INTEGRATION OF AGRICULTURAL COMMODITY MARKETS IN THE SOUTH PUNJAB, PAKISTAN

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Table of Contents

List of Maps

List of Tables

Glossary

Basmati	A long-grain rice of South Asian origin.
Beopari.	Mobile brokers (purchase commodities in villages and Sell them in the markets).
Commission agents	Permanent brokers of agriculture commodity markets.
Command area of canal	Area irrigated below the canal headworks.
Distributary	A water channel in which tertiary watercourse outlets are located.
KCA	Karachi Cotton Association.
Kharif	Summer time, warm-wet season, officially from mid-April to mid-October.
Mandi	Agricultural commodity market.
Minor	Small water channel, normally off-takes from a distributary.
Notified area of market	Official catchment area of a market.
OLS	Ordinary Least Square (regression method).
PASSCO	Pakistan Agriculture Storage and Supply Corporation.
Rabi	Winter time, cool-dry season, officially from mid-October to mid-April.
Sangli	Cotton waste, pieces of cotton boll shell and leaves, etc. normally picked with cotton during picking.
Tehsil	A sub-divisional administrative zone under a District Administration.
Zila Bandi	Restriction on the movement of agriculture commodities from one district to another (*Zila*=District and *Bandi*=Ban).

Abstract

The agriculture sector has a vital role in the economy of Pakistan. Agricultural productivity, however, remains low and is threatened by environmental degradation and deterioration of the irrigation infrastructure. Various measures have been developed and implemented to mitigate these problems and to make efficient use of available water supplies, including infrastructure development such as large drainage systems to reclaim waterlogged and saline land, or modifications in the institutional framework that promote the transfer of part of the irrigation system to water user groups.

The rationale behind the present study on commodity market integration is that increases in agriculture production that is expected as a result of the implementation of these measures do not always lead to higher farm incomes and to improvements in the economic well being of farmers. Specific market-related conditions are required for producers to take full advantage of production-enhancing interventions in the irrigation sector.

Farmers' income depends upon the price of their produce. And the behavior of prices is related to supply and demand conditions directly dependent on the level of market integration with the rest of the economy and larger markets. If a local market is segmented from other markets of the economy, any significant increase in the production of a specific commodity would depress the local market price. On the other hand, if the local market is well integrated with other markets of the country, any increase in the supply of a commodity will be partly transferred to other markets and price would not be depressed.

The present study analyses market integration using a model developed by Ravallion (1986). The geographic scope of the study is limited to areas of the South-Punjab. The study area is located off the main trade axis of the country i.e. the Lahore-Karachi highway and most of the agriculture commodity markets are small markets or *mandies*. Five local markets have been selected and the level of market integration is investigated for each market for the three main crops grown in the area, i.e. cotton, wheat and rice. Price data used in the study was collected from Market Committee Offices for the period January 1993 to December 1995. A model with a set of hypothesis is used to test the degree of market integration. This model offers the possibility to test for market segmentation and integration (short-tun and long-run).

The results shows that in the case of cotton and wheat, most of the markets are integrated in the long-run with the two large markets of Karachi and Multan, respectively. This stresses the fact that: (i) local markets are not isolated from large markets of the country; (ii) price shocks in the large markets do not transmit to local markets instantly and some time is required for the transmission of the price signal. For rice, some markets have been found segmented from the main markets. The low turn-over of rice in the markets considered in the analysis may be the main factor explaining this result.

Acknowledgments

Introduction

Agriculture is an important sector of Pakistan's economy, which provides livelihood to 70% of the population, contributes 23% of the gross national product (GNP) and 90% of the merchandize exports. Nearly 80% of the cultivated land in Pakistan is irrigated. Such a high ratio of irrigated area to total cultivated area is the result of the large investments in infrastructure that have been made for more than one century[1] in the irrigation sector.

Over time, the physical infrastructure of the irrigation system has deteriorated. A number of environmental problems, such as salinity, sodicity and waterlogging, have also emerged (World Bank, 1994). The causes of these problems include the lack of system maintenance, poor irrigation management and an interplay of economic and technological forces that have resulted in increased cropping intensities and a concomitant increase in the number of private tubewells.

The continued increases in living standards of large segments of Pakistan's population depend on the productivity and sustainability of its irrigated agriculture. Therefore, the impending environmental and economic crises, worsened by increasing scarcity of water, have drawn a variety of responses from the government, the international donors and, most importantly, from farmers themselves.

The recent thrust of the international donors and the Government of Pakistan (GOP) has been on: (i) making large investments in the physical infrastructure that would check environmental degradation, such as those envisaged under the proposed National Drainage Program; and (ii) exploring new institutional alternatives such as decentralization of irrigation facilities or development of water markets, to provide more flexibility to farmers in dealing with water supply and environmental problems[2].

Farmers' responses to declining agricultural productivity due to environmental problems has mainly taken place at the farm level. This has often consisted of a judicious choice of crops or inputs (e.g. application of farm yard manure or amendments such as gypsum). The former strategy is common among farmers who do not have sufficient financial resources to buy the needed inputs. For example, farmers often adopt rotation of rice and salinity grass to reclaim saline fields (Kielen, 1996, pp.48-53).

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[1] The Indus Basin Irrigation System (IBIS) was originally developed by the colonial British administration and is now the largest contiguous irrigation system in the world with a total command area of around 14.5 million ha.

[2] The comparison, here, is with the century old rigid warabandi system under which water allocation to individual farmers is proportional to his land area. Sales and purchases of canal water turns were (and still are) prohibited under the Canal and Drainage Act of 1873.

All successful efforts to improve water supply performance, or arrest adverse environmental trends, have production impacts. For example, construction of drains may increase production by lowering salinity levels, which might bring some previously abandoned farm land back into cultivation or increase yields on land already under cultivation. Better irrigation management may improve delivery performance of the system which could, in turn, lead to increased production by ensuring that crops do not face water stress during critical growth periods. Finally, water markets may lead to a more efficient allocation of scarce water resources and thereby increase total agricultural output. Similarly, farmers adoption of a rice-salinity grass rotation may restore land productivity and increase farm output.

Although the link between better management of the irrigation system and increased agricultural production is recognized, it is important to stress that increased agricultural production does not always lead to higher farm incomes (and welfare), nor does the lure of higher farm production levels necessarily induce farmers to adopt reclamation measures (e.g. rice-salinity rotation). Certain conditions pertaining to the performance of the marketing system need to be fulfilled if the producers are to derive the full benefits from production enhancing measures.

Market Integration & Project Benefits

Consider, first, the link between production and farm incomes. Higher production levels translate into higher revenues only if prices do not change. Behavior of prices in response to regional agricultural production shocks (including those resulting from improved environmental conditions as a result of interventions in the irrigation system) depends on the level of integration of the regional market with markets in the rest of the economy. If goods and information can move easily between markets, and if there is a sufficiently large number of producers and sellers engaged in arbitrage so that monopolistic pricing is difficult, then markets tend to be well integrated. However, the degree of integration between any set of markets need to be determined empirically.

To illustrate the importance of market integration and the response of prices to changes in regional agricultural production, consider the following scenario. Suppose that, due to constraints on the movement of goods, a given regional market is isolated from other markets. Then, any production increase for a given product resulting from an improvement in water supplies to the area will have to be absorbed in the local market. Given local demand conditions, an increase in agricultural production would depress prices. In some cases, the reduction in prices may be such that farmers' revenue from sales may decline although their total production has increased.

On the other hand, if the local market is well integrated with the rest of the marketing system, a different outcome in terms of changes in revenue would be expected. Any downward movement of the local price would lead to arbitrage activities and shipments to other high-price markets, thus limiting significantly price declines in the local market. The increase in production would be absorbed by the economy-wide marketing system and not just by the market that experiences the

original production shock. This would usually result in only a small price change in the local market.

Most irrigation projects aim at raising the standard of living of the rural population by increasing farm incomes. The above discussion emphasizes that the share of project benefits received by the concerned rural population depend on how well markets for agricultural commodities are developed in the project area. Areas covered by irrigation projects in Pakistan tend to be large (see, for example, the Left-Bank Outfall Drain Project that covers around 500,000 ha). One would not expect to find a general isolation of markets in the entire area, but specific individual markets may not be well integrated. To identify these isolated markets, before launching any project aimed at increasing agricultural production, there is a necessity to develop accompanying measures that would ensure that farmers in these regions also reap the full benefits of the project. These measures could include setting up government procurement centers or investments in transport and communication infra-structure that would accompany interventions focused purely on the irrigation and drainage sector.

Market Integration and Farmer Incentives To Adopt Salinity Mitigation Strategies

The link between farmers reclamation strategies and market integration will now be considered. As mentioned earlier, possibilities of achieving higher farm production levels are not sufficient to induce farmers to adopt salinity mitigation strategies. Adoption of any particular strategy for reducing salinity/sodicity depend on its cost and benefits. Many farmers adopt a rice-salinity grass rotation to control salinity. This strategy is popular in many areas because the cost of increased irrigation due to leaching requirements is offset, wholly or partially, by revenues from sales of rice, a crop that requires standing water in the field for most of the crop growth cycle.

Clearly, farmers' incentives to use rice-salinity grass rotation for controlling salinity depends on the behavior of rice prices. If the local market is not well integrated, the rice price is determined by local demand conditions. In salinity affected areas of the South-Punjab, for example, rice is not the main staple food and its local demand is likely to be modest. Therefore, any increase in rice production, as more farmers switch to rice-salinity grass rotation, will depress prices and raise the cost (foregone benefits) of this strategy. Moreover, farmers in an isolated market may not benefit from a government price stabilization program that stabilizes rice prices in central markets only and relies on market integration for stabilization of prices in other markets.

