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Analysis of Rice Price Volatility in Medan City, Indonesia

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Abstract. One of the primary challenges government policies face concerning agricultural commodities is maintaining food price stability. Instability in food prices can have significant economic, political, and social repercussions. This study provides an in-depth analysis of rice price fluctuations daily, offering a clearer understanding of rice price volatility in Medan. This research examines the changing trends in rice prices and their associated fluctuations through seasonality and volatility analysis. It is revealed that rice prices in Medan peak in February, and the lowest rice prices occur in December. The rice prices were more volatile before the pandemic than after it. During the pre-pandemic period, the correlation between the prices of various food items was relatively low, meaning that the prices of different commodities were not strongly linked. However, in the post-pandemic period, the correlation between rice prices and other food items in Medan became more significant, suggesting that rice prices were more closely tied to those of other essential foodstuffs. Although rice price volatility in Medan is generally low throughout most of the year, the government should focus on the months between October and February, when volatility tends to be higher due to factors such as seasonal demand spikes and external influences like weather conditions. By proactively managing supply and demand, ensuring adequate rice stocks, and supporting local rice production, the Medan government can more effectively navigate periods of heightened volatility and ensure that rice prices remain stable and affordable for all consumers.

Keywords: essential foodstuffs; external influences; GARCH; price volatility; seasonal demand

INTRODUCTION

One of the key challenges in government policies related to agricultural commodities is maintaining food price stability. Food price stabilization is imperative, as price volatility can lead to profound economic, political, and social impacts. The impact of rising food prices is that low-income populations will become even poorer (Putra et al., 2021), and their unchanged income reduces their ability to purchase food as a large portion of household spending is allocated to food needs (Kalaba et al., 2022).

Price is defined as the amount of value exchanged by consumers for a good or service (Adriani et al., 2022; Kotler & Amstrong, 2018). Food prices may fluctuate seasonally or annually as a result of the interaction between supply and demand (Chintia & Destiningsih, 2022). Food price fluctuations are also associated with national religious holidays (Eid al-Fitr, Christmas, Chinese New Year, and New Year's Day), which typically lead to price increases each year due to price speculation (Bahtiar & Raswatie, 2023).

The supply and demand for food commodities tend to be relatively inelastic in response to price changes, which results in greater price volatility. Unpredictable fluctuations, whether short-term or long-term, can have a ripple effect on other markets, including producer markets and their related products (Komalawati et al., 2021). Given that price fluctuations are associated with risks and uncertainties that influence decision-making (Wibowo, Rizaldi, et al., 2019; Wibowo, Sumono, et al., 2019), governments continuously strive to maintain food price stability (Ariestiyanti & Adrison, 2020).

Previous research shown that market integration (Serra & Gil, 2013), natural factors such as climate and weather (Iliyasu & Sanusi, 2024), exchange rates (Achsani et al., 2009), distance between production and consumption areas, (Arifin, 2005) can lead to food price fluctuation. Long-term food price fluctuations are shaped by factors such as technological advancements, changes in the balance of payments, policy shifts, government expenditure changes, alterations in wage scales, tax and duty modifications,

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and developments in transportation, storage, and marketing infrastructure for agricultural products (Nurhayanti & Susanto, 2022). Additionally, The prices of staple foods commonly consumed by the public will continue to rise due to inflation. As a result, when these incremental price increases accumulate over time, the rise in food prices becomes more noticeable to the public (Rahmanta & Maryunianta, 2020).

Developing countries, including Indonesia, typically implement government interventions to stabilize food prices and manage fluctuations (Arifin, 2005). On some staple foods, such as rice, changes in the price of rice are influenced by the level of government intervention. According to (Food Price Stabilization Policies in a Globalizing World, 2007), price stabilization policies can be categorized into two types: Non-Market Based Options and Market-Based Options. Non-Market Based Options include measures such as setting floor and ceiling prices, which are implemented alongside food reserves and market operations when price fluctuations become extreme. Other measures include maintaining food reserves, adjusting export and import tariff levels, and fostering collaboration between the government and private sector. Market-Based Options involve policies like warehouse receipt systems, commodity futures exchanges, crop insurance, weather index insurance, and participation in international futures exchanges.

