MARKET INTEGRATION AND PRICE TRANSMISSION IN INDIA: A CASE OF RICE AND WHEAT WITH SPECIAL REFERENCE TO THE WORLD FOOD CRISIS OF 2007/08

by

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1. INTRODUCTION

1.1 THE CONTEXT

International prices of food commodities increased sharply between 2005 and 2008. The prices of cereals increased even faster. The international prices of cereals (rice and wheat) started firming up in the later half of 2007 and peaked in April 2008. The rate of annual increase in global prices in April 2008 for rice was 206 percent and that for wheat was 83 percent. Subsequently, the inflation rate declined and came down to 123 percent by September 2008 for rice and 27 percent by August 2008 for wheat. The declining trend in inflation continued till the first half of 2009. In the case of wheat, the inflation rate even turned negative in the later part of 2008. The spurt in prices of staple grains in 2008 created several problems in many countries across the globe, obviously due to adverse impact on food security and nutrition. Several scholarly contributions were made by researchers, development thinkers and national and international organizations to unravel the factors associated with the world food crisis. However, most of the analysis and writings focused on the impact of world crisis of 2007/08 on consumers and transmission of world food prices to the retail level. An equally important aspect related to how and to what extent very high global prices of rice and wheat were transmitted to the farmers or producers of rice and wheat did not receive adequate attention. It is equally important to understand the price transmission also to the farmers or farmgate level, because only through this transmission, that a possible supply response to increase the supply of these cereals can be expected. Further, the FAO cereals price index for 2011 at 246.8 is higher by 3.8 percent than that for 2008 (237.8), which shows that price increase of 2008 was not a mere spike, it is rather persisting. However, this study relates to 2007-08 price situation for obvious reasons of inadequate evidence of the transmission of more recent global price spurt.

1.2 OBJECTIVES OF THE STUDY

The main objectives of this study are following:

(a) To review and explain the role of domestic policies related to marketing of rice & wheat, including public stocks, in influencing the price transmission from international to domestic markets;
(b) To asses the integration of domestic markets for rice and wheat;
(c) To analyze and quantify the extent of price transmission for rice and wheat from world markets to the farmgate and other levels (wholesale and retail) in the domestic marketing system; and
(d) To analyze the prices at the farmgate (prices received by the farmers), especially during and around the global crisis of 2007-08.

1.3 THE APPROACH AND METHODOLOGY

The study has used both econometric techniques and policy analysis approaches. It is recognized that the price transmission from international to domestic markets depends on the policy milieu prevailing in the country both during the normal period and in the times of abnormal situation like very high or very low global or domestic prices. In this context, we have very comprehensively reviewed the relevant policies which have potential impact on the price transmission. The main policy instruments that were reviewed include (a) minimum support prices (MSPs) for rice and wheat; (b) procurement of rice and wheat by the government at MSPs; (c) scale of subsidized public distribution and the prices at which rice and wheat supplied to the consumers; (d) levels and maintenance of buffer stocks and food security reserves; (e) imposition of stocking limits for traders

and bulk consumers; (f) trade policy instruments like import duties, quantitative restrictions, canalization, and imposition of minimum export prices; and (g) programmes and incentives for farmers to augment the production and supplies of rice and wheat.

The focus of food policy review has been on the last 10 years. A chronological analysis of various policy decisions in succession for the period beginning April 2006 has been brought out to show the government's response to the global food crisis. Relevant data for the analysis were collected from government's published documents or official websites.

Domestic market integration and price transmission were analyzed using 16 year data from January 1996 to December 2011. The monthly wholesale, retail and farmgate prices of rice and wheat were collected for a sample of markets from northern, eastern and southern parts of the country. As the farmgate prices are reported for 'six weeks period after harvest' rather than on monthly basis, the month-wise prices in the primary wholesale markets were used as proxy for the farmgate prices. The primary wholesale markets in India are those markets that are located in major production areas and are the first points of sale of the marketed surplus by either the farmers or assemblers (Acharya and Agarwal, 2011). Such markets are basically assembling markets and the surplus farm products move, through these markets, to secondary wholesale or terminal markets, and ultimately to retail markets and consumers. Even the private exporters and bulk processors meet their requirements from primary wholesale markets. Monthly prices for all the selected markets were obtained from the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, which is the national official nodal agency for collecting, compiling and maintaining, *inter alia*, the price statistics for agricultural commodities.

Based on the availability of long time monthly price series and for giving fair representation to various geographically spread regions of the country, five secondary wholesale markets, each for rice and wheat, were selected. These are Delhi, Mumbai, Hyderabad, Chennai and Banglalore/Bangaluru for wheat. For rice, the selected wholesale markets are Delhi, Mumbai Hyderabad, Chennai and Kolkata. As all of these markets are also large consuming centres, the monthly retail prices of these cities were used as retail prices.

For the selection of primary assembling wholesale markets, direction of flow of marketed surplus of rice and wheat from production area to the selected wholesale and retail markets was used as the logical basis. As wheat production is concentrated in northern India, Karnal (Haryana), Amritsar (Punjab), Moga (Punjab), and Kota (Rajasthan) were selected as primary wholesale market centres supplying wheat to Delhi wholesale market. Rice is grown almost throughout India, and so is the spread of rice markets. Primary wholesale markets of Karnal and Amritsar were identified as main supplier markets for Delhi; Nizamabad (A.P.) and Vijaywada (A.P.) for Hyderabad; Chidambaram (T.N.) and Kumbakonam (T.N.) for Chennai; and Cooch Behar (W.B.) and Bankura (W.B.) for the Kolkata wholesale market. A list of selected market is given in Table 1. The sample markets for the study, thus, include eight primary wholesale markets, five wholesale markets and five retail markets for rice; and four primary wholesale markets, five secondary wholesale markets, and five retail markets for wheat.

For analyzing the price transmission from international to domestic markets the international monthly prices for rice (Thai rice 5% broken) and wheat (US HRW wheat), as available in the World Bank Pink Sheet, were used.

Using the prevailing Indian Rupee-US $ exchange rate, all domestic prices were converted to US $ equivalents. The monthly price series in nominal terms were logarithmically transformed for analyzing the horizontal or spatial integration and vertical price transmission in the domestic markets.

The detailed methodology of econometric analysis for the assessment of market integration and price transmission is given in section 4. The sequence of econometric analysis has been (a) checking for stationarity of price series; (b) testing for cointegration between markets; (c) testing for causality; (d) application of error correction model on causality; and (e) testing for asymmetry.

Apart from the econometric analysis for assessing the transmission of international prices to the primary markets, the effect at the farmgate or farmer level was brought out by analyzing the movement in the following prices before, during, and after the global food crisis:

(a) Minimum support prices of rice and wheat fixed by the government.
(b) Prices actually received by farmers as available from large scale regular farm surveys for estimation of cost of production of rice and wheat.
(c) Wholesale price index of rice and wheat during the post-harvest peak marketing months (October for rice and April for wheat).
(d) Prices of rice and wheat in primary assembling markets.

1.4 STRUCTURE OF THE PAPER

The study is presented in six sections. Some basic features and the role of rice and wheat in the Indian economy have been presented in section 2. These include place of rice and wheat in the cropping system, production performance, changes in consumption levels, state-wise production and marketed surplus, market related taxes on rice and wheat, programmes of increasing rice and wheat production, and levels of input subsidies. India's food security policy review and specific policy measures taken during the crisis period have been presented in section 3. This section includes public procurement and distribution of rice and wheat, the extent of food subsidy, trade policy measures, buffer stocking of rice and wheat, and import-export of rice and wheat. All these policy instruments affect the transmission of international prices to the domestic markets. In the fourth section, we have presented the detailed methodology and results of econometric analysis of domestic market integration of rice and wheat. Both spatial and vertical integration of domestic markets were brought out. Analysis of transmission of international prices to domestic markets forms the scope of section 5. For studying the congruence in international and domestic prices, we have analyzed the long and medium term movement in international and domestic prices of rice and wheat. This section also includes the behavior of prices at the farmgate (received by the farmers). We have used alternative approaches to draw inferences on the impact of global price-surge of 2007-08 on the prices received by the farmers. Main conclusions of the study have been brought out in the last section.

2. RICE AND WHEAT IN INDIAN ECONOMY: SOME FEATURES

2.1 IMPORTANCE IN CROPPING PATTERN

Rice and wheat, taken together, are the basic staple food items for the entire 1.2 billion population of India. There are around 129 million operational holdings (farms), with an average size of 1.23 hectares. Most of these holdings grow either wheat, rice or both. Wheat is a rabi crop, generally

sown in November-December and harvested in March-April. But paddy (rice) is grown in three seasons viz., kharif (sown in May-June), rabi (sown in November-December), and summer (sown in February-March). However, the major output of rice is from the kharif season crop, which accounts for more than 80 percent of total rice production in a normal rainfall year.

Out of the grossed cropped area of nearly 195 million hectares, the share of rice is 23.2 percent and that of wheat is 14.3 percent. Nearly 91 percent of wheat area is irrigated and the rest is dependent on either retained moisture or winter rains. Rice is generally grown as a rain fed crop, but around 59 percent area receives artificial irrigation. There is considerable variation across states in the rice area receiving irrigation.

2.2 PRODUCTION PERFORMANCE

India produced 96 million tonnes of rice in 2010-11 and the production is expected to go up to 103 million tonnes in 2011-12. In the case of wheat, the production is likely to go up from 87 million tonnes in 2010-11 to 88 million tonnes in 2011-12. Performance of area, yield and production of rice and wheat in India during the last three decades shows deceleration in the growth rate of yield for both rice and wheat (Table 2). With the rice area growth not compensating for the deceleration in yield growth, the growth rate of rice production has come down to 1.51 percent per year during 2000-01 to 2010-11, from 3.62 percent per year during the 1980s. In the case of wheat, the area growth could partially compensate for the decline in the yield growth. The growth rate of wheat production during the recent decade at 2.16 percent per year was lower than that during the 1980s and 1990s.

