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Market Integration Analysis in Selected Rice Markets of Myanmar

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This study analyzed the price integration for selected rice markets in Myanmar from April 2001 to May 2004. The purpose of this analysis was to understand market functioning for helping lawmakers further developing the rice market. In order to make a liberalization of the rice market there has to be certain specific market improvements in behaviors and relationships between central and local rice markets.

The Autoregressive Distributed Lag model establishes existence of a long–run integration between pairs of markets. This indicates the influence of the Yangon Central Market price in the long–run to local markets. Error Correction Model results show the lack of short–run integration even though market segmentation does not exist. Insufficient transportation and communication facilities, lack of price transparency, and improper supporting services of middlemen cause inefficient price adjustment between the markets in the short–run. But, several markets show a significant time lag. The scope of improvement in market performance is ample. Privatization process in this market will face major challenges unless this situation is corrected.

INTRODUCTION

An efficient agricultural marketing system is an important means for raising the income level of farmers and for promoting the economic development of a country. The farmers allocate their resources according to their comparative advantage and invest in modern farm inputs to obtain enhanced productivity and production. The overall market performance may be indicated by spatial price behavior in regional markets. And spatial market performance may be evaluated in terms of its price relationships.

In 2003, Myanmar has adopted a New Rice Trading Policy in order to enhance the market oriented economic policy that has been implemented since 1988. Since the government abolished the state monopoly of rice marketing, most of the crop prices have become more attractive to the farmers. The new system of rice trading aims at ensuring local paddy price to be beneficial to farmers and at the same time to enable consumers to get rice at a fair price. The development of rice market system has played a main role in the implementing and accelerating the new rice policy in Myanmar.

Therefore, measurement of market integration in this study can be viewed as the basis for an understanding of how specific rice markets (in Myanmar) work. The goal to investigate price movement in each market and price correlation between the central and

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the local markets is twofold. First is the expectation that this price correlation can give specific market signals and transparency of market information. Second is that the results of this study will give the appropriate policy recommendations to lawmakers in order to further developing the rice market.

Thus in this paper the concept of spatial market integration and spatial market efficiency conditions are defined. Then, a model is presented to assess the degree of price integration among markets. Finally this model is applied to selected rice markets in Myanmar and the results are discussed.

SPATIAL MARKET INTEGRATION AND SPATIAL MARKET EFFICIENCY CONDITION

The terms "spatial market integration" and "spatial market efficiency" are extensively used in price analysis and need to distinguish the difference between them. Barret, C. B. (1996) mentioned that market integration concerns the free flow of goods and information– and thus prices– over form, space, and time and is thus closely related to concepts of efficiency.

Spatial market integration is defined as the extent to which demand and supply shocks arising in one location are transmitted to other locations (Fackler, 1996; McNew, 1996; McNew and Fackler, 1997; Fackler and Goodwin, 2001). Therefore, market integration will be taken as a measure of the expectation of the price transmission allotment.

Analysts have adopted that market integration is a distinct concept from the absence of arbitrage. Observing trade flows is a sufficient but not necessary condition for some degree of spatial market integration (Barrett *et al.*, 2000; Barett and Li, 2002). It is not necessary for two regions to be direct trading partners for a high degree of integration to be present. If regions are part of a common trading network, price shocks may therefore be transmitted indirectly through the network via the trading linkages that connect the regions (Fackler and Goodwin, 2001).

Spatial market efficiency is an equilibrium condition whereby all potential profitable spatial arbitrage opportunities are exploited. In equilibrium condition the price differential should be less than or equal to the transfer costs. If the spatial price differential is greater than transfer cost the market is said to be inefficient with or without trade (Negass and *et al.*, 2003). Therefore, prices generated by an efficient market should precisely reveal all concerned market information about demand and supply conditions as well as transactions costs.

Therefore, spatial market integration is neither crucial nor satisfactory for spatial market efficiency (and vice versa) and as a consequence tests for integration do not always point out the suitable inference regarding spatial market efficiency. In developing countries prices are the only data readily available to examine spatial relationships and spatial market integration is applied as an indicator of the market performance of these economies.

REVIEW OF PRICE INTEGRATION ANALYSIS

Until a decade or so ago, analysts were typically interested in bivariate correlation coefficients between distinct markets and at the difference between distinct markets and the difference between inter–market price spread. Even though much maligned, static price correlations remain the most common measure of spatial market integration in agriculture. By this method, bivariate correlation or regression coefficients are estimated between the time series of spot prices for an otherwise identical food or bundle of goods at different market locations (Ravallion, 1986).

