

## Environmental challenges due to COVID-19: Implications of altered distribution patterns and rice price dynamics in surplus and deficit areas of Indonesia

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### ABSTRACT

The effects of Covid-19 have disrupted staple food (rice) security, due to shifting distribution patterns, margins, and price dynamics. This study presents the effects of COVID-19 on rice distribution patterns and Margin of Trade and Freight (MTF); dynamics of rice prices in surplus and deficit areas in Indonesia. Using time series data on weekly rice prices, from January 2018 to December 2021, the National PIHPS source to answer the research objectives. Rice prices include prices at the traditional market level and at wholesale before and during COVID-19. Using descriptive analysis, MTF, CV and convergence test to answer the study objectives. The results of the study found that the general pattern of rice trade distribution experienced changes in the distribution chain and differed between surplus and deficit provinces. The dynamics of rice price fluctuations are weak and differ between surplus and deficit provinces at each market level. The government's policy of ceiling price and floor price has helped stabilize rice prices. However, the government needs to build an early warning system related to the food security system. It is necessary to provide a real time food data presentation system to reduce panic.

**Keywords:** Distribution pattern, Margin of Trade and Freight, Rice price, Indonesia

**Article type:** Research Article.

### INTRODUCTION

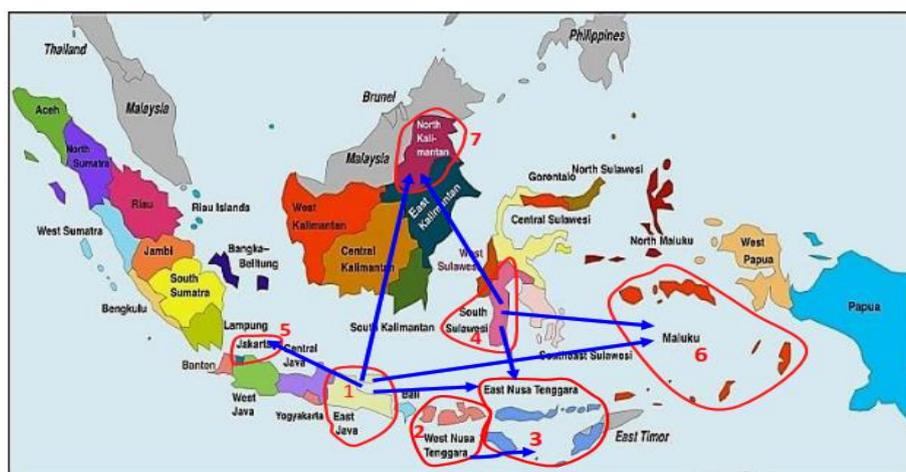
The COVID-19 pandemic has triggered profound changes across various sectors of life, ranging from healthcare to the environment. In this context, the attention to the pandemic's impact on rice distribution and price dynamics in surplus and deficit regions of Indonesia reveals a complex interplay between socio-economic dynamics and the natural environment. First and foremost, shifts in consumer demand patterns and mobility restrictions brought about by the pandemic have directly affected rice distribution across Indonesia. This has significant implications for transportation and logistics, which, in turn, can impact carbon emissions and contribute to climate change. Secondly, changes in agricultural production patterns and land use have also emerged as responses to pandemic challenges. The shifting focus of agricultural production and related activities may have long-term implications for agricultural sustainability and its impact on sensitive ecosystems. Furthermore, in the context of unstable rice