2.3 CONSUMPTION PATTERN

While there is deceleration in the growth rate of production, there is also a declining trend in the relative expenditure on food and cereals and also in the per capita consumption of rice and wheat, both in rural and urban families (Table 3). The expenditure on cereals, which includes rice, wheat and coarse cereals, as a proportion of total expenditure, has declined from 24.2 percent in 1993-94 to 15.7 percent in 2009-10 in rural areas and from 14.1 percent to 4.6 percent in urban areas. This has happened on account of both decrease in quantity consumed as well as decline in the real prices of cereals. The per capita monthly consumption of rice plus wheat has decreased from 13.4 kg in 1993-94 to 11.4 kg in 2009-10 in rural areas and from 10.6 kg to 9.4 kg in urban areas during the same period. As regards the relative prices of cereals, proportion of income spent on meeting the staple food (rice or wheat) needs has been continuously declining, as a part of food security policy.

2.4 STATE-WISE PRODUCTION AND MARKETED QUANTITY

Market integration and price transmission, in the case of a large producing and consuming country like India, depend on the geographical dispersion or concentration of production. While consumers are spread throughout the country, the production and marketed surplus is less spread-out, particularly for wheat. Out of 30 states and five union territories, six states account for 91 percent of wheat production. Around 55 percent of total wheat is produced by Uttar Pradesh and Punjab (Table 4). Rice production is relatively more diversified across states. Ten states account for over 83 percent of rice production. Four states viz., West Bengal, Andhra Pradesh, Uttar Pradesh, and Punjab, together account for 54 percent of total rice production in the country (Table 5).

Owing to the differences in consumption pattern (of rice and wheat), holding size and production per farm, the quantity of production sold or marketed by the farmers varies considerable from one state to the other. The marketed surplus (MS)-output ratio varies from 53 percent to 85 percent for wheat and 29 percent to 99 percent for paddy/rice. Consequently, the ranking of states according to the contribution to total marketed quantity is different than that to the production. For example, in 2008-09, while West Bengal had the highest share of 15.2 in rice production, its share in total rice marketed in India was 11.6 percent, mainly because marketed surplus-output (MS) ratio for West Bengal is 58 percent as against 99 percent for Punjab and Haryana. The implication is that nearly 25 percent of total rice production and 29 percent of total wheat production in India do not enter the market directly. These quantities are 24.5 million tonnes of rice and 23.4 million tonnes of wheat, which were retained by the producer families for self consumption or on-farm uses like payment of wages in kind and as seed in the next season. Even otherwise, in India it has been estimated that 10 to 12 percent of total production of cereals is used/retained for on-farm use and not available for human consumption and marketing.

2.5 MARKET RELATED TAXES ON RICE AND WHEAT

Apart from the marketing policies, an important aspect that impacts market integration for rice and wheat in India is that agriculture, being a state (provincial) subject in the constitution of India, the state governments are entitled to impose taxes or levies on marketing of farm products, including rice and wheat. There is considerable variation in tax incidentals on rice and wheat across Indian states. The taxes are imposed by the state governments and these are added to the price as soon as commodity is transferred from (or sold by) the farmer to the purchaser (trader, miller or government agency). These include purchase, trade or value added tax, market fee, commission of the marketing agents, and other charges (rural development cess, infrastructure development fee, and cess for shelter less people). All these taken together vary from 3.0 percent in Gujarat to 14.5 percent of the price in Punjab. It may be mentioned here that a major part of the marketed surplus in Punjab is sold to the government agencies under price support programme. As a consequence, most of these taxes are in the nature of transfer from the central government or Food Corporation of India (central nodal agency for rice/wheat price support operations) to the state government. These also get added to the economic cost of procurement of rice

and wheat by the central agency, which is sometimes attributed to the inefficiency of FCI vis-à-vis the private trade (which can evade these by by-passing the primary markets). In addition, there is indirect taxation on rice millers, who are required to deliver 50 to 75 percent of rice milled to the government agencies at the prices derived from the minimum support price of paddy, before selling the remaining rice in the open market. This is called levy on rice millers and has been continuing since mid-1960s as a part of food policy instruments.

2.6 RICE AND WHEAT IN AGRICULTURAL DEVELOPMENT PROGRAMS

While looking at the impact of global food prices on market and price integration for rice and wheat in Indian markets, it needs to be recognized that rice and wheat have been the critical agricultural commodities of focus both before and after independence (in 1947). At the time of independence, India had huge gap in demand and supply of cereals, very high cereal prices, and 60 percent of the people were living below the poverty line. Despite several initiatives, the situation did not improve much till the mid 1960s. The dependence on imports peaked at 16 percent with no reserves of foreign exchange. The new development strategy launched at that time focused on increasing the

production of wheat and rice (Acharya, 2009 and Acharya, 2010). The strategy that focused on technology, modern inputs, and price support paid rich dividends and within 15 years, India was comfortable on food security front. While farmers were provided incentives to increase production, there have been several forms of government intervention to safeguard the interests of farmers (rice and wheat growers) and consumers.

Apart from the price support and marketing system improvement (discussed later), three aspects that need to be pointed out are considerable expansion and investment in agricultural research; encouragement to private investment in agriculture by enhanced public investment; and implicit subsidies to farmers on fertilizers, electricity and surface irrigation systems. During the period of crisis (whether global or domestic), the government has responded by enhancing investment in agriculture research and development, which has prompted higher private investment. The government has been supplying fertilizers, electricity and canal irrigation to the farmers at very low prices which did not even cover the cost of production or landed cost of imported fertilizers and maintenance cost of the systems for supply of irrigation and electricity. The difference is construed as implicit subsidies on fertilizers, electricity and irrigation. The implicit subsidies on these three critical inputs, by and large, show an increasing trend. During the recent period, these went up from Rs 360 billion in 2000-01 to Rs 1276 billion in 2008-09. The rate of increase during the last five years has been relatively more than that during the earlier period. It may be mentioned here that one of the important factors in the global price surge has been the increase in the prices of crude oil and consequently on the cost and prices of fertilizers. Between 2005 and 2008, the international prices of fertilizers increased by 205 percent. India is dependent on imported fertilizers, to a considerable extent, but it did not allow the high international fertilizer prices to be passed on to the farmers. Instead, it hiked the fertilizers subsidies from Rs 185 billion in 2005-06 to Rs 766 billion in 2008-09. The prices of fertilizers, in real terms, in India declined by 13.4 per cent during this period. Out of the total input subsidies, rice accounts for 32 percent and wheat for 27 percent (Acharya and Jogi, 2004). Apart from enhancing the input subsidies, a special National Food Security Mission was launched to increase the production of rice and wheat in 305 potential districts of the country.

3. INDIA'S FOOD SECURITY POLICIES AND RESPONSE TO WORLD CRISIS

3.1 OVERVIEW

Agricultural development policy in India has remained focused on food security, both at the macro and household levels. Comprehensive reviews from time to time of policy objectives, strategy, policy instruments and impact is available in the literature (Acharya, 1997; Acharya, 2002; Acharya, 2007; Acharya, 2009; Chand, 2009; and Acharya, 2010). Apart from measures or incentives to increase food production (through technology, modern inputs, irrigation expansion, and infrastructure development), the policy instruments that impact the marketing system directly are (a) assurance of minimum support prices to rice and wheat growers; (b) building up and maintenance of buffer and food security stocks; (c) distribution of subsidized food grains, specially to vulnerable sections of the society, through public distribution system; (d) regulation of traders' marketing practices through *inter alia* imposition of stocking limits and levies; and (e) regulation of imports and exports through canalization, licensing, imposition of trade tariffs, and minimum export prices (MEPs), with a view to maintaining supplies and price stability in the domestic market. All these policy instruments have been rigorously reviewed from time to time and modified and scaled up or scaled down depending on the emerging situations.

For operationalizing the agricultural development and food security policy, a food management policy is in place. Food management policy in India has three basic objectives viz:, (a) announcement of minimum support prices at the time of sowing and procurement or purchases of rice and wheat at these prices, in the event of market prices falling below these levels; (b) maintenance of food buffers for food security and price stability; and (c) distribution of rice and wheat to the consumers, particularly to vulnerable sections, at affordable (subsidized) prices. The procurement of rice and wheat is open ended, while the distribution is governed by the scale of allocation and its off-take by the entitled consumers.

3.2 PRICE SUPPORT PURCHASES/PROCUREMENT OF RICE AND WHEAT

The Food Corporation of India (FCI) is the central nodal agency designated for purchase of rice and wheat at pre-announced support prices. The FCI establishes its own purchase centres but largely depends on the state agencies, which operate on behalf of the FCI. Some state governments also make purchases to meet the needs of their own initiated public distribution programmes, but the quantum of such procurement is a small proportion of total procurement at the national level.

As rice is grown in three seasons, the harvest and market arrivals of paddy/rice are spread through out the year. The rice produced in the kharif season accounts for more than half of the total market arrivals and consequent government purchases. Month-wise pattern of procurement of rice reveals that around 50 percent is procured during October-December, 30 percent during January-March, 15 percent during April-June, and remaining 5 percent during July-September. In the case of wheat, almost the entire procurement is completed during April to June.

The trend in procurement of rice and wheat during the last 16 years is shown in Table 6. As can be seen, there is considerable inter-year variation in the scale of procurement of rice and wheat. However, there is an increasing trend. The average annual procurement of rice during the triennium ending (TE) 2010-11 at 31 million tonnes was considerably higher than that during TE 2000-01 (17.4 million tonnes). Similarly, for wheat, the annual procurement during TE 2010-11 was 25.4 million tonnes as compared to 14.9 million tonnes during TE 2000-01. The procurement during the current marketing season (2011-12) is already at record level for wheat at 28.3 million tonnes and for rice is expected to reach around 35 million tonnes.

Another aspect of procurement that needs to be noted is that the state-wise procurement pattern does not match with the production pattern due to differences in food habits, and marketed surplus-output ratios across the states. During 2008-09, out of the total rice procurement of 33.7 million tonnes, 52.3 percent was contributed by Punjab and Andhra Pradesh, and 27.8 percent by UP, Chhattisgarh and Orissa. These five states together accounted for around 80 percent of total procurement of rice in India (Table 7). In the case of wheat, around 38 percent is contributed by Punjab, 25 percent by Haryana, and 14 percent by UP. These three states account for 77 percent of total wheat procurement in the country. Prior to the launch of a decentralized procurement scheme in 1997, the degree of concentration of procurement was very high. In recent years several non-traditional states have started contributing to the price support purchases of rice and wheat.

