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Bangladesh Rice Trade and Price Stabilization

Implications of the 2007/08 Experience for Public Stocks

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INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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ABSTRACT

The extent to which Bangladesh should rely on imports for rice price stabilization is a contentious policy issue. This issue was underscored in the wake of the 2007–08 world food crisis, during which international rice prices skyrocketed and rice import supplies from India were disrupted. For more than a dozen years, from 1994 to 2007, private-sector rice imports made a major contribution to price stabilization and food security in Bangladesh, adding to domestic supplies following production shortfalls. In particular, following massive floods in 1998, private-sector imports sourced from wholesale rice markets in India contributed more than 2 million tons to rice supply in Bangladesh. Subsequently, between 2003 and mid-2007, Bangladesh prices were particularly stable. This paper presents econometric evidence that trade with India was a determining factor in this price stability. In particular, the authors show that in this period, Bangladesh domestic wholesale prices were co-integrated with import parity prices of subsidized below-poverty-line rice from India's public stocks. Import flows in these years generated an estimated total of 1.0 to 1.6 billion US dollars in consumer surplus for Bangladesh households but reduced producer surplus by a similar amount.

This subsidized trade ended in late 2007, however, when India's domestic market supply situation changed, international cereal prices rose, and India cut off exports to Bangladesh to protect its own domestic market. Because of these problems with rice trade, Bangladesh policymakers and civil society no longer perceive India and the international market as reliable suppliers and thus call for increased stocks. This analysis suggests that an additional 300,000 tons (in addition to approximately 700,000 tons of net rice off-take that actually occurred) would have been sufficient to stabilize prices in the postmonsoon (*aman*) season from November 2007 to April 2008. These calculations suggest that ready availability of approximately 1.0 million tons of rice through drawdown of public stocks or imports would enable Bangladesh to handle similar disruptions in the future, provided that private imports can supplement supplies as in 2007/08 (or about 2.0 million tons otherwise). The medium-term solution to maintaining real rice prices at moderate levels and helping ensure household food security, however, continues to be investments in agriculture to increase production and raise rural real incomes.

Keywords: price stabilization, international trade, rice policy

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1. INTRODUCTION

Given the country's history, the role of international trade and public stocks for rice price stabilization is a highly contentious subject in Bangladesh. Due to a major shortfall in domestic rice production and unusually high international rice prices during 1973/74, the country faced a famine in 1974, just two years after its secession from Pakistan, which claimed 1.5 million lives.[1] Since then, all successive governments in Bangladesh, irrespective of their ideological differences, have strived for sufficiency in rice. This policy emphasis on increasing domestic production has paid off, as production of rice has more than doubled since the early seventies mainly due to the adoption of green revolution technology (improved seeds, increased fertilizer use, and irrigation). By the late 1990s, the country had reached near self-sufficiency in rice in normal years, although poor monsoon season (*aman*) rice crops in some years still cause substantial production shortfalls.

Private-sector rice trade has played a major role in stabilizing domestic supplies and prices following such production shortfalls since liberalization of imports in the 1990s, including following the massive 1998 flood that devastated the monsoon season rice crop that year (del Ninno et al. 2001; Dorosh 2001). Private-sector rice trade, mainly with India, continued through the mid-2000s, a period of highly stable prices in Bangladesh. However, when India banned rice exports for a short period in mid-2008, rice prices in Bangladesh rose sharply, and they have remained high and volatile as imports from India have fallen substantially. This more recent experience has led many in Bangladesh to question the wisdom of relying on the international market for rice supplies and has led to calls for substantial increases in public rice stocks.

This paper presents evidence that the rice price stability that Bangladesh enjoyed in the early 2000s was largely due to private trade with India. Co-integration analysis shows a strong significant relationship between domestic wholesale prices and calculated import parity prices derived from the price of subsidized below-poverty-line (BPL) rice in India.[2] These private-sector rice imports thus implied a substantial transfer of resources to the benefit of rice consumers but to the detriment of rice producers in Bangladesh. We also analyze the disruption in this private-sector trade in the second half of 2007 when India first banned rice exports and subsequently negotiated a fixed volume of rice exports at prices substantially higher than the BPL price. We present estimates of the amount of total rice injections that would have been required to stabilize prices at various levels in 2007/08—information pertinent to the question of optimal levels of public rice security stocks for Bangladesh or other arrangements for emergency rice imports.

The plan of the paper is as follows. Section 2 describes Bangladesh rice trade regimes, price movements, and imports, focusing on the experience since 2003. Section 3 presents a co-integration analysis of import parity prices for BPL rice and domestic wholesale prices in Bangladesh. Section 4 presents a partial equilibrium analysis of the Bangladesh rice market to estimate the gains in consumer surplus and loss of producer surplus arising from the trade with India as well as the volume of rice market injections that would have been required to stabilize prices in 2007/08. We conclude with implications for rice trade, stocks, and stabilization policy.

[1] The mortality estimate is from Alamgir (1980).

[2] As part of its food safety net, the Government of India sells rice and wheat through ration shops at fixed prices. For households below the poverty line with ration cards, these cereals can be purchased in relatively small quantities at subsidized prices. See India, Ministry of Finance (various years) for annual data on India's public food distribution system.

2. EVOLUTION OF RICE TRADE POLICY IN BANGLADESH

Bangladesh rice trade policy and its rice import trade have undergone numerous changes in the past several decades that have greatly affected domestic rice prices. Bangladesh achieved its independence from Pakistan in December 1971, just before the international food price shocks of 1973 and 1974, during which international rice markets were highly unstable. As a young independent nation, Bangladesh encountered major difficulties in importing rice due to both shortages of foreign exchange and highly uncertain international rice markets. Partly as a result of this experience, as well as a longer history of food insecurity including the Great Bengal Famine of 1943, the new Bangladesh government adopted a goal of rice self-sufficiency (Ahmed, Haggblade, and Chowdhury 2000). Thereafter, Bangladesh heavily invested in agricultural research, irrigation, and rural roads in an effort to increase domestic rice (and wheat) production.