Economists soon recognized serious methodological problems in these studies. Inter–seasonal flow reversals, which are common where infrastructure is poor, make price spread observations unreliable indicators of market integration or competition, since those spreads include a seasonal component (Timmer, 1974). It is sure that imprecision in a test equation based on the static bivariate model would be yielded by any measurement error or omitted variables.

Moreover, simple bivariate correlation coefficients require filtering to eliminate bias toward spurious integration due to common exogenous trends (e.g., general inflation), common periodicity (e.g., agricultural seasonality), of autocorrelation (Harriss, 1979). On the other hand, contemporaneous correlation tests may overestimate segmentation if lags in information, delivery, or contract expiration produce a natural lag in the price response between markets. Finally, these simple statistics fail to recognize the heteroskedasticity common in price data of reasonably high frequency.

Ravallion (1986) developed an Autoregressive Distributed Lag (ADL) Model to evaluate both the long– and short–run adjustment processes. The 'dynamic' structure of the model accounts the sluggishness of price adjustments. And markets are integrated in the short run when instantaneous and full price adjustment prevails.

The price formation process can be represented by two equations assuming the central market price is influenced by prices of all relevant rural markets and then central market is assumed to dominate price formation in rural markets.

$$P_{1t} = \sum_{j=1}^{n} a_{1j} P_{1t-j} + \sum_{k=2}^{N} \sum_{j=0}^{n} b_{1j}^{k} P_{kt-j} + X_{1t} c_1 + e_{1t} \quad (1)$$

$$P_{it} = \sum_{j=1}^{n} a_{ij} P_{it-j} + \sum_{j=0}^{n} b_{ij} P_{1t-j} + X_{it} c_i + e_{it} \quad (2)$$

t is the number of period, t = 1,2,...,T
i is the number of the rural markets, i = 1,2,..., N
j is the number of time lags, j = 0,1,2,..., n
and X is a vector of market characteristics affecting prices

An adapted version of this model, has been used to measure price relationships between markets by various analyst (e.g., Alderman, 1993; Faminow and Benson, 1990; Goodwin and Schroeder, 1991; Heytens, 1986; and van der Kamp *et al.*, 1994). Two major problems exist with this type of model when price series tend to be non–stationary, resulting in problems of inference and multicollinearity in the estimated equations.

Ravallion (1986) tests first price integration in the long run. When this is confirmed, the condition of long–run integration is imposed and the model is rewritten as an Error Correction Model to test for short–run integration.

THE EMPIRICAL MODEL

Rice market in Myanmar

Rice is an important export crop of Myanmar and is also designated as national crop to highlight its great importance as the main food of the increasing population, so that its price hike can easily hit the consumers badly, which does not allow lawmakers to liberalize the market as easily as the other agricultural commodities including pulses and beans.

The cultivated area of monsoon rice is usually bigger than that of summer rice and consequently monsoon rice harvest influences rice price for the whole year. Because of the cropping pattern and cultivated area, paddy and rice prices go up in the rainy season, namely July, August and September. The summer paddy production of the country is insufficient to lower the prices significantly during the rainy season. The prices go down substantially after the harvest of monsoon rice from October to January.

Rice farmers are used to store seeds from their production for the next planting season and for family consumption in granary. The store amount of surplus for sale is varied from farmer to farmer depending on the production volume and financial condition. Some farmers use the barter system exchanging extra workers for paddy. Generally, larger farmers usually keep in hand their surplus with the expectation of higher prices in the lean season. After that, stored paddy is taken out and sold to collectors or agents of millers or rice millers.

Concerning with selling, some farmers sell paddy at farm and some deliver to the nearest rice mill. After milling, some parts are delivered back home for consumption with the rest sold to rice millers or town wholesalers. Additionally, by–products of rice such as broken rice and bran are taken back for livestock feed. Most small farmers lack the facilities to hold rice surpluses until rice price is high in the lean season.

After harvesting monsoon rice, working capital requirement for the second crop such as pulses or summer rice urge small farmers to sell their products at lower prices. Usually surplus rice from the domestic markets flows through the central Yangon market directly to the deficit areas in order to fulfill the country consumption needs.

Rice markets for this study were selected as follows:

Market 1, *Yangon* market, the capital of the country, is the focal point of the internal and external rice trade. Agricultural produce enters Yangon City from surplus producing areas by road, rail and waterway.

Market 2, *Mandalay* market is the focal point of Upper Myanmar. It is an important terminal market and also a major transit market and Mandalay division as a whole is a large rice deficit area.

Market 3, *Pathein* market is located in the major town of the Ayeyarwady division, the largest rice producing area and is well known as the country's "rice bowl".

