Dynamics of Wheat Market Integration
in Northern Punjab, Pakistan

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1. INTRODUCTION

The economy of Pakistan is largely dependent on the agriculture sector which contributes about 21 percent to the GDP and employs about 43.4 percent of the labour force. Agriculture and agro-based industrial products contribute about three fourth of the total foreign exchange earnings from export [Pakistan (2007)]. About 66 percent of the population lives in rural areas of Pakistan and directly or indirectly depends on agriculture for its livelihood. The welfare and participation of the rural population in the economy is therefore, central to the country's progress. Despite the importance of agricultural sector in the national economy, there is a wide gap between food supply and demand due to low performance of agriculture [FAO (2000)].

The country is not producing enough commodities like wheat, rice and edible oil etc. to meet even the basic food needs of the population and as a consequence poverty is on the rise, particularly in the rural areas. In order to reduce poverty, agriculture has to grow faster and at a sustainable basis.

The growth of agriculture is influenced by three major factors which are greater use of inputs, increase in total factor productivity and institutional changes. The potential of growth in agriculture through greater use of inputs is limited mainly because of deteriorating land and water resources. Therefore, there is a need to conserve these two basic resources of production [Ahmad (2003)]. The major drivers of total factor productivity (TFP) are research and development, provision of infrastructure like roads, electricity, education and extension and agriculture credit [Iqbal (1989)]. The provision of these factors in rural areas is also deteriorating since early 1990s due to financial constraints. The strong institutional set up can improve the functioning of input and output markets as well as these drivers of TFP growth.

The input markets are related to improved seeds, fertiliser, pesticides, irrigation and mechanical power etc. while output markets are classified as the agricultural commodity markets, the efficiency of which is a prerequisite for sustained agricultural development. The efficiency of the farm sector depends not just only on farm production

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costs and yields, but also equally on marketing opportunities and rate of return to the farmers [FAO (2000)]. It influences well-being of both the producers and the consumers. The producer's (farmers) wellbeing is affected through prices they receive for their product and consumer's wellbeing is affected via prices they pay for agricultural commodities. Therefore, the nature of markets, working capabilities and their role in price determination is central for the allocation of resources and thus the resource productivity [Sexton (1991)]. A well integrated market system is the key to an efficient allocation of productive resources and results in stable and just prices which reduce risk and uncertainty and encourages investment in new technology in agriculture leading to rapid growth of the sector [Qureshi (1974); Dagher, *et al.* (1991); Kurosaki (1996); Ahmad (2003)].

The markets which are not integrated may convey inaccurate price informations that might distort production and marketing decisions of the producers and results in misallocation of resources [Bale (1981); Timmer (986); Goodwin (1991); Baulch (1997)]. According to Sexton (1991), spatial price behaviour is an important indicator of overall market performance which would be more beneficial when agricultural markets are well integrated. In addition, farmers can have good bargaining power to negotiate for better price in this situation [Dagher, *et al.* (1991)]. It has been noted that well integrated markets provide risk less profit opportunities for spatial traders and better bargaining power to negotiate better price for their produce [Baulch (1997); Goodwin (2001)]. In case markets are well integrated, government can stabilise price in one market and rely on arbitrage to produce similar outcome in other distinct markets reducing the cost of stabilising. Moreover with market integration, price signals and informations are fully transmitted among the markets and to the growers and form a base of important policy implications [Basu (2006)].

One of the major factors affecting the efficiency of resource allocation is how strongly the markets are integrated. The latter is a situation in which prices of commodities move together and the extent to which a price change in one market is transferred to another [Harris (1979); Monke (1984); Goodwin (1991); Dahlgran (1992)].[1]

There are different levels of agricultural markets. The participation of farmers at a particular market-level depends on the marketable surplus he holds after retaining wheat for their domestic consumption, feed, seed and labour charges for the force working in their fields. The marketable surplus of wheat passes through different channels before going to end consumers in the form of grain or flour which are shown in the following Figure 1.

The increase in farm productivity is likely to alter the environment within which an exchange between the farmers and the traders take place at different market levels. In this way, these markets can be divided mainly in to three kinds; village markets, primary wholesale markets and terminal markets.