supplies, deficit regions may be compelled to take swift actions to meet food needs. However, these actions might not always carefully consider environmental aspects, potentially leading to further vulnerability and ecosystem degradation. The pandemic's effects also provide an opportunity to reflect on food consumption patterns and their environmental impacts. Changes in consumer behaviour and potential food wastage can have consequences for resource use, such as water and land. The main food consumed by the Indonesian population, rice, is seen as a strategic item that helps with both food security and inflation. According to the results of the 2020 population census, the average Indonesian consumes 87.87 percent of all carbohydrates through rice, according to BPS RI (2021). As a result, the Indonesian government is continuously concerned about the security of its supply of rice. Indonesia's average household rice consumption and production are in excess by 49.83 percent, according to statistics from the 2020 Population Census (Table 1). However, there are many areas in Indonesia where there are surplus production areas compared to areas where there are deficit areas, which results in uneven access and rice sufficiency. Of Indonesia's 34 provinces, 17 have a rice deficit, of which 9 have a deficit of more than 50%. For instance, DKI Jakarta has a deficit of 99.61%, North Kalimantan has a deficit of 60%, and Maluku has a deficit of 55.05%. The province of East Nusa Tenggara (ENT), with a shortfall of 24.45%, is another one with a rice deficit that is less than 50%. Through the help of suppliers, rice is imported from provinces with a surplus to close the gap. Indonesia must import due to the impact of the season on stock and price stability. However, the disparity in rice production and consumption potential between areas results in a surplus and deficit in provincial trade. Since Indonesia is an island country with maritime connections, the distances between regions and the state of the commerce infrastructure between them vary. There are over 17,504 islands in Indonesia, and 2,342 of them are inhabited. As a result, different patterns of rice trade distribution throughout areas have developed, involving numerous trade chains and numerous corporate actors as intermediates. The capacity for production, consumption, trade infrastructure, transportation systems, governmental policies, war, and disease outbreaks like pandemics all have an impact on the distribution pattern that develops in a given location. Up until this point, no country has explicitly declared that the COVID-19 epidemic, which struck Indonesia and the rest of the world in early 2020, is gone. It was challenging for business players to play a part as a result of changes in the supply chain and the pattern of distribution of goods at the start of COVID-19 entering Indonesia. Business actors' revenues also reduced and some even declared bankruptcy. The social limitation policy has increased logistics expenses and made it more difficult to deliver rice from the point of production (South Sulawesi) to the Kalimantan region (Timorria 2021). alterations in distribution patterns that have an impact on each trading chain's MTF. As a result, the determination of rice's price will change quickly in response to changes in the economic and trade environment. Price volatility was wild and challenging to predict, especially in the early stages of the COVID-19 epidemic, because to the fluctuating food price movements (Hobbs 2020; Ellison *et al.* 2021; Adewopo *et al.* 2021; Hillen 2021; Sulandjari *et al.* 2022; Kormishkina *et al.* 2022; Heryadi *et al.* 2023). The lockdown measures adopted by numerous nations hindered export and import activities. Food supply networks between regions have been affected as a result of Indonesia's implementation of the Large-Scale Social Distancing (LSSD) and Enforcement of Restrictions on Community Activities (ERCA) policies to combat the COVID-19 outbreak. The closure of hotels and restaurants also had a significant negative impact on public consumption. According to BPS RI 2020 data, food consumption decreased by 0.71% (y-o-y) in the second quarter of 2020 from 5.1 percent in the first. Strategic food commodity prices in Indonesia are erratic as a result of this situation. Indonesia, an island nation, has a restricted transportation infrastructure between regions, which is the main reason for price changes in the production and consumption areas, particularly for goods that still rely on imports. Additionally, production risks brought on by extreme weather, plant pests, and the execution of government initiatives like LSSD and ERCA all contribute to variations in food costs. While high price dynamics will have an effect on inflation and other economic issues, the relatively modest price dynamics of staple foods are still relatively straightforward to control. The findings of the study by Sitorus & Ayu (2020) revealed that inflation in Padang City, West Sumatra Province, Indonesia, was influenced by changes in the price of several types of food. The global crisis resulted in a substantial increase in rice prices, according to research by Jusar *et al.* (2017) and Gulati & Dutta (2010). According to de Paulo Farias and de Araujo's (2020) research in the Brazilian region, the effects of COVID-19 have an impact on how food is distributed to different locations, resulting in price variations that depend on the location and the timing of trade transactions. One of Southeast Asia's top rice exporters, Vietnam, is considering restricting rice exports (Pascua, 2020), which could affect rice supplies in importers like Indonesia. According to Saliem *et al.* (2020), food commodity prices at the farm level declined largely during the COVID-19 epidemic,