The Indonesian government has implemented various policies to mitigate food price fluctuation, including market interventions through BULOG (National Logistics Agency), setting Maximum Retail Prices (HET) and Farmers' Benchmark Prices, and food subsidy programs such as Raskin (rice for the poor), as well as fertilizer subsidies for farmers, and tariff and import duty policies. Additional measures include direct assistance for high-quality seeds, direct fertilizer aid, and the promotion of low-cost food initiatives (Sujai, 2011). These food price stabilization policies aim to ensure that food needs are met through domestic production, with food imports serving as a last resort if domestic supply falls short (Amolegbe et al., 2021). To support this, the development of national food reserves is prioritized to maintain price stability, in line with good governance principles. Effective coordination between government agencies and relevant stakeholders is also crucial for the successful implementation of these stabilization policies (Indriani et al., 2024).

One of the most essential food products that has garnered significant attention is rice. As a staple food, rice is a key part of people's diets and must be available in every household. The rising price of rice is a major concern for many. During the 2019-2022 period, the Indonesian government refrained from importing rice to support domestic production. However, the impact of the El Niño phenomenon, coupled with an increase in domestic rice prices, prompted the government to import large quantities of rice in 2023. This decision was also driven by public demand for stable rice availability and prices.

However, the impact of government policies on rice price volatility still requires further investigation. Identifying a combination of food volatility policies that will have a positive impact on society is a challenge for policymakers. Therefore this research aims to contribute to the development of policies that can help stabilize food prices. To achieve this, we use daily data to examine short-term price volatility, as existing literature (Apergis & Rezitis, 2003; Ngare & Simtowe, 2014) primarily relies on monthly and annual data. By analyzing daily price volatility, this study provides a more detailed understanding of how rice prices fluctuate daily, offering a clearer representation of rice price volatility in Medan.

METHODS

The research was conducted using secondary data collected from several sources such as the Central Bureau of Statistics (BPS)

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of Medan, the Department of Food Security, Food Crops and Horticulture of North Sumatra Province, as well as direct interviews to the market to obtain valid information. The data collected is in the form of time series data on rice prices in Medan City, where data gaps are filled by interpolating the data.

To analyze the stabilization of rice prices, a seasonality analysis was first conducted to see how the influence of price constituent factors on food prices in Medan City. Prices are composed of four components including trend, cycle, seasonality, and disturbance. Using this approach, the following price component model was developed (Trotter, 1992).

$$P_t = (T_t) \times (C_t) \times (S_t) \times (E_t) \quad 1)$$

where P is the Price; T is the Trend Component; C is the Cycle Component; S is the Seasonal Component; E is the disturbance; and t is the observation time be it daily, weekly, or monthly. Seasonality is defined as a systematic change that repeats every 12 months. Generally, fluctuations in seasonal price movements occur due to fluctuations in the supply of goods. Fluctuations in demand will cause seasonal price changes.

Seasonality Analysis

The seasonal index will be calculated using Center Moving Averages (CMA). The seasonal index is estimated using CMA over a period of 12 months.

$$CMA^{12} = \frac{\sum_{i=t-6}^{i=t+5} P_i + \sum_{i=t+6}^{i=t-5} P_i}{12} \quad 2)$$

CMA eliminates all seasonal and random components of price data. The result of this analysis will depict the trend and cyclical components of the price and eliminate the seasonal and random factors. The Seasonal Index (SI) is then calculated using the following formula:

$$SI = \frac{P_i}{CMA^{12}} \times 100 \quad 3)$$

where SI is the Seasonal Index in month *i*, P*i* is the price in month *i*, and CMA is the Centered Moving Average at 12 Months.

The Grand Seasonal Index (GSI) describes the seasonal behavior of a time series. The GSI represents the real seasonal average over the analysis period or shows seasonal fluctuations in market prices.

$$GSI = \overline{SI}\, x \frac{100}{\sum \overline{SI}} \quad 4)$$

where SI is the average Seasonal Index in month *i*.

