Noisy Vertical Markets*

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ABSTRACT

In vertical markets volatility at one level of the market may transmit itself to another level. This paper examines the linkages that exist between spreads at different levels of the market hierarchy in Indian rice markets. It highlights the behavior of spreads in the presence of information asymmetry. This causes spreads to overshoot their equilibrium values. Second, we model possible differences between the reaction to an upward revision of the spread from that to a downward revision. We also propose policy prescriptions such that the policy maker can target specific levels of the market verticality given an understanding of the process of transmission and the magnitude of noise trading.

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I. Introduction

A recent headline in a major Indian economics daily read "Market arrivals of rice are picking, why haven't the retail prices fallen?" (*Economic Times*, 7 January 1999). The headline and the accompanying story essentially reflect the wisdom of a lay market watcher who expects a favorable input shock to translate itself into an appropriate response at the output level. It is expected that a price decline at say the wholesale level (in response to an increase in market arrivals) will be matched in some way by a comparable decline of prices at the retail level. If this is not observed then the usual interpretation is one of collusion and price fixing by the trading hierarchy. In reality the asymmetry in responses to favorable or adverse input shocks reflects the varied views on this issue held by the different constituents of the market hierarchy (Blinder (1994) and Blinder et. al. (1998). Thus Buckle and Carlson (1996) in a study of New Zealand businesses found that price and cost increases are paired more frequently in the same quarter than price and cost decreases.

An important puzzle in developing economies like India is the continued and often unpredictable volatility of prices of agricultural commodities. The markets for commodities like rice, wheat, livestock, and edible oil are vertical in nature. Multiple layers of traders, each occupying a distinct position in the market hierarchy and, performing a specific role characterize a vertical market. Asymmetric transmission of supply and demand shocks is endemic in vertical markets. The retail markets for these commodities could consequently see prolonged periods of increases in prices with accompanying volatility, a behavior that need not match those obtaining at the wholesale level of the market.

One of the important objectives of policy in developing economies is guaranteeing food security. Governments attempt to accomplish this, as in the Indian case, by providing a minimum requirement of the essential commodities through a parallel market (in India, this is accomplished though the Public Distribution System (PDS)) at predetermined prices. In addition to this, the free market prices are stabilized through various open market operations in grains by the government. This is an attempt to smoothen the prices at the lower end of the trade (market) hierarchy (usually at the retail level). There is evidence to show that prices stabilize at the time of intervention but volatility on either side of the intervention period is very high (see for example, Sharma (2000)). Even in the long run, the tendency for prices to change in an asymmetric manner is not eliminated.

A considered policy response would, therefore, examine the process and content of asymmetry in vertical markets. A fairly substantial body of literature examining the asymmetry in agricultural markets and in others[1] exists. In Indian grain markets such information asymmetries are very important. They occur at different levels of the market hierarchy, and create conditions for uncertainties in the markets. One of the features of such grain markets is the fairly high[2] proportion of margins (hereafter spreads) in prices. The movement of spreads constitutes the hidden element of price movements. Persistent information asymmetry will cause spreads to fluctuate in a non-symmetric manner. A

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[1] Examples include, Peltzman (2000), Vande Kamp and Kaiser (1999), Cook et. al. (1999), Taubadel (1998), Wohlgenant (1985) and Houck (1977).

[2] Spreads in Indian rice markets are nearly 85% of prices while they are only 40 to 45 percent in other South Asian economies. The proportion of spreads in prices in the United States is only 20 to 25 % (see Economic Times, February, (1997)).

ratcheting effect is likely to be created where any change in the level of information asymmetry leads to a permanent shift in the spreads which will then have a similar effect on prices.

A policy to control prices in such situations depends on a) the role of spreads in the process of price formation, b) the linkages that exist between the various markets and the different levels of the hierarchy, and, c) the structure of the markets themselves. The last point basically indicates that with markets having multiple layers, the process of causality between the layers is quite complex.

This paper attempts to explain this asymmetry by examining the linkages that exist between spreads at different levels of the hierarchy using various levels of Indian rice markets as an illustration. It makes contributions in the following areas. First, the behavior of spreads in the presence of information asymmetry is highlighted. As noted by Black (1986), noise trading can cause traders to revise their spreads continuously. This causes spreads to overshoot their equilibrium values. To investigate this possibility we present a simple model of overshooting spreads. Secondly, the role of spreads in asymmetric transmission is explained. The extant models concentrate on price levels - but even here there is no work in the Indian context. Models using prices are appropriate if margins are not significant. If the margins are large, then, it is pertinent to explain the asymmetry in adjustments of margins. Moreover, working with spreads allows us to understand the behavior of wholesalers and retailers in response to shocks, which a model using prices cannot. The model presented here endogenises the noisy trading of the traders. Also, no priors are attached to the direction of causality. It is claimed in the extant literature that middlemen (read here as wholesalers and retailers) can employ pricing strategies that can result in complete pass through of price increases while price decreases caused by favorable supply shocks are seldom and incompletely passed on. In addition, the literature is specific on the direction of causality in asymmetric transmissions. However, we treat this last point as an empirical proposition to be tested. Thus the model presented in this paper is a significant generalization of the extant literature. Finally, the paper proposes policy prescriptions where the policy maker can target specific levels of the market verticality given an understanding of the process of transmission and the magnitude of noise trading.

The structure of the paper is as follows. In Section II we describe the nature of the Indian rice markets with specific emphasis on the role of spreads. The model of overshooting and asymmetric transmission is described in Section III. In Section IV we briefly describe the data and the estimation procedure. The results are presented in Section V. Section VI concludes.

II. Structure of Rice Markets in India

Rice markets in India are dual in nature with two parallel links between the farmer and the consumer. The government controls one of the links and plays the role of a trader while, wholesalers and retailers of different types control trade in the free market segment. The government has introduced controlled markets for the purposes of welfare and reducing price volatilities that are endemic to vertical markets. The overall structure of such markets is summarized in Figure 1. We note that such a structure increases uncertainty at the various levels of the market hierarchy

Figure 1 here.

