COMPONENTS OF THE WHOLESALE BID-ASK SPREAD AND THE STRUCTURE OF GRAIN MARKETS: THE CASE OF RICE IN INDIA

BY

Raghbendra Jha
K.V. Bhanu Murthy
Hari K. Nagarajan
Ashok K. Seth

January 1998

Please address all correspondence to:

Hari K. Nagarajan
Assistant Professor
Indian Institute of Management
Bannerghatta Road
Bangalore - 560 076
India

Fax: (080) 6644050

Abstract

In this paper we propose a new method of splitting up the Bid-Ask Spread of the wholesalers in grain markets into its three constituent components: the order processing costs, the adverse information cost and the inventory holding cost. It is argued that the extant methods of splitting up this spread are peculiar to stock markets and cannot be applied to grain markets. The proposed method is shown to be more general than the extant approaches. This new method is used to examine the constituents of the bid-ask spread in the grain markets of twelve major centers in India. The results are then linked to the production and consumption patterns in these centers.

I. Introduction

Retail prices of food grains such as rice, exhibit continued volatility. Several governments, most notably those in Bangladesh, India and China, attempt to reduce this volatility by introducing a parallel controlled market. Grains like rice are made available through these controlled retail establishments at prices that do not necessarily reflect market forces. In addition, these governments periodically release previously procured stocks in the market in order to minimize any potential price increases at the retail level. Other measures include passing laws to curtail inventory with wholesalers and retailers and controlling the level of credit available to wholesalers. These measures are intended to control the supply side of the markets at both wholesale and retail levels. In India, the public procurement policy and the public distribution system (PDS) have been set up to procure and distribute farm output at predetermined procurement and issue prices.

Casual empiricism based on the behavior of retail prices of rice across various centers in India suggests that the government's measures to control volatility at the retail level have not been successful. We note that weekly changes in retail prices of rice are persistent and seemingly random. The public distribution system is used to control volatility through supply side measures such as procurement from farmers at pre-determined procurement prices. This would limit the flow of grains to the wholesale market. While there might be a causal link between the volume of grain movement and the retail prices, one cannot ignore the volatility of the same prices caused by the price setting behavior of the wholesaler. Since the retail markets in India depend entirely on the wholesalers for the supply of grains, government interventions to control the overall supply in the open market might actually worsen the price situation by increasing the supply side uncertainties to the wholesalers. These uncertainties are felt as costs by the wholesalers and are then incorporated by them into their bid-ask spreads. Given that retail and wholesale markets are linked, one can see the reason for "unexplained" retail price volatility.

In this paper, we are not concerned about the causality between wholesale bid-ask spreads and retail prices[1]. Instead, the structure of the bid-ask spread is studied in great detail. The bid-ask spread is the profit margin for the wholesaler. This is comprised of three components viz., adverse information cost, inventory holding cost, and the order processing cost. The inventory holding cost refers to the price risk and, the opportunity cost of capital tied up in the inventory. Adverse information cost is the expected loss to the traders due to trading with other traders who possess superior information. Finally, the order processing cost is the cost of processing orders. These costs are expected to vary with time and the level of activity as the inventory level changes and the degree of information asymmetry fluctuates. The wholesaler adjusts the profit margin (bid-ask spread) to cover these costs. The bid-ask spread is, as such, measurable. However, the components of the spread are not directly observed. Although there is a large literature on decomposition of the bid-ask spread into its components in the case of stock markets, to the best of our knowledge, there does not exist a parallel literature in respect of grain markets. In this paper we propose a direct method of estimating these components.

Our paper differs from the existing literature on the micro structure of spread behavior (Roll (1984), Stoll (1989), George, Kaul and Nimalendran (1991) (henceforth GKN) among others) in several important aspects. First, it is assumed in the extant literature that the spreads are time invariant. This assumption is unrealistic in the context of dynamic information acquisition and dissemination in the grain markets. This implies that the three cost components change over time in response to information asymmetries occurring in the markets.

Second, the extant literature (Afflec–Graves, Hegde, and Miller (1994), Stoll (1989)) has primarily examined variables that determine the value of the spread in cross-section data. Since we are using aggregate prices for the same quality of rice in various centers, variety induced cross-sectional variations are, as such, absent. Our focus will be to isolate those variables that explain the fluctuations over time of these spreads. We evolve a simple methodology to determine the various forms of informational asymmetries that occur in the market place. These are then directly used to determine the spread components.

Third, the existing work on the estimation of the spread components (Stoll (1989), GKN (1991)) relies on indirect procedures. These methods do not clearly show the relationship between the underlying economic variables such as, price, volume, and innovation (information shocks), on spreads. For example, it is not quite clear how an informational shock alters the adverse information cost component. Hence, these methods are of limited predictive ability when it comes to the components of spread, particularly in grain markets. In this paper, we explicitly identify the variables and the various shocks that have an impact on the specific spread components.

Finally, order flow imbalances occur due to a preponderance of buying or selling at a point of time. Due to the wholesaler's inventory control behavior, the inventory position gets evened out over time until fresh shocks in trading volume occur. It is unrealistic to assume that inventory holding costs remain constant over time. In this paper we allow the components of the spread to reflect the effect of variations in information asymmetry, and order flow imbalances to be fully captured by using appropriate variables.