These investments to increase agricultural productivity have paid off. During this period, rice area cultivated changed very little, increasing by only 0.19 percent per year, as little additional land is available and opportunities for increases in multiple cropping are nearly exhausted (see Table 2.1). However, rice yields grew at an average annual rate of 2.7 percent from 1980/81 to 2010/11. As a result, rice production increased by 141 percent during this period, from 13.9 million tons in 1980/81 to 34.5 million tons in 2010/11 (see Figure 2.1). Most of these gains have been due to an expansion of irrigated winter (*boro*) season rice planted with modern high-yielding varieties. Production of the traditional monsoon season (*aman*) rice has also increased, although area cultivated has declined slightly due to increases in planting of high-yielding varieties and greater fertilizer use.[3]

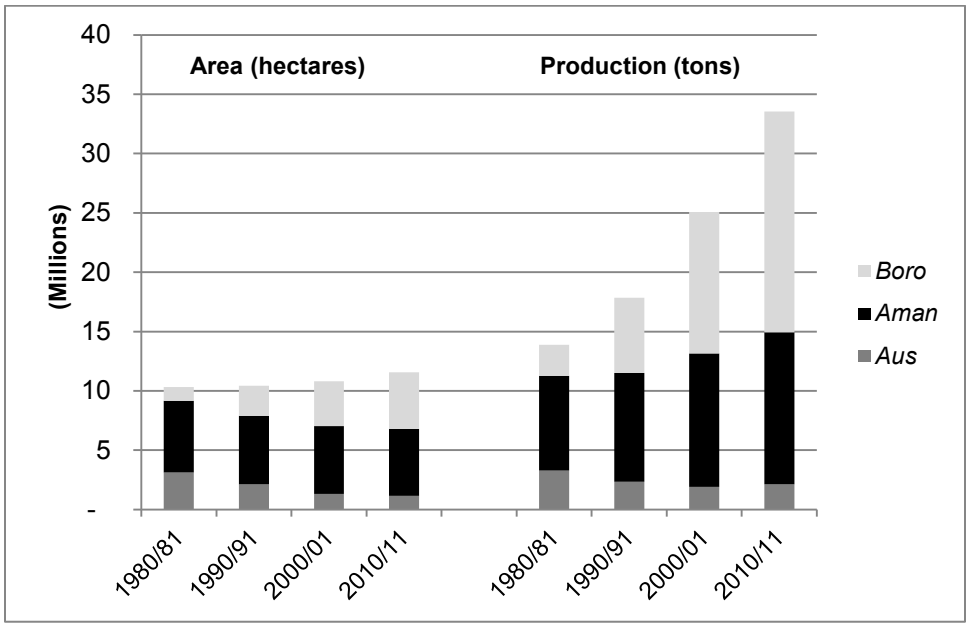
Table 2.1—Bangladesh rice area, yield and production, 1980/81–2010/11

	Aus			*Aman*			*Boro*			Total Rice		
	Area (million hectares)	Production (tons)	Yield (tons/ hectare)	Area (million hectares)	Production (tons)	Yield (tons/ hectare)	Area (million hectares)	Production (tons)	Yield (tons/ hectare)	Area (million hectares)	Production (tons)	Yield (tons/ hectare)
1980/81-1989/90	2,886	2,993	1.04	5,823	7,911	1.36	1,695	4,080	2.41	10,976	16,076	1.46
1990/91-1999/2000	1,655	1,902	1.15	5,674	9,127	1.61	2,863	7,746	2.71	10,891	20,174	1.85
2000/01-2009/10	1,095	1,727	1.58	5,505	10,956	1.99	4,182	14,589	3.49	11,328	28,388	2.51
2010/11	1,150	2,133	1.85	5,630	12,791	2.27	4,780	18,617	3.89	11,975	34,513	2.88
Growth Rate (%) 1980/81-2010/11	-4.43	-2.41	2.11	-0.30	1.55	1.86	4.69	6.63	1.85	0.19	2.86	2.67

Source: Author's calculation based on data from Bangladesh, FPMU (2011) and Bangladesh, Bureau of Statistics (various years).

[3] It is worth noting, though, that the yield increases for *aus* (a relatively minor rice crop), *aman,* and *boro* rice have increased by an average of only 2.11, 1.86, and 1.85 percent, respectively. The large gain in average yields is thus due to an increase in the share of area planted to higher-yielding *boro* season rice and a decrease in the shares of area planted in the *aus* and *aman* seasons, when lack of water control is a major factor limiting yields (see Dorosh 2000).

Figure 2.1—Bangladesh rice area and production by season, 1980/81 to 2010/11



Source: Authors' calculation based on data from Bangladesh, Bureau of Statistics (various years), and Bangladesh, FPMU (2011).

Gains in rice (and wheat) production enabled Bangladesh to reduce its dependence on (mainly wheat) food aid imports and eliminate its *notional food gap* (the difference between a target availability of 454 grams/person/day and net domestic production of rice and wheat) by 2000. Wheat food aid helped fill in the gap between domestic supplies and target levels of national foodgrain consumption from the 1970s through the later 1990s. Since then, food aid has been sharply reduced, although some food aid continues to supply targeted distribution programs through the Public Foodgrain Distribution System.