However, if the rice market is well integrated with the rest of the marketing system, then any production increase would not cause a significant downward movement of the local rice price. For this reason, it is important to study integration of rice markets in areas where farmers are likely to incorporate rice in their cropping patterns for purpose of mitigating salinity. Improving the performance of such local markets will provide a favourable environment for farmers to implement specific reclamation practices. It must be emphasized that poorly integrated rice markets are likely

to be found in areas that are traditionally neither rice growing nor rice consuming areas. Many areas in the South-Punjab meet this criterion.

The two examples above have demonstrated the importance of market integration for irrigation and the need to identify markets that are poorly integrated. The present study aims at empirically determining the degree of integration of selected commodity markets in South-Punjab. More specifically, the study will assess the level of integration of local cotton, wheat and rice markets, and investigate factors that may explain different market behaviour among markets and among crops.

The next section presents the methodology developed for the analysis of market integration. This section is followed by a description of the area, markets and commodities selected for the present study. Information and data sources are then presented. The main results obtained with the application of the proposed model to the analysis of selected commodity markets in the South-Punjab are presented and discussed in the final section of this report. A short conclusion stresses the limitation of the developed methodology and directions for further research.

Methodology

Market integration has been traditionally studied using static price correlation. The studies using correlation coefficients to infer spatial integration of agriculture prices include Jasdanwala (1966), Cummings (1967), Lele (1971), Qureshi (1974), Muhammad (1977), Raju (1982) and Jhala (1984). However, there are inferential dangers in drawing conclusions from correlation coefficients or from regression coefficients estimated from static regressions. As Ravallion (1986) pointed out, even if transportation costs between two markets are prohibitive, the time series of their prices could be affected by a shared dynamic seasonal pattern, or the price of a third commodity traded in a common market. It would then be possible to obtain a high correlation coefficient or an estimated regression slope (from a static regression) close to unity. Thus, static correlation methods can lead to acceptance of the market integration hypothesis when, in fact, markets are isolated.

The inferential danger pointed out above can be avoided by incorporating dynamic considerations into the model. Ravallion (1986) proposed a model that controlled for seasonality by allowing the local price to have its own dynamic structure. The model also allowed inter-linkages with other markets through which price shocks could be transmitted to the local market. Apart from its statistical considerations, the most noteworthy feature of the Ravallion Model was that it allowed adjustments to price shocks to take place over time. This feature is very important because in real world markets price adjustments seldom take place instantaneously. In Ravallion's framework, it is possible to test short-run and long-run price integration. So, even when instantaneous integration is rejected, long run integration could still hold. The following paragraph presents the Ravallion Model in more detail.

Converting a static regression structure into a dynamic structure and recognizing the fact that ordinary least square estimates become biased and inconsistent when there are endogenous regressors, Ravallion introduced the concept of a *reference* market. In his framework, the reference market is a dominant market having a nucleus position. Ravallion describes this situation with the terms *Radial Market Structure* where the reference market is at the hub and the different feeder (local) markets are at the rim. The reference market dominates prices in the feeder markets. Every individual feeder market can be affected by the reference market price, but it cannot individually affect the reference market. In other words, the price of the reference market may be influenced by the various feeder (local) markets taken together, but no individual feeder market can influence the reference market price to an appreciable degree.

Normally, such dominant (reference) markets have high turnover so that supply and demand shocks originating in individual feeder markets are absorbed without significant effect on prices. Examples of such markets include large supply centers located in the middle of agricultural regions, large metropolitan demand centers, and port cities providing export/import linkages to the rest of the world.

Ravallion assumes that there are n local markets and the local prices in these markets (P2,....Pn) are dominated by one reference market price (P1). A model linking prices can be expressed as follow:

$$P_1 = f_1(P_2, P_3, ... P_n, X_1) \qquad 1$$

and

$$P_i = f_i(P_1, X_i) \qquad i = 2, ..., n \qquad 2$$

Equation 2 postulates that prices in the feeder (local) markets are a function of prices in the reference market(P1), where X is as the vector of the seasonal or the policy variables. The above formulation is the most suited to a radial market structure. The econometric form of Equations 1 and 2, (as suggested by the Ravallion) was,

$$P_{1t} = \sum_{j=1}^{l} a_{1j} P_{1t-j} + \sum_{k=2}^{n} \sum_{j=0}^{l} b^k{}_{1j} P_{kt-j} + c_1 X_{1t} + e_{1t} \qquad 3$$

and

$$P_{it} = \sum_{j=1}^{l} a_{ij} P_{it-j} + \sum_{j=0}^{l} b_{ij} P_{1t-j} + c_i X_{it} + e_{it} \qquad (i = 2,..,n) \qquad 4$$

Where k indicates markets, t represents time, and j represents time lags (expressed in the same unit as t).

Ravallion estimated Equation 4, acknowledging that in many circumstances Equation 3 will be under identified. Using the general model Equation 4, various hypothesis tests concerning market integration and their implied parametric restrictions can be developed. These tests are described below.

Market Segmentation

The first test concerns complete market segmentation. In Equation 4, if the market is segmented from the reference market, then:

$$b_{ij} = 0 \qquad\qquad 5$$

for all values of j. This assumption involves testing that coefficients of the current prices of the reference market, along with coefficients of all lag prices of the reference market, are individually equal to zero. If this assumption is accepted, then current and lagged prices of the reference market do not influence local market prices. In other words, the price formation process in the local market is independent of conditions in the reference market.

Short-Run Integration

Since adjustment to price shocks may take place over time, it is necessary to distinguished between short-run and long-run integration. Short-run integration takes place when:

$$b_{i0} = 1 \qquad\qquad 6$$

and

$$a_{ij} = b_{ij} = 0 \qquad j = (1,.....n) \qquad\qquad 7$$

If this hypothesis is accepted, then changes in the reference market prices are completely transmitted to the local market in a single time period. The fact that only coefficients of the current reference market prices are different from zero implies that shock transmittal is completed within one time period. The coefficient being equal to 1 implies that 100% of the shock is transmitted to the local market.

Long-Run Integration

Because agriculture markets are spatially separated, price changes in one market may take time to influence prices in another market. Ravallion (1986) proposed the following test of long-run market integration:

$$\Sigma a_{ij} + \Sigma b_{ij} = 1 \qquad\qquad 8$$

If the summation of all price variables in the equation is equal to 1, then the local market is integrated with the reference market in the long run. In other words, price shocks in the reference market take more than a single time period (due to inadequate infrastructure, etc.) and finally price shocks are observed in the local market.

Description of the Selected Markets

As discussed in the first section of this report, the geographic scope of the study has been limited to the South-Punjab (see Map 1), an area where the International Irrigation Management Institute (IIMI) is already undertaking research activities focused on improved irrigation management to mitigate salinity problems. The command area of irrigation canals off-taking from the Sulemanki Headworks has been selected as the study area. There are three main canals off-taking from the Sulemanki Headworks. The Pakpattan Canal runs along the right bank of the Sutlej River while the Eastern Sadiqia Canal and Fordwah Canal irrigate land on the left bank of the river.

On the left bank, there are seven small and medium commodity markets. Those are Bahawalnagar, Chishtian, Dungabunga, Haroonabad, Faqirwali, Fort Abbas and Hasilpur. Out of these markets, the Hasilpur market only is located in the Bahawalpur District, while other markets belong to the Bahawalnagar District (see Map 2 and 3). As a follow-up of initial discussions with commission agents, four representative markets were selected for the present study, i.e. **Bahawalnagar, Chishtian, Fort Abbas** and **Hasilpur**. For comparative purposes, the **Pakpattan** market along the Pakpattan canal was also selected. The expectation was that this market would behave differently as it is closer to the Grand Trunk Road that links the major cities and markets of the country. The main characteristics of the selected markets are presented below.

The Bahawalnagar Market

The Bahawalnagar market is located between the Eastern/Sadiqia Canal and Fordwah Canal. Because of its location, water is generally abundant in the *notified area* (area being administrated by the market committee[3] or official catchment area of a market) or *zone of influence* of the Bahawalnagar Market. Groundwater levels are also high in most of the area. The notified area of the Bahawalnagar Market is equal to the administrative area of the Bahawalnagar *Tehsil*[4], that is 1729 km^2 for 244 villages or *Mauzas*. Due to the good availability of canal water and high

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[3] For more information about the market committees, See Appendix A ; " Agriculture Marketing System in Pakistan".

[4] This is observed as being the same for all markets.

groundwater levels, significant areas are cultivated under rice (see Table 1). However, cotton and wheat remain the predominant crops.

The Chishtian Market

The Chishtian Market is located to the West of the Bahawalnagar Market. Roughly speaking, only half of the notified area of this market is agriculture land. The other half of the area forms the Eastern edge of the Cholistan Desert and is uncultivated. Canal water supply is supposed to be less reliable than for the notified area of the Bahawalnagar Market. The main crops cultivated in the area are also wheat and cotton, but the area under rice is much less significant than in the Bahawalnagar area. However, a significant percentage of the area is under sugarcane to supply the sugar mill that is under operation close to the city of Chishtian.

Table 1.   Main features of the selected markets (Source: Bureau of Statistics, Punjab).