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[1]Findlay (2001) appraised this situation as "price convergence is the best measure of market integration". Ravallion (1986), McNew (1996) and Baulch (1997) consider market integration a situation in which trade occurs between two markets and there is an arbitrage condition in presence of the transaction cost. Gonzalez (2001) was of the view that market integration some how relates to the flow of goods and informations across space, time and form.

Fig. 1. Marketing Channels of Wheat in Pakistan
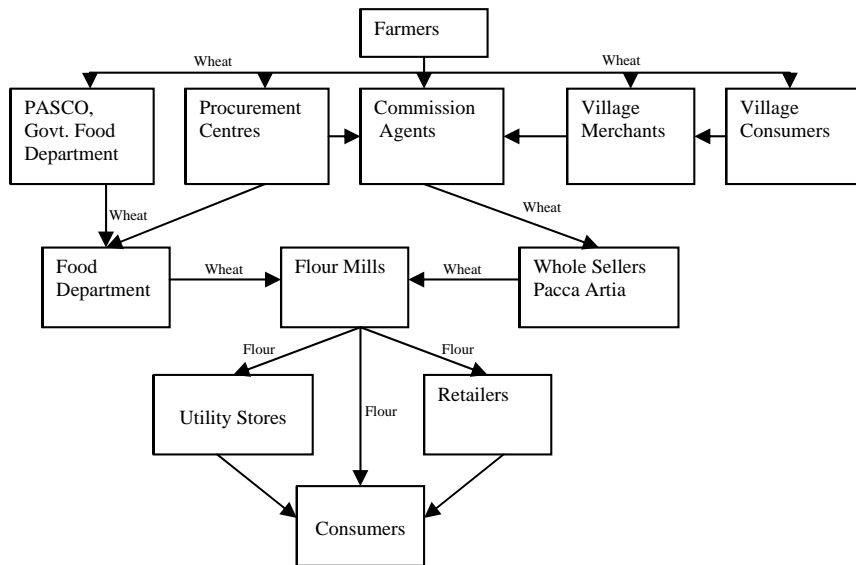
The village markets are situated close to farm gate and in some cases at some specified places where farmers and local traders called 'beoparis' meet regularly to bargain. The 'beoparis' usually purchase the produce from the farmers directly from these markets and sell it city markets to get some profit. According to an estimate about 50 percent of the surplus is sold in these markets [Kurosaki (1996)]. Cheating of farmers occurs in these markets by excessive deduction on account of impurities and under weighing etc. However, due to increase in transport facilities, these markets are loosing their importance in these days.

Primary wholesale markets which are entirely different from village markets usually located in district towns and are the main assembly points for the marketable surplus from the nearby areas. Commodity brought here by farmers and village 'beoparis' traders is sold to others through commission agents called 'arhti'-middlemen who is a wholesaler as well as an agent of traders from other markets and buys most of the product brought there. These markets are situated in city areas and have modern facilities such as phone, fax and transport. Market Committee controls the functions of these markets and keeps the record. The farmers get better prices here than village markets as prices are somewhat competitive here.

The third kind of markets is terminal markets, which are situated in large urban/economic centres like Karachi, Quetta and Rawalpindi. The marketable surplus which is not absorbed by village or primary markets is traded at the terminal markets. Wholesalers (pacca arhti) work in these markets and supply food grains to millers and to retailers as well. The traders in these markets buy directly from other markets through their agents. Most of these markets are well equipped with modern facilities and some of them are interlinked internationally.

In addition to these three main marketing systems, other practice is done by extremely small farmers, having very small income. These farmers get commodities for their daily use (including grocery items) in advance from the village shopkeepers. Major

portion of their harvest go to these shopkeepers in exchange at the time of harvest. As a result, the small farmers are being black mailed and not given full price of their produce. In some other cases, small vendors exchange their goods with agriculture produce in the villages on barter system. They exchange fruits, vegetables and other small items of daily use with grain; the latter valued at a very nominal price.

