Spatial Integration of Rice Markets in Vietnam

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ABSTRACT

The study analyzes the extent, pattern, and degree of the spatial integration of rice markets in Vietnam, as well as the dynamic relationship of the rice export prices of Vietnam and Thailand. The extent of market integration is determined by identifying locations that are linked by trade and whose prices share the same long-run relationship. The method of estimating the permanent component is applied to examine the importance of markets in shaping the long-run rice price. The pattern and degree of integration are assessed by testing for the existence of the law of one price (LOP) and ascertaining the speed of adjustment toward long-run equilibrium, using various tests in the cointegrated system.
Results show that only nine of 34 rice markets are integrated into a common rice market. However, prices are transmitted well among the integrated rice markets. The supply of rice appears to be the most important factor shaping the long-run behavior of its price levels in Vietnam. No single market is found to be the price leader. The prices of rice exported by Vietnam and Thailand are cointegrated and conform to LOP. The removal of the export quota plays an insignificant role in determining the relationship of rice prices in the two countries. The study suggests improving the extent of domestic rice market integration by focusing on the development of roads, communication and other market-related infrastructure, and instituting food policy reforms in the supply regions, while directly targeting the poor and mountainous areas. To improve the export price and become more active in the world rice market, Vietnam should (1) adopt modern postharvest technologies and develop better rice varieties, (2) develop an integrated rice marketing chain from farmers to exporters, (3) enhance the capacity to undertake rice market analysis and forecast, (4) encourage rice-exporting enterprises to follow certain rules to avoid cut-throat competition, and (5) establish a system of rice standards and create a trade mark for Vietnamese rice.

INTRODUCTION

Market reform is an indispensable part of economic reform and trade liberalization, which have been carried out in developing countries. It has been argued that the management of market reform requires an understanding of the operation of local markets. A measurement of market integration can be viewed as basic information needed to understand how specific markets work (Ravallion 1986).

In agricultural markets, the costs associated with market intervention policies may be massive or modest, depending on how well the market situation is understood. If markets are spatially integrated, the effects of government intervention in a particular market can be transmitted across markets, and with low associated cost. However, if the degree of market integration is not fully understood, there may be too much wastage of resources as governments try to intervene in all markets.

Recently, the Vietnamese government implemented policies toward a market-oriented economy. Economic integration and trade liberalization are likely to have a great impact on the national economy, in general, and on the agricultural sector in particular, especially the rice sector. Understanding the food market integration has important implications for an economy in transition like Vietnam.

The study aims at examining the spatial integration of rice markets in Vietnam in terms of the extent, pattern, and degree of market integration, and the dynamic relationship between rice export prices in Vietnam and Thailand. Based on the results of the study, policy recommendations are provided.

METHODOLOGY

Theoretical Price Relationships and the Vector Autoregressive (VAR) Model

A difference in commodity prices between two regions is a signal for *arbitrageurs*. Tomek and Robinson (1981) show that under a competitive market, if the price difference is greater than the transfer cost, and trade happens, the price in the importing region would decrease and the price in the exporting region would increase until the marginal profit of trading is zero. This situation is called perfect integration with trade (Barrett et al. 2000). Also, the law of one price (LOP) states that, once known exogenous factors such as transport costs, marketing margins, tariffs, and the monetary equivalent of nontariff barriers are taken into account, commodity arbitrage ensures that the price of a perfectly substitutable commodity in one country is equal to the price of the same commodity in all other countries, after adjusting for the exchange rate (Delpachitra and Hill 1994).

When markets are integrated, a price increase (shock) in one market would attract arbitrageurs to do trading until the price difference is equal to the transfer cost, and markets are in equilibrium.

Cointegration has been commonly used in testing market integration since the late 1980s. This approach is based on the idea of long-run equilibrium relationships, where "equilibrium is a stationary point characterized by forces which tend to push the economy back toward equilibrium whenever it moves away" (Engle and Granger 1987). Thus, market integration is regarded as the long-run equilibrium relationships among the price series in different markets. Cointegration is a characteristic of a system of variables, which can be demonstrated by a VAR in n variables and k lags as indicated in the following:

$$P_t = \Pi_1 P_{t-1} + \Pi_2 P_{t-2} + \ldots\ldots + \Pi_k P_{t-k} + \mu + \varepsilon_t \quad (1)$$

where $P_t = \begin{bmatrix} P_t^A \\ \ldots \\ P_t^n \end{bmatrix}$

is a vector of prices in n markets; μ is a vector of constants and $t = 1 \ldots. T;$ and $\varepsilon_t \sim IN(0,\Omega)$. Parameters ($\Pi_1, \Pi_2, \mu$ and Ω) are constant and unrestricted, except for Ω being positive-definite and symmetric. Given Equation (1), the conditional mean of P_t is

$$E[P_t | P_{t-1}, P_{t-2}, \ldots P_{t-k}] = \mu + \Pi_1 P_{t-1} + \Pi_2 P_{t-2} + \ldots + \Pi_k P_{t-k} = m_t$$

The deviation of P_t from the mean m_t defines ε_t, that is $P_t - m_t = \varepsilon_t$. As discussed in Hendry and Juselius (2000), the conditional mean m_t can be given an economic interpretation as the agents' plans at time t-1 given the past information of the process P_{t-1}, P_{t-2}… etc. The independently normal (IN) assumption of the error term ε implies that marketing agents are rational, or agents use all available information to form their expectation about the price and, during expectation formulation, agents always learn from forecast errors in the past.