3.3 PUBLIC DISTRIBUTION OF SUBSIDIZED RICE & WHEAT

Distribution of subsidized rice and wheat is an important instrument of food security policy in India. During the 1960s and 1970s, as the dependence on imports was high, the quantity distributed was around 10 million tonnes per year. During the 1980s and 1990s, the average quantity hovered around 15 million tonnes per year. However, during the last 10 years, the volume of subsidized grains distributed in the country has considerably gone up. It varied between 36 and 50 million tonnes during 2002-03 to 2009-10. It is expected to have exceeded 60 million tonnes during 2010-11, when food inflation was at very high level. The food grains, mainly rice and wheat, are supplied at subsidized prices under a large number of schemes covering around 50 percent of the total population. These include (a) targeted public distribution system (TDPS), (b) supplementary nutrition program, (c) mid day meals for school children, (d) food for work or employment-linked programs; and (e) other welfare programmes. The TPDS is the major programme and includes 20 million poorest of the poor households (Antyodaya), 65.2 million below poverty line families (BPL), and other vulnerable households that are otherwise above the poverty line (APL).

In addition to these, the government also releases rice and wheat in the open market (open market sales scheme-OMSS) for bulk buyers, small traders and retailers. The quantity of grains released or earmarked under OMSS is determined on the basis of government's stock situation (after meeting the commitment under TPDS and other welfare programmes) and level of market prices. The prices under OMSS are either procurement cost plus rail freight or determined through open auction. The overarching formula for pricing is to dispose of the pre-determined level of excess stocks. Since 2008-09, the Food Corporation of India has been using National Spot Exchange platform to sell wheat under OMSS to bulk buyers. The system of e-auction has ensured better price discovery and quick settlement of payments. The trend in off-take of rice and wheat under various programmes during the last 10 years is shown in Table 8 and 9. Trend in month-wise allocation and off-take of rice and wheat under the PDS shown in Figure 1 shows that the government released higher quantities of subsidized grains since the second half of 2008 and peaked in 2009. Even later, higher off-take continued mainly due to high food inflation in the domestic market.

The new Food Security Bill, which is under the consideration of Parliament, envisages to guarantee pre-defined quantity of staple grains to 75 percent of rural and 50 percent of urban population, with an overall coverage of 63.5 percent of the total population. Out of these, 46 percent of rural and 28 percent of urban population is categorized as priority households, which will be entitled for 7 kg of rice or wheat per capita per month. The remaining households, which include APL, will be covered on 'as and when available basis'.

3.4 ECONOMIC COST, ISSUE PRICES AND FOOD SUBSIDY

Economic cost of rice and wheat that is distributed under public distribution system is the sum of procurement (support) price paid to the farmers, procurement incidentals, and distribution cost of the grains. The procurement incidentals (PI) and distribution cost together account for around 31 percent of the economic cost (Table 10). This also implies that procurement and distribution costs account for around 45 percent of the procurement price paid to the rice or wheat growers.

While the economic cost consisting of procurement (support) price, procurement incidentals and distribution costs shows an increasing trend, the issue prices or prices at which rice and wheat are distributed under various food security programmes have not been raised during the last 10 years.

The latest revision in BPL and APL prices has been in 2002-03. For the poorest of poor (AAY), the prices have not been changed since December 2000, when the scheme was launched. The Central Issue Prices (CIPs) for the major programmes of TPDS are shown in Table 11.

The difference between economic cost and issue prices is met by the government and is shown as food subsidy in the government accounts. Obviously, the quantum of food subsidy has been increasing and has increased rapidly during the recent years. It was Rs 120 billion in 2000-01 and went up to Rs 629 billion in 2010-11 (Table 12). It is estimated to have gone up further during the most recent two years. The obvious reasons are hike in MSPs, increase in procurement incidentals and distribution costs, and expansion in the scale of PDS.

3.5 MAINTENANCE OF BUFFER AND FOOD SECURITY STOCKS

The Government of India (Ministry of Food, Public Distribution and Consumer Affairs) maintains the stocks of food grains, specially of rice and wheat, ever since the middle of 1960s. The Food Corporation of India (FCI) is the nodal agency for the purpose. The maintenance of stocks serves the dual purpose of providing price support to wheat and rice producers and meeting the requirements of the public distribution system. The size of stocks depends on several factors, but these are rigorously reviewed, at least once in five years, and based on several considerations, the norms for minimum level of stocks are specified by the government. The stocks are usually built-up through price support operations, but import route is also used occasionally for the purpose. As the procurement operations, in general, are seasonal, the stocking norms have been specified at four points of time during a year. These are first day of January, April, July and October. The latest revision of stocking norms was done in March 2005. However, owing to the domestic difficult situation during 2006-07, followed by global food crisis of 2007-08, an important component of food security reserves (3 million tonnes of wheat and 2 million tonnes of rice) was added to the norms of July for wheat in 2008 and of January for rice in 2009.

While the norms specify the minimum quantities, the actual stocks are usually higher than the norms. By very definition of minimum norms, there is nothing wrong in actual stocks exceeding the norms. However, if actual stocks exceed the norms by a considerable margin and that too for a longer period, there is a cause of concern and reflects lack of prudence in food management.

The norms and actual stocks of rice and wheat from January 2002 to January 2011 (Table 13) reveal that for rice, India's stocking management met the policy requirements. In the case of wheat, the country faced depletion of stocks (the actual stocks remaining below norms) from July 2005 to January 2008, despite considerable imports of wheat. However, by the time of commencement of global food crisis, India had overcome its difficult food situation and was relatively comfortable since April 2008. In fact, considering the entire ten year period, India faced the situation of surplus stocks (over norms) more frequently than the shortages (Figure 2).

3.6 FOOD MANAGEMENT AND TRADE POLICY MEASURES DURING THE CRISIS PERIOD

Apart from the increased level of procurement and higher quantities of subsidized rice and wheat distribution, the government took several policy measures during 2006-2011 to ward off the adverse impact of global food crisis (Chand, 2009 and Chand *et.al.*, 2010). A chronological review of year-wise decisions related to food management is presented below:

During 2006-07 (April-March)

(i) June 2006: Despite a bonus of Rs. 500 per tonne over and above the MSP, the procurement of wheat was subdued and remained at 9.2 million tonnes, which was considerably short of the public distribution commitments for the year. The stocks at the end of the procurement season were lower than even half of the norms for July 1. Wheat futures were also reflecting volatility, rising till June and then moderating slightly. In view of this, the government decided to import immediately at least 3.5 million tonnes of wheat and directed the State Trading Corporation (STC) to proceed. As the response to tenders floated by STC was poor, the quality specifications for imported wheat were relaxed.

(ii) September 2006: The import tariff on wheat was reduced to zero (which was earlier reduced from 50% to 5% in June 2006) and private sector was also allowed to import wheat to increase the supply in the open market.

(iii) In December 2006, the government permitted duty free imports of wheat flour also.

(iv) In February 2007, government banned the exports of wheat and wheat products. However, it did not impact much because domestic prices were ruling at higher levels (Dasgupta *et.al.*, 2011).

(v) In February 2007, the government banned futures trading in wheat. This was found to be effective in managing wheat price inflation (Dasgupta *et.al.*, 2011).

(vi) Upto the end of March 2007, total imports of wheat aggregated to 6.1 million tonnes, of which 5.5 million tonnes was on government account. This was at an average price of US$ 204.70 per tonne.

(vii) Apart from the actual imports, orders for imports of 1.8 million tonnes (at prices varying from US$ 325 to 400^{+} per tonne) were placed, which materialized in the subsequent period.

(viii) However, the export of rice was continued as usual, which during 2006-07 aggregated to 4.7 million tonnes, including one million tonnes of basmati rice.

During 2007-08 (April-March)

(i) Futures trading in rice was suspended by the Forward Market Commission.

(ii) On October 9, 2007, a ban on export of non-basmati rice was imposed (except some organic rice and for food aid).

(iii) On October 25, 2007: Ban on export of rice was revised and on export above the MEP of US$ 425 per tonne (F.O.B.) was permitted.

(iv) In December 2007: the MEP for non-basmati rice exports was raised to US$ 500 per tonne.

(v) Export of basmati rice was allowed but MEP was imposed at US$ 900 per tonne, to prevent non-basmati rice being labeled as basmati rice for export.

(vi) In March 2008, import duty on semi-milled or wholly milled rice was reduced to zero, to augment rice supplies in the domestic market.

(vii) In March 2008, MEPs for both basmati and non-basmati rice were further raised.

(viii) On March 17, 2008, basmati rice exports were restricted to only two ports (Mundra and Pipavav).

(ix) The imports of wheat on government account continued and till March 2008 aggregated to 1.8 million tonnes (since April 2007).

(x) The central government asked the state governments to impose stock limits on wheat traders and asked large trading companies to declare their purchases and stocks.

(xi) The export of both non-basmati and basmati rice continued during the year and aggregated to 6.5 million tonnes during the year.

During 2008-09 (April-March)

(i) On April 1, export of non-basmati rice was banned and MEP on basmati rice exports was raised to US $ 1200 (which was subsequently lowered).

(ii) On April 29, an export tax of US $ 162 per tonne was imposed on basmati rice.

(iii) Further imports of wheat, on government account, were not considered necessary in view of sufficient stocks, and adequate procurement of rice and wheat, owing to raise in MSPs, good production performance and adequate open market availability.

(iv) Norms of buffer stocks were raised to include two and three million tonnes, respectively, of wheat and rice as food security reserves.

(v) On January 20, 2009, export tax on basmati exports was withdrawn and MEP lowered.

(vi) The measures like zero import tariff, export bans (except on humanitarian or diplomatic considerations), MEP for rice and ban on futures trading continued.

(vii) India exported around 2.5 million tonnes of rice, including 1.5 million tonnes of basmati rice during 2008-09.

During 2009-10 (April-March)

As the inflationary pressures in the domestic economy were emerging, several measures were continued and new measures were taken.

(i) Zero import duty for rice and wheat continued.

(ii) Export of non-basmati rice continued to be banned.

(iii) MEP on basmati rice at US$ 900 per tonnes continued and India exported around two million tonnes of basmati rice (out of four million tonnes of basmati rice production).

(iv) Ban on futures trade in rice and wheat continued.

(v) MSPs for both rice and wheat were hiked.

(vi) In August 2009, stock limits on paddy and rice for bulk consumers were imposed.

(vii) In October 2009, two million tonnes of wheat and one million tonnes of rice allocated to state governments, over and above the normal quota, for distribution from October 2009 to March 2010.

