Abstract

Indonesia’s rice economy is in a transition from being a sector heavily regulated by a state trading enterprise (BULOG) to being market-oriented. Before September 1998, BULOG defended a floor price and a ceiling price for rice through a combination of the following policy instruments: domestic procurement to lift paddy prices, market operation to defend ceiling rice retail prices, and import monopoly. To support its operation, BULOG was equipped with financial support from the Indonesian Central Bank. Since September 1998, BULOG’s import monopoly was removed. Trade liberalisation is expected to bring about a better functioning of markets. Two essential measures of market performance are price volatility and market integration. While higher stability of prices would protect rice producers from fluctuating farm income, higher market integration is necessary for efficient resource allocation. Therefore, this paper particularly addresses the following research questions: (1) How volatile were paddy and rice prices in the pre- and post-liberalisation period? (2) Did integration of domestic rice markets improve after trade liberalisation? While standard deviation of the natural logarithm of inter-year price growth is used to address the first question, the second question is addressed via multivariate and bivariate price transmission analysis using the Johansen maximum likelihood method. Using monthly producer price series from 1987 to 2002 and monthly retail price series from 1981 to 2004, the results show that the volatility of both producer and retail prices are higher in the post-liberalisation period. Before trade liberalisation, markets are integrated. In the post-liberalisation period, 2 cointegrating vectors among 5 markets on Java — which should be 4 if markets are integrated — are found with multivariate cointegration. The ensuing test for bivariate cointegration finds that 60 percent of market pairs are cointegrated. Full integration is not found, which may be due to the delayed adjustment of markets to the new policy.

Keywords: Indonesia, market integration, price volatility, rice

2 Background and Objectives

Reasons to study market integration include identification of groups of integrated markets so as to avoid duplication of intervention, and relevance for the success of such policies as market liberalisation or price stabilisation (Goletti et al., 1995), assurance to regional balance between deficit and surplus regions (Goletti et al., 1995; Kherallah, et al. (2000), resolution to the debate
whether government’s market intervention is necessary during famine (RAVALLION, 1986), provision of accurate price information, thereby contribute to producers’ marketing decisions and efficient product movement (GOODWIN AND SCHROEDER, 1991), potential application to policy questions regarding government intervention in markets (ALEXANDER and WYETH, 1994), precondition for effective reform in many of the former centrally planned economies (BAULCH, 1997), and important implications for economic development (GONZÁLEZ-RIVERA and HELFAND, 2001).

Indonesia’s rice economy is in a transition from being a sector heavily regulated by a state trading enterprise (BULOG) to being market-oriented. Before September 1998, BULOG defended a floor price and a ceiling price for rice through a combination of the following policy instruments: domestic procurement to lift paddy prices, market operation to defend ceiling rice retail prices, and import monopoly. To support its operation, BULOG was equipped with financial support from the Indonesian Central Bank. Since September 1998, BULOG’s import monopoly was removed, and subsequently the role of BULOG has been reformed.

Because trade liberalisation is expected to bring about a better functioning of markets, two essential measures - price volatility and market integration - are performed. While higher stability of prices would protect rice producers from fluctuating farm income, higher market integration is necessary for efficient resource allocation. Therefore, this paper particularly addresses the following research questions: (1) How volatile were paddy and rice prices in the pre- and post-liberalisation periods? (2) Did integration of domestic rice markets improve after trade liberalisation?

3 Methods
3.1 Data series
This study used secondary data. Retail rice prices during 1981-2004 are obtained from BULOG. Paddy (unhusked rice) or rice producer prices, Consumer Price Index for 1987-2002 are from Central Board of Statistics (BPS).

3.2 Analysis
To compare rice price volatility in the pre- and post-liberalization periods, standard deviation of log \( \frac{P_t}{P_{t-1}} \), where \( P_t \) is average monthly price in year \( t \) and \( P_{t-1} \) is the average monthly price in year \( t-1 \), is used. Due to multivariate nature of price formation in different markets, this study applies multivariate Johansen maximum likelihood method with the following steps:

- **Test for stationarity (Augmented Dickey-Fuller /ADF):**
  \[
  \Delta P_t = \alpha + \beta_t + \phi P_{t-1} + \sum_{i=1}^{p} \delta_i \Delta P_{t-i} + u_t \quad \text{where} \quad \Delta P_{t-1} = P_{t-1} - P_{t-2}, \quad \Delta P_{t-2} = P_{t-2} - P_{t-3}
  \]
  Under the null hypothesis that \( \phi = 0 \), if the computed absolute value of the \( \tau \) statistic exceeds the Mac Kinnon DF absolute critical \( \tau \) values, then one cannot reject the hypothesis that the given time series is stationary. Price series integrated on first difference proceed to the next analysis.