Thus, the VAR model is consistent with the behavior of economic agents who seek to avoid systematic forecast errors when they plan for time t based on the information available at time t-1. Accordingly, VAR with autocorrelated residuals would show that agents do not use all the information in the data set as efficiently as possible. They would have done better by including the systematic variation left in the residuals; thereby, improving the accuracy of their expectations about the future price. When there are unit roots in the model, it is convenient to reformulate the VAR into an ECM or vector of error correction as follows:

$$\Delta P_t = \Gamma_1 \Delta P_{t-1} + \Gamma_2 \Delta P_{t-2} + \ldots\ldots \Gamma_{k-1} \Delta P_{t-k+1} + \Pi P_{t-1} + \mu + \varepsilon_t \quad (2)$$

where $\Gamma_1, \ldots, \Gamma_{k-1}$ are (n x n) parameter matrices which summarize the short-run relationships among the $\Delta P_1, \ldots \Delta P_n$. The short-run relationships show immediate change in price in one market as a result of a change in price in other markets, while the long- run relationship is the situation when markets are in equilibrium after the necessary short- run dynamics have been completed. Matrix Π can be decomposed into two matrices:

$$\Pi = \alpha \beta' \quad (3)$$

where α and β are (n x r) matrices, with r as the rank matrix Π or the number of cointegrating vectors. Matrix β is interpreted as the matrix of cointegrating vectors, representing the long-run relationships. Matrix α is the matrix of adjustment parameters, representing the speed of adjustment toward long-run equilibrium.

Data

For the required data on the domestic market, monthly retail rice prices in 34 provinces, covering the period 1998–2005, were collected from Vietnam's General Statistics Office (GSO) and the Price-Market Research Institute. For the weekly export prices of the 5 percent and 25 percent broken rice of Vietnam and Thailand for the period 1997–2006, data were collected from Vietnam's Ministry of Trade (MOT) and the United States Department of Agriculture (USDA). Information related to rice production and rice prices was gathered from GSO, the Information Center of Agriculture and Rural Development (ICARD), and the Food and Agriculture Organization (FAO) of the United Nations webpage.

Analytical Tools

Spatial patterns of production, consumption, and trade. In the absence of annual rice consumption and inter-provincial trade data, a rice balance sheet for each province is drawn up to establish the rice self-sufficiency levels of the regions and provinces. The study applies a simple accounting procedure to estimate the rice supply and demand situation in the province, as shown in Appendix A. First, the rice available for human consumption is estimated as the quantity of rice left after adjusting for other rice-consuming activities.

Second, the rice consumption of the human population in the provinces is computed based on the annual per capita rice consumption. Finally, the rice surplus/deficit is arrived at by subtracting the amount required for consumption from the total amount of rice available for human consumption. In other words, the rice self-sufficiency index is the ratio of rice available and rice required. The pattern of inter-provincial rice trade could be then inferred from this information since the surplus and deficit provinces are identified; the resulting numbers are also double-checked with the VINAFOOD Company, the biggest food trading company in the domestic and export markets.

The extent of market integration. The extent of market integration is determined by following three steps, namely: (1) pretesting (using the Augmented Dickey Fuller (ADF) test and the multivariate cointegration framework) and lag length determination; (2) searching for a set of markets belonging to an economic market; and (3) estimation of the integrating factor to show the relative importance in the contribution of markets to price formation in the long run.

Pretest and lag-length determination. The proposed multivariate cointegration[1] framework (Johansen 1988; Johansen and Juselius 1990) originates from the unrestricted VAR, where a process of n price series P_t (t = 1,...T)[2] is defined as a VAR in n variables and k lags, then represented in VECM as in equations (1) and (2), respectively. Lag length is determined by using the Akaike information criteria.

Searching for a set of markets belonging to an economic market. Following Rivera and Helfand (2001), a sequential procedure is implemented. It starts with a core of m locations ($m < n$); if the number of cointegrating vectors is ($m - 1$), an additional location is then added. In the study, bivariate Johansen cointegration is performed first, and then the sequential procedure to determine the extent of market integration follows, starting with markets that are likely to be integrated in one common market.

Empirically, it is not known *a priori* whether there are linear trends in some variables or whether they cancel in the cointegrating relations or not. The joint test, discussed in Johansen (1992), follows the so-called Pantula principle. The trace test is applied in the study.