This paper is divided into six sections. In section II, we define the variables that are used in the analysis. Section III describes the theory of spread formation by examining the reasons for changes in the components of the spread. The fourth section describes the data and the model used for deriving the spread components. In section V the results of the estimation are interpreted. The final section concludes.

II. Definitions

Bid-ask spread of a wholesaler is the difference between the wholesale selling price (ask price) and the wholesale buying price (the bid or the harvest price). A spread between these two prices arises when wholesalers attempt to establish margins in order to cover their costs. These costs are incurred in the process of buying and selling and include the adverse information, inventory holding and the order processing costs. The wholesalers set the initial selling price such that at least the order processing costs are covered. This is due to the fact that of the three cost components of the spread, the order processing cost is the easiest to measure. Following this, the wholesalers set the spread after making a rough estimate of the other two cost components. We next define the various cost components of the spread.

Adverse information cost: This is incurred when changing the spread in response to perceived information asymmetries arising out of trade with other wholesalers or retailers. Adverse information costs increase whenever we have uncertainties in supply, potential movement restrictions of grains, etc.

Inventory holding costs: This refers to the price risk and the opportunity cost of capital tied up in the inventory held by the wholesaler. The wholesaler is affected by unexpected changes in prices at the retail level. Such changes in price can affect the order flow, which prompts the wholesaler to adjust the spread. In India, the inventory holding cost is also influenced by the various credit policies of the Reserve Bank, which can authorize the subsidiary banks to withhold or increase credit to wholesalers.

Order processing costs: This is the cost incurred while honoring orders of various sizes and frequency. These consist of overhead costs such as those of maintaining and operating warehouses, costs of storage in anticipation of future changes in order sizes, etc. In the rice markets of India, these costs will also be affected by order flow imbalances due to the seasonal nature of production, and by the nature of these centers, *i.e.*, whether these centers are production or consumption centers.

All the components of spread viz., the adverse information, inventory holding, and the order processing costs will be affected by the arrival of new information. We call this arrival of new information "innovation", which is in the form of an exogenous event affecting the spread.

Innovation: We define innovation as an information shock that causes information asymmetries, in particular, between buyers and sellers. This will have a bearing on the future prices, and the traded volumes. We might expect the current prices to adjust in order to reflect these informational asymmetries. With rational expectations, the change in the current price will equal the expected change and, more importantly, the time taken for any price adjustment is nearly zero. We however assume that the wholesalers have imperfect information regarding the future prices and volumes. Hence, any informational event is treated as an innovation. Government announcements regarding exports and imports, procurement/support price, buffer stocks, etc., constitute innovations in the market place. Innovations can cause inventory imbalances for the wholesaler. If the wholesaler perceives this imbalance, then, a process could be initiated to rectify this during which the spread gets adjusted.

Inventory imbalance (Order flow imbalance): This occurs when the wholesaler moves away from his optimal inventory position. Given the environment in which wholesalers in India typically operate, 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.

Using these definitions and our earlier preamble on the structure of spreads, we are now in a position to examine the factors that influence the various components of the spread. Once we understand the formative characteristics of the spread components, effective identification of variables that influence these components is possible.

III. The Nature of Spread Formation

We summarize the manner in which the magnitudes of various spread components are set and change over time. This will help in setting up the model of component generation. We identify the underlying variables that affect the spread components as price (the true price), volume traded (at the wholesale level) and innovation. The true price of the commodity is given by the mid-point of the spread (either wholesale or retail). This will be the price of grain in the absence of any transaction costs. Innovation is inferred whenever there is a sudden change in the wholesale spread. These three underlying variables can, independently or jointly, influence one or more components of the spread. We consider the following eight possible combinations of changes in price, volume and innovation.

a) <u>None of the underlying variables changes:</u> In the absence of order imbalance and information asymmetry, we will not observe changes in any of the components of spread.

b) <u>There is innovation in the market:</u> An innovation will affect the degree of information asymmetry. If the information asymmetry is perceived by the wholesalers, they will usually react by changing the volume traded by changing the mid-point of the spread by appropriately modifying either the bid or ask prices. In this case we observe that innovation has not caused either the price or the volume to change. This is perhaps due to the fact that this innovation was fully anticipated by the market and the appropriate adjustments had already been made. It is also quite possible that the innovation is effectively ignored by the market participants.

c) <u>There is change in volume accompanied by innovation in the market place:</u> Since the true price has not changed, there is a rough equality of buying and selling. Innovation in the market creates information asymmetry and non-uniformly informed traders (Morse (1980)). Trade takes place to correct the information asymmetry and the order imbalance is not affected. Changes in volumes are caused by approximately equal changes in buying and selling. Due to changes in volumes, we expect the order processing costs to change. Innovations will cause information asymmetries which will, in turn, affect the adverse information cost.

d) Price alone changes: A change in the mid point of the wholesale or the retail spread is indicative of the true price perception of the trader. If a change in the true price is unaccompanied by other changes such as volume, then, inventory control behavior on the part of the trader is inferred. This also implies that the magnitude of change in the selling price (ask price) is much smaller than the magnitude of the change in the true price. Cohen et. al (1978) have shown that if the magnitude of changes in the ask price is much larger than that of the mid point of the spread, information asymmetry is immediately inferred. In the absence of such changes, only the inventory holding cost is affected.

e) There is change in price accompanied by a change in volume: Unlike the previous case where we saw a rough equality between buying and selling, in this instance, there is order imbalance. Such imbalances are also indicative of information asymmetry at the level of the traders. Morse and Ushman (1983) show that such order imbalances are corrected by trade. In the process, the inventory holding costs and the order processing costs are affected.

f) All the underlying variables change: If all the underlying variables change, we can infer the presence of order imbalance and information asymmetry. Hence there is an incentive to trade in order to correct these two forms of disequlibria. Hopewell and Schwartz (1978) show that a change in volume along with order imbalance is due to the presence of information asymmetry. The information asymmetry causes order imbalance which in turn gives rise to changes in volume traded. We might therefore expect all the three cost components to change.

g) Price changes along with an Innovation: Morse (1980) shows that a change in true price of a commodity is usually caused by the persistence of information asymmetry. There is uncertainty regarding the likely future movements of arrivals, offtake at the retail level. To cover this uncertainty, the wholesaler merely adjusts the spread and leaves the volumes traded unchanged. This is a case of the demand and supply of grains at the wholesale level moving in appropriate directions. The spread adjustment is caused by the adverse information cost.

h) Volume alone changes: A change in volume unaccompanied by any innovation or price is indicative of absence of order imbalance and information asymmetry. It reflects a change in the supply and demand of rice with no additional participation by the wholesalers. This implies that any change in spread is caused primarily by changes in order processing costs.

We can summarize the preceding paragraphs by stating that innovation and information asymmetries at both wholesale and the retail levels affect the adverse information cost while order imbalances cause the inventory holding costs to change. Order imbalances are also created by information asymmetries. It is also noted that, unlike in the extant literature on spread components, innovation and information asymmetries can cause the order processing costs to vary. Information asymmetries have a direct impact on volumes that are traded which, in turn, affect the magnitude of the order processing cost. In the next section we outline a direct method of generating the three cost components of spread. This method relies on identifying variables which imply information asymmetries, innovation, and order imbalance. These three forces together, or in various combinations, influence the magnitudes of the three cost components.

IV. Data and the Model

The extent of and frequency of rice crop varies across India. In the north-western parts, only one crop is grown while in the Gangetic plains at least two crops are grown. Up to three crops are grown in the north-eastern parts such as Bihar and coastal Orissa. In the south, there are regions where four crops are grown and the acreage is also very high. For instance in the coastal and deltaic districts of Andhra Pradesh four crops are grown. This is also the case in the Thanjavur district of Tamil Nadu. Additionally, the magnitude of local rice consumption varies widely across the country. We have chosen 12 centers (for which continuous and reliable data were available) to reflect the diversity of production and consumption patterns in India. Table 1 shows the centers, and, the average output per crop in the district surrounding these centers. Weekly data on wholesale selling price (ask price) harvest price (the bid price), volumes and retail prices for the years 1990 and 1991 are used. The data was provided by the Ministry of Civil Supplies, Government of India.

Table 1 here.

We propose a simple method based on the theory of spreads as elaborated in section 2, to decompose spreads into the three components. Empirical financial economists as part of the literature on market microstructure have extensively studied spreads and spread components. Methods used to estimate spreads and its components are to a large extent indirect ones. For instance, GKN (1991) make a distinction between quoted spreads and estimated spreads. The estimated spreads are derived using either the covariance of the transaction price changes or, covariance of the difference between transaction returns and bid-price changes. The estimated spread is then regressed on the quoted spreads to infer spread components. Coefficient of the quoted spread in the regression is the order processing cost. Since GKN (1991) assign little importance to inventory holding cost, the remainder is naturally the adverse information cost. Stoll (1989) also estimates spread components using covariance measures. Two measures of covariance are identified, viz., the covariance of transaction prices, and, the covariance of quoted prices. These two measures depend to a large extent on i) the probability of price reversal (i.e., the probability that the next trade would take place at the bid or ask given that the current trade is at ask or bid) and. ii) the magnitude of the price reversal. Stoll claims that these two factors explain to a large extent the order processing and the inventions cost components of spread. In addition to this, Stoll assumes that price reversals are asymmetric and, constant over time (for instance, the probability of a price reversal hovers around 50%).

Our model resembles that of Stoll (1989) and GKN (1991) in spirit. We recognize that spreads have three components. This is where the similarity ends (for the following reasons): i) agricultural markets in India are not auction markets. The market microstructure literature on spreads assumes the existence of an auction market where the auctioneer (the market maker) makes quotes. Given that, the grain markets in India function alongside a controlled market, the question of a market maker for a grain does not arise. There usually is a prevailing price at which the wholesaler buys from the farmer. The price is the "realized" price. We are then able to obviate the need to use covariance measures for deriving spread components. Therefore, there is no difference between quoted and realized spreads. This also enables us to get around the need to use transaction prices since these are irrelevant. ii) unlike the stock market upon which all of the spread literature is based, the grain markets in India exhibit periodic structural changes. The pattern of food production naturally exhibits seasonality[2]. Further, the spreads are trend stationary[3]. This implies that, they accumulate (grow) over time. Given this, the Stoll (1989) and, the GKN (1991) models would give biased estimates of the spread components since their covariance measures are based on spreads that do not accumulate over time. This is the reason why we have used a model that relies on the underlying variables such as, price, innovation and, volume.