- **Johansen’s cointegration test:**
  \[
  P_t = A_1 P_{t-1} + A_2 P_{t-2} + \ldots + A_p P_{t-p} + A_{(2(p-1))} P_{t-(p-1)} + A_{(3(p-1))} P_{t-(2(p-1))} + \ldots + A_t + \varepsilon_t
  \]
  \( t = 1,2,\ldots \) refer to the data frequency (months) \( \varepsilon_t \) = vector of error terms \( \Delta P_t = P_t - P_{t-1} \)
  \( P_t = (n \times 1) \) vector of prices \( P_{1t}, P_{2t}, \ldots , P_{nt} \)
  \( A_i = n \times (n-s) \) matrix of coefficients
  Cointegration exists if there are \( n - s \) cointegrating vectors among the elements of the vector \( P_t \) (Granger Representation Theorem in ENGLE and GRANGER, 1987). In this context, the definition
of an integrated market requires that \( s = 1 \) because one searches for locations that share the same long-run information. A major result of the Granger Representation Theorem is that a co-integrated system can be written as a vector error correction (VEC) model
\[
\Delta P_t = \mu + \Pi P_{t-1} + \Gamma_1 \Delta P_{t-1} + \Gamma_2 \Delta P_{t-2} + \ldots + \Gamma_{p-1} \Delta P_{t-p+1} + \varepsilon_t
\]
where \( \Gamma \) and \( \Pi \) are \( n \times n \) matrices and \( \Pi \) has reduced rank \( n - s \). The matrix \( \Pi \) can be written as \( \Pi = \alpha \beta' \), where \( \alpha \) is an \( n \times (n-s) \) matrix of coefficients, and \( \beta \) is an \( n \times (n-s) \) matrix of co-integrating vectors. The method proceeds by first testing the hypothesis \( r = 0 \), that is, there are no cointegrating vector. If this hypothesis can be rejected, it is possible to test the hypothesis that there is at most 1 cointegrating vector \( (r \leq 1) \), and so on.

4 Results
4.1 Volatility of rice prices

The volatility of rice producer prices (average of 3 provinces: West, Central, and East Java) and retail prices (average of 5 markets on Java) is presented at the following table. It shows that the volatility of both producer and retail prices are higher in the post-liberalisation period. This conclusion is obtained by excluding 1998.1-12, which experienced tremendously high volatility due to macroeconomic crisis.

<table>
<thead>
<tr>
<th>Price type</th>
<th>Period</th>
<th>Volatility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producer price</td>
<td>Pre-liberalisation (1987.1-1997.12)</td>
<td>0.0953</td>
</tr>
<tr>
<td></td>
<td>Post-liberalisation (1999.1-2002.12)</td>
<td>0.1637</td>
</tr>
<tr>
<td>Retail price</td>
<td>Pre-liberalisation (1981.1-1997.12)</td>
<td>0.0763</td>
</tr>
<tr>
<td></td>
<td>Post-liberalisation (1998.9-2004.12)</td>
<td>0.1322</td>
</tr>
</tbody>
</table>

4.2 Market integration


Step 1: Test for stationarity of price series

Test for stationarity is separated for pre- and post-liberalisation because prices show different patterns in both periods. Stationary series at level are then excluded from cointegration test (second step) because they do not share a common trend with other markets. When ADF is applied to 1981.1-1998.8, all series are neither stationary at level nor first difference. It is likely that extreme price increases during economic crisis, which tripled over the period of 21 months from January 1997 to October 1998 results in non-stationarity of most price series even after first differencing. Therefore, ADF is recalculated for 1981.1-1996.12; the result of which shows that the exclusion of abnormally high prices during the economic crisis produce stationary series at first difference. Similar results are found for post-liberalisation price series.