Volatility Analysis

Volatility analysis is conducted by measuring the coefficient of variation (CV), corrected coefficient of variation (CCV), and standard deviation of log prices (SDD). The CV is calculated using the following formula:

$$cv = \frac{standard\ deviation}{mean} = \frac{\sqrt{\frac{\sum_{i=1}^{n}(P_i - \bar{P})^2}{n}}}{\bar{P}} \quad 5)$$

Corrected Coefficient Variation (CCV) values at the same price level (using a linear trend) can be analyzed using the following calculation:

$$ccv = cv\sqrt{(1 - R^2)} \quad 6)$$

where R^2 is derived from regressing prices on a linear trend. The standard deviations of log prices (SDD) can be analyzed using the following formula:

$$sdd = \sqrt{variance\ (ln\frac{P_t}{P_{t-1}})} \quad 7)$$

The GARCH model estimation is used to analyze the volatility dynamics of a commodity in the market. To measure the level of price volatility, the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model is well-suited. Prior to constructing the GARCH model, an Autoregressive Integrated Moving Average (ARIMA) model is applied to identify the most appropriate ARCH model (Bollerslev, 1986) GARCH (p, q) representation is as follows:

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$$Y_{it} = a_O + b_1 Y_{it-1} + b_2 Y_{it-2} + e_{it} \quad 8)$$
(*autoregressive process*)

The variance of random errors is estimated as follows:

$$\sigma_{i,t}^2 = \omega + \sum_{i=1}^{p} \beta_i \sigma_{i=1}^2 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-1}^2 \quad 9)$$

where Y*it* is the t^{th} period price of i^{th} commodity, p is the order of the GARCH term and q is the order of the ARCH term. The sum αi+βi gives the degree of persistence of volatility in the data series. The closer it is to "1", the greater the tendency for volatility to persist for a longer time. If the sum exceeds "1", it indicates an explosive series with a tendency to deviate from the mean.

The Autoregressive Integrated Moving Average (ARIMA) model is used for forecasting time series data. The ARIMA (p, d, q) model combines an autoregressive model (AR(p)), which explains a variable's movement based on its past values, and a moving average model (MA(q)), which accounts for the movement of residuals from previous periods, particularly for non-stationary data (Hariadi & Sulantari, 2021). ARIMA models are sometimes referred to as atheoretical models because they are not derived from any specific economic theory, unlike simultaneous equation models, which are typically based on economic theory.

To estimate a univariate model using the Box-Jenkins (BJ) methodology, also known as ARIMA, there are four key stages: data identification to determine the appropriate Box-Jenkins model (AR, MA, ARMA, or ARIMA), parameter estimation for the identified model, diagnostic checking to assess the adequacy of the specified model, and forecasting future time series values. The general form of ARIMA can be expressed as follows:

$$\phi_p(B)(1-B)^d Y_t = c + \theta_q(B) e_t \quad 10)$$

where c is constant, $(1-B)^d$ is difference process (differentiation) at d_{th} order, $\phi_p(B)$ is $(1 - \phi_1 B - \phi_2 B^2 - \cdots - \phi_p B^q)$ which is the backward step operator for AR, $\theta_q(B)$ is $(1 - \theta_1 B - \theta_2 B^2 - \cdots - \theta_p B^q)$ which is the backward step operator for MA, and e_t is *error*.

RESULTS AND DISCUSSION

Food commodities play a crucial role in the economic, social, and political spheres. Persistent fluctuations in food prices signal a lack of stability within a country. When food prices remain stable, economic development proceeds smoothly, fostering social, political, and security stability. Additionally, as price fluctuations are linked to the risks and uncertainties faced during decision-making, people seek price stability. Consequently, the government continuously works to maintain stable food price fluctuations (Ariestiyanti & Adrison, 2020).