Markets	Notified Area (Sq.Km)	Year Established	No. of Shops	Population 1981 Census	Population 1994 Estimated	Cultivated Cotton Area (1994)	Cultivated Rice Area (1994)	Cultivated Wheat Area Acres (1994-95)
Hasilpur	3,436	1940	72	197,000	322,000	92,286	6,302	91,966
Chishtian	1,500	1930	85	327,000	486,000	116,156	7,778	136,046
Bahawalnagar	1,729	1947	150	367,000	477,000	116,349	39,206	164,374
Fort Abbas	2,536	1982	112	195,000	344,000	69,882	-	96,299
Pakpattan	1,843	1926	98	442,000	729,000	98,233	57,571	213,896

The Hasilpur Market

The Hasilpur market is located West of the Chishtian Market. The distance between both markets is close to 30 km, but as specified above, both markets are not in the same district. The Hasilpur Market belongs to the Bahawalpur District, while the Chishtian Market belongs to the Bahawalnagar District. Some areas served by the Hasilpur Market are sandy with low groundwater table, while other areas have clay soils and salinity problems. Half of the area is located in the tail reaches of different distributaries and minors of the Fordwah Branch and Malik Branch canals, and thus receive limited canal water supplies. The main crops in the area are wheat and cotton, with rice being mainly used for reclamation of saline fields.

Map 1. Location of study area, South Punjab, Pakistan.
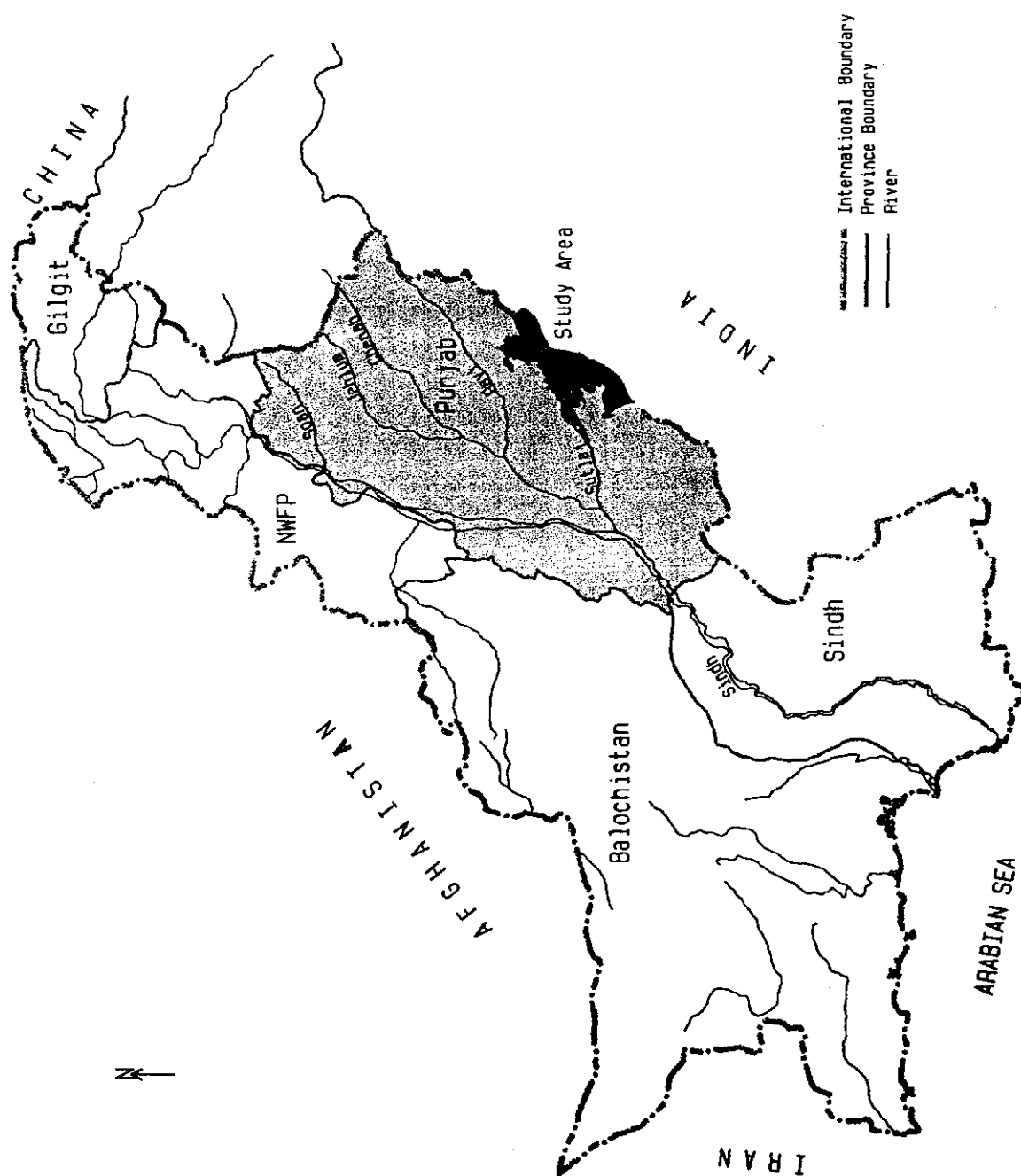
Map 2.   Notified area of selected markets.
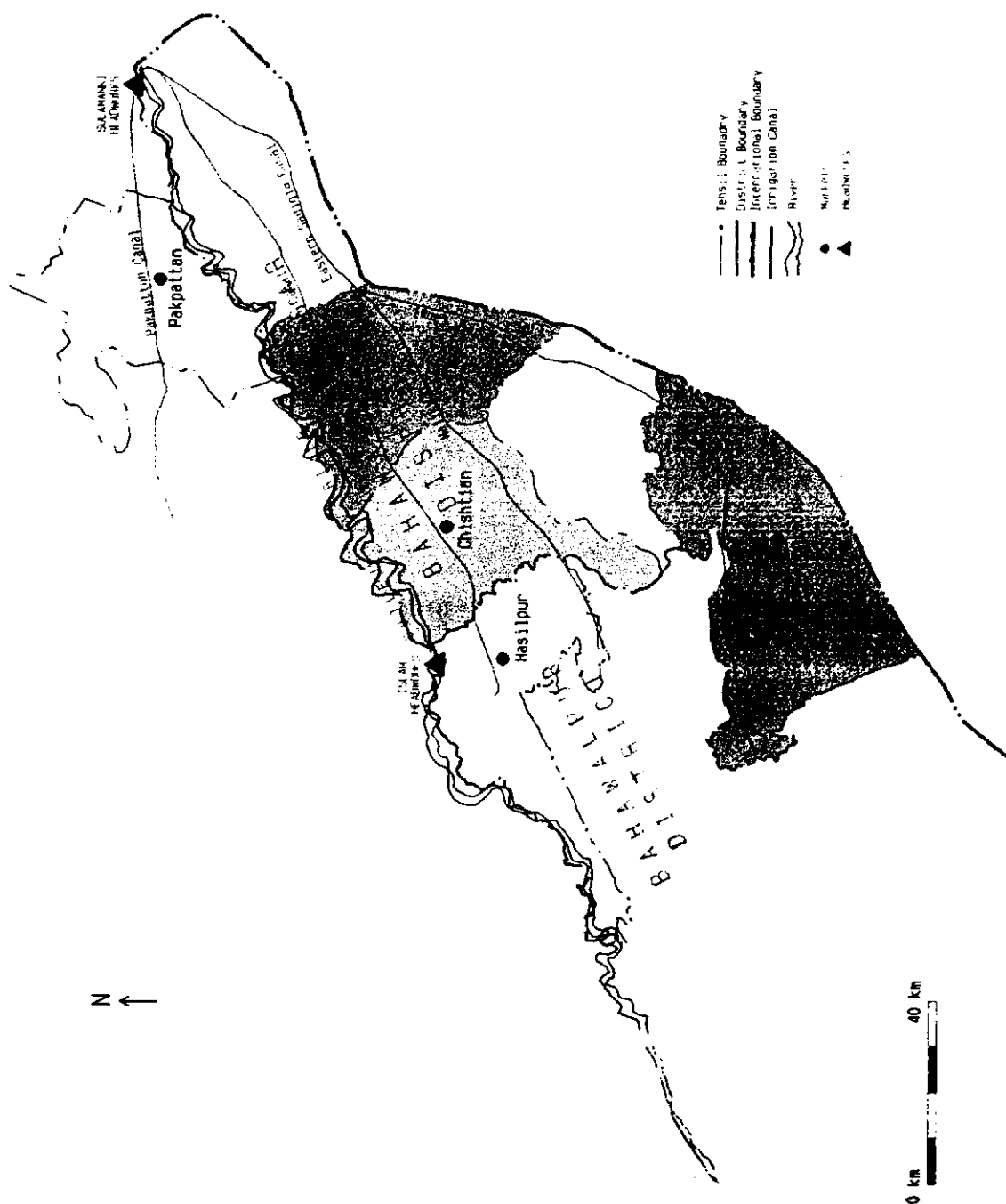
Map 3. Road links between markets.
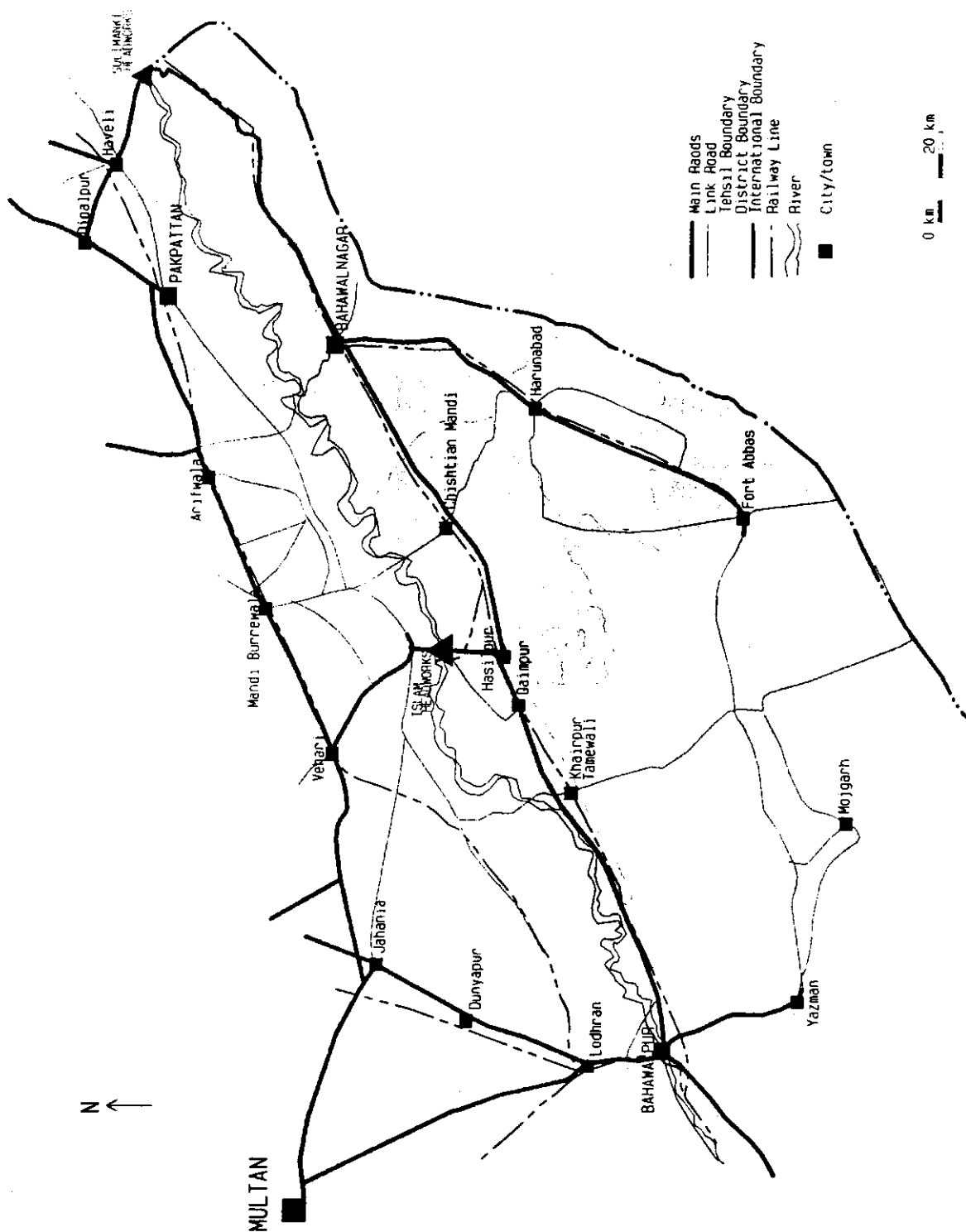
The Fort Abbas Market