Step 2: Cointegration test

The results of cointegration test before and after trade liberalisation are presented at the following two tables. While table 4.2.1 indicates that in the pre-liberalisation period, there are 4 cointegrating vectors among price series of 5 markets on Java, table 4.2.2 shows that 2 cointegrating vectors were found in the post-liberalisation period.
### Table 4.2.1 Johansen trace test for deflated monthly prices in Java pre-liberalisation (1981.1-1996.12)
trend and intercept included

<table>
<thead>
<tr>
<th>$H_0$</th>
<th>$H_1$</th>
<th>LR</th>
<th>p-value</th>
<th>90%</th>
<th>95%</th>
<th>99%</th>
</tr>
</thead>
<tbody>
<tr>
<td>r = 0</td>
<td>r &gt; 0</td>
<td>226.71</td>
<td>0.0000</td>
<td>84.27</td>
<td>88.55</td>
<td>96.97</td>
</tr>
<tr>
<td>r &lt;=1</td>
<td>r &gt; 1</td>
<td>128.08</td>
<td>0.0000</td>
<td>60.00</td>
<td>63.66</td>
<td>70.91</td>
</tr>
<tr>
<td>r &lt;=2</td>
<td>r &gt; 2</td>
<td>57.47</td>
<td>0.0007</td>
<td>39.73</td>
<td>42.77</td>
<td>48.87</td>
</tr>
<tr>
<td>r &lt;=3</td>
<td>r &gt; 3</td>
<td>27.62</td>
<td>0.0277</td>
<td>23.32</td>
<td>25.73</td>
<td>30.67</td>
</tr>
<tr>
<td>r &lt;=4</td>
<td>r &gt; 4</td>
<td>9.79</td>
<td>0.1396</td>
<td>10.68</td>
<td>12.45</td>
<td>16.22</td>
</tr>
</tbody>
</table>

### Table 4.2.2 Johansen trace test for deflated monthly prices in Java post-liberalisation (1998.9-2004.12),
trend and intercept included

<table>
<thead>
<tr>
<th>$H_0$</th>
<th>$H_1$</th>
<th>LR</th>
<th>p-value</th>
<th>90%</th>
<th>95%</th>
<th>99%</th>
</tr>
</thead>
<tbody>
<tr>
<td>r = 0</td>
<td>r &gt; 0</td>
<td>106.82</td>
<td>0.0010</td>
<td>84.27</td>
<td>88.55</td>
<td>96.97</td>
</tr>
<tr>
<td>r &lt;=1</td>
<td>r &gt; 1</td>
<td>60.63</td>
<td>0.0892</td>
<td>60.00</td>
<td>63.66</td>
<td>70.91</td>
</tr>
<tr>
<td>r &lt;=2</td>
<td>r &gt; 2</td>
<td>35.60</td>
<td>0.2242</td>
<td>39.73</td>
<td>42.77</td>
<td>48.87</td>
</tr>
<tr>
<td>r &lt;=3</td>
<td>r &gt; 3</td>
<td>16.13</td>
<td>0.4903</td>
<td>23.32</td>
<td>25.73</td>
<td>30.67</td>
</tr>
<tr>
<td>r &lt;=4</td>
<td>r &gt; 4</td>
<td>5.44</td>
<td>0.5437</td>
<td>10.68</td>
<td>12.45</td>
<td>16.22</td>
</tr>
</tbody>
</table>

### 5 Conclusion and Recommendation

Prices are more volatile after liberalisation, which points toward BULOG’s success in stabilising rice prices. The higher volatility resulting from the release of some BULOG interventions should not affect the poor adversely. Therefore, the so-called “rice for the poor” program should be continued with tough control in order to reach the target group.

Before liberalisation, rice prices across markets move similarly resulting in full market integration. After liberalisation, full integration was not found, which could be due to the delayed response of market to the new policy. Nevertheless, prices in 5 markets on Java show different levels reflecting transfer costs between surplus and deficit regions and serve as a higher incentive for arbitrage.

Further studies should address the response of farmers, traders, and consumers to the new policy and how this affects their welfare. Comparison to later period would be also useful to find out market response.

### References:


