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Rice Demand Dynamics in Manggarai Regency, Indonesia: A VECM Approach

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ABSTRACT

Rice is recognized as the principal food commodity for the inhabitants of Manggarai, characterized by high per capita consumption and serving as the main source of energy. This research examined the patterns of rice consumption in Manggarai regency, employing a Vector Error Correction Model (VECM) and utilizing monthly data from 2020 to 2024. The data-gathering process involved coordination with the Department of Agriculture and Food Security, the Department of Trade and Industry, the Population and Civil Registration Office, and the Manggarai Regency Statistics Bureau. Stationary tests confirmed that the variables were integrated of order one, and Johansen cointegration analysis indicated several long-run equilibrium linkages among rice consumption, food prices, population, and ceremonial festivities. The research implies rice consumption is not significantly affected by short-run fluctuations in food prices, population, or cultural factors. Instead, adjustment occurs through the long-run equilibrium mechanism. In the long run, rice consumption is significantly influenced by rice prices, demographic changes, and ceremonial practices: rising rice prices reduce consumption, population growth increases demand, and cultural rituals suppress consumption. These outcomes emphasize the need for policies that stabilize food prices, promote dietary diversification, and integrate demographic and cultural considerations into regional food security strategies.

1. Introduction

Rice is a staple food of great importance to the Indonesian population, including those in Manggarai Regency, East Nusa Tenggara. According to the National Socio-Economic Survey (SUSENAS) conducted by Statistics Indonesia (BPS, 2024), the national average weekly per capita rice consumption ranges from 1.50 to 1.55 kg. However, a significant disparity is observed when compared to the East Nusa Tenggara region, particularly Manggarai Regency, where the average per capita rice consumption in Manggarai reached 2.4 kg of raw rice per week. This high consumption rate underscores that rice is not merely a food preference but a fundamental necessity, with high price inelasticity for the people of Manggarai.

Manggarai Regency possesses significant agricultural potential; however, it still faces challenges in meeting the growing demand for rice in line with population growth. According to data from the Department of Population and Civil Registration of Manggarai Regency in 2024, the total population is 349,836 people and continues to increase annually. The rise in population implies a higher demand for food, including rice. The high demand for rice is influenced by population growth that exceeds the growth rate of rice production (Septiadi & Joka, 2019). Besides population size, rice demand is also affected by price levels and the availability of substitute food commodities. When rice prices increase, people often turn to alternative staples such as corn, cassava, and sago. Zulaeka *et al*., (2024) explained that when the prices of essential commodities (including rice) rise significantly, consumers tend to switch to substitute products.

Cultural consumption patterns vary across regions, influencing the types and quality of food consumed, as well as cooking and processing techniques (Nurdiansyah *et al*., 2023). Culture also affects rice demand patterns. In Manggarai Regency, rice often serves as a symbol in various traditional and ceremonial events. Despite price fluctuations, rice's integral role in daily life sustains its high demand. Dependence on rice as a staple food goes beyond physical needs; it also reflects the community's cultural values.

This study addresses a critical gap in the literature (Asih *et al*., 2021; Farizi & Komilaari, 2023; Iskandar *et al*., 2023; Matatula & Kewilaa, 2023) by integrating ceremonial dummy variables and pork prices into a dynamic econometric framework. The inclusion of pork prices is justified by its role as one of the primary animal protein commodities, which shares a complementary relationship with rice consumption patterns during traditional ceremonies in Manggarai regency, such as penti (Iswandi *et al*., 2025; Resmini & Mabut, 2020), teing hang, kelas, wagal, and pesta sekolah. Additionally, according to (Keraru *et al*., 2021), pork consumption in Indonesia is higher in rural households, particularly in East Nusa Tenggara, including Manggarai regency.

Unlike prior studies that often rely on annual or cross-sectional data, this study uses monthly observations (2020–2024) to estimate a dynamic rice demand function and quantify the effects of own-price, cross-price, population, and socio-cultural events in Manggarai Regency. The monthly frequency allows a clearer identification of short-run and long-run demand responses to price movements by applying a Vector Error Correction Model (VECM) framework. The findings provide evidence to support local policies on price stabilization and dietary diversification to enhance regional food security.

