Market Integration and Price Causality in the Myanmar Rice Market

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ABSTRACT

In Myanmar, rice is an invaluable commodity both as a staple food and a source of high foreign exchange earnings through export. The country's agricultural economy has been transitioning from a planned economy to a market system since the late 1980s; however, the government has yet to engage in full-scale rice export deregulation. Therefore, Myanmar's rice marketing system works within the boundaries and limitations of a halfway-liberalized economy, inevitably eliciting questions about its performance.

Using the Engle and Granger two-step co-integration method and the restructured Ravallion model of unrestricted vector auto-regression (VAR) error correction form, three surplus markets, three deficit markets, and Thai rice price series were tested to determine market integration and price causality. All price series were monthly data in both nominal and real values from 2001 to 2004.

Results revealed that in the domestic market, integration was weak in real value of rice price, and the supply side eventually depended on the demand side. Price co-integration did not exist between Myanmar and Thai rice prices in real value, reflecting market segmentation. Consequently, accurate price information from international rice market price over time was unavailable for Myanmar rice price movement. Looking at the direction of rice price causality, deficit market prices were driving the consumer price index (CPI), and the CPI was forcing the surplus rice market price. Hence, deficit markets are the prime movers in rice price changes in Myanmar.

Market integration suggests that the government should focus on managing inflationary pressure instead of being directly involved in the rice marketing sector in order to control the domestic rice price stability in the long run. Government monopoly in rice export has caused segmentation between domestic and international markets. If private rice export was permitted via trade policies, the marketing system would be able to transfer correct price signals from the world market to the producers, consumers, market participants, and finally, the government. Only then will Myanmar's rice market not be isolated from the international market and get the right price co-integration that may push the efficient market-oriented economy to move faster.

INTRODUCTION

The Myanmar Rice Market

Natural resources are abundant in Myanmar, a member of the Association of Southeast Asian Nations (ASEAN), as reflected by its cultivable land, available water resources, and climate favorable for agriculture. Rice, the country's staple food, is economically and politically significant. Successive governments have attempted to develop the country's rice economy to match production with domestic consumption, to maintain stable rice prices for political reasons, and to increase the rice surplus for export. However, Myanmar's rice export has had a decreasing trend over time. Moreover, paddy farmers are implicitly taxed because of the ban on private-sector export of rice.

As stated in the World Development Report 2001 (World Bank 2002), the international price of rice was higher than domestic prices, and because of that the price received by paddy farmers was about a third lower than what they could export freely. Eventually, policies in rice production, land, and rice pricing affected not only agricultural production but also rice marketing in the country.

Myanmar consumes relatively more rice compared with other countries because it also utilizes the crop for different varieties of snack food (e.g., vermicelli, rice noodle, and rice cake). In 1999, it had the highest average annual per capita consumption of rice at 211 kilograms (kg), which accounts for two thirds of calorie intake and 68 percent of daily protein consumption (World Bank 2002). In the same year, the share of household expenditure for food was about 79 percent, of which about 19 percent was for rice. According to Kriesberg (1974), consumers in developing countries frequently spend more than 50 percent of household income on basic foodstuffs. Rice is the most important food item for Myanmar's inhabitants; the largest expenditure of the average household is for food, of which rice is the largest component.

With these issues in view, the income level of the average family in Myanmar can be estimated using Engel's Law: when a family's income increases, the proportion of money they spend on food decreases. The high share of food in total expenditure and the high rate of cereal consumption indicate a low standard of living. The income level of the average household must be increased substantially to boost the family's ability to spend on other items that are considered desirable in any economic policy. Moreover, rice price stability is an important factor in consumers' expenditure.

Therefore, rice is the most important crop in Myanmar. Sustainable growth in paddy production is key to economic growth and poverty alleviation in the country. National planners have always prioritized increasing rice production—the major policy objectives are to increase production for self-sufficiency and to produce an exportable surplus to inflate Myanmar's foreign exchange earnings.

The drastic political and economic transitions that occurred in the latter part of 1988 instigated major economic changes that significantly affected Myanmar's agriculture. That period was called the first liberalization of the agriculture sector in Myanmar. The government had introduced the market economic system and allowed farmers to cultivate crops according to their choice, except paddy production. This was succeeded by a post-crisis year for agricultural commodity exporters.

Such was the condition, that paddy still had to be purchased from farmers under a quota system through the Myanmar Agricultural Produce Trading (MAPT) handled by the Ministry of Commerce. This quota was applied to all monsoon paddy production at the rate of 10 to 12 baskets per acre, which

went to government employees, police, army, hospitals, and other social welfare institutions at subsidized prices as a rationing system. The rest of the quota was for exports.