(viii) One million tonnes of wheat was allocated to FCI for open market sales.

(ix) National Agricultural Cooperative Marketing Federation (NAFED) was given 37400 tonnes of wheat and 15500 tonnes of rice for distribution through its outlets at the same rates as charged from the state governments.

(x) National Cooperative Consumers Federation (NCCF) was given 33680 tonnes of wheat and 11000 tonnes of rice for distribution through cooperative consumer stores at the same rates as for NAFED.

During 2010-11 (April-March)

Measures to contain food inflation (though rice and wheat were not the drivers of food inflation) were the following:

(i) The measures taken in 2009-10 continued like (a) Zero import duty for rice and wheat, (b) Ban on export of non-basmati rice, (c) MEP of US$ 900 per tonne on basmati rice, (d) suspension of futures trading in wheat and rice; and (e) stock limits order on paddy and rice (extended upto September 2011).

(ii) State governments were requested to (a) set up farmers' markets; (b) mobile bazaars; (c) improve functioning of cooperatives and civil supplies corporations; (d) waive mandi tax, octroi and other local taxes/levies; and (e) reduce commission agents' charges for smooth flow of rice and wheat across the country.

(iii) A committee of Secretaries, chaired by the Cabinet Secretary, was appointed to regularly monitor the price situation.
(iv) Export of non-basmati rice permitted on diplomatic and humanitarian considerations.
(v) In February 2011, the government allowed the export of 1,50,000 tonnes of three premium non-basmati rice varieties.
(vi) India exported 2.3 million tonnes of rice, which was mainly basmati rice, during the year.

During 2011-12 (April-February)

(i) In July 2011, the MEP on non-basmati rice was reduced to US $ 400 per tonne.
(ii) In September 2011, the ban on export of non-basmati rice and wheat was lifted and exports were put on OGL (Open General Licence).
(iii) The Government also allowed export of three million tonnes each of non-basmati rice and wheat from its stocks.
(iv) The MEP on exports of non-basmati rice was withdrawn.
(v) The government allowed exports of rice through diplomatic channels to Nepal, Bangladesh and Sri Lanka.
(vi) Export of rice to Indonesia allowed through private trade.
(vii) In December 2011, government allowed exports of 10,000 tonnes of non-basmati rice to horn of Africa (Kenya, Somalia and Djibouti) through FCI at the economic cost (Rs 21000 per tonne) under food-aid programme.
(viii) Owing to Indian 30% broken rice being cheaper than comparable Vietnamese variety and also Thai rice, India could export only 2.2 million tonnes of non-basmati rice (from September 2011 onwards) till January 9, 2012. However, till March end, total rice exports touched four million tonnes. Depreciation of Indian rupee also helped in increasing exports. Indian exports reportedly pulled down global prices of rice.
(ix) The futures trading continued to remain banned.

3.7 TREND IN EXPORTS AND IMPORTS OF CEREALS

The policy related to exports and imports of rice and wheat operates within the framework of food security and food management policy. From a situation of heavy dependence on imports of basic staple food in the middle of 1960s, India steered itself to a comfortable situation during the 1990s. The supply-demand balance became visible since the first half of 1980s, when the net imports came down to less than one (0.88) million tonnes. The annual average of net imports of cereals decreased to 0.2 million tonnes in the second half of 1980s. Considering the average for a five year period, India emerged as net exporter of cereals in the early 1990s. Between 1990-91 and 1994-95, India exported an average of 0.5 million tonnes of cereals (mainly rice and wheat). Net exports went up to 2.6 million tonnes per year during 1995-2000, and further to 6.4 million tonnes during 2000-2005 (Table 14).

The exports and imports of rice and wheat for the last 10 years show that India imported about 7.9 million tonnes of wheat during 2006-08 (Table 15). However, taking the five year average from 2006-07 to 2010-11, India has been net exporter of rice plus wheat, mainly owing to rice exports, even though the exports of rice went down considerably. During 2008-09, 62 percent of rice exported from India was basmati rice. The share of basmati rice in total rice exports went up to 94 percent in 2009-10 and further to 96 percent in 2010-11 (Table 16). As mentioned in the preceding section, during the last three years, exports of non-basmati rice were restricted and basmati rice export was allowed only at a price higher than the specified MEP.

As already mentioned, the duty on imports of rice and wheat was reduced to zero during the crisis period, and even beyond, when India was reeling under high food inflation. This was in a situation of bound rates of 100 percent on wheat and 70 percent on semi-milled or wholly milled rice (polished or unpolished).

3.8 IMPACT OF GOVERNMENT INTERVENTION ON NET AVAILABILITY OF RICE AND WHEAT

As mentioned earlier, the government intervened in the market by adopting several policy instruments like regulation of exports and imports, incentives to the farmers in the form of price support purchases, and subsidized public distribution of rice and wheat. The net availability of the grains in the domestic market is affected by all these interventions. The net availability is enhanced by imports, restrictions on exports, and releases from public stocks, beside increase in domestic production. On the other hand, net availability is reduced by exports, restrictions on imports, higher procurement, and built up of the stocks by the government, besides a decrease in domestic production. The Directorate of Economics and Statistics, in the Ministry of Agriculture (Government of India) regularly does the exercise of computing and monitoring the year-wise net availability of a large number of essential commodities, including rice and wheat.

For estimating the net availability of rice and wheat, the first step is to estimate the net production, which is calculated as gross production minus a component of seed, feed, and wastage at the farm level. Net production plus imports minus exports, with adjustment for built-up or depletion of government stocks gives an estimate of net availability. The difference between procurement and public distribution is captured by built-up or depletion of government stocks. The estimate of national net availability is divided by the estimated population for the particular year to arrive at the per capita net availability. The estimates are available on calendar year basis since 1950. The production figures pertain to the agricultural year July to June. For example, net production estimates for calendar year 2003 are based on the gross production estimated for the agricultural year 2002-03. We have used last seven years estimates to assess whether government's intervention during the global crisis period affected the net availability of rice and wheat in the Indian domestic market.

There is a considerable year to year variation in the net availability of cereals (including rice, wheat and other cereals). For example, it increased by 6.2 percent in 2004, decreased by 7 percent in 2005 and again increased by 7.3 percent in 2006. It increased only marginally (by 0.4 percent) in 2007. During the global high price year of 2008, the net availability of cereals declined by 2.1 percent (Table 17). This was despite 20.5 million tonnes jump in net domestic production, mainly due to jump in net exports and huge addition (of 17 million tonnes) of cereals to government stocks. However, in 2009, the net availability went up by 4.8 percent, despite decrease in net production, due to reduction in net exports and lower addition to government stocks. The trend in year to year changes in per capita net availability of rice wheat is almost similarly to that in total net availability (Table 18). The per capita net availability in 2010 was the same as that in 2009.

4. DOMESTIC MARKET INTEGRATION FOR RICE AND WHEAT

4.1 METHODLOGY

A comprehensive review of approaches for analyzing the market integration and price transmission by Rapsomanikis *et.al.* (2006) was helpful in sharpening the methodology for this study. The

following methodology was used to examine the spatial and vertical integration of rice and wheat markets. Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were applied to the price series to check its stationarity, and the order at which it becomes stationary. The non-stationarity of the series is determined by the unit root test. The autoregressive formulation of the ADF test with a drift term is as follows:

$$\Delta p_{it} = a_0 + \gamma p_{it-1} + \sum_{j=2}^{n} \beta_i \Delta p_{it-j+1} + \epsilon_t$$

Where p_{it} is the price in market *i* at time *t*, $\Delta p_{it} = (p_{it} - p_{it-1})$ and a_0 is the intercept or drift term. The joint hypothesis to check for the presence of unit root is: $H_0: \gamma = a_0 = 0$ using ϕ_1 statistic. Failure of the rejection of null hypothesis means that the series is non-stationary. ADF and PP tests determine the order of difference at which the series becomes stationary.

The distribution theory supporting the Dickey-Fuller test assumes that the errors are statistically independent and have a constant variance. Phillips and Perron (1988) developed a generalization of the Dickey-Fuller procedure that allows for fairly mild assumptions concerning the distribution of the errors (Enders, 2004). The PP test, unlike the ADF test, allows the disturbances to be weakly dependent and heterogeneously distributed. The PP test statistics are a modification of the ADF statistics that take into account the less restrictive nature of the error process, hence do not depend on a lag order. Both tests were conducted to determine the presence of unit root in the price series and order of the first difference.

To construct a Vector Error Correction Mechanism (VECM), we model the short-term equilibrium adjustment process among markets, and invoke the Granger representation theorem according to which if two or more series are cointegrated then there is a long-term equilibrium relationship between these series.

For cointegration analysis, we have chosen Johansen (1988) maximum likelihood estimators over Engle and Granger (1987) two-step procedure which is easy to use but has several important limitations and can, sometimes, provide misleading results. The Johansen approach circumvents the two-step procedure and can check for multiple cointegrating vectors.

Johansen (1988) relies heavily on the relationship between the rank of a matrix and its characteristic roots. The Johansen procedure is a multivariate generalization of the Dickey-Fuller test. The formulation is as follows:

$$p_{it} = A_1 p_{it-1} + \epsilon_t$$

So that

$$\Delta p_{it} = A_1 p_{it-1} - p_{it-1} + \epsilon_t$$

$$\Delta p_{it} = (A_1 - I) p_{it-1} + \epsilon_t$$

$$\Delta p_{it} = \Pi p_{it-1} + \epsilon_t$$

Where p_{it} and ϵ_t are (nx1) vectors; A_1= an (nxn) matrix of parameters;

I = an (nxn) identity matrix; and $\Pi = (A_1 - I)$ matrix.

Rank of $(A_1 - I)$ matrix equals the number of cointegrating vectors. The crucial thing to check is whether $(A_1 - I)$ consists of all zeroes or not. If it does, that implies all the $\{\Delta p_{it}\}$ in the above VAR are unit root processes, and there is one linear combination of $\{p_{it}\}$ which is stationary, and hence

the variables are not cointegrated. The rank of matrix Π is equal to the number of independent cointegrating vectors.

