barat	Lombok Timur	Sumbawa
1	196.6186	1.002460	2.244253	96.75329	0.000000	0.000000	0.000000	0.000000
2	217.2038	0.863676	1.921859	95.43882	0.020640	0.363090	0.185182	1.206733
3	255.7861	0.688563	1.689816	93.21388	0.256138	0.398698	0.386489	3.366417
4	283.5737	0.549498	1.601285	93.03888	0.308108	0.291894	0.521705	3.608822
5	308.8551	0.510246	1.548698	93.12900	0.263864	0.274955	0.557778	3.721255
6	332.2647	0.472307	1.486471	93.05037	0.317881	0.258642	0.605740	3.808593
7	354.2867	0.404420	1.393278	93.10239	0.318198	0.256842	0.605740	3.970795
8	374.9831	0.376421	1.316757	93.12663	0.295220	0.250522	0.660689	3.964222
9	394.4323	0.354069	1.262511	93.24162	0.324149	0.248593	0.645489	3.923570
10	413.0435	0.323055	1.234305	93.35672	0.305032	0.251127	0.638057	3.931666
11	430.8917	0.300610	1.186669	93.41027	0.290581	0.251254	0.646608	3.913013
12	447.9568	0.289049	1.155604	93.30049	0.330807	0.239591	0.638884	4.070683
13	464.4696	0.275836	1.066177	93.34913	0.332983	0.237347	0.644429	4.094402
14	480.3802	0.264176	1.038650	93.36657	0.330806	0.235521	0.648346	4.117027
15	495.7941	0.253498	1.019829	93.38582	0.336166	0.233867	0.651978	4.118487

Source: Processed Primary Data (2024)

The table above presents the results of the variance decomposition of the DOMPU variable over 15 periods. The variance decomposition illustrates the contribution of each variable to the forecast error variance of DOMPU over time. In the initial period (Period 1), DOMPU explains most of its own variance (96.75%); however, its contribution gradually decreases over time. Other variables, such as SUMBAWA, BIMA, and MATARAM, begin to make small contributions to the forecast error variance of DOMPU over longer periods. This indicates that although DOMPU remains dominant in explaining its own variance, the influence of other variables on its forecast increases slightly as the number of periods increases.

Table 13. Varian decomposition Kota Bima

Period	S.E.	Mataram	Bima	Domp	Kota Bima	Lombok Barat	Lombok Timur	Sumbawa
1	258.2772	0.675258	0.868798	0.316536	98.13941	0.000000	0.000000	0.000000
2	311.7999	1.805698	1.999008	0.759732	91.77282	0.273604	1.310116	2.078921
3	363.2546	2.539392	2.139576	0.831488	89.13878	0.278574	1.953227	2.955089
4	405.1109	2.543472	2.264556	0.870805	89.55052	0.219860	1.114327	3.395656
5	451.6651	2.679802	2.378668	0.917768	89.19399	0.198253	0.879733	3.608180
6	481.6263	2.790108	2.410971	0.917768	89.19399	0.199253	0.879733	3.808650
7	514.9329	2.865353	2.492976	0.908088	89.06726	0.200144	0.806033	3.660558
8	546.3376	2.911298	2.542108	0.888222	88.93863	0.195209	0.761654	3.761887
9	576.2693	2.953441	2.548975	0.925798	88.95568	0.192630	0.720468	3.701650
10	604.4438	2.968761	2.573610	0.935330	88.96956	0.190312	0.688065	3.674362
11	631.4669	3.020639	2.593946	0.936463	88.94688	0.188824	0.665268	3.766482
12	657.3762	3.045741	2.611893	0.940508	88.84482	0.187175	0.637688	3.764482
13	682.3037	3.067268	2.627193	0.943678	88.75032	0.186584	0.617498	3.807675
14	706.3368	3.085821	2.640313	0.947284	88.74695	0.184896	0.600433	3.794396
15	729.5914	3.101782	2.651701	0.949861	88.72204	0.183951	0.585296	3.805364

Source: Processed Primary Data (2024)

The table above presents the variance decomposition of the KOTA BIMA variable over a 15-period horizon. The results indicate the relative contribution of each variable to the forecast error variance of KOTA BIMA over time. In the initial period (Period 1), shocks originating from KOTA BIMA itself account for 98.14% of its forecast error variance, indicating that its own innovations overwhelmingly explain short-term fluctuations in the variable. As the forecast horizon increases, the contribution of KOTA BIMA's own innovations gradually declines, while the contributions of other variables, particularly MATARAM, BIMA, and SUMBAWA, increase marginally. This pattern indicates that cross-market shocks become increasingly relevant in explaining the forecast error variance of KOTA BIMA over the longer term. Nevertheless, KOTA BIMA's own innovations continue to account for the largest proportion of its forecast error variance, indicating that the variable remains predominantly influenced by its own shocks.

