COVID-19 PANDEMIC, REGIONAL STRUCTURAL BREAK AND THE VOLATILITY OF CHICKEN MEAT PRICES IN INDONESIA

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ABSTRACT

The Covid-19 pandemic has shocked the demand and supply of food product leading to large price fluctuations in the market not only at the national level but also at the regional level. This paper examines the existence of structural break and the volatility of chicken meat prices in six main islands in Indonesia by using additive outlier and ARCH-GARCH models. During the Covid-19 outbreak in Indonesia, the structural break in the chicken meat prices occurred in the six islands. There were variations in terms of the timing of the structural break where Kalimantan and Java island experienced the fastest structural break. Further examinations showed that after the structural break time, the prices of chicken meat in Sumatera, Java, Sulawesi and Papua tended to increase. Meanwhile, the prices of chicken meat in Kalimantan and Bali-NT tended to decline after the break time. The Covid-19 pandemic had a significant impact on chicken meat prices in Java and Bali-NT. The results have important implications for local and central governments that are still under the Covid-19 crisis on how to attain price stabilisation of regional chicken meat prices during the Covid-19 pandemic.

Key words: coefficient of variations, demand shock, price stabilization, supply shock, time break

INTRODUCTION

The Covid-19 pandemic exposed unprecedented shocks to demand and supply in all economic activities including in the food products (FAO 2020; Hobbs 2020; Hossain 2020). The demand shock is evident in many countries when many food businesses close their business putting downward impact on food demand. From the supply side, the production, transportation and distribution network are disrupted due to the restriction policies. The combinations of supply and demand shocks contribute to big food price fluctuations.

Food price fluctuations (both decreasing and increasing) will disrupt the livelihood of both consumers and producers (Workie et al. 2020). From consumer side, increasing food prices will limit their access to sufficient and good quality food particularly for poor people. From producer side, decreasing price will reduce farmers' commitment to produce in the next season (Sahara et al. 2015). While increasing output prices might provide spill over effect for farmers since the majority of farmers are consumers as well. Furthermore, big price fluctuations in food markets will threaten food security in many countries including in Indonesia (FAO 2020; Yu et al. 2020).

The first case of the pandemic was announced by the President of Indonesia on 2 March 2020[1], followed by the policy of large-scale social restrictions[2] to limit the spread of virus. Without offering much time for demand and supply to adjust, restriction policy and stay at home orders contributed to food price fluctuations. Indonesia experienced deflation as indicated by negative value of inflation component from volatile food, -0.38% in March, -0.09% in April and -0.5 in May 2020. But, in June 2020, the inflation rate of volatile food jumped to 0.77, then dropped in the period of July and September 2020 before increasing again in the period of October to November 2020 (Statistics Indonesia 2020b).

Ensuring price stability should be the main agenda for Government of Indonesia not only for stapple food (*e.g.,* rice), but also for animal protein sources (Sutawi et al. 2020) including chicken meat, the most popular protein source in Indonesia. Since the chicken meat price is more affordable compared to beef price, it is not surprising that until 2019 the weekly per capita consumption of chicken meat in Indonesia was higher compared to beef, 0.124 kg versus 0.009 kg, respectively (Statistics Indonesia 2020a). From the production side, about 67% of Indonesian meat production consisted of chicken meat (EIBN 2018).

The spread of Covid-19 will undoubtedly affect both the consumption and production of the chicken meat, leading to the changes in the price. Consumers of chicken meat in Indonesia are restaurant and catering sectors; and households. Since many restaurants, caterings and other food stalls are closing their business during the pandemic combined with the reduction of consumer income, the demand for chicken meat reduced significantly leading to price reduction in chicken meat market. On the supply side, the restrictio n policy during Covid-19 impact on reduction in poultry supply at farm level due to input price fluctuations during restriction particularly DOC (Day Old Chicken) and feed. Input price fluctuations might potentially increase the prices of chicken meat in the markets. The restriction policy will also impact on traders since their face difficulty to distribute chicken meat to consumers and inputs to producers which will in turn contribute to the chicken meat price fluctuation in the markets. However, whether the prices of chicken meat in market increases or decreases during the pandemic need to be examined. It is expected that the dynamic in chicken meat prices will still continue considering the spread of Covid-19 is still ongoing and tends to get worse.

The paper examines the dynamic behaviour of chicken meat prices in the main islands in Indonesia (Sumatera, Java, Bali-NT, Kalimantan, Sulawesi and Papua) by using longer time series data on daily prices, the structural change in the chicken meat prices occur s during Covid-19 pandemic, and the impact of Covid 19 pandemic on chicken meat price volatility. To the best of our knowledge, studies focusing on food price behaviours during the pandemic are still limited. This study also focuses on regional level since the price behaviour might vary across islands. The results from this paper will inform policy makers related to the dynamic of chicken meat prices in the six islands and can be used as a base for policy mitigation actions to focus on the islands likely to suffer the most of the price shocks during the pandemic.

