Price Interdependence in Indonesian Rice Market in the Presence of Quality Differential

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PRICE INTERDEPENDENCE IN INDONESIAN RICE MARKET IN THE PRESENCE OF QUALITY DIFFERENTIAL

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ABSTRACT

Being the main food commodity, the dynamics of rice prices is one of the most important issues for Indonesian economy. The prices at the retail level and at the farm level are not only influenced by the demand and supply in each of these markets, but also influenced by price behaviour at the wholesale market. This study aims to analyse the dynamics of the relationship and behaviour of the prices of various varieties and qualities of rice in the wholesale market during the period of 1October 2014 until 12 February 2018 using multivariate error correction model. The results showed a strong price relationship between premium-quality rice and medium-quality rice, and between medium-quality rice and low-quality rice. Changes in the price of premium quality rice and changes in the price of low-quality rice will have a large influence on the price of medium quality rice, but not vice versa.

Keywords: Price relatioships, Rice, Indonesia, VECM
JEL Classifications: Q110, Q130, C320

INTRODUCTION

The study of dynamics of rice prices has been widely discussed within the existing economics literatures around the world. As one of the most globally consumed food products, rice plays a role as a strategic commodity which raises much attention for many developing countries especially for Asian countries. In several rice-producing countries, rice generally accounts for half of farmers' income, though with declining trend of its share due to its changing nonfarm rural economies. Meanwhile, at the consumer side, rice accounts for 25-40 % of households' expenditure (Dawe and Timmer, 2012, Timmer *et al* 2010). Therefore, changes in rice prices will likely lead to large changes in purchasing power and nutrition of the poor (Hasan, 2016, Dawe and Timmer, 2012, Block *et al*, 2004).

The global rice market has been generally found to be thin and volatile during some recent periods. This relates to the situation which nearly one half of the world population has consumed rice as their staple food, but with only 7 percent are traded across the borders (Gibson and Kim, 2013). Furthermore, after global food price spikes in 2007-2008, people are more aware to the existence of food price instability and thus some governments revise their policy to maintain their food security. During this period, within four months in the early of 2008, the world largest exporters i.e., Vietnam and India (the second and the third world largest exporters) banned their export and was followed by panic buying by the Philippines as the largest rice importer. This export bans by Vietnam and India which have driven to the increasing world rice prices, reflect political goals of protecting domestic consumers from the rice price inflation, but the situation was contradictory. The local rice prices were reported to being doubled in Ho Chi Min City as rice were disappeared in the city market over two days (Slayton, 2009). Volatile market has discouraged governments to rely on the world market for maintaining their domestic consumption, and thus make the thinner world market become more unstable (Timmer, 2009).

Being the fourth most populous country in the world, Indonesia has played a strategic role in the world rice market considering rice as the staple food of the people. Playing as consumer and producer at the same time, Indonesian economy heavily relies on the dynamics of rice prices. Many studies have emphasized this situation. Grabowski and Self (2016) found that rice price stability was one of the main drivers of structural change in Indonesia. The shifting labor from agriculture to manufacturing is critically dependent on the existence of food price stability. Therefore, rice is not only considered as an economic commodity but also political commodity. Indonesian government has maintained many policies for decades regularizing the rice market. Rice price stabilization, for example, is one of the most highlighting political issue especially during the political momentum such as presidential and general election in the country. In addition, the rice self-sufficiency has become main agenda for every president. Indonesian government has claimed achieving rice self-sufficiency in some periods i.e., 2005, 2010, and 2014. However, there are still growing debates regarding the data validity whether the rice production is sufficient while at the same time the rice prices tend to increase over time. Following this issue, the debates are more complex when the government conducts import for rice.

Within the existing economics literature, rice is usually treated as one single commodity. In the estimation technique, mainly due to data availability, most of studies have not account for the type and quality differences in the price analysis. This empirical way to some extent may lead to the unclear conclusion in explaining the real market behavior and the price dynamics, as well as to the policy implication. For the case of Indonesian rice industry, for instance, as studied by (Rachmat *et al,* 2016), along with the variation of consumer preferences, the consumers of rice in Indonesia are becoming more discriminating on the rice quality. In addition, following the changing of socioeconomics condition, especially for the people from up and middle-class income, the correlation between price and quality difference is becoming more important in the consumption behavior.

Research on price transmission between market levels along the marketing chain has been widely carried out (Aguiar and Santana, 2002; Chavas and Mehta, 2004; Çamoğlu, 2015). Those studies also assume that the quality of products traded at each level along the marketing chain is the same. However, research on the price relationship of similar but different quality agricultural products or varieties in one market is relatively rare. This research attempts to fill this gap. This study aims to analyze the behavior of rice prices at the wholesale market in Indonesia by investigating the interdependence among rice products and finding out whether there are differences among rice products in the market. Furthermore, the price interdependency is investigated through estimating the cross products' price elasticity among the varieties of rice products. The next session explains the economics background and data and methods of analysis. Then it is followed by the empirical results and discussion. Finally, the last session will end up with the conclusion as well as the policy implications.