Market 4, *Pyay* market is situated in the western part of Bago division, the second largest rice area after Ayeyarwady Division. This market serves as transit area to go to the Rakine States and border area of Bangladesh.

Market 5, *Mawlamyine* market is situated in Mon State, a rice surplus region and is supplied to Taninthayi division and other destinations.

Market 6, *Taunggyi* is the major town of Shan state. Rice production is insufficient for the local consumption. Transportation from Yangon to Taunggyi is limited only by truck and it takes approximately 24 to 30 hours to reach.

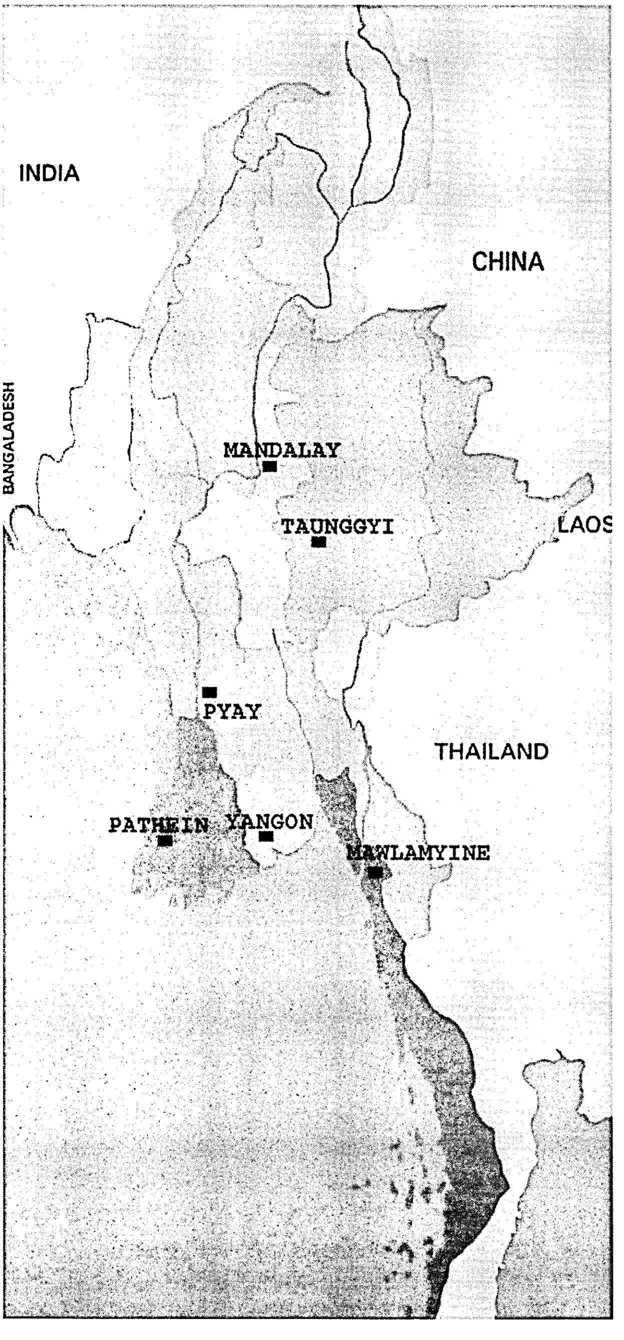

Fig. 1. Selected rice markets in Myanmar

Table 1. Surplus and deficit regions of selected rice markets

Surplus area		Deficit area	
Market	Price series	Market	Price series
Yangon	P1	Mandalay	P2
Pathein	P3	Taunggyi	P6
Pyay	P4		
Mawlamyine	P5		

Data availability

Weekly wholesale rice prices of major cities are officially released from Department of Agricultural Planning which is under Ministry of Agriculture and Irrigation and are therefore the ones used. The weekly wholesale rice prices of six large cities are taken from the period of April 2001 to May 2004. In total, 166 weekly observations of average prices are available. This is a complex task, both logistically and practically because rice comes in a number of varieties which differ widely in value.

The problem becomes more complex because of the following factors: local naming differences between the long–grain, japonica and coarse vary between local markets and central market of Yangon. Second, key weekly data from long–grain and japonica were altogether unavailable. Third spatial and temporal changes in consumers' tastes and preferences made it difficult to select a variety for the study. As a result, the coarse variety of rice was selected due to its rather homogeneous naming among all markets, almost similar consumer taste and preference and the near perfect availability of a continuous series that is reasonably to use.