Presently, the agriculture markets in Pakistan are rather complex. These problems are likely to become more complex, because of a tremendous increase in urban population and in per capita income which will tend to increase the demand for food in general and for quality food in particular. Wheat is one of the main parts of food, having contribution of 14.4 percent to value added in agriculture and 3 percent to GDP of Pakistan with a strong politic-socio-economic importance in society of Pakistan. Punjab plays an important role as 82 percent of total wheat grown in Pakistan is produced here and 76 percent of the total area of Pakistan is under cultivation of wheat in Punjab which needs a comprehensive study to increase wheat productivity where as only a few studies have been carried out to test the market efficiency including Qureshi (1974), Muhammad (1977), Cornelisse (1984) and Tahir and Riaz (1997).

The present study fills the gap by analysing the performance of wheat markets in Punjab using monthly data for the period from 1980 to 2006. Therefore, the specific objective of this paper is to analyse wheat market integration in the long-run in Punjab, Pakistan and to suggest some policy implications.

Following Ravallion (1986) concept of "Radial Configuration" as presented in Figure 2, we selected Lahore as the central market and Gujranwala, Sialkot, Gujrat, Faisalabad and Sargodha as feeder markets for testing market integration. All of these markets of different sizes lie in wheat growing areas of Punjab having sufficient surplus wheat which is being transported as the time of shortage into other markets. Lahore is selected as the central market being the biggest city of Punjab, having 80 percent of its population in the urban area forming the largest consumption centre, while the other cities comprise mainly on rural population releasing reasonable wheat surplus for Lahore.

Fig. 2. Radial Configuration of Wheat Markets
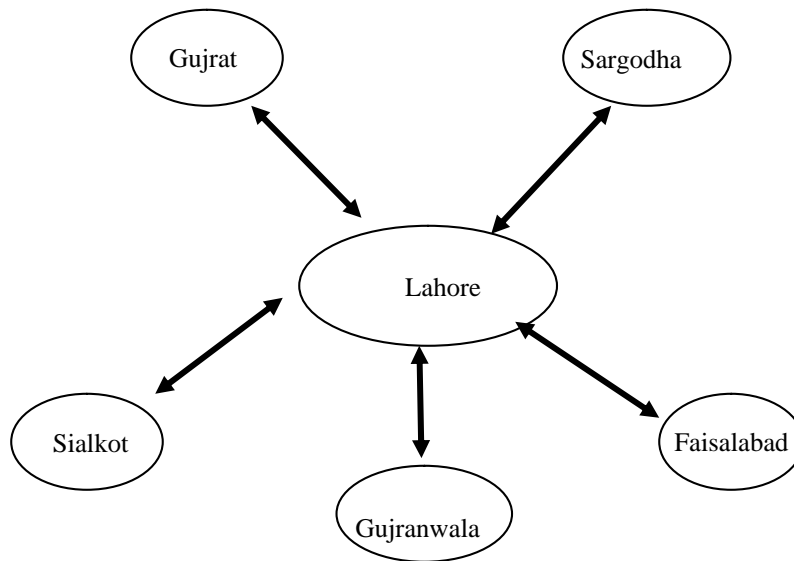
The paper is organised as follows. Methodology has been explained in Section 2. Next Section 3 examines whether different wheat markets are efficient. Section 4 offers conclusion as well as policy implications.