The Fort Abbas Market is located at the Eastern edge of the Cholistan Desert. The notified area of the Fort Abbas Market is irrigated from the different distributaries and minors at the tail of the Hakra Branch Canal. Water-tables in this area are very low. Due to its desert location and sandy soil, and poor groundwater quality that limits private tubewell installation and groundwater use, farmers face shortages of irrigation water. Although the notified area served by this market is the second largest among all of sample markets selected for this study, the population density is the lowest for the Fort Abbas Market (see Table 1). The major crops cultivated in the area are cotton and wheat. As a result of the nature of the soils (sandy) and the lack of water, rice is not cultivated in this area.

The Pakpattan Market

The Pakpattan Market is located along the right side of the Sutlej River and its area is irrigated by the Pakpattan Canal. Most of the area served by this market is located in the head reach of the Pakpattan canal. Hence, canal water supplies are, in general, good. As a consequence, a significant area is cultivated under rice. Other crops in the region are wheat, cotton and sugarcane.

Selection Of Commodities

Analyzing secondary data, interviewing the commission agents of each market and observing the turnover of each commodity, the main crops in the selected markets were chosen for the analysis, i.e. **Cotton, Wheat** and **Rice**. Sugarcane is also an important crop in the area considered. However, information on marketing of the sugarcane at the local level is not easily accessible and available with private sugar mill owners that may not have interest in sharing the information. The following paragraphs briefly describe the three crops selected.

Cotton

Cotton is the major kharif season crop in all of the selected markets. Different varieties of cotton are sown in the area. Cotton transactions are observed in the market from September to March. Some markets are well-known for the good quality of traded cotton, while others are notorious for the poor quality of their product. According to commission agents and brokers that were interviewed for the present study, cotton transacted in Fort Abbas market is of very clean and good quality. Different factors determine the quality of the cotton, e.g. mode of payment of labour hired for harvesting, the way of weighing the produce, and the moisture level in the cotton[5].

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[5] For more information on quality aspects, see Appendix B *Effect of cotton quality on cotton price.*

Interviews of different commission agents suggested that the price of cotton (seed cotton) depends on the price of lint cotton. To understand this relationship, consider the following example. Suppose the price of lint cotton is 1900 Rs for 40 kg of product[6]. In 40 kg of cotton, there is approximately 13.5 kg of lint (with a value of around 50.9 Rs.kg^{-1}) and 26 kg of seed (with a value of. 6.3 Rs.kg^{-1}). Thus, the price of cotton in the local market will be 13.5 x 50.9 + 26 x 6.3 = 850 Rs. for 40 kg of cotton. However, commission agents subtract specific market costs/fees and the final market price is around 815 Rs. for 40 kg. This price formation criteria is reported in all of the local markets selected for the present study.

Rice

South-Punjab is not an important rice growing area in Pakistan. Thus, the total turnover in each market is not very large and rice remains a minor commodity for most of the markets in the area. Due to their small size, these markets may not be as well integrated as more important markets located in the rice growing zone of the country.

Four of the selected markets are located along the Sutlej River, and some rice is sown in these areas. Rice is not sown in the **Fort Abbas** area due to the proximity of the desert, the shortage of canal water and, also, the bad quality ground water underlying the area. Different varieties of rice are sown in these four markets, but the most common variety is *Basmati 385* with a significantly higher market value than the other more common varieties. This variety was selected for the purpose of the present study. According to the area cultivated,. the Bahawalnagar and Pakpattan markets are the two larger rice markets among the selected markets.

Wheat

Wheat is the major rabi season crop. Wheat acreage in each market is greater than the acreage under any other crop. There are a lot of impediments to integration of wheat markets including restrictions on its movement during certain months of the year. The government normally procures 25% to 30% of the total wheat production. For this purpose, procurement centers are established in each market's notified area. Two departments, PASSCO and the Food Department of the Ministry of Agriculture are involved in wheat procurement activities. Wheat is either sold directly by farmers to the procurement centers[7] or it is sold on the open market.

At the start of the season, PASSCO and the Food Department request the Deputy Commissioner of the district to impose a restriction or ban (*Zila Bandi*) on the movement of wheat from their district to other districts. This restriction would hold until PASSCO and the Food Department have achieved their required procurement target[8]. Farmers also keep some wheat for self-consumption

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[6] In local language, 40 kg are equivalent to 1 *maund*.

[7] Some centers are temporarily established in the field during harvesting.

[8] Source: Interviews of food inspectors and some officials of deputy commissioner's office.

and for use as seeds for the following year. Despite all these factors, sizable quantities of wheat are transacted every year through the open market.

Choice of the reference market

To implement Ravallion's model, reference markets are to be selected for each crop. Reference markets could be different for the different crops, but they must have common characteristics regarding prices: reference market prices are to be exogenous to local market influences. To identify reference markets for each crop, detailed interviews were undertaken with commission agents and brokers in all selected markets. According to the interviewees, the Karachi Cotton Association (KCA) lint cotton price could be considered as a reference price for the formation of the cotton price. As will be stressed below, this choice had to be refined to take into account the complexity of the cotton market and the importance of processing of part of the produce in the notified areas of the markets selected.

For the case of Wheat and Rice, the Multan Market has a dominant position in the area. Note that the Multan market is located along the Grand Trunk Road and has an average distance of 200 km from the selected markets. The following table summarizes the distances

Table 2.   Road distances between the 5 selected local markets and reference markets (in km).

Fort Abbas						
110	Bahawalnagar					
95	55	Chishtian				
130	88	37	Hasilpur			
225	105	160	197	Pakpattan		
278	238	183	146	225	Multan	
1077	1037	982	945	1150	945	Karachi

Data

Daily data was obtained from rosters of the market committee in each sample market. These rosters record daily low and high prices for each commodity. The price information was collected for the period January 1993 to December 1995. Information for earlier periods was not available in easily accessible form. A series of daily price was constructed for each commodity by averaging the relevant daily low and high price values. Next, prices were aggregated into weekly prices. Weekly prices for each commodity were computed as an average of all daily prices in the week.

Wheat price series of all markets was continuous because wheat transactions take place in the market through out the year. Price series of cotton and rice presented information gaps for part of the year when no trading takes place in these markets.

As discussed in the previous section, the analytical framework used in this study assumes that there is a dominant reference market for each commodity. For wheat and rice, the Multan Market was considered the reference market. For cotton, however, the situation is more complicated. There is no single market for seed cotton that can serve as a reference market. This is because seed cotton is processed in local ginneries to produce cotton lint and cotton seed (or sometimes, also, cotton seed oil).

This poses considerable difficulty because the tests of market integration in the Ravallion Model assume that integration is being studied between two price series of the same commodity in two different locations. When the commodity moves up the processing chain before reaching the reference market (which is the case for cotton), Ravallion's test of integration between the price of the processed commodity in the reference market and the commodity price in its raw form in the local market can give misleading results[9].

This difficulty was resolved by constructing an *equivalent price of raw cotton* in the Karachi reference market. The equivalent price was a composite price computed from price of cotton lint and price of cotton seed. More specifically, and as explained above, 40 kg of raw cotton contains roughly 13.5 kg lint, 26 kg of seed and 0.5 kg of waste. The equivalent price of raw cotton was computed as the price of 13.5 kg of cotton lint and 26 kg of cotton seed. The lint price was taken to be the average of the KCA price of three varieties (namely *MNH93*, *K68* and *NIAB78*). The seed price was taken as the price of cotton seed in the Multan market[10].