In the controlled hierarchy, the government procures from both the farmers and the wholesalers through open market operations in grains. Such procurement is for a) enhancing the buffer stock and b) for supporting the farmers when the market prices are declining. The procurement and support prices are announced in May and August/September of each year to coincide with the beginning of the two growing seasons. The support price provides relief to the farmer if market prices are declining. There is no guarantee that the government will intervene immediately. Intervention is conditioned upon the government's perception regarding expected price movements, surplus with the farmers and the government's own buffer stock.

The wholesale markets segment of the free market hierarchy resembles a call auction market where there is a temporal aggregation of buyers and sellers. Continuous order imbalances and information asymmetries that can lead to fluctuations of the spread characterize these markets. Indian rice markets resemble a call auction market for the most part at the clearing stage only. This is because buying prices are relatively sticky (depending on the season) while the selling prices fluctuate. This sets the stage for possible ratcheting effects in the market. The sources for such ratcheting lie in the ways in which the wholesalers and retailers adjust their spread components in reaction to different types of uncertainties in the market. Ratcheting is also compounded by highly inelastic demand. The price elasticity of demand for rice in both urban and rural India is less than unity (see for example Jha et. al (1999b)). We now sketch an explanation of the dynamics of spread movements in Indian rice markets.

Spreads adjust because of changes in adverse information, inventory holding and order processing costs (Jha et. al. (1999a)). These components of spreads change due to i) uncertainties due to government interventions, ii) uncertainties arising from competition between traders in the free market and the controlled market and iii) uncertainties caused by information about the inventory position with the government. Any change in the uncertainty level will make the traders revise the spread. A rise in the support price for example may force the traders to raise their spreads upwards. This would enable them to compete with the government for procurement. This is shown in Figure 2. When the government increases the support price (from S_0 to S_1), the true price perception of the trader (the mid-point of the spreads, T_0) is revised. In Indian rice markets, this revision is permanent[3].

Figure 2 here.

Other possible spread adjustments are shown in Figures 3, 4 and 5.

Figure 3, 4 and 5 here.

We note that the buying prices (B) are quite sticky while the selling prices (A) are less so. Even then, the magnitude of the decline is consistently less than the overall increases. In addition, the decline in the buying prices is never symmetric with the selling prices[4]. The extent of asymmetry in adjustment of spreads is, therefore, apparent.

[3] A survey of over 1000 retailers and wholesalers indicated that the revision on the buying side (B_u) is permanent. The selling pries for the wholesaler (A) may decline but this will be slightly less than the magnitude of the increase (see Jha et. al. (1997b)).
[4] The traders surveyed (in Madurai, Bangalore, Vijayawada, Bhuvaneshwar and Amritsar) indicated that the two magnitudes differed in absolute value by at the very least 25%. That is, the decline in selling prices is almost always 25% less than the decline in buying prices.

In vertical markets, such asymmetry in adjustments can have serious consequences on markets at the lower end of the hierarchy, in the form of price volatility. It is also possible that the traders at the retail level can have a similar effect on the wholesalers. Therefore, it becomes necessary to explain such asymmetry without presupposing any particular direction of causality. To this we now turn.

III. Methodology

Indian rice markets are noisy. The traders for the most part are noise traders (i.e., they trade on noise as if it were information). Noise in the markets is in the form of uncertainties regarding supply, changes in demand, government interventions etc. This makes prices and spreads highly resistant to any form of policy measures to control volatilities. Noise causes spreads and prices to overshoot their target values consistently. We first propose a simple model of adjustment of spreads to explain the time taken by spreads to adjust to their equilibrium values.

Consider the group of N centers (indexed by i) spatially separated over economic space observed over time (indexed by t). Let SP_{it} be the wholesale spread in center i at time t. Let ΔSP_{it} be the change in spread of center i at time t. Within the partial adjustment framework, this is a function of excess spreads[5] at time $t-1$ i.e.,

$$\Delta SP_{it} = a_i \left(SP_{it}^{*} - SP_{it-1} \right) \quad \textbf{(1)}$$

[5] Peltzman (2000) has a similar specification where he treats the adjustment as an error correction process. The actual values of the variable adjust towards the equilibrium whenever the variable is not in equilibrium.

where SP^*_{it} is the desired (equilibrium) spread at time *t-1*. This is unobservable and is modeled as a function of traders' perception of information asymmetry and order imbalance in the market. These are proxied by the retail price and the inventory of the wholesalers[6], i.e.

$$SP^*_{it} = b_i\left(st_{it-1}, rtl_{it-1}\right) \tag{2}$$

where st_{it-1} is the inventory level of the wholesalers and rtl_{it-1} is the retail price at *t-1*. We can approximate (2) by a linear function as

$$SP^*_{it} = b_{i0} + b_{i1}rtl_{it-1} + b_{i2}st_{it-1} \tag{3}$$

Substituting (3) in (1) and expanding

$$\Delta SP_{it} = a_i b_{i0} + a_i b_{i1}rtl_{it-1} + a_i b_{i2}st_{it-1} - a_i SP_{it-1} + e_{it} \tag{4}$$

For stable adjustment, we would need a_i to be positive and significant. In a symmetrical fashion the change in the retail spreads can be written as

$$\Delta RT_{it} = f_i(RT^*_{it} - RT_{it-1}) \tag{5}$$

where ΔRT_{it} is the change in the retail spread in market *i* at time *t*. Now the desired retail spread RT* is written as:

$$RT^*_{it} = t_{i0} + t_{i1}wsp_{it-1} + t_{i2}vol_{it-1} \tag{6}$$

Where wsp_{it} is the wholesale price and vol_{it} is the volume traded at the wholesale level which indicates order imbalance. Substituting (6) into (5) and expanding, we have

$$\Delta RT_{it} = f_i t_{i0} + f_i t_{i1}wsp_{it-1} + f_i t_{i2}vol_{it-1} - f_i RT_{it} + e_{it} \tag{7}$$

[6] The choice of variables is based on the traders' survey.

We would require f_i in equation (4) to be positive and significant in order to obtain stable adjustments.

The partial adjustment models outlined above are augmented to reflect asymmetric responses to price increase and decreases. There are two extant strands of literature that attempt to model asymmetric adjustments. The first is based on Wolffram (1971) and Houck (1977) where the variables in question are segmented[7]. The second follows from Davidson et. al. (1978) where the adjustments are modeled as an error correction process with predetermined direction of causality[8]. The latter allows forward-looking expectations to play a role. We use the Houck (1977) procedure to model asymmetry because the variables studied are all stationary so that we do not require non-classical techniques such as cointegration. In addition, the method used here gives significantly greater weight to week-to-week changes in the variables. This implies some form of hysteresis in the behavior of the different variables. Casual empiricism based on the surveys suggests that spread adjustments be based on immediate past values. This renders the Houck (1977) procedure useful because it attaches greater weights to near contemporaneous values. There is also a large degree of permanence in the revision of spreads. Hence there is a sound prior to suggest that a longer lag length may not be significant for explaining asymmetry[9].

The model for estimating asymmetry can be written as follows.

$$\Delta RT_{it} = g_{i0} + g_{i1}\sum \Delta SP'_{it} + g_{i2}\sum \Delta SP''_{it} + g_{i3}\sum \Delta F'_{it} + g_{i4}\sum \Delta F''_{it} + q_i \Delta SP_{it} + e_{it} \qquad \textbf{(8)}$$

[7] Others who have used the methodology are Hein (1980), Wohlgenant (1985), Kinnucan and Forker (1986), (1987), Kinnucan (1986), and Vande Kamp and Kaiser (1999).

[8] Others that have modeled asymmetric adjustments as an error correction process include Peltzman (2000), Taubadel (1998), Granger and Lee (1989) and Escribano and Pfann (1997).

[9] We tested the significance of longer lags during the process of estimation. The chi-squared test strongly rejects longer lags. A lag of one week is used for explaining overshooting since it is modeled as partial adjustments.

$$\Delta SP_{it} = x_{i0} + x_{i1}\sum \Delta RT'_{it} + x_{i2}\sum \Delta RT''_{it} + c_i \Delta RT_{it} + h_{it} \quad \textbf{(9)}$$

For t= 1, 2… where $\Delta RT_{it} = RT_{it} - RT_{it-1}$ and $\Delta SP_{it} = SP_{it} - SP_{it-1}$.

The sum of all the increases in wholesale spread from the initial value is written as $\sum \Delta SP'_{it}$, the sum of all the negative changes is $\sum \Delta SP''_{it}$, the sum of all positive changes in farm prices is given by $\sum \Delta F'_{it}$ and the sum of all negative changes is given by $\sum \Delta F''_{it}$. The sum of all positive changes in retail spread is $\sum \Delta RT'_{it}$ while the sum of fall negative changes is $\sum \Delta RT''_{it}$. Non-reversibility occurs in ΔRT_{it} or ΔSP_{it} if the coefficients of the segmented variables are not equal to each other. Since asymmetries are measured with respect to a previous point in time, it is quite obvious that the starting point is central to the analysis. To link (8) and (9) to the initial position (where RT_{i0} and SP_{i0} are the initial positions of the retail and the wholesale spreads respectively) we note that the value of say RT_{it} at any point in time is

$$RT_{it} = RT_{i0} + \sum_{t=1}^{n} \Delta RT_{it} \quad \textbf{(8a)}$$

$$SP_{it} = SP_{i0} + \sum_{t=1}^{n} \Delta SP_{it} \quad \textbf{(9a)}$$

Where t = 1, 2…t, t+1, ……n.

We can write (8a) and (9a) as

$$RT_{it} - RT_{i0} = \sum_{t=1}^{n} \Delta RT_{it} \quad \textbf{(8b)}$$

$$SP_{it} - SP_{i0} = \sum_{t=1}^{n} \Delta SP_{it} \quad \textbf{(9b)}$$

Substituting (8b) and (9b) in (8) and (9) and simplifying we get (10) and (11).

$$RT_{it} - RT_{i0} = g_{i0} + g_{i1}\sum \Delta SP'_{it} + g_{i2}\sum \Delta SP''_{it} + g_{i3}\sum \Delta F'_{it} + g_{i4}\sum \Delta F''_{it} + q_i \Delta SP_{it} + e_{it} \qquad \textbf{(10)}$$

$$SP_{it} - SP_{i0} = x_{i0} + x_{i1}\sum \Delta RT'_{it} + x_{i2}\sum \Delta RT''_{it} + c_i \Delta RT_{it} + h_{it} \qquad \textbf{(11)}$$

An example of the segmentation visualized in (10) and (11) is given in Table 1. It is implicit that these summations are up to the last period as the current period change in wholesale (retail) spread has an independent effect on change in the retail (wholesale) spread. Since there are no priors regarding the direction of causality, equations (10) and (11) have to be estimated as a system.

Table 1 here.

