Wholesaler Stocks and Hoarding in Rice Markets in India

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This paper examines how a combination of local and marketwise uncertainties can lead to order imbalances at the level of wholesalers. Do wholesalers have a tendency to hold more than optimal inventory in response to uncertainties in the market? More importantly, is such overshooting mean reverting? Finally, why, in the context of integrated markets, should there be such hoarding on the part of the wholesalers, for integrated markets imply that information is mobile across centres, at least in the long run?

I
Introduction

GRAIN markets in India are complex. There are several types of relationships between the various players in the market, namely, the government, farmers, wholesalers, retailers and consumers. These complex relationships give rise to various types of price movements both at the level of wholesalers and at the level of retailers. These price movements do not fully reflect the actual nature of demand or supply conditions in the market. They further create uncertainty within the trading hierarchy, which originates at the level of the farmer and ends with the consumer. This uncertainty will also affect grain movements even within well-integrated markets.

In this paper we wish to examine how a combination of local and marketwise uncertainties can lead to order imbalances at the level of the wholesalers. This is done for the following reason. In the context of a dual market the wholesalers (including the hullers and the mills) are at the apex of the free market hierarchy of trade. Wholesalers compete with the government for grain from the farmers. Procurement is easy in a major production zone, where this is accomplished by dominant wholesalers through a hierarchy comprised of lesser wholesalers. These lesser wholesalers directly purchase from the farmers and mills in smaller towns and villages. However, in a consumption zone, this is often fraught with a large number of impediments and is costly. This is often caused by the wholesalers having to procure from longer distances and having to face a large number of barriers to movements. For example, it is costlier to procure grain in Bangalore than in Tanjavur since the latter is situated in a major production zone and the wholesalers in this centre do not have to face any type of movement restriction.

When the government intervenes in these markets it is bound to produce different types of results in terms of the creation of order imbalances. We posit that order imbalances will be greater primarily in trade and consumption centres rather than those centres where local production is high and/or combination of both production and trade is high. Both transient and permanent order imbalances will cause non-optimal order imbalances with the wholesalers. In dual markets such conditions lead to hoarding at the wholesale levels. Such hoarding behaviour will cause distortions at the wholesale level and, given the dependence of the lower end of the market (see Figure) on the wholesalers, will cause systemwide price distortions. Therefore, the government must be aware that hoarding is caused by uncertainties in the system and, most often, is also the cause of most of these uncertainties. In addition, the reaction to uncertainties depends on the nature of the centre. The government must be aware that when markets are integrated [Jha et al 1997] hoarding in one market could cause hoarding in seemingly unrelated markets. This is due to the fact that a local intervention could cause marketwide uncertainty.

