

What Determines the Domestic Prices of Agricultural Commodities in Pakistan?

Henri Lorie and Kiran Younas Khan

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Prepared by Henri Lorie and Kiran Younas Khan¹

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Abstract

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The paper investigates whether the *modus operandi* of the domestic markets for agricultural commodities in Pakistan have succeeded in isolating domestic prices from developments in the exchange rate and international prices. Co-integration between the domestic price, exchange rate, and international price is generally weak. The domestic support price for wheat appears to be a key determinant of its domestic market price, even in the long-run. The applicability of a “weak” law of one price in the long-run is rejected for wheat and sugar, but cannot be rejected for cotton and rice. For the purpose of monetary policy, more complex price dynamics need to be considered for inflation forecasting. There is room for improving the market mechanisms, including through reduction in government interventions and enforcement of more competitive behaviors.

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Author’s E-Mail Address: hlorie@imf.org
kkhan@imf.org

¹ The authors are, respectively, Senior Resident Representative of the IMF in Pakistan, and Economist in the IMF representative office in Islamabad. The views expressed are entirely those of the authors and do not necessarily reflect those of the IMF.

1. Introduction

Rarely a month passes-by in Pakistan without complains on the state of basic commodity markets, be it wheat or sugar, cotton or rice. Prices are too high for the consumers, or too low for the farmers; and often the government is asked to intervene, buying for or selling from stocks, prohibiting export or import, increasing or reducing import duties, introducing/ withdrawing export taxes, or taking other measures to protect the consumer or producer. It is as if domestic prices can have a life on their own, with the government asked to guarantee “fair” prices for everybody.

The resulting on-and-off policy intervention by the government is likely to have had a deleterious effect on the development of the domestic and international trade for these commodities. This is because of the uncertainty so generated, with the private traders always facing the risk of a regime change at a time when import or export contracts have already been signed. As a result too, the role of the state-owned Trading Corporation of Pakistan self-perpetuates, even if the government would like to see it minimized, as it is always being asked to intervene because of the private sector’s “failings”.

The purpose of this paper is not to analyze the extent of the under-development of commodity markets in Pakistan, although this would be an interesting topic of its own. Instead, the paper will look at whether the *modus operandi*, including government interventions, on the domestic commodity markets have succeeded in isolating domestic commodity prices from developments in the exchange rate and international prices, both in the short and long-run, in other words, escaping the “law of one price”. Answers to this question have implications not only for the welfare of consumers and producers, but also for the conduct of monetary policy to control inflation. The prices of wheat and other key agricultural commodities are important direct or indirect determinants of the CPI. Since these commodities are close-to-perfect “traded-goods”, monetary policy should be expected mostly to determine their domestic prices through its impact on the exchange rate, taking the developments in international prices as exogenous. If other mechanisms are at work, monetary policy would need to integrate them into any model of inflation forecasting. Furthermore, departure from the law of one price for key agricultural commodities would also make it possible for domestic *relative* prices to differ from those dictated, *inter alia*, by the international markets, with implications for allocative efficiency.

Section 2 takes a descriptive look at the data. Section 3 proposes a “political economy of domestic prices adjustment” able to explain some of the observed price dynamics. Any domestic or external shock that threatens to make one of the market participants (consumers or producers) worse off brings about attempts to resist the adjustment, with or without the help of government. Section 4 uses a general co-integration approach to test (1) the existence of a long-run relationship between the domestic prices, the exchange rate, the international prices, and, when applicable, the domestic “support” prices; and (2) whether the law of one price applies, at least in a “weak” sense, allowing for a possible constant wedge between domestic and international prices. The associated short-run dynamics, in the form of an error correction mechanism, are also discussed. Section 5 summarizes the findings of the paper and draws policy recommendations. The main conclusions are:

- There is only weak evidence of co-integration between domestic price, international price, exchange rate, and domestic support price (when applicable) for key agricultural commodities in Pakistan. Only in the case of wheat is the evidence stronger, but it is mainly on account of the inclusion of the support price variable.
- The elasticity of domestic prices to a change in the exchange rate is close to unity for all commodities. In contrast, the elasticity of domestic prices to a change in international prices is close to unity only for cotton and rice. In the case of wheat and sugar, they are much smaller than unity.
- The hypothesis that the “weak” law of one price applies in the long-run can be rejected in the case of wheat and sugar, but cannot be rejected in the case of cotton and rice.

The above results are consistent with a theory of domestic price determination that emphasizes political economy considerations when markets are subject to domestic and external shocks, real or monetary, leading to government interventions. Under this *modus operandi* of commodity markets, monetary policy would need to take into account more complex domestic price dynamics of the type illustrated in the paper for inflation forecasting. The results also suggest that there is room to improve the functioning of domestic markets for agricultural products, including through a reduction in government interventions and enforcement of more competitive behaviors.

2. A descriptive look at the data

In this section, we look at charts depicting time series of domestic prices (in PRs) and international “parity” prices (i.e. international prices in US\$ converted in PRs at the market exchange) for wheat, cotton, sugar, and rice (Charts 1a, 1b, 1.c, 1.d). Time series depicting domestic prices expressed in US\$ at the market exchange rate, and international prices in US\$ also guide the interpretation (Charts 2a, 2b, 2c, 2d). International prices for wheat are taken to be US Gulf Ports; for cotton, Liverpool; for sugar, Caribbean (New York); and for IRI rice, Thailand.² In the case of wheat and rice, for which there exists a long time series of domestic support prices, the charts also plot these prices, expressed in PRs and US\$, respectively.³

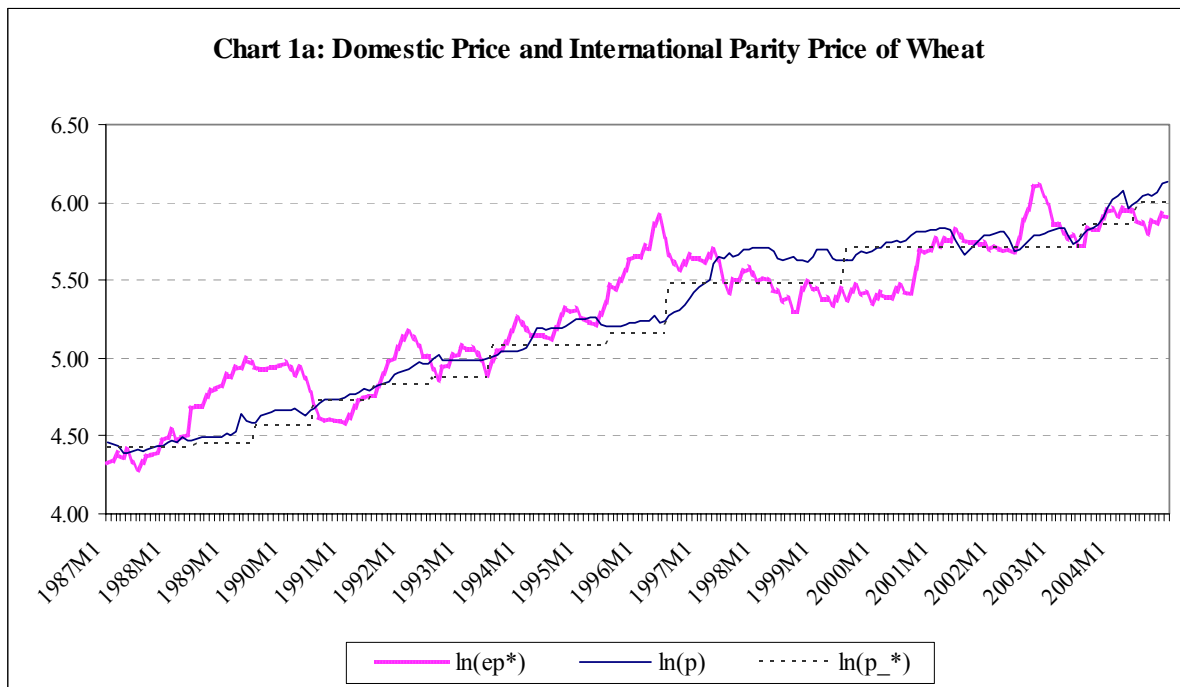
For wheat and cotton, the domestic and international “parity” prices appear close to each other, if we look at average levels; for sugar, the domestic prices have been systematically