About 11 percent of paddy production was below market prices, which thereby reduced farm gate prices by about 8 percent (World Bank 2002). The quota failed to respond to the farmers' actual acreage under paddy; hence, it resembled implicit tax. The main policies of implicit taxes were levied by the paddy procurement system and the ban on private sector paddy exports. Consequently, government intervention in the rice market led to the emergence of different rice prices in official and in parallel markets. The dual pricing system in the domestic market resulted in inefficient resource allocation in both production and marketing sectors.

In addition, the State Trade Council oversees foreign trade. Myanmar has a history of abrupt changes in government policy, and such changes are highly disruptive in the marketing process. The 10-percent export levy on all agricultural commodities, which was imposed on January 1, 1999, became a big disincentive for foreign trade. Thus, to date, Myanmar's agricultural marketing system operates within the boundaries and limitations of a halfway-liberalized economic system.

In the cropping season of 2003-2004, the government abolished the low-price procurement system on rice. The new rice trading policy was adopted to ensure free trade of the crop to aid the market-oriented economy. This marked the second liberalization of the agricultural sector under the present government.

According to the new rice export policy, export tax is not transparent for private rice exporters. Private firms that intend to conduct import or export operations must register at the Registration Office for Export and Import at the Ministry of Trade, and receive an import or export license. Import license holders should obtain permission for every import, to which an application fee is charged. Conversely, state-owned enterprises and the Ministries are exempted from this requirement. The aftermath of the second liberalization manifests the government's lack of readiness to undertake full-scale rice export deregulation.

Another major obstruction to the progress of agricultural marketing is the insufficient infrastructure facilities in Myanmar. It has become a substantial problem especially in the promotion of foreign trade, since infrastructure such as harbour facilities and bonded warehouses are lacking. In the policy reform, policymakers have prioritized stable rice price and sufficient supply of affordable rice to consumers.

However, under this situation, the higher nominal rice price may have resulted from price deregulation, removal of subsidies, depreciation of an over-valued exchange rate, and relaxation of compulsory government procurement policy. Meanwhile, the domestic rice price was lower than the international rice price; its effect on the rural poor is ambiguous because they are both producers and consumers of rice. A higher nominal rice price almost certainly has a negative impact on the urban poor, since the latter spend a relatively large share of their budget on food. Hence, as with other rice-producing countries, the Myanmar government is often confronted with a classic policy dilemma: retaining low prices for poor consumers while keeping prices attractive to producers.

Objectives of the Study

In general, this study sought to investigate the structure, conduct, and performance of the rice market in the private sector within the context of rice market liberalization. In particular, it aimed to (1) appraise the performance of the domestic rice market by evaluating the spatial market integration in the long run, (2) investigate the price co-movement between the domestic rice

price and the international rice price in the long run, and (3) identify the driving force of rice price formation and price causality of market mechanism in the domestic market.

METHODOLOGY

Time Series Price Data Collection

To determine the long-term performance of the rice market, weekly wholesale rice price data from 2001 to 2004 were analyzed. The markets of Yangon, Pathein, Pyay, Mandalay, and Taunggyi were chosen to represent the spatial market integration, along with the following rice varieties: Pawsan, Ngasein, Manawthukha, and Inmayebaw. Based on the 10 sets of data on domestic rice markets, there are 216 sets of weekly price data and monthly consumer price indices; and 48 sets of data on Thai rice export prices.

Among the selected rice varieties, the most popular is Pawsan, which is marketed from Pathein and Yangon to all other deficit markets. In this study, the markets of Mandalay and Taunggyi were emphasized as deficit markets. Ngasein, the coarse rice, is preferred by low-income consumers, especially in rice-deficit areas. It is mainly transported from Yangon to Mandalay. Manawthukha, which has a fair eating quality and a reasonable price, is the most preferred variety of middle-class consumers. It is produced in all paddy-grown areas and marketed across all regions in Myanmar. The integration of the price series in surplus and deficit markets such as Pathein and Mandalay is also worth noting. The last variety, Immayebaw, which is produced in the surplus region of Pyay, is mainly transported to Taunggyi.

The price signal from the international market concerned is the free on board (FOB) price of Thai rice (5% broken). Thailand, a neighboring country of Myanmar, is the dominant world exporter of rice. Thus, Thai export price is generally considered the indicator of the world rice price. The prices of Pawsan from Yangon and Thai rice were analyzed to determine the external market integration. All price series were monthly data for years 2001-2004. In addition, the monthly market exchange rates were used for domestic currency conversion. Monthly consumer price index (CPI) was applied in calculating the real price of selected rice price series.

These time series data were obtained from the Market Information Service (MIS), which is under the Ministry of Agriculture and Irrigation (MOAI). Secondary data were gathered from published documents and official records of MOAI, Food and Agriculture Organization, MAPT, Central Statistical Organization, MIS, International Rice Research Institute, and various companies in Yangon.