The gaps present in the coarse price series were easier to work with than other series for individual rice varieties. It should be recognized, however, that it is far from perfect: it refers only to urban areas, a different variety is used in each area and the variety designated as "Coarse" in any one location may change along with technology and tastes. Although this does lead to discontinuities in the price series it remains the best series to use because of the lack of gaps and because of the fact that, even though rice varieties in different areas are different, they are chosen so that they are of similar quality and popularity and are broadly comparable both between cities and over time. Those data are necessary for summarizing the recent situation of rice production and marketing problems.

A model to analyze the price integration of selected rice markets in Myanmar

Market integration commonly refers to a degree rather than specific relationship as completely separated markets in one extreme and perfectly integrated markets in others. A less restrictive notion of market integration acknowledges that short–run price differences may exist but that, in the long run, one–to–one correspondence of price changes across regional markets should exist.

Selected rice markets are divided into i local markets and 1 central market. P_i denotes the price data of local markets and P_1 denotes the price data of central market. t denotes the time and j denotes the number of time lag. Let the subscript $j=1$ *to* 2 denotes the time lag from 1 to 2. Δ denotes the price first difference of the selected market. is a vector of other influences on local markets. X_t Two variables are selected as likely non–price influences on local markets aiming to capture the seasonality of the main harvest season of November to January and local time trend.

Formula Derivation

Typical formula with lag 3

$$P_{it} = k + c_1 P_{it-1} + c_2 P_{it-2} + c_3 P_{it-3} + d_0 P_{1t} + d_1 P_{1t-1} + d_2 P_{1t-2} + d_3 P_{1t-3} + X_t + \varepsilon_t$$

subtract P_{it-1} from both sides and add and subtract $d_0 P_{1t-1}$ on the right hand side.

$$P_{it} - P_{it-1} = k + c_1 P_{it-1} - P_{it-1} + c_2 P_{it-2} + c_3 P_{it-3} + d_0 P_{1t} + d_0 P_{1t-1} + d_0 P_{1t-1} + d_1 P_{1t-1} + d_2 P_{1t-2} + d_3 P_{1t-3} + X_t + \varepsilon_t$$

$$\Delta P_{it} = k + (c_1 - 1) P_{it-1} + c_2 P_{it-2} + c_3 P_{it-3} + d_0 \Delta P_{1t} + (d_0 + d_1) P_{1t-1} + d_2 P_{1t-2} + d_3 P_{1t-3} + X_t + \varepsilon_t$$

subtract and add $(c_1 - 1) P_{it-2}$ and $(d_0 + d_1) P_{1t-2}$

$$\Delta P_{it} = k + (c_1 - 1) P_{it-1} + (c_1 - 1) P_{it-2} + (c_1 - 1) P_{it-2} + c_2 P_{it-2} + c_3 P_{it-3} + d_0 \Delta P_{1t} + (d_0 + d_1) P_{1t-1} - (d_0 + d_1) P_{1t-2} + (d_0 + d_1) P_{1t-2} + d_2 P_{1t-2} + d_3 P_{1t-3} + X_t + \varepsilon_t$$

$$\Delta P_{it} = k + (c_1 - 1) \Delta P_{it-1} + (c_1 + c_2 - 1) P_{it-2} + c_3 P_{it-3} + d_0 \Delta P_{1t} + (d_0 + d_1) \Delta P_{1t-1} + (d_0 + d_1 + d_2) P_{1t-2} + d_3 P_{1t-3} + X_t + \varepsilon_t$$

subtract and add $(c_1 + c_2 - 1) P_{it-3}$ and $(d_0 + d_1 + d_2) P_{1t-3}$

$$\Delta P_{it} = k + (c_1 - 1) \Delta P_{it-1} + (c_1 + c_2 - 1) P_{it-2} - (c_1 + c_2 - 1) P_{it-3} + (c_1 + c_2 - 1) P_{it-3} + c_3 P_{it-3} + d_0 \Delta P_{1t} + (d_0 + d_1) \Delta P_{1t-1} + (d_0 + d_1 + d_2) P_{1t-2} - (d_0 + d_1 + d_2) P_{1t-3} + (d_0 + d_1 + d_2) P_{1t-3} + d_3 P_{1t-3} + X_t + \varepsilon_t$$

$$\Delta P_{it} = k + (c_1 - 1) \Delta P_{it-1} + (c_1 + c_2 - 1) \Delta P_{it-2} + (c_1 + c_2 + c_3 - 1) P_{it-3} + d_0 \Delta P_{1t} + (d_0 + d_1) \Delta P_{1t-1} + (d_0 + d_1 + d_2) \Delta P_{1t-2} + (d_0 + d_1 + d_2 + d_3) P_{1t-3} + X_t + \varepsilon_t$$

$$\Delta P_{it} = k + \alpha_1 \Delta P_{it-1} + \alpha_2 \Delta P_{it-2} + (c_1 + c_2 + c_3 - 1) P_{it-3} + \beta_0 \Delta P_{1t} + \beta_1 \Delta P_{1t-1} + \beta_2 \Delta P_{1t-2} + (d_0 + d_1 + d_2 + d_3) P_{1t-3} + X_t + \varepsilon_t$$

$$\Delta P_{it}=k+\sum_{j=1}^{2}\alpha_i\Delta P_{it-j}+(c_1+c_2+c_3-1)\ P_{it-3}+\sum_{j=0}^{2}\beta_j\Delta P_{1t-j}$$
$$+(d_0+d_1+d_2+d_3)P_{1t-3}+X_t+\varepsilon_t$$

$\alpha_1=c_1-1$
$\alpha_2=c_1+c_2-1$
$\beta_0=d_0$
$\beta_1=d_0+d_1$
$\beta_2=d_0+d_1+d_3$

long–run integration can be supposed then:

$$c_1+c_2+c_3+d_0+d_1+d_2+d_3=1$$

then the following the ECM can be derived:

$$\Delta P_{it}=k+\delta\ (P_{it-3}-P_{1t-3})+\sum_{j=1}^{2}\alpha_i\ \Delta P_{it-j}+\sum_{j=0}^{2}\beta_j\Delta P_{1t-j}+X_t+\varepsilon_t$$

$$c_1+c_2+c_3-1=-\ (d_0+d_1+d_2+d_3)=\delta$$

MODEL RESULT AND INTERPRETATION

Test for stationary of price series

The classical assumption in the applied econometrics is that the means and variances of the variables are well defined constants and independent of time. However, macroeconomists have been aware that many macroeconomic time– series are non–stationary in their levels and that are most adequately represented by first differences. Variables whose means and variances change over time are known as non–stationary or unit root variables. As a consequence, unit root tests are applied to determine if the variables in a regression are stationary or non–stationary.

Before applying the cointegration tests, Augmented Dickey–Fuller (ADF) unit root tests are applied to each price series and their first differences to determine the stationarity of each individual price series. The ADF test requires regressing ΔP_t on a constant, P_{t-1} and several lags of P_{t-j} in order to avoid autocorrelated disturbance as follows:

$$\Delta P_t=c_1+\delta P_{t-1}+\sum_{j=1}^{n}\delta_{1j}\Delta P_{t-j}+\varepsilon_{1t} \tag{3}$$

$$\Delta^2 P_t=c_2+\delta_2\ \Delta P_{t-1}+\sum_{j=1}^{n}\delta_{3j}\Delta^2 P_{t-j}+\varepsilon_{2t} \tag{4}$$

where $\Delta P_t=P_t-P_{t-1}$, $\Delta P_{t-1}=P_{t-1}-P_{t-2}$, $\Delta^2 P_t=\Delta P_t-\Delta P_{t-1}$, $\Delta^2 P_{t-j}=\Delta P_{t-j}-\Delta P_{t-j-1}$

Then the t–statistics of the estimated coefficient of P_{t-1} is used to test the hypothesis.

In equation (3) with H_0: $\delta=0$ implying non-stationary of the time-series at level and P_t, t=1,2,..., T or $P_t \sim I$ (1) and H_1: $\delta<0$ implying stationary or $P_t \sim I$ (0). If the value of the ADF statistic is less (that is, more negative, because these values are always negative) than the critical values and cannot reject the null hypothesis, it shows that P_t is non-stationary. If P_t is non-stationary, it should be determined whether P_t is stationary in the first difference by using equation (4), H_0: $\delta_2=0$ implying non-stationary of the time-series at first difference {$\Delta P_t \sim I$ (1) or $P_t \sim I$ (2)} and H_1: $\delta_2<0$ implying stationary of series at first difference {$\Delta P_t \sim I$ (0) or $P_t \sim I$ (1)}. If the ADF test can be rejected for the null hypothesis, as is usually the case with price series, it may be concluded that $P_t \sim I$ (1).