THEORETICAL BACKGROUND

Price behavior in the wholesale rice market needs to be analyzed so that any policy intended to influence the price level in retailers or the price at the farmer level can be formulated appropriately. The wholesale market connects the market at the farm level with the retail market. Price movement behavior at the retail level and at the farm level will be largely determined by the role of every trader in the wholesale market in setting the price. Therefore, the wholesaler's behavior will determine whether the changes in the retail price level will be transmitted perfectly to the market at the farm level, or vice versa.

Traders or wholesalers in the wholesale rice market can be classified as multi-product firms which sell more than one quality of rice products. Rice sold in the wholesale market is categorized as premium quality, medium quality, and low-quality rice. Quality differences between rice occur due to differences in varieties and differences in rice characteristics, such as how much content of broken rice, off-color, chalkiness, and the absence or presence of dirt. Medium quality rice can be further processed to become premium quality rice. Similarly, low quality rice can be improved to have medium quality rice characteristics. This process of changing characteristics certainly requires additional costs. The quality differences of rice products reflect the condition of both production and consumption sides which can be different each other. Consequently, according to this assumption, how strong the price relationships among the different quality of rice products will depend on the interaction of both supply and demand side characteristics.

On the demand side, rice with different quality or characteristics has a relationship to substitute one another. Consumers determine the choice of the quality of rice they like based on preferences. Consumers' willingness to pay for each unit of rice they buy depends on the characteristics of rice. Hedonic price function theory has shown that consumers provide certain implicit prices for each change in the characteristics of a product (Lancaster, 1966; Rosen, 1974; Hendler, 1975, and Lucas, 1975). Several studies have been done in the characteristics of agricultural products and their implicit prices (Espinosa and Goodwin, 1991; Misra and Bondurant, 2000; Chang et al., 2010; Ahmad and Anders, 2011).

Following Midrigan (2011) and Alvarez and Lippi (2012) who examine pricing in multi-product companies, this study assumed that trader or firm in the wholesale rice market can be categorized as not fully acting as price taker. The sales amount of each firm in the wholesale market is relatively large compared to the volume of rice sold in one day on the market. Accordingly, assuming that there is one firm in the wholesaler rice market, which can represent the behavior of all wholesalers in the rice market. This firm sells different quality of rice. Company assumed to employ technology that linear in the use of labor ($l_{i,t}$) to produce output of rice quality i ($q_{i,t}$) in period t, as follows $q_{i,t} = \alpha l_{i,t}$.. Assuming the firm as a price taker in the labor market and given technology, the marginal cost of firm for rice i is $MC_{i,t}=W_t$ where W_t is nominal wage.

The firm faces the demand for every variety of rice (i) it produced as follows:

$$q_{i,t}=f\,(p_{1,t},\ p_{2,t},\ \ldots,\ p_{n,t}),\ \ i=1,2\ldots,n \qquad \text{(Equation 1)}$$

$$Q_t=q_1+q_2+\ldots+q_n \qquad \text{(Equation 2)}$$

where $p_{i,t}$ is the price of rice i and Q_t is the aggregate rice demand that faced by firm. Therefore, marginal revenue of firm for each additional unit of rice quality i is

$$MR_{i,t} = q_{i,t}\left(\frac{\partial p_{i,t}}{\partial q_i} + \sum_{i \neq j}\frac{\partial p_{j,t}}{\partial q_{j,t}}.\frac{\partial q_{j,t}}{\partial q_{i,t}}\right) \qquad \text{(Equation 3)}$$

The marginal revenue of each additional one-unit sale of rice i will not only be determined by the value of the own price elasticity of rice quality i but also determined by the magnitude of cross price elasticity of rice quality i with rice quality j, where $i \neq j$. The lower the value of own price elasticity of demand for rice quality i, the higher the marginal revenue for each additional one unit of rice quality i. The lower the substitution relationship between rice quality i and rice quality j, or the smaller the magnitude of cross price elasticity between these two qualities of rice, the higher the marginal return obtained for each additional one unit of rice quality i. Furthermore, the profits obtained by the company in a certain period are as follows:

$$\pi_t = \sum_{i=1}^{n}\pi_{i,t} = \sum_{i=1}^{n} TR_{i,t} - TC_{i,t} \qquad \text{(Equation 4)}$$

The problem faced by the company is to determine the price of each quality of rice to obtain maximum profits in each period t. The maximum profit of the company will be obtained if the marginal cost of rice quality i will be equal to its marginal revenue i.e. $MC_{i,t}=MR_{i,t}$ or $W_t=MR_{i,t}$. In the equilibrium condition, the total amount of rice ($q_{1,t}+q_{2,t}+\ldots+q_{n,t}$) sold is the same as the aggregate demand rice faced by the firm (Q_t). The optimal determination of price of rice quality i will affect the determination of the price of other rice quality j. With constant quantity of total demand for rice (Q_t), each price increase in one quality of rice i will be followed by a decrease in the price of the other quality of rice (j), so that the total of all variety of rice sold is the same as the total demand. The closer the substitution relationship between two qualities of rice the greater the effect of changes in one quality of rice price (i) on the other quality of rice prices (j).

