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Impacts of Rice Prices on Farm Revenue: Evidence from Indonesia

Yogi Makbul[a*], Nandan Limakrisna[b], Uly Faoziyah[c], Sudrajati Ratnaningtyas[d], Siti Herni Rochana[c]

[a]*School of Architecture, Planning and Policy Development.*
Institut Teknologi Bandung (ITB). Indonesia.
[b]*Universitas Persada Nusantara YAI, Indonesia.*
[c]*Regional and Urban Planning Department, Institut Teknologi Bandung, Indonesia.*
[d]*Entrepreneur Department, Institut Teknologi Bandung, Indonesia.*

Abstract

Rice has a strategic role in the food structure and socioeconomic system of Indonesia. Fluctuations in prices directly impact the welfare of farmers and communities. Instability impacts the achievement of Indonesia's food security objectives, particularly those related to stability. Using an econometric model, this study analyzes the impact of increasing rice prices on farm revenues from Indonesian rice paddies. Monthly data on rice prices and farm revenue from 2013 to 2016 are taken from the website of the Indonesian Central Bureau of Statistics. Error correction models (ECMs) are used to analyze the impact of rice prices on farm revenue in the short and long runs. Vector ECMs are used to provide an in-depth analysis of ECM and to predict how pricing lags impact farm revenue. This research found that rice prices have significant short- and long-run impacts on farm revenue.

Keywords*: Rice price, farm revenue, error correction model, vector error correction model*

JEL codes: Q1; C5

1. Introduction

Rice is a strategic asset of the Indonesian food industry. Although Law No. 18 of 2012 stated that food security should be achieved by providing a variety of food products (Indonesian Government, 2012), 97.16% of consumption participation rates remain attached to rice commodities. The average Indonesian consumed 4.861 kg of rice each month in 2018, which was much higher than the consumption of other carbohydrate foods (<1 kg per month) (BPS, 2018a). The same report added that urban and rural communities spent 4.5% and 8.73%, respectively, of their total expenditures on rice. Moreover, rice has a high multiplying effect on the rural economy, especially in the labor market (McCulloch & Timmer, 2008). Warr (2005a) noted that the entire rice production chain employed 7.1% of the total workers and 23.92% of full-time workers from the Indonesian agricultural sector. The widespread dominance of rice has resulted in high levels of political, economic, and social vulnerability related to the availability, distribution, and affordability of rice as a strategic asset (Arjayanti, 2010; Masyhuri, 2001). It certainly has become essential to national food security (Indonesian Government, 2014). Therefore, any decline in rice production will threaten not only Indonesia's food security but also its economic system.

As the fifth-highest importer of rice in the world in 2018 (Workman, 2019), the Indonesian economy is very vulnerable to changes in prices. Often, price changes in any direction fail to contribute positively to welfare. This is worsened by the structure of poverty in Indonesia, which remains dominated by farmers (McCulloch, 2008; Warr, 2005a). Agricultural labor, the main livelihood for most Indonesians, faces a number of complex problems, including limited access to effective food production methods, climate uncertainties, natural disasters, and competition (Hidayat, 2000). Although production remains high, the limited production knowledge has resulted in decreased value in the global market, because, despite massive participation, the output remains low. Investment in the agricultural sector is

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therefore limited and is dominated by small businesses, resulting in limited improvements nationwide. Furthermore, there is no certainty of profits as production costs continue to increase. Some have argued that rising rice prices result in increases in paddy farm revenue, because revenue directly correlates with prices (Dev & Rao, 2015; Timmer & Dawe, 2007). However, in the long run, paddy farming is not profitable for most businesses, resulting in higher risks to food security. Warr (2011) suggested that the rice-farming system in Indonesia was influenced more by non-land-owning farm laborers earning cheap labor wages. In this case, increasing rice prices would not necessarily result in increased revenue. In either case, increases in rice prices encourage disproportional increases in retail prices. This phenomenon can be detrimental, especially when the poor comprise the majority of consumers (Dawe, 2008, 2000; Poulton, Kydd, Wiggins, & Dorward, 2006). When their access to food decreases, they are forced to reduce their caloric intake, increasing the risk of malnutrition and other diseases. Middle-class families are also hard hit. All these things create compounded high risks. Therefore, rice-pricing policy is a critical and necessary instrument for ensuring food security (Anderson, Ivanic, & Martin, 2013; Dev & Rao, 2010; Poulton et al., 2006; Tsakok, 1990).