Time Series Data Generation Process

The co-integration method was used in the integration analysis of the Myanmar rice market. Briefly, co-integration means: (I) two variable series, for example P_{it} and P_{jt}, are non-stationary in levels but stationary in first differences, that is, P_{it}~I(1) and P_{jt}~I(1); (II) a linear combination exists between these two series that are stationary. Therefore, the first step of co-integration is to test whether the series are stationary. Should they both be I(1), the second step is to test for co-integration with the residual of the regression equation and causality test.

The Augmented Dickey-Fuller (ADF) method tests whether the series or the order of integration of each variable is stationary (Dickey and Fuller 1979). Therefore, each price series to be tested for null hypothesis is $\beta = 0$ by using the following equation with constant and time trend:

$$\Delta P_t = \alpha + \beta P_{t-1} + \gamma t + \sum_{k=1}^{n} \delta \Delta P_{t-k} + \xi_t \quad (1)$$

where:

$$\Delta P_t = P_t - P_{t-1};\ \Delta P_{t-k} = P_{t-k} - P_{t-k-1}$$

(Δ is the difference in prices);
$k = 2, 3...n$ (k is the number of lagged differences);
P_t = the price at time t;
α = vector of constants;
γ = trend coefficient;
β and δ = parameters to be estimated;
and ξ_t = the white noise error term.

If the coefficient of t-statistic on P_{t-1} (β), or the ADF statistic, is positive and not negative, the price series will not be stationary I(1). In this case, the test should be repeated using ΔP_t as the dependent variable and so on, until the order of integration is determined. If the value of the ADF statistic is less—that is, more negative, since these values are always negative—than the critical values which are provided by Mackinnon (1990), it shows that P_t is stationary. Hence, it may be concluded that $P_t \sim$ I(1). If P_t is non-stationary, it should be determined whether P_t is stationary in the first difference—that is, to test $P_t - P_{t-1} \sim$ I(1)—by repeating the above procedure. The second step of testing for co-integration can be done using the Engle and Granger (1987) two-step residual-based test.

Method of Market Integration

The two-step, residual-based test developed by Engle and Granger (1987) was adopted to test for co-integration, which was analyzed using Time Series Processor software. The first step of the test is the co-integrating regression of one I(1) price series (P_{it}) on another I(1) price series (P_{jt}). However, some linear combinations of these series exist, which is I(0). This is the co-integration of order (1, 1). The co-integration vector is the vector of coefficients of the linear combination of the series that is stationary.

The co-integration vector is a vector of constants, such that $e_t = aP_{it} - bP_{jt}$ is I(0). In this case, the coefficient estimate of the price P_{jt} of the ordinary least squares (OLS) regression of P_{it} on a constant is the ratio of a and b; therefore, ω = b/a. Then, the co-integration vector of the form (ω, 1) should be identified. The first step is to determine ω as the slope coefficient of co-integration regression, and as a constant and time trend of price P_i.

$$P_{it} = \phi + \omega P_{jt} + \eta_t + e_t \quad (2)$$

where:
P_{it} is the price in market i at time t,
P_{jt} is the price in market j at time t,
ϕ is constant,
ω is parameters to be estimated,
η is the time trend parameter,
and e_t is the error term.

The second step is to test whether the residuals, e_t, from the co-integration regression are stationary by using the ADF test,

$$\Delta e_t = \lambda e_{t-1} + \sum_{k=1}^{n} \theta_k \Delta e_{t-k} + \mu_t \quad (3)$$

$$\Delta e_t = e_t - e_{t-1};\ \Delta e_{t-k} = e_{t-k} - e_{t-k-1};$$

where e_t, e_{t-1}, e_{t-k}, and e_{t-k-1} are the residuals at times t, $t-1$, $t-k$, and $t-k-1$, respectively; λ and θ_k are parameters to be estimated; and μ_t is the error term.

In this regression for the residual, the constant and time trend are not included because the residuals from the co-integration regression will have a zero mean and be de-trended. The null hypothesis that $\lambda=0$ is tested again. However, this is a test of residual

stationary rather than original time series. If the ADF *t*-statistic value of the λ coefficient is less than the relevant critical value (Mackinnon 1990), the null hypothesis is rejected and two price series are co-integrated to order 1 _, which means two markets are integrated in the long run.

The main problem in the Engle and Granger procedure is the small sample bias, particularly when there are more than two variables in the co-integration regression. To overcome this problem, this study calculates ADF statistics twice for each pair of price series by using the dependent variable in turn. This is to determine whether the same level of significance will be obtained in either direction of the market or how much bias there is in identifying the problem.