with the exception of shallots, where prices increased due to a shortage. Nhlengethwa *et al.* (2020) analyzed the price trends for corn and grains in Zambia's food surplus and deficit regions. The analysis discovered that the surplus area experienced significant negative price swings, and that the period immediately following the pandemic saw the highest levels of price volatility. Similar results were found by de Paulo Farias, de Araujo (2020). Espitia *et al.* (2020) regarding the protective effect due to COVID-19 against price changes; Saliem *et al.* (2020) on the effects of COVID-19 on the dynamics of food demand; Rahmanta *et al.* (2020) regarding the effect of fluctuations in food prices on inflation in the province of North Sumatra, Indonesia; and Karim *et al.* (2014) on rice fluctuations in Bangladesh. According to the study of Sarker and Fagun published in 2021, the lockdown in Bangladesh's Dhaka City caused food prices to fluctuate differently from one location to the next. Because of the disruption to the distribution system, the effects on COVID-19, the price gap between high locations, and the pattern of price swings are unpredictable (Byrne *et al.* 2021; Elleby *et al.* 2020; Merow & Urban 2020; Surni *et al.* 2020; Li & Zhang 2021; Norouzi *et al.* 2021; Umar *et al.* 2021; Romano *et al.* 2021). As the COVID-19 pandemic began, pressure from the supply and demand sides caused global food prices to start moving dynamically (FAO 2020a; Hobbs 2020; Wang *et al.* 2020; Hobbs 2021; Lugo-Morin 2021; Boyac-Gündüz *et al.* 2021; Reardon *et al.* 2021; Ali *et al.* 2022). COVID has had both immediate and long-term effects, particularly in developing nations where there are significant food shortages and levels of extreme poverty. Due to their limited purchasing power, Nasereldin *et al.* (2020). Some of these studies give hints that in order to make the best decisions, it is necessary to observe and learn about the dynamics of food price movements in various contexts and across various time periods. Particularly for Indonesia's political and business leaders, this information is desperately needed. Due to Indonesia's geography as an archipelago nation, restrictions on marketing infrastructure, cross-country transit, and interregional/provincial trade have increased regional pricing discrepancies. The portion of this study that is being observed changes in the pattern of rice distribution and the degree of MTF among provinces in the rice surplus and deficit areas. In order to reduce price volatility, pressure is put on the supply and demand sides in this study to investigate and measure the dynamics of price movements immediately. Prices at the conventional market level and wholesale prices in seven Indonesian provinces are the dynamics of rice price changes that have been documented. Each province has different production, consumption, and economic infrastructure potentials and issues, therefore this study can result in significant results and measures to mitigate the effects of these changes.

## MATERIALS AND METHODS

This study utilizes weekly rice price time series data from the first week of January 2018 through the fourth week of December 2021. National Strategic Food Prices Information Centre provides the data (SFPIC). The study region consists of seven provinces, which represent the highest rice surplus and deficit areas in Indonesia (exceeding 50% surplus and 50% deficit). The seven sample provinces can illustrate the features of rice surplus and deficit regions in Indonesia, as well as economic and trade infrastructure conditions. Figure 1 is a map of the study area and the rice distribution throughout Indonesian regions.



**Fig. 1 .** Surplus and deficit areas, rice distribution and trade patterns in Indonesia (BPS RI, 2021, processed); Notes: No. 1, 2 and 4 rice surplus province; No. 3 deficit < 50%; and No. 5, 6 and 7 deficit > 50%.

The pattern of food distribution that is formed can affect the trade margin of each business actor. Margin of Trading and Freight (MTF) is the difference between the sales and purchases of each business actor involved (BPS RI, 2021). MTF formula:

$$MTF_T = \left( \prod_{i=1}^n (1 + MTF_i\%) - 1 \right) 100\% \quad \dots\dots\dots \text{(BPS RI 2021)}$$

where  $MTF_T$  is Total margin of trading and freight;  $MTF_i$  is the difference between the sales value and the purchase value to- $i$ ;  $i$  are business actors involved in food commodity trading;  $n$  is the number of business actors involved in a distribution pattern.  $MTF_T$  explains the ratio of the increase in rice prices at the final consumer level to prices at the producer level. The dynamics of food price movements is carried out by analysing graphical trends followed by measuring fluctuations in rice prices at each market level (traditional and wholesale markets) in the seven provinces. Measure price fluctuations using coefficient of variation (CV) analysis. CV formula:

$$CV = \left( \frac{\rho}{\bar{u}} \right) \cdot 100\%$$

Before calculating the  $cv$ , the standard deviation ( $\rho$ ) is calculated, using the formula:

$$\rho^2 = \frac{\sum_{i=1}^n (\chi_i - \bar{u})^2}{\eta} \quad \rho = \sqrt{\frac{\sum_{i=1}^n (\chi_i - \bar{u})^2}{\eta}}$$

where,  $\rho$  is the standard of deviation;  $\chi_i$  is the rice prices data to- $i$ ;  $\bar{u}$  is the average price and  $\eta$  is the amount of rice price data. The Indonesian Ministry of Trade uses standard  $cv$  values ranging from 5-9% categorized as low to moderate price fluctuations,  $cv \gg 9\%$  is categorized as high fluctuations (Roy *et al.* 2019, 2020).