Equations (4) and (7) explain the impact of noise in the process of adjustment of wholesale and retail spreads. To explain the behavior of wholesale and retail spreads we add on the asymmetric adjustment and the partial adjustment terms separately (for each of) the retail and wholesale spread adjustment as in (10) and (11) below. This is suggested as a generalized explanation of the impact of noise trading at different levels of the market hierarchy.

$$\begin{aligned} RT_{it} - RT_{i0} = g_{i0}t + g_{i1}\sum \Delta SP'_{it} + g_{i2}\sum \Delta SP''_{it} + g_{i3}\sum \Delta F'_{it} + g_{i4}\sum \Delta F''_{it} + \Omega_{i1} b_{i1} rtl_{it-1} + \Omega_{i2} b_{i2} st_{it-1} \\ - \Omega_i{}' SP_{it-1} + f_i t_{i1} wsp_{it-1} + f_i t_{i2} vol_{it-1} - f_i RT_{it} + e_{it} \end{aligned} \qquad \textbf{(12)}$$

$$\begin{aligned} SP_{it} - SP_{i0} = x_{i0}{}' t + x_{i1}\sum \Delta RT'_{it} + x_{i2}\sum \Delta RT''_{it} + \Phi_{i1} t_{i1} wsp_{it-1} + \Phi_{i2} t_{i2} vol_{it-1} - \Phi_i{}' RT_{it-1} \\ + a_i b_{i1} rtl_{it-1} + a_i b_{i2} st_{it-1} - a_i SP_{it-1} + h_{it} \end{aligned} \qquad \textbf{(13)}$$

Equations (12) and (13) are to be estimated as a system[10]. Equations (12) and (13) can be estimated with or without a constant. If they are estimated with a constant then the constant terms in the final estimation must be replaced with a trend (Houck 1977). We, however, use trend because the variables are trend stationary as opposed to being level stationary. Hence time trend t is included in equations (12) and (13). From the partial adjustment side, in equation (12), ΔSP_{it} is given by

$$\Omega_{i1} b_{i1} rtl_{it-1} + \Omega_{i2} b_{i2} st_{it-1} - \Omega_i ' SP_{it-1} \qquad \textbf{(4a)}$$

and ΔRT_{it} is given by

$$f_i t_{i1} wsp_{it-1} + f_i t_{i2} vol_{it-1} - f_i RT_{it} \qquad \textbf{(7a)}$$

Similarly in equation (13) ΔSP_{it} is given by

$$a_i b_{i1} rtl_{it-1} + a_i b_{i2} st_{it-1} - a_i SP_{it-1} \qquad \textbf{(4b)}$$

and ΔRT_{it} is given by

$$\Phi_{i1} t_{i1} wsp_{it-1} + \Phi_{i2} vol_{it-1} - \Phi_i ' RT_{it-1} \qquad \textbf{(7b)}$$

The estimation strategy followed also allows us to measure the half-life of information shocks at the wholesale and the retail levels in the process of asymmetric transmission. The half-life of shock in the context of asymmetric transmission between the wholesale and the retail level is given by

[10] One can ask whether it would make any difference if the estimation was carried out by using wholesale and retail prices as opposed to spreads. We estimated the process of asymmetric transmissions by replacing spreads with the appropriate price levels. That is, the retail spreads were replaced by retail prices, and the wholesale spreads were replaced by wholesale prices. We find that the results are essentially the same. These results are not reported here for the sake of brevity. Modeling the adjustment process in terms of spreads clarifies the role of wholesalers and retailers which is lost when we use prices. Since rice markets in India are integrated (Jha et. al. (1997a)) the equations are estimated as a system.

$$R_{imp} = \frac{\ln 2}{\Omega_i'} \text{ and } \frac{\ln 2}{f_i} \tag{14}$$

where R_{imp} is the impact on the transmission towards the retail level. The terms $\frac{\ln 2}{\Omega_i'}$ and $\frac{\ln 2}{f_i}$ measure the impact of a shock to the wholesale and the retail levels respectively. Similarly, the impact on the transmission from retail to wholesale level is measured by

$$S_{imp} = \frac{\ln 2}{\Phi_i'} \text{ and } \frac{\ln 2}{a_i} \tag{15}$$

where S_{imp} is the impact on the retail-wholesale transmission process, $\frac{\ln 2}{\Phi_i'}$ and $\frac{\ln 2}{a_i}$ are the half-lives of shocks on the retail and wholesale markets respectively (Randolph (1991)).

IV. Data and Methodology

Weekly data on spreads, the wholesale selling prices, retail prices, volumes, stocks and the farm harvest price, was collected from twelve[11] wholesale and retail centers in India for the period 1992-1997. Since we use high frequency data over a 5-year period, temporal movements in these variables (including any seasonal behavior) are captured completely. The variables were tested for unit roots. They were found to be stationary with a time trend. Hence (12) and (13) are estimated with a time trend.

The methodology used in this paper captures the simultaneity in the process of asymmetric transmission of changes in spreads between the retail and the wholesale levels. Whether the causality runs between wholesale and the retail level or otherwise is a hypothesis

[11] The centers chosen for the analysis are well dispersed through the country. Wholesale and retail markets in Amritsar, Kanpur, Karnal, Lucknow and Ludhiana in the north, Ahmedabad in the west, Bhuvaneshwar, Cuttack and Patna in the east and Bangalore, Madurai and Vijaywada in the south are chosen. Continuous and complete data were available for these centers alone.

to be tested. Hence we anticipate that the error terms from the two regressions will be related. Therefore, the appropriate method of estimation is the Generalized Least Squares (GLS).

The two-equation system in (12) and (13) can be written as:

$$y_m = X_m b_m + e_m \tag{16}$$

where $m = 1,2$.

The error term for the system is written as

$e = [e_1', e_2']$

Hence

$V = E(e_i e_j') = s_{ij} I$, $i, j = 1,2$ is the covariance matrix of the error terms. Clearly

$V = \Sigma \otimes I$ with $\Sigma = [s_{ji}]$

Hence the generalized least squares estimates is written as

$$\begin{aligned} \overline{b} &= [X'V^{-1}X]^{-1} X'V^{-1}y \\ &= [X'(\Sigma^{-1} \otimes I)X]^{-1} X'(\Sigma^{-1} \otimes I)y \end{aligned} \tag{17}$$

This estimates will be consistent, unbiased and efficient. We can test whether Σ is diagonal using a variety of tests e.g. the Breusch-Pagan test (Greene (1993)). Σ is found to be non diagonal in each case.