2. METHODOLOGY

The earlier studies used static techniques for analyses such as correlation and regression for measuring spatial market integration where bivariate correlation or regression coefficients are estimated between the time series of the spot prices for identical goods or bundles of goods at different markets [Lele (1971)]. These techniques are criticised and rejected due to their static nature and inferences drawn from correlation coefficients and regression coefficient are not robust since these methodologies do not explore the time series properties of the data as the time series of prices could be affected by the shared dynamic seasonal pattern or the price of the third commodity traded in the co-market. Therefore, there was a possibility of obtaining high correlation/regression coefficient close to unity leading to market integration even if the markets were isolated [Tahir and Raiz (1997)]. To overcome the earlier problems, Ravallion (1986) developed a dynamic model introducing the concept of a reference market serving as a "hub" which is a dominant market in a radial structure of surrounding markets, so called feeder markets assuming that a price shock originated in one market could effect the other market with a lag and thus bringing dynamism in the system instead of sticky type of situation [Tahir and Riaz (1997)]. In addition, this method allows us to control seasonality and to capture some more informations from the same data which was used in traditional models [Tahir and Raiz (1997)]. Although Ravallion (1986) model captures dynamism of the system and provides an improved technique to researchers, yet this methodology faces many short comings. This model measures the long run market integration, but the short run dynamics is absent here [Sexton, *et al.* (1991)]. In addition, the problem of multicollinearity exists there and the estimates are also insufficient to measure market integration by this method [Ravallion (1986); Basu (2006)]. This dynasim in the system is captured by latest technologies called co-integration techniques introduced during 1980s which covers a lot of deficiencies of previous methods and also measure market integration [Baluch (1997); Asche, *et al.* (1999); Dawson and Dey (2002)]. Many other researchers like Ardeni (1989), Goodwin and Schroeder (1991), Faminow and Benson (1990), Sexton, *et al.* (1991), Baffes (1991), Dahlgram and Blank (1992), Palaskas and Harris-White (1993), Alexander and Wyeth (1994), Dercon (1995), Moosa and Razzak (1995), Muwanga (1997), Asche, *et al.* (1999), Laping (2001), Goodwin and Nicholas (2001), Narayan, *et al.* (2004), Sharif, *et al.* (2005) and Basu (2006) have used this technique for the analysis of market integration.

Among different co-integration techniques, Engle and Granger (1987) technique is useful and suitable test for market integration within two time series of data [Goodwin and Ted (1989)]. This is a two-step residual based test involving estimation of the co-integration regression between one central (exogenous) and some feeding (endogenous) market

[Laping (2001); Basu (2006)]. If individual price series are found non-stationary[2] after testing by unit root test, the first step is to estimate OLS regression of first I(1) price series say P_t^1, on the second I(1) price series say P_t^2 plus error term by the following model:

$$P_t^1 = a + bP_t^2 + \varepsilon_t \quad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (1)$$

Where P_t^1 and P_t^2 are prices of a commodity in first and second market respectively at time t, ε_t is residual [Baffes (1991)]. If the value of slope coefficient 'b' in the above equation one is 1, the markets are perfectly integrated and any price shock originated at one market is fully transmitted to the other market. But in case the slope coefficient is less than 1, the markets are partially integrated. The second step involves testing of ε_t from co-integration regression whether it is stationary using ADF test proposed by Engle and Granger (1987) by estimating from the following equation.

$$\Delta\varepsilon_t = \lambda\varepsilon_{t-1} + \sum_{k=2}^{n} \phi_k \Delta\varepsilon_{t-k} + \mu_t \quad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (2)$$

Where $\Delta \varepsilon_t = \varepsilon_t - \varepsilon_{t-1}$ and μ_t is the usual error term. If the calculated t value of λ is less than the critical value provided by Engle and Granger (1987), the null hypothesis is rejected and two series are said to be co-integrated which implies that two markets are integrated.

Monthly time series data from 1980-2006 published by the Federal Bureau of Statistics and Provincial Agriculture Department Lahore is used to get long run results of market integration.

3. EMPIRICAL RESULTS OF MARKET INTEGRATION

We investigate graphically the relationship between the wheat price series of Lahore and other five markets (Figures 1–5, Appendix 1). As can be seen from the figures all the pairs of series are closely moving together with increasing trend.

Unit Root Test

Unit root tests developed by Dickey and Fuller (1979, 1981) is applied to investigate the presence of a unit root in individual price series to diagnose whether the series are non-stationary which is a pre-requisite to use Engle and Granger test [Engle and Yoo (1987); Goodwin and Ted (1991)]. All the wheat price series of individual markets are used in log form for this purpose. We compare the ADF t-statistics with values of Mac Kinnon (1991). Results of unit root test at level and at first difference are shown in Table 1.