The three components of spread are generated using Zellner's seemingly unrelated regression techniques. One of the problems with both Stoll (1989) and the GKN (1991) models is that the various components are independently determined, each through an OLS regression, say as in GKN (1991). This is incorrect given the fact that the three components are, in practice, simultaneously determined. In any case, estimation of the latter model would permit us to test whether the OLS specification is valid. In our model a set of similar variables along with certain unique ones affect the three different spread components. Hence, it is only natural that efficient estimation would anticipate that the error terms from the three regressions might be related and hence, prescribe Generalized Least Squares (GLS) estimation. The system of equations to be estimated is written as:

$$aic = \alpha_0 + \alpha_1 mp\_rtl + \alpha_2 mp\_sp + \alpha_3 pt\_p + \alpha_4 d\_sp + \varepsilon_1 \qquad \ldots(1)$$

$$ihc = \beta_0 + \beta_1 mp\_rtl + \beta_2 mp\_sp + \beta_3 s\_st + \varepsilon_2 \qquad \ldots(2)$$

$$opc = \gamma_0 + \gamma_1 mp\_rtl + \gamma_2 mp\_sp + \gamma_3 d\_vol + \varepsilon_3 \qquad \ldots(3)$$

where *aic* represents the adverse information cost component, *ihc* the inventory holding cost and *opc* the order processing cost. The exogenous variables are determined as follows.

We noted earlier that information asymmetry affects the order flow and the magnitude of adverse information cost. Information asymmetry is detected whenever the true price (i.e., the price that would prevail in the absence of any transaction cost) changes. From the wholesaler's perspective, two types of prices are identified viz., the true wholesale and retail prices. The true wholesale price is the midpoint of the wholesale spread and it is the price that would prevail in the absence of any of the cost components. A change in this is measured by mp_sp and, implies possible changes in the rate of arrival of grains in the markets, possible changes in the demand from other wholesalers, etc. Information asymmetry can also originate at the retail level.

The mid point of the retail spread measures the likely true price of grain at the retail level. A change in this, measured by mp_rtl, detects information asymmetry arising out of perceived uncertainties in grain availability at the wholesale level and the potential changes is demand from other lower end retailers. In India, the last mentioned case is a peculiarity in that trade takes place between various retailers where a "higher-end" retailer supplies a lower-end retailer. The measure mp_rtl is useful to the extent to which the wholesaler has an ability to judge the retail spread in terms of its origin.

If the wholesaler believes that the retailers are able to procure grain from elsewhere, then, a better measure of information asymmetry at the retail level is the estimate of the true retail selling price. The retail selling price reflects whatever mark ups the retailer adds to his buying price. These mark ups reflect the cost components of the retail spread. To detect information asymmetry at the retail level, the wholesaler can first estimate the normative retail price and compare it with actual retail price. The normative retail price reflects that price which ought to prevail under ideal typical market condition. Any change in this, reflects the presence of information asymmetry. The normative retail price is measured by pt_p. This is derived in the following manner:

Let

$$\text{mp1\_sp} \doteq \text{mp\_sp} + .5\ (\text{spread}) \qquad \ldots(4)$$

$$\text{mp1\_rtl} = \text{mp\_rtl} + .5\ (\text{rtl\_sp}) \qquad \ldots(5)$$

where, mp_sp and mp_rtl are the mid points of the wholesale and the retail spreads respectively. The variables spread and, rtl_sp represent the wholesale spread and retail spread respectively. Given mp1_sp and mp1_rtl, we determine the normative retail price pt_p as:

$$pt\_p = (mp1\_sp + mp1\_rtl)/2 \qquad \ldots(6)$$

Any change in pt_p reflects information asymmetries in the retail markets.

Information asymmetry is usually caused by innovations in the market place. These are exogenous events that occur randomly. In dual markets, such as in India, the external noise in the trading process is very high. Evidence of the continuous nature of this external noise is found in the week to week changes in the true prices of rice at both the wholesale and the retail levels. This implies that information asymmetries are never fully corrected. The reason for this is the continuous nature of innovations (of an unknown nature) which contributes to noise trading on the part of wholesalers. We measure innovations by examining the magnitude of change in wholesale spreads. This is given by d_sp. Innovation can affect order balance in the wholesale markets. We do not find any marked seasonal variation in the stock levels held by the wholesalers. In fact, the stocks vary from week to week. The order imbalance is given by s_st and it measures the stock held by the wholesalers. Volumes that are traded (d_vol) by wholesaler are also affected by information asymmetry.