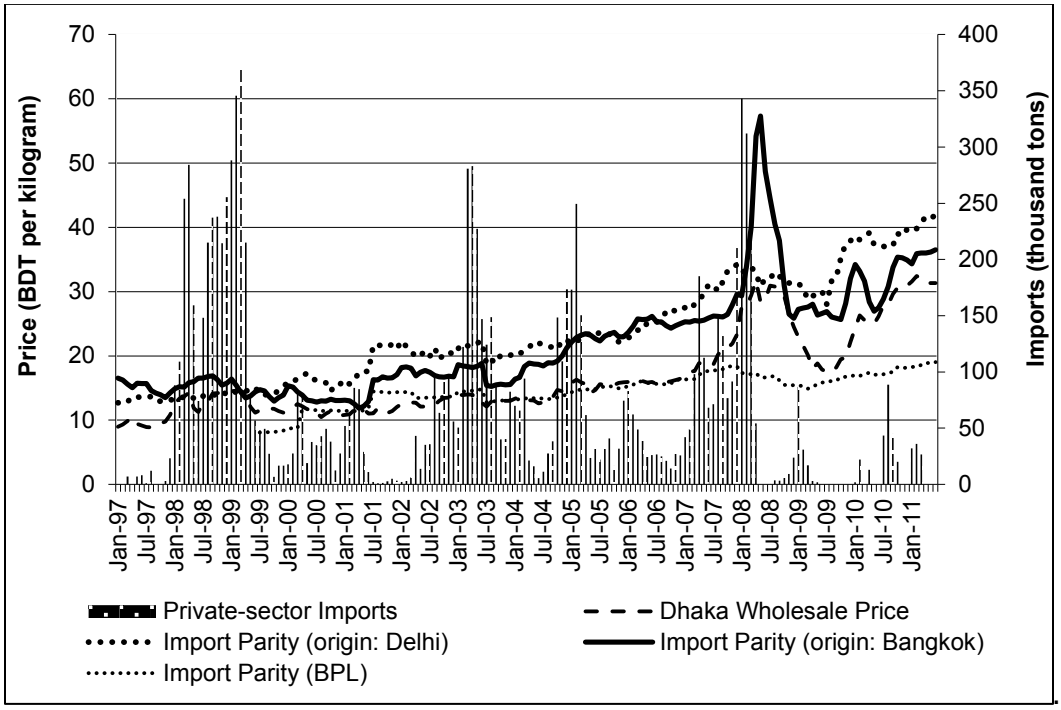
Historically, imports have constituted only a small share of rice supplies, however. During the 1970s and 1980s, only relatively small amounts of rice were imported (all by the public sector, since private imports were banned). Liberalization of private-sector cereal import trade in the early 1990s, however, made possible large-scale imports of rice (and wheat) in years of major domestic production shortfalls. In years of normal harvests such as 1996/97, Bangladesh rice prices were less than import parity prices for rice originating from both India and Thailand. As a result, private-sector imports were negligible (see Table 2.2 and Figure 2.2). Private-sector rice import trade was particularly important in adding to foodgrain supply and stabilizing rice prices following the 1998 flood, which resulted in a 2.2 million ton monsoon season rice production shortfall (del Ninno et al. 2001; Dorosh 2001).

Table 2.2—Bangladesh rice import trade regimes

Period	Trade Regime	Private Imports (thousands of tons /year)	Description
1996/97	Autarky	30	Abundant harvests keep domestic prices below import parity
1997/98 - 1998/99	Private imports from India	1834	Consecutive poor *aman* harvests raise domestic prices to import parity (for example, wholesale India)
1999/2000 - 2001/02	Autarky / minimal private imports	358	Good harvests keep domestic prices below import parity (Bangkok and BPL)
2000/01, 2002/03 - 2007/08	Private imports from India (BPL rice?)	948	Domestic prices track BPL import parity
2007/08	Transition from import parity (BPL) to autarky	1681	India bans private rice exports as world prices rise; domestic prices rise sharply but generally far below import parity, for example, Bangkok
2008/09 - 2010/11	Autarky	172	Domestic prices above BPL India import parity, but generally below import parity, for example Bangkok and Delhi import parity.

Source: Authors.
Note: BPL = below-poverty-line.

Figure 2.2—Bangladesh domestic and import parity rice prices and imports



Source: Author's calculation based on data from Bangladesh, FPMU (2011), India, Ministry of Finance (various years), and International Monetary Fund (2011).
Note: BDT = Bangladeshi Taka.

India's wholesale prices of rice rose in the early 2000s, making private-sector exports to Bangladesh sourced from open markets unprofitable. During this period, however, India accumulated large public rice and wheat stocks, reaching 65 million tons in the summer of 2001 due to a series of good harvests and relatively high procurement prices (Rashid, Cummings, and Gulati 2007; Rashid, Gulati, and Cummings 2008). To reduce some of these stocks, the government of India implemented a program in 2002/03 to subsidize exports of rice obtained from Food Corporation of India stocks at the subsidized BPL price.[4] Bangladesh imported 1.6 million tons of rice that year, and Bangladesh domestic prices closely tracked import parity based on BPL sales prices (as opposed to import parity based on India's wholesale market prices as following the 1998 flood). Large private-sector rice imports continued through 2006/07, and Bangladesh wholesale prices closely tracked import parity based on BPL sales prices through this period, resulting in a high degree of price stability in Bangladesh.

Calm in Bangladesh rice markets was shattered in the second half of 2007 as world prices of rice and other cereals rose sharply and India cut off rice exports in October 2007 due to relatively low public wheat stocks (Slayton 2009; Dorosh 2009; Headey and Fan 2008). Average wholesale rice prices in Bangladesh rose sharply and for the November 2007 to April 2008 period were 45 percent higher in real terms than they were one year earlier. India later agreed to fixed quantities of rice exports to Bangladesh at a price higher than BPL prices. Yet total rice imports by Bangladesh ultimately reached 1.7 million tons of rice in 2007/08.

Since 2008, domestic rice prices in Bangladesh have remained significantly greater than BPL import parity but less than import parity based on India wholesale market prices. Moreover, Bangladesh domestic wholesale prices have generally been less than import parity of Thai rice. As a result, Bangladesh private-sector imports have been minimal. Thus, from mid-2008 to mid-2011, apart from small-scale Bangladesh government commercial imports, rice was essentially a nontraded commodity. In the absence of high levels of imports to boost domestic supply, Bangladesh real prices since 2008 have fallen about 15 percent relative to their peak of early 2008 but remain about 40 percent higher than in the 2002/03 to 2006/07 period.