DATA

This study uses daily price series taken from Cipinang Wholesale Rice Market in Jakarta with the period of 1st October 2014 until 12th February 2018 (n = 1225 observations). The Cipinang Wholesale Market (PIC) is the main wholesale rice market located in Jakarta which transfers most of rice products from several producing areas in Java as well as supply rice products to several regions outside Java. This study covers 11 rice products which are mostly traded in the Cipinang market, based on the type and quality as summarized in the Table 1. All price series are then transformed into logarithmic form.

Table 1. Description of Investigated Rice Prices in IDR

Rice Variety	Quality Category	Mean	Standard Deviation	Minimum	Maximum
Cianjur Kepala (CK)	Premium	13366	496.6	12000	15600
Cianjur Slyp (CS)	Premium	12171	486.7	11000	14925
Setra (SE)	Premium	12219	583.3	10900	13825
Saigon (SA)	Medium	11117	602.7	9900	13200
Muncul 1 (M1)	Medium	10465	734.6	9000	13675
Muncul 2 (M2)	Low	9656.8	719.9	8200	12400
Muncul 3 (M3)	Low	8938.3	704.1	7500	11825
IR 641	Medium	9990.3	649.1	8800	12650
IR 642	Low	9091.8	713.2	8100	12075
IR 643	Low	8198.2	488.16	7200	10300
IR 42	Medium	10486	730.4	9000	12600

Source: Cipinang Market

METHODOLOGY

The dynamics of rice prices are investigated by employing multivariate vector error correction model (VECM). A VECM can give information about how the reactions among investigated prices are both in the long run and short run periods. We first presumably ask whether the investigated rice prices in PIC share the same long run information. According to this assumption, we test for the existence of one common cointegrating factor. Suppose that we have n x 1 vector of nonstationary price series i.e. I(1) $P_t = P_1, P_2, \ldots, P_{nt}$ at time *t* for the *i* rice product. This P_t can be written as:

$Pt = A_{nxs}f_t + \sim P_t$ (Equation 5)

where Pt is an s x 1 vector of s (s < n) common unit root vectors and $\sim P_t$ is an 1 x n nonstationary components. This equation implies the common factor representation if and only if there are n-s cointegrating vector among the elements of the vector of Pt as depicted in the Engel-Granger representation theorem. Based on this theorem, a cointegrated system can be explained by a vector of error correction model as follows:

$\Delta Pt = \mu + \eta Pt\text{-}1 + T1\Delta Pt\text{-}1 + T2\Delta Pt\text{-}2 + \ldots + Tp\text{-}12\Delta Pt\text{-}p+1 + \varepsilon t$ (Equation 6)

where π and T are the coefficient of matrices of n x n and π has reduced ranks of n-s. The matrix of π can also be written as π = αβ´where α is an nxn (n<s) cointegrated vector. Accordingly, we have Π Pt- 1 = αβ' Pt-1 = α Zt-1. The interest point here is the error correction term as Zt-1 = β' Pt-1 with α called as adjustment coefficient from the long run disequilibrium. With this framework, the market integration is hold when s = 1 since we search for markets which share the same long run information.

Therefore, searching the common factor representation as in (Equation 15) is equivalent with the searching for n-1 cointegrating vectors. The search for n-1 cointegrating vectors is conducted in a multivariate framework proposed by Johansen (1998) i.e., the reduced rank ofVAR cointegration testing.

In addition, to capture the effect of policy during the periods of investigation between 2014-2017, we augment the long run equation with the dummy variables representing the implementation of rice policy. Therefore, for this purpose the normalized cointegrating vector for each pair is defined as follows:

$P_{1t} = \beta_0 + \beta_1 P_{2t} + \beta_3$ HET 2016 + β_4 HET 2017 + u_t (Equation 7)

where P_{1t} and P_{2t} are the price pairs of the respective rice products, while HET 2016 is the dummy variable which values 1 representing the implementation of the price reference policy in 2016 and HET 2017 for the implementation of the ceiling price policy in 2017 respectively. According to these results, the estimation of cross product price elasticities is calculated which refers to the magnitude of β_1 for each pair of rice product prices.

Subsequently, the investigation on interdependency among the rice prices is conducted by referring to the magnitude of error correction coefficients i.e. αresulted from the MVECM. The VEC in equation 6 contains the short-run dynamics of the vector Pt as a function of αpast disequilibrium and the lags of P_{t-1} for every Δ Pt. The matrix of speed of adjustments provides information about the structure of the market which can be observed by referring to which coefficient is statistically significant. For instance, if all α are found to be statistically significant it implies the reactions of one rice product to every disequilibrium of any other rice products. In addition, the investigation on the presence of exogenous rice product which dominate the long run behavior of the system is conducted. Furthermore, to capture the structure of interdependency among the rice prices, the estimated of half live time adjustments are then calculated to picture the reactions among the rice prices. The estimated half live time adjustments provide the information about the time required for the effect of 50 % of price shocks to phase out.

In brief, our empirical technique is summarized as follows: 1) we are checking the time series properties by testing the stationary of the price variables using Augmented Dickey Fuller unit root test. 2) For the price variables which have the same order of integration at the first difference i.e. I(1), we test for the existence of cointegration relationships by employing Johansen multivariate cointegration test. Then, 3) after finding the number of cointegration rank, we employ multivariate error correction model (MVECM) with several modifications in normalizing the cointegrating vector for each rice product. Finally, checking for the robustness of the estimation is conducted to evaluate the possibility of model misspecification by employing Lagrange Multiplier test for serial correlation, the RESET test for functional form, White Test for heteroscedasticity, and Chow Test for the model stability.