METHODS

Secondary data on daily chicken meat prices at retail level in the six islands in Indonesia (Java, Sumatera, Bali-NT, Kalimantan, Sulawesi and Papua) were utilized in this study. The price data was compiled from Strategic Food Pricing Information Center, the official data sources of volatile food

[1] https://www.cnnindonesia.com/nasional/20200302111534-20-479660/jokowi-umumkan-dua-wni-positif-corona-di-indonesia

[2] https://nasional.kompas.com/read/2020/04/15/09375511/pemerintah-psbb-diberlakukan-di-daerah-pusat-penularan-covid-19?page=2

prices produced by Indonesian Central Bank (Bank Indonesia 2020). In order to test the structural break of the chicken meat before and during Covid-19 outbreak, this study used a longer time series data, i.e., daily retail prices for 494 days from 1 January 2019 to 31 December 2020. Data from 1 January 2019 to 2 March 2020 represented to the period before covid outbreak in Indonesia, while the period during covid 19 showed by the data from 3 March 2020 to 31 December 2020.

Descriptive statistic and Coefficient of Variations (CV) were performed in this study. CV was used to examine food price stability (Jati 2014) which the value was calculated by comparing between the standard deviation and the mean of the price. Higher value of CV indicated the fluctuations of chicken meat prices.

This study utilized an additive outlier model to analyze structural break in the time series data of the chicken meat prices in the six islands (Cariappa et al. 2020; Perron and Vogelsang 1992; Baum 2005), There were two steps implemented in this study. The first step was performing the first regression analysis for each island by following equation (1) below.

$$y_t = \mu + \beta . t + \gamma DT_t^* + \tilde{y}_t \ldots (1)$$

Where t was number of time series data (t=1,2..T, in this case T=494), DT_t^* was a dummy variable which the value was equal to one if $t > T_b$ (T_b is the break date) and $\tilde{y}_t$ represented the detrended chicken meat prices.

The next step was performing the second regression analysis by using $\tilde{y}_t$ as dependent variable with dummies and lagged differences as independent variables (equation 2).

$$\tilde{y}_t = \sum_{i=0}^{k} \delta_i D(TB)_{t-1} + \alpha \tilde{y}_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-1} + \varepsilon_t \ldots (2)$$

Where $D(TB)_t$ referred to dummy variable which the value is equal to one if $t=T_b+1$, and ε_t is the error term. The null hypothesis of unit root was rejected if the value of t statistic for α=1 was larger than the critical values as given in Perron and Vogelsang (1992), showing the evidence of structural break. The truncation lag parameter was represented by the value of k where the additive outlier model, the value of k was unknown and identified after a grid search for the least t-statistic of unit root hypothesis (α=1) and sequential F tests. This study used 'clemao1' procedure to conduct AO1 test. This procedure captured the sudden changes of chicken meat prices by using the two step procedures as well as testing hypothesises related to the existence of structural break.

In order to test whether the Covid pandemic outbreak had a significant influence on the prices of chicken meat, this research utilized the ARCH-GARCH model. The model had been widely used as a powerful model in the literature in analysing food price volatility since it could capture the heterogeneities in first and second order moment simultaneously (Wang et al. 2020; Yu et al. 2020). This study included daily new infection of Covid 19 as the proxy of pandemic impact in the model (Yu et al. 2020).

$$y_t = u_0 + uy_{t-1+} u_2 Infected + \varepsilon_t + \rho_1 \varepsilon_{t-1} \ldots (3)$$

The variable y_t referred to the daily chicken meat prices in the seven islands during Covid 19 pandemic (March-December 2020). The variable of 'Infected' represented the number of daily new confirmed infections officially reported by the Ministry of Health of Indonesia and ε_t is residual:

$$\varepsilon_t|\psi_t \sim N(0, \sigma_t^2) \ldots(4)$$

Where σ^2 is the variance and followed the equation:

$$\sigma^2 = \omega_0 + \omega_1 Infected + \alpha\sigma_{t-1}^2 + \beta\varepsilon_{t-1}^2 \ldots(5)$$

The parameters estimated were ρ_1, α, and β where α represents the coefficient for GARCH, while β represents ARCH. To capture the impact of Covid 19 pandemic in each island, this study included the variable of dummy interaction by multiplying dummy variable with the number of daily new infections in each island. To avoid dummy trap issues, the study utilized Papua Island as baseline, therefore, the model consists of five dummy interaction variables. The extended model of equation (5) is as follows:

$$\sigma^2 = \omega_0 + \omega_1 Infected + \alpha\sigma_{t-1}^2 + \beta\varepsilon_{t-1}^2 + \theta_1(D_s * Infected_s) + \theta_2(D_j * Infected_j) + \theta_3(D_b * Infected_b) + \theta_4(D_k * Infected_k) + \theta_5(D_w * Infected_w)$$

The variable of D_s, D_j, D_b,D_k, and D_w were dummy variables in the islands of Sumatera, Java, Bali-NT, Kalimantan, and Sulawesi, respectively. The dummy variables for each island were interacted with the number of daily new confirmed infections for the respective island.

