The long-run equilibrium between retail price and market operations: Based on the Presidential Instruction for Rice Policy

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Abstract. The objective of Indonesian government based on the Presidential Instruction for Rice Policy is to preserve rice price stabilization. The instrument used is the government’s rice stocks by conducting rice market operations. The aim of this study is to see a long-run relationship between retail price of rice and rice market operations. Monthly data are taken from January 2005 to December 2017 and analyzed by carrying out cointegration analysis starting with a stationarity test of each variable, i.e. retail price of rice (PRR) and rice market operations (MO). The PRR and MO variables are stationary in the first difference test or I (1). The cointegration test indicates that MO and PRR have a long-run equilibrium. The result of the analysis using an error correction model shows that the sign of cointegration is negative, real and in line with expectation which shows a convergence to the long-run equilibrium, so that there is a rice price stabilization in the long-run equilibrium.

Key words: price stabilization, rice market operations, the Presidential Instruction, error correction model, the long-run equilibrium

1. Introduction

Based on the Presidential Instruction of Republic of Indonesia No. 2 of 2005 on Rice Policy states that providing and distributing rice is to maintain a domestic rice price stabilization through a management of government’s rice reserves [1]. This policy aims to overcome a rice price volatility in the market by conducting rice market operations. The government through its Bulog (Food Logistics Agency) distributes government’s rice reserves to maintain a rice stabilization. Although Bulog undergoes institutional reform, it remains consistent in stabilizing the rice price [2]. Bulog has maintained rice price stabilization for around 25 years throughout Indonesia [3] but Bulog finds the goal still difficult to achieve because Indonesia is a very large country [4]. Some advantages of the rice price stabilization are to create an economic growth and food security, to enable households to gain benefit, and to stabilize rice price [3, 5-7].

The government’s rice reserves as national rice stock reserves are provided for the purpose of emergency relief, post-disaster food insecurity, and rice price hike control [8]. Not only Indonesia but also other countries like India and Bangladesh maintain their national food reserves themselves for the purpose of food distribution to their people and for the emergency relief [9, 10]. One of the effective price stabilization schemes is to preserve a price stability due to supplies and demand shocks [11]. The price of rice will rise at the same time when demands exceed rice supplies. In response to this, the government needs to carry out rice market operations by distributing a certain quantity of rice to the market at a fixed price level to make the rice price stable again [12]. In some cases, the national stocks or national reserves have succeeded in reducing price fluctuation or in creating price stability automatically, but these cost a lot [13, 14]. Therefore, it is concluded that there is a relationship between price stability and the activity costs of the price stability [15].

Another strong reason to bring about the price stability is to minimize the impacts of the extreme price volatility of global rice price towards domestic rice price [16]. Indonesia, Malaysia, and Thailand are very consistent in stabilizing the rice price for the three reasons; the improper rice price as staple foods creates a political instability, the volatility of rice price is transmitted to other prices in economy, and the rice price instability is a signal of inadequacy of domestic rice [17].
The study of the effects of price instability is carried out on households from two sides: the consumers and the producers [18], while the grain price stabilization experiences in Asia, such as Indonesia, Pakistan, Philippine, and India are different [14], the implementation of the rice policy instrument accomplishes the rice price stabilization [19]. At the national level, the government’s rice stock is one of the rice policy instruments. By using simultaneous equations, economic variables that affect the government’s rice distribution are retail price of rice, dummy variables, and lag distributions of government rice [20]. The aim of this study is different from previous research because of the objective of this study is to analyze a long-run relationship between retail price of rice (PRR) and rice market operations (MO) based on government rice policy.