Trace test was used to determine the presence of cointegrating relationship between the price series. Using the estimates of the characteristic roots, the test for the number of characteristic roots that are insignificantly different from unity was conducted using the following statistic:

$$\lambda_{trace}(r) = -T \sum_{j=r+1}^{n} \ln(1 - \hat{\lambda}_j)$$

Where $\hat{\lambda}_j$= the estimated values of the characteristic roots (eigen values) obtained from the estimated Π matrix; and T = the number of usable observations.

After establishing, by the use of Johansen procedure, that two markets, p_1 and p_2 are cointegrated, we conducted Granger (1969) causality tests to find out the order and direction of short-term and long-term equilibrium relationships. Whether market p_1 Granger causes market p_2 or vice-versa was checked using the following equation:

$$p_{1t} = c + \sum_{j=1}^{n} (\phi_j p_{1t-j} + \delta_j p_{2t-j}) + \epsilon_t$$

A simple test of the joint significance of δ_k was used to check the Granger causality, i.e. $H_0: \delta_1 = \delta_2 = \ldots \delta_n = 0$.

It may be mentioned here that the Granger Causality test determines the effect of lagged values of explanatory variables on the current values of dependent variable and does not indicate the instant causality or transmission. Due to this limitation, these results were used with caution.

Error Correction Model (ECM)

After establishing the cointegrating relationships between the two price series, the next step is to construct the Vector Error Correction Model (VECM) to model the short-term disturbances and adjustment mechanism to estimate the speed of adjustment. The VECM has almost the same formulation as of the cointegration equations but with addition of the errors from the simple regression of the hypothesized long-term relationship.

The difference in the value of a variable in period t and its value in t-1 could be explained by a number of factors. The error correction model (ECM) includes the variable's co-integration (or long run) relationship with other variables as one of the explanatory variables. The ECM would explain the difference in y_t and y_{t-1} (i.e. Δy_t) by the following method:

$$\Delta y_t = \alpha + \mu(y_{t-1} - \beta x_{t-1}) + \sum_{i=0}^{i=t} \delta_i \Delta x_{t-i} + \sum_{i=1}^{i=t} \gamma_i \Delta y_{t-i}$$

It includes lagged differences in both x and y, which have a more immediate impact on the value of Δy_t. For example, if Δx_t increases by one percentage point, then Δy_t would increase by δ percentage point. The value of β indicates the percentage point y has to change in the long run in response to changes in x. Therefore, part of the change in Δy_t could be explained by y correcting

itself in each period to ultimately reach the long run path with x. The amount by which the value of y changes (or corrected) each period is signified by μ. This coefficient (μ) indicates the percentage of the remaining amount that y has to move to return to its long run path with x. For example, assuming x and y are representing international and domestic price respectively, if β = 0.64 and μ = 0.50, then for a one percent increase in x, the value of y has to rise by 0.64 percentage point (both x and y are logs). However, the value of y will not rise by 0.64 in one period. In the first period after the shock the value of y will have risen by 0.32 (50 percent of the remaining 0.64). The value of y increases by 0.16 after the second period (50 percent of the remaining 0.32) and so on until y reaches its long run path with x (Alogoskoufis and Smith, 1991). In short, the speed of adjustment is measured by μ.

In explaining changes in a variable, the ECM accounts for its long run relationship with other variables. The advantage of ECM over an ordinary OLS model is that it accounts for dynamic relationships that may exist between a dependent variable and explanatory ones, which may span several periods.

Asymmetric Error Correction Model (AECM)

The ECM indicates the speed with which a variable returns to its long run relationship path with another variable. However, the speed of adjustment may depend on whether the variable is subjected to negative or positive shock. There could be asymmetry in response to deviations from the long run path, depending on whether the variable is above or below the long run path. Following Prakash *et al* (2001), the positive and negative deviations from a simple OLS estimate were incorporated into the vector error correction model (ECM) as dummy variables. The positive and negative deviations were assigned positive or zero, and negative or zero value respectively. The test for asymmetry first estimates the values of μ and ϕ in the following equation and then tests to determine if they are statistically equal. In the case where they are not equal then there is asymmetry in transmission. For example, if μ > ϕ, then price increase in x is transmitted to y faster than a price decrease. When the error term is negative in the OLS, it means that the explanatory variable has increased and the error term needs to be negative in order to balance the equation The AECM is represented by the following equation:

$$\Delta y_t = \alpha + \mu(y_{t-1} - \beta x_{t-1})^- + \varphi(y_{t-1} - \beta x_{t-1})^+ + + \sum_{i=0}^{i=t} \delta_i \Delta x_{t-i} + \sum_{i=1}^{i=t} \gamma_i \Delta y_{t-i}$$

Asymmetry in price transmission has been cited in other studies. Kinnucan *et. al.* (1987) find that retail prices in the dairy market adjust faster to increases in dairy farm prices than to their decrease (Kinnucan and Forker 1987). Abdulai (2000) concludes that the local maize markets in Ghana are integrated with the central market and prices in these markets respond faster to price increases in the central market than decreases. Therefore, detecting and measuring asymmetry is important in fully understanding the dynamics and extent of price transmission in different price shock regimes.

4.2 INTEGRATION OF RICE MARKETS

4.2.1 TEST FOR STATIONARITY OF PRICE SERIES

To check the stationarity in price series, Augmented Dickey Fuller (ADF) and Phillip-Peron (PP) tests were applied at level and first difference to the logarithmically transformed monthly prices of rice.

These tests yielded almost similar results when the prices were taken as nominal, real and US $. We report results of the price series in US$ in Table 19. For price series to be cointegrated these must be stationary at the same order. Our results show that none of the price series (international, wholesale, retail and farm gate) is stationary. However, at first difference, all the price series turned out to be stationary. This means that all the price series are integrated of the order one, that is [I(1)], when linear trend is excluded from the unit root test. It also explains the long-run equilibrium relationship in rice markets.

In the short-run, markets, however, can deviate from the long-run equilibrium path due to exogenous shocks, and the original long-run equilibrium path is reinstated only when some error correction process begins. The error correction process is explained by the Vector Error Correction Model (VECM). The optimal lag length of the Vector Autoregressive Model (VAR) is selected based on the minimum value of Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC). Based on these criteria we identified 'two months' as the optimal lag length (p = 2) for all the price series based on VAR model. AIC and SIC values were computed by changing lag and the ones corresponding to the lag where they were minimum were chosen. Competitive conditions will force the price to adjust instantaneously to any new piece of information so that all available information is reflected in the prices (Wilson, 2001). If markets are integrated, then these are interdependent and there exists price dissemination across markets.

4.2.2 WHOLESALE PRICES

The integration of wholesale prices between selected pairs of markets was tested using Johansen cointegration test (Table 20), which shows cointegration between Mumbai and Kolkata; Delhi and Chennai; and Hyderabad and Chennai, although these markets are far apart geographically. Granger causality tests suggest bi-directional causality between Delhi and Chennai markets. However, Delhi Granger cause Chennai is more significant. There is also bi-directional causality between Hyderabad and Chennai markets. The causality between Mumbai and Kolkatta markets is unidirectional from Mumbai to Kolkatta. Coefficients of the long-run cointegrating equations (Johansen maximum likelihood approach) for different pairs of markets (Hyderabad-Chennai; Chennai-Delhi, and Kolkata-Mumbai) are statistically significant at less than 1% level, which suggest that that there is a long-run equilibrium relationship between these pairs of markets (Table 21).

The results of the error correction model (ECM) are presented in Table 22. The coefficient of the speed of adjustment for different pairs of markets is negative which implies that wholesale prices in different markets tend to converge in the long-run. The coefficient of the speed of adjustment between Chennai and Hyderabad is -0.215, which indicates that adjustment process is relatively fast with around 22% of divergence from the long-run equilibrium being corrected each month. The speed of adjustment is comparatively slow between Chennai and Delhi, and between Kolkata and Mumbai (It may be noted that no-lagged difference could not be included as the Johansen standard methodology did not permit it in the ECM model, to allow for the contemporaneous effect of the explanatory variable).

In the short-run, both Delhi and Hyderabad wholesale prices have a tendency to come closer to the wholesale prices in Chennai, while shocks in Chennai market have a tendency to move away from its equilibrium process. In Kolkata market, its own lagged wholesale prices and prices in Mumbai market tend to move closer. The short-run dynamics, thus, indicates that changes in wholesale prices in Chennai, Delhi, Hyderabad, Kolkata and Mumbai are transmitted to Chennai and Kolkata markets

contemporaneously though not fully. This indicates that these markets are well-integrated in the short-run.

In order to examine whether price transmission between these pairs of markets is symmetric or not, we tested hypothesis of equal coefficients of the negative deviations and positive deviations. For symmetric price transmission between a pair of wholesale markets, the coefficient on the negative deviation should be equal (statistically) to the coefficient on the positive deviation. Using this criterion, it was found that there is a symmetric price transmission between Chennai and Hyderabad, and asymmetric price transmission in other pairs of markets (Table 23). Asymmetric response of one price to another implies non-linear adjustment. Slow and incomplete transmission of price signals from one market to another may occur due to several factors like lack of competition, collusive behavior among traders and increased role of middlemen, in addition to the differences in market resources, infrastructure, policies and institutional capacity (Scherer and Ross, 1990; Abdulai, 2000; Serra and Goodwin, 2007; Mukim *et.al*., 2009).

4.2.3 RETAIL PRICES

The pair-wise integration of retail markets of rice is shown in Table 24. Retail markets exhibit the same pattern of integration as the wholesale markets. Three pairs of markets, namely Mumbai-Kolkata, Delhi-Chennai and Hyderabad-Chennai are integrated.

4.2.4 FARMGATE PRICES (PRIMARY WHOLESALE MARKETS)

Integration of different pairs of primary wholesale markets in different regions is shown in Table 25. Primary wholesale markets of Bankura and Cooch Behar, adjoining Kolkata, are neither integrated themselves nor with any other market in the country, except with Amritsar. However, in the southern region, primary wholesale markets of Nizamabad and Vijyawada in Andhra Pradesh, and Kumbhakonam and Chidambaram in Tamil Nadu are integrated. Primary wholesale market of Nizamabad is also integrated with Kumbhakonam and Chidambaram markets, while Vijawada is not. In the north, primary wholesale rice markets of Karnal and Amritsar are integrated. This gives an idea of intra-state and inter-state regional primary wholesale market integration and linkages with the national market. Geographically far apart markets, like Karnal shows integration with Nizamabad and Chidambaram, and Amritsar with Vijaywada, Kumbhakonam and Chidambaram. Hence, we conclude that geographically dispersed markets are linked spatially in the long-run, which implies regional linkages even among primary wholesale markets. Spatial pricing relationships are consistent with market integration, suggesting that prices provide relevant signals to the regional markets within and across states; hence all exchange locations are in the same economic market.