RESULT AND DISCUSSION

As common procedure in the time series analysis, first we are checking for the time series properties to investigate whether the investigated variables are stationary. To do this we employ Augmented Dickey Fuller (ADF) unit root test including both constant and trend in the test specification. According to the results of ADF test as summarized in the Table 2, most price variables are stationary at the first ifference i.e. I(1), except IR 643 which is stationary at level. This finding has confirmed the unique behavior of IR 643 which has the lowest price among the other rice products. The Indonesian government uses the IR 643 as the aid for the poor, the so-called *raskin* rice or rice for the poor. Due to this situation, therefore as subsidized by the government, IR 643 has different market than other rice products.

Table 2. Corresponding p-value of ADF Unit Root Test

Price Variables	Level		First Difference	
	Constant	Constant and Trend	Constant	Constant and Trend
CK	0.9066	0.9254	0.0000	0.0000
CS	0.9660	0.9668	0.0000	0.0000
SE	0.2139	0.2489	0.0000	0.0000
SA	0.7147	0.4243	0.0000	0.0000
M1	0.5061	0.6154	0.0000	0.0000
M2	0.2484	0.2964	0.0000	0.0000
M3	0.3257	0.4363	0.0000	0.0000
IR 641	0.4352	0.1142	0.0000	0.0000
IR 642	0.6897	0.6641	0.0000	0.0000
IR 643	0.0025	0.0147	0.0000	0.0000
IR 42	0.6144	0.7241	0.0000	0.0000

Notes: The lag selection in the unit root test is based on the AIC. Null hypothesis is the existence of unit root.

Furthermore, after finding that all price variables have the same order of integration at the first difference (excluding IR 643), then cointegration test are conducted by employing Johansen cointegration test. The results suggest the existence of nine cointegration rank for the ten price variables being investigated, as shown in the Table 3.

Table 3. Results of Johansen Cointegration Test

Rank of Cointegration	Constant		Constant and Trend	
	Trace-Test	P-value	Trace-Test	P-value
0	314.11	0.0000	382.70	0.0000
1	235.57	0.0001	268.53	0.0001
2	165.92	0.0218	192.40	0.0282
3	111.98	0.2588	137.10	0.2315
4	78.770	0.4156	103.03	0.2988
5	48.965	0.6870	72.907	0.4047
6	29.367	0.7563	43.131	0.7334
7	13.154	0.8815	23.712	0.8478
8	4.6736	0.8394	8.2297	0.9724
9	0.14233	0.7067	2.1733	0.9430

Notes: Number of lags is selected by AIC.

After finding the existence of cointegrating relationships among the 10 investigated price products, we employ multivariate VECM using normalized Johansen cointegrating methods to estimate the cross-product price elasticity among rice products. To explore the pattern of interdependence among rice products, we conduct several modifications in normalizing the cointegrating vector for each rice product. The results of estimated cross product price elasticity are presented in the Table 4, while for the details of estimated cointegrating vectors are presented in the Attachment 1. For instance, when we normalize the cointegrating vector by CK rice product, then we will have nine cointegrating vectors: 1) CS = -3.5CK + 0.05 HET 2016 – 0.38 HET 2017 + u_t , 2) SE = -2.11CK + 0.02 HET 2016 + 0.2 HET 2017+u_t, 3) SA = -3.31CK + 0.01HET 2016 + 0.37 HET 2017 + u_t, 4) M1 = -8.05CK + 0.18HET 2016 + 1.08 HET 2017 + u_t, 5) M2 = -6.33 CK + 0.13HET 2016 + 0.83 HET 2017 + u_t, 6) M3 = -1.12 CK + 0.02HET 2016 + 0.02 HET 2017 + u_t, 7) IR 641 = -4.40 CK + 0.06HET 2016 + 0.52 HET 2017 + u_t, 8) IR 642 = 3.59 CK - 0.10HET 2016 - 0.75 HET 2017 + u_t, 9) IR 42 = 14.88 CK + 0.29HET 2016 + 2.23 HET 2017 + u_t.

Accordingly, the pattern of rice price interdependences is investigated by calculating the cross-product price elasticities. Based on Table 6, it appears that any increase in prices in one of rice variety will be accompanied by a decrease in the prices of other types of rice varieties. Most of cross-product price elasticities were found to be negative which implies substitution relations among each rice products, as expected. However, the exception was found for IR 642 variety rice which the cross-product price elasticities were positive implying complementary relation. This finding may be related to the situation where IR 642 variety rice is generally not intended for household end consumers. The IR 642 rice is commonly used as input for the rice processing industry into rice flour. Therefore, the IR642 rice is indeed not a substitution of other rice varieties which are intended for the retail market. The price of IR 642 rice variety tends to move in the same direction as the increase and decrease in the price of other rice varieties. Table 4 presents the results of the average cross product price elasticity based on rice quality category, while for the complete estimations are presented in the Table 6.