Estimation of the integrating factor. The method of estimating the long-run component as proposed by Gonzalo and Granger (1995) is used for the model chosen in step 2. The integrating factor is estimated by using the factor model denoted by the equation

$$P_t = A_1 f_{1t} + \widetilde{P}_t \qquad (4)$$

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[1] The multivariate cointegration framework was used in various studies on market integration, such as Asche et al. (1998), Asche et al. (1999), Sanjuán and Gil (2001), and Yang et al. (2000).

[2] T is the total number of observations, while t indicates the order of observation.

where A is the cointegrating vector. That is, P_t is decomposed into two components, namely, the permanent (trend) component f_{1t} and the transitory (cyclical) component $\widetilde{P}_t$. In other words, the elements of *Pt* can be explained in terms of a variable, which is I(1), f_{1t}, plus the I(0) component. Basically, two conditions are imposed to identify the common factor: (1) f_{1t} is a linear combination of the elements of the vector of prices, and (2) the transitory component $\widetilde{P}_t$ does not have any permanent effect on P_t in the long run. This condition implies that, in the ECM, the only linear combination of $\{P_{1t}, P_{2t}, ..., P_{pt}\}$ such that $\widetilde{P}_t$ does not have any long-run effect on P_t is

$$f_{lt} = \alpha'_{\perp} P_t \qquad (5)$$

where , $\alpha'_{\perp} \alpha = 0$ and matrix α is the matrix of adjustment coefficients as decomposed from matrix Π .

The degree of integration. The degree of market integration is determined by using two criteria: (1) the existence of LOP among markets[3] and (2) the speed with which the market adjusts toward long-run equilibrium. First, a test for perfect integration among markets is conducted.

$$H_0: \beta = \begin{bmatrix} 1 & 1 & ... & 1 \\ -1 & 0 & ... & 0 \\ 0 & -1 & ... & 0 \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ 0 & 0 & ... & -1 \end{bmatrix}$$

Second, the adjustment coefficient matrix α is examined in terms of significance and magnitude. A high adjustment coefficient means that the market responds quickly to close the discrepancy with equilibrium in the previous time period.

Pattern of interdependence. The pattern of interdependence refers to the set of relationships among the different markets as revealed through the analysis of the ECM Test for weak exogeneity which ascertains the absence of long-run causality. Suppose that there is an exogenous central location *i* that dominates the long-run behavior of the system. In this case, the i^{th} row of α equals zero, i.e., cointegration relations do not enter the i^{th} equation.

$$\alpha = \begin{bmatrix} 0 & 0 & 0 & ... & 0 \\ * & * & * & ... & * \\ . & . & . & . & . \\ . & . & . & . & . \\ . & . & . & . & . \\ * & * & * & * & * \end{bmatrix}$$

Dynamic Relationship of Export Rice Prices between Vietnam and Thailand

The dynamic relationship of export prices between Vietnam and Thailand is investigated by using the Johansen cointegration test and ECM interpretation. The analytical procedure consists of the following four steps: (1) pretest and determine lag length; (2) test for rank of cointegration and choose the appropriate model; (3) test the impact of removing the export quota of Vietnam in May 2001; and (4) test for LOP.

DISCUSSION OF RESULTS

Agriculture plays a critical role in the development of Vietnam's economy, as evidenced by its roughly 22 percent contribution to total GDP in the period 2000-2006. In agriculture, rice cultivation is critical in terms of employment and export earnings. Recently, Vietnam was ranked as the second largest rice exporter after Thailand.

[3] The law of one price is discussed and documented well in various studies, e.g., Ardeni (1989), Delpachitra and Hill (1994),, Mc New and Fackler (1997), Sexton et al. (1991), and Snyder et al. (1997).

Spatial Patterns of Production, Consumption, and Trade

At the national level, Vietnam produced around 4.84 million tons of rice surplus in 2005, meriting a rice self-sufficiency index of 1.33 in the same year (Table 1).

The two regions that register a rice surplus in the country in 2005 are the Red River Delta (RRD) and Mekong River Delta (MRD), with rice sufficiency indices of 1.06 and 3.44, respectively. The other regions are in deficit[4]. Rice surplus in the RRD is transported mainly to rice-deficit provinces in the North, while rice surplus in the MRD is transported to the many other rice-deficit regions in the country. From 2002 to 2005, there is an improvement in the rice sufficiency index of the North East (NE), North West (NW), North Central Coast (NCC), South Central Coast (SCC), and Central Highland (CH) regions. On the other hand, a reverse pattern is observed in the two biggest rice production areas (RRD and MRD) and the fast-growing industrial zone in the North East South (NES)[5].

Pretests and lag length. Results from ADF tests show that all 34 price series have a unit root. The optimum lag length is 1.

Search for a set of markets belonging to the common rice market. The procedure of searching for a single common trend starts with a core of two provinces in the South, namely, Dong Thap and Ho Chi Minh City (HCMC). Results show that a maximum of nine markets: Dong Thap, HCMC, Ninh Thuan, Lam Dong, Binh Dinh, Quang Ngai, Thanh Hoa, Thai Binh, and Quang Tri are integrated into one common rice market in Vietnam (Table 2).