RESULTS AND DISCUSSION

Regional price variations. In Indonesia, chicken meat is included as one of the volatile food commodities which contributes to the inflation rate. In order to stabilize the prices of staple food including chicken meat in Indonesia, the Ministry of Trade issued regulation No 07 Year 2020 stating that the maximum prices of chicken meat at consumer lever is Rp 35,000 per kg (Ministry of Trade 2020). In response to Covid-19 pandemic, the Indonesian Ministry of Agriculture through the Directorate General of Livestock and Animal Health issued a Circular Letter 09246T/SE/PK/230./F/08/2020 to stabilize chicken meat price at farm level[3] by controlling chicken meat production. In the circular letter, the supply control is conducted by implemented two strategies: (1) reducing the production of DOC and (2) promoting the utilization of cold storage to increase the shelf life of slaughtered chicken. By implementing these efforts, the prices of chicken meat at farm level is expected to increase and remain stable towards the market reference prices as set by the regulation No 07 Year 2020. The regulation and the circular letters, however, apply to all regions in Indonesia. In fact, the dynamics of chicken meat prices differ among regions in Indonesia.

Descriptive statistic of chicken meat prices in the six islands during the period of analysis (1 January 2019- 31 December 2020) is presented in Table 1. The price of chicken meat per kg in six islands ranged from Rp 29,392 to Rp 38,545 which Papua was the highest, followed by Bali-Nusa Tenggara (Bali-NT), Kalimantan, Java, Sumatera and Sulawesi.

The results from previous studies show food price differ across regions (Chen et al. 2020; Daryanto et al. 2020; Ghosh 2010). This study concludes similar results in which there are differences in chicken meat price among islands. It is expected that production and consumer demand are the

[3] https://ditjennak.pertanian.go.id/kementan-jaga-stabilisasi-harga-ayam-potong

main sources of the price variations of the chicken meat prices. Food prices in low production areas tend be more expensive compared to the high production areas (Kim and Mark 2017; Jati 2014).

Table 1. Descriptive statistic of chicken meat prices in the six islands, 1 January 2019- 31 December 2020

Island	Number of Observations	Mean	Std. Dev.	Min	Max	Coefficient Variation (CV)
Sumatera	494	32,545	2,811	26,040	39,670	8.64
Java	494	33,690	2,310	28,875	41,175	6.86
Bali-NT	494	37,859	3,602	30,817	53,450	9.51
Kalimantan	494	35,182	3,813	27,040	45,380	10.84
Sulawesi	494	29,392	2,334	24,092	35,992	7.94
Papua	494	38,545	1,726	36,000	46,125	4.48

Java is the main production zone of chicken meat in Indonesia, contributing 67.57% to national production in 2019 (2.4 million tonnes), followed by Sumatera Island (443 thousand tonnes or 12.66% of national production), Kalimantan Island (237 thousand tonnes or 6.8% of national production), Bali-NT (139 thousand tonnes or 3.99% of national production), Sulawesi (109 thousand tonnes or 3.14% of national production) and Papua (7.9 thousand tonnes or 0.23% of national production) (Statistics Indonesia 2020c) .

From the production data above, Papua had the lowest chicken meat production. Regional disparities in infrastructure contribute to price variations among islands (Ghosh 2010). Lack of logistic infrastructure provides challenges to distribute food (including chicken meat) from production areas to consumer areas particularly during Covid-19 pandemic (Reardon et.al. 2020). Limited chicken production combined with geographic location Papua - located in Eastern Part of Indonesia which lack infrastructure for food logistic- contribute to high prices of chicken meat in this island.

Bali-NT island had the second highest chicken meat prices. Although production of chicken meat in this island was relatively high and its distance is close to Java Island (the main production zone of chicken meat in Indonesia), demand for chicken meat in this island is not only sourced from local people, but also from tourists visiting this island. It is well known, that Bali-NT is the main tourist destination in Indonesia, particularly before Covid-19 pandemic; therefore, the food prices, including chicken meat are usually relatively high in this island.