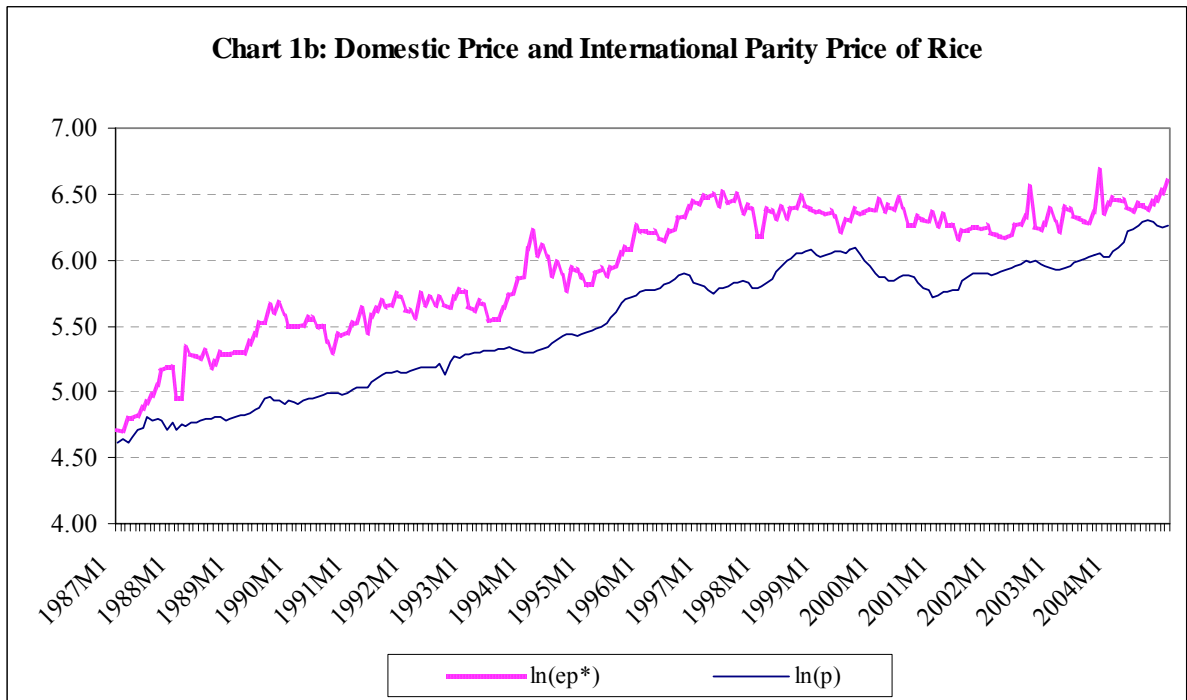
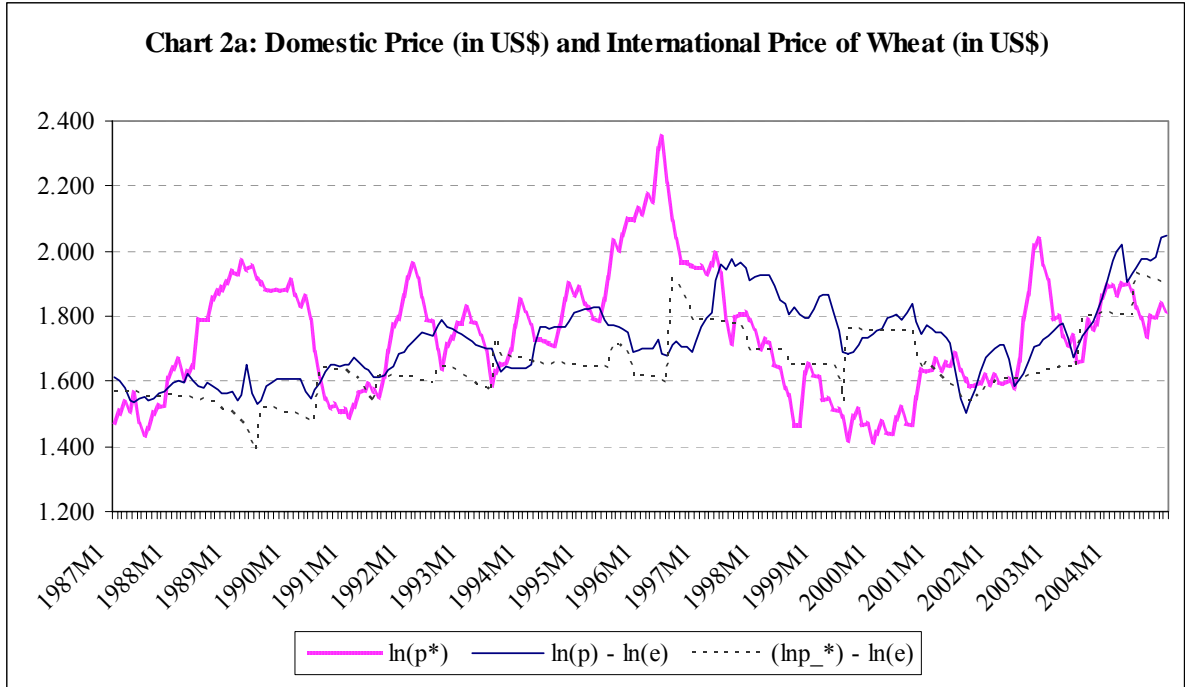
² International Financial Statistics (IFS), IMF.