4.2.5 VERTICAL PRICE TRANSMISSION (WHOLESALE TO FARMGATE)

The coefficients of the long-run cointegrating equations for price transmission from wholesale to farmgate for different pairs of markets (Delhi wholesale-Amritsar and Karnal primary wholesale; Chennai wholesale-Kumbhakonam and Chidambram primary wholesale; and Hyderabad wholesale – Nizamabad primary wholesale) are statistically significant at less than 1% level (Table 26) indicating that there is a long-run equilibrium relationship between wholesale and farmgate prices. The integrating coefficient in each of the equation is close to one, implying that in the long-run the wholesale prices and farmgate prices move in tandem.

The results on speed of adjustment between wholesale and farmgate prices are shown in Table 27. There is a considerable difference in the speed of adjustment. In the northern region, prices in

Amritsar primary wholesale market adjust slowly, that is 11% percent per month, while prices in Karnal primary wholesale market adjust at a faster rate (27%) in response to a disturbance in the equilibrium. In southern markets, the speed of adjustment is between 15 and 20%. However, for different markets, short-run dynamics are different. In Amritsar market, a change in wholesale price (lagged) in Delhi causes a marginal tendency to move away, while reverse happens in the case of Karnal. In southern region, a change in wholesale prices in all the selected markets causes them to drift apart. It may be pointed out that contemporaneous effect of the independent variable, which we could not include, may change some of these results.

To examine the nature of price transmission from wholesale to farmgate, we tested the hypothesis of equal coefficients of the negative deviations and positive deviations between wholesale and farm-gate prices. The dynamics of price transmission is contrasting between northern and southern markets. In southern region, price transmission is asymmetric, while in northern region it is symmetric. The model equation is implicit in Table 28.

4.3 WHEAT MARKET PRICE INTEGRATION

The methodology to examine the spatial and vertical integration of wheat markets is the same as for rice, the details of which were presented in section 4.1

4.3.1 TEST FOR STATIONARITY

The results of ADF and PP tests applied at level and first difference to the logarithmically transformed prices of wheat are shown in Table 29. We obtained similar results when prices were taken as nominal, real and in US $. The results pertain to the price series converted to US $. As in the case of rice, for wheat also the price series for the selected markets are non-stationary. However, at first difference, the null hypothesis of the presence of unit root was rejected at 1% level of significance for all the price series (international, wholesale, retail and farmgate). This implies that all the price series are integrated of the order one i.e. [I(1)], when linear trend is excluded from the unit root test. It shows a long-run equilibrium relationship in wheat markets.

4.3.2 WHOLESALE PRICES

The results of Johansen cointegration test on pair-wise integration of wholesale markets are given in Table 30. There emerge two patterns of integration. One, there is integration of Delhi wholesale market with geographically far apart wholesale markets of Mumbai, Bangalore and Hyderabad. The Granger causality test indicates a direction of price signals from Delhi to Mumbai, Bangalore and Hyderabad. This is expected as wheat production is concentrated in north India. Two, there is integration between geographically proximate markets of Bangalore and Hyderabad with Chennai. Here, the direction of Granger cause is from Bangalore and Hyderabad to Chennai wholesale market.

The coefficients of long-run cointegrating equations between different pairs of wholesale markets are statistically significant at less than 1% level, providing evidence of a long-run equilibrium relationship between these pairs of markets(Table 31).

Results of the vector error correction model are presented in Table 32. The coefficient of the speed of adjustment for different pairs of markets is negative implying convergence of wholesale prices in the long-run. The coefficient of the speed of adjustment ranges from

-0.107 to -0.152 which indicates that between 11 and 15% of divergence from the long-run equilibrium is being corrected each month. The process of adjustment, however, is relatively faster between Chennai and Hyderabad and between Mumbai and Delhi wholesale markets.

The effects of lagged prices in the independent and dependent markets are positive as well as negative in the identified integrated markets. This suggests that, in the short-run, price shocks are contemporaneously transmitted in these markets but not fully. For example, while a change in wholesale prices in Delhi market would lead to divergence in wholesale prices in Mumbai and Bangalore in the short-run, the changes in wholesale wheat prices in these markets themselves have a tendency to cause convergence.

The t-test for the difference between positive and negative deviations between the pairs of integrated markets is statistically significant at 1% level, indicating that price transmission in these pairs of markets is asymmetric (Table 33). The asymmetry in price transmission is very high in the markets which are integrated with Delhi market. This is expected as Delhi is the main supplier of wheat to the geographically distant markets. The transfer and transaction costs from the major producing region to the deficit region are high. This also implies that there is a considerable scope for spatial arbitrage in these markets.

4.3.3 RETAIL AND FARMGATE PRICES

Retail prices of wheat in different markets exhibit a similar pattern of integration as observed for the wholesale prices. Since wheat production is concentrated in northern India, farmgate price series in all primary wholesale markets are co-integrated, except Kota with Karnal (Table 34). This is expected because Kota and Karnal are independently linked to different secondary wholesale markets. Moreover, government's procurement programme, available storage facilities and adequacy and otherwise of transportation infrastructure may cause relatively less price integration among this pair of primary wholesale markets. The quality of wheat produced in Kota region is relatively superior, which also comes in the way of perfect price integration. The demand-supply dynamics of durum wheat is different than the normal wheat.

4.3.4 VERTICAL TRANSMISSION (WHOLESALE TO FARMGATE)

The results of the cointegrating equations for price transmission from wholesale (Delhi) to primary wholesale wheat markets (Amritsar, Moga and Karnal) are presented in Table 35. The coefficient of the long-run cointegrating equation for each of the primary wholesale wheat market is statistically significant at less than 1% level, revealing that there exists a long-run equilibrium relationship between farmgate and wholesale prices. The value of the coefficient in all the equations is close to unity which suggests that a 1% change in Delhi wholesale prices will cause almost an equal change (0.90-0.96%) in the farmgate prices (These results have been generated from the ECM in EVIEWS).

The results of the error correction models are presented in Table 36. The estimates show that speed of adjustment between wholesale and farmgate prices is fairly fast (-0.33 to -0.57) in all the markets feeding Delhi wholesale market, implying that 33% to 57% of divergence from long-run equilibrium is being corrected each month. The speed of adjustment, however, is faster in Karnal, followed by Moga and Amritsar.

The coefficients of their own lagged prices in the primary wholesale markets are positive meaning thereby that, in the short-run, changes in farmgate prices lead to divergence in the equilibrium

adjustment process. On the other hand, the changes in wholesale prices in the Delhi market cause a convergence in Moga and Karnal markets (Table 37). The difference between negative and positive deviations between Delhi wholesale prices and farmgate prices in Amritsar is substantial and is significant at 1% level indicating that price transmission from wholesale to farmgate is asymmetric there. However, the nature of price transmission in Karnal and Moga is symmetric. Amritsar market is far away from Delhi than the other two markets, hence there is a larger scope for arbitrage in Amritsar market.

5. TRANSMISSION OF INTERNATIONAL PRICES TO DOMESTIC MARKETS

5.1 LONG TERM TREND IN INTERNATIONAL PRICES

Analysis of nominal prices (US$ per tonne) by Chand (2008) has shown that prices of wheat (HRW) during 1950 to 1971 hovered below 100, averaging at 65. These increased in 1973 and 1974, but hovered between 100 and 200, with an average of 146 till 2005. Since then, the prices sharply increased touching US$ 440 in March 2008. However, wheat prices in real terms have been declining ever since the world oil crisis of 1973-74 except the upsurge of 2006-08. More or less similar was the trend in nominal and real prices of rice (Thai 5 % broken) in the international market up to April 2008 (Table 38).

It may be mentioned here that after a steady decline for a long period, international prices of almost all food commodities, in both nominal and real terms, increased drastically since 2005. Between 2005 and 2008, the international food price index, in real terms, increased by 63 % (Table 39). The rise in prices of cereals was even faster. During this period, rice price almost doubled and that of wheat increased more than 76%. After reaching a peak in April 2008, prices of both rice and wheat declined until June 2010 but started rising again. The rise in prices has been attributed to a number of factors including natural calamities, depleting stocks, speculative tendencies, diversion of grains for ethanol production and rise in oil prices. Rise in oil prices directly impacts cost of fertilizers - one of the most critical inputs in crop production. Therefore, food prices are expected to be highly correlated with fertilizer prices. Between 2005 and 2008, fertilizer prices in real terms in the international market increased by 205%.

Since March-April 2008, international wheat prices started softening and revealed a declining trend till May-June 2010, after which not only the down-turn was reversed, but the prices of wheat more than doubled within a year. In the case of rice also, the prices went up by around 15 percent from June 2010 to June 2011 (Table 40).

5.2 CONGRUENCE BETWEEN INTERNATIONAL PRICES AND DOMESTIC PRICES

The term congruence connotes identical geometric shapes. We have used this term to represent similarities (and lack of it the differences) in price changes in the international and domestic markets. Some studies have shown the lack of congruence between international prices and Indian domestic prices of rice and wheat. For example, Chand (2008 and 2009) has shown that India, through policy interventions, did not allow, to a great extent, the transmission of abnormally high global prices of cereals in 2007-08. Though domestic prices of rice and wheat did increase substantially, but the increase was considerably lower than that in the global prices. The rice and wheat prices in India not been affected by the abnormal increase in international prices was mainly owing to (a) considerable increase in domestic production; (b) timely and effective government intervention in the domestic market; and (c) considerable insulation of the cost of production from transmission of the increase in

crude oil prices in the international market. Even after the global crisis of 2007-08, the movement in monthly index numbers of international and domestic prices of both rice and wheat has been almost in the opposite direction (Figure 3).