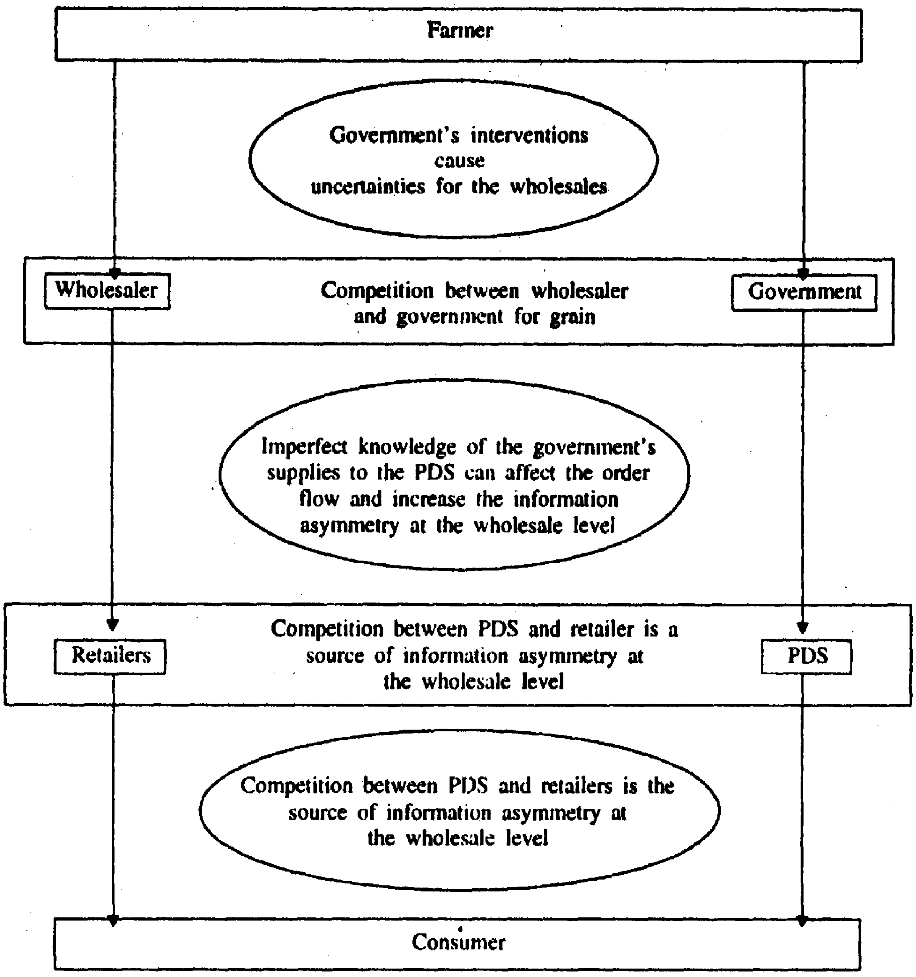
In this paper we examine whether wholesalers have a tendency to hold more than optimal inventory in response to uncertainties in the market. More importantly, we wish to test whether such overshooting is mean reverting or not. We propose to investigate whether there is a link between the morphology of the trading system and mean-reverting inventory behaviour. For example, do wholesalers tend to hoard in predominantly trade or consumption zones, where local production is low. Finally, we wish to ask why, in the context of integrated markets, there should be such hoarding on the part of the wholesalers for integrated markets imply that information is mobile across centres, at least in the long run.

The paper is divided into four sections. In Section II the data and methodology are explained. We use a partial adjustment model to infer mean-reversion. Section III explains the results of the estimation and the paper concludes (in Section IV) by stating certain broad policy implications.

II
Model and the Data

In this section we develop a model that will help us examine the dynamic behaviour of stocks with wholesalers. This would give us an idea of the nature and speed of adjustment in wholesale rice markets. This would admit the possibility of no adjustment or unstable adjustment. Evidence of this nature would indicate hoarding behaviour on the part of the wholesalers. If this is the case it would be useful to investigate whether such hoarding is more likely in major consumption as opposed to major production centres. There are several strands of literature that examine the mean-reversion tendencies of variables like exchange rate, interest rates, and stock prices. One strand of literature uses methods that crucially depend on the non-stationarity assumption of the variable in question. Representative work in this area includes those of Engsted and Tanggaard (1994), Hall, Anderson and Granger (1992) and Stock and Watson (1988). These papers examine the co-integration relationship between interest rates of different maturities. A second group of papers attempt to examine mean reversion in stock prices by using variance ratio tests. If stock prices are mean revert-

FIGURE: STRUCTURE OF RICE MARKETS IN INDIA



ing, then, the ratio of long run volatility to short run volatility is quite small. Poterba and Summers (1988) examine whether stock markets are efficient (f e, absence of mean reversion) by testing whether volatility of prices rise in proportion to the length of the time series. Finally, various types of linear models based on the methodology of Fama and French (1988) regress stock returns on a constant term plus past returns. In order for the market to be efficient, the coefficient on the lagged return must be zero or close to it.