Results And Discussion

To test for market integration, the Ravallion Model (Equation 4) was estimated using separate OLS regressions for cotton, rice and wheat in each of the markets. The estimated equations employed several lags of local and reference market prices in addition to seasonal dummy variables. The number of lag time periods to be included in each equation was determined using the F-test.

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[9] The hypothesis was tested for each market by using the KCA lint price as a reference price. Not surprisingly, all markets were found to be segmented from the Karachi cotton lint market.

[10] Commission agents explained that cotton seeds of the area are mainly traded to the Multan area due to a large concentration of the oil industry around Multan. Thus, the Multan Market seed price affects the local seed price that partly explains the price formation of cotton.

Different time lags were included in the different models. The results of the OLS regressions and F-test for the identification of appropriate time lags are reported in Appendix D.

The remainder of this section deals with the various tests of market integration. As explained in the Methodology section, the hypothesis considered here relates to market segmentation, short-run market integration and long-run market integration. The tests for the market integration hypothesis were conducted using an F-test. The results are presented below, separately for each commodity in (see Tables 3, 4 and later). All tables list the hypothesis to be tested in the first column and the corresponding calculated value of the F-statistic in the second column. The tabulated value of the F-statistic at the 1% significance level and the appropriate degrees of freedom are reported in the third column. The last column specifies whether the hypothesis is accepted or rejected.

Cotton

The results for cotton are presented in Table 3. Clearly market segmentation is rejected for all cotton markets as the calculated F values are very high compared to the tabulated values. Hence, in the selected markets, price formation does not take place completely independently of the equivalent price of cotton constructed from the cotton lint price at Karachi. Note that market segmentation was rejected despite the fact that the selected markets are located off the Grand Trunk Road, the main trading route of the country.

Having established that the markets are not completely isolated from the central lint market at Karachi, the next question is about the nature of the market integration. Is market integration strong enough to immediately transmit signals from the central market (short run integration) or does this process involve lagged adjustments to changes in central market price?

The F-test presented in Table 3 indicates that short-run market integration is rejected for all markets. This result is according to expectations. First, the periodicity of the data used for this study is just a week, a somewhat short period for 100% of the price signal to be transmitted from the central market which is almost 1000 km away (see Table 2). Second, integration involves two different stages in the processing chain (cotton lint and seed cotton). Therefore, instantaneous adjustment to lint price shocks were not expected.

The picture vis-a-vis long-run integration is rather different. In all markets except the Bahawalnagar Market, the hypothesis of long-run integration of seed cotton markets with the central lint market at Karachi is accepted. In view of the location of these markets off the major trade axis in the country, this is quite a remarkable result. It suggests that if sufficient time is allowed for adjustment, the price signals in the equivalent price of cotton get fully transmitted to most of the selected markets.

As mentioned earlier, the exception to the above conclusion regarding long-run integration is the Bahawalnagar Market. Because the market is surrounded by other selected markets integrated in the long-run with the equivalent price in the central market, physical distance cannot be a reason explaining the absence of long-run integration. The relative importance of rice in the Bahawalnagar

Market, resulting from good canal water supplies and high water-tables, may explain the relative specializsation of this market in rice with less importance given to the marketing of cotton. The proximity of the large and active cotton market at Chishtian[11] (about 30 km away), found to be well integrated in the long run with the central market, may also explain that cotton of the Bahawalnagar area may be sold on the Chishtian market. However, information on the turn-over, origin and characteristics of the different markets would be required to further explain the differences between Bahawalnagar and the other markets.

Table 3.   Tests of market integration for cotton.

Hypothesis	F- Value	Tabulated Value F(N1,N2) At 1%	Remarks
Hasilpur			
H_0 = Mkt segmentation	12.5595	F(6,77) = 3.22	Rejected
H_0 = S.R. integration	46.7256	F(9,77) = 2.60	Rejected
H_0 = L.R. integration	4.8917	F(1,77) = 6.96	Accepted
Chishtian			
H_0 = Mkt segmentation	23.7140	F(2,101) = 4.81	Rejected
H_0 = S.R. integration	154.4585	F(3,101) = 3.98	Rejected
H_0 = L.R. integration	5.0004	F(1,101) = 6.88	Accepted
Bahawalnagar			
H_0 = Mkt segmentation	22.3859	F(2,57) = 4.98	Rejected
H_0 = S.R. integration	31.4723	F(3,57) = 4.13	Rejected
H_0 = L.R. integration	10.1471	F(1,57) = 7.08	Rejected
Fort Abbas			
H_0 = Mkt segmentation	10.2511	F(5,62) = 3.34	Rejected
H_0 = S.R. integration	6.9008	F(9,62) = 2.72	Rejected
H_0 = L.R. integration	0.0346	F(1,62) = 7.08	Accepted
Pakpattan			
H_0 = Mkt segmentation	10.1141	F(5,60) = 3.34	Rejected
H_0 = S.R. integration	31.6043	F(9,60) = 2.72	Rejected
H_0 = L.R. integration	3.1641	F(1,60) = 7.08	Accepted

[11] Chishtian is in Bahawalnagar district so merchants do not have to pay octroi at the district boundary. This is another reason that may lead to a relative specialization of the Bahawalnagar and Chishtian markets in rice and cotton, respectively.

Rice

The result of market integration tests for rice are presented in Table 4. As mentioned above, the Fort Abbas Market is omitted because there is no rice cultivation in that area. The reference market for these tests was taken to be the rice market in Multan. The F-statistics reported in the table indicate that the Bahawalnagar and Chishtian rice markets are integrated with the Multan Market. The Chishtian Market is integrated with the Multan Market in the long-run, while the Bahawalnagar Market is integrated even in the short-run. This is consistent with the observation made earlier related to the relative specialization of the Bahawalnagar market (with abundant water supply and sizable area under rice) in rice trading that leads to almost instantaneous adjustment in rice prices to changes in the central market price.

The analysis shows that the remaining markets, Hasilpur and Pakpattan, are not integrated with the Multan Market. The calculated F-Values for these markets were smaller than the respective values from the F- distribution tables (column 3), therefore, leading the acceptance of the null hypothesis of market segmentation. The segmentation of the Hasilpur rice market can be explained by low turnover of rice in that market. Hasilpur is located at the tail of the Fordwah and Azim distributaries. Thus, there is a general scarcity of canal water in that area and little area is grown under rice. And farmers who cultivate rice have often salinity reclamation objectives. Thus, they are willing to incur the extra costs of supplemental tubewell water to leach salts in addition to meeting irrigation requirements of this water intensive crop. Also, rice sales serve to off-set all or part of the cost of this extra water rather than providing income to households. In this context, the finding that the Hasilpur Market is isolated from the reference market has important implications. It raises the possibility that farmers' returns to rice may be depressed by the low local demand. In this situation, the cost of salinity mitigation strategies would increase with related environmental impact.

Table 4. Tests of market integration for rice.

Hypothesis	F values	Tabulated values F(n1,n2) at 1%	Remarks
Hasilpur			
H_0 = Mkt segmentation	2.9795	F(2,37) = 5.20	Accepted
Chishtian			
H_0 = Mkt segmentation	13.0795	F(2,34) = 5.27	Rejected
H_0 = S.R. integration	44.0815	F(3,34) = 4.39	Rejected
H_0 = L.R. integration	3.7356	F(1,34) = 7.44	Accepted
Bahawalnagar			
H_0 = Mkt segmentation	13.1924	F(3,32) = 4.50	Rejected
H_0 = S.R. integration	2.1335	F(5,32) = 3.69	Accepted
Pakpattan			
H_0 = Mkt segmentation	2.0590	F(2,29) = 5.42	Accepted

Results in Table 4 indicate that the Pakpattan Market is also segmented from the Multan Market. This result is difficult to explain because the Pakpattan rice area is relatively important. The large population in the Pakpattan area may explain that most of the rice produced in the area is consumed locally. Also, the final destination of the rice produced may be a market other than the Multan Market (most probably Lahore), which has its own price dynamics. This stresses again the difficulties related to the selection of the reference market for each commodity, as it strongly influences the results of the analysis.

Wheat

The results of the tests of the various hypotheses regarding wheat markets are reported in Table 5.

Table 5.   Tests of market integration for wheat.

Hypothesis	F- value	Tabulated value F(n1,n2) at 1%	Remarks
Hasilpur			
H_0 = Mkt segmentation	2.6729	F(3,145) = 3.78	Accepted
Chishtian			
H_0 = Mkt segmentation	4.0183	F(3,149) = 3.78	Rejected
H_0 = S.R. integration	149.0959	F(5,149) = 3.02	Rejected
H_0 = L.R. integration	0.2907	F(1,149) = 6.63	Accepted
Bahawalnagar			
H_0 = Mrt segmentation	6.9427	F(2,78) = 4.91	Rejected
H_0 = S.R. integration	37.4457	F(3,78) = 4.08	Rejected
H_0 = L.R. integration	2.8347	F(1,78) = 7.01	Accepted
Fort Abbas			
H_0 = Mkt segmentation	3.5878	F(5,114) = 3.17	Rejected
H_0 = S.R. integration	103.6379	F(9,114) = 2.56	Rejected
H_0 = L.R. integration	0.5595	F(1,114) = 6.85	Accepted
Pakpattan			
H_0 = Mkt segmentation	6.1867	F(2,122) = 4.79	Rejected
H_0 = S.R. integration	311.7482	F(3,122) = 3.95	Rejected
H_0 = L.R. integration	3.7190	F(1,122) = 6.85	Accepted

The results indicate that all markets except the Hasilpur Market, are integrated with the Multan Market in the long-run. None of the wheat markets were integrated in the short-run. As for rice, the Hasilpur wheat market is also segmented from the Multan Market.