The Price Causality Model

Working for the causality of the price movement between two markets, the basic equation of the Ravallion model (Ravallion 1986) can be restructured in the form of unrestricted vector auto-regression (VAR) of the error correction form testing on the causality. The model can be presented as follows:

$$\begin{aligned}\Delta P_t = {} & C_{it} + \rho_{il}\Delta P_{t-1} + \ldots + \rho_{in}\Delta P_{t-n} \\ & + \rho_{jl}\Delta R_{t-1} + \ldots + \rho_{jn}\Delta R_{t-n} \\ & + \beta_1 P_{t-1} + \beta_2 R_{t-1} + \xi_{it}\end{aligned} \tag{4}$$

$$\begin{aligned}\Delta R_t = {} & C_t + \rho_{fl}\Delta P_{t-1} + \ldots + \rho_{fn}\Delta P_{t-n} \\ & + \rho_{ll}\Delta R_{t-1} + \ldots + \rho_{ln}\Delta R_{t-n} \\ & + \beta_3 P_{t-1} + \beta_4 R_{t-1} + \xi_t\end{aligned} \tag{5}$$

The model can be written as:

$$\begin{aligned}\Delta P_t = {} & C_{it} + \sum_{n=1}^{k} \rho_{in}\Delta P_{t-n} + \sum_{n=1}^{k} \rho_{jn}\Delta R_{t-n} \\ & + \beta_1 P_{t-1} + \beta_2 R_{t-1} + \xi_{it}\end{aligned} \tag{6}$$

$$\begin{aligned}\Delta R_t = {} & C_t + \sum_{n=1}^{k} \rho_{fn}\Delta P_{t-1} + \sum_{n=1}^{k} \rho_{\ln}\Delta R_{t-n} \\ & + \beta_3 P_{t-1} + \beta_4 R_{t-1} + \xi_t\end{aligned} \tag{7}$$

where Δ denotes the first difference operator, k is the number of lag to be determined, ξ_{it} and ξ_t are random error terms, and P_{t-1} and R_{t-1} are the one-period lagged value of the respective prices that are replaced by the single term of the residual from the co-integration regression (usually in error corrections models).

The auto-regression term is due to the appearance of the lagged value of the dependent variable. Meanwhile, the vector term is due to dealing with a vector of two or more variables. These equations state that the change in price of market *P* at time *t* can be predicted by its past prices and those of market *R*, and it postulates a similar behavior for *R*. There is a strong connection between co-integration and causality in this procedure, and the Granger causal relationship must exist at least once in an integrated system.

If the estimated coefficients of the lagged prices *R* (ρ_{jl}, ρ_{jn}, and β_2) are statistically different from zero, these will be on a unidirectional causality from *R* to *P* as indicated in the equation (4). Conversely, if a unidirectional causality from *P* to *R* exists, the set of the lagged coefficients of *P* (ρ_{fl}, ρ_{fn}, and β_3) should be significantly different from zero in the equation (5). Lagged alternative prices provide a better prediction of current changes in one price. Bilateral causality is suggested when the sets of price *P* and *R* coefficients are statistically significantly different from zero in both regressions.

Therefore, rejection of the joint hypothesis by using the standard F test is:

$$\mathrm{H}_0 : \rho_{jl} = \ldots \rho_{jn} = \beta_2 = 0 \text{ and } \rho_{fl} = \ldots \rho_{fn} = \beta_3 = 0 \tag{8}$$

The number of lagged terms is an important consideration for the testing of causality. The direction of causality may depend critically on the number of lagged terms applied. Therefore, the Akike Information Criterion will be used for the suitable lag length.

RESULTS AND DISCUSSION

Data Generating Process of Selected Rice Price Series

According to the econometric methodology, one of the first steps in co-integration analysis is to test for the stationary properties of the univariate time series. The results of the unit root test (with intercept and trend) presented in Table 1 indicate that the ADF *t* value of all selected price series and CPI were not significantly different from zero at price level.

Therefore, all price series were tested again on first differences. The results of coefficients were significantly different from zero as all ADF values of price series and CPI were less than the critical value (more negative). As a result, all nominal and real value price series were I(1), which means these series were integrated in order 1.