However, none of these preceding types of models are useful for our purposes. Pretesting of our data shows that quantities traded are stationary. Hence cointegration methods cannot be used for modelling adjustment in stocks. The variance-ratio tests have two flaws. First, the rate of convergence (mean-reversion) is never clear in the extant models. Hence, the half-life of an exogenous shock cannot be measured. Second, the results of these tests depend on the length of the time interval. These would then imply that mean-reversion could be absent if one chose a longer time interval. Linear autoregressive models of the type used by Fama and French (1988) at best partially represent the adjustment in stocks since they assume that current quantities are a function of past quantities alone.

An alternative to the above formulation would recognise that the optimum (the target or the expected value) quantity of stock to be held by the wholesaler might be unobservable. To treat it otherwise may lead to misspecification. We explicitly recognise this non-observability of optimum stock and model the adjustments to it as a partial response, along the lines of Jorgenson (1986). Such models of stock adjustment are common in the investment and inventory adjustment literature but, to the best of our knowledge, this is the first attempt to model wholesaler stock adjustment in grain markets anywhere. The partial adjustment model that is used here will help us derive the reversion. This model has several appealing features. First, it is consistent with the idea of overshooting since, the change in quantity is considered a function of 'excess' quantities in the previous period. Second, the role of expectations is made explicit in explaining changes in quantity. Expectations are formed by taking into account variables that capture both the information content and, the magnitude of order imbalance in the market place. Hence, this model also has the properties of adaptive expectations models. This implies that mean-reversion is now a function of both lagged stocks and, other variables that capture information asymmetries and, order imbalances.[1] We now describe the model of partial adjustment used in this paper.

Consider the group of wholesale centres, of N centres spatially separated over the economic space of India. Let ST_{it} be the stocks in these centres observed at a point in time t, where, i = 1,2...14 and t = 1,2...104 weeks. (We have weekly data on 14 centres for two years). Let ΔST_{it} represent the changes in stocks of centre i at time t. Within the partial adjustment framework, this is then a function of excess stocks at time t-1.

Hence,

$$\Delta ST_{it} = \alpha_i (ST^*_{it-1} - ST_{it-1}) \quad ...(1)$$

where, ST^*_{it-1} is the desired stock at time t-1 and,

$$ST^*_{it-1} = f(harp_{it-1}, rtl_{it-1}, wsp_{it-1}) \quad ...(2)$$
$$= (\beta_{i0} + \beta_{i1} harp_{it-1} + \beta_{i2} rtl_{it-1} + \beta_{i3} wsp_{it-1}$$

where, $harp_{it-1}$, is the farm harvest price (wholesale buying price)) in centre i at time t-1, and, rtl_{it-1} and wsp_{it-1} are the corresponding retail and wholesale selling prices. These variables represent the information asymmetries at the level of the farmers and the retailers respectively. Substituting in (1) and expanding, we have the following estimable equation,

$$\Delta ST_{it} = \alpha_i\beta_{i0} + \alpha_i\beta_{i1} harp_{it-1} + \alpha_i\beta_{i2} rtl_{it-1} + \alpha_i\beta_{i3} wsp_{it-1} - \alpha_i ST_{it-1} + \varepsilon_{it} \quad ...(3)$$

where α_i is the mean reversion rate of centre i and we have added a stochastic error term ε_{it}.

Equation (3) is estimated as a non-linear system of equations. This is done for the following reasons. First as shown in Table 1, the across the centre correlations are fairly high. Hence, this technique will capture the contemporaneous cross-centre correlations. Secondly, given that rice markets in India are integrated [Jha et al 1997], it is only logical that we estimate mean-reversion in this manner. Integrated markets transmit changes in information quickly across the economic space.

The data used is derived from the various issues of *Agricultural Situation in India*, and the *Bulletin of Economics and Statistics*. This has been augmented by weekly data for 14 markets. We used weekly data on wholesale stocks, farm harvest price, retail price and wholesale selling prices, to estimate the model in equation (3). The time period is between January 1990 and December 1991 (i e, 104 weeks).[2] The estimation technique used corrected for both within and across equation centre serial correlation. The results of the estimation are explained in the following section.