The full model of 24 equations is estimated. We then impose several restrictions to test the direction of causality, the impact of overshooting etc. The following non-parametric statistic is calculated

$$l = 2(l(r^u) - l(r^r)) \tag{18}$$

where $l\left(r^{u}\right)$ represents the value of the log of the likelihood function with unrestricted values of the vector of parameters r and $l\left(r^{r}\right)$ represents the log of the likelihood function with r restrictions. The statistic l is distributed as a c^{2} with r degrees of freedom under the null hypothesis that the r restrictions hold (see Davidson and Mackinnon (1993)). These results of the estimation are outlined in the next section.

V. Results

For asymmetries to be captured, the coefficients of the partitioned (segmented) variables reflecting the speed of adjustments on either side must satisfy three criteria. These are: i) they should posses the correct signs, ii)) they must be statistically significant, and iii) they must be statistically different from each other (Cook et. al. (1999)). The results of our estimation are presented in Table 2.

Table 2 here.

These results can be summarized as:

a) The coefficients g_1, g_2, g_3, g_4 have the correct sign. The hypothesis that $g_1 = g_2 = g_3 = g_4$ is rejected at the 1% level for all centers[12]. Hence there is asymmetric transmission in the direction of the retailers. Concurrently the coefficients x_1, x_2 are positive. We are not able to reject the hypothesis that $x_1 = x_2$, nor is the hypothesis that $x_1 = x_2 = 0$ rejected.

b) The terms signifying response of retail spreads to adjustments in the wholesale spreads as captured by the 6th to 8th terms on the right hand side of equation (12) are significant.

[12] The null hypotheses that any subset of the γ's are equal to each other are also rejected. These are not reported to conserve space.

Similarly the terms signifying the response of the wholesale spread to changes in the retail spread as captured by the 4th. to 6th. terms on the right hand side of (13) are significant. The chi-square test rejects the hypothesis that these terms may be zero. Thus noise plays a significant role in spread adjustment in both retail and wholesale markets.

c) Noise plays a significant role in the process of asymmetric transmission. However the role of noise traders at the retail level is not significant in the direction of wholesale to retail levels. We also find that the cycles caused by noise at the retail levels are larger (except in the case of Karnal) than those at the wholesale level irrespective of the direction of asymmetric transmission.

d) On an average the speed of adjustment is 3 times slower when the price declines as opposed to a price increase. Hence the asymmetry in spread adjustment is quite strong[13].

Implications

Policy makers have to examine these results in the context of designing an agricultural policy that caters to both food security and price stability. The government of India, for example, has been intervening at the level of the farmer, wholesaler and retailer with different objectives. Thus, the intervention at the level of the farmer is for providing price incentives in case of market failure, while the wholesaler and the retailer level intervention is for providing price stability and food security. The multiplicity of objectives leads to noise trading. The role of noise trading exacerbates both asymmetry and volatility in the markets (as shown in Table 3).

Table 3 here.

[13] We also estimated (12) and (13) with prices instead of spreads, and found the speed of adjustment to remain nearly unaltered. Since we know that spreads constitute nearly 85 percent of the prices, it is optimal to estimate the equations with spreads. This will implicitly bring into focus, the role of information asymmetry, and order imbalances in the process of asymmetric transmission.

In the Indian context, the buoyancy of the support prices is absent since the difference between procurement and support prices has vanished. The timing and magnitude of intervention at the various levels have become less synchronized. This has contributed, to a large extent, to the magnitude of uncertainty in the market place. We posit here that the cause for noise and asymmetry is the asynchronous nature of intervention.

When the estimation is done using price levels, the speed of adjustment on either side of the attractors is only marginally less than if we had used spreads. This indicates that policy makers have not been able to insulate prices any level of the hierarchy from the impact of either the lower level or the higher level. For example, open market operations at the wholesale level do not seem to have reduced significantly the extent of asymmetry between the wholesaler and the retailer. As Table 3 indicates retail prices and spreads are quite volatile.

VI. Conclusions

This paper has proposed a simple model of asymmetric transmission of shocks in vertical markets by focusing on spreads. This helps in shedding light on the impact of noise trading on asymmetric adjustment of spreads. In this process the extant literature in considerably generalized by including elements germane to the process of error correction within the context of asymmetric transmission of shocks. Moreover, from a policy perspective, the analysis has helped to identify the causes of asymmetry. The policy maker in this context should tailor the elements of policies pertinent to food security in a manner that they do not create information asymmetries in the market place.

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Table 1

Segmenting the Retail Spread using the Houck Method

Time	RT_{it}	RT'	RT''	$\Sigma RT'$	$\Sigma RT''$
0	13	-	-	-	-
1	16	3	0	3	0
2	14	0	-2	3	-2
3	17	3	0	6	-2
4	20	3	0	9	-2
5	15	0	-5	9	-7
6	12	0	-3	9	-10
7	19	7	0	16	-10
8	23	4	0	20	-10
9	21	0	-2	20	-12

Table 2[14]

The Non-linear Model of Transmission of Shocks with Endogenous Overshooting[15]