## RESULTS AND DISCUSSION

### Rice price distribution pattern in surplus and deficit areas in seven provinces

The availability of food between the unequal regions when the COVID-19 pandemic hit Indonesia and the world. Areas with a food surplus have difficulty distributing it to deficit areas in need. These disturbances make it difficult for consumers to obtain an even supply of food, on the other hand, demand declines when there is a policy of restricting the movement away people and goods. Companies, factories and marketing agencies are limited in their operating hours, so that economic activity declines. In general, during the early period of COVID-19, Indonesia experienced strong disruptions in the distribution pattern of food trade, especially rice. Fig. 2 shows the change in the main pattern of general rice distribution of Indonesia during the COVID-19 pandemic, from previously 4 chains with 3 business actors to 3 chains with 2 business actors. The missing wholesaler plays a role in the distribution of rice in Indonesia. Margin of trading and freight (MTF) also fell 0.87% entering the pandemic. This means that the price of rice from producers to final consumers decreased by 0.87%. Although MTF decreased, the MTF figure of 20.83% (Fig. 2) included a high disparity in the MTF ratio. The MTF figure are considered moderate when the MTF is in the 15-17% range. Entering the COVID-19 pandemic, it was found that there were two deficit provinces where the number of trade chains had decreased, namely DKI Jakarta and North Kalimantan, while WNT added one chain of business actors. This proves that changes in the main pattern of distribution are not only influenced by surplus or deficit but also by other economic factors, Nhlengethwa *et al.* (2020), In their respective regions. The Indonesian government implements the *LSSD* policy and the Enforcement of Restrictions on Community Activities ERCA according to the level of spread of COVID-19 in each region, for example ERCA from low level 1 to high 4. At the beginning of COVID-19 there was panic, many countries were not ready to face it, so there was pressure on food demand due to panic buying because consumers were afraid of food shortages Hobbs (2020), during restrictions on activities outside the home. because consumers make price spikes, especially staple foods. This affects the flow structure of staple food products. In terms of profit margins for marketing institutions, the percentage of MTF shows an extreme negative change in both surplus and deficit areas, in 6 provinces. Except for the province of WNT, the percentage of MTF increased by 11.13%, (as explained in Fig. 3). The decline in the percentage of MTF was the highest in DKI Jakarta (-17.66%), East Java (-14.93%) and ENT (-11.66%) while the other 3 provinces fell by 3-6%. The decline in MTF in 6 provinces was greater than the average decline in MTF nationally. The decline in MTF seems to indicate an improvement in the trading system because the difference between price increases to the level of final consumers and producers is getting smaller. However, this decrease is very weak to conclude that the rice distribution system is getting more efficient.

The complex effects of the COVID-19 pandemic make it difficult to draw valid conclusions. The PSBB and PPKM policies have closed many business activities, companies are not operating, people's incomes have decreased so that purchasing power has decreased as a result of stockpiling and prices falling, even though at the beginning of COVID the prices had increased due to panic buying, his explanation corroborates the findings of Mussell *et al.* (2020), Hobbs (2020), Arafat *et al.* (2021), Chua *et al.* (2021), Hall *et al.* (2021), Islam *et al.* (2021); Loxton *et al.* (2021) and O'Connell *et al.* (2021).

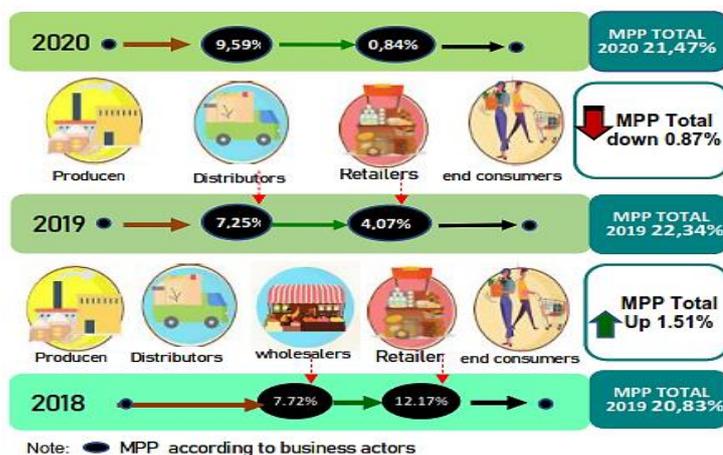


Fig. 2. Main patterns of rice trade distribution in Indonesia in 2018 and 2020 (BPS RI, 2021, processed).