2. Materials and methods
This study takes monthly data from 2005 to 2017. There are three steps in data analyze using Eviews 8. The first step is performing stationarity test on each variable; the second one is examining the variables using cointegration analysis; and the last one is apply in error correction model. The stationarity test using autoregressive equation is formulated as follows [21]:

$$\hat{X}_t = \alpha + \phi_1 X_{t-1} + \phi_2 X_{t-2} + \ldots + \phi_p X_{t-p} + u_t$$ (1)

where $X_t$ is a dependent variable of estimation, $\alpha$ is a constant, $\phi$ is a coefficient, $X_{t-1}$ is value of the dependent variable 1 of the previous period, $X_{t-k}$ is value of the dependent variable in period $k$, and $u_t$ is an error standard. The autoregressive equation formula of each variable is formulated based on a general formula, as follows:

$$PRR = a + \alpha PRR_{t-1} + \alpha PRR_{t-2} + \ldots + \alpha 156 PRR_{t-156} + \mu$$ (2)

where $PRR$ is estimated value of retail price of rice, $a$ is a constant, $\alpha$ is a coefficient of retail price of rice, $PRR_{t-1}$ is retail price of rice a month before, $PRR_{t-2}$ is retail price of rice 2 months before, $PRR_{t-156}$ is retail price of rice in the past 156 months, and $\mu$ is the standard errors of retail price of rice.

$$MO = b + \beta MO_{t-1} + \beta MO_{t-2} + \ldots + \beta 156 MO_{t-156} + \mu$$ (3)

where $MO$ is estimated value of rice market operations, $b$ is a constant, $\beta$ is a coefficient of rice market operations, $MO_{t-1}$ is rice market operations a month before, $MO_{t-2}$ is rice market operations 2 months before, $MO_{t-156}$ is rice market operations in the past 156 months, $\mu$ is the standard errors of rice market operations.

If the Augmented Dickey-Fuller statistical value is less than the critical value in the DF table or MacKinnon table at the 1%, 5%, and 10% confidence levels and the probability value is less than 0.05 then the PRR and MO variables in equations 2 and 3 are stationary. However, if the test at the level indicates that the data are not stationary, the estimate is repeated again in the first difference form. The general formula of the first difference in equation (4) is

$$\Delta X_t = \alpha + \phi_1^{*} X_{t-1} + \phi_2^{*} X_{t-2} + \ldots + \phi_p^{*} X_{t-p} + u_t$$ (4)

If the Augmented Dickey-Fuller statistical value is less than the critical value in the DF table or MacKinnon table at the 1%, 5%, and 10% confidence levels and the probability value is less than 0.05 then the variables are stationary. The first difference test is carried out on each variable i.e. PPR and MO at equation 5 and 6:

$$\Delta PRR = c + \alpha \Delta PRR_{t-1} + \alpha \Delta PRR_{t-2} + \ldots + \alpha \Delta PRR_{t-156} + \mu$$ (5)

$$\Delta MO = d + \beta \Delta MO_{t-1} + \beta \Delta MO_{t-2} + \ldots + \beta \Delta MO_{t-156} + \mu$$ (6)
Where $\Delta PRR$ is $PRR_t - PRR_{t-1}$, $\Delta MO$ is $MO_t - MO_{t-1}$, $c$ and $d$ are constants, $\alpha$ and $\beta$ are coefficients, and $\Delta$ is a differentiation. If the Augmented Dickey-Fuller statistical value is less than the critical value in the DF table or MacKinnon table at the 1%, 5%, and 10% confidence levels and the probability value is less than 0.05, the PRR and MO variables in the first differentiation are stationary, then a cointegration test can be applied. The cointegration test consists of two stages. The first stage is performed by regressing the dependent and independent variables so that a regression equation can be obtained, as follows:

$$\hat{y}_t = \beta_0 + \beta_1 x_t \quad (7)$$

From the estimate result of equation 7, trace statistic and maximum Eigen value will be achieved by using a cointegration test. Then, the trace statistic and maximum Eigenvalue are compared with the 5% critical point. If they are greater than 5% critical point, there is a cointegration between $X$ and $Y$ [22]. After that a Dickey-Fuller and augmented Dickey-Fuller tests are proceeded to see whether residual $\hat{e}_t$ is stationary or not stationary. The next methods is examining the stationarity $\hat{e}_t$ by using a MacKinnon table [21] then estimating $\mu_t$ from the equation (7):