There are four possible reasons for the exclusion of the other provinces from the common rice market. First, many provinces in the MRD are more export-oriented, and rice

Table 1. Rice balance sheet, by region, Vietnam, 2005.

Region	Available rice ('000 Tons)	Rice requirement ('000 Tons)	Rice balance ('000 Tons)	Index of sufficiency
Red River Delta (RRD)	3,387.32	3,209.04	178.28	1.06
North East (NE)	1,389.60	1,665.14	-275.53	0.83
North West (NW)	297.35	456.23	-158.89	0.65
North Central Coast (NCC)	1,736.69	1,887.65	-150.96	0.92
South Central Coast (SCC)	963.53	1,254.86	-291.34	0.77
Central Highland (CH)	392.94	846.91	-453.97	0.46
North East South (NES)	890.12	2,401.52	-1,511.40	0.37
Mekong River Delta (MRD)	10,571.72	3,071.57	7,500.15	3.44
Country	19,629.26	14,792.92	4,836.34	1.33

Source: Computed on the basis of GSO data.

[4] The term rice surplus/deficit refers to the situation where the area can/cannot satisfy its rice requirement for consumption, using its own rice output produced

[5] The estimates for the rice self-sufficiency index in 2002 are 1.19 (RRD), 0.8 (NE), 0.6 (NW), 0.94 (NCC), 0.78 (SCC), 0.42 (CH), 0.41 (NES), and 3.26 (MRD).

transported to other deficit provinces does not account for a significant share in the provinces' total rice traded. Second, most of the rice-deficit provinces in the Red River Delta do not belong to the common rice market. Notably, Ha Noi is the biggest rice-deficit city in the RRD but it is outside the common market. Apart from having a large number of rice suppliers, rice quality requirements might be a factor here, as this market serves various income groups.

Third, many deficit provinces in NES do not belong to the common market partly because most of the NES provinces in RRD are not integrated with the surplus provinces in RRD, namely; Ninh Binh and Thai Binh. The weak link to the surplus provinces in MRD could be explained by the fact that (1) many rice surplus provinces in MRD are export-oriented, and (2) rice transported by private traders accounts for a small percentage of total rice surplus in these surplus regions.

Fourth, the integration between CH with RRD surplus provinces can be justified through indirect links with other markets, such as HCMC or Dong Thap. It is also observed that CH provinces are not integrated within the region. The main reasons could be their low rice production, their main focus on coffee production for export, the mountainous terrain, and the poor transportation system. Given these conditions, it is understandable why the arbitrage in rice trade activities in these provinces might not be strong enough.

The nine integrated markets are distributed from the South to the North, and consist of one province each from the MRD, CH, and RRD regions; and two provinces each from the NES, SCC, and NCC regions. The participation of RRD and MRD is to be expected since they are the main rice suppliers; the others are mostly rice buyers, the largest of which is NES (which buys mainly from MRD), followed by the CH

Table 2. Johansen's trace test [a] for number of cointegrating rice markets, Vietnam, 1998-2005.

No. of markets	Series	Significance level	
		5%	10%
2	Dong Thap + HCMC	1	1
3	Dong Thap + HCMC + Ninh Thuan	2	2
4	Dong Thap + HCMC + Ninh Thuan + Lam Dong	3	3
5	Dong Thap + HCMC+ Ninh Thuan + Lam Dong + Binh Dinh	4	4
6	Dong Thap + HCMC + Ninh Thuan + Lam Dong + Binh Dinh + Quang Ngai	4	5
7	Dong Thap + HCMC + Ninh Thuan +Lam Dong + Binh Dinh + Quang Ngai + Thanh Hoa	5	6
8	Dong Thap + HCMC + Ninh Thuan +Lam Dong + Binh Dinh + Quang Ngai + Thanh Hoa+ Thai Binh	6	7
9	Dong Thap + HCMC + Ninh Thuan +Lam Dong + Binh Dinh + Quang Ngai + Thanh Hoa + Thai Binh + Quang Tri	6	8

Source: Computed on the basis of GSO data.

and SCC regions. The participation of SCC and NCC which are deficit regions may be explained by the fact that they are found along the way where rice is transported from the South to the North.

The participation of only a few provinces from the NCC, SCC, and CH regions in the common rice market could be explained by their infrastructure situation and economic development. According to TDSI (2004), these regions suffer from poor road conditions. UNDP (2001) shows that a large percentage of the population is below the poverty line in Kon Tum (31.9%), followed by Ha Tinh (28.9%), Quang Binh (28.4%), and Quang Ngai (24.7%). Low income, coupled with poor infrastructure and the distance separating them from the large rice markets (such as Ha Noi, Da Nang and HCMC), might have prevented these provincial markets from being integrated into the common rice market.