Table 4. Average of cross product price elasticity based on rice quality category

Rice Product	Premium	Medium	Low
Premium	-1.43	-4.66	-2.18
Medium	-0.39	-1.50	-0.66
Low	-1.15	-4.01	-2.90

The increase in the premium quality rice prices will have a greater impact on the medium quality rice prices than the low-quality rice. The medium rice prices will decrease by 4.66 percent for every 1 percent increase in the premium rice prices. A one percent increase in the premium rice prices only lowers the price of low- quality rice by 2.18 percent. Similarly, if there is an increase in the price of the low-quality rice, a reduction in the price of medium quality rice will be greater than the price of premium quality rice. The medium quality rice has a substitution relationship which is closer to the premium quality rice and to the low-quality rice than the substitution relationship between the premium quality rice and the low-quality rice. On the other hand, changes in the price of medium quality rice groups have the lowest effect on prices of other quality rice groups, namely premium quality rice (-0.39) and low-quality rice (-0.87). Therefore, it can be concluded that the effect of cross price changes between quality groups is not symmetrical for medium quality rice groups.

The average cross product price elasticity among rice varieties in the premium quality group has the lowest value compared to the medium quality and low-quality rice groups. In addition, the cross-product elasticity that occurs among premium rice groups (-1.43) is lower than cross product price elasticity of impact of premium quality rice price changes on medium quality rice (-4.66) and low-quality rice (-2.18). Changes in the price of one of the rice varieties that occur in the premium quality rice group have a greater relationship with the price of rice in the medium quality and low-quality rice group than the relationship with the price of other varieties of rice in the same premium quality group.

Beside investigating the value of cross product price elasticity among the rice products with different quality, the pattern of interdependence among the rice prices are also explored by calculating the half live time adjustment to see how much time required for each rice product to react for the shock in the market disequilibrium. Table 5 summarizes the average of half live time adjustment based on rice quality category. As presented in the table 5, if there is a shock of the price of one of the rice varieties, it turns out that the premium quality rice takes the longest time to return to its balance. Meanwhile, the adjustment from the price of medium and low-quality rice groups is relatively faster back to balance condition. The detail estimated half live time adjustment from Restricted VECM are presented in the Table 7.

Table 5. Average half live time adjustment (days) based on rice quality category

Rice quality price	Premium	Medium	Low
Premium	10.14	5.88	4.54
Medium	9.16	6.71	5.33
Low	9.69	5.12	6.20

Prices included in the premium quality rice group need a longer time to return to their balance condition, which is an average of half a live time vacation for more than 9 days. Whereas for medium quality rice and low-quality rice, each has a half live time adjustment average of 5.90 days and 5.35 days. The estimated half live time adjustment premium quality rice that is relatively longer than medium quality rice and low-quality rice is possibility due to the elasticity of premium quality rice demand is relatively lower than the demand for medium quality rice and low-quality rice. Premium quality rice is generally consumed by households that fall into the upper-middle income category. Najmudinrohman's research (2015) using the 2013 National Socio-Economic Survey (Susenas) data shows that the price elasticity of demand for rice for households with high income category is -0.093, that is smaller than the elasticity of demand for middle or low-income households each of which is -0.154 and -0.277. The same finding is also found when comparing the half live time adjustment of medium quality rice which is longer than low quality rice.

Table 6. Estimated Cross-Product Price Elasticity

Normalization (Independent)	Dependent Variable									
	CK	CS	SE	SA	M1	M2	M3	IR 641	IR 642	IR 42
CK	**1.00**	-3.50	-2.11	-3.31	-8.05	-6.33	-1.12	-4.40	3.59	-14.88
CS	-0.28	**1.00**	-0.60	-0.95	-2.30	-1.81	-0.32	-1.26	1.03	-4.25
SE	-0.47	-1.65	**1.00**	-1.56	-3.81	-2.99	-0.53	-2.08	1.70	-7.04
SA	-0.30	-1.05	-0.64	**1.00**	-2.43	-1.91	-0.34	-1.33	1.08	-4.49
M1	-0.12	-0.43	-0.26	-0.41	**1.00**	-0.78	-0.14	-0.54	0.45	-1.85
M2	-0.16	-0.55	-0.33	-0.52	-1.27	**1.00**	-0.18	-0.69	0.57	-2.35
M3	-0.89	-3.11	-1.88	-2.95	-7.17	-5.63	**1.00**	-3.92	3.19	-13.25
IR 641	-0.22	-0.79	-0.48	-0.75	-1.83	-1.44	-0.25	**1.00**	0.82	-3.38
IR 642	0.28	0.97	0.59	0.92	2.24	1.76	0.31	1.22	**1.00**	4.14
IR 42	-0.06	-0.23	-0.14	-0.22	-0.54	-0.42	-0.07	-0.29	0.24	**1.00**

Note: The estimated elasticity is calculated based on the normalized cointegrating vectors by Johansen methods. All parameters are found to be statistically significant at 5 % level of significance. The cointegrating vector is also specified by including constant and dummy variables representing the implemented price policy during the periods of investigation.