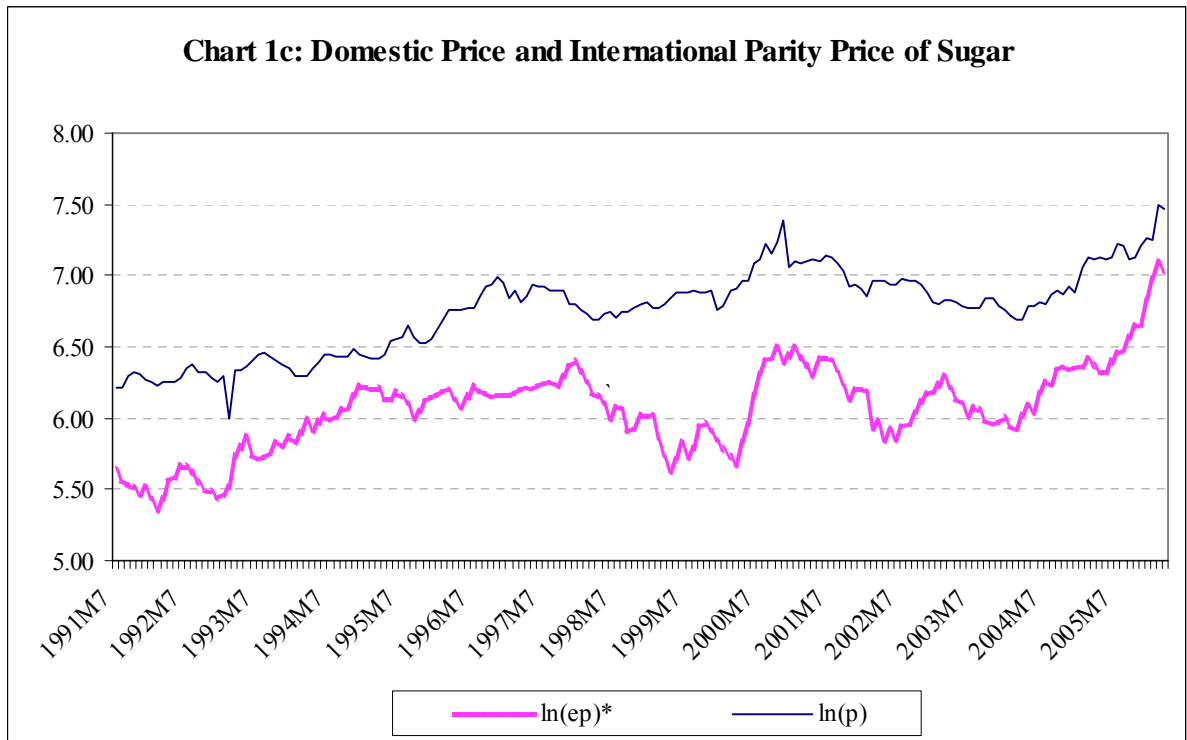
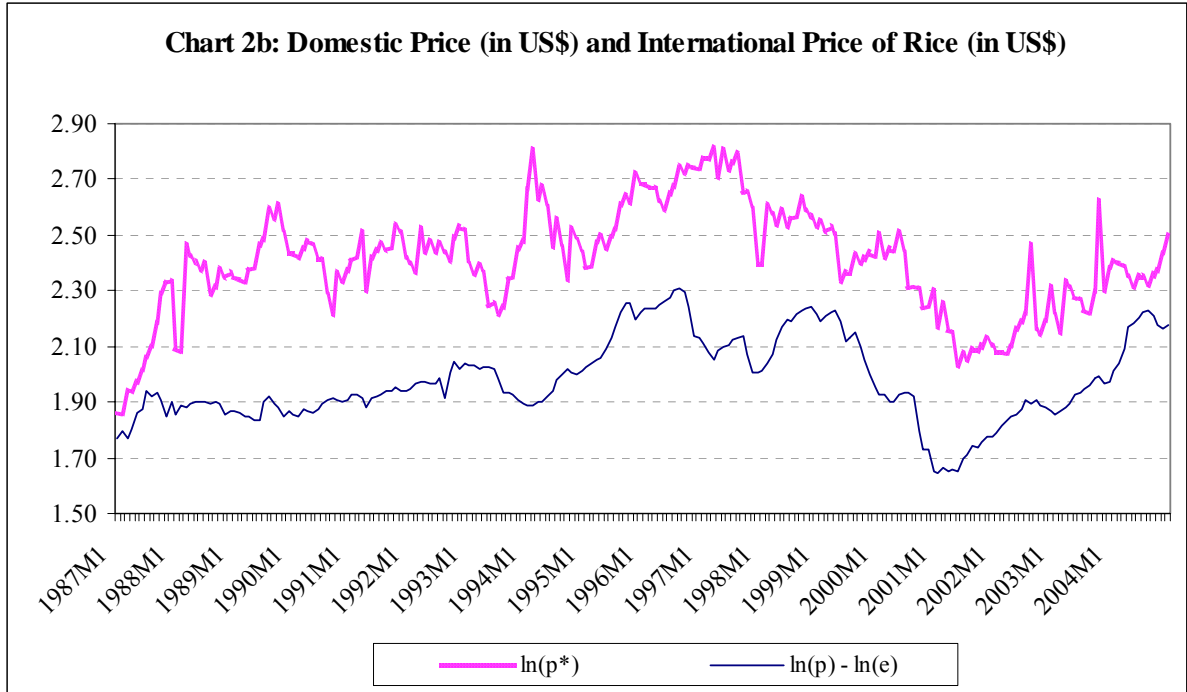
³ The Ministry of Agriculture also publishes a list of support/ intervention prices for rice and cotton (seed). In contrast to the case of wheat support price, they operate mainly as indicative prices, with very limited government intervention taking place at those prices. An initial effort to integrate them in the empirical analysis suggested their irrelevance. Therefore, we have excluded them from the analysis reported in this paper.