Co-integration Among Nominal Rice Price Series

Testing the co-integration of rice price series in nominal value is the primary consideration in this paper. The selected Pawson rice markets were Yangon, the biggest market; Pathein, the major supply market; Mandalay, the focal point of deficit areas; and Taunggyi, the important transit market of deficit mountainous and border areas. The results of the bivariate tests for Pawson in terms of nominal value are reported in Table 2. To check the small sample bias in the Engle-Granger procedure, this study calculates twice for each price series using each

Table 1. ADF statistics of unit root test on selected rice price series

Price Series	ADF *t* Value (Price Level)		ADF *t* Value (First Differences)	
	Nominal	Real*	Nominal	Real*
Surplus Markets				
Yangon-Pawsan	-1.6012	-1.2517	-8.5972	-5.1348
Pathein-Pawsan	-1.9633	-2.7269	-6.4328	-5.4978
Yangon-Ngasein	-1.2584	-1.6866	-6.0511	-4.0452
Pathein-Manawthukha	1.8101	-1.9491	-6.4414	-4.6072
Pyay-Immayebaw	-1.6594	-1.8551	-6.2647	-5.0937
Deficit Markets				
Mandalay-Pawsan	-1.5227	-0.8626	-7.4922	-3.6088
Taunggyi-Pawsan	1.4415	-1.4272	-8.3228	-4.1876
Mandalay-Ngasein	-1.3942	-0.8527	-7.0536	-4.2377
Mandalay-Manawthukha	-1.4035	-1.3972	-7.0741	-4.1330
Taunggyi-Immayebaw	-1.1345	-1.4649	-5.9037	-4.2078
Thai Rice	-2.099*	-2.1147	-5.5690*	-6.0047
CPI		0.3027		-4.5725

Notes: 1. Number of lag are 4 for weekly data and 2 for monthly data allowed by AIC
2. * is monthly price series
3. Mackinnon critical value: -4.1678 (1%) and -3.5088 (5%) for monthly data
4. Mackinnon critical value: -3.99 (1%) and -3.43 (5%) for weekly data

Table 2. Co-integration between Pawson nominal price series (ADF *t* statistics)

Price Series	Yangon	Pathein	Mandalay	Taunggyi
Yangon		-8.9575***	-8.4628***	-8.5830***
Pathein	-5.4875***		-5.2573***	-5.3482***
Mandalay	-6.6009***	-6.5092***		-6.6654***
Taunggyi	-7.3972***	-7.3511***	-7.3634***	

Notes: 1. Row variables are dependent variables in co-integrating regression
2. Mackinnon critical value: -4.4085 (1%), -3.8308 (5%), and -3.5343 (10%)
3. *** indicates market integration at 1% level

price series as a dependent variable, as seen in Alexander and Wyeth (1995).

The ADF *t* statistic results from both sets of regression are shown in Table 2. There were fewer negative ADF *t* values of residuals than critical values at 1 percent level, which indicated that all pairs of nominal rice price series were highly co-integrated in the long run. All price pairs of co-integration results were reasonably robust to trade off dependent and independent variables. There was no significant difference among all their estimated ADF *t* values in terms of dependent and independent variables.

Other rice varieties included in the co-integration analysis were Ngasein for Yangon and Mandalay, Manawthukha for Pathein and Mandalay, and Immayebaw for Pyay and Taunggyi. The results of integration regressions of nominal price series are presented in Table 3.

According to ADF *t* values of the residuals, there was a long-run rice market integration in Myanmar in 2001-2004, since ADF *t* values of regressions were less than the critical *t* value at 1 percent level. According to the results of nominal price co-integration in the Myanmar rice market, the question arising is whether or not inflation was driving the rice price co-integration during the study period. If so, then it is the reason why market integration was stronger in terms of nominal price series.

Co-integration among Real Rice Price Series and Consumer Price Index

To address the above question, all price series were deflated and tested again using the same procedure to determine if a strong market integration in the real price series still existed. Integration analysis was also carried out for the Pawson price series with CPI, which was the series used to indicate inflation in the country over the study period. The estimated co-integration results of the real price series of Pawson rice prices in the study markets are shown in Table 4.

The ADF results of the integration regressions indicated that Yangon-Mandalay was integrated at 1 percent level and Yangon-Pathein and Yangon-Taunggyi market pairs were integrated at 5 percent level in real price value when Yangon was a dependent variable. However, there was no market integration between Mandalay-Yangon and Taunggyi-Yangon when Yangon was tested as an independent variable.

Among the market pairs, Yangon-Pathein (both surplus markets) and Mandalay-Taunggyi (both deficit markets) pairs were co-integrated in both regressions of dependent and independent variables at 5 percent significance level. They were not co-integrated in deflated price series analysis for the market pairs of Mandalay-

Table 3. Co-integration among other varieties of nominal price series (ADF *t* statistics)

Pairs of Price Series	Coefficient of Residual	Standard Error	ADF *t* Statistics
Ngasein			
Yangon- Mandalay	-0.9564	0.1341	-7.1332***
Mandalay-Yangon	-0.8839	0.1264	-6.9915***
Manawthukha			
Pathein-Mandalay	-1.0465	0.1699	-6.1575***
Mandalay-Pathein	-0.9564	0.1341	-7.1332***
Immayebaw			
Pyay-Taunggyi	-0.9331	0.1526	-6.1143***
Taunggyi-Pyay	-1.0222	0.1577	-6.4789***