We tested each of these variables including spread for unit roots. The spread was trend stationary (i.e. I (0) when a time trend was included) and the other variables were all I (0). This implies that in the system of equation (1-3), we have to use trend as an independent variable so that the entire estimation is done in I (0) space. The following system of equations was estimated using SUR:

$$aic = \alpha_0 + \alpha_1 trend + \alpha_2 mp\_sp + \alpha_3 mp\_rtl + \alpha_4 pt\_p + \alpha_5 d\_sp + \varepsilon_1 \qquad \ldots(7)$$

$$ihc = \beta_0 + \beta_1 trend + \beta_2 mp\_sp + \beta_3 mp\_rtl + \beta_4 s\_st + \varepsilon_2 \qquad \ldots(8)$$

$$opc = \gamma_0 + \gamma_1 trend + \gamma_2 mp\_sp + \gamma_3 mp\_rtl + \gamma_4 d\_vol + \varepsilon_3 \qquad \ldots(9)$$

The other independent variables in the system of equations (7-9) now represent changes in their respective values. For example, mp_sp is now measuring changes in true price at the wholesale level, mp_rtl represents changes in true price at the retail level etc.

The model is estimated using SUR in the following manner. Since the variables in the left-hand side (the various cost components) are not directly observable, we impute certain initial values to the variables such that the sum equals the total spread. The system is estimated using SUR with the observed magnitudes on the right hand sides as exogenous variables. We repeat this procedure by giving different values to the left-hand side till the log of the likelihood function of the system is maximized. Those left hand side values for which the log of the likelihood function is maximized represents the optimal division the bid-ask spread into the various components. These estimates are efficient and not biased in any manner and reflect the underlying market structure and any changes in it.

V. Interpreting the Results

The results are summarized in tables 2 and 3. Table 2 depicts the averages of the components of the spread at the iteration where the likelihood value is maximized. Table 3 shows the results of the SUR estimation and the determinants of the components of the spread. For all the centers the Breusch-Pagan Test strongly rejects the null hypothesis that the off diagonal elements of the variance-covariance matrix of the error terms in equations (7-9) are zero. This vindicates our contention that the spread components should be estimated as a system and not separately by OLS. The maximum values of the log of the likelihood function are quite high (table (2)). This suggests that, the results that have been derived, are robust. Throughout the country (as represented by the 12 centers), innovation does not seem to play a significant direct role in setting the magnitude of adverse information cost. The impact of innovation is felt through information asymmetry. The wholesalers are significantly impacted by information asymmetry at both the wholesale and retail level. What is interesting here is that the wholesalers seem to lose from trading with other wholesalers (the fact that the coefficient of mp_sp is almost uniformly negative), while gaining from trade with retailers (the coefficient of mp_rtl is significantly positive). This implies that if wholesalers restrict their trade only with other wholesalers then the profit making is dampened. There is less of information asymmetry wheh it comes to trade between wholesalers. This could also lead us to believe that order imbalance is not of serious concern. This is proven by the fact that s_st (the term representing order imbalance), is mostly insignificant in affecting the inventory holding cost component. It is weakly significant in 3 centers (Bangalore, Ludhiana, and, Vijayawada). Another variable which, the theory says, should impact spread formation is volume (d_vol). The results are not strong in this case. A change in volume independently explains spread formation only in 4 centers (Amritsar, Bhubaneshwar, Chandigarh and Cuttack). In both Cuttack and Bhubaneshwar, the volumes traded are fairly high with significant week to week variations. The same is the case in Amritsar and Chandigarh. This is perhaps the reason why d_vol is significant in these centers.

Tables 2 and 3 here.

The structure of the market in all of these centers seems to be common knowledge to the wholesalers. This is the reason why a change in normative price, pt_p, is insignificant in all the centers. Another point to be noted is the significance of trend. This implies that in almost all centers, the spread components change over time. This proves one of our earlier claims that any assumption to the contrary is unrealistic. The consequence of the significance of trend, given that spreads are trend stationary, is that the spread components also show a perceptible tendency to also accumulate over time. This reinforces our earlier hypothesis that the structure of these grain markets could be changing over time. In centers like Ludhiana and Chandigarh, the coefficients of trend are significantly negative. This implies that, the spread itself is moving towards its true value. This is a unique result in the market micro-structure literature.

Another point worth highlighting is the significance of the constant term – the time invariant part of spread components. The magnitude of this is large and significant. This implies that the wholesalers believe that, over time, they are likely to lose if they did not make any provisions for the various types of costs. That is, the magnitude of the information asymmetries in the markets forces the wholesalers to overstate their time invariant part of the cost components. This is a direct consequence of the presence of a parallel controlled market. Another evidence of the impact of the controlled market on the wholesalers in the open market, is the magnitude of the cost components. Suppose we consider the Amritsar-Ludhiana corridor in northwestern India, we find that in both centers, the adverse information and the inventory holding costs are large (table (2)). We also find that the constant terms in the SUR regression are large and significant (table (3)). The reason for that is the behavior of the government in this area. The Food

Corporation of India does most of its procurement here. The magnitude of procured is almost never made known. Hence, the wholesalers perceive a great degree of information asymmetry in the market place, especially, given the fact there is only a single crop grown in these areas (table (1)).