Wheat is a commodity that is heavily regulated. In many months during a year, wheat movement between districts is banned. Thus, wheat markets were expected to be less well integrated, especially, in the short-run. However, as the government is quite active in wheat procurement and has procurement centers all over the country, it might explain the better long-run market integration for wheat.

Conclusions

The present study analyzes market integration for wheat, cotton and rice in five selected local markets in the South-Punjab. Wheat and cotton are major crops in all selected markets, while rice is grown in areas with good canal water supply or with salinity problems. The analysis shows that in the case of cotton, all selected markets were integrated with the Karachi Cotton Association (KCA) equivalent price in the long-run. That is, if sufficient time was allowed, the price shocks in the KCA equivalent prices were fully transmitted to local markets. Thus, any large increase or decrease in the production of cotton due to a specific irrigation or drainage project would not affect the local cotton price and the economic well being of the farmers in the notified areas of the markets selected for the analysis.

The market integration tests for rice markets gave mixed results. The rice markets of Chishtian and Bahawalnagar were found integrated with the Multan Market (reference) even in the short-run. However, the Hasilpur and Pakpattan markets were found to be segmented from the Multan Market. Hasilpur is not a rice growing area and rice is grown there mainly as a part of land reclamation strategies. The isolation of this market from the reference market implies that farmers' returns to rice cultivation are constrained by local demand conditions. This might diminish farmers' incentives to use rice cultivation as part of a land reclamation strategy.

Wheat markets were generally found to be integrated in the long-run. Short-run integration was rejected for all wheat markets. This may be due to government imposed restrictions on movement of wheat between districts, which generally remain in place during several months of the year. The Hasilpur wheat market was found to be isolated from the Multan reference market even in the long-run. As for rice, this may be due to the small turnover reported for this market.

The general conclusions that emerge from this study are that agricultural commodity markets for cash crops, such as cotton, tend to be well integrated regardless of size and location. For non-cash crops, smaller markets may be isolated. In the area served by these small markets, farmers may cultivate rice as a way of dealing with salinity; however, the lack of integration of these markets may adversely affect farmers incentives to follow this strategy.

An interesting element relates to the number of time lags found significant in the different models. In most of the cases when the hypothesis of market segmentation has been accepted or long-run integration has been rejected, one time period only became significant in the models, thus highlighting that markets do not react strongly to a series of prices, but rather to one price only.

One objective of this study was to supplement other research activities being undertaken by IIMI in South Punjab. Only five markets were considered. There is a need to conduct a study on a larger number of small markets. In this regard, special attention needs to be paid to markets located in the salinity affected areas where farmers land reclamation strategies may include specific cropping pattern choices such as the rice-salinity grass rotation.

The results obtained so far specifies whether markets are integrated or not with reference markets. However, sufficient information was not available to clearly explain differences among crops and among markets. Follow-up research will concentrate on the factors that influence market integration and explain differences between markets, in order to identify possible policy interventions that may be applied to promote market integration. Possible factors that would explain different levels of market integration include distance to different reference markets, location within the Province, proximity to other local markets, road access to markets, turnover of various commodities, specific organization of the local markets, etc.

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Appendices

APPENDIX A

Agriculture Marketing System In Pakistan

Agriculture marketing development in Pakistan has a long history. In 1927, a royal commission on agriculture was constituted in India to examine and report on the conditions of agriculture and rural economy and to make recommendation for the agrarian sector. The commission submitted its report in 1928. Following its recommendations, a marketing organization was created in the Central Ministry of India in 1935. The commission found that farmers were being charged a number of fees on top of brokers' commissions. Among these were pan filler fees, bag opening fees and similar charges. Farmers were also asked to make donations for sweepers, guards, watermen and beggars and to contribute to various religious charities. The commission reported that farmers were also cheated on the weight of commodities. Deductions were implemented for impurities and for excess moisture. A wide variety of weights and measures were used. Overall, the use of inaccurate scales and false weighing techniques were estimated to contribute to another 5% of the commission of the traders.

The enactment of the Punjab Agricultural Produce Markets Act in 1939 was the prime result of the commission's report. The act has been revised a number of times. In its present form, the Punjab Agricultural Produce Markets Ordinance of 1978 is the main regulation for the operation of agricultural markets. The same act has been adopted in Sindh and NWFP. And the act is in the process of being adopted in Balochistan. An improvement under the legislation is the establishment of market committees.

The major responsibility of the market committee is the management of the regulated markets. Regulated markets are those markets who are covered under the agricultural market acts. They operate in the domain of notified area and under the administrative control of market committees. Regulated markets or *mondies* have a controlled schedule of fees and charges. Regulated markets exist for cattle, goats, sheep, fruit, vegetable and grains. In large cities, regulated markets are also established for fish. Except for fruits and vegetables markets and grain markets, all other markets are periodic. Generally, the fruits and vegetables and grain markets are the largest and the most actively controlled of the regulated markets. The grain markets only are active the day round; fruits and vegetables markets are primarily held in the morning, as great pains are taken to move the commodities before the day become too hot.

By the early 1980s, Pakistan had approximately 650 market places with an average notified area of 473 square miles and an average of 63 villages for every market[12]. In the Punjab, 144 urban grain

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[12] Source: Directorate Of Agriculture Economics And Marketing, Punjab.

markets and 83 feeder markets are reported. Market committees are classified into class A, B, C or D according to the annual income. Depending on its class, a market committee is constituted by 10 to 18 members. Of these members, one may be appointed by the Government from among salaried civil servants by virtue of his office, five to nine members are growers of the notified area, three to six members are persons involved in business in agriculture commodities (including brokers, weighmen, measurers and surveyors), and one to two members represent consumers and are nominated by the Deputy Commissioner. Every member holds office for a 3-year period from the date of his appointment.

The main duties of the market committees include:

- Enforce the provisions of APMA (Agriculture Produce Marketing Act) and its rules and by-laws;

- Arrange open auction of agriculture produce and supervise all operations;

- If considered necessary, establish one or more fair price shops;

- Set up or acquire markets, warehouses and cold storage facilities for the benefit and facility of growers, dealers and other market functionaries; and

- Under take any other relevant duty as directed by the Government.

Any entrepreneur who operates in the notified area of a regulated market, except for farmers who directly sell to traders, requires a license from the concerned market committee.

APPENDIX B

Effect Of Cotton Quality On Cotton Price

There are two reasons for studying the quality of cotton in relation with market price. The first one relates to price differentials resulting from differences in cotton quality, and the second one relates to market specialization according to quality.

During market visits, it was observed that markets are specialized according to the quality of the cotton produce transacted. Some markets are famous for good quality cotton while others are notorious as poor quality cotton markets. The factors that explain differences in quality and market specialization are discussed below.

Commission agents report that there are different prices in different markets of the same region during the same time. For example, in 1995, the Chishtian cotton market price was higher than the Hasilpur market price by 10 Rs per 40 kg. Similarly, the Bahawalnagar market price was lower than the Hasilpur market price by 40 Rs. per 40 kg. Neighbouring markets such as the Vehari and Mailsi markets reported also lower prices than the Hasilpur market cotton price by 45 Rs. per 40 kg. Commission agents attributed these price differentials to differences in the quality of the cotton produce traded on each market.

There are two major factors that explain quality differences. The first factor is the *moisture content* of the cotton. The second factor is the *ratio of Sangli* still in the cotton at the time of sale. Both factors are further described in the following paragraphs.

Moisture contents in cotton

Commission agents in the selected markets stressed the negative relationship between moisture contents and cotton prices. High moisture contents, mainly found in areas located along the river or near large water bodies, lead to low cotton prices. Low prices were reported in the area around Bahawalnagar and some areas of the Vehari and Mailsi markets due to high moisture contents. Three reasons explain the low cotton price for high moisture contents:

- Commission agents face extra losses in weight of the final produce due to the high moisture content;

- High moisture content increases the chances of the cotton heating-up during storage, which results in the ratio of oil in the cotton seed to be reduced; and

- As a result of the cotton heating-up, the lint becomes yellow during storage and loses its quality.

There are two main factors that increase moisture contents in the cotton produce. The first factor is dew fall at night. During early morning, there are a lot of dew drops in the cotton fields. Thus, if cotton picking is started early, then the moisture content will be high. The second factor is related to the storage place after picking; if cotton is stored in the open air, then the dew fall will also increase the moisture contents during the night. Although there are more chances of high dew fall and there are higher percentages of moisture in the air in the areas close to the rivers and water bodies, high moisture contents can be avoided with late morning picking and proper storage during the night.

Ratio of sangli in cotton

The word *sangli* means cotton waste in Punjabi. It includes small pieces of cotton boll shell and leaf that are taken with the cotton during picking. The ratio of sangli has a major role in determining the cotton market price. Different markets have various ways of dealing with the sangli whose presence is generally considered as lowering the quality. Some markets have well established procedures for detecting sangli, while others do not follow any specific procedure.

The process for measuring sangli is very simple. When a farmer approaches to a commission agent, the commission agent first weights 20 kg cotton and separates out the sangli for these 20 kg of produce. The sangli obtained for these 20 kg is then added to the 20 kg weight on the scale. Sangli plus 20 kg are then considered as equivalent to 20 kg and are used as a basic unit to weight the rest of the cotton harvest and take sangli into account.

The amount of sangli in cotton depends on how carefully the cotton has been picked. In fact, contracts for cotton picking directly influence the quality grades with respect to sangli. For example, in the Mailsi area, the mode of payment for cotton picking is a net cash of around 1 Rs. per kg. When women pick cotton, they do not give special attention to sangli as it does not influence their final salary. With larger land holdings in this area, landowners and cultivators do not have enough time to monitor and supervise cotton picking and prefer to maximize the quantity picked per unit of time than the quality of the harvest.