III
Results

The results of the estimation are shown in Table 2. These results show that stocks held constantly diverge away from target values in response to exogenous shocks. There is a tendency to hoard across all markets. Movements away from the target values are not slow. We have hoarding taking place within extremely short intervals. This is the result of feed back traders operating in these areas.

The results also bring to light the effect of the morphology of the trading centres on the rate of change of stocks. We can classify the centres into production and trading centres (Amritsar and Ludhiana), trading centres (Karnal and Chandigarh), consumption and trade centres (Madurai and Lucknow), consumption centres (Bhubaneshwar, Cuttack, Bangalore and Kanpur), and production and consumption centres (Vijayawada). We find for example in centres that are in primarily consumption zones, both the harvest and local retail prices have a significant impact. The harvest price is significant because local production is not very high and procurement from distant places has to be undertaken to meet the local demand. This explains the positive relationship between harvest price and the change in stocks.

The relationship between retail price and changes in stocks is dependent on whether the wholesaler primarily supplies to local retailer or to a hierarchy of retailers. If the latter is the case, then the demand side uncertainty will cause the wholesalers to change their stock levels. This explains the positive sign on the coefficient of the retail prices in these centres. A similar situation prevails in the case of those centres where the primary activity is trade. In these centres, the trade is between wholesalers. Local consumption is not very high. In Amritsar and Ludhiana the local production is very high. Hence supply uncertainties between wholesalers are not of a very high order. However in the case of Karnal and Chandigarh, the supply uncertainties are higher because of low local production. This explains the positive relationship between wholesale selling price and the changes in stock in centres such as Karnal and Chandigarh.

We thus find that the overall instability in the market is very high. This is irrespective of the fact that a center might be in a production or consumption zone. We find that either the harvest price or the retail price causes instability. These capture the information uncertainties at the level of the farmer and the retailer respectively. Such uncertainties could be caused by the existence of the dual market.

TABLE 2: RESULTS OF THE ESTIMATION OF THE NON-LINEAR SYSTEM OF EQUATIONS

Centre	Explanatory Variables (t-Ratio Shown within Brackets)				
	Constant	alpha	harp	rtl	wsp
Ahmedabad	-340.9	-.219	-370.43	117.26	106.55
	(-.255)	(-3.364)	(-.738)	(.704)	(.575)
Amritsar	-665.61	-.749	28.729	146.33	-20.6
	(-1.17)	(-7.647)	(.123)	(1.0019)	(-2.204)
Bangalore	-4882.5	-.0083	-20467	-40702	-15561
	(-6.956)	(-6.208)	(-6.815)	(-6.857)	(-6.727)
Bhubaneshwar	-7458.7	-.172	5020.6	-22423	11472
	(-5.857)	(-3.534)	(3.644)	(-5.49)	(3.92)
Chandigarh	-6908.5	-.802	505.47	1673.9	3092.9
	(-1.38)	(-9.104)	(.628)	(1.82)	(2.03)
Cuttack	-15761	-.125	8168.6	-27623	16383
	(-4.814)	(-3.169)	(3.658)	(-5.994)	(4.176)
Kanpur	-1344.3	-.456	485.5	-197.34	-168.98
	(-2.015)	(-5.489)	(1.975)	(-1.949)	(-1.285)
Karnal	-1617.2	-.225	4.122	26.006	113.93
	(-.537)	(-4.139)	(.0057)	(.0537)	(.306)
Lucknow	-4407.5	-.371	3821.4	77.408	1634.7
	(-4.021)	(-5.648)	(-1.981)	(.0728)	(1.618)
Ludhiana	-2481.3	-.475	-358.9	517.75	-153.71
	(-1.613)	(-5.426)	(-1.285)	(1.395)	(-2.447)
Madurai	-3626	-.466	2535.1	648.4	-1158.8
	(-1.911)	(-6.33)	(1.96)	(.973)	(-1.134)
Patna	-188.64	-.303	-119.36	56.173	-2.227
	(-.597)	(-4.159)	(-.765)	(.990)	(-.0269)
Shimla	248.81	-.485	.505.45	283.84	-231.35
	(.149)	(-5.242)	(-1.060)	(.836)	(-.546)
Vijayawada	-27009	-.334	15964	-1964.3	-16.948
	(-6.027)	(-5.299)	(4.994)	(-1.919)	(-.0088)