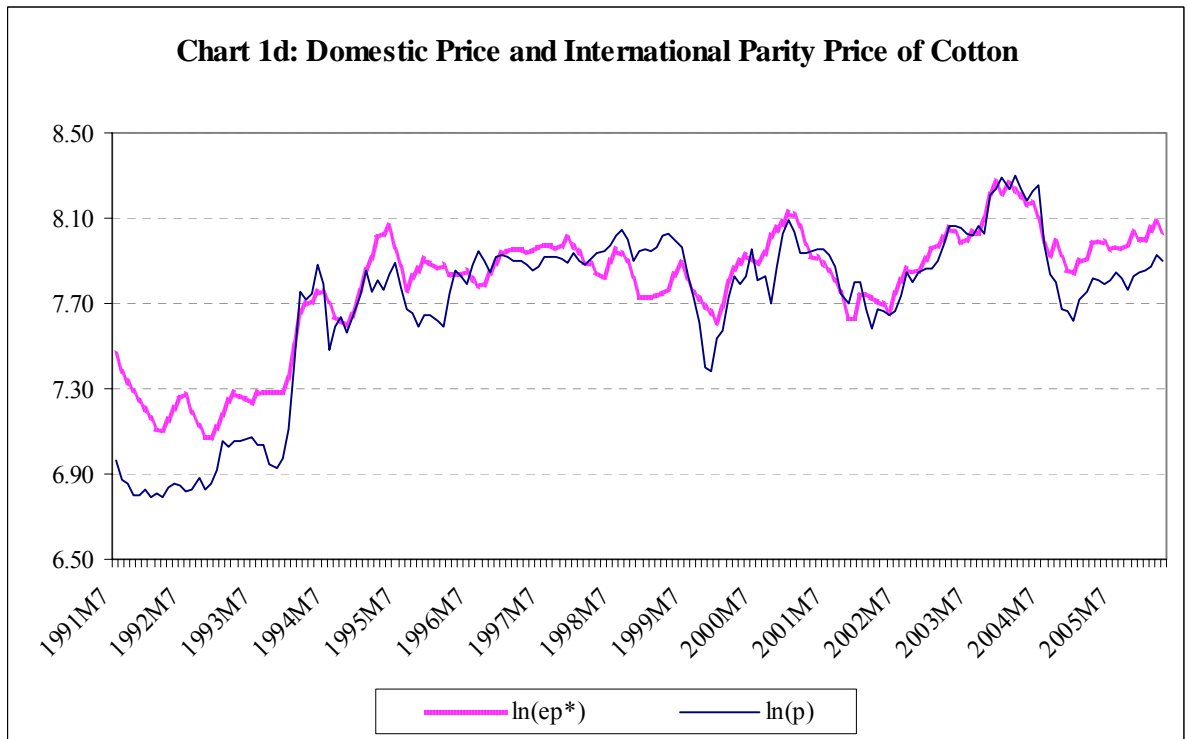
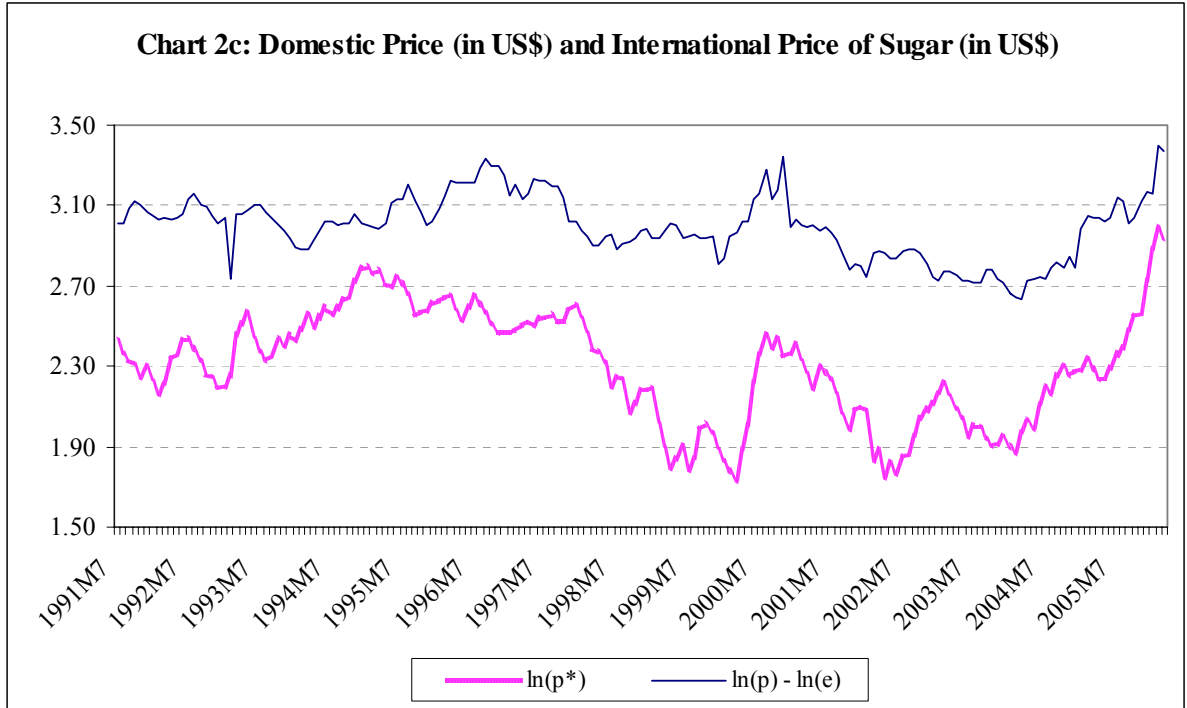
higher than their international parity prices based on Caribbean (New York) prices; and for rice, the domestic rice prices have been systematically lower than their international parity prices based on the Thailand prices. For sugar, the (positive) discrepancy would be explained by the systematic protection offered to local sugar producers; for IRI rice, the (negative) discrepancy appears to reflect quality differences, as well as a relatively weak market infrastructure.

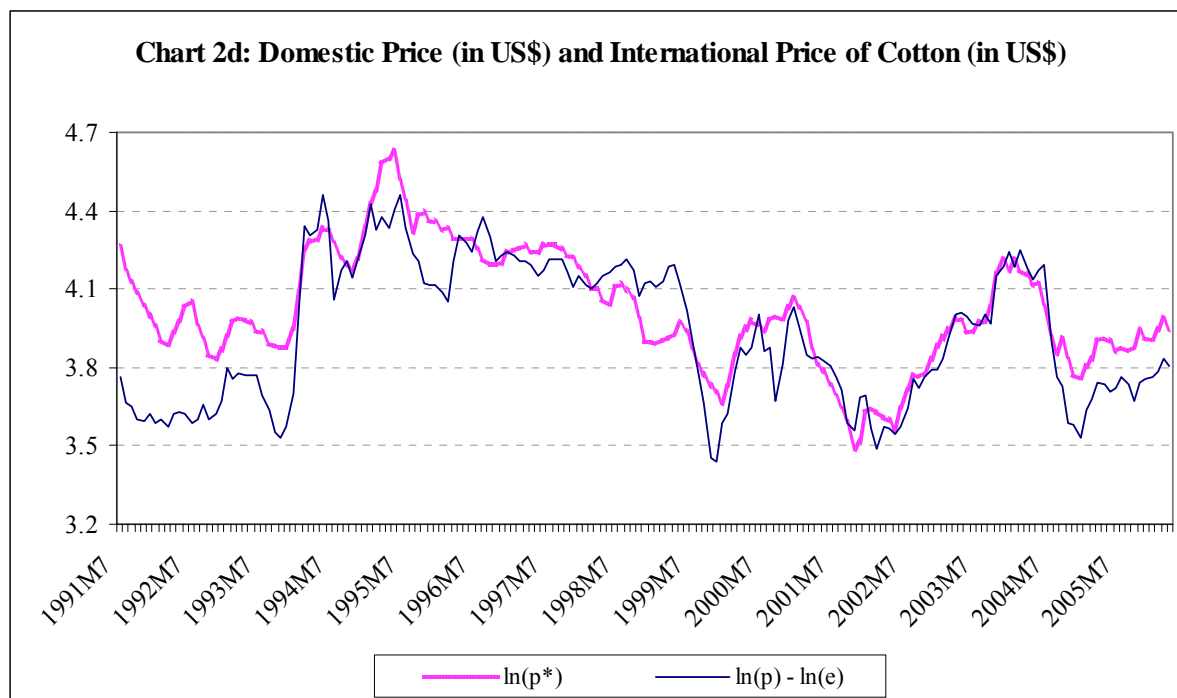
The time series display some interesting properties. First, while, in general, domestic and international parity prices appear to move together, domestic prices tend to be more stable, whether we look at prices in PRs or US\$. This is especially the case for wheat, apparently reflecting the effectiveness of domestic support prices. One exception are domestic cotton prices, which, if at all, appear more volatile than their international parity prices.











Second, there is evidence of fairly long periods of time during which domestic prices have tended to be systematically higher or lower than their international parity prices (in the case of sugar and rice, this statement must be understood as the *wedge* between the two prices being systematically higher or lower than on average). This is particularly striking for wheat during 1989-90, 1996-97, and 2003 (domestic prices lower), as well as 1998-2000 and 2005-06 (domestic prices higher). Typically, when international prices for wheat (in US\$) have surged, domestic prices have not followed up, and the same has been true when international prices have dipped, suggesting, in the first instance, that measures were taken to protect the domestic consumers, and in the second instance, the domestic producers, including through the support price mechanism.

Cotton prices since 2004 offer a striking contrast, with domestic prices in 2004 falling more than their international parity prices, and remaining below. The reason appears to be the bumper crop of 2004-05, which was allowed to strongly impact on domestic prices, thereby providing especially cheap inputs to the textile sector, with cotton exports only partially picking up the excess supply. A similar situation appears to have prevailed in 1999.