Table 7. Estimated Half Live Time Adjustment from Restricted VECM (day)

Normalization	Dependent Variable									
	CK	CS	SE	SA	M1	M2	M3	IR 641	IR 642	IR 42
CK	13.86	2.89	17.33	9.90	5.77	1.77	8.66	6.93	2.57	3.54
CS	11.55	3.30	16.50	9.49	5.45	1.79	8.55	7.06	2.57	4.41
SE	8.29	2.21	14.51	9.52	5.44	2.02	8.54	7.05	2.81	4.07
SA	8.28	2.05	14.51	18.21	6.75	1.78	8.54	7.05	2.79	3.61
M1	8.27	2.27	14.54	9.52	5.44	2.09	8.54	9.83	2.91	5.09
M2	12.44	2.26	53.77	9.52	8.00	3.05	8.50	18.60	3.80	5.22
M3	8.27	2.04	14.51	9.52	5.44	2.06	8.54	7.05	2.96	3.61
IR 641	8.27	2.23	14.51	14.54	8.03	1.98	14.19	7.05	3.00	4.04
IR 642	7.34	2.04	19.87	9.52	4.71	1.78	13.99	7.05	2.83	3.61
IR 42	8.26	2.04	14.51	11.08	6.52	1.92	10.85	7.81	2.56	3.61

Note: The estimated live time adjustment is calculated based on the estimation of error correction coefficients which are statistically significant at 5 % level of significance from the restricted VECM.

Regarding the effect of policy intervention during the investigated period, this study suggested the variation effects of those policy for each rice product. Along with the argument for maintaining food price stabilization, Indonesian government has set up some food price policies for some main food commodities including rice. This price policy is mainly coordinated by the Ministry of Trade (MoT) which is technically by issuing Minister's regulation. During the last five years, the MoT has issued two regulations in 2016 and in 2017 as a revision from the previous regulation. In 2016, through the Minister regulation number 63/M-DAG/PER/9/2016, the government published the application of purchasing price reference policy and the price reference policy for the sale. According to this regulation, the purchasing price reference is applied at the farmers' level while the price reference for the sale is set at the consumer's level. The government argues that the price reference is determined by considering the reasonable cost structure including production costs, distribution costs, as well as profits and other possible costs. The purchasing price preference at the farmers' level for rice was set at 7500 IDR, while the price reference for the sale at the consumers' level was set at 9500 IDR.

In 2017, the government has made a revision for the previous price reference policy by issuing the Minister of Trade's Regulation, number 57/M- DAG/PER/8/2017. According to this regulation, ceiling price policy at the retail level for rice has been applied, which is so-called as *Harga Eceran Tertinggi* (HET). Different with the previous regulation in 2016, the rice price is set up at the retail level and applied for the medium and premium rice product. The previous regulation in 2016 did not consider the difference of the rice products quality. In addition, the HET is also set differently for each area in Indonesia.

In the long run, the effect of the implementation of price policy on the rice price dynamics generally show variations both in the magnitudes and signs of the estimated policy variable i.e., HET 2016 and HET 2017. This implies that each price variable has different reaction to the implementation of price policy. Regarding to the significance of policy variables, the findings shows that price policy in 2016 does not have significant effect to the price dynamics in most cases. The significant effect of HET 2016 is found in some rice products which are commonly characterized as medium and low rice product i.e. SA, Murni 1, Murni 2, IR 641 and IR 642. Meanwhile, different findings are found in the significance effect of price policy in 2017. For instance, in the case of Cianjur Kepala (CK), this variable does not react to the implementation of HET 2016 in most cases, but contrary with respect to HET 2017. As shown in the Table 8, the effect of HET 2017 on the price dynamics is generally negative. However, an exception is found when we normalize the cointegrating vectors by using CK price variable. According to this model, it is suggested that the effect of HET 2017 is positive for most variables, but with an exception for the response of IR 64 which is negative. Regarding the sign of the estimated coefficient, an exception is also found in the case of IR 42. It is suggested that the effect of HET 2017 is positive. Combining the empirical findings of the effect of price policy, this study suggests that Indonesian rice market seems to become more heterogeneous. Each rice product has been found to have different reaction to the implementation of price policy. These findings have also confirmed the assumption that rice consumers have been differentiated according to the type and quality of rice products.