On the other hand, with naturally low moisture contents in cotton for the desert areas surrounding Hasilpur, Chishtian, and Fort Abbas, the contract for cotton picking is different. The mode of payment in these areas is based on a share of the picked cotton (usually one 16th of the final produce). In this case, a woman that picks has an interest in minimizing the sangli in her picking as it will also affect the ratio of sangli in her own share of the produce and eventually her wage at the end of the day. With relatively small land holdings, farmers in these areas have also enough time for good supervision of labor and can better implement the share based contract.

APPENDIX C

REGRESSION TABLES

Variable definitions

Cotton

BCOTTONP	= Dependent Variable (Bahawalnagar Cotton Price)
BCOTTON1	= 1st Lag of dependent variable.
CCOTTONP	= Dependent Variable (Chishtian Cotton Price)
CCOTTON1	= 1st Lag of dependent variable.
FCOTTONP	= Dependent Variable (Fort Abbas Cotton Price)
FCOTTON1-4	= 1st To 4th Lag of dependent variable.
HCOTTONP	= Dependent Variable (Hasilpur Cotton Price)
HCOTTON1-5	= 1st To 5th Lag of dependent variable.
JNDUMY	= Dummy for joining gaps in the data.
KCAECP	= Karachi market equivalent price.
KCAECP1-5	= 1st To 5th lag of KCAECP.
PCOTTONP	= Dependent Variable (Pakpattan Cotton Price)
PCOTTON1-4	= 1st To 4th Lag of dependent variable.
SNDUMY	= Seasonal dummy (During picking season =1)

Rice

BRICEP	= Bahawalnagar Rice Price.
BRICE1-2	= 1st & 2nd lag of dependent variable.
CRICEP	= Chishtian Rice Price.
CRICE1	= 1st lag of dependent variable.
HRICEP	= Hasilpur Rice Price.
HRICE1	= 1st lag of dependent variable.
JNDUMY	= Dummy for joining gaps in data.
MRICEP	= Multan market rice price.
MRICEP1-2	= 1st & 2nd lag of MRICEP.
PRICEP	= Pakpattan Rice Price.
PRICE1	= 1st lag of dependent variable.

Wheat

BWHEATP	= Dependent Variable (Bahawalnagar Wheat Price)
BWHEAT1	= 1st lag of dependent variable.
CWHEATP	= Dependent Variable (Chishtian Wheat Price).

CWHEAT1-2   = 1st & 2nd Lag of dependent variable.
FWHEATP   = Dependent Variable (Fort Abbas Wheat Price).
FWHEAT1-4   = 1st To 4th Lag of dependent variable.
HWHEATP   = Dependent Variable (Hasilpur Wheat Price).
HWHEAT1-2   = 1st & 2nd Lag of dependent variable.
MWHEATP   = Multan market wheat price.
MWHEATP1-2   = 1st & 2nd lag of MWHEATP.
PWHEATP   = Pakpattan Wheat Price.
PWHEAT1   = 1st lag of dependent variable.
SNDUMY   = Seasonal dummy (During harvesting season =1)

Table C-1.   Regression table of Hasilpur cotton market.

===
Dependent Variable : HCOTTONP
R-SQUARE =   0.9720   R-SQ ADJUSTED = 0.9676

- -

VARIABLE	B	STD ERROR	T-RATIO
HCOTTON1	0.66087	0.1077	6.137
HCOTTON2	0.39164	0.1377	2.844
HCOTTON3	-0.29439	0.1395	-2.110
HCOTTON4	-0.33030E-02	0.1408	-0.2345E-01
HCOTTON5	0.47624E-01	0.1092	0.4361
KCAECP	1.0215	0.1245	8.206
KCAECP1	-0.77640	0.2031	-3.823
KCAECP2	-0.27885	0.2108	-1.323
KCAECP3	0.12150	0.2071	0.5866
KCAECP4	-0.10386	0.1946	-0.5338
KCAECP5	0.19213	0.1407	1.365
SNDUMY	15.996	9.067	1.764
JNDUMY	66.913	20.83	3.212

===

Table C-2.   Regression table of Chishtian cotton market.

===
Dependent Variable : COTTONP
R-SQUARE = 0.9720 R-SQ ADJUSTED =   0.9676

- -

VARIABLE	B	STD ERROR	T-RATIO
CCOTTON1	0.82647	0.6395E-01	12.92
KCAECP	0.62895	0.9622E-01	6.537
KCAECP1	-0.47161	0.1089	-4.332
SNDUMY	13.577	8.049	1.687
JNDUMY	32.844	21.12	1.555

===

Table C-3. Regression table of Bahawalnagar cotton market.

```
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```
Dependent Variable : BCOTTONP
R-SQUARE = 0.8400   R-SQ ADJUSTED = 0.8287

VARIABLE	B	STD ERROR	T-RATIO
BCOTTON1	0.53209	0.1078	4.935
KCAECP	0.98822	0.2200	4.492
KCAECP1	-0.57147	0.2539	-2.251
SNDUMY	32.527	15.65	2.078
JNDUMY	102.57	45.63	2.248

```
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```

Table C-4. Regression table of Fort Abbas cotton market.

```
===================================================
```
Dependent Variable : FCOTTONP
R-SQUARE = 0.9728   R-SQ ADJUSTED = 0.9685

VARIABLE	B	STD ERROR	T-RATIO
FCOTTON1	0.77957	0.1351	5.772
FCOTTON2	-0.17989	0.1656	-1.086
FCOTTON3	0.28007E-01	0.1611	0.1738
FCOTTON4	0.84583E-01	0.1402	0.6034
KCAECP	0.83979	0.1265	6.639
KCAECP1	-0.40213	0.1769	-2.273
KCAECP2	0.52739E-01	0.1584	0.3330
KCAECP3	-0.34930	0.1588	-2.199
KCAECP4	0.14534	0.1299	1.119
SNDUMY	15.619	8.135	1.920
JNDUMY	26.745	22.76	1.175

```
===================================================
```

Table C-5. Regression table of Pakpattan cotton market.

```
============================================================
Dependent Variable : PCOTTONP
R-SQUARE =   0.9630   R-SQ ADJUS ED =   0.9569
------------------------------------------------------------
VARIABLE      B          STD ERROR     T-RATIO
------------------------------------------------------------
PCOTTON1    0.55205      0.1241        4.447
PCOTTON2    0.30298      0.1518        1.996
PCOTTON3   -0.35275      0.1360       -2.593
PCOTTON4   ·0.22529      0.1126        2.001
KCAECP      0.69018      0.1154        5.980
KCAECP1    -0.28099      0.1692       -1.660
KCAECP2    -0.49233      0.1614       -3.051
KCAECP3     0.30784      0.1679        1.833
KCAECP4     0.24380E-01  0.1329        0.1835
SNDUMY     11.150       10.81          1.031
JNDUMY     76.861       24.75          3.105
============================================================
```

Table C-6. Regression table of Hasilpur rice market.

```
============================================================
DEPENDENT VARIABLE : HRICEP
R-SQUARE =   0.8772   R-SQ ADJUSTED = 0.8672
RAW MOMENT R-SQUARE =   0.9980
------------------------------------------------------------
VARIABLE      B          STD ERROR     T-RATIO
------------------------------------------------------------
HRICEP1     0.79928      0.1203        6.642
MRICEP      0.29788      0.1610        1.850
MRICEP1    -0.62498E-01  0.1973       -0.3168
JNDUMY     -5.9982       6.690        -0.8965
============================================================
```

Table C-7.   Regression table of Chishtian rice market.

```
==============================================
Dependent Variable : CRICEP
R-SQUARE =    0.8682      R-SQ ADJUSTED = 0.8566
RAW MOMENT R-SQUARE =    0.9979
----------------------------------------------

VARIABLE     B          STD ERROR    T-RATIO
----------------------------------------------

CRICEP1   0.63896        0.1220       5.237
MRICEP    0.70265        0.1493       4.706
MRICEP1  -0.31236        0.1798      -1.737
JNDUMY    15.405         8.222        1.874
==============================================
```

Table C-8.   Regression table of Bahawalnagar rice market.

```
==============================================
Dependent Variable : BRICEP
R-SQUARE =    0.9520      R-SQ ADJUSTED = 0.9445
RAW MOMENT R-SQUARE =    0.9989
----------------------------------------------

VARIABLE     B          STD ERROR    T-RATIO
----------------------------------------------

BRICEP1   0.31514        0.1663       1.895
BRICEP2   0.20973        0.1784       1.176
MRICEP    0.88460        0.1430       6.188
MRICEP1  -0.48912        0.2175      -2.249
MRICEP2   0.81123E-01    0.1852       0.4381
JNDUMY    7.7674         5.379        1.444
==============================================
```

Table C-9. Regression table of Pakpattan rice market.
```
================================================
 Dependent Variable : PRICEP
 R-SQUARE =    0.1081     R-SQ ADJUSTED = 0.0159
 RAW MOMENT R-SQUARE =   0.9957
 -----------------------------------------------
 VARIABLE     B          STD ERROR    T-RATIO
 -----------------------------------------------
 PRICEP1   0.73796       0.1409       5.236
 MRICEP.   0.40273       0.3888       1.036
 MRICEP1  -0.10695       0.3884      -0.2754
 JNDUMY   -9.4105        17.46       -0.5391
================================================
```