[4] This policy was explicit in 2002/03. The econometric evidence in the next section suggests that the policy continued through 2006/07.

3. EVIDENCE OF PRICE LINKAGES BETWEEN THE BANGLADESH AND INDIA RICE MARKETS: A CO-INTEGRATION ANALYSIS

The apparent co-movement of Bangladesh wholesale prices with import parity prices of India's BPL rice (see Figure 2.2), together with a steady flow of large-scale imports from 2003 through mid-2008, suggests that Bangladesh domestic prices were in fact determined by the price of subsidized rice in India in this period. To test this hypothesis, we present a co-integration analysis of the relationship between the monthly import parity prices of BPL rice and national average wholesale prices of coarse rice in Bangladesh. The import parity price is calculated as the official BPL price, adjusted for estimated costs of transport and other marketing costs in India and Bangladesh, as well as import tariffs.[5] Marketing costs are based on cost estimates from the late 1990s and adjusted thereafter using the consumer price indices for India and Bangladesh. The analysis covers the period from July 1997 to March 2011.

Relationship between BPL and Dhaka Wholesale Price (DWP)

To examine the relationship between import parity BPL price and the Bangladesh wholesale price, a vector error correction model is considered:

$$\begin{bmatrix}\Delta BPL_t \\ \Delta DWP_t\end{bmatrix} = \begin{bmatrix}\alpha_0 \\ \beta_0\end{bmatrix} + \begin{bmatrix}\alpha_1 & \alpha_2 \\ \beta_1 & \beta_2\end{bmatrix}\begin{bmatrix}\Delta BPL_{t-1} \\ \Delta DWP_{t-1}\end{bmatrix} + \begin{bmatrix}\varphi_1 \\ \varphi_2\end{bmatrix} \cdot [c \;\; 1 \;\; \gamma] \cdot \begin{bmatrix}1 \\ BPL_{t-1} \\ DWP_{t-1}\end{bmatrix} + \begin{bmatrix}\varepsilon_{1t} \\ \varepsilon_{2t}\end{bmatrix}, \quad (1)$$

where α_i and β_i are short-run parameters, $\begin{bmatrix}\varphi_1 \\ \varphi_2\end{bmatrix}$ are adjustment coefficients, $[c \;\; 1 \;\; \gamma]$ are long run parameters, ε_i are error terms, and DWP and BPL are Dhaka wholesale rice price and import parity price, respectively, derived from the BPL rice price in India. Imports at the BPL import parity price will take place as long as exports are allowed (by India) and the following condition holds:

$$DWP_t \leq T_t + \mu_1 BPL_t. \quad (2)$$

Here T_t is transactions costs and μ_1 is a long-run slope coefficient. From equation 1, one can derive transaction cost $T_t = \left(-\frac{c}{\gamma}\right)$ and $\mu_t = \left(-\frac{1}{\gamma}\right)$. Since both variables are in natural logarithms, μ_t also represents the long-run elasticity between the two prices.

We estimate the long-run relationship using Johansen (1988) and Johansen and Juselius's (1990) multivariate maximum likelihood vector auto-regression (VAR) co-integration method. The concept of co-integration states that if there exists a long-run relationship among a set of nonstationary variables, then the deviation from the long-run equilibrium path should be bounded. In other words, existence of a long-run relationship implies that co-integrated variables cannot wander too far away from each other. Formally, two nonstationary series X_t and Y_t are said to be co-integrated if the following conditions are satisfied: (1) Both series are integrated of the same order, and (2) there exists a linear combination of X_t and Y_t, which is I(0), that is, stationary. Therefore, a critical first step in conducting co-integration analyses is to examine the order of integration (stationarity) of relevant variables.

[5] In an effort to promote the import trade in January 1998, the small 2.5 percent import tariff on rice was eliminated. A 7.5 percent import tariff was imposed in January 2000 and remained in effect until 2007/08, except for July 2001 through June 2003 when total import taxes varied 26.0 to 37.5 percent as part of a government policy to boost producer prices and promote production. See Ahmed et al. (2009) for more details about rice trade and pricing policy in Bangladesh.

Empirical Results

Table 3.1 presents results of Augmented Dickey-Fuller tests. Note that the tests are performed for both the full sample (July 1999 to March 2011) and the subperiod in which India allowed rice exports at BPL prices. Results clearly show that both DWP and BPL are nonstationary in levels and stationary in first differences.

Table 3.1—Stationarity tests: Bangladesh wholesale price (BWP) and below-poverty-line (BPL) import parity price[a]

Series	Augmented Dickey-Fuller Test for Unit Roots	
	Level	First Difference
Full sample		
BWP	–2.16	–7.72
BPL	–2.16	–9.30
BPL period (2002–2007)		
BWP	–2.67	–7.64
BPL	–1.74	–7.67

Source: Authors' calculations.

Notes: [a.] All variables are in natural logarithm; Augmented Dickey-Fuller tests $H_0 : X_i \sim I(1)$ against $H_1 : X_i \sim I(0)$; and the critical values at 5 percent level of significance are –3.07.

Using the first differences of both variables, we then determine the number of co-integrating relationships (rank of Π in Johansen's framework), as both estimated long-run parameters and structural hypothesis testing are meaningful only if the rank is determined properly. First, as Boswijk and Franses (1992) pointed out, results of VAR are sensitive to the choice of lag length. Therefore, it is important to test whether the lag length is determined in such a way that the residuals are normal. The second test deals with which deterministic components (that is, a constant, a trend, a trend and a constant, and so on) enter into the co-integration space. We have employed both reduction tests and Lagrange multiplier tests to determine the optimal lag length and Johansen's (1995) method to examine the significance of the deterministic components.