The transmission of changes in international prices to the domestic prices depends on several factors viz., quality of grains, distance & transportation costs, and most importantly the trade policy wedges. As mentioned earlier, trade policy instruments like export bans, import duties or restrictions, canalization, and imposition of minimum export prices (MEPs) have been used as important instruments as a part of food security policy in India. A recent study, on Indian wheat price transmission, by Dasgupta *et.al*. (2011) has shown that price formation in wholesale domestic wheat markets is weakly and only moderately affected by international price movements mainly due to intermediation by policy wedges and other domestic factors. However, there is some effect through wheat futures trade behaviour on both domestic wholesale price as well as relative domestic prices to international prices. Nevertheless, this effect is still being debated and the evidence is inconclusive. In any case, as the ban or otherwise on operation of futures trading is also being used by the government off and on, the possibility of global price behaviour impacting the domestic prices of rice and wheat is further ruled out.

The lack of congruence between world and domestic prices of rice and wheat during the period of world food crisis is also visible from monthly movement of inflation rates. Global annual inflation in rice peaked with three digits in April 2008, at 206 percent. However, this declined progressively to 123.3 percent by September 2008, and further falling into two digits from 94.4 in October 2008 to 27.1 percent by February 2009 and even to 4.7 percent in March 2009. The trend in domestic rice prices (reflected in WPI) was in contrast to the world prices. From April to September 2008, the inflation fell from about 8.7 percent to 5.4 percent, but subsequently rose to double digits at 11.2 in October 2008 and increased to 17.1 percent in February 2009 (Table 41).

In wheat, the global inflation declined from 82.7 percent in April 2008 to 26.8 percent in August 2008, and posted increasingly negative rates during September 2008 to March 2009. Against this, the inflation in domestic prices of wheat was around 7 to 8 percent during April to September 2008 and 5 to 6 percent during October 2008 to March 2009.

More evidence of lack of congruence is also available from the comparison of changes in annual index numbers of global and domestic prices of rice and wheat (Table 42). For international prices, we have taken FAO cereal price index (CPI) and for domestic prices, official wholesale price index (WPI) for rice and wheat for the recent six year period. It is observed that the rate of increase in prices during 2006 to 2008 was considerably higher in the international market, than that in the domestic market. Further, in 2009-10, while the change in the international market was negative and very high, it was positive and quite high in the domestic market. However, subsequently the modest rise was observed in both international and domestic market. As the policy milieu in Indian foodgrain markets, reviewed in the preceding section, shows, the higher rates of price increase in rice and wheat markets in India, despite comfortable domestic production situation, was owing to considerable hikes in minimum support price of wheat and rice. Between 2005-06 and 2009-10, the support price of rice (common grade) was increased by 75 percent and that of wheat by 69 percent.

Another aspect of lack of congruence in international and domestic prices of rice and wheat is the India's policy of maintaining price stability of these staple foods, which is revealed from Table 43.

During the five year period for which comparable data are available (includes period of global food crisis), the coefficient of variation in domestic prices (received by the farmers) was considerably lower (less than half) than that in international prices of both rice and wheat. Moreover, there was a steady increase in prices that accrued to farmers in India, whereas international prices witnessed up and down swings during this period. Evidently, India's mix of policies could provide right and sustained price signals to the producers of rice and wheat for a positive supply response and at the same time maintaining a large scale subsidized public distribution to safeguard the food security needs of a large section, particularly vulnerable sections of the population. Dasgupta *et.al.* (2011) have found that PDS has played an important role in stabilizing the prices of rice and wheat in India. Had the changes in international prices been allowed to transmit to the domestic markets, the consumption of rice and wheat would have been adversely affected. De Janvry and Sadoulet (2009), based on the simulation exercise, have reported that rural poor in India would have been affected more by the transmission of international prices to the domestic markets.

The movement in monthly prices of rice and wheat in the international market and wholesale and retail prices in important consumption centres of India show the relative stability in domestic prices as against wide fluctuations in international prices (Figure 4 and 5). The correlation coefficients between international prices and domestic prices at different market centres for the pre-crisis and the crisis periods are given in Table 44. In the case of rice, the correlation between international and wholesale prices is not significant in pre-crisis as well as in crisis periods in most of the markets. In fact, the relationship weakened during the crisis period. On the other hand, domestic wheat prices appear to be significantly correlated with international prices in the pre-crisis period, which during the crisis period became insignificant. Similar observations were made by Ghoshray (2011). It may be mentioned here that, during 2006 and 2007, India faced critical shortage of wheat and had to import 7.9 million tonnes to meet its domestic needs.

5.3 COINTEGRATION OF INTERNATIONAL AND DOMESTIC PRICES

We applied Johansen cointegration test to further probe the issue of cointegration between international and domestic prices of rice and wheat, and the results are presented in Table 45. For integration to exist between two markets the estimated eigen value from this test ought to be close to one, which is not in the cointegration equations for rice as well as wheat. We applied trace test to ascertain significance of the estimated eigen values. The test shows that none of the eigen value from the cointegration equation for rice is statistically significant at 5% level of significance, leading us to conclude that there is no cointegration between domestic and international rice prices. However, for wheat the Johansen test provides evidence of cointegration of Delhi and Chennai wholesale prices with international prices. Chennai is a thin market for wheat and any such significant statistical relationship may be spurious or co-incidental.

Since Delhi wheat prices are cointegrated with international prices, an attempt was made to capture short-run dynamics between international and domestic prices. We estimated three cointegrating equations to assess the effect of changes in international prices (i) on wholesale prices, (ii) farmgate prices, and (iii) retail prices. Of the three primary wholesale markets for wheat, we found Moga market providing statistically sound results. Hence, we present results for Moga market only. The coefficients of the long-run cointegrating equations are statistically significant at 1% level (Table 46), indicating that there is a long-run equilibrium relationship between international and domestic prices at different levels of market. The long-run elasticity for price transmission from international to wholesale and retail is larger than to farmgate prices.

The coefficients of the speed of adjustment are negative irrespective of market levels (Table 47). However, the correction in wholesale prices, in response to changes in international prices, is slow than in farmgate and retail prices. In the case of wholesale prices, approximately 4.4% of the divergence from long-run equilibrium is being corrected as against 47.5% in the case of farmgate prices and 29.6% in the case of retail prices. Interestingly the short-run shocks in international prices do not have any significant influence on domestic prices at any level of the wheat supply chain. India allows a small fraction of international prices to be transmitted at the level of price discovery in the domestic market (wholesale prices). The higher speed of adjustment of farmgate prices and retail prices need to be looked through the policy lens. The government provides support prices to producers, and we find a co-movement of support prices and international prices though the increase in the former is not commensurate with surge in international prices.

The price transmission from international prices to farmgate and retail prices is asymmetric (Table 48), which shows that farmgate and retail prices respond differently to international prices in its rising and falling phases. The price transmission is symmetric in the case of wholesale prices.

5.4. PRICES AT THE FARMGATE

We have also analyzed the changes in prices at the farmgate level, particularly during and around the period of high global prices in 2007-08. As India faced very high food inflation during the period of two years following the global crisis, we have also looked at the prices at the farmgate till the availability of latest price data.

5.4.1 INDEX OF PRICES RECEIVED AND TERMS OF TRADE FOR FARMERS

The index numbers of prices received (PR) and prices paid (PP) by the farmers, and of the terms of trade (PR divided by PP) are worked out regularly by the Commission for Agricultural Cost and Prices, Government of India. The estimates for the last 10 years (2000-01 to 2009-10) presented in Table 49 show that the index numbers of prices received by the farmers have consistently gone up during the last 10 years. The annual increase during 2007-08 (11.4 %), 2008-09 (8.3 %) and 2009-10 (17.3 %) was considerably higher than that during the preceding years. The sharp increase during 2009-10 was contradictory to global prices trend, but was consistent with the high food price inflation in India. Similar were the movements in the index of prices paid by the farmers. Obviously, the index of terms of trade for the farmers did not swing either way except a marginal upward moment to 102.6 during 2009-10. It may be mentioned here that these index numbers pertain to all agricultural commodities and not specific to rice and wheat.

5.4.2 PRICES RECEIVED BY SAMPLE FARMERS

The information on prices actually received by the farmers for paddy and wheat is also available from cost of production studies conducted by the Ministry of Agriculture through State Agricultural Universities, for use by the Commission for Agriculture Cost and Prices and in turn by the government itself in taking the price policy related decisions. These are based on a comprehensive study of around 9000 farmers for which plot (crop-parcel) wise data are maintained on almost daily basis. Based on the state averages of quantity and value of produce, the implicit price received by the farmers for various crops, including wheat and paddy, are available from published records of cost of production studies. The relevant prices for the global crisis period are shown in Table 50. These are the estimates available for the latest year. Only the most important four states, each for rice and wheat, in terms of production and/or marketed surplus were selected for this purpose. There is clear

evidence that the paddy and wheat growers of India received considerably higher prices during 2006-07 and 2007-08 and it continued in 2008-09, owing to the mix of domestic policies pursued by India, as reflected in the hikes in MSPs.

5.4.3 FARM HARVEST PRICES

Farm harvest prices (FHP) are the prices prevailing in primary wholesale markets (as these are nearest marketing centers, farmers sell a major part of their surplus produce in these markets) during the six weeks after the harvest of the crop. These prices are collected by state level departments of economics and statistics and transmitted to the Directorate of Economics and Statistics of the Union Ministry of Agriculture. These prices are available with a lag at the state level. The data in Table 51 show that in the case of wheat, the FHPs were 14.7 percent higher in 2006-07, 21.9 higher in 2007-08 and 21.7 percent higher in 2008-09 than that in the respective preceding year. In the case of paddy also, the year-on increase in FHP was 7.9 percent in 2006-07, 8.3 percent in 2007-08 and 19.6 percent in 2008-09. Thus, there is clear evidence that Indian farmers received considerably higher prices during the period of global crisis.

5.4.4 WHOLESALE PRICE INDEX DURING PEAK MARKETING MONTHS

In India, peak marketing month for rice/paddy is October and for wheat it is April. We also analyzed the movement in the wholesale price index (WPI) for these months over the last 10 year period and compared with the movement in international prices for the corresponding month (as quoted by the International Monetary Fund). We converted the base of WPI to 2001 and computed the index of international prices with 2001 as 100. It can be seen that (a) while there have been violent fluctuations (up and down swings) in international prices, there has been a gradual and steady upward movement in domestic prices; and (b) the annual increase in price of both wheat and rice in India, during the peak marketing months has been substantially more during the 2007 to 2009. This analysis also provides evidence that Indian farmers received better prices for wheat and rice during the period of global crisis and following years, when international prices dipped (Table 52).