Notes: 1. First variables are dependent variables in co-integrating regression
2. Mackinnon critical value: -4.4085 (1%), -3.8308 (5%) , and -3.5343 (10%)
3. *** indicates market integration at 1% level

Table 4. Co-integration among Pawsan real price series and CPI (ADF *t* statistics)

Price Series	Yangon	Pathein	Mandalay	Taunggyi	CPI
Yangon		-4.4326**	-5.1333***	-4.5561**	-5.1212***
Pathein	-4.4612**		-4.3459**	-4.3136**	-4.3707**
Mandalay	-2.5569 ns	-3.4128 ns		-4.6176**	-4.1755**
Taunggyi	-3.5061 ns	-3.6016 ns	-4.3287**		-4.1460**
CPI	-2.2812 ns	-2.1808 ns	-2.1955 ns	-2.3164 ns	

Notes: 1. Row variables are dependent variables in co-integrating regression
2. Mackinnon critical value: -4.6972 (1%), -4.0028 (5%), and -3.6617 (10%)
3. ***, **, and ns indicate market integration at 1%, 5% level, and no integration, respectively

Yangon, Mandalay-Pathein, Taunggyi-Yangon, and Taunggyi-Pathein. For these, regressions were analyzed using surplus markets as the independent variables. Therefore, the deficit rice markets appeared to be independent from the long-run integration in real terms. Remarkably, each rice price was consistently integrated with the CPI at 1 percent and 5 percent level, while each of the rice prices was a dependent variable. Hence, with regard to integration, CPI or inflation effect appeared to be independent of the rice price; simultaneously, rice price in Myanmar would depend on the CPI over time.

Table 5 shows similar results of other chosen rice varieties. Market pairs of Ngasein, Manawthukha, and Immayebaw varieties were integrated at 5 percent level, whereas surplus markets (Yangon, Pathein and Pyay) were dependent variables of integration regressions. When the deficit rice markets (Mandalay and Taunggyi) were tested as dependent variables in regressions, the null hypothesis of the market integration test could not be rejected because these markets were not integrated for the long run in real terms. This may be the reason for the different results of nominal price series and real

Table 5. Co-integration among other varieties of real price series

Pairs of Price Series	Coefficient of Residual	Standard Error	ADF *t* Statistics
Ngasein			
Yangon-Mandalay	-1.3713	0.2668	-4.1310**
Mandalay-Yangon	-1.1024	0.4113	-3.3339 ns
Manawthukha			
Pathein-Mandalay	-1.9188	0.4312	-4.4995**
Mandalay-Pathein	-1.1397	0.3580	-3.1829 ns
Immayebaw			
Pyay-Taunggyi	-1.8096	0.4096	-4.4175**
Taunggyi-Pyay	-1.4870	0.4035	-3.6245 ns

Notes: 1. First variables are dependent variables in co-integrating regression
2. Mackinnon critical value: -4.6972 (1%), -4.0028 (5%), and -3.6617 (10%)
3. ** and ns indicate market integration at 5% level and no integration, respectively

price series. The price co-movement between pairs of markets in nominal value seemed to include the inflation effect. Therefore, after the deflated price series, the integration was significant only at 5 percent level.

This result provided evidence for the Myanmar rice market integration. The latter was leading to a lower degree of co-integration between pairs of price series in deflated value than nominal value price series, which shows why inflation will be the driving factor for the rice market integration over time. Furthermore, market integration still existed in turn of regressions between market pairs of both surplus-surplus markets (Yangon-Pathein) and both deficit-deficit markets (Mandalay-Taunggyi). On the other hand, the movement of surplus rice market prices on the supply side depended on the demand side, which was the deficit rice market price series concerning the market integration during the period 2001-2004.

Co-integration between Myanmar and International Rice Price

Co-integration testing between Myanmar and Thai rice prices was employed to investigate the link of the Myanmar rice market price movement to the international rice price fluctuation. The rice price signal from the international market concerned was the Thai rice (5% broken) FOB price. The price used for the local market that was analyzed with the Thai price was that of Pawsan from Yangon, which was the focal point of rice marketing in Myanmar. ADF *t* values of the residuals from integration analysis are addressed in Table 6.