To adequately understand the relationship between BPL prices and DWP, the model is estimated for two periods with various specification tests. First we investigated whether there was co-integration between the two variables for the entire sample period (1999:07 - 2011:03); and estimations were conducted with and without a break in 2007 when India placed an export ban.[6] We then investigated the relationship for the period in which India allowed rice exports to Bangladesh at BPL prices. The results are presented in Table 3.2.

Table 3.2—Johansen's co-integration test results[a]

Sample Specifications	Null Hypotheses	Johansen's Trace Test Statistics	95 Percent Critical Values	p-Value[a]
Full sample (1999:07 to 2011:03)	$r = 0$	17.99	20.16	.100
Without structural break	$r = 1$	2.49	9.14	.684
Full sample (1999:07 to 2011:03)	$r = 0$	21.47	30.95	.337
With a structural break	$r = 1$	3.06	14.81	.549
Below-poverty-line export period	$r = 0$	19.21	12.28	.003
Subsample (2002:01 to 2007:07)	$r = 1$	1.79	4.07	.214

Source: Authors' calculations.

Notes: [a.] The test statistics are corrected for the small sample size.

[6] The main rationale behind considering the entire sample period is that even though India imposed export restrictions, the cross-border illegal trade was still significant and indirectly affected Bangladeshi prices.

Consider the first specification with the entire sample, where the first row shows the results of the null hypothesis of no co-integration ($r = 0$) and the second row for one co-integrating relationship. The calculated trace test statistic is 17.99, which is smaller than the 95 percent critical value of 20.16. Therefore, the null hypothesis of no co-integrating relationship ($r = 0$) cannot be rejected at a 5 percent level of significance. However, the test has a p-value of .100, suggesting that the converse would have been true at a 10 percent level of significance. However, this result is spurious in that it does not account for the break in 2007 (refer to Figure 2.2). Thus, when a structural break is specified in July 2007, the results change dramatically. With a p-value of 0.337, the hypothesis of no co-integration between the two variables is strongly rejected.

The main focus of our analysis is the period in which India allowed rice export to Bangladesh at BPL prices. The results for this time period are presented in the bottom two rows of the table. Notice that with a calculated trace statistic of 19.206 and a p-value of .003, the null hypothesis of no co-integration ($r = 0$) is now rejected at less than a 1 percent level of significance and that the null hypothesis of one co-integrating vector cannot be rejected at a conventional level of significance. We thus conclude that there was a unique co-integrating relationship between Indian BPL prices and the DWP of rice. To further test the robustness of these results, we have conducted a host of tests, including optimal lag length, deterministic components, and residual normality.[7] A likelihood ratio test for lag reduction in choosing VAR (1) against VAR (2) gives a test statistic of 4.93 with a p-value of .292, suggesting that one lag is adequate to specify a VAR for this specification of the model. We then estimated the model with various deterministic terms and tested for the significance. A model with a constant term gives us the following long-run relationship between DWP and the BPL prices:

$$\mathrm{DWP_t} = 0.661 + 1.024\mathrm{BPL_t} \tag{3}$$

Following Johansen and Juselius (1992), the significance of each of the variables was then tested by imposing exclusion restrictions with a likelihood ratio test that follows a χ^2 distribution with one degree of freedom. The test statistics for DWP, BPL, and the constant were calculated to be 16.38, 14.39, and 2.42, respectively. Clearly, test statistics for both DWP and BPL are much larger than the 5 percent critical value of 3.841. The test statistic for the constant term was however only 2.42. Therefore, when the constant term is restricted to zero, the estimated long-run elasticity (μ_l) between DWP and BPL becomes 0.99.

In summary, the above co-integration analysis shows that the DWP of coarse rice is co-integrated with the BPL parity prices during 2002–2007, with an estimated long-run elasticity of 0.99. This estimate suggests an almost perfect long-run transmission of BPL price to the Dhaka rice market. These estimates are robust to specifications of co-integrating relationships with various deterministic components. Residuals from the estimated relationship also appear to be normal. The results also suggest that there has been a break since the middle of 2007. This coincides with a cessation in subsidized exports of BPL rice by India.

[7] The same tests were performed for the other two specifications as well but not reported for the sake of brevity. Detailed results are available from the authors on request.

4. BANGLADESH RICE PRICES, IMPORTS AND PRIVATE STOCK CHANGES: A PARTIAL EQUILIBRIUM ANALYSIS

Imports of subsidized rice by Bangladesh in the early to mid-2000s had important effects on both consumers and producers. In this section, we provide quantitative estimates of the gains in consumer surplus and loss of producer surplus arising from these imports using a simple partial equilibrium model[8] of the Bangladesh rice market. In addition, we analyze the effects of the rice production shortfall and possible changes in private stocks on wholesale rice prices in 2007/08 as well as the volume of rice market injections that would have been required to stabilize prices in 2007/08.

In the model, we assume that domestic rice production is a function of the domestic price with an elasticity of supply e_s and total supply is equal to domestic production less losses plus net public-sector market injections (distribution minus domestic procurement) plus exogenous changes in private stock. Domestic demand is a function of the change in (real) prices and (real) income, with elasticities of demand e_d and income e_y. Unless otherwise specified, we hold changes in private-sector stocks to zero.[9]

Imports of Subsidized BPL Rice: Estimates of Producer and Consumer Surplus

The considerable price stability during the 2002/03 to 2006/07 period was attained due to a major transfer of resources to Bangladesh consumers through India's subsidized exports. For example, in 2005/06 rice imports were nearly 500,000 tons, equivalent to about 2.3 percent of net supply. Assuming an own-price elasticity of demand of –0.3 and an own-price elasticity of supply of 0.2, domestic rice prices would have risen about 4.7 percent in the absence of international trade (2.9 percent with more elastic demand and supply elasticities of –0.5 and 0.3).[10,11] Thus, the gain in consumer surplus to Bangladesh consumers due to these subsidized imports was about 265 million US dollars[12] (166 million dollars with more elastic parameters). Losses in producer surplus were approximately the same absolute magnitude since imports were such a small share of total net supply. During the four years, 2003/04 through 2006/07, the total gain in consumer surplus was 1.0 to 1.6 billion dollars. Producers lost a similar amount, and production would have been about 300,000 tons per year higher without the imports. Achieving similar gains in consumer surplus in the absence of subsidized exports by India would entail substantial additional fiscal costs if the Bangladesh government subsidized sales of publically imported rice.