$$\hat{e}_t = y_t - \hat{\beta}_0 - \hat{\beta}_1 x_t \quad (8)$$

and using equation (4) to estimate residual $\hat{e}_t$ but by substituting it first with $\hat{e}_t$:

$$\Delta e_t = \alpha + \phi^* e_{t-1} + \phi_1^* \Delta e_{t-1} + \phi_2^* \Delta e_{t-2} + \cdots + u_t \quad (9)$$

The null hypothesis $H_0: \phi^* = 0$, whereas $H_1: \phi^* < 0$. If $\phi^* = 0$ is rejected then the residual is stationary. This indicates that there is a cointegration between $x_t$ and $y_t$. If there is a cointegration between $x_t$ and $y_t$, an error correction model test will be proceeded.

$$\Delta Y_t = b_1 \Delta X_t - \lambda (Y_{t-1} - \beta_0 - \beta_1 X_{t-1}) + \epsilon_t \quad (10)$$

where $\lambda$ is an adjustment parameter, $b_1$ is a long-run elasticity from $Y$ to $X$, $b_1$ is a short-run imbalance of $Y$ to the change of $X$. Equation 10 can not be estimated because $\beta_0$ and $\beta_1$ are unknown so the multiplication of notation in the parentheses should be done and the result is

$$\Delta Y_t = \lambda \beta_0 + b_1 \Delta X_t - \lambda Y_{t-1} + \lambda \beta_1 X_{t-1} + \epsilon_t \quad (11)$$

Where $\lambda < 0$, there is a convergence or a speed of adjustment to the long-run equilibrium [23, 24].

### 3. Result and discussion

Table 1 shows that the variables of the retail price of rice are not stationary at zero or I (O) order and the ADF value of the statistic test is greater than the MacKinnon critical value at 1%, 5%, and 10% confidence levels with the probability value which is greater than 0.05. On the other hand, the variable of rice market operations are stationary at zero or I (O) order and the ADF value of the statistic test is less than the MacKinnon critical value at 1%, 5%, and 10% confidence levels with the probability value which is less than 0.05. In order to make the variable of retail price of rice also stationary, there will be a test on first difference or I (1). Both PRR and MO variables are stationary at the first order or I (1). In summary, the stationary test results of each variable using ADF test are shown below. After verifying the stationarity of the data, a cointegration test is conducted by applying Johansen method. The variables to be tested must be stationary at the same degree or at d-order, i.e. MO and PRR.
Table 1. Stationary Test at Level I (0) and Order I (1)

| Variable | Statistic Value of ADF | Test at Level I (0) and Order I (1) | Mac-Kinnon Value | Prob | Conclusion |
|----------|-------------------------|-------------------------------------|-----------------|------|------------|
| PRR      | -0.967                  | -3.473                              | -2.880          | 0.7642 | Not Stationary at I (O) |
| MO       | -7.41                   | -3.473                              | -2.880          | 0.0000 | Stationary at I (0) |
| PRR      | -9.407                  | -3.473                              | -2.880          | 0.0000 | Stationary at I (1) |
| MO       | -10.727                 | -3.473                              | -2.880          | 0.0000 | Stationary at I (1) |

Table 2 shows that the trace statistic and maximum Eigenvalue at none are greater than the critical value at the 5% significance level. The trace statistic test indicates that there is a cointegration at the 5% level, and so does the maximum Eigenvalue test. This means a null hypothesis which states that no cointegration can be rejected and an alternative hypothesis showing that there is a cointegration can be accepted. Based on the above analysis there is a cointegration at the 5% significance level between the two variables, i.e. PRR and MO. Thus, the cointegration test results indicate that MO and PRR have a long-run equilibrium.