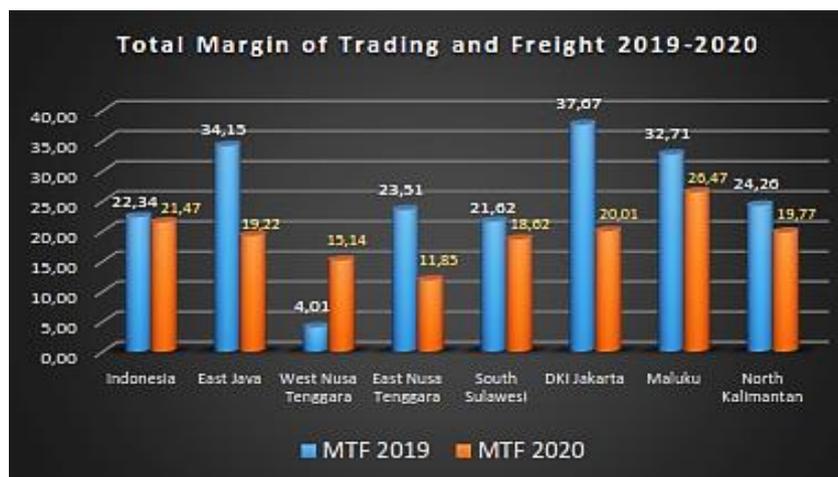


Fig. 3. Percentage change in rice MTF in 7 provinces and in Indonesia, years before covid (2019) and during covid (2020) (BPS RI, 2021, processed data).

East Java rice production apart from being consumed within the province, the surplus is sold outside the province, including to ENT. An example of a general pattern of rice distribution of East Java in 2021 as a surplus area, starting from producers/mills to final consumers, involves 7 middlemen, namely collectors, distributors, sub-distributors, agents, wholesalers, supermarkets and retailers before reaching the final consumers with almost a portion evenly (Fig. 4). The results of a survey conducted by BPS RI 2021 found that the rice distributor chain in ENT province as a deficit area, involves several intermediary traders, ranging from collectors, distributor, wholesaler, agent, supermarket, retailers and to final consumers (Fig. 5). Most of the rice production (51.81%) is channelled from producers to retailers. The formation of a rice distribution pattern of ENT because most of ENT's rice needs is supplied from with / to the ENT province. BPS RI data, (2021), not that the supply of rice to ENT came from surplus areas, namely East Java 64.92%, WNT 34.28% and 0.8% from South Sulawesi (Fig. 5). The dynamics of rice prices before and during COVID-19 in several provinces in Indonesia. Price uncertainty that often occurs to agricultural commodities is due to inelastic demand and supply (Nerlove 1956; Piot-Lepetit *et al.*

2011; Sukirno 2015; Beckman & Countryman 2021; Goodrich *et al.* 2021; Rajpu *et al.* 2021; Paraschivu & Cotuna 2021). Figs. 6 and 7 show that the dynamic trend of wholesale rice prices is more volatile than in the traditional market, especially before the COVID-19 pandemic, in both surplus and deficit areas. During a pandemic, prices are relatively flat. Judging from the trend in the position of the price chart in Figs. 6 and 7, the highest rice prices occurred in Maluku, North Kalimantan and DKI Jakarta and the pattern was the same in both markets, both before and during the COVID-19 pandemic. The lowest prices occurred in WNT and South Sulawesi in the traditional and wholesale markets.