Table 14. Varian decomposition Lombok Barat

Period	S.E.	Mataram	Bima	Dompu	Kota Bima	Lombok Barat	Lombok Timur	Sumbawa
1	292.6274	0.025924	5.483398	1.420139	0.377510	92.69303	0.000000	0.000000
2	337.3675	0.715324	5.604166	1.852870	0.417801	89.82078	0.570267	0.856802
3	401.0488	0.655279	6.545996	1.386853	0.430853	90.08604	0.455997	1.135083
4	447.1763	0.799629	5.712786	1.495465	0.636388	89.55677	0.533433	1.265533
5	490.3190	0.775091	5.880340	1.465628	0.597014	90.10277	0.452292	0.784867
6	529.7383	0.821274	5.878884	1.418698	0.617451	90.24350	0.357356	0.779844
7	566.4743	0.838929	5.852282	1.416106	0.646336	90.51784	0.355784	0.772722
8	600.8945	0.839692	5.927459	1.391718	0.647576	90.37403	0.291740	0.527853
9	633.5004	0.845962	5.830253	1.367289	0.671465	90.47213	0.255164	0.557737
10	664.4676	0.850358	5.852836	1.369856	0.663698	90.47213	0.255164	0.557737
11	694.0879	0.864367	5.961171	1.362950	0.665069	90.50938	0.241457	0.395850
12	723.0700	0.865970	5.823663	1.358304	0.678516	90.45822	0.330537	0.365573
13	749.7925	0.874550	5.978012	1.350189	0.675258	90.56528	0.230048	0.365073
14	776.1491	0.878752	5.945494	1.345159	0.675952	90.58730	0.211865	0.316423
15	801.6403	0.882261	5.990163	1.340805	0.678634	90.60709	0.204432	0.296613

Source: Processed Primary Data (2024)

The table above presents the variance decomposition of the LOMBOK BARAT variable over a 15-period forecast horizon. The results show the relative contribution of each variable to the forecast error variance of LOMBOK BARAT over time. In the initial period (Period 1), shocks originating from LOMBOK BARAT itself account for 92.69% of its forecast error variance, indicating that its own innovations constitute the primary source of short-term fluctuations. As the forecast horizon extends, the contribution of LOMBOK BARAT's own innovations gradually declines, while the contributions of other variables, particularly BIMA and DOMPU, increase slightly. This pattern indicates that although LOMBOK BARAT remains the dominant source of variation in its forecast error variance, shocks originating from other markets—particularly BIMA—become increasingly relevant in explaining its forecast error variance over the longer term.

Table 15. Varian decomposition Lombok Timur

Period	S.E.	Mataram	Bima	Dompu	Kota Bima	Lombok Barat	Lombok Timur	Sumbawa
1	337.9423	0.698878	3.116240	4.254010	0.387311	8.669508	82.87405	0.000000
2	398.0954	3.459879	6.039935	3.067191	2.198276	9.028686	73.65626	2.549768
3	465.2593	3.359138	5.237879	3.690495	2.802228	8.466422	74.08861	2.355227
4	519.0177	3.495151	5.149714	2.755582	2.865344	8.891603	73.48480	2.357808
5	568.3815	3.659615	5.926441	2.974394	3.030869	9.118962	73.48480	2.357808
6	613.4547	3.738047	6.164851	2.812929	3.137441	9.016983	73.48480	2.357808
7	655.8640	3.856622	6.236937	2.597155	2.997838	9.016422	72.83473	2.535177
8	694.8332	3.856622	6.236937	2.597155	2.997838	9.016422	72.83473	2.535177
9	732.3878	3.869878	6.273668	2.763802	3.187948	8.989938	72.60917	2.295528
10	767.7773	3.891036	6.303140	2.461330	3.405874	9.045146	72.65576	2.151147
11	801.7720	3.906367	6.326974	2.411452	3.441335	9.026308	72.67421	2.211540
12	834.3301	3.922469	6.349997	2.371300	3.474769	9.002258	72.68132	2.197059
13	865.6621	4.014091	6.369000	2.332990	3.498216	9.062358	72.57595	2.147836
14	895.8979	4.032125	6.400264	2.301055	3.520919	9.063530	72.54561	2.144748
15	925.1547	4.047957	6.400264	2.273340	3.540737	9.075757	72.50300	2.142594

Source: Processed Primary Data (2024)

The table above presents the variance decomposition of the LOMBOK TIMUR variable over a 15-period forecast horizon. The results indicate the relative contribution of each variable to the forecast error variance of LOMBOK TIMUR over time. In the initial period (Period 1), shocks originating from LOMBOK TIMUR itself account for 82.87% of its forecast error variance, indicating that its own innovations constitute the primary source of short-term fluctuations. However, this contribution gradually declines as the forecast horizon extends. In contrast, the contributions of other variables, particularly BIMA, MATARAM, and LOMBOK BARAT, increase progressively over time. This pattern indicates that although LOMBOK TIMUR remains the dominant source of variation in its forecast error variance, shocks originating from other markets become increasingly important in explaining its forecast error variance over the longer-term forecast horizon.