Estimation of the integrating factor. Results of the factor model indicate that not all markets contribute significantly to price formation. The integrating factor can be written as follows:

$$\begin{aligned} f_t = \quad & 0.200P_{HCM,t} - 0.546P_{Dongthap,t} \\ & - 0.245P_{Ninhthuan,t} - 0.196P_{Lamdong,t} \\ & - 0.185P_{Binhdinh,t} + 0.049P_{Quangngai,t} \\ & + 0.055P_{Thanhoa,t} + 0.530P_{Thaibinh,t} \\ & + 0.209P_{Quangtri,t} \end{aligned}$$

The provinces that do not have any significant roles in shaping the long-run behavior of the rice price in the common market are Ninh Thuan, Lam Dong, Binh Dinh, Thanh Hoa, and Quang Tri.

The provincial markets that have an impact on the long-run behavior of rice prices in order of importance are Dong Thap, Thai Binh, and HCMC. This finding could be attributed to two factors: 1) Dong Thap is the largest rice supplier among the nine provinces; hence, the quantity of rice traded with other provinces is large (larger than that of Thai Binh); and (2) rice is moved from South to North, and there is rarely trade reversal (i.e., the movement from North to South). HCMC is the largest rice-deficit area in terms of its self-sufficiency index and is located beside MRD. Hence, HCMC is expected to play an important role in the long-run price formation.

Degree of market integration. The LR test for perfect integration yields a statistic of 2.879 (after being corrected by the Bartlett rule). The null hypothesis of LOP among the nine rice markets could not be rejected, implying that prices are transmitted fully among these markets. The degree of market integration is examined further through the adjustment coefficient matrix. Table 3 presents the adjustment coefficients of markets to the cointegrating vectors. Results show that, despite the acceptance of the LOP hypothesis among the nine markets, not all markets interact.

Results also indicate that each market adjusts to its long-run equilibrium with Dong Thap, with the fastest speed adjustment compared with its adjustment coefficients with the other market pairs. For example, the rice price in Lam Dong only adjusts to its long-run equilibrium with Dong Thap and to the long-run equilibrium between Dong Thap and Ninh Thuan. The absolute adjustment coefficients are 0.423 and 0.357, respectively. Meanwhile, Dong Thap rarely adjusts to its long-run equilibrium with the eight markets (except with Thai Binh and Binh Dinh). This is consistent with the fact that Dong Thap is the most important market based on its ability to influence the long-run rice price in the system.

The (absolute) adjustment coefficients of the eight markets with Dong Thap take values ranging from 0.18 to 0.656. Of these, six coefficients are greater than 0.39, indicating

that these markets need at most five months to fully adjust to their equilibrium with Dong Thap. The largest is found in the case of HCMC, which has an absolute adjustment coefficient of 0.656, indicating that in month *t*, the rice price in HCMC adjusts close to 65.6 percent of the disequilibrium with Dong Thap in the month (*t*-1), and HCMC needs only three months to complete the adjustment.

Pattern of interdependence. The null hypothesis of weak exogeneity is rejected for all nine markets (Table 4). The fact that no price series is exogenous to the system, or that no leading price exists, is consistent with the finding that no price series is found to be the integrating factor of the system. Instead, all price series are present in the factor model, and more than one price series contribute significantly to the long-run price formation. This implies the absence of any one market leading the rice price.

Dynamic Relationship between Vietnam and Thailand Export Rice Prices

All export price series have a unit root. Lag length determination results show that optimum lag lengths are 4 for 5 percent broken rice, and 2 for 25 percent broken rice.

For 5 percent broken rice, the *p* value of the trace test for one-rank cointegration is 0.696 (Table 5). Therefore, the null hypothesis cannot be rejected at the 5 percent level of significance. The same conclusion is found with 25 percent% broken rice. Hence, the export prices of Thailand and Vietnam are, as expected, cointegrated. This can be partly explained by the fact that these

Table 3. Results showing the adjustment coefficients (α) imposed on the LOP model, Vietnam, 1998-2005.