The price of rice in Medan exhibits considerable volatility throughout the year, with fluctuations between periods of relatively low and high price levels. Prices generally rise from January to April, then decrease from May to August, followed by an increase again after September. This cyclical nature of rice prices is a typical pattern observed annually, influenced by various factors such as seasonal demand, production levels, and market dynamics. As shown in Figure 1, rice prices in 2023 are notably higher than in 2021 and 2022. The increase in rice prices from 2022 to 2023 is particularly significant, as it is much higher than the rise observed between 2021 and 2022. This indicates a more rapid upward trend in rice prices, which can be attributed to supply disruptions, increased demand, and inflationary pressures on food commodities.

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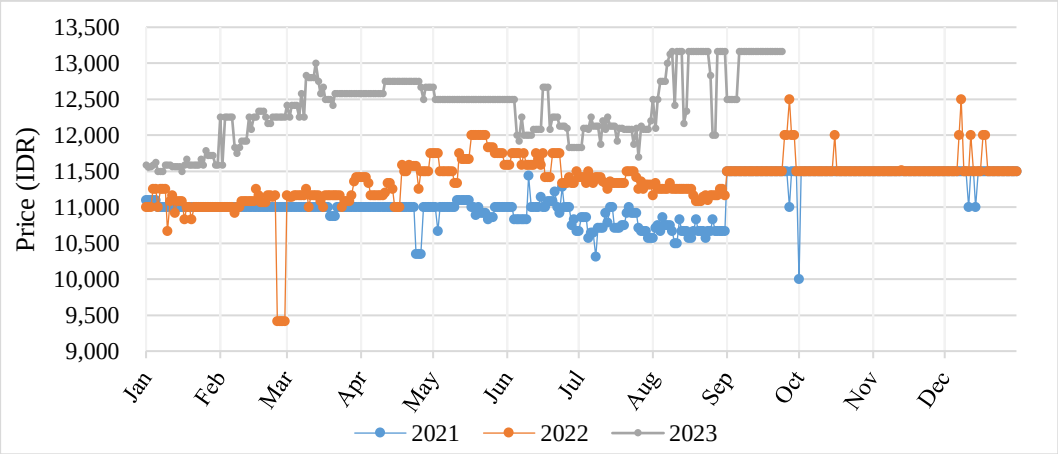

Figure 1. The price of rice in Medan 2021-2023

In order to better understand the underlying trends and cycles of rice prices, an analysis was conducted to remove seasonal and random components from the medium rice price data in Medan City. This approach helps isolate the actual price trend from seasonal fluctuations caused by seasonality and other random factors. The result provides a clearer view of the long-term movement of rice prices, enabling a better understanding of the broader economic forces at play. The trend of rice prices in Medan can be observed in Figure 2 below, which illustrates the overall trajectory of rice prices over time.