Table 2. Johansen’s Cointegration Test (trace statistics) and Maximum Eigen Value

| Hypothesis | Eigen Value | Trace Statistic | 5% Critical Value | Prob |
|------------|-------------|-----------------|-------------------|------|
| None\(^a\) | 0.153399    | 26.87821        | 15.49471          | 0.0007 |
| At most 1  | 0.011410    | 1.732770        | 3.841466          | 0.1881 |

Table 3. The Regression Result of Residual Value with et (-1)

| Variable | Coefficient | Standard Error | t.statistic | Prob |
|----------|-------------|----------------|-------------|------|
| C        | 49.78613    | 10.86795       | 4.581005    | 0.0000 |
| Et (-1)  | 0.995228    | 0.004759       | 209.1438    | 0.0000 |

The next method is estimating the regression between residual value et and et-1 to see whether there is a long-term equilibrium between variables. The regression results are shown in Table 3.
Table 4 shows the coefficient of determination (R squared): PRR variable = 0.25734 and MO variable = 0.289001. It means that about 25.73% out of the PRR total variation and about 28.9% out of the MO total variation are explained by explanatory variables. The results of vector error correction model (VECM) show that the short-run parameter is positive and significant. The sign of cointegration is negative as expected, which indicates the long-run convergence of PRR to the equilibrium level. The result of VECM indicates that the adjustable velocity value ranges from 0.0005 to 0.17. The rice market operations have a greater speed of adjustment to equilibrium than retail price of rice. The rice market operations adjust 17% per month to the long-run equilibrium so that it requires approximately 5.72 months to fully be adjusted. The retail price of rice has the slowest speed of adjustment, only 0.05% per month. In accordance with the results, it is concluded that there will be a long-run rice price stabilization so that the government’s goal can be achieved.

Figure 1. Residual Analysis
Table 4. The result of Vector Error Correction Model

| Cointegrating Eq: CointEq1 | + |
|---------------------------|---|
| PRR(-1)                   | 1.000000 |
| MO(-1)                    | 3.374985 |
|                           | (0.54474) |
|                           | [6.19556] |
| C                         | -33952.35 |

Error Correction:

| D(PRR)              | D(MO) |
|---------------------|-------|
| CointEq1            | -0.000546    | -0.174874 |
|                     | (0.00020)    | (0.02890) |
|                     | [-2.79164]   | [-6.05052] |
| D(PRR(-1))          | 0.328418     | 16.88873 |
|                     | (0.08139)    | (12.0348) |
|                     | [4.03531]    | [1.40332] |
| D(PRR(-2))          | -0.226716    | -16.84699 |
|                     | (0.07853)    | (11.6119) |
|                     | [-2.88716]   | [-1.45084] |
| D(MO(-1))           | 0.002434     | 0.061215 |
|                     | (0.00065)    | (0.09543) |
|                     | [3.77118]    | [0.64148] |
| D(MO(-2))           | 0.001612     | 0.076140 |
|                     | (0.00057)    | (0.08487) |
|                     | [2.80915]    | [0.89717] |
| C                   | 44.94473     | 107.4211 |
|                     | (10.9662)    | (1621.61) |
|                     | [4.09847]    | [0.06624] |
| R-squared           | 0.257349     | 0.289001 |
| Adj. R-squared      | 0.232089     | 0.264817 |
| F-statistic         | 10.18793     | 11.95027 |

Note: Error standard in ( ) and t statistic in [ ]

4. Conclusion

The analysis results using error correction model indicate that the sign of cointegration is negative, real and in line with expectation, which shows that there is a convergence to the long-run equilibrium level, so that there will be a rice price stabilization in a long-run equilibrium. The rice market operations have a greater speed of adjustment to the equilibrium than the retail price of rice. The monthly rice market operations adjust 17% each month to the long-run equilibrium requiring approximately 5.72 months to fully be adjusted.
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