Table C-10. Regression table of Hasilpur wheat market.
```
================================================
 Dependent Variable : HWHEATP
 R-SQUARE =    0.9315     R-SQ ADJUSTED = 0.9291
 RAW MOMENT R-SQUARE =   0.9992
 -----------------------------------------------
 VARIABLE     B          STD ERROR    T-RATIO
 -----------------------------------------------
 HWHEATP1   0.60975      0.8305E-01   7.342
 HWHEATP2   0.23827      0.8620E-01   2.764
 MWHEATP    0.23497      0.1399       1.679
 MWHEATP1  -0.27673      0.1892      -1.463
 MWHEATP2   0.19723      0.1297       1.521
 SNDUMY    -2.1492       1.425       -1.508
================================================
```

Table C-11. Regression table of Chishtian wheat market.
```
===============================================
Dependent Variable : CWHEATP
R-SQUARE =    0.9666     R-SQ ADJUSTED = 0.9655
RAW MOMENT R-SQUARE =    0.9996
-----------------------------------------------
VARIABLE      B            STD ERROR    T-RATIO
-----------------------------------------------
CWHEATP1     1.1213       0.8032E-01    13.96
CWHEATP2    -0.20711      0.8213E-01    -2.522
MWHEATP      0.24804      0.8937E-01    2.776
MWHEATP1    -0.10719      0.1264        -0.8480
MWHEATP2   -0.54133E-01   0.8881E-01    -0.6096
SNDUMY      -1.1329       0.8950        -1.266
===============================================
```

Table C-12. Regression table of Bahawalnagar wheat market.
```
===============================================
Dependent Variable : BWHEATP
R-SQUARE =    0.8134     R-SQ ADJUSTED = 0.8062
RAW MOMENT R-SQUARE =    0.9988
-----------------------------------------------
VARIABLE      B            STD ERROR    T-RATIO
-----------------------------------------------
BWHEATP1    0.68097       0.8663E-01    7.861
MWHEATP     0.26331       0.1867        1.411
MWHEATP1    0.47637E-01   0.1850        0.2575
SNDUMY      1.3791        2.267         0.6085
===============================================
```

Table C-13. Regression table of Fort Abbas wheat market.

```
===================================================
Dependent Variable : FWHEATP
R-SQUARE =   0.9722  -SQ ADJUSTED = 0.9700
RAW MOMENT R-SQUARE =   0.9997
```

VARIABLE	B	STD ERROR	T-RATIO
FWHEATP1	1.0522	0.9227E-01	11.40
FWHEATP2	-0.38064	0.1246	-3.055
FWHEATP3	0.54483	0.1255	4.340
FWHEATP4	-0.31203	0.9647E-01	-3.235
MWHEATP	0.33864	0.8831E-01	3.835
MWHEATP1	-0.28401	0.1182	-2.404
MWHEATP2	0.65455E-01	0.1214	0.5390
MWHEATP3	-0.13755	0.1210	-1.136
MWHEATP4	0.11074	0.8861E-01	1.250
SNDUMY	-0.78517	0.8491	-0.9247

```
===================================================
```

Table C-14. Regression table of Pakpattan wheat market.

```
====================================================
Dependent Variable : PWHEATP
R-SQUARE =   0.9751    R-SQ ADJUSTED = 0.9745
RAW MOMENT R-SQUARE =   0.9996
```

VARIABLE	B	STD ERROR	T-RATIO
PWHEATP	0.14283	0.9208E-01	1.551
PWHEATP1	0.85872	0.4281E-01	20.06
MWHEATP1	-0.64805E-02	0.9637E-01	-0.6725E-01
SNDUMY	1.6731	0.9542	1.753

```
====================================================
```

APPENDIX D

Lag Period Determination

The different lag periods for each equation were determined using a F-test. The results of the OLS regressions and the F-test are presented in the tables below.

Table D-1.   Lag period determination for Hasilpur cotton market.

No	DF	Sum of Sq	Rsq Chg	F	Lag Used
1	2	286796.21327	.00702	108.05374	*
2	2	851.22446	.00002	.31548	*
3	2	8071.97556	.00020	3.14841	*
4	2	2089.14143	.00005	.81100	*
5	2	5666.39238	.00014	2.27139	*
6	2	813.81958	.00002	.32039	
7	2	1279.01770	.00003	.49668	
8	2	1553.90696	.00004	.59667	

Table D-2.   Lag period determination for Chishtian cotton market.

No	DF	Sum of Sq	Rsq Chg	F	Lag Used
1	2	278547.25548	.00565	125.68030	*
2	2	425.94622	.00001	.18894	
3	2	4313.87188	.00009	1.95230	
4	2	857.40293	.00002	.38282	
5	2	931.91908	.00002	.41064	
6	2	1761.26875	.00004	.77207	
7	2	3011.21784	.00006	1.33013	
8	2	223.68921	.00000	.09668	

Table D-3.   Lag period determination for Bahawalnagar cotton market.

No	DF	Sum of Sq	Rsq Chg	F	Lag Used
1	2	141961.70594	.00460	16.45624	*
2	2	8014.29985	.00026	.92639	
3	2	2830.77689.	.00009	.31829	
4	2	9212.56685	.00030	1.03748	
5	2	10606.57101	.00034	1.20512	
6	2	8785.43794	.00028	.99812	
7	2	4184.93192	.00014	.46330	
8	2	4908.98158	.00016	.53071	

Table D-4.   Lag period determination for Fort abbas cotton market.

No	DF	Sum of Sq	Rsq Chg	F	Lag Used
1	2	43766.88401	.00106	18.09668	*
2	2	6371.82811	.00015	2.77644	*
3	2	712.12363	.00002	.30355	*
4	2	5441.71392	.00013	2.42627	*
5	2	978.36638	.00002	.42790	
6	2	852.71505	.00002	.36478	
7	2	3998.60081	.00010	1.75676	
8	2	2172.52230	.00005	.95282	

Table D-5.   Lag period determination for Pakpattan cotton market.

No	DF	Sum of Sq	Rsq Chg	F	Lag Used
1	2	114787.24159	.00387	32.46169	*
2	2	1676.98085	.00006	.46634	*
3	2	16037.21725	.00054	5.04101	*
4	2	7021.02576	.00024	2.30277	*
5	2	1500.82868	.00005	.48348	
6	2	5701.40288	.00019	1.89539	
7	2	2050.16984	.00007	.67332	
8	2	7018.61175	.00024	2.43200	

Table D-6.   Lag period determination for Hasilpur rice market.

No	DF	Sum of Sq	Rsq Chg	F	Lag Used
1	2	6434.40073	.00368	30.10851	*
2	2	94.88831	.00005	.42910	
3	2	43.53287	.00002	.18686	
4	2	166.89458	.00010	.70214	
5	2	188.15013	.00011	.77908	

Table D-7.   Lag period determination for Chishtian rice market.

No	DF	Sum of Sq	Rsq Chg	F	Lag Used
1	2	3160.71877	.00194	14.28163	*
2	2	331.54479	.00020	1.55137	
3	2	160.65713	.00010	.73817	
4	2	184.59917	.00011	.83800	
5	2	3.14466	.00000	.01315	

Table D-8.   Lag period determination for Bahawalnagar rice market.

No	DF	Sum of Sq	Rsq Chg	F	Lag Used
1	2	812.48743	.00053	9.38403	*
2	2	216.61510	.00014	2.74430	*
3	2	56.38892	.00004	.70186	
4	2	56.53074	.00004	.68999	
5	2	287.45114	.00019	4.27442	

Table D-9.   Lag period determination for Pakpattan rice market.

No	DF	Sum of Sq	Rsq Chg	F	Lag Used
1	2	3839.59184	.00369	7.05807	*
2	2	182.51786	.00018	.31358	
3	2	340.04794	.00033	.55698	
4	2	1496.00437	.00144	3.03783	
5	2	551.58803	.00053	1.14115	

Table D-10.   Lag period determination for Hasilpur wheat market.

No	DF	Sum of Sq	Rsq Chg	F	Lag Used
1	2	4159.73488	.00102	80.09698	*
2	2	223.30663	.00005	4.50942	*
3	2	36.29538	.00001	.73016	
4	2	73.25563	.00002	1.48388	
5	2	8.10605	.00000	.16220	
6	2	96.89600	.00002	1.96647	

Table D-11.   Lag period determination for Chishtian wheat market.

No	DF	Sum of Sq	Rsq Chg	F	Lag Used
1	2	7812.77184	.00190	338.06273	*
2	2	91.29377	.00002	4.11671	*
3	2	26.23787	.00001	1.18616	
4	2	21.23663	.00001	.95953	
5	2	31.83756	.00001	1.44757	
6	2	112.10961	.00003	5.41913	

Table D-12.   Lag period determination for Bahawalnagar wheat market.

No	DF	Sum of Sq	Rsq Chg	F	Lag Used
1	2	2656.29631	.00121	41.67052	*
2	2	19.61799	.00001	.30195	
3	2	36.70552	.00002	.55802	
4	1	15.64527	.00001	.47211	
5	2	32.84207	.00001	.48817	
6	2	79.30468	.00004	1.18531	

Table D-13.   Lag period determination for Fort abbas wheat market.

No	DF	Sum of Sq	Rsq Chg	F	Lag Used
1	2	3319.24362	.00109	166.86369	*
2	2	9.28000	.00000	.46230	*
3	2	45.18729	.00001	2.30118	*
4	2	95.84393	.00003	5.24087	*
5	2	10.87419	.00000	.59030	
6	2	30.28324	.00001	1.66357	

Table D-14.   Lag period determination for Pakpattan wheat market.

No	DF	Sum of Sq	Rsq Chg	F	Lag Used
1	2	1016.42048	.00057	68.93673	*
2	2	15.33031	.00001	1.04097	
3	2	8.92437	.00001	.59884	
4	2	105.27787	.00006	8.71604	
5	2	47.55251	.00003	4.34892	
6	1	3.48594	.00000	.63385	

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