Based on results of CV, Kalimantan experienced big price fluctuations of chicken meat compared to other islands as indicated by the highest CV in the island, followed by Bali-NT. In these two islands, the prices of chicken meat were relatively high and above the reference chicken meat price set by Ministry of Trade (Rp 35,000 per kg). Sumatera, Sulawesi and Java also experienced big price fluctuations, but the prices of chicken meat in these islands were below the reference price. Papua has the lowest CV, but the price of chicken meat in this island is relatively high and above the reference price; therefore, more attentions to monitor the price volatility is also needed in this island.

Structural break of chicken meat prices. The results from additive outlier model for unit root testing of sudden (structural) change in the prices of chicken meat are presented in Figure 1-6, which is the summarized in Table 2. All structural break in the six islands occurred during the pandemic, which the times of break varied among islands. Kalimantan experienced the fastest sudden change in

chicken meat prices (2 April 2020), followed by Java (19 May 2020), Sumatera (28 May 2020), Sulawesi (27 May 2020), Papua (5 June 2020) and Bali-NT (3 July 2020).

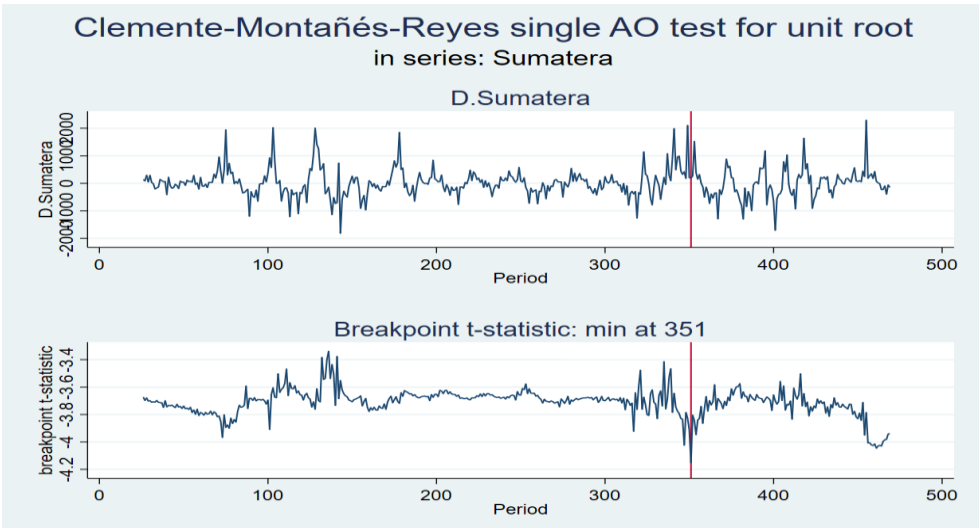


Fig. 1. Structural break of chicken meat prices in Sumatera Island

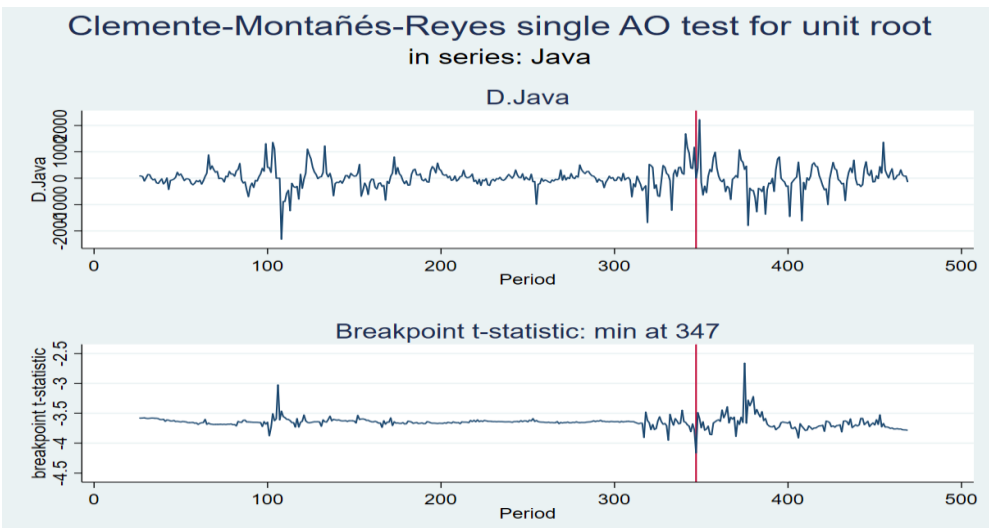


Fig. 2. Structural break of chicken meat prices in Java Island

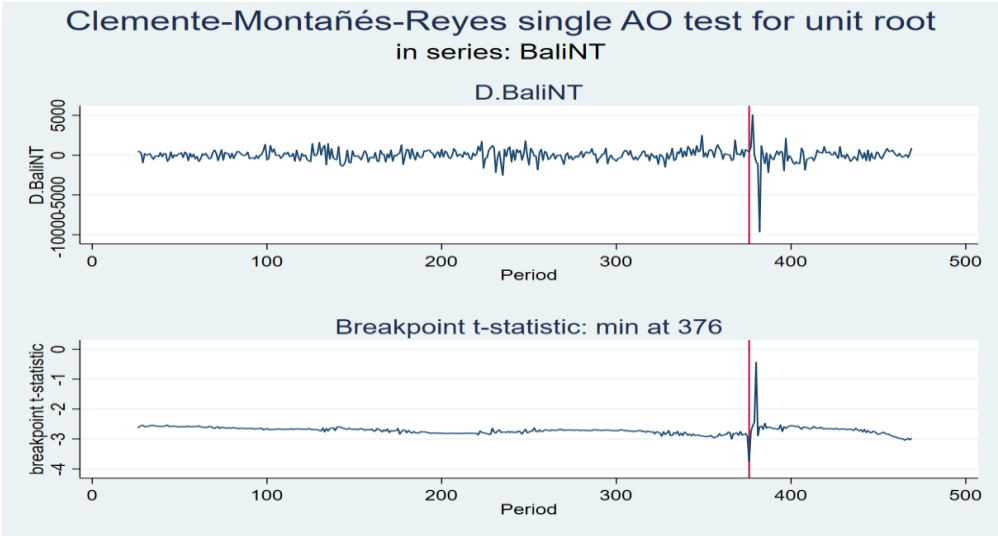


Fig. 3. Structural break of chicken meat prices in Bali-NT Island