2. Methodology

The data used in this study were secondary time-series data covering the period from 2020 to 2024, with a monthly frequency. Data collection in this study employed a census of available months, 60 observations. The samples in this study include data on rice consumption (kg), rice prices (IDR/kg), corn prices (IDR/kg), cooking oil prices (IDR/kg), fish prices (IDR/kg), broiler chicken meat prices (IDR/kg), pork prices (IDR/kg), population (number of people), and a ceremonial dummy variable (1 = ceremonial month; 0 = non-ceremonial month). The data were obtained from the Department of Agriculture and Food Security, the Department of Trade and Industry, the Department of Population and Civil Registration, and the Central Bureau of Statistics (BPS) of Manggarai Regency.

Rice consumption data were derived indirectly from household expenditure on the cereals group (IDR per capita per month), divided by the monthly price of medium-quality rice (IDR/kg), resulting in consumption measured in kilograms per capita per month. The expenditure data were obtained by interpolating average monthly per capita cereal expenditure in Manggarai Regency. Rice price data were sourced from the Department of Trade and Industry. Population data were also included in the analysis and converted to monthly observations by interpolating from semiannual records. The ceremonial dummy variable captures socio-cultural consumption patterns: months identified as ceremonial periods (December, January, June, July, August, and September) are assigned a value of 1. These months correspond to major cultural and social events in Manggarai, including Christmas and New Year celebrations, as well as traditional ceremonies such as teing hang, penti, wagal, and other communal gatherings.

The data were analyzed using the Vector Error Correction Model (VECM) (Sari *et al*., 2021; Utami *et al*., 2023) to estimate the dynamics of rice demand. The VECM estimation and its diagnostic tests in this study were performed using EViews 13. The VECM is an extension of the Vector Autoregression (VAR) model designed for non-stationary time-series data that exhibit cointegration relationships. It allows for the estimation of both long-run equilibrium relationships and short-run dynamic adjustments among variables. Unlike conventional regression models, VAR/VECM treats all variables as endogenous, enabling a more comprehensive analysis of interdependent relationships within the system (Suminto & Huda, 2025). The estimation procedure follows several sequential steps.

2.1 The Stationarity Test

Since monthly time-series data often exhibit trends, seasonality, and autocorrelation, testing for stationarity is essential to avoid spurious regression results. Stationarity of the data is tested using the Augmented Dickey–Fuller (ADF) test. Since monthly time-series data often exhibit trends, seasonality, and autocorrelation, testing for stationarity is essential to avoid spurious regression results. Non-stationary variables at the level are differenced to achieve stationarity at the first difference. It is also argued that the econometric results of the model at the series level may not be ideal for policy-making (Kjosevski & Petkovski, 2015). It is notable that the unit root tests did not incorporate the ceremonial dummy variable. Dummy variables lack the stochastic characteristics essential to stationarity tests, which are typically used for continuous time-series data to detect trends and intercepts, because they are discrete qualitative variables that represent particular temporal shocks.

2.2 Determination of The Optimal Length

The optimal lag length is determined using multiple information criteria, including the Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Criterion (SC), and Hannan–Quinn Criterion (HQ).

2.3 The Stability Test

The stability of the VAR system is examined to ensure the validity of subsequent dynamic analyses. A stable model is indicated when all characteristic roots have a modulus less than one (Basuki & Prawoto, 2016).

2.4 The Cointegration Test

The Johansen cointegration test (Johansen, 1988) is therefore performed after a preceding cointegration investigation. The trace test and the maximum eigenvalue statistics indicate that there are two cointegration relations under the conditions of an intercept and a trend. at most one cointegration rank at a time, allowing identification of a single cointegration relation that characterizes the system's long-run behavior. Granger causality can be investigated at different levels since the time series are cointegrated (Havrlant & Hušek, 2011).

2.5 The VECM estimation

VECM model according to Johansen approach was derived as follows (Rumánková, 2016):

$$\Delta X_t = \eta + \Pi X_{t-1} + \sum_{s-1}^{p} C_s \Delta X_{t-s} + U_t$$

where $C_s = 0$ for $s > p$, X_t is a k x 1 vector of variables supposed being integrated of order 1, $\left(I(1)\right), u_i, \dots, u_t$ are nid $(0, \sum)$ and is a matrix of the long-run relationship. All variables are transformed into logarithmic form to stabilize variance and facilitate elasticity interpretation.

2.6 The Granger Causality Test

To ascertain whether two variables have a reciprocal relationship, the Granger Causality Test is used. In other words, because every variable in the study has the potential to be either endogenous or exogenous, it looks at whether one variable has a substantial causal link with another (Basuki (Basuki & Prawoto, 2016).