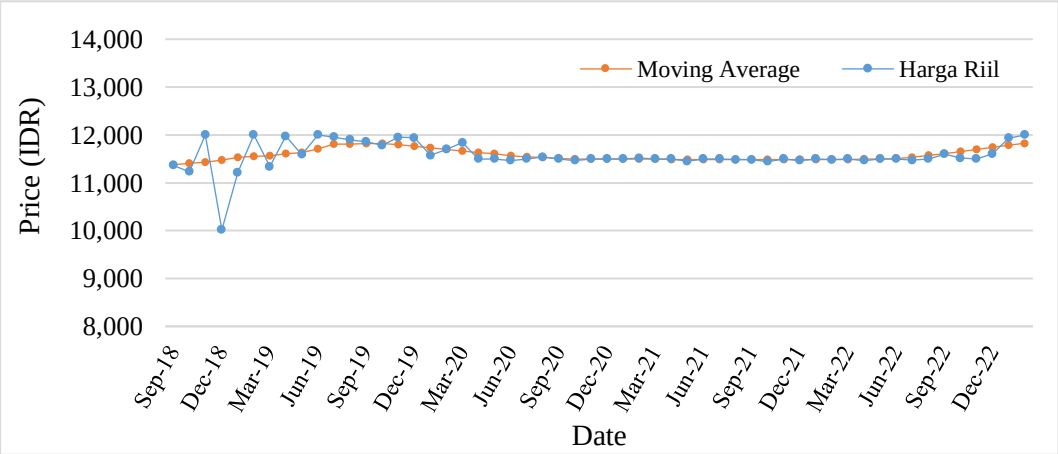

Figure 2. Rice price trends in Medan 2018-2023

From Figure 2, it is apparent that rice prices were more volatile in 2018 and 2019, prior to the onset of the pandemic. During this period, the rice market experienced sharp fluctuations, likely due to weather conditions, supply chain disruptions, and market speculation. However, since 2020, rice prices have remained relatively stable, with a noticeable decline between 2020 and 2021, followed by a steady increase from 2021 to 2023. Government intervention measures, including stabilising rice supply and price regulation policies likely influenced this period of stability. However, the upward trend in rice prices between 2021 and 2023 has raised concerns, as it is likely to have significant socio-economic impacts, particularly for low-income groups in Medan.

For low-income households in Medan, the rising cost of rice has serious implications for their purchasing power and overall financial well-being. As rice is a staple food and a significant portion of household expenditure, any price increase can considerably strain household budgets. In the case of low-income groups, whose incomes

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are already limited, the rising price of rice means that a larger portion of their earnings will need to be allocated to purchasing food. This can reduce their disposable income, making it more difficult for them to meet other basic needs such as healthcare, education, and transportation. Consequently, the higher price volatility in rice, particularly the sharp price increases observed between 2021 and 2023, could have a more severe impact on these low-income groups.

The real price of rice in Medan City during the study period exhibited significant volatility, with fluctuations likely influenced by seasonal and other factors. To better understand the development of real rice prices, seasonal factors were excluded from the price variable. The Center Moving Average (CMA) graph was used to analyze the rice prices in Medan, and seasonal factors and trends were removed. The CMA graph indicates that rice prices in Medan tend to stabilise after 2021. This suggests that the government's policies have been effective in stabilising rice prices.

Managing the balance between rice supply and consumption is crucial for maintaining price stability and ensuring food availability for the population (Harahap et al., 2024). The government has implemented various policies to mitigate food price volatility, including market interventions through BULOG, establishing the Highest Retail Price (HET) and Farmer Benchmark Price, food subsidy programs, and fertilizer subsidies for farmers. Additional policies include direct assistance for superior seeds and fertilizers and initiatives like the affordable food movement (Sujai, 2011). The Medan government has implemented various interventions to stabilize national rice prices while controlling inflation. In addition to distributing rice under the Food Supply and Price Stabilization (SPHP) program, which is sold at the Highest Retail Price (HET) of IDR 11,500 per kg, the government continues to provide rice food aid for low-income communities.