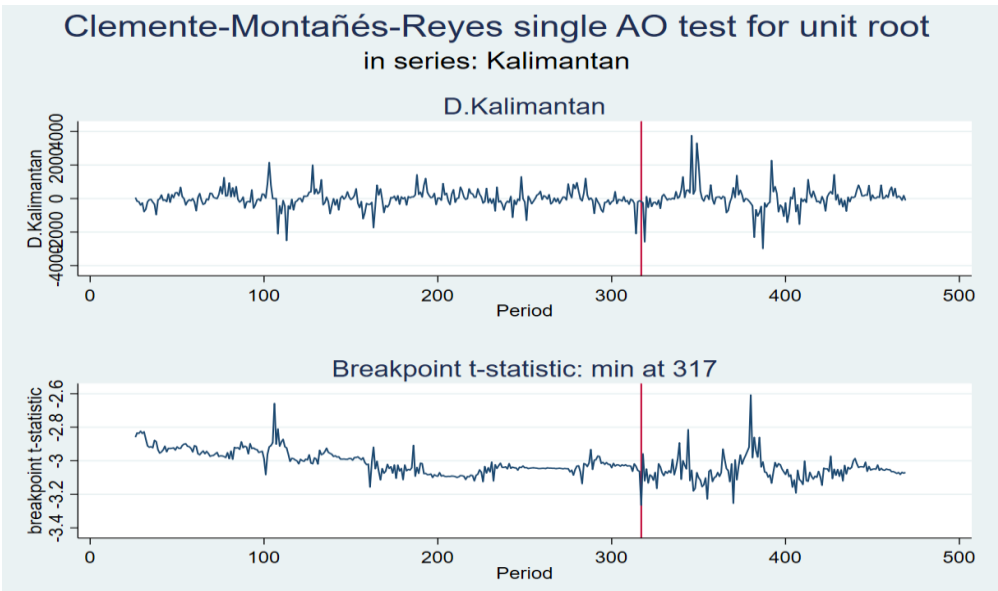


Fig. 4. Structural break of chicken meat prices in Kalimantan Island

During the pandemic, chicken meat prices increased in the four islands, i.e., Sumatera, Java, Sulawesi, and Papua. In Sumatera, the average price before break point was about Rp 32,275 per kg and after the break point the average price increased to Rp 33,209 per kg. In Java and Sulawesi Islands the average chicken meat price after break point increased to Rp 33,949 per kg and Rp 30,737 per kg, respectively. Although these three islands experienced increased chicken meat prices during the pandemic, the average prices were still below the consumer reference prices set by Ministry of Trade.

In Papua, the chicken meat prices before and after break point was always higher compared to the reference prices. Before break time, the average chicken meat price in Papua was Rp 38,060 per kg, increasing to Rp 39,799 per kg after the break point. The fact that food price increased during the pandemic is similar to the previous study by Yu et al. (2020). One possible explanation for this situation is that Covid-19 pandemic has more substantial effect on the chicken meat supply than the reduction in chicken meat demand in the four islands. Restriction policy implemented by Indonesian Government during the pandemic disrupts the transportation and distribution of commodities including inputs for poultry production, leading to the increase in the input prices. This will promote price increase of chicken meat in the four islands.