2.7 Impulse Response Function (IRF)

IRF aims to see the impact of changes in one variable on another variable by giving a shock to one of the (Sari *et al*., 2021). A shock from an endogenous variable directly affects the variable itself and is also passed on to all other endogenous variables through the dynamic structure in the VECM model (Suminto & Huda, 2025).

2.8 Forecast Error Variance Decomposition (FEVD)

The use of variance decomposition to predict the percentage contribution of variance of each variable due to changes in certain variables in the VAR system (Sari *et al*., 2021).

3. Results and Discussion

3.1. Trends and Characteristics of Rice Consumption

Figure 1 illustrates the relationship between rice prices and rice consumption in Manggarai Regency during the period 2020–2024. The data show consistency with the law of demand, which states that the higher the price of a good and/or service, the lower the quantity of that good and/or service demanded, ceteris paribus. Despite theoretical expectations that higher prices should reduce demand, rice consumption persists because it is necessary. For instance, during economic crises or price spikes, households often allocate a larger share of their income to rice, reducing expenditure on other foods (Widarjono, 2016).

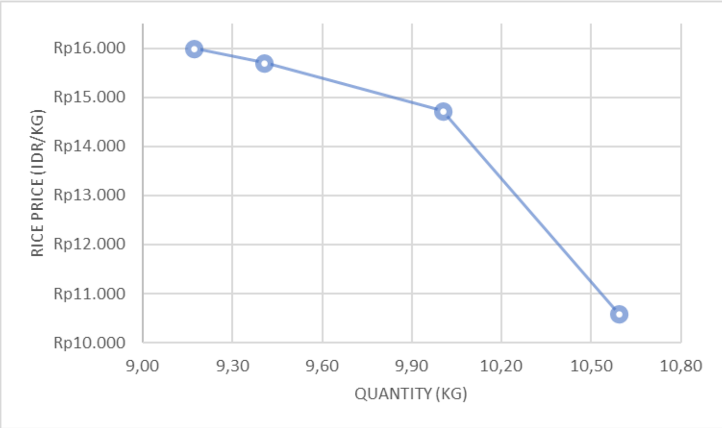

Figure 1. Rice Consumption in Manggarai Regency from 2020 to 2024 at Various Price Levels
Source: Secondary data (processed) (2026)

3.2 The results of VECM Assumption and Instrument Test

The ADF test results presented in Table. 1 indicate that most variables are non-stationary at level but become stationary after first differencing. For instance, rice prices, corn prices, pork prices, and cooking oil prices are non-stationary at level but stationary at first difference, confirming that the variables are integrated of order one.

Table 1. The Results of The Stationary Test

Variables	Level			First difference		
	ADF Test		Results	ADF Test		Results
	t-Stat	Prob.		t-Stat	Prob.	
Rice consumption	-4.60	0.00	Stationary	-10.17	0.00	Stationary
Rice price	-1.09	0.71	Not stationary	-9.71	0.00	Stationary
Corn price	-1.33	0.60	Not stationary	-6.49	0.00	Stationary
Fish price	-4.19	0.00	Stationary	-7.55	0.00	Stationary
Broiler chicken meat price	-6.72	0.00	Stationary	-8.94	0.00	Stationary
Pork price	-0.73	0.82	Not stationary	-8.13	0.00	Stationary
Cooking oil price	-1.13	0.69	Not stationary	-7.50	0.00	Stationary
Population	-1.11	0.70	Not stationary	-3.55	0.00	Stationary

Source: Secondary data (processed) (2026)

Considering these characteristics, the Johansen cointegration test verifies the presence of long-run equilibrium correlations between population, ceremonial variables, food prices, and rice consumption. The VECM model is suitable for representing both short-run and long-run dynamics, according to the stability and specification tests.

Table 2. The Result of VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	790.4796	NA	3.68e-24	-28.41744	-28.08897*	-28.29042
1	905.1602	187.6592	1.12e-24*	-29.64219	-26.35746	-28.37196*
2	989.5185	110.4327*	1.25e-24	-29.76431	-23.52333	-27.35087
3	1051.063	60.42506	4.99e-24	-29.05682	-19.85958	-25.50017
4	1173.036	79.83714	5.74e-24	-30.54676*	-18.39327	-25.84691

Source: Secondary data (processed) (2026)

The VAR lag-order selection criteria presented in Table 2 provide the basis for determining the most appropriate lag structure for the model. The lag length was chosen to balance model fit and parsimony. The optimal lag length was determined using several criteria, including the Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criteria (AIC), Schwarz Criterion (SC), and Hannan-Quinn (HQ). While the AIC suggested a longer lag structure, both FPE and HQ indicated that lag 1 was optimal. Considering the relatively short sample period (monthly data from 2020-2024), model parsimony, and the need to avoid overparameterization, this study adopts a lag length of one. This choice ensures that the short-run dynamics are captured effectively while maintaining model stability and efficiency.