We next analyze the behavior of some of the other centers in greater detail:

i) **Chandigarh:** The Government intervenes all around the area surrounding Chandigarh. There is not much local production (table1)). However this being a metropolis, consumption of rice is significant. Hence, wholesalers procure from other areas. Due to government intervention, we have uncertainties concerning the arrivals. This leads to information asymmetry. We therefore find that both adverse information and inventory holding costs are high (table (2)).

ii) **The Lucknow-Kanpur Corridor:** These two cities are close to each other in the northern state of Uttar Pradesh. There is substantial local consumption and low moderate local production. Hence, the wholesalers procure from other districts. This induces supply side uncertainties. We find that the coefficient of the term mp_sp is strongly negative. It implies that wholesalers tend to loose out with more trade between themselves. This creates the need to have adequate inventory levels. Hence in both these centers, the order processing and the inventory holding costs must be substantial.

iii) **Bhubaneshwar-Cuttack Corridor:** This is an area of high tourist traffic. Local consumption is also otherwise very high. In these areas two crops of rice are grown. The production is moderate. There are no procurement problem faced in these districts by the wholesalers. Procurement by the government is negligible and there are no movement restrictions on grain. To meet the fluctuating and heavy demand (which is known with a reasonable degree of certainty given the tourist seasons), the wholesalers have to hold on to substantial inventories. Hence in both these centers the inventory holding costs must be substantial.

iv) **Vijayawada:** This center is situated in one of the major rice producing and consuming areas in the south. Upwards of 4 crops are grown in these areas. Production is very high and so is the volume traded (whose variability is also high given the number of crops grown). This implies that order processing and inventory holding costs must be significant. In centers such as these we should find a significantly large constant term explaining the inventory holding costs. This is indeed the case as shown in table (2). A given wholesaler in such a center has to provide for sudden fluctuations in market arrivals.

We thus note that our model of generating spread components is able to shed to light on the structure of the markets. The model is also able to provide robust results in support of our postulates regarding the market structure of the rice trade in India.

VI. Conclusions

We have suggested a simple model of determining spread components from an understanding of the market fundamentals. These fundamentals are, volume, price, and, innovation. We find that, the results thus generated are consistently robust and supports to a large extent the theory of spread formation in the market micro structure literature. Our model, unlike the standard ones, suits the study of agricultural markets which, constantly undergo changes. Several significant results emerge from our paper viz.,

i) There is a significant time variation in the spread components. This arises out of the inherent information asymmetry that never seems to be entirely purged from these markets.

ii) All the components of spread show a tendency to 'accumulate' that is, the spread components mirror the changing structure of the grain markets. The exceptions are Ludhiana and Chandigarh, where, the behavior of these components seems to suggest that the spreads might be slowly moving towards their true values.

iii) Government intervention and the presence of a parallel controlled market creates information asymmetries that are strong. This is perhaps the reason why spreads themselves are constantly adjusting upward (though periodically showing mean-reverting tendencies.

Footnotes

1. This has been studied exhaustively in Jha et. al. (1996).
2. However, we could not discover any seasonal unit roots.
3. Implying that with a trend the spreads are I(0) but without the trend they are I(1).

REFERENCES

Afflect-Graves, J., S.P. Hegde, and R.E. Miller, 1994, Trading Mechanisms and the Components of the Bid-Ask Spread, *Journal of Finance* 49, 1471-1486.

Copeland, T.E., and D. Galai, 1983, Information effects on the Bid-Ask Spread, *Journal of Finance* 38, 1457-1469.

George, T.H., G. Kaul, and M. Nimalendran, 1991, Estimation of the Bid-Ask Spread and its components: A new approach, *Review of Financial Studies*, 4, 623-656.

Glosten, L.R., 1987, Components of the Bid-Ask Spread and the statistical properties of transaction prices, *Journal of Finance* 42, 1293-1307.

Glosten, L.R., and P. Milgrom, 1985, Bid-Ask and transaction prices in a specialist market with heterogeneously informed traders, *Journal of Financial Economics* 14, 71-100.

Ho, T., and H.R. Stoll, 1981, Optimal dealer pricing under transactions and return uncertainity, *Journal of Financial Economics* 9, 47-73.

Hopewell, M.H., and A.L. Schwartz, Jr, Temporary trading suspensions in individual NYSE securities, *Journal of Finance* 33, 1355-1373.

------------, 1983, the dynamics of dealer markets under competition, *Journal of Finance* 38, 1053-1074.

Morse, D., Price and trading volume reaction surrounding earnings announcements: a closer examination, *Journal of Accounting Research* 19, 374-383.

-----------, Asymmetrical information in securities markets and trading volume, *Journal of Financial and Quantitative Analysis* 15, 1129-1148.

Roll, R., 1984, "A Simple Measure of the Effective Bid-Ask Spread in an Efficient Market," *Journal of Finance* 39, 1127-1139.

Snell, A. and I. Tonks,' Determining of Price quote revisions on the London stock exchange, *The Economic Journal* 105, 77-94.

Stoll, H.R., 1978, The pricing of security dealer services: An empirical study of NASDAQ stocks, *Journal of Finance* 33, 1153-1172.

----------, 1989, Inferring the components of the Bid-Ask spread: Theory and empirical tests, *Journal of Finance* 44, 115-134.