Price changes in the Indonesian rice economy correspond very little to the global rice market. In 2014, rice prices in Indonesia were 65% higher than those in the international market (Ministry of Trade, 2015). However, Indonesia cannot completely avoid rice imports, despite the government's 2007 Rule No. 93, which stated that it must avoid rice imports (Ministry of Finance, 2007). The consequence of such a trade protection scheme is inflation. This phenomenon exacerbates black market economies, which harm rice consumers and worsen the poverty situation. Seemingly, the government protects farming producers *via* upstream government purchase prices (HPP), which are set above market-balance prices. During the harvest season, market prices usually fall below equilibrium. Thus, excess supply is absorbed by the government. The government tries to protect consumers, especially the poor, by limiting the highest retail price (HET). HET varies by region per rice quality. Nevertheless, policy cannot be implemented only partially; it must also provide comprehensive influence.

Studies have suggested that improving farm-labor welfare can be achieved by focusing on rice price interventions (Peiffer, 2013; Dev & Rao, 2010; Timmer & Dawe, 2007; Poulton et al., 2006; Barrett & Dorosh, 1996; Abdulai & Rieder, 1995; Tsakok, 1990). A root cause of poverty among farmers is the low value attained by low rice prices. Several governments have intervened to regulate prices, including Indonesia, *via* HPP and HET (Peiffer, 2013). However, farmers' low bargaining value has left them with little choice but to sell their commodities at lower prices (Suryadi, Anindita, Setiawan, & Syafrial, 2014). Farmers in developing countries must deal with merchants who limit product distribution to the broad market and regulate meager wholesale prices. Limited access to capital and economics makes it easy for merchants to confine farmers with capital investments and loans. Theoretically, *via* government intervention, farmers' welfare will increase with income. However, that is hardly the case in most regions. Because of the high dependence of third-world economies on rice production and consumption, the Indonesian Government should take a controlling role with respect to rice imports and exports while regulating domestic food prices *via* production (Timmer, 2010).

Increasing rice prices is likely to transform the structural economy in a country, because it will encourage increased agricultural productivity in return for high-quality agrarian products. This will increase the added value to the agricultural sector, reflected by an increase in farmers' income. Both the gross domestic product (GDP) and GDP per capita will also increase. However, a study conducted by Rabbi, Kydd, Wiggins, and Dorward (2017) suggested that policies to increase rice prices must be implemented alongside policies that encourage increased market participation, either through subsidization, improved logistics, cold-storage development, vocational education, new technologies, or education. A case study in Uganda conducted by Perego (2019) found a positive correlation between the increase in rice prices and farmers' income. However, it would have been more positive if farmers had adequate access to nearby roads and markets. Abdulai conducted several studies in Ghana (1995), Mali

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(2001), Zambia, and Tanzania (2013), finding positive relationships between product prices and farmers' income. Suryadi et al. (2014) discovered a similar positive impact on domestic output. When rice prices increased by 5%–15%, the quantity of domestic production increased by at least 0.10%. On the other hand, Anderson et al. (2013), Ivanic and Martin (2008), McCulloch (2008), and Wodon and Zaman (2008) warned that this type of increase could not be sustained without a mature policy because of the potential to drive higher poverty levels in regions. As a strategic asset, rice has a great ability to influence inflation and cause tangential increases in the prices of other goods. Therefore, unmitigated and unmanaged policies could greatly harm the poor.

As a first step in preparing policy, empirical evidence must be gathered to determine how the price of rice can stimulate paddy farm revenues. The purpose of this research is to determine the impact of rice price on-farm revenue, using econometric models.

2. Material and Methods

2.1. Analysis

We use a timed series, because impacts are not expected to be immediate; they have lag times of several months. Thus, this study relies on a long-run relationship that can be tested by error correction models (ECM) (Gujarati & Porter, 2009), which are functions of distributed lags from the first differences of two variables and the once-lagged equilibrium. Thus, it reinstates the original levels and maintains long-run considerations (Abdulai & Rieder, 1995). The ECM method is suitable for this study, because results can be derived from dynamic behaviors of agricultural agents, and it can avoid partially realistic adjustment assumptions from a farmer's income target based on stationary expectations. Furthermore, vector ECMs (VECM) are used for long-term in-depth analyses *via* cointegration equations (Ekananda, 2015).