Center	**Dependent Variable**																
	change in retail spread								**change in wholesale spread**								
	Independent Variables																
	trend	SP′	SP″	F′	F″	st	rtl	Ω′	trend	RT′	RT″	wsp	vol	Φ′	st	rtl	γ
Ahd	8.222	-0.835	-0.262	-1.242	-0.250	0.237	1.660	0.25	3.9958	0.6283	0.5112	1.0417	1.8892	0.01	0.4327	3.2798	0.216
	(10.202)	(-2.213)	(-1.992)	(-2.144)	(-2.505)	(4.972)	(1.969)	(4.225)	(6.746)	(7.7979)	(5.8845)	(2.0417)	(3.86)	(1.9988)	(15.43)	(3.3186)	(9.43)
Amr	0.481	-0.819	-0.217	-1.000	-0.397	0.014	5.110	0.35	1.0523	2.0854	1.6788	0.9550	0.0073	0.04	0.0270	3.1083	0.436
	(3.013)	(-5.67)	(-3.508)	(-2.33)	(-2.126)	(14.92)	(6.200)	(6.352)	(3.285)	(3.354)	(3.281)	(1.9556)	(2.686)	(5.514)	(18.88)	(3.414)	(7.24)
Bhu	0.613	-0.497	-0.127	-1.120	-0.418	0.000	4.171	0.016	1.3443	1.6728	1.4120	1.0688	0.0529	0.05	0.0001	1.0346	0.215
	(2.961)	(-2.016)	(-2.739)	(-3.708)	(-1.952)	(2.885)	(4.336)	(4.073)	(4.4804)	(4.4477)	(3.3763)	(1.9688)	(2.158)	(9.0442)	(2.2268)	(2.0690)	(9.30)
Bng	2.627	-0.572	-0.103	-1.615	-0.394	0.001	1.948	0.09	2.4201	0.9080	0.7286	1.4344	0.0407	0.04	0.0180	1.9574	0.875
	(9.799)	(-2.067)	(-2.546)	(-4.654)	(-5.222)	(3.085)	(2.708)	(4.005)	(11.348)	(2.334)	(3.728)	(1.9945)	(2.7782)	(10.367)	(3.3568)	(1.988)	(10.25)
Cut	1.437	-2.381	-0.811	-1.448	-0.413	0.001	1.274	0.35	1.8761	-1.8127	-1.539	0.9890	0.0124	0.10	0.0001	1.0888	0.987
	(4.598)	(-4.786)	(-3.925)	(-2.321)	(-2.095)	(2.298)	(2.078)	(9.068)	(3.806)	(-3.58)	(-2.51)	(1.9890)	(2.140)	(9.4954)	(3.7096)	(2.217)	(6.01)
Kar	4.338	-0.746	-0.187	-1.622	-0.433	0.006	2.191	0.05	6.5105	1.9533	1.5200	0.7230	0.0000	0.7283	0.0032	0.1652	0.976
	(9.892)	(-2.220)	(-2.379)	(-1.964)	(-1.958)	(2.097)	(2.212)	(8.253)	(6.8723)	(4.7446)	(3.9882)	(1.9713)	(2.1550)	(3.61)	(2.268)	(2.1669)	(21.48)
Knp	0.166	-0.979	-0.262	-1.529	-.302	0.169	3.152	0.10	1.7849	1.9461	1.702	1.3246	0.0009	0.0286	0.0018	4.1775	0.175
	(2.285)	(-1.986)	(-2.395)	(-14.48)	(-5.474)	(2.341)	(3.345)	(18.15)	(3.375)	(11.668)	(13.040)	(2.3346)	(2.499)	(7.5856)	(2.0233)	(5.184)	(6.166)

[14] The unrestricted version of the model is rejected. The model was also estimated with a number of other restrictions. Some of them include, assuming no correlation between errors, no overshadow, and no asymmetric adjustment. All of which were rejected at the 1% level. The results are not shown here for the sake of brevity.

[15] Figures in parentheses indicate t-values.

Table 2 cntd…

Center	Dependent Variable																
	change in retail spread								change in wholesale spread								
	Independent Variables																
	Trend	SP′	SP″	F′	F″	st	rtl	Ω′	trend	RT′	RT″	wsp	vol	Φ′	st	rtl	γ
Luc	1.176 (2.330)	-2.216 (-4.393)	-0.819 (-6.760)	-1.043 (-2.972)	-0.592 (-11.87)	0.107 (9.443)	0.479 (2.479)	0.20 (8.33)	0.9528 (1.8182)	0.7911 (-19.05)	0.8010 (-16.97)	3.2670 (3.2773)	0.0004 (1.9815)	0.038 (7.8918)	0.0019 (9.8318)	0.8789 (1.982)	0.471 (12.11)
Lud	3.216 (8.370)	-0.907 (-3.497)	-0.184 (-0.734)	-1.291 (-6.145)	-0.191 (-1.951)	0.001 (2.709)	8.145 (10.529)	0.35 (2.7646)	3.1056 (5.728)	0.9727 (8.1134)	0.6630 (8.446)	0.3475 (2.3477)	0.0061 (4.9197)	0.058 (7.774)	0.0145 (1.9894)	1.4055 (1.996)	0.359 (8.26)
Mad	1.445 (3.048)	-0.537 (-1.973)	-0.194 (-2.397)	-1.321 (-2.156)	-0.346 (-1.956)	0.000 (2.068)	0.059 (2.087)	0.125 (5.310)	0.2564 (2.2939)	0.7206 (3.1676)	0.6497 (2.9423)	0.4177 (2.5981)	0.0005 (2.5470)	0.0273 (2.549)	0.0010 (2.743)	1.4609 (1.9641)	0.184 (6.6846)
Pat	0.331 (2.09)	-0.725 (-3.689)	-0.196 (-2.555)	-1.812 (-8.350)	-0.338 (-7.661)	0.246 (10.11)	3.080 (3.45)	0.10 (14.62)	0.3913 (2.0555)	1.9175 (18.773)	2.1127 (2.0889)	1.8609 (2.526)	0.0006 (2.1492)	0.0367 (3.7932)	0.0327 (9.796)	3.7283 (4.572)	0.246 (14.07)
Vij	2.287 (8.674)	-0.916 (-9.325)	-0.201 (-6.580)	-0.985 (-12.44)	-0.278 (-4.7.22)	0.000 (1.9545)	0.253 (2.288)	0.011 (8.924)	1.5445 (7.1596)	0.9746 (14.699)	0.6611 (14.801)	1.3606 (1.973)	0.0000 (-1.990)	0.024 (1.999)	0.0132 (10.313)	2.3416 (2.4050)	0.25 (9.3540)

Table 3
The Kurtosis for Retail Prices, Retail Spread and Wholesale Spread[16]

Center	Retail Price	Retail Spread	Wholesale Spread
Ahmedabad	10.752	9.9315	14.55875
Amritsar	13.46	23.8525	17.1625
Bhuvaneshwar	11.635	9.43975	16.8325
Bangalore	12.41425	19.91925	13.467
Cuttack	13.25775	15.86425	10.24175
Karnal	12.0315	21.22625	13.85875
Kanpur	10.5635	14.8035	13.461
Lucknow	13.4595	16.12975	11.17925
Ludhiana	13.27388	16.691	16.8965
Madurai	16.09375	13.6565	14.99775
Patna	11.5085	13.85	11.302
Vijayawada	11.3495	24.2845	12.385

[16] Kurtosis for retail prices is greater than three times the fourth moment, while for spread, it is greater than three times the third moment. These certainly indicate spikes in these variables.