Table 1

Cropping Pattern of Rice in India[a]

Center	State	District	No. of Crops	Average output over the crop cycle (tonnes)
Ahmedabad	Gujarat	Ahmedabad	1	54,666
Amritsar	Punjab	Amritsar	1	7,00,000
Bhubaneshwar	Orissa	Puri	2	4,70,496
Bangalore	Karnataka	Bangalore	2	2,80,000
Chandigarh	Punjab/Haryana	Chandigarh	No local production	-
Cuttack	Orissa	Cuttack	2	6,72,400
Kanpur	Uttar Pradesh	Kanpur	2	1,40,913
Lucknow	Uttar Pradesh	Lucknow	2	62,700
Ludhiana	Punjab	Ludiana	1	7,13,000
Patna	Bihar	Patna	2	1,57,286
Shimla	Himachal Pradesh	Shimla	1	5,200
Vijayawada	Andhra Pradesh	Krishna	3	11,64,360

Source: **Agricultural Situation in India** (various issues)

Table 2

Components of the Bid-Ask Spread (Averages at Maximum Value of Likelihood Ratio)

Center	Components (as percentage of spread)			log of the likelihood function
	aic[1]	Ihc[2]	opc[3]	
Ahmedabad	12	28	60	897.451
Amritsar	40	45	15	864.346
Bhubaneshwar	24	60	16	858.486
Bangalore	13	28	59	914.18
Chandigarh	44	36	20	803.01
Cuttack	27	61	12	898.186
Kanpur	20	40	41	810.429
Lucknow	15	45	40	845.625
Ludhiana	48	40	12	832.96
Patna	41	24	35	899.334
Shimla	19	34	47	872.767
Vijaywada	15	35	50	891.428

1. adverse information cost
2. inventory holding cost
3. order processing cost

Table 3

Results of the Seemingly Unrelated Regression of equations (7-9)

Center	Dep_var	Explanatory variables	Coefficients (t-ratios)
Ahmedabad	aic	constant	.464 (6.93)
		trend	.0014 (8.86)
		mp_rtl	.196 (2.92)
		mp_sp	-.865 (-4.13)
		pt_p	-.0002 (-.112)
		d_spread	-.0016 (-.696)
	ihc	constant	1.07 (6.44)
		trend	.004 (8.89)
		mp_rtl	.478 (2.84)
		mp_sp	-2.15 (-4.10)
		s_st	.00009 (.368)
	opc	constant	2.56 (6.91)
		trend	.0088 (8.93)
		mp_rtl	1.247 (2.86)
		mp_sp	-5.56 (-4.09)
		d_vol	-.002 (-.767)
Amritsar	aic	constant	1.314 (20.11)
		trend	.00019 (1.07)
		mp_rtl	.505 (6.69)

Table 3 cntd ...

Center	Dep_var	Explanatory variables	Coefficients (t-ratios)
		mp_sp	-1.806 (8.93)
		pt_p	.0015 (1.35)
		d_spread	.0023 (1.01)
	ihc	constant	2.56 (15.79)
		trend	.0005 (1.08)
		mp_rtl	1.29 (6.92)
		mp_sp	-4.61 (9.17)
		s_st	.00003 (.117)
	opc	constant	4.36 (10.25)
		trend	.0013 (1.08)
		mp_rtl	3.36 (6.86)
		mp_sp	-11.97 (-9.09)
		d_vol	-.0034 (-2.15)
Bhubaneshwar	aic	constant	1.22 (7.4)
		trend	.0026 (6.09)
		mp_rtl	.68 (4.72)
		mp_sp	-1.21 (-2.31)
		pt_p	-.001 (-.963)
		d_spread	-.0042 (-1.63)
	ihc	constant	1.33 (3.09)
		trend	.0068 (6.11)

Table 3 cntd ...

Center	Dep_var	Explanatory variables	Coefficients (t-ratios)
		mp_rtl	1.73 (4.63)
		mp_sp	-3.10 (-2.28)
		s_st	.0003 (.665)
	opc	constant	.733 (11.01)
		trend	.001 (6.06)
		mp_rtl	.269 (4.65)
		mp_sp	-.493 (-2.35)
		d_vol	.0017 (2.18)
Bangalore	aic	constant	.793 (9.47)
		trend	.0007 (4.60)
		mp_rtl	.473 (5.69)
		mp_sp	-2.01 (-7.52)
		pt_p	.0003 (.153)
		d_spread	-.005 (-1.41)
		trend	.0018 (4.57)
		mp_rtl	1.20 (5.87)
		mp_sp	-5.06 (-7.71)
		s_st	-.0002 (-1.20)
	opc	constant	4.80 (8.96)
		trend	.0046 (4.52)
		mp_rtl	3.14 (5.91)

Table 3 cntd ...

Center	Dep_var	Explanatory variables	Coefficients (t-ratios)
		mp_sp	-13.27 (-7.77)
		d_vol	.0004 (.06)
Chandigarh	aic	constant	.848 (2.8)
		trend	-.004 (-4.13)
		mp_rtl	.506 (1.57)
		mp_sp	1.22 (1.39)
		pt_p	.00004 (.0337)
		d_spread	.0013 (1.09)
	ihc	constant	.605 (5.06)
		trend	-.0015 (-4.07)
		mp_rtl	.207 (1.60)
		mp_sp	.499 (1.41)
		s_st	.0002 (.788)
	opc	constant	.157 (.77)
		trend	-.01 (-4.14)
		mp_rtl	1.33 (1.58)
		mp_sp	3.13 (1.36)
		d_vol	.004 (2.05)
Cuttack	aic	constant	1.08 (6.43)
		trend	.0034 (8.88)
		mp_rtl	.478 (2.83)

Table 3 cntd ...