2.2. Data

The data for this research were collected from the Indonesian Central Bureau of Statistics (BPS, 2016, 2015, 2014, 2013). The variables used are rice prices in the produce market and prices received by farmer indices. The rice prices from the producer market are taken monthly from 2013 to 2016 (BPS, 2018b). The amount received by farmer indices is used as an indicator of farm revenue. The index only references rice; it does not reference other crops. Farmers usually produce complementary crops (e.g., soybeans, peanuts, vegetables). *Farm income* is when all crops are tallied, and it can be biased if it is impacted only by rice prices. Therefore, in this research, the dependent variable only considers farm revenue from paddies. The independent variable, *X*, is the increase or decrease in medium rice prices at a 1-month lag. The dependent variable, *Y*, is the increase or decrease in price received from farmer indices of paddy crops at a 1-month lag.

2.3. Analysis Steps

Our analysis is carried out in five stages, as presented in Figure 1. The first step is a stationary test. According to Gujarati, Porter, and Gunasekar (2012), assumptions of time series analysis are stationary (i.e., Dickey–Fuller test). If the data are stationary, the analysis of the second analysis is the optimum lag. Thus, we can predict how many optimum lags should be used. The criteria of the optimum lag include lag range (*LR*), final prediction error (*FPE*), the Akaike information criterion (*AIC*), the Schwarz information criterion (*SC*), and the Hannan–Quinn information criterion (*HQ*). The next step is the cointegration test (Johansen & Juselius, 2009), which is used to test the integration of rice price and paddy revenue. Afterwards, ECM analysis is conducted. This analysis meets the primary objective of this research, because it tests the short- and long-run relationships between prices and revenue. The next analysis is VECM, which is used to explain the cyclic relationship between rice prices and farm revenue from paddies.

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Fig. 1. Analysis Steps

3. Results

Outputs of the stationary test of variables *X* and *Y* can be found in Table 1.

Variable	t-test	Prob.
Y	–3.464513	0.0136
X	–4.663469	0.0005

Table 1. Stationary Test

The Dickey–Fuller test was used. The probability to accept *Y* and *X* was $H_0 < 0.05$, indicating that the variables were stationary. Stationary data can then be applied to the cointegration test with optimum lag. The optimum lag of this analysis can be found in Table 2.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	–3,686.864	NA	10,5397.3	17.24123	17.32315	17.27144
1	–3,482.419	38.03635	49,073.16	16.47637	16.72212*	16.56699*
2	–3,448.727	5.954891	50,618.16	16.50571	16.91529	16.65675
3	–3,384.699	10.72101*	45,435.01*	16.39395*	16.96736	16.60540
4	–3,373.428	1.782366	52,280.26	16.52757	17.26482	16.79944

Table 2. Optimum Lag

The asterisk (*) indicates the optimum lag suggested from the analysis. For one lag, *SC* and *HQ* are recommended. For the other three, *LR*, *FPE*, and *AIC* is recommended. These three lags are more suggestive than the first. Thus, we focus on the latter three. Next is cointegration. The result of the cointegration analysis is found in Table 3.

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.434581	36.07405	15.49471	0.0000
At most 1 *	0.235660	11.55594	3.841466	0.0007

Table 3. Cointegration Test

Table 3 shows that the rice price and farm revenue are correlated at a 95% confidence level because the trace statistic is greater than the critical value of 0.05. The null hypothesis, therefore, cannot be accepted, because the probability is less than 0.05. Because the null hypothesis cannot be accepted, the alternative hypothesis is accepted, and hence, the model has been cointegrated. After the data pass stationarity and the variables are cointegrated, the data can undergo ECM analysis (see Table 4).

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.010256	0.203306	0.050448	0.9600
D(X)	0.009730	0.001201	8.104361	0.0000
U1(–1)	–0.711067	0.162094	–4.386762	0.0001

Table 4. ECM Analysis

From Table 4, the rice prices have significant short- and long-run influences on rice-farm revenues at a 95% confidence level. The $D(X)$ parameter is the short-run influence, and U_1 is the long-run correction model. Thus, increasing rice prices have an impact on paddy revenue. This evidence is vital for rice-pricing policy in Indonesia. The result of VECM is found in Table 5.