Analysis of the 2008 Rice Price Increase and Stabilization Options

To shed light on the reasons for the steep rice price increase in early 2008, we model the price effect of the sharp reduction in net production of the monsoon season (*aman*) rice harvest from 9.76 million tons in late 2006 to only 8.70 million tons in late 2007, a decline of 1.06 million tons (see Table 4.1, simulation 1). In this analysis of the short-run effects of the 2007/08 *aman* harvest shortfall, we hold the elasticity of supply to zero since between the November *aman* harvest and the following May *boro* harvest, there is essentially no domestic rice production.

[8] For a similar simple partial equilibrium model, see Dorosh, Dradri, and Haggblade (2009).

[9] Model equations are given in annex 1.

[10] An own-price elasticity of demand of –0.3 approximates econometric estimates using national time-series data of rice demand in Bangladesh (Dorosh 2001); the more elastic own-price elasticity of demand is closer to cross-section estimates (Ahmed, Haggblade, and Chowdhury 2000). Own-price elasticities of rice supply approximate the range of estimates from Dorosh, Shahabuddin, and Rahman (2002).

[11] The elasticities of supply are short-run elasticities, meant to capture the effects of changes in total production (aus, aman and *boro* seasons combined) in one year (July-June harvests). Note that in the short-run simulations modeling post-aman harvest price movements, domestic production is exogenous.

[12] All dollars are US dollars.

Table 4.1—Bangladesh domestic rice prices 2007/08: Model simulations

	2007/08	2007/08	2007/08	2007/08
	Sim 1	Sim 2	Sim 3	Sim 4
		Private stock	Stock, including distribution	Including distribution
Net Production	8.696	8.696	8.696	8.696
Net Offtake	0.702	0.702	1.802	1.002
Private imports	1.254	1.254	1.254	1.254
Private stock change	0.000	0.885	0.885	0.000
Supply	10.651	10.651	11.751	10.951
Per capita supply (% change)	-1.2	-9.4	0.8	1.6
Per capita demand income effect (%)	1.4	1.4	1.4	1.4
Supply-Demand Gap (as % of initial demand)	-2.6	-10.6	-0.6	0.2
Real Price Change[a] (%)	**9.0**	**45.5**	**2.0**	**-0.6**
Real Price Change[b] (%)	7.3	27.7	3.1	1.5

Source: Model simulations.

Note: Sim = simulation. The range 2007/08 indicates November 2007 through April 2008.

[a.] Own price elasticity of demand for rice = –0.3; income elasticity of demand for rice = 0.3.

[b.] Own price elasticity of demand for rice = –0.5; income elasticity of demand for rice = 0.5.

Due to an increase in net imports and net distribution in the November 2007 to April 2008 period, net supply per capita fell only 1.2 percent relative to November 2006 to April 2007, in spite of the large production decline. Comparing 2007/08 with 2006/07, net per capita demand increased by 1.4 to 2.4 percent due to increased per capita income (assuming a 0.3 or 0.5 income elasticity of demand for rice). To meet the resulting 2.6 to 3.5 percent gap in supply versus demand (at 2006/07 prices) requires a simulated real price rise of 10.1 percent to 12.2 percent, far lower than the historical real price rise of 45 percent.

The above simulation assumes no change in private stocks, however. Various analysts of the 2008 rice price rise in Asia have suggested, however, that speculative increases in private stock holdings by consumers and traders were a major factor behind the large increase in market prices (Timmer 2009, 2010; Headey and Fan 2008). In simulation 2, we assume a change in private stocks equivalent to one-half month of 2006/07 rice consumption (885,000 tons). The result is a simulated real rice price increase of 28 percent (with an own-price elasticity of –0.5) to 46 percent (with an own-price elasticity of demand of –0.3), as compared to the actual historical real price rise of 45 percent. Thus, the simulations indicate that a relatively small increase in private-sector stocks could account for much of the observed increase in real rice prices in Bangladesh in early 2008.

Simulation 3 then shows the implications of increasing net public-sector market injections. Historically, the Bangladesh government's net rice market injections equaled 430,000 tons from November 2006 through April 2007. If private-sector stocks increase by 885,000 tons (an additional two weeks of consumption) as in simulation 2, it would require an extra 1.1 million tons of net distribution to reduce the real price rise to within 2 to 3 percent of the 2006/07 level. However, if increased net rice distribution were sufficient and timely enough to calm markets and forestall an increase in private-sector stocks, an additional injection of only 300,000 tons would be sufficient to keep real prices near 2006/07 levels (simulation 4). If a 10 percent increase in the real price of rice would have been an acceptable outcome, injections could have been about 150,000 tons less than the historical level, provided that they were done on a timely basis to avoid a buildup of private stocks.

Note that in early 2008, public rice stocks were insufficient to allow much more distribution. By drawing down stocks and increasing public-sector imports, the Bangladesh government injected 702,000 tons of rice distribution into Bangladesh markets in the November 2007 to April 2008 period. End April public stocks of rice were only 220,000 tons; those of wheat were only 120,000 tons. Increasing net distribution would not have been possible without either increased imports, increased public stocks, or both. Thus, to have met the production shock of late 2007 would have required the capability to inject about 1.0 million tons of rice into the market (in a timely enough fashion to avoid an increase in private stock holding) in addition to the 1.25 million tons of private-sector imports that added to market supplies during this period.