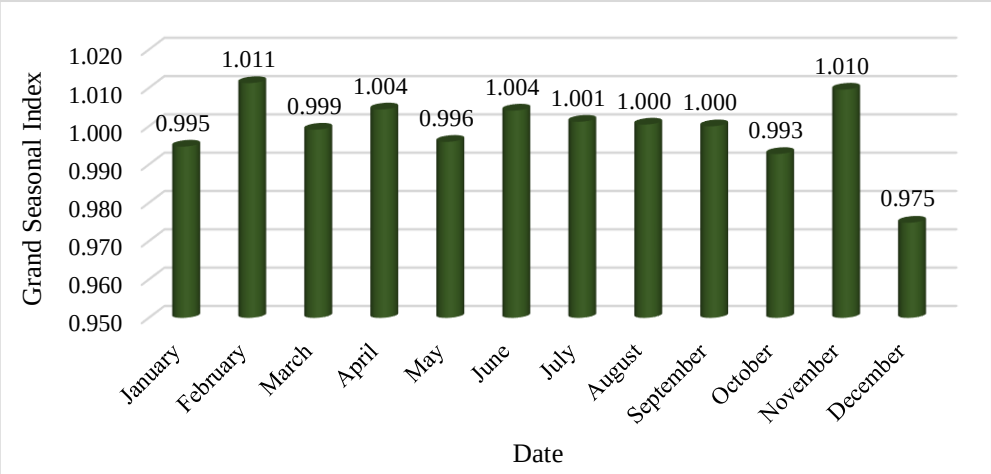

Figure 3. Grand seasonal index (GSI) for rice price in Medan

The Grand Seasonal Index (GSI) provides a comprehensive view of the seasonal price fluctuations of rice in Medan, offering valuable insights into the pricing patterns throughout the year. Based on the GSI, the price cycle analysis reveals that rice prices in Medan City experienced their peak in February, with a grand seasonal index value of 1.011, which suggests a relatively high price during this period. In contrast, the lowest rice prices occur in December, as indicated by a grand seasonal index value of 0.975, reflecting a seasonal dip in rice prices during the year's final month (see Figure 3). This information highlights the seasonal nature of rice price fluctuations in Medan, helping to identify critical periods when price adjustments are most likely to occur.

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The GSI values also show that the price variations between months are relatively minimal, with the price fluctuations not exceeding 2.5% compared to the average price for the year. This relatively small percentage change indicates that rice prices in Medan remain stable overall, and there are no extreme or volatile price movements between months. Such stability is important for both consumers and producers, as it helps ensure predictability in the market and reduces the risks associated with sudden price shocks.

Based on these insights from the GSI, policymakers can take proactive measures to maintain price stability in Medan. For instance, during February and November, when rice prices are more likely to experience upward pressure, the government could increase rice supply across various markets in Medan City. By doing so, the government can prevent significant price hikes and ensure that consumers continue to have access to affordable rice, especially in periods of heightened demand or supply constraints.

On the other hand, when rice prices are typically at their lowest in December, the government should closely monitor and regulate the supply of rice in the markets to prevent a sharp decline in prices. Excessive rice supply during this period could lead to a drastic reduction in prices, which may negatively affect the incomes of local rice producers and destabilize the market. By carefully managing the rice supply during these critical periods, the government can maintain a balance that supports consumers and producers, ensuring that rice prices remain stable and equitable for all stakeholders in Medan City. This strategic intervention based on the GSI analysis can contribute to long-term food price stability, which is crucial for the overall economic well-being of the region.

Volatility Analysis

Volatility analysis measures the standard deviation or coefficient of variation of rice prices that fluctuate over time. The corrected standard deviation value and correlation coefficient are used as projections of food price volatility. The value of food volatility before and after the pandemic can be seen in the following table.

Table 1. Estimated rice price volatility in Medan

Period	Standard Deviation (SDD)	Corrected Coefficient of Variation (CCV)
Before Pandemic	0.021	0.033
After Pandemic	0.003	0.012

The SSD value of rice before the pandemic (0.021) was greater than after the pandemic (0.003), and the CCV value before the pandemic (0.033) also shows a higher value than the period after the pandemic (0.012). This indicates that rice prices before the pandemic were more volatile than the post-pandemic period. During the pandemic, the Indonesian government took significant steps to stabilize rice prices by importing rice to ensure an adequate stock supply. This policy helped stabilize prices, as the sufficient rice supply prevented sharp price increases.

In addition, the Indonesian government actively coordinated with provincial and city governments to implement effective price stabilization strategies. One of the primary strategies involved maintaining a strong and efficient supply chain distribution across provinces and cities. The Medan city government worked closely with other cities and provinces with surplus rice production to ensure a steady supply to meet the demand. This collaboration played a crucial role in

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stabilizing rice prices in Medan during the pandemic.

Furthermore, the Indonesian government provided subsidies to keep rice prices stable. These subsidies helped to maintain a steady supply of rice, even during times of uncertainty, such as during the pandemic. The government also supported domestic rice production by providing farmers with fertilizer subsidies and other agricultural inputs, including machinery. These initiatives encouraged local rice production and helped ensure a reliable and sufficient supply of rice, contributing to price stability in the country.

Despite maintaining strong domestic production, the Indonesian government also introduced regulations to limit rice exports. This strategy helped to protect the domestic rice market by preventing the outflow of rice to other countries, which could have caused supply shortages and price hikes. The government of North Sumatra Province adopted a similar strategy, ensuring that Medan City had an adequate rice supply throughout the pandemic. By controlling the flow of rice into and out of the country, the North Sumatra government successfully prevented potential supply shortages that could have driven up prices, especially in large cities like Medan.