Since the second half of 2005, measures have been taken to prevent the surge in international prices for sugar to all time highs to lead to a similar increase in domestic prices, including the removal of pre-existing protective duties and taxes, and a ban on exports. As a result, the positive wedge between domestic and international prices has virtually disappeared. This is in sharp contrast with the 1998-2000 period during which a sharp decline in international prices was accompanied by only a marginal decline in the domestic prices, resulting in a widening of the wedge between the two prices.

3. Theoretical considerations

This section provides a simple theoretical framework to analyze the empirical observations. If domestic prices fail to reflect international prices at prevailing exchange rates for long periods of time, what is inhibiting the international price arbitrage for those key agricultural commodities?

There are obvious reasons why the law of one price may not fully apply, such as quality differences, imperfect market development, systematic protection from imports or discouragement of exports, transportation bottlenecks and thus costs, or simply statistical problems with the price series used. Many of these factors appear to have been fairly constant in the period studied, though the possibility of structural and systematic policy shifts, and thus the so-called Lucas' critique, must be recognized. Here, we will focus on factors more directly related to the short-run functioning of markets, in particular possible interferences (by government or others) in the competitive market mechanisms on behalf of one or other participant when those markets are subject to domestic and external shocks. The analysis will, in particular, highlight the political economy considerations underpinning these interventions.

It is convenient to think of the following demand and supply functions for commodity i :

$$(1) \quad d_i = a_i (M/p_i)^{c_i}$$

where: d_i = demand for commodity i
 a_i, c_i = fixed parameters
 M = money stock
 p_i = domestic price of commodity i

$$(2) \quad s_i = k_i (w/p_i)^{b_i}$$

where: s_i = supply of commodity i
 k_i, b_i = fixed parameters⁴
 w = domestic money wage

Furthermore, we will make the simplifying assumption that the domestic money wage is constant in foreign currency (US\$) terms⁵, i.e.:

$$(3) \quad w = e \underline{w}^*$$

where: \underline{w}^* = fixed US\$ wage
 e = exchange rate (PRs per US\$)

⁴ We will assume the stability condition $b_i < c_i$.

⁵ This is to abstract from peripheral issues.

Figure 3a

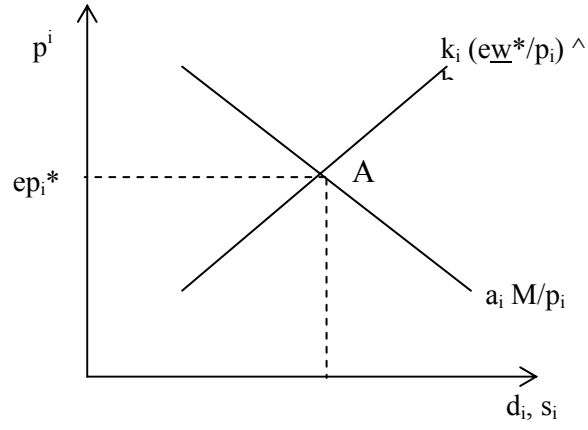


Figure 3b

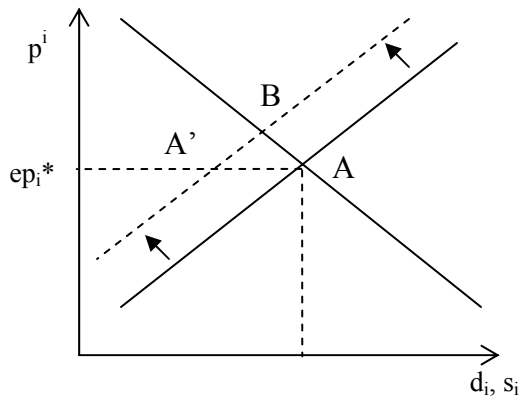


Figure 3c

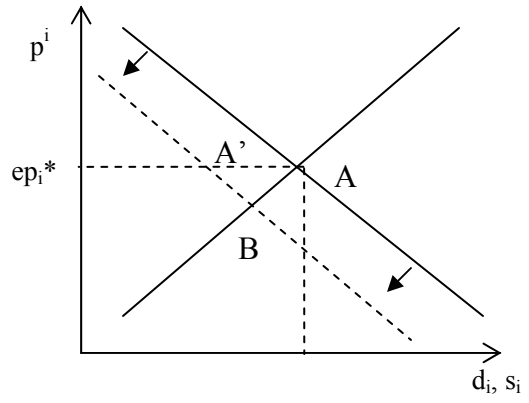


Figure 3d

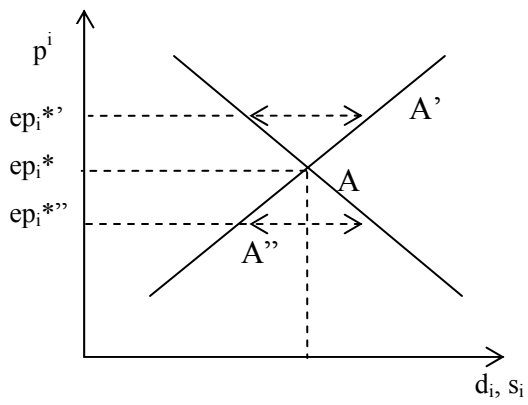


Figure 3e

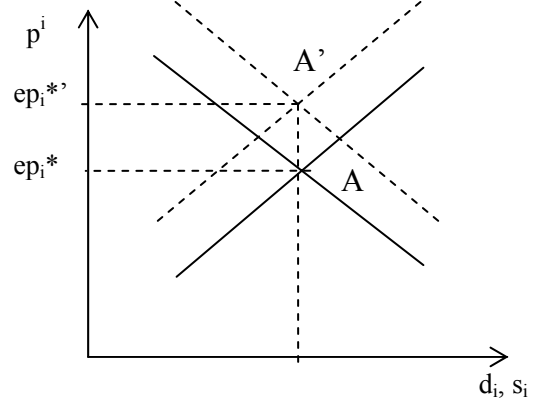


Figure 3a illustrates a market equilibrium for which it happens that $p_i = e p_i^*$, where p_i^* is the international (US\$) price for commodity i , i.e. the law of one price applies, and furthermore, autarky prevails at this equilibrium (neither export nor import). Equilibrium point A is a useful benchmark.

Four types of shocks are considered. In each experiment, we limit the discussion to the *cases where the direction of shocks point to at least one of the market participants (i.e. the demand/ consumer or supply/ producer side) being made worse off by not resisting the market mechanism/ trade*. This can perhaps be viewed as a sufficient condition for any real pressure to resist the market mechanisms to materialize. With this qualification, the following shocks are highlighted.

1. **Negative domestic supply shock**, in the form of downward shift in the supply parameter k_i , for example the impact of poor rains (figure 3b). If the law of one price continues to prevail, the market equilibrium moves from A to A' , with the country *importing* AA' . Clearly, the domestic producer would prefer to move from A to B rather than to A' , i.e. the no-trade option. Preempting imports would allow the producer to limit its losses from the adverse supply shock. If he is successful, the law of one price will generally cease to apply.⁶ Any domestic support price at the initial equilibrium price would then become ineffective.

2. **Negative domestic demand (non-monetary) shocks**, for example impact of adverse shift in preferences or perceived lower permanent income (figure 3c). The market equilibrium moves from A to A' , with the country *exporting* AA' . In this case, it is the consumer who would prefer to see the market equilibrium moving from A to B rather than A to A' . Any domestic support price at the initial equilibrium price would become effective in support of an export scenario.