Table 8. Normalized Cointegrating Vector by Johansen Method

Normalization	Dependent Variables									
	CK	CS	SE	SA	M1	M2	M3	IR 641	IR 642	IR 42
CK	1.00	- 3.50**	-2.11**	-3.31**	-8.05**	-6.33**	-1.12**	-4.40**	3.59**	-14.88**
HET 2016		0.05	0.02	0.01	0.18	0.13	0.02	0.06	-0.10	0.29
HET 2017		0.38**	0.20**	0.37**	1.08**	0.83**	0.02	0.52**	-0.75**	2.23**-
CS	-0.28**	1.00	-0.60**	-0.95**	-2.30**	-1.81**	-0.32**	-1.26**	1.02	-4.25**
HET 2016	-0.01		-0.00	-0.04	0.07	0.03	0.00	-0.01	-0.05	0.07
HET 2017	-0.11**		-0.03	0.00	0.21**	0.14**	-0.10**	0.04	-0.36**	0.61**
SE	-0.47**	-1.65**	1.00	-1.56**	-3.81**	-2.99**	-0.53**	-2.08**	1.69**	-7.04**
HET 2016	-0.01	0.01		-0.03	0.09	0.05	0.00	0.00	-0.06	0.11
HET 2017	-0.09**	0.04		0.05	0.32**	0.23**	-0.09**	0.09	-0.41**	0.81**
SA	-0.30**	-1.05**	-0.64**	1.00	-2.43**	-1.91**	-0.34**	-1.33**	1.08**	-4.49**
HET 2016	-0.00	0.04	0.02		0.16**	0.11**	0.014	0.04**	-0.09	0.24**
HET 2017	-0.11**	-0.00	-0.03		0.19**	0.13**	-0.11**	0.03	-0.35**	0.58**
M1	-0.12	-0.43**	-0.26	-0.41**	1.00	-0.78**	-0.14	-0.55**	0.44**	-1.85**
HET 2016	-0.02	-0.02	-0.02	-0.06**		-0.02	-0.00	-0.04**	-0.02**	-0.05
HET 2017	-0.13**	-0.09**	-0.08**	-0.08**		-0.02	-0.13**	-0.07**	-0.26**	0.22**
M2	-0.16	-0.55**	-0.33**	-0.52**	-1.27	1.00	-0.18	-0.69**	0.56**	-2.35**
HET 2016	-0.02	-0.02	-0.02	-0.06**	0.02**		-0.00	-0.03**	-0.03	-0.01
HET 2017	-0.13**	-0.08**	-0.07**	-0.07**	0.03		-0.13**	-0.06**	-0.28**	0.28**

M3	-0.89**	-3.11**	-1.88**	-2.94**	-7.17**	-5.63**	1.00	-3.92**	3.19**	-13.25**
HET 2016	-0.02	-0.00	-0.00	-0.04	0.05	0.02		-0.01	-0.05	0.05
HET 2017	-0.01	0.32**	0.17**	0.31**	0.95**	0.73**		0.45**	-0.69**	1.99**
IR 641	-0.23	-0.79**	-0.48**	-0.75**	-1.83**	-1.44**	-0.25**	1.00	0.82**	-3.38**
HET 2016	-0.01	0.00	-0.00	-0.03**	0.08**	0.04**	0.00		-0.05	0.09
HET 2017	-0.11**	-0.03	-0.05	-0.02	0.14**	0.08**	-0.11**		-0.33**	0.48**
IR 642	0.28	0.97**	0.58**	0.92**	2.24**	1.76**	0.31	1.22**	1.00	4.14**
HET 2016	0.78**	-0.05	-0.03	-0.08**	-0.04	-0.05	0.01	-0.07**		-0.14
HET 2017	-0.21**	-0.35**	-0.24**	-0.32**	0.32**	-0.49**	-0.21**	-0.04**		0.09**
IR 42	-0.06	-0.23	-0.14	-0.22	-0.54**	-0.42**	-0.07	-0.29	0.24**	1.00
HET 2016	-0.02	-0.01	-0.01	-0.05**	0.03	0.00	-0.00	-0.03	-0.03	
HET 2017	-0.15**	-0.14**	-0.11**	-0.13**	-0.12**	-0.12**	-0.15**	-0.14**	-0.21**	

CONCLUSION

As the strategic food commodity for Indonesian economy, the rice market has been commonly assumed to be homogenous. However, along with the changing socioeconomic condition, the situation may require to be further clarified. Following this motivation, the study found the different behavior among different rice products. It generally found that different quality and characteristics of the rice products in Indonesia has different price behavior. As the price reflect the dynamics of both consumption and production sides, the study on the price at the wholesale market can provide insights on how the interactions among the market of rice products along the supply chain which also relates to the trader behavior. According to this, the study has explored the pattern of interdependence of rice prices with different product quality and characteristics.

Generally, the study found that the prices of various variety and quality of rice in the wholesale market are found to be statistically significant related among each other. However, the results also found an exception which proposes a unique behavior from the lowest price rice product i.e. IR 643. The IR 643 is found to be stationary at level, while the remaining rice products are stationary at the first difference, and thus this price variable is not cointegrated with all other price variables. This finding may relate to the fact that the IR 643 is commonly used by the government for the aid program for the poor people. Therefore, the price of IR 643 is strictly set up to be at the low level by the government.

Based on the magnitude of cross product price elasticity, the prices of premium quality rice have larger influence on the price of medium quality rice rather than to the price of low-quality rice. Similarly, the prices of low-quality rice have greater influence on the price of medium quality rice than to the price of premium quality rice. Therefore, it can be concluded that the substitution relationship between the premium quality rice and the low-quality rice is lower than the substitution relationship between the premium quality rice and the medium quality rice as well as lower compared to the substitution relationships of low-quality rice with medium quality rice. Furthermore, based on the half live time adjustment indicator, any shock affecting the price of premium quality rice product will require longer time to return to the equilibrium condition compared to the price of medium quality rice product and the price of low-quality rice product.