Table 3. The Results of Stability Test

Root	Modulus
0.793511 - 0.005095i	0.793527
0.793511 + 0.005095i	0.793527
0.191608 - 0.452320i	0.491230
0.191608 + 0.452320i	0.491230
-0.358623	0.358623
-0.133756 - 0.244154i	0.278391
-0.133756 + 0.244154i	0.278391
-0.147342	0.147342
0.127524	0.127524

Source: Secondary data (processed) (2026)

Based on the data presented in Table 3, the VECM model is stable, validating the robustness of the VECM specification with lag 1. This is indicated by all modulus values being less than 1 (<1) or all the characteristic roots lying inside the unit circle. Therefore, we can proceed to the cointegration test.

Table 4. The Results of The Johansen Cointegration Test

Hypothesis	Trace Statistic	Critical Value (5%)	Prob.** Critical Value	Max-Eigen Statistic	Critical Value (5%)	Prob.** Critical Value
None *	353.0269	197.3709	0.0000	80.37273	58.43354	0.0001
At most 1 *	272.6541	159.5297	0.0000	69.57715	52.36261	0.0004
At most 2 *	203.0770	125.6154	0.0000	58.94534	46.23142	0.0014
At most 3 *	144.1317	95.75366	0.0000	49.11678	40.07757	0.0037
At most 4 *	95.01487	69.81889	0.0001	35.96622	33.87687	0.0278
At most 5 *	59.04865	47.85613	0.0032	23.51054	27.58434	0.1527
At most 6 *	35.53811	29.79707	0.0098	21.77135	21.13162	0.0406
At most 7	13.76676	15.49471	0.0896	12.69795	14.26460	0.0871
At most 8	1.068811	3.841465	0.3012	1.068811	3.841465	0.3012

Source: Secondary data (processed) (2026)

The Johansen cointegration test shown in Table 4 indicates 7 cointegrating equation(s) at the 0.05 level based on the trace test and indicates 5 cointegrating equation(s) at the 0.05 level based on the Max-eigenvalue test. These results indicate strong long-run equilibrium relationships among rice consumption, food prices, populations, and ceremonial dummy variables.

Table 5. The Summary Results of Granger Causality Test

Null Hypothesis	F-Statistic	Prob.
RICE PRICE does not Granger Cause RICE CONSUMPTION	1.15914	0.2863
RICE CONSUMPTION does not Granger Cause RICE PRICE	24.4216	7.E-06
CEREMONIAL DUMMY does not Granger Cause RICE CONSUMPTION	4.92710	0.0305
RICE CONSUMPTION does not Granger Cause CEREMONIAL DUMMY	3.53302	0.0654
PORK PRICE does not Granger Cause RICE PRICE	0.85831	0.3582
RICE PRICE does not Granger Cause PORK PRICE	5.72405	0.0201
POPULATION does not Granger Cause RICE PRICE	0.72576	0.3979
RICE PRICE does not Granger Cause POPULATION	74.3318	7.E-12
CEREMONIAL DUMMY does not Granger Cause RICE PRICE	6.91169	0.0110
RICE PRICE does not Granger Cause CEREMONIAL DUMMY	0.12579	0.7242
POPULATION does not Granger Cause CORN PRICE	0.10191	0.7507
CORN PRICE does not Granger Cause POPULATION	38.8334	6.E-08
POPULATION does not Granger Cause FISH PRICE	0.11430	0.7366
FISH PRICE does not Granger Cause POPULATION	10.4741	0.0020
CEREMONIAL DUMMY does not Granger Cause BROILER CHICKEN MEAT PRICE	3.05813	0.0858
BROILER CHICKEN MEAT PRICE does not Granger Cause CEREMONIAL DUMMY	6.66649	0.0125
COOKING OIL PRICE does not Granger Cause PORK PRICE	0.01608	0.8996
PORK PRICE does not Granger Cause COOKING OIL PRICE	9.10322	0.0038
POPULATION does not Granger Cause PORK PRICE	1.11775	0.2949
PORK PRICE does not Granger Cause POPULATION	32.0100	5.E-07
CEREMONIAL DUMMY does not Granger Cause PORK PRICE	8.39717	0.0054
PORK PRICE does not Granger Cause CEREMONIAL DUMMY	1.44579	0.2343