The North Sumatra Provincial government established the Regional Inflation Control Team (TPID) to further strengthen its efforts in stabilising prices. The TPID is a coordinated team comprising various government institutions and agencies, including Bank Indonesia, the Provincial Government of North Sumatra, and other relevant stakeholders. The team worked together to monitor and control inflation at the provincial level, focusing on ensuring the stability of food prices, particularly rice. The TPID successfully implemented measures that stabilized basic commodity prices during the pandemic through strategic collaboration between provincial and city governments. The comprehensive approach of the TPID helped to maintain stability in the rice market, benefiting consumers and farmers alike.

Table 2. Correlation coefficient matrix of rice and other food price in Medan

Periode	Shallot	Onion	Chili	Beef	Chicken	Egg
Pre-Pandemic	0.057	0.300	0.367	0.274	0.120	0.104
Post-Pandemic	-0.036	0.624	0.624	0.464	0.053	0.836

The correlation analysis between foodstuffs was conducted by dividing the observation period into two distinct phases: pre-pandemic and post-pandemic. In general, before the pandemic, the correlation between the prices of various food items was relatively low, indicating that the prices of different food commodities were not strongly linked to each other. However, in the period following the pandemic, the correlation between the price of rice and other foodstuffs in Medan City became more noticeable and significant, as evidenced by the data presented in Table 2.

The results of the correlation analysis indicate that, before the pandemic, there was no substantial or consistent relationship between the price of rice and the prices of other food commodities. In this pre-pandemic period, price movements in rice appeared to be relatively independent of the prices of other staple foods. However, the situation changed significantly in the post-pandemic period. During this latter period, a stronger correlation between rice and other food items was observed, suggesting that the price fluctuations of rice were more closely related to the price movements of other key foodstuffs.

The highest correlation value found in the pre-pandemic period was with red chili, which had a correlation coefficient of 0.367.

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This indicates a moderate positive relationship between the price of rice and red chili, meaning that when rice prices rose, the prices of red chili also tended to increase, and vice versa. Moreover, the correlation between rice and other food items was even more pronounced, with particularly strong correlations observed with eggs (0.836), red chili (0.624), and onion (0.624). These strong correlations suggest that in the post-pandemic period, rice prices were increasingly tied to the prices of other essential foods.

The high correlation values, especially with eggs, indicate that consumers may see these commodities as substitutes or complementary goods to rice, making them more sensitive to each other's price movements. The correlation with red chili and onion further suggests that the overall dynamics of the food market in Medan City became more interconnected during the pandemic period, possibly due to shifts in consumer behavior, supply chain disruptions, and other macroeconomic factors. These findings provide important insights into how the prices of different food items, including rice, began to exhibit greater interdependence in the post-pandemic period, which could have implications for policymakers and market regulators aiming to stabilize food prices.

The volatility of rice prices in Medan is measured using the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model, which effectively addresses the issue of heteroscedasticity in the data. The variance measurement from the GARCH model indicates that rice prices are generally stable throughout the year, with certain periods showing more fluctuations than others. Specifically, there is a noticeable increase in price volatility from October to February. This trend suggests that rice prices tend to be more unpredictable and subject to larger swings during these months, possibly due to various seasonal, economic, and environmental factors. As a result, the Medan government should be particularly focused on managing the balance between rice supply and demand during this period to avoid significant price hikes or shortages.