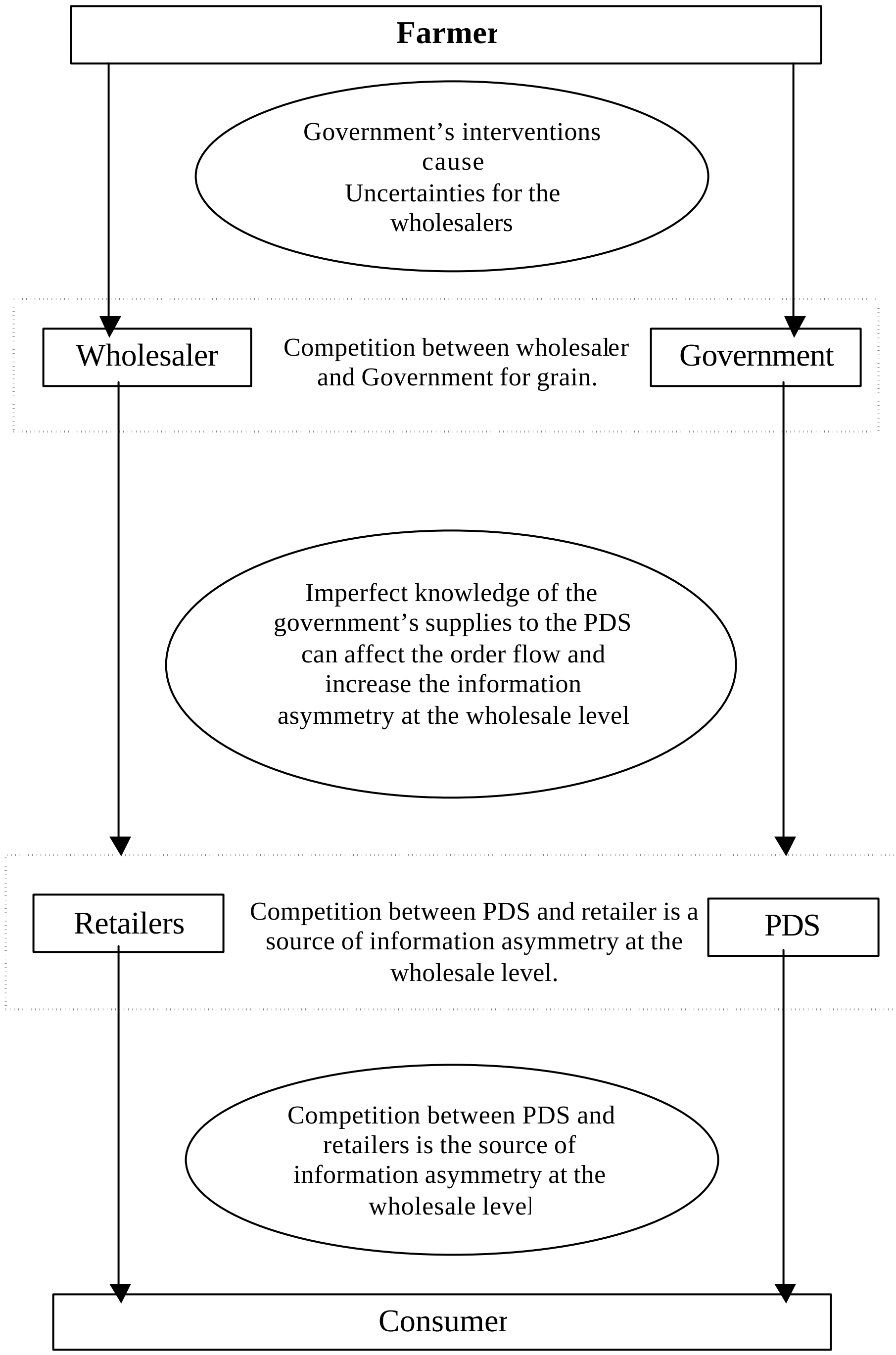


Figure 1

Structure of Rice Markets in India

Figure 2
Adjustment of spreads to a shock

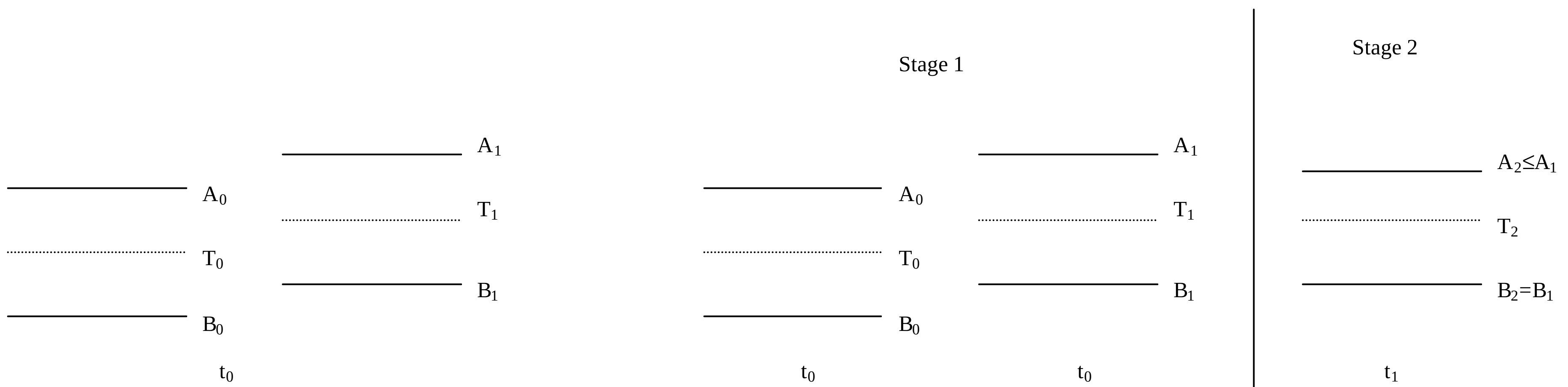


Figure 3
Spread adjustments with optimal inventory

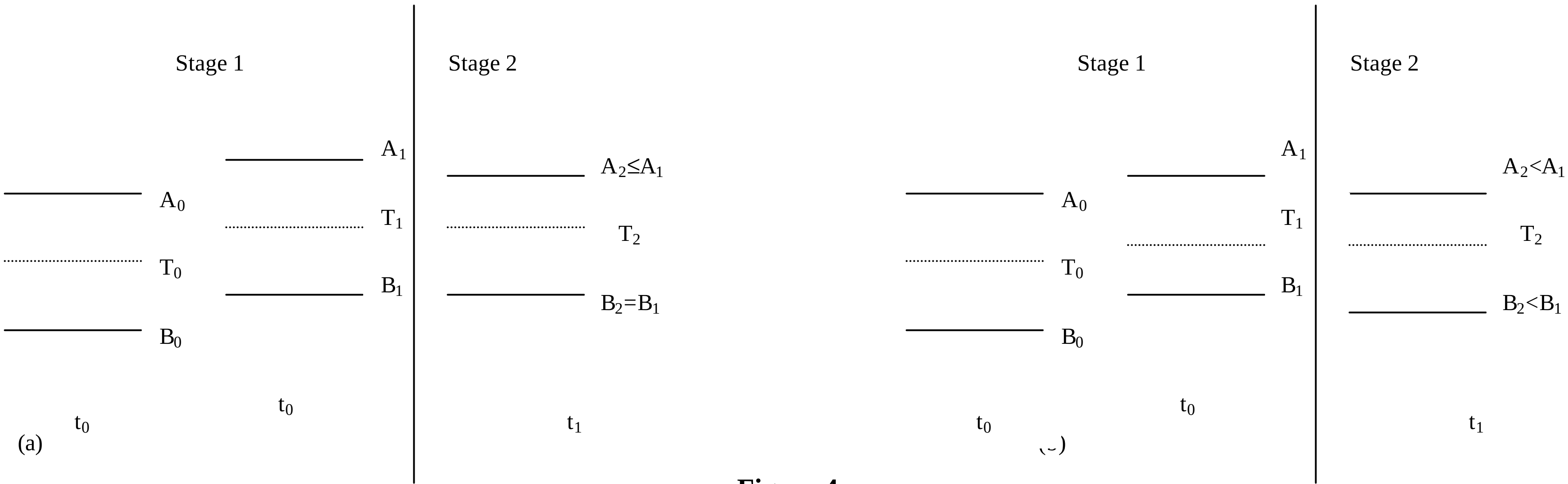