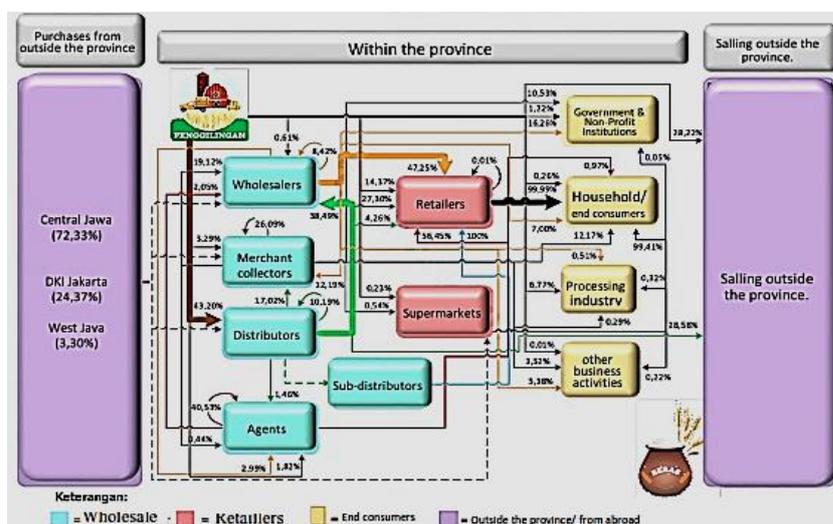


Fig. 4. Rice trade distribution pattern in East Java (BPS RI 2021; processed data).

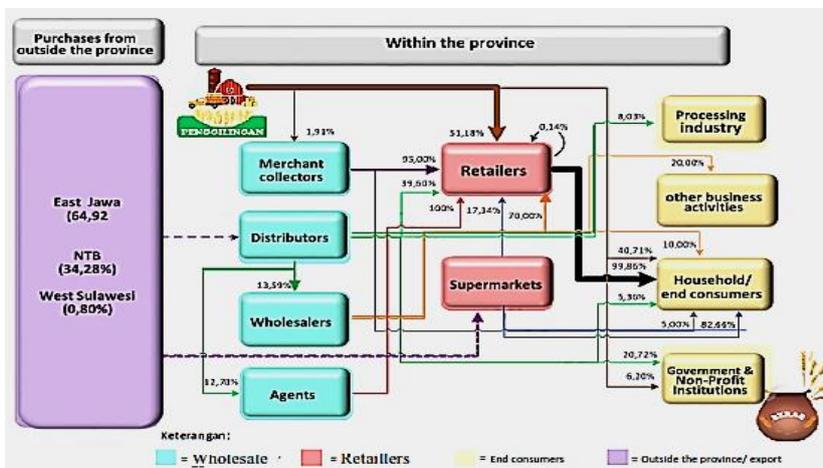
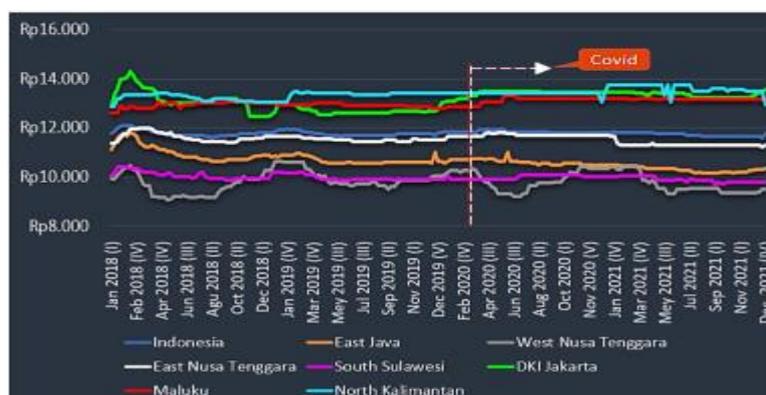


Fig. 5. Distribution pattern of rice trade in NTT (BPS RI 2021; processed data).

**The dynamics of rice prices before and during COVID-19 in several provinces in Indonesia.**

Price uncertainty that often occurs to agricultural commodities is due to inelastic demand and supply (Sukirno 2021). Figs. 6 and 7 show that the dynamic trend of wholesale rice prices is more volatile than in the traditional market, especially before the COVID-19 pandemic, in both surplus and deficit areas. During a pandemic, prices are relatively flat. Judging from the trend in the position of the price chart in Figs. 6 and 7, the highest rice prices occurred in Maluku, North Kalimantan and DKI Jakarta and the pattern was the same in both markets, both before and during the COVID-19 pandemic. The lowest prices occurred in WNT and South Sulawesi in the traditional and wholesale markets. In terms of price variations in the traditional market, during the pandemic (January 2020 - December 2021), price fluctuations moved up in the ENT provinces, Maluku and North Kalimantan. Compared to the other four provinces, price fluctuations fell in DKI Jakarta, East Java, WNT and South Sulawesi, which were shown by CV Figs., as shown in table 1 and figure 8). Of the 7 provinces the highest price fluctuations

occurred in the WNT province (CV 4.43% before the pandemic and 4.12% during the pandemic), and the lowest in Maluku CV 0.73% before the pandemic and 0.19% during the pandemic.