3. **Shocks to international commodity prices**. Everything else the same, including the exchange rate, an increase (decrease) in international commodity prices, if passed-through onto domestic prices, would decrease (increase) domestic demand and encourage (discourage) domestic supply and exports (imports). In the event of an increase in international prices, domestic prices could remain unchanged if the government introduces an export ban to protect the consumer. Any domestic support price at the initial equilibrium price would become ineffective unless accompanied by an export ban. In the event of a decrease in international prices, domestic prices could remain constant if imports are discouraged by a ban on imports or the imposition of import duties to protect the producers. Any domestic price at the initial equilibrium price would become effective if accompanied by an import ban. In either case, interference would preempt domestic prices to be consistent with the law of one price (Figure 3d).

⁶ In the case of a positive supply shock, the surplus could simply be exported, leaving the consumer unaffected and the producer better off. However, as observed, with the bumper cotton crop of 2004-05, the consumer (the textile sector) was apparently allowed to benefit from domestic prices lower than international prices.

We complete this theoretical discussion by considering one type of shock for which there does not appear to be any incentive for neither the producer nor the consumer to block the market mechanism, the case of a purely monetary/ exchange rate shock.

4. **Monetary/ exchange rate shocks to demand and supply**, for example an increase in the money stock leading to a proportional depreciation of the exchange rate (figure 3e). There appears to be no obvious reason preventing the equilibrium to move from A to A', with the depreciation of the exchange rate being fully passed through onto the domestic price, and the law of one price continuing to prevail. Any domestic support price at the initial equilibrium price would have to increase proportionally not to become ineffective.

Thus, the analysis also suggests that some types of shocks are more likely to induce intervention in the competitive market mechanism than others. In particular, "real" shocks in the domestic supply and demand, and in international prices appear more likely to induce such intervention, and thus failure of the law of one price, than purely "monetary/ exchange rate" shocks.

The intuitive analysis presented above suggests that, in practice, *actual* domestic prices could turn out to be some weighted average of the *no-trade equilibrium* domestic prices, obtained from $d_i = s_i$, and of the *international parity* prices. Assuming that the weights are λ and $(1-\lambda)$, respectively, we derive:⁷

$$(4) \ln p_i = \lambda [(\ln a_i - \ln k_i - b_i \ln \underline{w}^*) / (c_i - b_i)] + \lambda [(- b_i \ln e + c_i \ln M) / (c_i - b_i)] + (1-\lambda) \ln e + (1-\lambda) \ln p_i^*$$

Assuming that M / e is always constant, and without loss of generality that it is equal to 1, expression (4) reduces to:

$$(5) \ln p_i = \lambda [(\ln a_i - \ln k_i - b_i \ln \underline{w}) / (c_i - b_i)] + \ln e + (1-\lambda) \ln p_i^*$$

Note that the coefficient for $\ln e$ is unity.⁸

An interesting question is whether it is reasonable to assume that the contemporaneous international price alone enters the domestic price equation in the linear fashion assumed, irrespective of its *absolute* level. The Charts 1 and 2, for wheat in particular, clearly suggest

⁷ When there is a systematic wedge between domestic and international parity prices, the weighted average is between the no-trade equilibrium price and $\ln \theta + \ln p_i^*$, where the constant θ is the wedge.

⁸ Ardeni (1989) does not allow for differentiated impact of the exchange rate and international price.

that this is not the case; temporary spikes or collapses in international prices are less passed-through. Some notion of “normal” international prices seems to play a role in the determination of domestic prices.

In the case of wheat, the domestic support price (expressed in US\$) appears to be a reasonable proxy for that “normal” price. Because in Pakistan procurement at the support price covers only a fraction of market transactions, domestic *market* prices can of course differ from the support price.

4. Econometric analysis

The domestic price equation of expression (5) above has the following immediate empirical counterpart (omitting from now on the subscript i , and for the moment the time subscript t as well):

$$(6) \quad \ln p = \alpha_0 + \alpha_1 \ln e + \alpha_2 \ln p^* + v$$

with the theoretical prior $\alpha_1 = 1$. The domestic supply and demand shocks can be viewed as incorporated within the random term v .

To account for the likelihood that the prevailing domestic price might also reflect the impact of the support price, through its relationship with the notion of “normal” international price, the domestic price equation (6) is expanded into:

$$(6') \quad \ln p = \alpha_0 + \alpha_1 \ln e + \alpha_2 \ln p^* + \alpha_3 \ln \underline{p}^* + v$$

where $\ln \underline{p}^*$ is the domestic support price (expressed in US\$).^{9, 10} If the law of one price strictly applies, in addition to $\alpha_1 = 1$ we also have $\alpha_0 = 0$; $\alpha_2 = 1$ ($\lambda = 0$ in expression (5)); and $\alpha_3 = 0$.¹¹ In what follows, we will mostly be interested in whether the “relative” law of one price applies, i.e. we allow for the constant α_0 to be different from zero.

⁹ Expressing the domestic support price in US\$ is consistent with the theoretical reasoning of the previous Section.

¹⁰ The paper by Khan and Schimmelpfennig (2006) provides support for a link between the domestic support price for wheat (in PRs) and domestic inflation, albeit only in the short-run. Here, the analysis distinguishes between adjustment in domestic support price (in PRs) which reflects *adjustment* to inflation (via the exchange rate), and that which reflects *independent push* from the domestic support price (in US\$).

¹¹ If $\ln \underline{p}^*$ is independent of $\ln p^*$, $\alpha_3 = 0$ is clearly the correct statistical interpretation of the law of one price. If $\ln \underline{p}^*$ were not independent of $\ln p^*$, in the extreme case for instance if $\ln \underline{p}^*$ directly follows $\ln p^*$, $\alpha_2 + \alpha_3 = 1$ might, trivially, be a proper interpretation of the law of one price.

Since we will use long monthly times series data and we suspect non-stationarities, co-integration techniques to estimate expression (6') is the right approach.

The first step is to analyze the statistical properties of each data time series y_t . The generalized model accommodating higher-order autoregressive process for the error term is:

$$(7) \quad y_t = \mu + \beta_t + \gamma y_{t-1} + \sum_{j=1}^p \gamma_j \Delta y_{t-j} + \varepsilon_t$$

The augmented Dickey-Fuller test for the existence of a unit root has the null hypothesis $\gamma = 1$; the lag length is up to the last lag for which the estimated coefficient is statistically significant according to the t-statistic.

The null hypothesis of a unit root *cannot* be rejected for all (log of) domestic prices time series. Furthermore, the statistically significant estimated lag coefficients indicate that (log of) domestic prices for wheat, cotton, rice, and sugar are all I(1) time series, i.e. integrated of order one. The same is true for the (log of) exchange rate (PRs per US\$) time series, as well as for the (log of) support price (in US\$) time series. On the other hand, the null hypothesis of a unit root *can* be rejected for all (log of) international prices (in US\$) time series, which appear to be I(0), i.e. stationary, though not at the 1 percent level. Sugar also appears to be an exception, and integrated of order 1, I(1) (Table 1). Since the stationarity test for the international prices (in US\$) is weak on the level of prices, but improves significantly when taking the first difference, we can reasonably *assume* in what follows that all series are integrated of the same order 1, and thus proceed with co-integration.