Market	Vector of the Matrix of Adjustment Coefficients (α)							
	Alpha (1)	Alpha (2)	Alpha (3)	Alpha (4)	Alpha (5)	Alpha (6)	Alpha (7)	Alpha (8)
DHCM	0.114	-0.656***	-0.087	0.129	-0.136	-0.211	-0.308**	-0.083
	(1.470)	(-5.555)	(-0.664)	(0.970)	(-1.215)	(-1.649)	(-2.414)	(-0.804)
DDong Thap	-0.051	-0.045	-0.189	0.213*	-0.279**	0.033	-0.157	-0.152
	(-0.692)	(-0.400)	(-1.503)	(1.678)	(-2.602)	(0.269)	(-1.285)	(-1.548)
DNinh Thuan	0.043	-0.053	-0.044	-0.121**	-0.136**	0.035	0.179***	-0.003
	(1.312)	(-1.071)	(-0.808)	(-2.178)	(-2.902)	(0.652)	(3.354)	(-0.058)
DLam Dong	0.064	-0.084	-0.058	-0.012	-0.144	0.072	-0.357***	0.423***
	(0.979)	(-0.852)	(-0.533)	(-0.108)	(-1.546)	(0.677)	(-3.361)	(4.925)
DBinh Dinh	0.059	-0.071	-0.007	0.305**	-0.124	0.267**	-0.417***	0.137
	(0.947)	(-0.750)	(-0.068)	(2.856)	(-1.369)	(2.581)	(-4.063)	(1.647)
DQuang Ngai	-0.027	0.016	-0.128	-0.006	-0.195*	0.448***	-0.235**	0.052
	(-0.381)	(0.151)	(-1.087)	(-0.050)	(-1.950)	(3.910)	(-2.066)	(0.570)
DThanh Hoa	0.052	-0.107	-0.468***	-0.283**	-0.101	-0.169*	0.067	0.060
	(0.879)	(-1.194)	(-4.682)	(-2.807)	(-1.180)	(-1.732)	(0.688)	(0.770)
DThai Binh	0.133**	-0.131	0.178*	-0.277**	0.280***	0.083	0.114	-0.012
	(2.235)	(-1.447)	(1.770)	(-2.727)	(3.258)	(0.846)	(1.169)	(-0.157)
DQuang Tri	0.391***	0.029	0.311**	-0.133	0.094	-0.024	0.094	0.053
	(5.505)	(0.274)	(2.592)	(-1.094)	(0.922)	(-0.202)	(0.804)	(0.565)

Source: Computed on the basis of GSO data.
Notes: *t* values are in parentheses.
***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
The cointegrating vectors 1-8 are those between Dong Thap and 8 provinces, namely: Quang Tri, HCM, Thanh Hoa, Binh Dinh, Thai Binh, Quang Ngai, Ninh Thuan and Lam Dong, respectively.

countries are the two leading rice exporters and they supply the world market with the same types of rice ─ 5% broken for high quality rice and 25% broken for lower quality rice. Furthermore, recognizing the losses they may both incur due to price competition, Thailand and Vietnam had started discussing possible cooperation in rice export in the early 1990s but a memorandum of agreement (MOA) was only signed in April 2001.

Impact of the removal of export quota in Vietnam. Starting on May 1, 2001, the country's rice export quota had been removed. The test results show that the shift dummy is insignificant and should be excluded from the analysis (Table 6). This also means that the removal of the rice export quota has no impact on the long-run relationship between Vietnam's and Thailand's rice prices.

There are two reasons behind this conclusion. First, like other many developing countries, Vietnam faced most notably a trade-off between food security and generation of foreign exchange from rice exports. Hence, a kind of "flexible quota" was set, which was less constraining on the rice export volume in relation to rice output. Therefore, the removal of the quota did not radically change the export volume of Vietnam, as expected. Second, Vietnam's abolition of the rice export quota was implemented at the same time that India

Table 4. Test results showing weak exogeneity for nine integrated markets, Vietnam, 1998-2005.

Market	Chi-Square statistic	Critical value [a]
HCMC	33.212	15.51
Dong Thap	24.019	15.51
Ninh Thuan	36.562	15.51
Lam Dong	41.539	15.51
Binh Dinh	37.945	15.51
Quang Ngai	28.061	15.51
Thanh Hoa	48.201	15.51
Thai Binh	26.056	15.51
Quang Tri	51.453	15.51

Source: Computed on the basis of GSO data.

[a]/ Significant at the 5% level.

Table 5. Cointegration rank test for rice price, Vietnam and Thailand, 1997-2006.

Null Hypotheses	Eigen Value	Trace	P-value
5% broken rice			
r = 0	0.052	28.982	0.020
r = 1	0.010	4.537	0.696
25% broken rice			
r = 0	0.071	36.652	0.000
r = 1	0.005	2.363	0.712

Source: Computed on the basis of USDA data.

launched its rice export subsidy and supplied the world market with a large volume (3 million tons). This amount actually contributed to an even more serious decline in world rice price and drove down Vietnam's and Thailand's export prices to the lowest level in 30 years. Considering such impact of foreign trade policy and the prevailing world rice market situation then, the removal of the rice export quota in Vietnam had no significant effect on the price relationship with Thailand.

Test for the LOP. The test results from the application of the LOP presented in Table 7 show that in the long run, Vietnam and Thailand's export prices for 5% broken rice and 25% broken rice conform to the law of one price.