Parameters	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.257529	0.049789	5.172400	0.0000
C(2)	–0.815222	0.234623	–3.474600	0.0014
C(3)	–0.616728	0.246904	–2.497848	0.0173
C(4)	–0.076661	0.213621	– 0.358864	0.7219
C(5)	0.013516	0.003685	3.667521	0.0008
C(6)	0.008369	0.003233	2.588644	0.0139
C(7)	0.002731	0.002480	1.101456	0.2782
C(8)	–0.073973	0.245932	– 0.300785	0.7654

Table 5. VECM Analysis

Table 5 provides the VECM analysis. There are eight parameters from the model VECM equation.

$$D(Y) = C(1)*(Y(-1) - 0.062478744715*X(-1) + 1.80543171783) + C(2)*D(Y(-1)) + C(3)*D(Y(-2)) + C(4)*D(Y(-3)) + C(5)*D(X(-1)) + C(6)*D(X(-2)) + C(7)*D(X(-3)) + C(8). \quad (1)$$

C(1) represents the model impacts, revealing significantly positive impacts. C(2) represents the impacts of farm revenue at a 1-month lag. The coefficient of C(2) has significant negative impacts and is a correction from the cycle graph. C(3) represents the same results as C(2). C(4) represents a correction cycle, but is not significant. C(5) and C(6) are impacted by rice prices lagging 1 and 2 months before farm revenue. This coefficient has significant positive impacts. C(7) is impacted by a 3-month lag and is not significant. C(8) is constant and not significant.

Price regulation ostensibly ensures balanced value, so that farmers can produce rice of reasonable quality in sufficient quantities and the community can obtain rice products at affordable prices (Mears & Afiff, 1969). A good balance supports national food security objectives and increases social welfare. Furthermore, it can obviously protect farmers and reduce poverty. McCulloch and Timmer (2008) argued that most poor rural citizens were associated with the agricultural sector. In another study, McCulloch (2008) added that positive spillover effects would occur with rural economies as a result of price increases if consumption patterns were concentrated locally. Thus, value would circulate among local communities to encourage the growth of small businesses. Barrett and Dorosh (1996) studied in Madagascar, strengthening the idea that rice was significantly impacted by gross farm income. Lam (1977) studied in Thailand, concluding that the exportation of premium rice impacted domestic rice prices and farm income. McCalla (2009) showed the impact of rice prices on farm incomes, finding that the consequences of high rice prices influenced farm income and larger firm production.

These external results align with ours, which show that rice prices have significant effects on farm revenue in the short and long runs. This is evidenced by the poverty rate in rural areas, which tends to decrease with higher rice prices. During the first year of observation, the poor rural population totaled 17.74 M, representing 14.32% of the total. At the end of the year, there was a decrease in the number of poor people by 0.46 M to 14.11% (Laucereno, 2018). Timmer (2004, 2003) stated that rising rice prices would increase farmers' confidence with respect to investing in new technologies and improved farming methods. Moreover, higher prices would also discourage farmers from selling away productive agricultural land for other uses.

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Notably, if rice prices do not ascend, farmers have the option to shift their business from rice commodities to others, which are often more profitable. In macro terms, this condition does not threaten overall food security, considering that food security is not only viewed from the perspective of rice commodities. However, it will threaten the staple food security of the Indonesian people. The increase in rice prices will, alternatively, encourage the realization of food security in line with improved availability. However, McCulloch and Timmer (2008), Warr (2011; 2005b), and Hidayat and Adinata (2001) warned that the positive impact of increasing rice prices must also consider the agricultural conditions of the regions in question. This condition is related to the structure of the agricultural sector in Indonesia, which is still dominated by imbalanced and regional rice fields. More than half of the paddies in Indonesia are controlled by 20% of households having substantial land ownership, whereas 75% of households only have access to fewer than 0.5 ha of paddy fields. Such small-scale production is unable to meet the needs of farming families.

4. Conclusions

Our econometrics model using ECM and VECM predicted the impact of growing rice prices on the increase of farm revenue. Our analysis revealed that rice prices had a significant effect on short- and long-run revenue of rice farmers in Indonesia. VECM analysis showed that the most significant impact of rice prices on farm revenue occurred between 1- and 3-month lags. Regarding this finding, the government should develop synchronous and integrated regional price-control policies. Any regulation policy should be mindful of the rice harvest season and regional social characteristics, so that the price increases will not burden the local communities. Policy must be synergized with others to increase agricultural investment while facilitating construction and infrastructure rehabilitation, including improved irrigation. Policies must be prepared considering the interests of all stakeholders. An action plan for stabilizing food prices is urgent, given the fact that Indonesia is currently a net importer country, making it very sensitive to changes in food prices both at local and global levels. This research, in turn, presents an opportunity for the Indonesian Government to develop and implement policy to reduce strategic economic risk while improving social welfare.

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