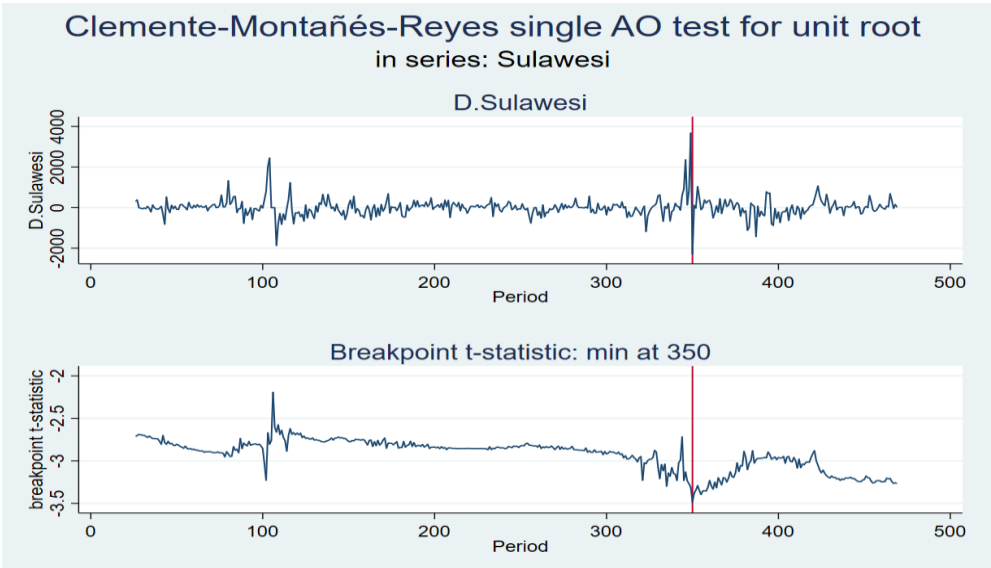


Fig. 5. Structural break of chicken meat prices in Sulawesi Island

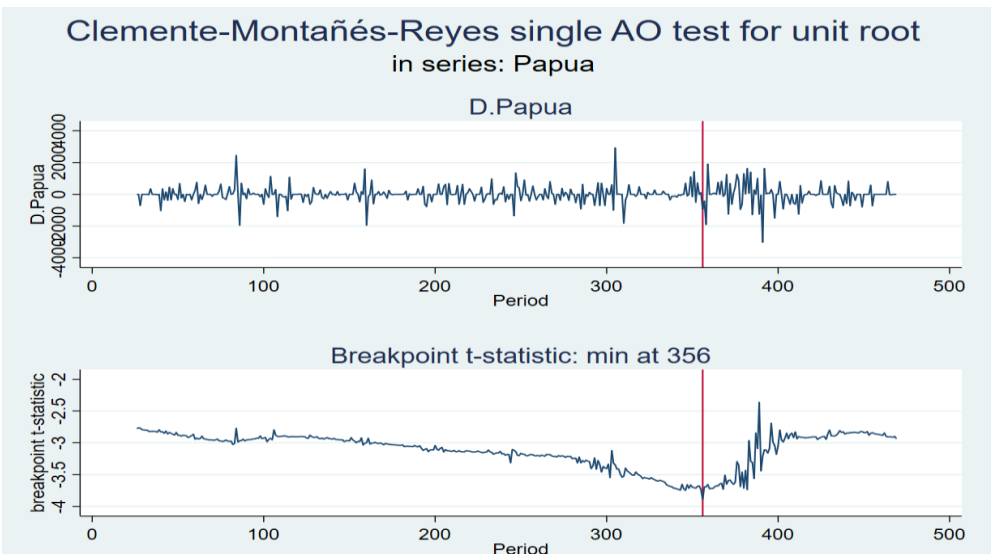


Fig. 6. Structural break of chicken meat prices in Papua Island.