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[2]Test for non-stationary of price series are applied by using unit root test. To understand this test let us consider simple univariate model as $P_t = \alpha P_{t-1} + \varepsilon_t$ where P_t is a price series and ε_t is usual error term. The α is parameter to be estimated. If estimated a is less than one, the price series is stationary. And in case α is greater than one, the price series is said to be explosive but in case a is equal to one, the price series is said to be non-stationery (difference stationery, Random walk) means that the mean, variance and covariance of the series are not independent of time and there is a presence of unit root in that series which can change the long run trend of the process equal to unity. In the terminology of Engle and Granger (1987), a time series which is stationary after taking difference first time is denoted by I (1) have a unit root while I(0) is called stationary at level.

Table 1

Unit Root at Level and at First Difference

Variables	ADF Stat. at Levels	ADF Stat. at First Difference	Result
Lahore (l)	–2.64	–5.56	I(1)
Faisalabad (f)	–2.75	–5.45	I(1)
Gujrat (gt)	–2.38	–4.92	I(1)
Gujranwala(gu)	–1.98	–5.36	I(1)
Sialkot (st)	–2.63	–5.33	I(1)
Sargodha(sg)	–2.60	–5.80	I(1)

[Critical value; –3.42 and –2.87].

The Augmented Dickey Fuller (ADF) statistics at levels of prices in wheat markets at Lahore, Gujranwala, Faisalabad, Gujrat, Sialkot and Sargodha do not exceed the critical values of –3.42 at 5 percent significance level. However, after taking first difference of each of the variable, the ADF statistics of these variables are higher that the critical values. Therefore, we conclude that the price series in each of the wheat markets under study are non-stationary i.e. integrated of order one i.e. I(1).

Testing of Long-run Marketing Integration

We estimate the long-run relationship between prices of different wheat markets including Lahore (L), as central market and five other markets namely Faisalabad (F), Sargodha (Sg), Sialkot (St), Gujranwala (Gu), and Gujrat (Gt) as feeder markets. There are five different pair-wise relationships indicating the combination of Lahore-Faisalabad (L-F), Lahore-Sargodha (L-Sg), Lahore-Gujrat (L-Gt), Lahore-Sialkot (L-St) and Lahore-Gujranwala (L-Gu). The results of analysis between Lahore and five surrounding markets are shown in Table 2.

Table 2

Co-integration Analysis of Central with Five Feeder Markets

Sr. No.	Variables	Intercept	Coefficient	ADF-stats	Adjusted R^2	S.E.
1	L-F	0.09	0.99	–4.261	0.996	0.044
		(0.44)	(0.00)			
2	L-Gu	0.156	0.93	–3.818	0.99	0.044
		(0.176)	(0.00)			
3	L-Sg	0.72	0.83	–4.262	0.996	0.044
		(0.00)	(0.00)			
4	L-Gt	0.83	0.77	–4.57	0.99	0.046
		(0.00)	(0.00)			
5	L-St	0.69	0.82	–3.62	0.99	0.057
		(0.00)	(0.00)			

[Critical Values; (3.8; 1 percent), (3.5; 5 percent), (3.37; 10 percent)].

Test for Co-integration

The ADF statistics for all pairs of markets as shown in Table 2 confirms that there exists co-integration between these as the null hypothesis of unit root on the residuals for these pairs is rejected easily. It means that there is co-movement (integration) between all pairs of markets and now we can test the degree of market integration between the market pairs one by one.

Lahore-Faisalabad (L-F)

Analysis of market integration indicates that the slop coefficient of wheat markets of Lahore and Faisalabad is almost 1 which implies that there is a perfect market integration between these two markets. LOP also exists. It also imply that Law of One Price also exist between them indicating that any price shock originated at Lahore market is fully reflected at Faisalabad market. The reason behind this is that Lahore which is the biggest consumption centre in the area is well connected to Faisalabad by road and rail. A lot of passengers are travelling daily between these two cities for their daily business and jobs and thus have close economic and cultural similarities in addition to a lot of information flows between these two cities.

Lahore-Gujranwala (L-Gu)

It is clear from the results shown Table 2 that slope coefficient is equal to 1, indicating perfect market integration between these two markets. The reason for this result is that Gujranwala is located only 35 miles from Lahore on G.T. Road and became almost a part of Lahore and a lot of people go to Lahore and come back to Gujranwala after their daily business causing a good flow of informations and similar social environment. In addition both the markets are also well connected with each other with road and rail and surplus wheat from Gujranwala is easily transported to Lahore at the time of need in Lahore.