If we take an extreme assumption that no public imports are available (but private imports can supplement supplies as in 2007/08), then a security stock of about 1.2 million tons (1.0 million tons plus the 200,000 tons kept in reserve as in April 2008) in November/December would be sufficient to meet a shortfall like that of late 2007 without a real price increase. If private imports are unavailable (or import parity prices are unacceptably high), a total net injection of 2.4 million tons would be required, from a combination of public imports or drawdown in stocks. If a moderate real price increase of 10 percent is acceptable and market injections are timely, then total market injections (or stock levels) could be smaller by about 450,000 tons (net distribution 150,000 tons less than the historical level), about 2.0 million tons (simulation not shown).

Nonetheless, it is important to note that public stocks also involve substantial costs (storage losses, other financial costs, risk of possible disruption of private trade and storage). To the extent that international markets can provide for at least part of additional supplies to domestic markets, the costs of these net market injections can be sharply reduced. Moreover, government policy following the 1998 flood shows that it is possible both to have public stocks (with a substantial Public Foodgrain Distribution System) and to promote private import trade at the same time, with even greater savings to the government than with public-sector imports (Dorosh 2001).

5. SUMMARY AND CONCLUDING OBSERVATIONS

For more than a dozen years, from 1994 to 2007, private-sector rice imports made a major contribution to price stabilization and food security in Bangladesh by adding to domestic supplies. In the first half of this period, including the crucial eight months following the massive floods in August 1998, these imports were sourced from private markets in India. However, from 2003 to 2007, Bangladesh wholesale prices were consistently below the calculated import parity price of rice sourced from wholesale markets in India even though there were steady private-sector imports from India. Econometric evidence in this period provides an answer to this puzzle by establishing a strong statistical comovement (co-integration) between Bangladesh domestic wholesale prices and import parity prices of subsidized BPL rice from India's public stocks. Rice imports at these subsidized prices during the 2003/04 to 2006/07 period resulted in a major benefit to Bangladesh consumers through lower market prices, generating an estimated 1.0 to 1.6 billion dollars in consumer surplus. The effect of lower prices for producers was a loss of income of a similar magnitude.

The flow of subsidized rice imports ended, however, when India's domestic market supply situation changed. As international cereal prices rose in 2007, India cut off rice exports to Bangladesh to protect its own domestic market from possible price increases. Although India subsequently did allow rice exports (at prices much higher than BPL prices) that ultimately reached almost 1.7 million tons (July 2007 to June 2008), Bangladesh rice prices rose substantially. Because of this experience, Bangladesh policymakers and civil society no longer perceive India and the international market as reliable suppliers and thus call for increased stocks.

Model simulations of the Bangladesh rice market suggest that changes in net supply (production, imports, and net market injections by the government) and consumption demand (as determined by real per capita income and population growth) account for only 9 percent of the actual 45 percent increase in real rice prices actually observed (November 2007 to April 2008, compared to one year earlier). However, if in addition to these changes in net supply and demand, private stockholding increased by about 900,000 tons, equivalent to about two weeks of consumption, this would reduce available market supply and result in a simulated real price increase, essentially matching the historically observed increase (45 percent). The implications are that private stock changes could have been a major factor in explaining the price increases of 2007/08 and moreover that measures to add to domestic supplies and calm markets earlier may have prevented this extra stockholding and limited the real price increase to only about 10 percent.

This paper also shows that if the hypothesized increase in private stockholding had been avoided through timely intervention, a total of about 1 million tons of net market injections (that is, an extra 300,000 tons of rice in addition to the approximately 700,000 tons of net rice offtake that actually occurred in the period from November 2007 to April 2008) would have been sufficient to stabilize prices. These calculations suggest that ready availability of approximately 1 million tons of rice through drawdown of public stocks or imports would enable Bangladesh to handle similar disruptions in the future, provided that private imports could supply an amount similar to that in 2008 (1.25 million tons). Further sensitivity analysis is needed, though, regarding alternative assumptions of model parameters.[13]

Looking forward, it is important to note that since 2008 Bangladesh domestic prices have generally been less than import parity sourced from either Thailand or wholesale markets in India but far greater than export parity to the world market. As a result, there have been relatively large domestic price fluctuations. In the absence of interventions in domestic markets, this price volatility will likely continue due to fluctuations in domestic rice harvests. In this environment, private trade at import parity prices still provides a price ceiling and can dramatically reduce the volume of stocks needed for price stability (although in some years an import parity price ceiling may be unacceptably high, as it was in 2008). A

[13] It is important to note, however, that in general, private stocks serve a crucial function in smoothing out market availability over time and reducing price volatility between harvest periods. Discouraging private stock holding through build-up of excess government stocks and non-transparent policies decreases market efficiency and increases public sector costs. (See Rashid, Gulati, and Cummings Jr. 2008, and Timmer, Falcon, and Pearson 1983).

return to the stable and low prices of the 2002–06 period is not possible in the absence of subsidized exports by India, however, without massive (and costly) domestic rice market interventions by the Bangladesh government.

Finally, the medium-term solution to maintaining real rice prices at moderate levels thus remains investments in agriculture. Bangladesh successfully reduced real prices of rice during the 1970s and 1980s through increases in supply, largely brought about by the efficient use of green revolution technology: irrigation (private tubewells), improved seeds, and fertilizer. Increased productivity of rice (and other crops) remains a key channel for increasing availability of food, reducing its price, raising rural incomes, and enhancing food security.