The result of the two-step Granger residual-based test indicated that Yangon-Pawsan price was integrated with the Thai rice price only in nominal value, at 10 percent significant level, while Yangon market price depended on the Thai rice price. The Myanmar rice price movement did not co-integrate with the Thai rice price in the deflated value during the study period. Market segmentation existed between two markets in real value. The presence of co-integration between two series indicated strong interdependence. Market segmentation

Table 6. Co-integration between Yangon-Pawsan and Thai rice price series

Statistics	Nominal Value		Real Value	
	Y-P Vs Thai	Thai Vs Y-P	Y-P Vs Thai	Thai Vs Y-P
Coefficient of residual	-1.2659	-1.0858	-1.4763	-0.7888
Standard error	0.3350	0.3819	0.4431	0.3387
ADF *t* statistic	**-3.7780***	**-2.8427** ^{ns}	**-3.3318** ^{ns}	**-2.3285** ^{ns}
R^2	0.5650	0.5435	0.5832	0.5778
Durbin-Watson Stat.	1.9650	1.8654	1.9999	1.9289

Notes: 1. First variables are dependent variables in co-integrating regression
2. Mackinnon critical value: -4.6972 (1%), -4.0028 (5%), and -3.6617 (10%)
3. * and ^{ns} indicate market integration at 10% level and no integration, respectively

occurred when there was no co-integration. In this situation, the price signal in one market did not translate to the other market, implying that price changes were not the same in different markets. Hence, two markets were economically segmented in the long run.

Consequently, the Myanmar rice price movement was isolated between external rice market prices over time. The relationship between the Myanmar rice market and the international rice market was not good. Therefore, the Myanmar rice market could not get the price signal from the international rice price because the domestic rice price movement was not co-integrated with the international rice price over time. The monopolized rice export and firmly limited rice marketing in the border area could not reflect the international rice price over time under the present government's policies in the Myanmar rice market.

Price Causality Analysis of Selected Rice Price Series

According to the Granger causality, the causal relationship between two price series can be determined by examining the way they move with respect to each other over time. The results from the causality analysis of each market pairs for Pawsan and CPI are presented in Table 7.

Based on the causality F values, causality between Yangon and Pathein was only unidirectional. Yangon was the major transit focal point and Pathein was the main supply side of the Pawsan variety. Therefore, Pathein rice price changes were caused by Yangon at 1 percent significance level. However, Yangon rice price changes were not caused by Pathein.

Bilateral causality existed between Yangon and Mandalay, which was the focal transit market of deficit regions. The Yangon rice price movement was caused by the Mandalay market lag price at 1 percent level; Mandalay-Yangon feedback was found at 10 percent level. Also, Yangon market rice price changes were caused by Taunggyi rice price changes at 10 percent significance level. The price changes of the major supply market of Pathein was caused by Yangon at 1 percent level and caused by the Mandalay and Taunggyi rice price at 5 percent level.

On the other hand, changes in the Pathein rice price could not take place in any other selected market according to the causality result. Though the case was less strong, the Mandalay price was changed by the Yangon price. At the same time, the Taunggyi rice price could change the Mandalay rice price at 1 percent level. As such, the Mandalay and Taunggyi market rice price movements were

Table 7. Causality *F* statistics of Pawson market pairs

Price Series	Yangon	Pathein	Mandalay	Taunggyi	CPI
Yangon		1.8626 ns	6.2609***	2.7321*	2.5518*
Pathein	6.7904***		3.1582**	3.3245**	2.7723**
Mandalay	2.2815*	1.3924 ns		6.0004***	0.9457 ns
Taunggyi	0.0082ns	0.2033 ns	0.0044 ns		0.3530 ns
CPI	1.3995 ns	0.1722 ns	3.7983**	3.8105**	

Notes: 1. Null hypothesis: Row market is not caused by column market in each pair
2. ***, **, * and ns indicate significant F values at 1%, 5%, 10% levels and not significant, respectively

Table 8. Causality *F* statistics of other varieties of market pairs

Market Pairs	*F* Value	Decision for Null Hypothesis
Ngasein		
Yangon-Mandalay	7.2291	Reject null hypothesis at 1% level
Mandalay-Yangon	2.7035	Reject null hypothesis at 10% level
Manawthukha		
Pathein-Mandalay	8.1789	Reject null hypothesis at 1% level
Mandalay-Pathein	1.2705	Accept null hypothesis
Immayebaw		
Pyay-Taunggyi	2.2459	Reject null hypothesis at 10% level
Taunggyi-Pyay	0.1922	Accept null hypothesis

Notes: 1. Null hypothesis: First market is not caused by second market in each pair
2. Critical value: 2.18 (10%), 2.76 (5%), and 4.13 (1%)

likely to be the source of rice price formation, being the important centers of the demand side. Causality directions between CPI and each rice price series were enlightening; CPI changes were caused by Mandalay and Taunggyi rice prices at 5 percent level. The CPI lag value caused changes in the Yangon and Pathein rice prices at 5 percent level.