Table 2. Augmented Dickey-Fuller Test

Market	Price series	N	m	Price levels		First Differences	
				δ	t-value	δ_2	t-value
Yangon	P1	166	14	-0.015	-0.65	-1.374	-8.15
Mandalay	P2	166	14	-0.018	-1.29	-0.69	-6.79
Pathein	P3	166	16	-0.024	-1.26	-1.159	-8.19
Pyay	P4	166	13	-0.017	-1.08	-0.968	-8.13
Mawlamyine	P5	166	15	-0.017	-1.05	-1.01	-7.58
Taunggyi	P6	166	16	-0.017	-0.82	-1.243	-7.54

Critical Values for ADF statistics	Significant level	ADF
	1%	-4.02
	5%	-3.44
	10%	-3.14

Note: N=number of observations; m=missing variables; No serial correlation was detected (5% significant level)
Source: Weekly rice price series from 2001 April to 2004 May. ADF analysis was carried out in EVIEWS©3.0

ADF test as described above table (2) tested with two lags and reports the resulting ADF(2) statistics. All of the tests in price level with equation (3) show that t-values are too small to reject the null hypothesis. Hence none of the rice price series is stationary. The test for integration of order 2 with the first difference by using equation (4) indicates that the null hypothesis is rejected at one percent in all cases and all the price series are I (1) process and are stationary at first difference level. This result implies that instead of using normal price series as variables in the model, inclusion of first differences as variables can eliminate the stochastic trend to which the nominal series are revealed.

Co-integration test based on an ADL model specification

Current prices of markets entirely and correctly reflect all relevant information in an efficient market system. Price series P_{it} (local price) and P_{1t} (central price) are said to be co-integrated to the order of d, b where $d \geq b \geq 0$ (written as $P_{it}, P_{1t} \sim CI(d, b)$ if P_{it} *and* $P_{1t} \sim I(d)$ and $P_{it} - \beta P_{1t} \sim I(d-b)$). $[1-\beta]$ is the co-integration vector. Several authors indicated that co-integration vector for the price series P_{it} and P_{1t} should be [1, -1] in an efficient market system where the difference between the prices in the two price series is a white noise process.

Co–integration between P_{it} (local price) and P_{1t} (central price) is tested with an Autoregressive Distributed Lag model by identifying the long–run dynamic of the price series. According to the econometric theory, the non–stationary price series cannot be investigated by the F–test in order to find out the long–run integration. In order to solve this problem by rewriting ADL model as follows in equation (5): (Boswijk, 1992)

$$\Delta P_{it} = k + \sum_{j=1}^{n-1} \alpha_i \, \Delta P_{it-j} + (c_1 + c_2 + \cdots c_n - 1)\ P_{it-n} + \sum_{j=0}^{n-1} \beta_j \Delta P_{1t-j} + (d_0 + d_1 + \cdots d_n)\ P_{1t-n} + X_t + \varepsilon_t \quad (5)$$

where X_t is the seasonal dummy variable and time trend variable

The appropriate number of lag for the ADL model is determined by the general to specific modelling (Charemza and Deadman, 1992; Kiviet 1986). Langrange multiplier F test with the lag order 8 is carried out for all the regression.

Concerning with the Ravallion's restriction on long–run integration:

$$\sum_{j=1}^{n} c_j + \sum_{j=0}^{n} d_j = 1$$

The long run multiplier is:

$$\beta^* = \frac{\sum_{j=0}^{n} d_j}{1 - \sum_{j=1}^{n} c_j}$$

when price series are related, then $\beta^* \approx 1$.

When $\Sigma\,(c+d)$ and β^* are not significantly different from 1, prices can converge in

Table 3. Test for co–integration based on an ADL model

Local Market	Central Market	Test for Co–integration							
		Lags	d	F–coin[a]	Σc	Σd	Σc+Σd	β*	F–LR[b]
Mandalay (P2)	Yangon (P1)	8	2	3.61	0.82	0.22	1.04	1.23	2.34
Pathein (P3)	Yangon (P1)	3	2	3.89	0.85	0.13	0.98	0.84	1.68
Pyay (P4)	Yangon (P1)	2	2	6.60	0.80	0.20	1.00	1.00	0.0001
Mawlamyine (P5)	Yangon (P1)	3	2	1.26*	0.94	0.05	1.00	0.92	0.04
Taunggyi (P6)	Yangon (P1)	2	2	2.05*	0.89	0.10	0.99	0.91	0.25

Note: d is the number of dummies used to indicate seasonal (main harvest season) period from November to January and time trend variable. Langrange multiplier test with order 8 at 5% significant level is carried out for each regression and the appropriate number of lag is decided.

a. F–coin, Wald test for co–integration, H_0: $\Sigma c = 1$, $\Sigma d = 0$, (no co–integration exist), critical value at 5% level is 3.00 to 3.07. The values marked with an asterisk do not reject H0, indicating a lack of co–integration.

b. F–LR, test for long–run integration: H_0: $\Sigma c + \Sigma d = 1$ (Long–run integration exists), the results do not reject the existence of long–run integration at the 5% level critical value 3.84 – 3.92.