The estimates of ECM for 5% broken rice are as follows:

$$\begin{aligned}\Delta Thai5_t = \; & 0.036\Delta Thai5_{t-1} + 0.014\Delta Vn5_{t-1} \\ & + 0.171\Delta Thai5_{t-2} - 0.042\Delta Vn5_{t-2} \\ & + 0.132\Delta Vn5_{t-3} - 0.053 \\ & (\Delta Thai5_{t-1} - Vn5_{t-1} - 16.201) \\ & + \varepsilon_{tt5}\end{aligned}$$

and

$$\begin{aligned}\Delta Vn5_t = \; & 0.026\Delta Thai5_{t-1} + 0.091\Delta Vn5_{t-1} \\ & + 0.068\Delta Thai5_{t-2} - 0.088\Delta Vn5_{t-2} \\ & + 0.105\Delta Thai5_{t-3} - 0.008\Delta Vn5_{t-3} \\ & + 0.023\ (\Delta Thai5_{t-1} - Vn5_{t-1} \\ & - 16.201) + \varepsilon_{tv5}\end{aligned}$$

The ECM estimates for 25% broken rice are:

$$\begin{aligned}\Delta Thai25_t = \; & -0.005\Delta Thai25_{t-1} + 0.050\Delta Vn25_{t-1} \\ & - 0.061(Thai25_{t-1} - Vn25_{t-1} \\ & - 12.937) + \varepsilon_{tt25}\end{aligned}$$

and

$$\begin{aligned}\Delta Vn25_t = \; & 0.096\Delta Thai25_{t-1} + 0.082\Delta Vn25_{t-1} \\ & + 0.055(Thai25_{t-1} - \Delta Vn25_{t-1} \\ & - 12.937) + \varepsilon_{tv25}\end{aligned}$$

In the long run, Thailand's export price for 5 percent broken rice is always higher than Vietnam's by 16.201 USD/ton. It can be seen that Vietnam adjusts to the long-run equilibrium with Thailand more slowly.

Table 6. Results on the test for restriction of exclusion of dummy variable, Vietnam, and Thailand, 1997-2006.

Null Hypothesis	LR-Test Statistic
5% broken rice	
Dummy variable can be excluded. (No impact of policy)	CHISQR(1) = 0.114 P-value [0.7351]
25% broken rice	
Dummy variable can be excluded. (No impact of policy)	CHISQR(1) = 0.815 P-value [0.367]

Source: Computed on the basis of USDA data.

Table 7. Results on the test for LOP between Thailand and Vietnam rice export prices, 1997-2006.

Null Hypothesis	LR-Test Statistic
5% broken rice	
Law of One Price holds	CHISQR(1) = 2.546 P-value [0.111]
25% broken rice	
Law of One Price holds	CHISQR(1) = 2.443 P-value [0.148]

Source: Computed on the basis of USDA data.

The lower speed of adjustment of Vietnam to the long-run equilibrium with Thailand in the rice export market implies that (1) Thailand maintains a relative price competitiveness with Vietnam and gains in times when Vietnam is in a tight supply situation, and (2) Vietnam is less active in adjusting its price and has not taken advantage of the opportunities to earn more foreign exchange from the high export price. Vietnam should be more active in responding to changes in Thailand's rice export price.

The price gap between the two countries' rice exports can be explained by several factors as discussed below:

Rice export quality. Thai rice tends to be of higher quality and is subject to fewer variations in availability (FAO 2004). The Thai government's policy has favored research and development that leads to the improvement of rice varieties. The quality of Vietnamese rice is generally not as high as that of Thai rice because of significant losses in quantity and quality brought about by lesser care in postharvest handling, pre-storage activities, and quality control.

The rice marketing sector. While rice market channels in Thailand are well-organized and integrated from producers to consumers, Vietnam has not had much experience in international trading. The latter's trading arrangements have led to high risks in meeting the terms of the contracts, thus contributing to a lower price for Vietnam export rice compared with comparable quality rice from Thailand (Khiem et al. 2002).

Limited capacity to do forecasting and market analysis. This shortcoming results in advanced contracts with low prices, like what happened in late 2003 when an advanced contract of approximately 1 million tons of rice was signed. The said contract was completed in 2004 with the price set at 30-40 USD/ton lower than contemporaneous prices. The weak market forecast has also resulted in inappropriate timing in releasing stock. For instance, in late 2002, exporting enterprises and farmers held about 500,000 tons of rice stock, in anticipation of higher prices by early 2003. Unfortunately, the price dropped, causing them a loss estimated to be almost 100 million USD (Vietnam News Agency 2004).

Reliable supply of rice. Thailand has a high export capability because it has devoted as much as around 10 million hectares to rice production. Hence, Thai rice export is characterized by sustainable supply, and consistent quality, coupled with a long trading experience. Vietnam is still regarded as an unreliable rice supplier (IFPRI 1996) and its rice, inconsistent in quality. These have contributed to the unfavorable conditions surrounding Vietnam's rice exports.

Competition among rice exporting companies. The backbone of Thailand's rice

export is the Thai Exporters' Association. The association is like a "club" of rice exporters in which every member can compete with one another in rice export markets, but the arrangement is conditioned by certain rules that ensure better competition in the world rice market. In Vietnam, the Vietnam Food Association, which includes 81 exporting companies, is the main body dealing with rice export. It was reported that until 2004, there had been no consistent pricing rules for exporting companies to follow. Exporting companies in Vietnam competed strongly among themselves, thereby lowering the rice price to attract new contracts.