TABLE 1: CORRELATION MATRIX OF STOCKS OF 14 WHOLESALE CENTRES IN INDIA

	Ahd	Amr	Bhu	Bng	Chd	Cut	Kar	Knp	Luc	Lud	Mad	Pat	Sim	Vij
Ahmedabad	1.000	0.347	0.397	0.331	0.767	0.442	0.485	0.575	0.575	0.338	0.482	0.586	0.653	0.459
Amritsar	0.347	1.000	0.310	0.535	0.621	0.494	0.665	0.571	0.467	0.224	0.362	0.676	0.310	0.339
Bhubaneshwar	0.397	0.310	1.000	0.453	0.420	0.281	0.276	0.317	0.389	0.167	0.135	0.421	0.386	0.392
Bangalore	0.331	0.535	0.453	1.000	0.487	0.495	0.574	0.501	0.557	0.425	0.872	0.426	0.147	0.601
Chandigarh	0.767	0.621	0.420	0.487	1.000	0.443	0.778	0.561	0.645	0.556	0.486	0.462	0.317	0.617
Cuttack	0.442	0.494	0.281	0.495	0.443	1.000	0.525	0.679	0.522	0.155	0.142	0.551	0.410	0.376
Karnal	0.485	0.665	0.276	0.574	0.778	0.525	1.000	0.550	0.642	0.529	0.477	0.348	0.681	0.449
Kanpur	0.575	0.571	0.317	0.501	0.561	0.679	0.550	1.000	0.750	0.173	0.292	0.845	0.459	0.475
Lucknow	0.575	0.467	0.389	0.557	0.645	0.522	0.642	0.750	1.000	0.267	0.321	0.554	0.509	0.663
Ludhiana	0.338	0.224	0.167	0.425	0.556	0.155	0.529	0.173	0.267	1.000	0.353	0.861	0.229	0.279
Madurai	0.482	0.362	0.135	0.872	0.486	0.142	0.477	0.292	0.321	0.353	1.000	0.295	0.081	0.182
Patna	0.586	0.676	0.421	0.426	0.462	0.551	0.348	0.845	0.554	0.861	0.295	1.000	0.649	0.532
Shimla	0.653	0.310	0.386	0.147	0.317	0.410	0.681	0.459	0.509	0.229	0.081	0.649	1.000	0.407
Vijayawada	0.459	0.339	0.392	0.601	0.617	0.376	0.449	0.475	0.663	0.279	0.182	0.532	0.407	1.000

IV
Conclusion

The paper demonstrates the inherent instability of the Indian grain markets. We have used a non-linear partial adjustment model to test mean reversion for a representative sample of 14 centres in India. The data of the centers have been pooled and the non-linear model of partial adjustments has been estimated. It is found that there is a basic for tendency to hoard. The half-life of any such is potentially infinity. The wholesalers are permanently holding non-optimal inventory levels. There is thus a persistent order imbalance in the wholesale markets of India. We believe that this is due to the dual nature of the grain markets.

Notes

1 Order imbalances (inventory imbalance) occur, when the wholesaler moves away from his optimal inventory position. Since the wholesalers in India are operating in a Fooling environment, they will not be able to perfectly forecast the changes in supply and demand. This implies that the order imbalance will persist and change over time.

2 Even though data for 4 years were available, we chose to use the data between 1990 and 1991 since, information on retail price and volumes were not consistently available for all centres. The 14 centres chosen have given a clear representation of the various types of potential consumption zones found within India.

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