Notes: This table only displays variables that have a statistically significant influence. *** = significant at the 1% level, ** = significant at the 5% level and * = significant at the 10% level. Table t values: t(α=1%) = 2.33, t(α=5%) = 1.96, t(α=10%) = 1.65
Source: Secondary data (processed) (2026)

The Granger causality results presented in Table 5 highlight several significant directional relationships between the variables in the model. Due to the high dimensionality of the dataset and for the sake of conciseness, Table 5 selectively reports only those variable pairs that exhibit statistically significant causal linkages. A Granger causal relationship is identified where the associated probability value is less than α=0.05 significance level, indicating that the lagged values of one variable provide statistically significant information for predicting the future values of another.

The Pairwise Granger Causality analysis reveals several significant unidirectional causal relationships among the variables within the 2020–2024 observation period. Most notably, the null hypothesis that rice price does not Granger cause population is rejected at a highly significant level, alongside corn price and pork price, indicating that fluctuations in staple commodity prices precede shifts in demographic or consumption-related indicators. furthermore, the ceremonial dummy variable exhibits a significant influence on both rice consumption and rice price, while being itself influenced by broiler chicken meat price. interestingly, the results indicate a lack of bidirectional causality across all tested pairs, as evidenced by probability values exceeding α=0.05 the threshold for the inverse relationships, confirming that the identified causalities are strictly one-way.

The results reveal that food commodity prices and other basic socio-economic indicators in Manggarai have a considerable predictive relationship. The clear causal influences of rice and corn prices on population dynamics reflect the critical role of these staples in local food security, where price volatility likely triggers immediate behavioral or distributive adjustments. The significant role of the ceremonial dummy as a stimulus for rice consumption and pricing affirms the deep integration of cultural and religious events into the market economy, where specific periods of high demand for meat, such as broiler chicken, subsequently ripple through the rice market. These results align with the theory of consumer behavior in emerging markets, where "shocks" in one primary commodity can serve as a leading indicator for shifts in related agricultural sectors. The lack of bidirectional causality reflects a hierarchical market structure in which price discovery in major protein and grain sectors leads rather than influences the broader agricultural economy.

3.3 The Results of VECM Estimation

The VECM estimation identifies several critical long-run and short-run dynamics among the variables, as presented in Table 6. For the purpose of conciseness and clarity, only variables with statistically significant impacts are presented. The Error Correction Term (Cointeq1) is significant for rice consumption, rice prices, and population, confirming the existence of a stable long-run equilibrium. In the short run, significant inter-commodity linkages are observed, particularly the negative impact of second-lag pork prices on cooking oil prices. Additionally, population dynamics are significantly influenced by the first-lag of rice prices and the second-lag of broiler chicken meat prices.

The findings confirm the interdependence between staple food prices and socio-demographic factors. The significance of the error-correction terms shows that short-run shocks are eventually corrected, bringing the system back to its long-run steady state. The analysis addresses certain variables to delineate the relevant factors in the agricultural market. The observed short-run impact of protein-based commodities, such as pork and broiler chicken, on population and other food prices indicates a high degree of cross-price elasticity. Specifically, the ceremonial dummy's significant effect in corn prices underscores the impact of cultural festivities on market demand. These results imply that food security policies must account for both the direct price of staples and the indirect pressures exerted by substitute goods.

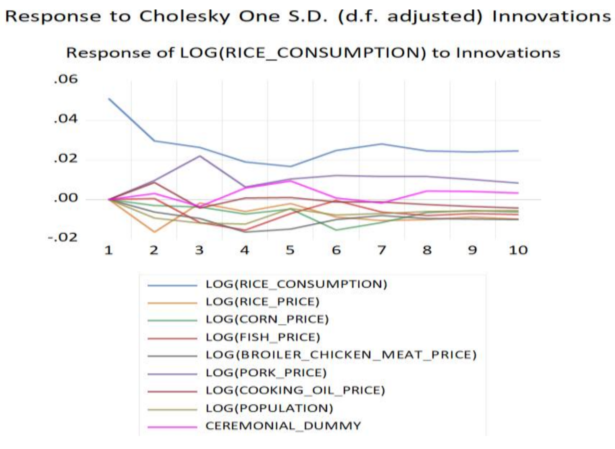

Figure 2. IRF

Source: Secondary data (processed) (2026)