**Fig. 6.** Rice prices dynamics in traditional markets in several provinces in Indonesia (before and during the Covid-19 pandemic).

Compared to the wholesale price level, the rate of price fluctuations in the pandemic moves in reverse, namely price fluctuations increased to the provinces of DKI Jakarta and South Sulawesi. Meanwhile, in the other four provinces, the fluctuating rate decreased (East Java, WNT, Maluku and North Kalimantan, (Table 1 and Figure 8.). Of the 7 provinces, price fluctuations in wholesalers before the COVID-19 pandemic, the highest occurred in WNT province (CV 4.14%) and the lowest was ENT (CV 1.36%), while during the COVID-19 pandemic, the highest price fluctuations occurred in DKI Jakarta (CV 5.43%) and the lowest was in Maluku, CV 0.58%

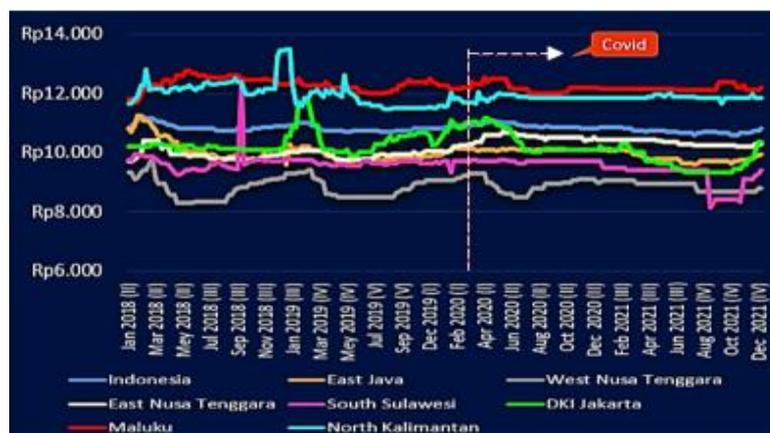
**Table 1.** Coefficient of variation in rice prices in traditional markets and in wholesalers, before 2018-2019 and during 2020-2021 COVID-19 pandemic.

Province	CV traditional market (%)		CV wholesalers (%)	
	2018-019	2019-2020	2018-2019	2020-2021
East Java	2.85	1.82	3.73	1.81
West Nusa Tenggara	4.43	4.12	4.14	2.22
East Nusa Tenggara	1.31	1.74	1.58	1.36
South Sulawesi	1.49	1.14	3.10	4.29
DKI Jakarta	3.19	0.89	3.57	5.43
Maluku	0.73	0.91	1.78	1.06
North Kalimantan	1.08	1.23	3.72	0.58
Indonesia	0.92	0.69	1.09	1.11

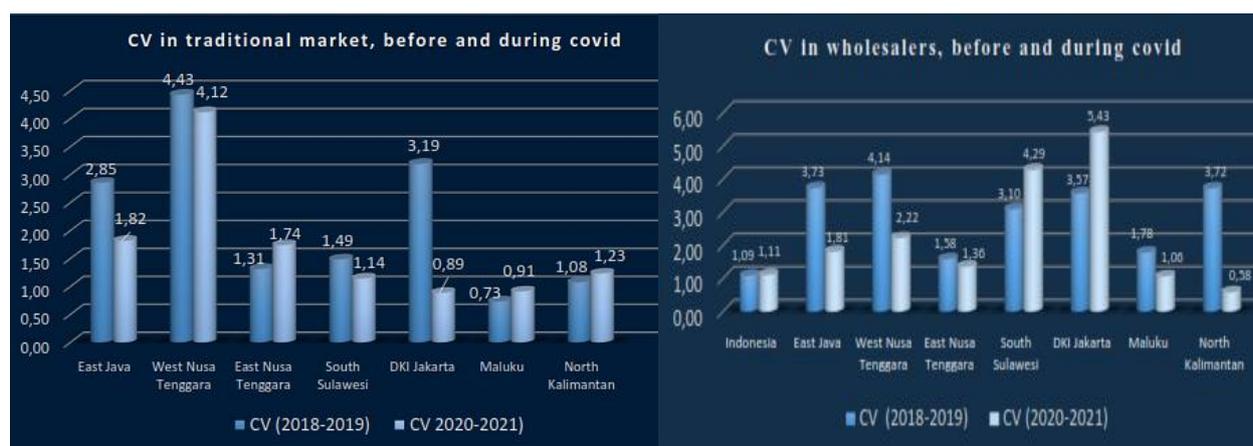
Sumber: Dianalisis data SFPIC (2018-2021).

The trend of rice price dynamics in traditional markets in 4 provinces is relatively low. The dynamics of price movements towards / away WNT province are wider than the other 6 provinces. Rice prices in ENT Province appear to be higher than the other three provinces, but ENT and South Sulawesi are more stable than WNT and East Java. The price dynamics is explained by the rate fluctuations in ENT, East Java, NT and South Sulawesi, namely 1.88%, 2.88%, 4.88% and 1.58% (Table 1). Study findings of Roy *et al.* (2020); Charles *et al.* (2020) and Olviana *et al.* (2020) provided support that the rice commodity has a low level of price fluctuation and high fluctuation in the commodities of onion, garlic, red chili. Entering COVID-19 early 2020, the trend of rice prices was relatively stable. This is because the stock of rice in the market is relatively sufficient and accompanied by a decrease in demand after being hit at the beginning of COVID. Although distribution channels were disrupted by the enactment of the PSBB and ERCA policies, they returned to stability after several seasons. Price fluctuations in traditional markets are smaller during the COVID-19 pandemic compared to before COVID-19. Rice prices at the wholesale level in several provinces show different dynamics compared to other strategic foods, because rice prices are always controlled through government policies. So they are kept stable. If there is a trend of rising

prices approaching the ceiling price or decreasing towards the floor price, the government will immediately intervene in the market through market operations. If there is a shortage of domestic supply or stock, imports are carried out to maintain the balance of supply and demand. The fluctuations in rice price before and during the pandemic in the seven provinces were low, both in surplus and deficit areas. Low rice prices / priced fluctuations as shown by the CV figure of less than 5%, In both deficit and surplus areas (explained in Table 1 and Fig. 8).



**Fig. 7.** Rice prices dynamics in wholesalers in several provinces in Indonesia (before and during the Covid-19 pandemic).



**Fig. 8.** Coefficient of variation in rice prices in traditional markets and in wholesalers, before 2018-2019 and during 2020-2021 Covid-19 pandemic.

The high fluctuations are caused not just by seasonal issues, unusual events such as the COVID-19 epidemic, and disruptions in supply distribution, but also by the absence of special stability strategies, such as in rice. According to the pricing dynamics described, the effects of COVID-19 will have no long-term impact on rice commodities. Following the annual price cycle, the dynamics that transpired only a moment before stabilized. This is consistent findings with John & Li (2021). The pandemic shocks affected not only domestic trade but also overseas commercial operations (Espitia *et al.* 2020), The COVID-19 pandemic cannot be predicted; even the variation of the COVID-19 virus has reached the second wave, which appears to be more hazardous than the first. Several countries have recently enacted policies to restrict economic and social activities. What if the food crisis lasts for a long time and price increases cause panic if the government is not prepared with diverse strategic measures that can anticipate the danger of loss in all sectors. Accurate food data and information support are critical in regularly updating the national food situation in terms of stock, quantity of demand, and supply. Monitoring and recording food distribution holistically and continually throughout the region to anticipate early if there are challenges in the logistics supply chain. Improving trade infrastructure to enable a fluid flow of transportation is required to ensure a steady food supply if necessary, particularly from surplus areas to deficit areas.

## CONCLUSION

The shift in the distribution pattern of the rice trade prior to the COVID-19 pandemic has disrupted distribution channels in both surplus and deficit areas, without leading to reasons of surplus or deficit, as well as the trend of rice price dynamics providing similar indications. Aspects of the readiness of trade infrastructure and the COVID situation in each different region make different policies for each region. Price fluctuations at the wholesale level are higher than traditional markets, especially before the COVID-19 pandemic. During COVID, dynamics and fluctuations occur at the beginning and then stabilize. The Indonesian government's policy of maintaining price stability with ceiling prices and floor prices has succeeded in maintaining the stability of rice prices compared to other staple food prices. The Indonesian government has implemented a flexible COVID-19 pandemic handling policy through *PSBB* and *PPKM* according to the level so that the share price is stable and facilitates excess rice. The government needs to educate the public through an early warning system if a similar disaster occurs so that the loyal components of the community are able to anticipate and avoid panic. The presentation of food availability data, access systems, price information and economic dynamics needs to be delivered in real time. Food assistance policies for vulnerable communities need to be prioritized.

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