the long run. If $\sum(c+d)$ and β^* differ significantly from 1, prices can diverge in the long run and it is difficult to interpret. On the other hand, an acceptable condition for co-integration is that $\sum c \neq 1$ and $\sum d \neq 0$. F test can be used to clarify by the following null hypothesis $\sum c=1$ and $\sum d=0$. When these tests are satisfied, some error term will exist in the model in order to capture the equilibrium situation and ECM model can be derived. When integration does not exist in the long run, it does not make sense to test for integration in the short run. (Lutz, C. 1995)

The results in table (3) indicated that, according to F-coin test: $\sum c=1$, $\sum d=0$, 2 market pairs cannot exist in the long-run integration condition. However, F-LR test, $\sum c+\sum d=1$ confirms the existence of long-run integration in all market pairs: β^* does not differ significantly from 1. These two tests can support that the co-integrating vector equals [1, −1]. Especially in the case of market pair Mawlamyine and Yangon Market, the price co-integration is rejected. Therefore, the results of F-LR test for these two market pairs become ambiguous because $\sum c$ is close to 0 and $\sum d$ is close to 1.

However, the overall tests support that the majority of market pairs are integrated in the long-run and the ADL model is reformulated in an ECM model.

Short run integration tested with an error correction model.

After testing for co-integration of the two price series, the ADL model of Ravallion can estimate the existence of short run dynamics by constructing an Error Correction Model. Sargan (1964), Henery and Anderson (1977), Davidson *et al.* (1978) used Error correction terms as a means of capturing adjustments in a dependent variable which depended not on the level of some explanatory variable, but on the extent to which an explanatory variable deviated from an equilibrium relationship with the dependent variable. A particular advantage of the error-correction mechanism is that the extent of adjustment in a given period to deviations from long-run equilibrium is given by the estimated equation without any further calculation.

Even though Ravallion distinguishes lags for the error-correction term and the price changes in the reference market, the following equation (6) is chosen for the ease of testing including lags for price changes in local and central market and together with one error-correction term.

$$\Delta P_{it}=k+\delta(P_{it-n}-P_{1t-n})+\sum_{j=1}^{n-1}\alpha_i\Delta P_{it-j}+\sum_{j=0}^{n-1}\beta_j\Delta P_{1t-j}+X_t+\varepsilon_t \qquad (6)$$

where the existence of short run integration is tested with the null hypothesis of $\beta_0=1$ and $\delta=-1$. The market segmentation is also tested with the null hypothesis of $\beta_j=\delta=0$ by Ravallion's restriction.

Table (4) shows the results of the parameters in the ECM model and the combination of local and central price series. The existence of short-run integration ($\beta_0=1$ and $\delta=-1$) was rejected for all pairs of markets even though the market segmentation $\beta_j=\delta=0$ does not exist between the markets. The error-correction term is significant in all cases except the market pair Mawlamyine (local market) and Yangon (central market). This shows that the short-run adjustment of price changes at most market places react significantly on the deviation from the long-run equilibrium.

The ADL test results already indicated that Mawlamyine (local market) and Yangon

Table 4. Error Correction Model illustrating the short–run integration process

Dependent Market	Central Market	Lag	R^2	δ	α_1	α_2
Mandalay (P2)	Yangon (P1)	8	0.41	−0.10*	0.26*	−0.17*
Pathein (P3)	Yangon (P1)	3	0.24	−0.17*	−0.16*	−0.17*
Pyay (P4)	Yangon (P1)	2	0.17	−0.20*	0.14*	
Mawlamyine (P5)	Yangon (P1)	3	0.17	−0.06	0.10	−0.11
Taunggyi (P6)	Yangon (P1)	2	0.14	−0.11*	−0.35*	

Dependent Market	Central Market	α_3	α_4	α_5	α_6	α_7
Mandalay (P2)	Yangon (P1)	−0.16*	−0.22*	−0.12	−0.16*	−0.20*
Pathein (P3)	Yangon (P1)					
Pyay (P4)	Yangon (P1)					
Mawlamyine (P5)	Yangon (P1)					
Taunggyi (P6)	Yangon (P1)					

Dependent Market	Central Market	β_0	β_1	β_2	β_3	β_4
Mandalay (P2)	Yangon (P1)	0.20*	0.19*	0.33*	0.19*	0.14*
Pathein (P3)	Yangon (P1)	0.22*	0.28*	0.51*		
Pyay (P4)	Yangon (P1)	0.11*	0.26*			
Mawlamyine (P5)	Yangon (P1)	0.28*	−0.09	0.10		
Taunggyi (P6)	Yangon (P1)	0.21*	0.20*			