Table 16. Varian decomposition Sumbawa

Period	S.E.	Mataram	Bima	Dompu	Kota Bima	Lombok Barat	Lombok Timur	Sumbawa
1	224.5764	1.252221	2.091481	0.062250	3.036925	0.388687	3.830881	89.33756
2	252.0725	1.687141	2.429688	8.680741	2.425739	2.237595	11.32788	71.21122
3	279.8452	3.127608	2.976930	10.13095	6.200983	2.216395	16.12245	59.27710
4	305.2195	3.170689	2.507624	9.520207	6.212168	2.268138	17.81352	58.50765
5	323.6484	3.290911	2.297197	10.81003	5.980148	2.018089	19.63037	55.97336
6	341.5377	3.737160	2.114364	11.31035	6.480637	1.874428	21.54495	52.93812
7	359.2603	3.864832	1.943320	11.76919	6.647098	1.725303	22.94953	51.09992
8	375.5851	3.999270	1.814292	12.04248	6.725743	1.611762	23.93115	49.87531
9	391.3009	4.140094	1.701693	12.39988	6.829737	1.515159	24.92234	48.49121
10	406.4131	4.254558	1.608269	12.66365	6.943200	1.431652	25.74445	47.35432
11	421.0459	4.344890	1.525392	12.87177	7.018082	1.359949	26.42541	46.45378
12	435.1226	4.426981	1.457443	13.07297	7.082866	1.297633	27.03022	45.56686
13	448.7714	4.502504	1.396656	13.22446	7.147846	1.244444	27.57035	44.91373
14	462.0338	4.566200	1.335046	13.39964	7.202981	1.193683	28.04333	44.25912
15	474.9114	4.623507	1.285141	13.53590	7.250457	1.150067	28.46517	43.68976

Source: Processed Primary Data (2024)

The table above presents the results of the variance decomposition of the SUMBAWA variable over a 15-period horizon. The variance decomposition illustrates the contribution of each variable to the forecast error variance of SUMBAWA over time. In the initial period (Period 1), SUMBAWA accounts for most of its own variance (89.34%). However, its contribution decreases over time, while other variables, particularly EAST LOMBOK, DOMPU, and KOTA BIMA, increasingly contribute to the variance of SUMBAWA. This indicates that although SUMBAWA remains the primary factor in explaining its own variance, the influence of other regions gradually increases over the longer-term forecast period. Based on the variance decomposition analysis of corn market integration in NTB, the determination of the reference or benchmark market can be based on the region that has the greatest influence on price variance in other regions, as well as the region whose price variation is relatively stable and influences other regions over the long term.

The final results of the variance decomposition indicate that, in the short term, each variable tends to dominate the explanation of its own forecast variance, with a very large contribution from the variable itself to its own variance. However, as the forecast horizon increases, the contributions of other variables to the variance of each variable gradually increase. Overall, certain variables, such as EAST LOMBOK, SUMBAWA, and BIMA, have a more significant influence on other variables than the other variables. This indicates the existence of linkages or influences among these regions in the long term, whereby prices or conditions in one region can affect those in other regions. These findings indicate that although each region has strong local factors, inter-regional relationships continue to play an important role in the long term. In other words, price patterns or variables occurring in one region can gradually affect other regions, indicating the existence of market integration or inter-regional linkages over a longer period. These results are important for policy planning, particularly with regard to price stability and inter-regional linkages.

IV. CONCLUSION

Based on the discussion of the research findings, the following conclusions can be drawn:

1. The corn markets in West Nusa Tenggara Province during the 2021–2023 period were integrated in the long term across six regional markets, namely Mandalika Market in Mataram City, Aikmel Market in East Lombok Regency, Dompu Market in Dompu Regency, Seketeng Market in Sumbawa Regency, Amahami Market in Bima City, and Tente Market in Bima Regency. In contrast, Gerung Market in West Lombok Regency was not integrated with the other markets in NTB. In the short term, several regional markets in NTB influenced one another. Corn prices in Bima and East Lombok each influenced three regions in NTB in the short term, while Mataram, Dompu, Bima City, and West Lombok each influenced two regions in NTB in the short term. Meanwhile, Sumbawa influenced Mataram in the short term.
2. The reference markets for corn in West Nusa Tenggara Province that influence other markets in NTB are Seketeng Market in Sumbawa Regency, Aikmel Market in East Lombok Regency, and Tente Market in Bima Regency. These reference markets remain important focal points for establishing price consistency and can serve as a guide for other regions in gradually achieving price stability.

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