Table 6. The Summary Results of Long Run And Short-Run VECM Estimation

Relationship type	Dependent Variable	Independent Variable (Lag)	Coefficient	T-Statistic
Long-run (ECT)	Log(Rice Consumption)	Cointeq1	0.7147	[2.3915]**
	Log(Rice Price)	Cointeq1	-0.6512	[-2.2763]**
	Log(Population)	Cointeq1	0.0282	[2.1763]**
	Ceremonial Dummy	Cointeq1	-7.7834	[-2.8878]***
Short-run	Log(Corn Price)	Log(Broiler Chicken Meat Price) (-1)	0.0755	[1.9261]*
	Log(Fish Price)	Log(Fish Price) (-2)	-0.4833	[-2.7500]***
	Log(Broiler Chicken Meat Price)	Log(Broiler Chicken Meat Price) (-2)	-0.3986	[-2.3166]**
	Log(Pork Price)	Log(Corn Price) (-2)	0.4228	[2.0527]**
		Log(Broiler Chicken Meat Price) (-2)	0.0857	[1.9747]*
		Log(Pork Price) (-2)	-0.4926	[-3.1162]***
	Log(Cooking Oil Price)	Log(Pork Price) (-2)	-1.0318	[-3.0754]***
		Log(Rice Price) (-2)	0.3309	[2.1692]**
	Log(Population)	Log(Rice Price) (-1)	-0.2412	[-2.0486]**
		Log(Broiler Chicken Meat Price) (-2)	0.0061	[2.6901]***
		Log(Pork Price) (-2)	-0.0168	[-2.0192]**
		Log(Population) (-2)	0.3385	[2.2088]**
	Ceremonial Dummy	Log(Corn Price) (-1)	-7.1215	[-3.0643]***
		Ceremonial Dummy (-1)	-0.4677	[-2.8337]***
		Ceremonial Dummy (-2)	-0.3757	[-2.4128]**

Notes: This table only displays variables that have a statistically significant influence. *** = significant at the 1% level, ** = significant at the 5% level and * = significant at the 10% level. Table t values: t(α=1%) = 2.33, t(α=5%) = 1.96, t(α=10%) = 1.65
Source: Secondary data (processed) (2026)

Figure 2 illustrates rice consumption's response to shocks in other variables. A positive shock to rice prices reduces rice consumption, reflecting substitution effects. Shocks to corn, fish, broiler chicken meat, and pork prices show negative responses, indicating competition among staple and protein sources. Population shocks elicit consistent and significant responses, underscoring the influence of demographics. Ceremonial dummy shocks generate fluctuations in rice consumption, reflecting seasonal or cultural demand patterns. These results confirm the dynamic interplay between food demand, prices, and demographic factors.

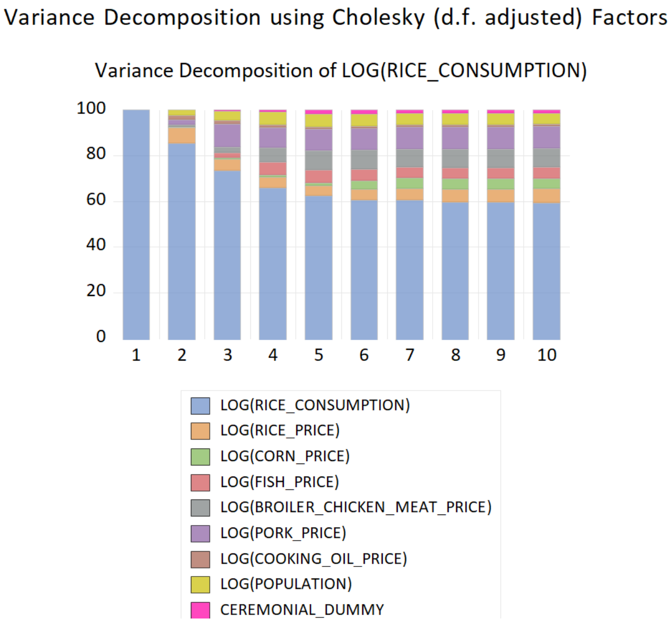

Figure 3. Variance Decomposition of Log (Rice consumption)
Source: Secondary data (processed) (2026)

Variance decomposition, as shown in Figure 3, indicated that rice consumption is initially explained entirely by its own past values. Over time, rice prices, corn prices, fish prices, chicken prices, pork prices, cooking oil prices, and population increasingly contribute to the variation in rice consumption. This highlights the growing importance of food price dynamics and demographic changes in explaining rice demand, consistent with findings in food security literature.