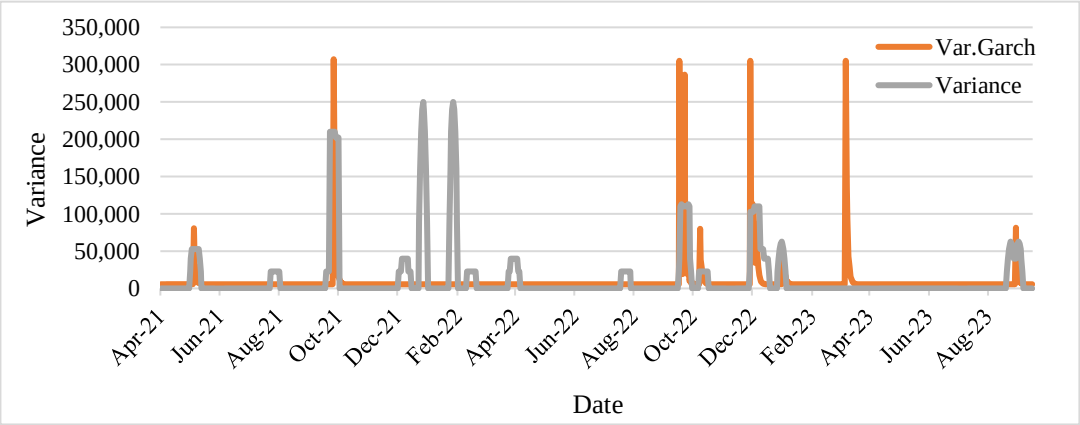

Figure 4. Variance Estimation using Garch Model

In contrast, from March to September, the volatility of rice prices is relatively low, indicating a more predictable and stable market. This lower volatility suggests that the rice market in Medan is less susceptible to sudden fluctuations during these months, and the government may not need to implement drastic measures to stabilize prices. However, while the overall volatility is low during this period, the government should still monitor the market to ensure that any unexpected changes in demand or supply are promptly addressed to maintain price stability.

The higher volatility observed between October and February is likely influenced by several factors contributing to the fluctuations in rice prices during this time. One of the key drivers is the long holiday

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period between December and January, which often leads to increased demand for rice as households prepare for festive celebrations and gatherings. This surge in demand and a potential slowdown in supply during the holiday season can place upward pressure on prices. Additionally, the rainy season, which typically lasts from October to March, can negatively impact rice production by affecting crop yields, transportation, and distribution channels. Adverse weather conditions, such as heavy rainfall and flooding, can reduce the availability of rice in the market (Lindawati et al., 2024), leading to price spikes due to supply shortages.

Given these factors, the Medan government should focus on strengthening supply chain management and ensuring sufficient rice stocks are available to meet the heightened demand during the holiday season. They should also work closely with farmers to mitigate the impact of adverse weather on production and distribution. This can involve supporting irrigation systems, improving infrastructure for storage and transportation, and offering incentives to encourage increased domestic rice production in anticipation of the volatile period. Furthermore, the government could consider implementing strategic rice reserves and trade policies that allow for timely imports or exports of rice to stabilize the market when local supply is insufficient.

CONCLUSION

One of the primary challenges government policies face concerning agricultural commodities is maintaining food price stability. This is crucial, as instability in food prices can have significant economic, political, and social repercussions. This study provides an in-depth daily analysis of rice price fluctuations, offering a clearer understanding of rice price volatility in Medan. This research examines the changing trends in rice prices and their associated fluctuations through seasonality and volatility analysis. Based on the Grand Seasonal Index (GSI), it is revealed that rice prices in Medan peak in February, with a grand seasonal index value of 1.011, indicating higher prices during this period. In contrast, the lowest rice prices occur in December, with a grand seasonal index value of 0.975, reflecting a seasonal dip in prices at the end of the year. The Standard Deviation (SSD) value of rice prices before the pandemic (0.021) was higher than after the pandemic (0.003), and the Corrected Coefficient of Variation (CCV) value before the pandemic (0.033) was also greater than the post-pandemic period (0.012). This indicates that rice prices were more volatile before the pandemic than after it. During the pre-pandemic period, the correlation between the prices of various food items was relatively low, meaning that the prices of different commodities were not strongly linked. However, in the post-pandemic period, the correlation between rice prices and other food items in Medan became more significant, suggesting that the prices of rice were more closely tied to those of other essential foodstuffs. Although rice price volatility in Medan is generally low throughout most of the year, the government should focus particular attention on the months between October and February, when volatility tends to be higher due to factors such as seasonal demand spikes and external influences like weather conditions. By proactively managing supply and demand, ensuring adequate rice stocks, and supporting local rice production, the Medan government can more effectively navigate periods of heightened volatility and ensure that rice prices remain stable and affordable for all consumers.

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