Dependent Market	Central Market	β_5	β_6	β_7	F–short	F–seg
Mandalay (P2)	Yangon (P1)	0.17*	0.22*	0.33*	251.08	5.43
Pathein (P3)	Yangon (P1)				99.31	10.76
Pyay (P4)	Yangon (P1)				145.35	5.71
Mawlamyine (P5)	Yangon (P1)				321.91	6.44
Taunggyi (P6)	Yangon (P1)				139.63	3.33

Note: *Coefficients are significant at 5 percent level.
F–short, test for short run integration: $\beta_0=1$ and $\delta=-1$, F (5%, 120–∞, 1)= 3.84–3.92
F–seg, test for segmentation: $\beta_j=\delta=0$, F (5%, 120–∞, 4)=2.60–2.68, F (5%, 120–∞, 5)=2.37 - 2.45, F (5%, 120 - ∞, 9)=1.88 - 1.96.

(central market) were only weakly integrated in the long run because of the nonexistence of co–integration between markets. Although the coefficient (δ) is insignificant, (β_0) is significant in ECM test and, consequently, the hypothesis of market segmentation is rejected. It is evident that there is an indirect link between Yangon central market and the Mawlamyine market.

Moreover, Mawlamyine market is situated in a region of rice surplus areas and regional surpluses are mostly sold at Taninthayi Division. The demand of rice in that division can mainly influence the price formation at Mawlamyine market. Lack of a developed transportation infrastructure is also the main indicator for the price sluggishness. Because of transportation inconveniences and lack of a stable communication infrastructure between Mawlamyine market and Yangon market, the price changes in Yangon market do not have any considerable influence on Mawlamyine market price.

If there is a lack of direct price link between a pair of markets, there can be an indirect link through an intermediate market or a series of intermediate markets, entailing indirect market integration. More insights might be obtained by testing multivariate co–integration on these markets.

Concerning the relationship between Taunggyi market and Yangon market pair, the coefficients (δ) and (β_0) are significant in ECM test and there is no market segmentation between these markets. However, their long–run integration in ADL shows only a weakly integration. Even though the Taunggyi market is situated in rice deficit area; it appears that the price integration process is far from optimal in the short run. Transportation infrastructure and communication facilities can distort the transmission of price information. A further study of the functioning of this market emphasized on the practices of market intermediaries is necessary.

The influence of the Yangon central market is strong with regards to Mandalay, Pathein and Pyay markets. This result was expected and demonstrates that market intermediaries perform a key function with their services. They directly affect the price integration of the local and urban areas. But, as in most developing countries, there are inefficiencies. This inefficiency in price information leads to price sluggishness. At present analysis none of the markets are fully integrated in the short–run.

CONCLUSION

This study analyzed the spatial price differences for selected rice markets in Myanmar from April 2001 to May 2004. The purpose of the analysis was to understand market functioning for helping lawmakers further develop the rice market. In order to make a liberalization of the rice market there has to be certain specific market improvements in behaviors and relationships between central and local rice markets.

The First conclusion that results from each data series showed that there existed a non–stationality, but the first differences in prices are stationary. The Autogregrssive Distributed Lag model establishes existence of a long–run integration between pairs of markets. This indicates the influence of the Yangon Central Market price in the long–run to other markets.

Second conclusion is that short–run integration is affected by the transparency of the prices, which can lead to inefficient price adjustment between the markets. The lack of reliable market information shows the producers' unawareness of equilibrium market price. This creates uncertainty among all participants in the market. With this in mind, up–to–date rice price information in Myanmar should be distributed effectively and efficiently in order to get the short–run price integration between local markets and the Yangon Central Market. This transparency will benefit everyone in the market thereby reducing price uncertainty.

Third conclusion is that the selected rice markets in this study reflect a working arbitrage system. Lack of adequate transportation and communication infrastructure between local and central market distort the price adjustment in the short–run. Moreover, the performance of market intermediaries and their supporting services affect the price signal transmission in domestic rice market. But, several markets show a significant time lag. The scope of improvement in market performance is ample. Privatization process in this market will face major challenges unless this situation is corrected. The method used in this study demonstrates that price integration models are useful for lawmakers in formulating policies because the indications of where there is sub–optimal competition.

Traditionally the analysis of market integration is often confined to studies of price integration. This is done between prices on different markets. To interpret the results of this integration correctly studies at participant and market level are necessary. Further studies in these markets will show which types of market imperfections prevail: entry or exit barriers, general lack of market information, etc.

Finally, a much more complete picture could also be obtained by using a multivariate framework which provides statistically more robust results, and analysis which makes it possible to distinguish the different types of common trends and periodicities in the data.

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