Lahore-Sargodha (L-Sg)

Result of market integration between Lahore and Sargodha indicates that there is no indication of perfect market integration as the value of slope coefficient is less than 1. So, both the markets are partially integrated to the extent of 83 percent as Sargodha is connected to Lahore by road having 135 miles. Surplus wheat from Sargodha is sent to other near market like Faisalabad than to Lahore due to long distance and more transportation cost. In addition, price information from Lahore cannot be fully transmitted to Sargodha due to long distance and different socioeconomic conditions of both the cities.

Lahore-Gujrat (L-Gt)

Looking at the results in Table 2 it emerges that slope coefficient is less than 1 showing no indication of perfect market integration rather the markets are partially integrated to the extent of 77 percent. Insignificance of intercept term indicates no role of transaction cost between the markets. However, there are other factors that may be important for partial market integration. Gujrat is situated on GT road to the north of

Lahore at a distance of 70 miles and Gujranwala lies between Lahore and Gujrat on G.T. Road may dilute the effect of any price shock originated from Lahore market to Gujrat market. It may also be possible that Gujrat may support the other big market of Punjab like Rawalpindi instead of Lahore which may have more impact on the agriculture market of Gujrat. In addition, Gujrat is in rice growing belt and it may not be able to produce surplus wheat to be sent to Lahore.

Lahore-Sialkot (L-St)

It is revealed that both the markets are partially integrated to the extent of 82 percent because the value of slope coefficient is less than 1. The reason for this result may be that Lahore is not directly linked with Sialkot but via Gujranwala which is on GT road, while Sialkot is off GT road at a distance of 70 miles from Lahore and 30 miles from Gujranwala. The other reason may be because its economy is not mainly based on agriculture but on export of surgical instruments and sports goods and it also lies in the rice growing area thus producing less wheat surplus. The situation here is very much similar to as in the case of Lahore and Gujrat.

4. CONCLUSION

Spatial market integration is tested in different wheat markets in Northern Punjab which are spatially segregated from each other. We find that all these price series are non-stationary by applying Unit root test for each market. The Engle and Granger test of co-integration is applied to analyse long-run market integration between the central market of Lahore and 5 feeder markets namely Faisalabad, Sargodha, Gujrat, Gujranwala and Sialkot. It emerges from the analyses that the market pairs of Lahore-Faisalabad and Lahore-Gujranwala are perfectly integrated with each other in the long run because of direct and better road and rail link and common socio-economic culture. In addition, a lot of people of these localities travel daily between these centers forming better flow of information. This strong relationship between these markets also exist because most of the trade takes place within these markets realising Lahore having pivotal role being the biggest consumption centre of the area. The pairs of Lahore-Sargodha, Lahore-Gujrat, and Lahore-Sialkot markets are partially integrated having some what a long distance and different socioeconomic conditions between them and lesser information flow. These pairs of markets do not have any direct road and rail link for transporting the commodities. The present study reveals that government should develop infrastructure, especially roads and rails and improve flow of informations. In addition expansion and construction of transportation system is accorded priority.

Zahid, Qayyum, and Malik

APPENDIX 1

Fig. 1. Wheat Prices at Lahore and Faisalabad
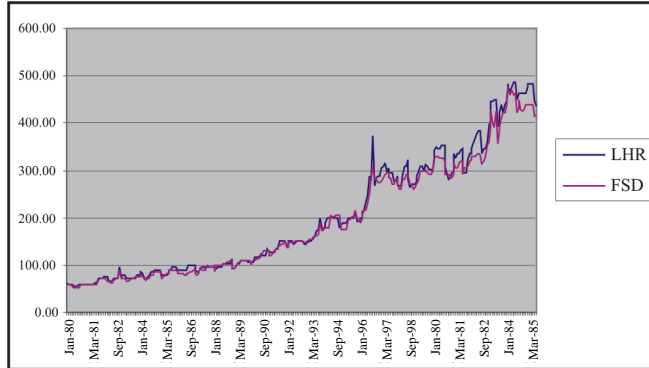