APPENDIX: MODEL EQUATIONS

Production $X = X0 * (P/P0)^{ES}$

Consumption $C = C0 *(P/P0)^{ED}$

Private Imports:
(P = PM with free trade) $MPRIV = D – [X * (1 – loss) - DPROC + DIST + MPUB]$
(P = P* market clearing price) $MPRIV = \underline{MPRIV}$

Commodity Supply $S = X * (1 – loss) - DPROC + DIST + MPUB + MPRIV$

Demand $D = C+ \Delta STOCKS$

Equilibrium $S = D$

Market Price

$P = PM$ if $PD > PM$
$P = P^*$ if $PE < P^* < PM$
$P = PE$ if $PD < PE$

Consumer Surplus $CS = (C + C0) * (P – P0) * 1/2$

Producer Surplus $PS = (X + X0) * (P – P0) * 1/2$

Variable names
C0 = base level rice consumption
C = rice consumption
D = total demand for rice
DPROC = government domestic rice procurement
DIST = government domestic rice distribution
MPRIV= net private rice imports
MPUB= net public rice imports (exogenous)
P = domestic price of rice
P0 = base price of rice
PD = autarky price = equilibrium price with MPRIV = 0
PM = import parity price
PE = export parity price
S = total supply of rice
ΔSTOCKS = changes in private rice stocks
X = total national production of rice
X0 = base level rice production
Parameter names
ES = own price elasticity of supply of rice
ED= own price elasticity of demand for rice
loss = seed, feed and storage as a percentage of domestic production

REFERENCES

Ahmed, N., Z. Bakht, P. Dorosh, and Q. Shahabuddin. 2009. "Bangladesh." In *Distortions to Agricultural Incentives in Asia,* edited by K. Anderson and W. Martin, 305–338. Washington, DC: World Bank.

Ahmed, R., S. Haggblade, and T. Chowdhury. 2000. *Out of the Shadow of Famine.* Baltimore: Johns Hopkins University Press.

Alamgir, M. 1980. *Famine in South Asia: Political economy of mass starvation.* Cambridge, MA: Oelgeschlager, Gunn & Hain.

Bangladesh, Bureau of Statistics. Various years. *Statistical Yearbook of Bangladesh.* Dhaka, Bangladesh: Ministry of Planning, Government of Bangladesh.

Bangladesh, FPMU (Food Planning and Monitoring Unit). 2011. *Various reports and bulletins*. Dhaka, Bangladesh: Ministry of Food and Disaster Management, Government of Bangladesh.

Boswijk, P., and P. H. Franses. 1992. "Dynamic Specification and Cointegration." *Oxford Bulletin of Economics and Statistics* 54 (3): 369–381.

del Ninno, C., P. A. Dorosh, L. C. Smith, and D. Roy. 2001. *The 1998 Floods in Bangladesh: Disaster Impacts, Household Coping Strategies and Response.* IFPRI Research Report No. 122. Washington, DC: International Food Policy Research Institute.

Dorosh, P. 2000. "Foodgrain Production and Imports: Toward Self-Sufficiency in Rice?" Iin *Out of the Shadow of Famine,* edited by. R. Ahmed, S. Haggblade, and T. Chowdhury, 21-48. Baltimore: Johns Hopkins University Press.

Dorosh, P. A. 2001. "Trade Liberalization and National Food Security: Rice Trade between Bangladesh and India." *World Development* 29 (4): 673–689.

_____. 2009. "Price Stabilization, International Trade and National Cereal Stocks: World Price Shocks and Policy Response in South Asia." *Food Security* 1 (2): 137–149.

Dorosh, P. A., S. Dradri, and S. Haggblade. 2009. "Regional Trade, Government Policy and Food Security: Recent Evidence from Zambia." *Food Policy* 34:350–366.

Dorosh, P. A., Q. Shahabuddin, and M. S. Rahman. 2002. "Price Responsiveness of Foodgrain Supply in Bangladesh and Projections to 2020." *Bangladesh Development Studies* 28 (1/2) 47-75.

Headey, D., and S. Fan. 2008. "Anatomy of a Crisis: The Causes and Consequences of Surging Food Prices." *Agricultural Economics* 39 (suppl.): 375–391.

India, Ministry of Finance. Various years. *Economic Survey, various years.* New Delhi, India: Ministry of Finance, Government of India.

International Monetary Fund. 2011. "International Financial Statistics." elibrary-data.imf.org/.

Johansen, S. 1988. "Statistical Analysis of Cointegration Vectors." *Journal of Economic Dynamic and Control* 12:231–254.

_____. 1995. "Identifying Restrictions of Linear Equations with Applications to Simultaneous Equations and Cointegration." *Journal of Econometrics* 69(1) 111-132.

Johansen, S., and K. Juselius. 1990. "Maximum Likelihood Estimation and Inference on Cointegration—With Applications to the Demand for Money." *Oxford Bulletin of Economics and Statistics* 52 (2): 169–210.

_____. 1992. "Testing Structural Hypotheses in a Multivariate Cointegration Analysis of the PPP and the UIP for UK." Journal of Econometrics 53:211–244.

Rashid, S., R. Cummings Jr., and A. Gulati. 2007. "Grain Marketing Parastatls in Asia: Results from Six Case Studies." World Development 35 (11): 1872–1888.

Rashid, S., A. Gulati, and R. Cummings Jr. 2008. *From Parastatals to Private Trade: Lessons from Asian Agriculture.* Baltimore: Johns Hopkins University Press.

Slayton, T. 2009. *Rice Crisis Forensics: How Asian Governments Carelessly Set the World Rice Market on Fire.* Working Paper No. 163. New Delhi, India: Global Development Network.

Timmer, C. P. 2009. *Did Speculation Affect World Rice Prices?* ESA Working Paper No. 09-07. Rome: Food and Agricultural Organization of the United Nations.

Timmer, C. P. 2010. "Reflections on Food Crisis Past." *Food Policy* 35:1–11.

Timmer, C.P., W.P. Falcon, and S.R. Pearson. 1983. *Food Policy Analysis*. Baltimore: Johns Hopkins University Press.

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