Results of the causality regression models of other selected rice varieties are shown in Table 8. The causality F values were consistent with the integration result between market pairs. Bilateral causality could be seen in Yangon-Mandalay Ngasein market pairs, though with different levels of significance. There was strong causality from the Mandalay rice price to the Yangon focal market price at 1 percent level. Expectedly, the Yangon market rice price could have caused the changes in the Mandalay rice price at 10 percent level, as these two markets represented the major supply side and major demand side of the Myanmar rice sector.

For the Manawthukha variety, Pathein was considered the supply source while Mandalay was the main deficit market. Causality was present only on one side — from Mandalay to Pathein. The Mandalay rice price could control rice price variation in Pathein, since the causality F value was significant at 1 percent level in the regression model. For the Immayebaw variety, Taunggyi was the most important in the demand side while Pyay was

the major supply market center. Indeed, there seemed to be a weak causality from Taunggyi to Pyay since the null hypothesis was rejected at 10 percent level. However, causality analysis results showed that the Taunggyi rice price volatility was not caused by the Pyay rice price.

Based on the causality results, Figure 1 reveals clearly the rice price formation system in Myanmar under the present government. The Myanmar rice market price formation was driven by the deficit markets through inflation in particular; and rice price causality finally went to the capital market and supply side. The price signal from the capital market was back to the deficit market in turn though the result of causality was slightly weak. From the inflation effect and rice price relationship, it seems that the rice price of the major demand side was the source of inflation and inflation, in turn, could possibly be the root of the rice price changes in capital and major surplus markets.

CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis of the Myanmar rice market integration, sample pairs of markets were highly integrated in nominal terms due to the reasonable development of market infrastructure, such as road network and communication system for the price information conveyed, during the present government era. However, the market pairs were weak in real terms of the price series. The difference between nominal and real values was present four times during the study period. Thus, there is a possibility that rice market integration in Myanmar is influenced by high inflation.

In addition, the price of Myanmar rice was not integrated to the Thai rice price in the deflated value. Consequently, accurate price information from the international rice market over time could not be conveyed for rice price movement in Myanmar. According to Tomek and Robinson (1990), inefficient product movements could happen in the Myanmar rice market because of the distortion of rice producers' marketing decision making.

Looking at the direction of price causality, it was clear that prices came from the rice-deficit markets along with the CPI, which then finally go to the surplus markets. Alternatively, the paddy supply side in Myanmar is also essentially stable over time due to land policy limitation and restricted cropping choice. Price formation is consequently based on the demand-supply relationship. If demand is less constant than supply, the changes in demand will affect the demand supply relationship. Subsequently, price formation is driven by the demand side.

As a result of rice price causality, rice price was driven by the inflationary pressure in deficit markets. Consequently, this price signal was heading towards the supply side. This result suggested that the demand side was more fluctuated by the effect of inflation pressure than the supply side over the course of the year,

Figure 1. Causality-based rice price formation in Myanmar, 2001-2004 (real value)

which is why price changes originated from the deficit markets in Myanmar.

As far as government interventions in the rice market are concerned, achieving stable rice price for domestic consumers was the main priority of the rice marketing policy. However, their attempts to maintain the stable rice price were failing under inflationary pressure. Therefore, rice price signal was transmitted all the way through inflation from deficit market to surplus market over time.

According to the price causality analysis, policymakers and market participants should pay attention to the fact that rice price that originated in Myanmar is pulling inflation to the demand side. Also, the state should lessen the pressure on the supply side of the rice market in the bilateral price causality to achieve balanced rice price formation in both sides of the market mechanism.

The overall performance of the rice market in the long run is affected not only by the direct link of the marketing system but also by macroeconomic policies. The rice prices changed from time to time, including inflation, and this signal went to market participants, farmers, and finally, consumers. Such price and integration may also not be appropriate signal for the government. Therefore, policy makers should consider very carefully the inflation effect on the rice market when a new policy is implemented in rice marketing in Myanmar.

It is clear that future growth in the rice sector depends on export. The export-oriented strategy should be consistent with food security and smallholder paddy production. The state should seriously consider that the price signal from the international rice market is vital to the farmers and market participants; hence, the state should allow the international rice price signal to reach the farmers and market participants by allowing private rice export.

Nevertheless, if private rice export is permitted through trade policies, the marketing system would transfer the price signal from the world market to the producers, consumers, market participants, and finally, the government. Only then will Myanmar's rice market stop being isolated from the international market and get the right price co-integration that may push the efficient market-oriented economy to move faster.

The Myanmar government has been taking steps to achieve a market-oriented economy. In 2003, paddy procurement and the rice rationing system were abolished, and the monopolized export was relaxed. These were initiatives to boost future rice marketing efficiency and performance in the country. However, the government still lacks credibility in policy announcement and transparency. Therefore, successful market reform needs not only liberalization but also market information support, research and extension, and development of the legal and financial infrastructure, which requires promoting a competitive rice market in Myanmar.

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