3.3.1 *Rice Price Elasticity and Long-run Equilibrium*

The VECM results indicate that while the short-run impact of rice price on consumption is statistically insignificant, it plays a crucial role in the long-run equilibrium. The value of the Error Correction Term (Cointeq1) at 0.7147 (t = 2.39) indicates that rice consumption in Manggarai Regency exhibits a well-functioning stabilizing mechanism, ensuring long-run stability following market shocks. Furthermore, the low coefficient values confirm that rice demand remains highly inelastic. This implies that rice is a primary staple necessity for the Manggarai community, where consumption persists despite price fluctuations. This finding aligns with Iskandar *et al*. (2023), and reinforces rice's status as an indispensable food source.

3.3.2 *Cross-Price Elasticities and Complementary Dynamics*

In the short run, variations in pork and cooking oil prices do not directly determine rice demand. Instead, these variables exhibit significant interdependencies. Specifically, the negative and elastic coefficient of pork price on cooking oil indicates a complementary relationship within the local protein and fat sector. This reflects local food culture, where meat preparation is intrinsically linked to the use of cooking oil. Cooking oil is among the nine essential commodities most Indonesians require (Hildayanti, 2024).

Interestingly, corn price was found to have a significant influence on the ceremonial dummy variable (t = -3.06) rather than directly on rice consumption in the short run. This shows that the "rice-corn mixture" tradition mentioned in previous studies (Asih *et al*., 2021) is highly seasonal and event-driven in Manggarai. The negative elasticity between corn prices and ceremonial periods indicates that during periods of high corn prices, the intensity of traditional ceremonies, which usually involve high food consumption, may be adjusted. This highlights that corn serves not just as a simple substitute but also as a cultural-economic indicator of communal food logistics.

3.3.3 *The Dummy Ceremonial and Cultural Market Rhythm*

Based on the outer model loading factor values in Figure 3, the highest value is obtained for indicator X3.2 with a loading of 0.860. This indicates that the statement, "I understand that the cooperative helps market harvest products in accordance with RSPO standards," is the strongest indicator in representing the knowledge construct. Cooperative members are free to sell their Fresh Fruit Bunches (FFB) to any collection point (ram). However, the sales receipt must be reported to cooperative officers for the record. From these recorded sales, an incentive of IDR 30 per kilogram of FFB is accumulated. At the end of the year, the total incentive is converted into fertilizer and distributed to cooperative members. This system shows that members clearly understand the cooperative's role in supporting marketing mechanisms aligned with RSPO standards, particularly through transparent recording and benefit-sharing arrangements. Such practical and experience-based knowledge strengthens members' trust in the cooperative and significantly contributes to their participation in the certified smallholder program.

3.4 Study Limitations

This study has several limitations. First, the data used were obtained from secondary sources across institutions and were limited to monthly data from 2020 to 2024. This makes the analysis highly dependent on the accuracy and consistency of recorded data, which may introduce potential bias. Longer time series could provide more comprehensive insights into structural changes. Second, the analysis did not include other economic factors, such as income, urbanization, policy interventions and external shocks like pandemics and climate change, which may also influence rice consumption. Third, the use of VECM for analysis assumes a linear relationship. This may not fully capture nonlinear dynamics or threshold effects in food demand. Future research could expand on this study by incorporating longer time periods, more comprehensive variables, and alternative analysis methods.

4. Conclusion

The VECM results demonstrate that rice consumption in Manggarai Regency is not significantly affected by short-run fluctuations in food prices, population, or cultural factors. Instead, rice consumption adjusts primarily through the long-run equilibrium mechanism, with significant influences from rice price, demographic changes, and ceremonial practices. This indicates that rice consumption remains relatively stable in the short term, but in the long run, it responds to structural determinants and cultural dynamics. Policy efforts should therefore emphasize long-run strategies that integrate economic, demographic, and socio-cultural dimensions to ensure sustainable food security.

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