Table 1 : Unit-Root tests on Individual series

$$y_t = \mu + \beta_t + \gamma y_{t-1} + \sum_{j=1}^p \gamma_j \Delta y_{t-j} + \varepsilon_t \quad 1/$$

Variables		Level ADF	1 st Difference ADF	Order of Integration
Exchange Rate				
ln(e)	2/	-1.22	-9.37***	I(1)
ln(e)	3/	-1.80	-8.83***	I(1)
Wheat				
ln(p)		-0.35	-11.02***	I(1)
ln(p*)		-2.92**	-	I(0)
ln(p*)		-2.23	-15.35***	I(1)
Rice				
ln(p)		-0.99	-10.70***	I(1)
ln(p*)		-3.56**	-	I(0)
Cotton				
ln(p)		-2.46	-10.42***	I(1)
ln(p*)		-2.60*	-	I(0)
Sugar				
ln(p)		-0.74	-15.77***	I(1)
ln(p*)		-1.71	-10.25***	I(1)

Note: *, ** and *** indicates the significance at 10 %, 5% and 1% respectively.

1/ The optimal lag length p for conducting ADF tests is found by the Schwartz information criteria (SIC). The maximum lag length is 14 in case of 216 observations and 13 in case of 177 observations.

2/ For Wheat and Rice: total observations 216

3/ For Cotton and Sugar: total observations 177

Proceeding most generally, we give a VAR representation to the equation (6'), as follows:

$$(8) \quad z_t = \mu + \sum_{\tau=1}^k \Pi_{\tau} z_{t-\tau} + \varepsilon_t$$

where $z_t' = [\ln p_t, \ln e_t, \ln p_t^*, \ln p_t^*]$; $\mu' = [\mu_1, \mu_2, \mu_3, \mu_4]$ is a vector of constants (linear trend in at least some of the variables); and $\varepsilon_t' = [\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t}, \varepsilon_{4t}]$.¹²

Reparameterization of expression (8) yields:

$$(9) \quad \Delta z_t = \mu + \sum_{\tau=1}^{k-1} \Gamma_{\tau} \Delta z_{t-\tau} + \Gamma_k z_{t-k} + \varepsilon_t$$

where the matrix $\Gamma_{\tau} = -I + \Pi_{\tau} + \dots + \Pi_{\tau}$. If all z_t are I(1), then their first difference is I(0), and therefore the lefthand side of expression (9) is clearly stationary. Whether the righthand side of expression (9), including the estimated ε_t , is stationary will critically depend on the estimated parameters in the matrix Γ_k . Essentially, we are looking for a matrix of vectors, β (the co-integrating vectors), with $\alpha \beta' = -\Gamma_k$ (where α is a matrix of adjustment coefficients) that will ensure that $\Gamma_k z_{t-k} = -\alpha \beta' z_{t-k}$ is stationary, and thus also the estimated vector of residuals ε_t . These co-integrating vectors will define the long-run relationship between the elements of z_t . We follow the Johansen (1988) and Johansen and Juselius (1990) approach, based on maximum likelihood estimation.

Johansen proposes a test to identify how many linearly independent co-integrating vectors might exist, if any; this number is the rank of the (estimated) matrix Γ_k .¹³

Table 2 presents the results of the Johansen co-integration test. For all commodities, we conclude that there is at most one co-integrating vector. In the case of wheat, co-integration is established under both the Max Eigen Value test and the Trace test at 5 percent confidence. In the case of cotton, co-integration is established at 5 percent only under the Trace test. And for sugar and rice, the co-integration is established only at 10 percent, and only under the Max Eigen value test for sugar.

Table 3 listed the co-integrating equations. Note that we have also allowed for an intercept in the co-integrating equations. For wheat, all signs of estimated parameters, i.e. elasticities, of the co-integrating equation are of the right sign; the parameters are close to 1 with high t statistic for $\ln e$; somewhat above 1 with high t statistic for $\ln p^*$; and surprisingly small with low t statistic for $\ln p$. The results suggest that the domestic support price (in US\$) is

¹² These vectors do not include $\ln p_i^*$ when no support price exists, in the case of sugar and cotton.

¹³ Note that the lag length in expression (9) will be selected using the Hannan-Quinn and Schwartz Information Criterion.

a key determinant of the domestic price, quite *independent* from the international price, even in the long-run. Indeed, we verified that the Johansen co-integration tests fail to suggest co-integration when the price equation excludes the support price variable and considers only the international price variable.

Table 2: The Cointegration Test

	H_0	H_1	Lag length 1/	Max-Eigen Value Test			Trace Test			Test for cointegrating restrictions 2/	
				Actual Value	Critical Value		Actual Value	Critical Value		LR statistics	Prob.
					5%	10%		5%	10%		
Wheat	$r = 0$	$r > 0$	2	36.12**	27.58	25.12	59.50**	47.86	44.49	26.59***	0.00
	$r \leq 1$	$r > 1$		14.00	21.13	18.89	23.38	29.79	27.06		
	$r \leq 2$	$r > 2$		8.91	14.26	12.29	9.38	15.49	13.42		
Cotton	$r = 0$	$r > 0$	2	16.33	21.13	18.89	30.16**	29.79	27.06	3.29	0.19
	$r \leq 1$	$r > 1$		9.11	14.26	12.29	13.82	15.49	13.42		
	$r \leq 2$	$r > 2$		4.71	3.84	2.70	4.71	3.84	2.70		
Sugar	$r = 0$	$r > 0$	2	18.97*	21.13	18.89	26.09	29.79	27.06	10.94***	0.00
	$r \leq 1$	$r > 1$		6.67	14.26	12.29	7.11	13.42	13.42		
	$r \leq 2$	$r > 2$		0.45	3.84	2.70	0.45	2.71	2.70		
Rice	$r = 0$	$r > 0$	2	21.92*	21.13	18.89	31.83*	29.79	27.06	4.21	0.12
	$r \leq 1$	$r > 1$		7.67	14.26	12.29	9.91	15.49	13.43		
	$r \leq 2$	$r > 2$		2.24	3.84	2.71	2.24	3.84	2.70		

*, ** and *** denotes the rejection of H_0 at 10, 5 and 1 percent confidence, respectively.

1/ Lag length selected by using the Hannan-Quinn and Schwarz Information Criterion.

2/ Test of the law of one price. (Refer to the foot note 5)

Table 3: Cointegrating Equations

	<u>Wheat</u>	<u>Cotton</u>	<u>Sugar</u>	<u>Rice</u>
A. Number of cointegrating vectors	<u>r = 1</u>	<u>r = 1</u>	<u>r = 1</u>	<u>r = 1</u>
B. coefficients on cointegrating vector variables	Vector 1	Vector 1	Vector 1	Vector 1
Constant	0.61	2.18	-2.14	1.13
ln(e)	-0.94 (-22.80)	-1.28 (-11.69)	-1.04 (-11.36)	-1.15 (-16.06)
ln(p*)	-1.50 (-8.19)	-	-	-
ln(p*)	-0.04 (-0.48)	-1.26 (-7.93)	-0.29 (-2.69)	-1.06 (-6.32)
ln(p)	1.00	1.00	1.00	1.00
Log Likelihood	1909.17	1042.26	975.57	1385.51

Note: Numbers in parenthesis are t-statistics.

In the case of sugar, the parameters are close to 1 for $\ln e$ but very low for $\ln p^*$ with high t -statistic. In contrast, in the case of cotton and rice, the parameters for $\ln e$ and $\ln p^*$ are all close to 1 and with high t statistic.