Rice standardization and trade mark. According to IFPRI (1996), the Thailand export market can meet the diverse requirements of foreign buyers. Its rice is graded into 32 quality categories based on the percentage of broken rice, degree of polishing, size of grain, and moisture content. Thailand is famous for a number of high-quality rice such as Jasmine (Thai Hom Mali rice). On the other hand, rice in Vietnam is assembled by many intermediary agents and sold to exporting companies with different mixes of varieties. Hence, the rice it exports is simply called "Vietnam white rice" and has no trade mark in the global market.

Government policies. Thailand is able to maintain its position as the largest and most reliable rice supplier in the world due to its favorable growing conditions and a number of supportive government policies. Aside from a strong R&D and marketing support program, the government has implemented fewer restrictions in rice trading (e.g., export tax or quota, or export ban), unlike the case of Vietnam. In the latter, the export quota and export ban possibly have had a negative impact on the perception of foreign consumers. In 2004, the MOT suddenly implemented an export ban to ensure that there was enough supply of 25 % broken rice to complete its transaction with the Philippines and to keep domestic prices stable. This export ban likely damaged Vietnam's reputation in the international market (GAIN 2004).

RECOMMENDATIONS

Based on the results of the study, the following recommendations are proposed to enhance the spatial integration of rice markets in Vietnam.

1. Provision of better marketing infrastructure and communication system in Vietnam. To facilitate the integration of the rice-deficit areas with the country's common rice market, the government can focus on three measures. First, it needs to improve the road system to reduce transportation costs, which would ultimately help to promote economic growth and reduce poverty. In the case of the Central Highland region, coffee production for export was done at the expense of food (rice) production, but this region has very high poverty incidence and weak infrastructure. By investing on local infrastructure in the region, the government can achieve more than just a strongly integrated rice market. Several other benefits can be attained, such as the reduction in high transportation costs which presently constrain coffee growers in CH, as well as the promotion of the economic and social development in the region, which would ultimately help eradicate hunger and alleviate poverty.

Secondly, the Vietnamese government must invest in the communication system to provide information on rice price and on the supply and demand situation in domestic rice markets. At present, ICARD broadcasts information on various food consumer prices in some provinces. However, it is necessary to have rice trade information with a broader geographic

coverage and price types, such as producer prices. Lastly, the marketing system must be developed to ease the rice commodity trade by increasing the number of markets, especially in the rural and mountainous areas.

2. Harmonization of food policies that affect food security and export earnings. The weak connection of many rice-surplus provinces in the MRD with rice-deficit provinces, especially in mountainous and remote areas, might have dual results. On one hand, at a time of high and fluctuating world rice prices, the rice-deficit areas suffer less from strong price variation as the price transmission from other major markets is weak. On the other hand, at a time of low world price, consumers in rice-deficit areas are not able to gain from the low price, and rice producers in surplus areas have little chance to improve their selling price. In this sense, the better solution is for the government to harmonize food security and exchange rate earnings by (1) promoting integration among rice markets as discussed above, and (2) supporting the mountainous and remote areas when rice prices are high.

3. Implementation of food policy that will target first the surplus areas. The mountainous and remote areas separated from the common rice market should be targeted directly by the policies intended to enhance food sufficiency. The food price policy was first implemented in Dong Thap and Thai Binh and has the largest impact on the system of the nine rice markets. The fact that these two rice-surplus provinces are also integrated with a number of other markets out of the system might expand the impact of food policy to some extent. Given the poor marketing system and infrastructure in mountainous and remote areas, they should be targeted as the direct beneficiaries of the food policy reforms (e.g., buffer stock program, marketing cost subsidy) in order to ensure food security within the shortest time and save cost on delaying food transfer from surplus regions to deficit regions.

4. Improvement of Vietnam's rice trade in the world market by adopting the following measures: (1) enhancing the quality of rice exports through more modern postharvest technologies/practices (e.g., harvesting, drying, polishing) and better rice varieties; (2) developing an integrated rice marketing chain, especially in the Mekong River Delta; (3) strengthening the capacity to undertake rice market information analysis and forecast; (4) encouraging rice-exporting enterprises to follow certain rules to avoid cut-throat competition; and (5) establishing a system of rice standards and creating a trademark for Vietnamese rice.

Appendix A. Accounting procedure used in estimating the rice supply and consumption in Vietnam.

Let *Q* be total paddy outputs in a year.

Paddy available after adjusting for postharvest (with postharvest loss equal to 10%)	= 90% *Q*
Paddy used for seed estimated at 4.5% * 90% *Q*	= 4.05% *Q*
Paddy utilized for animal feed (4%*(100%-(90%+3.6%))	= 3.02% *Q*
Total paddy available for human consumption (100%-17.07%)	= 82.93% *Q*
Total rice available for human consumption is 82.93% *Q** 66% (66% is paddy-rice conversion factor)	= 54.73%*Q*
Total rice consumed by households per year (*N* is population) (The socioeconomic survey of the Ministry of Agriculture and Rural Development in 2001 pointed to an annual per capita rice consumption of 178 kg, which included both home and outside consumption, and different rice-made products such as noodles, cakes, etc).	=178 **N*

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