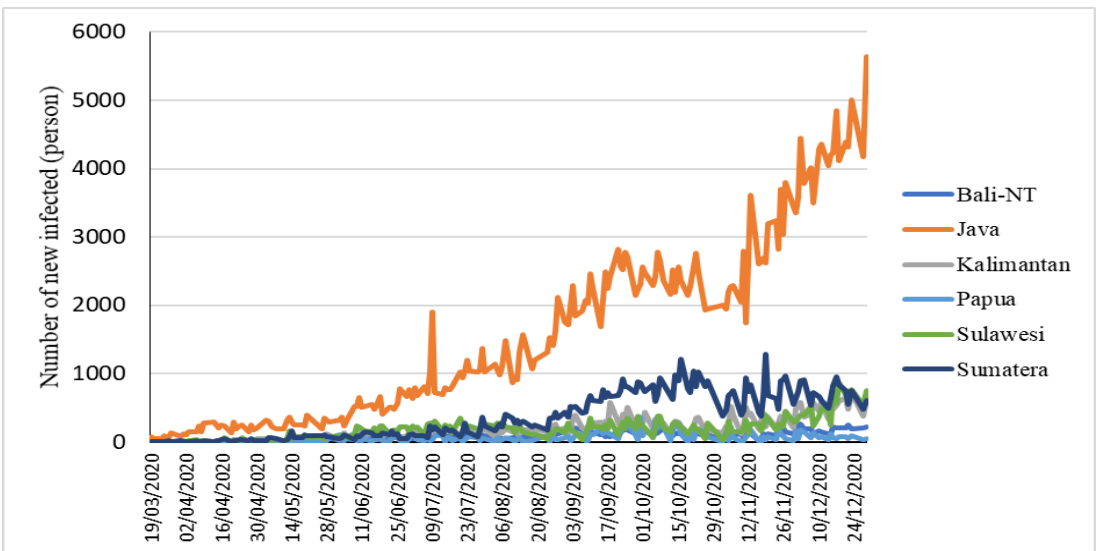
Table 2. Chicken meat prices (Rp/kg) and the coefficient of variation (CV) before and after structural change in the six islands

Island	Before Break Point						After Break Point					
	Period	Mean	Std. Dev.	Min	Max	CV	Period	Mean	Std. Dev.	Min	Max	CV
Sumatera	1/1/19-27/5/20	32,275	2,675	26,040	39,670	8.29	28/5/20-31/12/20	33,209	3,027	27,940	39,650	9.11
Java	1/1/19-18/5/20	33,580	1,746	28,875	38,967	5.20	19/5/20-31/12/20	33,949	3,272	29,325	41,175	9.64
Bali-NT	1/1/19-2/7/20	37,944	3,260	30,817	47,400	8.59	3/7/20-31/12/20	37,591	4,529	31,667	53,450	12.05
Kalimantan	1/1/19-1/4/20	35,464	3,177	28,650	45,380	8.96	2/4/20-31/12/20	34,675	4,712	27,040	43,750	13.59
Sulawesi	1/1/19-26/5/20	28,839	2,152	24,092	35,992	7.46	27/5/20-31/12/20	30,737	2,215	25,450	34,625	7.21
Papua	1/1/19-4/6/20	38,060	1,037	36,000	42,150	2.73	5/6/20-31/12/20	39,799	2,396	36,925	46,125	6.02

The opposite situation occurred in Kalimantan and Bali-NT islands in which during the pandemic, the chicken meat prices tended to decrease. Restrictions implemented by Indonesian Government reduced demand for the chicken meat (Surni et al. 2020). This was noted especially in Bali-NT, the main tourist destination in Indonesia, where demand from restaurants and hotels was reduced reflecting a negative impact on demand for chicken meat. As such the average prices of chicken meat in Bali fell to Rp 37,591 per kg after the time break. It is also important to note that the price of chicken meat in Bali-NT both before and after time break was always higher than the reference price of chicken meat at consumer level set by Ministry of Trade. In Kalimantan, the average price of chicken after the time break was reduced to Rp 34,675 per kg, slightly lower than the reference price. The phenomenon of price reduction during the Covid-19 outbreak is similar to the case of cabbage in China (Yu et al. 2020).

The price fluctuations were more evident after the structural break occurred in the six islands (Table 2). Kalimantan and Bali-NT were the islands registering the highest increase of CV after the break time which the values of CV were above 10. The value of CV of chicken meat in Java doubled from 5.20 to 9.64. A dramatic increase in the CV has also occurred in Papua Island which the value of CV raised from 2.73 to 6.02. A big price fluctuation in the chicken meat products provides a major price risk to consumers and producers.

The impact of Covid 19 pandemic on chicken meat price volatility. Figure 7 shows the trends of newly confirmed infections in each island. The virus has spread to every island with case numbers continuing to increase. Java Island has the highest daily new cases in Indonesia followed by the islands of Bali-NT, Sumatera, Kalimantan, Sulawesi and Papua.



Source: Indonesian Ministry of Health (2021)[4]

Fig. 7. Daily confirmed case of Covid 19 in the six main islands in Indonesia from March-December 2020 (person)

[4] https://infeksiemerging.kemkes.go.id/document/download/cover, downloaded on March 2021

The results of ARCH-GARCH model with the exogenous of daily infected case of Covid-19 pandemic are presented in Table 3. The variable of daily infected case has a significant impact on chicken meat prices.. The regional differences exist shown by dummy interactions are significantly positive in Java Island and negative in Bali-NT Island. The historical chicken meat prices have a significant positive effect on the current prices.