We formally test the hypothesis that the vector of coefficients $[1, -1, -1, 0]$ for z_t , consistent with the “weak” law of one price, belongs to the co-integrating space by looking at the ratio between the likelihood function at these values and the maximum likelihood value of the Johansen test; this ratio has a χ^2 distribution. The null hypothesis that the “weak” law of one price applies is, not surprisingly, strongly rejected in the case of wheat and sugar, while it cannot be rejected in the case of rice and cotton (see last right-hand side column of Table 2).

There is a close relationship between co-integration and error correction models in the sense that error correction models generally “underpin” co-integration, although co-integration could exist without strong evidence of an error correction model at work. The estimated error correction model directly associated with the Johansen co-integration test and the co-integrating equations reported in Tables 2 and 3 are shown in Table 4. These short-run equations for Δz_t coincide of course with expression (9) estimated at the co-integrating vector. All the estimated coefficients attached to the error correction term are of the right (negative) sign with fairly high t statistic (except in the case of rice). The standard errors of the equation are not bad for wheat and rice but rather high for cotton and sugar; and the R^2 are low, except perhaps for wheat. The conclusion is that these error correction models only partially represent the complex short-run price dynamics. Needless to say, this conclusion correlates with the relative weak evidence of co-integration. Nevertheless, the short-run equations for Δz_t could still be used for period-ahead forecasting.

Table 4: VECM Estimates

Error Correction variables	Wheat	Cotton	Sugar	Rice
<i>Dependent Variable:</i>				
$\Delta \ln(p)$				
<i>Independent Variables:</i>				
Constant	0.01 (3.74)	0.01 (1.01)	0.01 (0.74)	0.00 (2.21)
$\Delta \ln(e_{-1})$	-0.11 (-0.81)	0.07 (0.15)	0.65 (1.72)	0.05 (0.38)
$\Delta \ln(e_{-2})$	0.03 (0.19)	-0.20 (-0.45)	-0.07 (-0.19)	-0.03 (-0.22)
$\Delta \ln(p^*_{-1})$	-0.04 (-0.88)	-	-	-
$\Delta \ln(p^*_{-2})$	-0.05 (-1.12)	-	-	-
$\Delta \ln(p_{-1})$	-0.03 (-0.95)	0.38 (2.45)	0.13 (1.85)	-0.03 (-1.55)
$\Delta \ln(p_{-2})$	0.07 (2.10)	-0.04 (-0.26)	0.09 (1.26)	0.01 (0.64)
$\Delta \ln(p_{-1})$	0.24 (3.69)	0.19 (2.21)	-0.15 (-1.78)	0.26 (3.77)
$\Delta \ln(p_{-2})$	-0.07 (-1.19)	-0.12 (-1.36)	0.03 (0.32)	0.18 (2.56)
ECT1	-0.10 (-5.40)	-0.12 (-2.51)	-0.09 (-1.95)	-0.00 (-0.12)
<i>Key Statistics:</i>				
S.E. of Equation	0.02	0.07	0.06	0.02
R ²	0.22	0.15	0.11	0.13

Note: Numbers in parenthesis are t-statistics.

5. Conclusions and policy implications

There is only weak evidence of the existence of long-run co-integrating equations between domestic price, international price, exchange rate, and (when applicable) domestic support price (in foreign currency terms) for key agricultural commodities in Pakistan. The co-integration tests appear especially weak for sugar and rice, while in the case of wheat, the stronger evidence of co-integration is mostly on account of the inclusion of the support price.

Within co-integration, domestic prices, at least for wheat and sugar *do* seem to have a “life of their own” in the sense that they are far from directly reflecting the prevailing international parity prices, even in the long-run, and allowing for a systematic wedge between domestic and international parity prices. The long-run elasticities to changes in international prices are very low for both these commodities. In the case of wheat, the empirical analysis suggests that the domestic support price (in foreign currency terms) has been a key *independent* explanatory variable, even in the long-run.

In the case of rice and cotton, the long-run elasticities to changes in international prices are much larger, and close to unity.

For all commodities, the long-run elasticities to changes in the exchange rate are around unity.

The above findings are consistent with the theory we proposed to explain how domestic prices adjust to domestic and external shocks. They support the theoretical prediction that monetary/ exchange shocks are more likely to be passed-through than real (including international price) shocks. Nevertheless a “weak” applicability of the law of one price in the long-run *cannot* be rejected for cotton and rice under some standard confidence interval.

Estimation of equations governing the short-run domestic price dynamics are imbedded in the Johansen co-integration test based on a VAR, and have the form of an error correction mechanism. These equations could be used for period-ahead forecasting based on full information up to then. Admittedly, however, the explanatory power of these short-run equations is rather weak, except in the case of wheat.

Policy implications of this paper are twofold. First, under the current *modus operandi* of commodity markets in Pakistan, any monetary policy framework, say inflation targeting, cannot take for granted the assumption that domestic prices of even highly homogenous traded goods such as agricultural commodities will closely reflect import parity prices. Rather, how changes in import parity prices will be passed-through into the domestic prices could depend on the sources of these changes, monetary/ exchange rate versus international prices, the direction of these changes, and the prevailing political economy of markets functioning and related government interventions. The latter will also determine how domestic prices respond to domestic shocks, be it on the demand or supply side, which are also part of the domestic price equation. The short-run price equations modeled and estimated in this paper are examples of dynamic price equations which could be part of an inflation forecasting model. The second policy implication follows from the observation that

departures from the weak law of one price are associated with distortions in the optimal allocation of resources in the open economy context. The fact that such departures appear to be the rule in Pakistan, at least for wheat and sugar, even in the long-run, would highlight the need to further focus reforms toward improving the functioning of domestic markets for agricultural commodities. In this context, there would still be room to improve the market mechanisms, including through a reduction in government interventions and enforcement of more competitive behaviors.

Definition of Variables and Sources

		<i>Source</i>
Exchange Rate		
e	Official exchange rate (annual average PRs per US Dollar)	International Financial Statistics (IFS)
Wheat		
p	Domestic Price of Wheat (PRs/40kgs)	Ministry of Food, Agriculture & Livestock (Minfal)
p*	Wheat US Gulf Price (US\$/40kgs)	International Financial Statistics (IFS)
p*	Support Price of Wheat (US\$/40kgs) ¹⁴	Ministry of Food, Agriculture & Livestock (Minfal)
Rice		
p	Domestic Price of Irri-Rice (PRs/40kgs)	Ministry of Food, Agriculture & Livestock (Minfal)
p*	Thailand: Rice Price (US\$/40kgs)	International Financial Statistics (IFS)
Cotton		
p	Domestic Cotton Spot Price (PRs/40kgs)	Federal Bureau of Statistics (FBS)
p*	Cotton Liverpool Price (US\$/40kgs)	International Financial Statistics (IFS)
Sugar		
p	Domestic Refined Sugar (PRs/50kgs)	Federal Bureau of Statistics (FBS)
p*	Caribbean Sugar Price (US\$/50kgs)	International Financial Statistics (IFS)

Time Period

The data used for all the commodities is on monthly basis.

Wheat : 1987M01 – 2004M12 (216 observations)

Rice : 1987M01 – 2004M12 (216 observations)

Cotton : 1991M07 – 2006M03 (177 observations)

Sugar : 1991M07 – 2006M03 (177 observations)

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¹⁴ Converted to US dollars by using the official exchange rate (annual average PRs per US Dollar, as reported in IFS).

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