By assuming that the trader in the wholesale market behave as a firm with multiproduct, we propose the finding about price interdependence is related to this assumption where the trader is not fully acting as a price taker in the market. According to the sign of cross product price elasticities, which mostly negative for most rice products, the empirical findings support the existence of substitution relationships among the rice products with different quality and characteristics. This substitution relation may reflect that the trader in the market will adjust their decision on trading, and may be pricing, depending on the dynamics of each rice product. For example, when trader may decide to mix some rice products to exploit more profit due to price differences. Therefore, this will lead to substitution relations among the different rice products. However, an exception is also found in the case of the IR 642 rice price which is categorized as the low-quality rice product. The IR 642 is found to have positive sign of cross product price elasticity with all other rice products.

The results of this research have important implications for the policy formulation especially in the food sector in Indonesia. In the context of agricultural policy in Indonesia, where rice market has been quite highly intervened, the understanding of market dynamics therefore needs to be improved. Differentiation by considering into more detail behavior of each rice products as well as the behavior of each actor along the commodity's value chain is then crucial in the policy formulation process. Furthermore, policy to stabilize rice prices in the market need to pay attention to the price linkages between various varieties and the quality of rice in the market. The policies aimed at regulating medium quality rice prices are estimated to have relatively weak effects on the price of premium quality rice category and low-quality rice prices. However, if there is a change in the price of premium quality rice or a change in the price of low-quality rice, it will have a major impact on the price of medium quality rice.

REFERENCES

Aguiar, D.R.D. and Santana, J.A. 2002. Asymmetry in farm to retail price transmission: Evidence from Brazil. *Agribusiness*, 86 (1): 37-48.

Ahmad, W., and Anders, S. 2011. The value of brand and convenience attributes in highly processed food products. *Canadian Journal of Agricultural Economics*, 00:1-21.

Alvarez, F.A. and Lippi, F. 2012. Price setting with menu cost for multi-product firms. *Working Paper 17923*. National Bureau of Economic Research.

Block, S.A.,Jayne,T.S, Webb,P.,Kosen, S.,Moench-Pfanner,R.,Bloem, M.W., Timmer,C.P.,2004. Macro Shocks and Micro Outcomes: Child Nutrition during Indonesia's Crisis. Economic and Human Biology 2, 21-44.

Chang, J.B., Lusk, J.L. and Norwood, F.B. 2010. The price of happy hens: A hedonic analysis of retail egg prices. *Journal of Agricultural and Resource Economics*, 35(3):406-423.

Chavas, J.P., and Mehta, A. 2004. Price dynamics in a vertical sector: The case of butter. *American Journal of Agricultural Economics*, 86(4):1078-1093.

Çamoğlu, S.M., Serra, T., and Gil, J.M. 2015. Vertical price transmission in the Turkish poultry market: The avian influenza crisis. *Applied Economics* 47(11):1106-1117.

Dawe, D., Timmer, P., 2012. Why Stable Food Prices Are A Good Thing: Lessons From Stabilizing

Rice Prices In Asia. Global Food Secur. 1 (2), 127–133. http://dx.doi.org/10.1016/j.gfs.2012.09.001.

Espinosa, J.A., Goodwin, B.K. 1991. Hedonic price estimation for Kansas wheat characteristics. *Western Journal of Agricultural Economics*, 16(1):72–85.

Gibson, John, and Bonggeum Kim. 2013. Quality, Quantity, and Nutritional Impacts of Rice Price Changes in Vietnam. World Development. Volume 43, pages 329-340. https://doi.org/10.1016/j.worlddev.2012.11.008

Grabowski, Richard and Sharmirta Self.2016.Staple Food Price Instability and Structural Change: Indonesian Experience. Journal of Asian Economics, Vol. 47, December 2016, pages 35-44. https://doi.org/10.1016/jasieco.2016.10.001

Hasan, S.A. The distributional effect of a large rice price increase on welfare and poverty in Bangladesh. Australian Journal of Agricultural and Resource Economics, 61(1), 154–171. https://doi.org/10.1111/1467-8489.12141

Hendler, R. 1975. Lancaster's new approach to consumer demand and its limitations. *American Economic Review*, 65: 194-200.

Lancaster, K.J. 1966. A new approach to consumer theory. *Journal of Political Economy*, 74:132-57. Lucas, R.E.B. 1975. Hedonic price function. *Economic Inquiry*, 13: 157-78.

Midrigan, V. 2011. Menu costs, multi-product firms, and aggregate fluctuation. *Econometrica*, 79 (4): 113

Misra, S.K., Bondurant, J. 2000. The role of product and market characteristics in determining cottonseed prices. *Agribusiness* 16(3), 357–366.

Najmudinrohman, C. 2015. *Determinants of Rice Consumption in Indonesia*. Thesis. Graduate School, Bogor Agricultural University.

Rachmat, R., Thahir, R., & Gummert, M. (2016). The empirical relationship between price and quality of rice at market level in West Java. Indonesia. *J. Agric. Sci*, 7(1), 27–33.

Rosen, S. 1974. Hedonic prices and implicit markets: Product differentiation in pure competition. *Journal of Political Economy*, 82(1): 34-55.

Slayton, Tom. 2009. Rice Crisis Forensics: How Asian Governments Carelessly Set the The World Rice Market on Fire. Center for Global Development Working Paper No. 163. http://dx.doi.org/10.2139/ssrn.1392418

Timmer, C. P.2010. Reflections on food crises past. *Food Policy*, *35*(1), 1–11. https://doi.org/10.1016/j.foodpol.2009.09.00