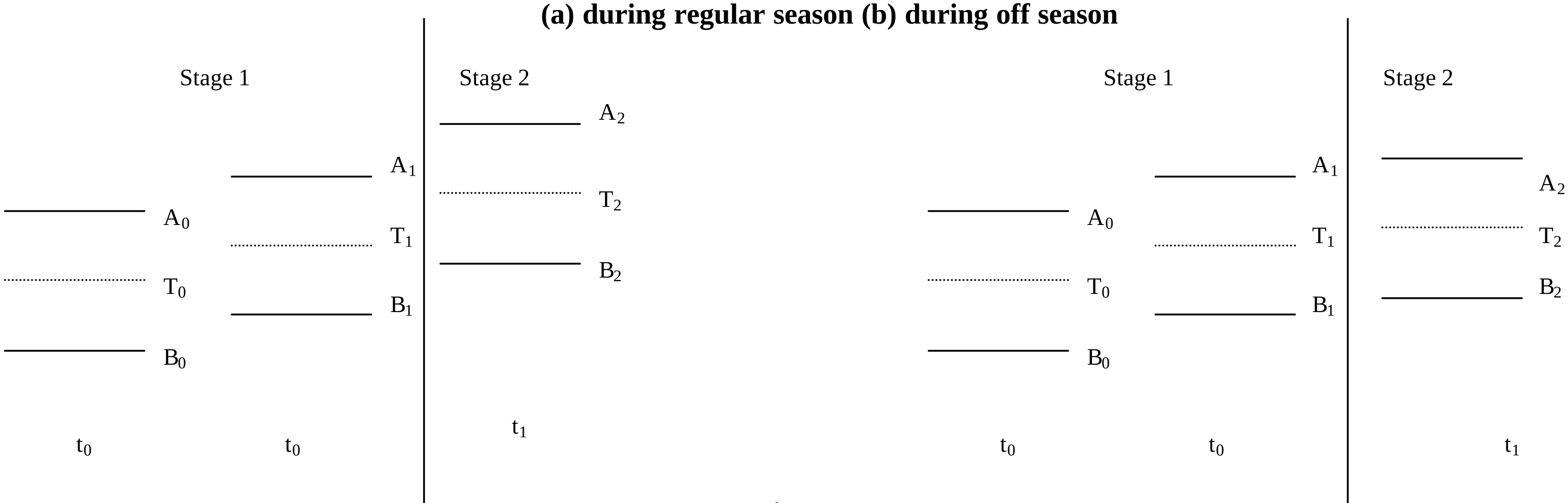


Figure 4
Spread adjustments with excess inventory
(a) during regular season (b) during off season



(a) (b)

Figure 5
Spread adjustments with less than optimal inventory
(a) during regular season (b) during off season