Table 3. The impact of Covid 19 on the Indonesian chicken meat prices.

Variables	Coefficient	Standard error	z	
Prices				
Infected	0.01	0.01	1.92	**
Dummy Sumatera_infected	0.00	0.14	0.01	
Dummy Java_infected	-0.07	0.04	-1.74	*
Dummy BaliNT_infected	2.55	0.71	3.60	***
Dummy Kalimantan_infected	-0.14	0.19	-0.72	
Dummy Sulawesi_infected	-0.12	0.19	-0.63	
Constant	31029.55	1954.68	15.87	***
AR (1)	0.99	0.00	334.87	***
MA (1)	0.19	0.02	7.62	***
ARCH	97.37	25.56	3.81	***
GARCH	0.70	0.05	15.19	***
Constant	-2982.57	2324.305	-1.28	
Observation	1122.00			
Likelihood	-8595.08			
Wald chi2	118810.33***			

Note: *** Significant at 1%, ** Significant at 5%, * Significant at 10%

The present price of chicken meat in Indonesia is influenced by the historical prices and the number of infected cases. The number of new infections have a significant negative effect in Java Island indicating that as the number of confirmed Covid-19 cases increase in Java Island, the chicken meat price experiences a downturn trend compared to the baseline price (in this study the baseline is Papua Island). Java is the epicentre of Covid-19, as such Indonesian government implemented a more strict quarantine policy in this province. This will reduce more demand for the chicken meat than the negative effect of supply.

The outbreak of Covid-19 significantly increased the chicken meat price in Bali-NT than in Papua Island. As outlined previously, Bali-NT depends on Java Island to fulfil the demand for chicken meat. As such, Covid-19 outbreak disrupted the supply of chicken meat in Bali-NT leading to increase in chicken meat prices.

The fact that the pandemic impacted on the food price anomalies does not only appear in the case of chicken meat as examined in this paper, but also for other commodities in several countries such as China (Yu et al. 2020; Chen et al. 2020), Italy (Coluccia et al. 2021) and India (Cariappa et al. 2020). The degree of impact, in terms of changes in food prices, will depend on the magnitude of demand and supply shocks of the commodities in the regions. If reduction in supply due to the

pandemic outstrips demand shock, then food prices spike, and vice versa (Barrett et. al. 2020). It is important to note that the attention to the changes in food prices during Covid 19 should focus at the national level as well as the regional level. This is because demand and supply shock due to the pandemic differs among regions, with implications of a regional price gap. This study confirms the existence of regional price gap with different trends among islands.

Learning from the situation, the idea of having daily food price monitoring is no longer seen as a necessity for the Government of Indonesia. Considering that the spread of Covid-19 pandemic is getting worse, particularly after new strain was confirmed, it is expected that price changes will continue in the future and might provide another break. It is worth noting that price fluctuations directly hinder the ability of the producers to invest in the production and consumers' ability to buy food. Reducing access to food, in this case chicken meat, will impact on a reduction of protein intake providing a negative consequence on health of Indonesian people which will in turn increase the risk of infection of the virus.

CONCLUSIONS AND RECOMMENDATIONS

The impacts of Covid-19 on chicken meat prices are heterogeneous in different islands. Structural break of chicken meat prices exists in which the chicken meat prices in Sumatera, Java, Sulawesi and Papua Island increased after the structural break, while in Kalimantan and Bali-NT Islands experienced price reduction. Considering the virus has spread all around the islands of Indonesia, the supply chain of chicken meat will continue to be disrupted. Therefore, the government needs to ensure price stability in the islands since fluctuations in price impact regional food security in chicken commodity.

Local governments, particularly in the islands with higher retail prices above the reference price set by Ministry of Trade, should coordinate more actively with the central government to avoid scarcities and maintain stable chicken meat prices. One of the efforts that can be implemented is by improving infrastructure for safety that can support chicken meat distribution from the production area (Java) to other islands in Indonesia particularly to Papua and Bali-NT. Major reforms are also needed in the marketing system of chicken meat in Indonesia by implementing digital platforms particularly for frozen and processed chicken products to support social distancing policy. Consumers can access chicken meat as well as avoid crowded areas, reducing the probability of being infected by the virus by using these platforms. Local governments should actively release information on the situation of Covid-19 and the supply of chicken meat to meet the price stabilization.

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CONFLICT OF INTEREST

The author reports that there is no competing interest with any institutions and persons in this manuscript.

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