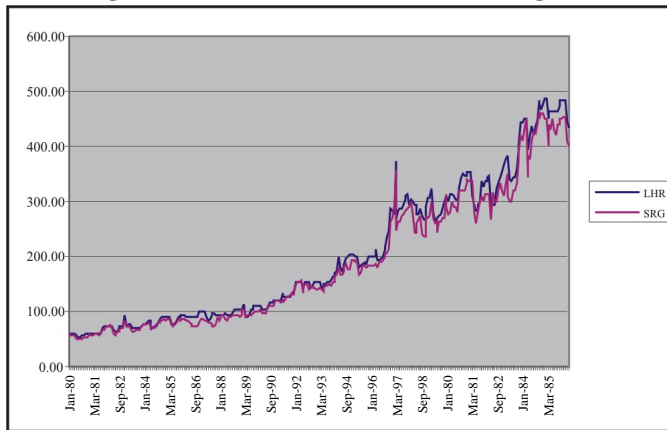**Fig. 2. Wheat Prices at Lahore and Sargodha**

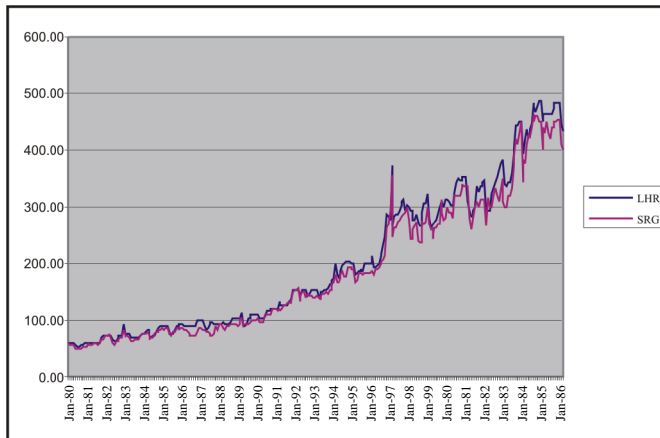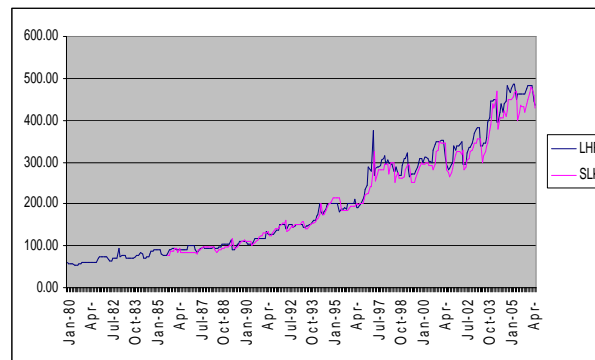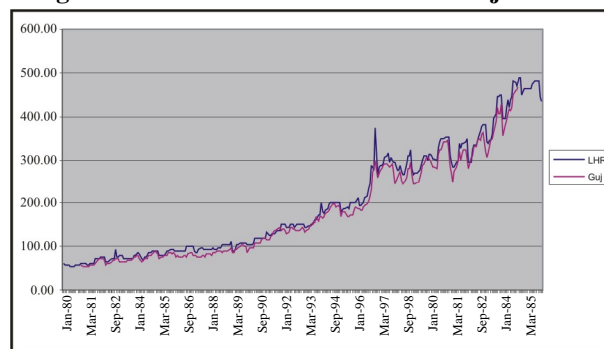**Fig. 3. Wheat Prices at Lahore and Gujrat**

Fig. 4.   Wheat Prices at Lahore and Sialkot

Fig. 5. Wheat   Prices at Lahore and Gujranwala

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Comments

(1) The study has used long-term historical data. But the integration we study is not for the long run (in the future). Revising of the title of the paper is suggested.

(2) The discussion of the integration is focused on the distance, but recommendation come on the infrastructure.

(3) I suggest to discuss the market integration on the basis of decision variables instead of the geographic variables that we can not change.

(4) The paper can be revised before publication, taking into account the marketing information system, relationships and communication among the traders, number of middlemen, and market efficiency.

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