Center	Dep_var	Explanatory variables	Coefficients (t-ratios)
		mp_sp	-2.15 (-4.09)
		pt_p	.002 (.883)
		d_spread	-.002 (-.88)
	ihc	constant	2.56 (5.91)
		trend	.008 (8.93)
		mp_rtl	1.24 (2.86)
		mp_sp	-5.55 (-4.09)
		s_st	.0001 (.016)
	opc	constant	.462 (6.92)
		trend	.0013 (8.89)
		mp_rtl	.1943 (2.90)
		mp_sp	-.858 (-4.11)
		d_vol	-.001 (-.667)
Kanpur	aic	constant	1.30 (11.75)
		trend	.001 (1.52)
		mp_rtl	.546 (5.12)
		mp_sp	-1.82 (-5.82)
		pt_p	.0001 (-.04)
		d_spread	.002 (1.25)
	ihc	constant	2.52 (9.02)
		trend	.001 (1.45)

Table 3 cntd ...

Center	Dep_var	Explanatory variables	Coefficients (t-ratios)
		mp_rtl	1.38 (5.16)
		mp_sp	-4.57 (-5.80)
		s_st	.002 (-.86)
	opc	constant	4.23 (5.90)
		trend	.003 (1.42)
		mp_rtl	3.60 (5.18)
		mp_sp	-11.96 (-5.85)
		d_vol	.001 (1.30)
Lucknow	aic	constant	1.88 (4.70)
		trend	.012 (8.80)
		mp_rtl	3.36 (6.34)
		mp_sp	-4.61 (-3.81)
		pt_p	.0012 (.7133)
		d_spread	.02 (.474)
	ihc	constant	1.33 (8.67)
		trend	.0045 (8.86)
		mp_rtl	1.28 (6.30)
		mp_sp	-1.75 (-3.85)
		s_st	.0001 (-.63)
	opc	constant	.74 (12.1)
		trend	.0018 (8.87)

Table 3 cntd ...

Center	Dep_var	Explanatory variables	Coefficients (t-ratios)
		mp_rtl	.523 (6.43)
		mp_sp	-.703 (-3.86)
		d_vol	.0003 (.5)
Ludhiana	aic	constant	1.16 (10.54)
		trend	-.0015 (-6.66)
		mp_rtl	.519 (4.28)
		mp_sp	-2.37 (-6.27)
		pt_p	-.0003 (-.28)
		d_spread	.001 (-.91)
	ihc	constant	2.42 (8.89)
		trend	-.38 (-6.67)
		mp_rtl	1.31 (4.34)
		mp_sp	-5.87 (-6.24)
		s_st	-.0003 (-1.12)
	opc	constant	4.92 (6.97)
		trend	-.009 (-6.67)
		mp_rtl	3.37 (4.32)
		mp_sp	-15.3 (-6.27)
		d_vol	.01 (1.02)
Patna	aic	constant	.871 (12.79)
		trend	.002 (4.38)

Table 3 cntd …

Center	Dep_var	Explanatory variables	Coefficients (t-ratios)
		mp_rtl	.819 (4.40)
		mp_sp	-2.43 (-4.49)
		pt_p	-.001 (-.49)
		d_spread	-.003 (-1.39)
	ihc	constant	1.58 (9.26)
		trend	.004 (4.35)
		mp_rtl	2.13 (4.43)
		mp_sp	-6.32 (-4.52)
		s_st	-.001 (-.97)
	opc	constant	2.28 (5.17)
		trend	.001 (4.32)
		mp_rtl	.322 (-4.45)
		mp_sp	-.962 (-4.45)
		d_vol	-.0001 (-.19)
Shimla	aic	constant	.537 (8.23)
		trend	.001 (4.38)
		mp_rtl	.35 (5.09)
		mp_sp	-.786 (-3.6)
		pt_p	-.0001 (-.08)
		d_spread	.001 (.60)
	ihc	constant	1.10 (6.77)

Table 3 cntd ...

Center	Dep_var	Explanatory variables	Coefficients (t-ratios)
		trend	.002 (4.36)
		mp_rtl	.881 (5.15)
		mp_sp	-1.90 (-3.51)
		s_st	.0001 (.72)
	opc	constant	.01 (4.41)
		trend	.004 (4.41)
		mp_rtl	2.31 (5.22)
		mp_sp	-4.95 (-3.52)
		d_vol	.0026 (.94)
Vijayawada	aic	constant	1.93 (8.98)
		trend	.003 (6.10)
		mp_rtl	.982 (5.67)
		mp_sp	-4.82 (-7.30)
		pt_p	-.00001 (-1.04)
		d_spread	-.01 (-2.17)
	ihc	constant	4.75 (8.50)
		trend	.01 (6.13)
		mp_rtl	2.51 (5.57)
		mp_sp	-12.42 (-7.23)
		s_st	-.001 (-1.22)
	opc	constant	.7959 (9.17)

Table 3 cntd ...

Center	Dep_var	Explanatory variables	Coefficients (t-ratios)
		Trend	.001 (6.08)
		mp_rtl	.382 (5.47)
		mp_sp	-1.91 (-7.16)
		d_vol	-.0003 (-.51)