5.4.5 MINIMUM SUPPORT PRICES

In the preceding section, it was seen that the prices received by the farmers have, by and large, moved in line with the prices paid by the farmers (for inputs, farm investment, and consumer goods), except that during 2009-10 (the period of very high domestic food price inflation) increase in index of prices received exceeded that of prices paid. It may be mentioned here that the MSPs are fixed by the government after taking into account *inter alia* the cost of production, movement in the prices of inputs, international prices situation, and demand-supply scenario in the country. It is in this context that the hike in MSPs of rice and wheat during the period of 2006-07 to 2009-10 needs to be seen (Table 53). During 2006-07, a hike of around nine percent was found necessary on account of lower procurement which forced the government to go for huge imports of wheat at much higher prices (compared to MSPs) to meet PDS commitments. The hike in subsequent two years i.e. 2007-08 and 2008-09 at around 20 percent each time was even higher. Even during 2010-11, the hike was around 11 percent in MSP of paddy and 8 percent in that of wheat. There were three reasons for such unprecedented hikes during these four years. One, the cost of production was rising due to general high inflation in Indian economy. Two, due to very high food price inflation, the government wanted to provide relief to the general public by increasing the allocation under PDS. And, three, to meet additional PDS needs and to keep in check speculative tendencies in domestic markets, the government tried to provide incentives to farmers to increase production and to contribute higher quantities to the government at MSPs (there is no compulsion on farmers to sell to the government),

thus in a way ruling out the compulsion of imports. Thus, the Indian farmers or wheat and rice growers definitely received higher assured prices during the period of global crisis of 2007 and 2008, but it was owing to the policy response of India, as a part of its own food security policy.

5.4.6 EFFECT OF INTERNATIONAL PRICES ON MSPs

As already mentioned, MSPs for paddy (rice) and wheat are fixed by the government and, therefore, are administered prices. These are decided by the government on the recommendations of Commission for Agricultural Costs and Prices (CACP). The CACP takes into account a large number of factors in formulating its recommendations but one of the important factors is the international price situation. Obviously, international prices enter into the government's decision related to the level of MSP of rice and wheat. For assessing the impact of international prices on the MSPs fixed by the government, we used a step-wise regression of MSP separately of rice and wheat on respective international prices for the latest 15 year period (1996 to 2010). As the MSPs in India, are meant to serve as a medium- term price guarantee to the farmers, the year to year change is always non-negative, but mostly positive. Hence, we tried a combination of Trend (T), current international price (IPt), and one-year lagged international price (IPt-1) as explanatory variables. The highest explanatory power (adjusted R-square) was when all the three appeared as explanatory variables. The coefficients of all three were statistically significant and these together explained 94 percent of the variation in MSP of rice and 85 percent in that of wheat (Table 54). These results corroborate our earlier observations that high global prices have impacted farmgate prices of rice and wheat, not directly but through their influence on the decisions of the government related to the levels of fixation of guaranteed support prices.

6. SUMMARY AND CONCLUSIONS

6.1 GENERAL

The study was conducted to examine the transmission of prices of rice and wheat from the world markets to the domestic markets, specially to the farmgate during the world food crisis of 2007-08. As the price transmission is influenced by the marketing and price policies pursued in the country, the paper reviewed the domestic policies related to marketing of rice and wheat, including holding of public stocks, assessed the integration of domestic markets, analyzed the congruence between international and domestic prices and finally assessed the impact of high global prices on the farmgate prices. The study has used both econometric tools and policy analysis approaches.

Rice and wheat are staple foods and grown by most of the 129 million farms in India. These account for 37.5 percent of the gross cropped area in the country. There has been a deceleration in the growth of production of these cereals during the last three decade, mainly due to deceleration in the growth of yield. However, during the last five years, the growth rate of production has accelerated. Out of 30 states in India, six states account for 91 percent of total wheat production and 10 states account for 83 percent of total rice production. During 2011-12, the production of rice is likely to be at a record level of 103 million tonnes and that of wheat at 88 million tonnes. Rice and wheat have been receiving emphasis in the agricultural development programmes, owing to the focus on food security both at the national and household levels. During the last five years, there has been a considerable increase in input subsidies, with rice and wheat accounting for around 59 percent of the total, valued at Rs 766 billion in 2008-09.

6.2 FOOD POLICY MEASURES

For operationalizing the food security policy, the food management in the country is *inter alia* aimed at (a) announcement of minimum support prices (MSPs) at the time of sowing; (b) procurement or purchases of rice and wheat at these prices; (c) maintenance of buffer stocks of rice and wheat; and (d) distribution of rice and wheat to the consumers, particularly vulnerable sections, at subsidized prices. While looking at the role of these policy instruments in impacting transmission of world prices to domestic markets, it needs to be kept in view that in the two years preceding the world crisis of 2007-08, India faced severe shortages of wheat and had to import 7.9 million tonnes to meet its domestic needs. Even after the world crisis, India faced very high food inflation in the domestic market for around two years. Thus, India's response during the last five years is a combination of response to the world crisis and its own domestic situation both before and after the crisis.

The public procurement of rice and wheat at MSPs has been at considerably higher levels during the last four years. The average annual procurement of rice during the triennium ending (TE) 2010-11 at 31 million tonnes was considerably higher than that during TE 2000-01 (17.4 million tonnes). Similarly, for wheat, the annual procurement during TE 2010-11 was 25.4 million tonnes as compared to 14.9 million tonnes during TE 2000-01. The procurement during the current marketing season (2011-12) is already at a record level for wheat at 28.1 million tonnes and for rice is expected to reach around 35 million tonnes. Distribution of subsidized rice and wheat is an important instrument of food security policy in India. During the 1960s and 1970s, as the dependence on imports was high, the quantity distributed was around 10 million tonnes per year. During the 1980s and 1990s, the average quantity hovered around 15 million tonnes per year. However, during the last 10 years, the volume of subsidized grains distributed in the country has considerably gone up. It varied between 36 and 50 million tonnes during 2002-03 to 2009-10. It is expected to have exceeded 60 million tonnes during 2010-11, when food inflation was at very high level. The food grains are supplied at subsidized prices under a large number of schemes covering around 50 percent of the total population. The government also releases rice and wheat in the open market (open market sales scheme-OMSS) for bulk buyers, small traders and retailers. The quantity of grains released or earmarked under OMSS is determined on the basis of government's stock situation (after meeting the commitment under TPDS and other welfare programmes) and level of market prices. Analysis of allocation and off-take of rice and wheat under the PDS shows that the government released higher quantities of subsidized grains since the second half of 2008 and peaked in 2009. Even later, higher off-take continued mainly due to high food inflation in the domestic market.

While the economic cost consisting of procurement (support) price, procurement incidentals and distribution costs shows an increasing trend, the issue prices or prices at which rice and wheat are distributed under various food security programmes have not been raised during the last 10 years. The difference between economic cost and issue prices is met by the government and is shown as food subsidy in the government accounts. Obviously, the quantum of food subsidy has been increasing and has increased rapidly during the recent years. It was Rs 120 billion during 2000-01 and went up to Rs 582 billion in 2009-10. It is estimated to have gone up further during the most recent two years. The reasons are hike in MSPs, increase in procurement incidentals and distribution costs, and expansion in the scale of PDS.

The Government of India maintains the stocks of food grains, mainly of rice and wheat, ever since the middle of 1960s. The Food Corporation of India (FCI) is the nodal agency for the purpose. The maintenance of stocks serves the dual purpose of providing price support to wheat and rice

producers and meeting the requirements of the PDS. The size of stocks depends on several factors, but these are rigorously reviewed, at least once in five years, and based on several considerations, the norms for minimum level of stocks are specified by the government. The stocks are usually built-up through price support operations, but import route is also used occasionally for the purpose. As the procurement operations, in general, are seasonal, the stocking norms have been specified at four points of time during a year. These are first day of January, April, July and October. The latest revision of stocking norms was done in March 2005. However, owing to the domestic difficult situation during 2006-07, followed by global food crisis of 2007-08, an important component of food security reserves (3 million tonnes of wheat and 2 million tonnes of rice) was added to the norms during 2008-09. The norms and actual stocks of rice and wheat during 2002 to 2011 reveal that for rice, India's stocking management met the policy requirements. In the case of wheat, the country faced depletion of stocks (below norms) from July 2005 to January 2008, despite considerable imports of wheat. However, by the time of commencement of global food crisis, India had overcome its difficult food stock situation and was relatively comfortable since April 2008. In fact, considering the entire ten year period, India faced the situation of surplus stocks (over norms) more frequently than the shortages.

Apart from the increased level of procurement and higher quantities of subsidized rice and wheat distribution, the government took several policy measures during 2006-2011 to ward off the adverse impact of global food crisis. These include (a) imports of 7.9 million tonnes of wheat; (b) ban on exports of wheat and non-basmati rice; (c) imposition of MEP on basmati rice exports; (d) ban on futures trade in rice and wheat; (e) permission to private traders to import wheat, wheat flour and rice at zero duty; (f) imposition of stocking limits on traders or bulk buyers; (g) hike in MSPs to encourage production and for built-up of public stocks; and (h) raise in norms of buffer and food security stocks. It may be mentioned here that the export of basmati rice was not banned and most of the other measures have been withdrawn in September 2011.

The policy related to exports and imports of rice and wheat operates within the framework of food security and food management policy. From a situation of heavy dependence on imports of basic staple food in the middle of 1960s, India steered itself to a comfortable situation during the 1990s. The supply-demand balance became visible since the first half of 1980s, when the net imports came down to less than one million tonnes. The net imports further decreased to 0.2 million tonnes in the second half of 1980s. India emerged as a net exporter of cereals in the early 1990s. Between 1990-91 and 1994-95, India exported an average of 0.5 million tonnes of cereals (mainly rice and wheat). Net exports went up to 2.6 million tonnes per year during 1995-2000, and further to 6.4 million tonnes during 2000-2005. India imported about 7.9 million tonnes of wheat during 2006-08. However, taking the five year average from 2006-07 to 2010-11, India has been net exporter of rice plus wheat, mainly owing to rice exports, even though the exports of rice went down considerably. During 2008-09, 62 percent of rice exported from India was basmati rice. The share of basmati rice in total rice exports went up to 94 percent in 2009-10 and further to 96 percent in 2010-11.

The net availability of rice and wheat in the country is affected by the government interventions. There is some year to year variation in the net availability of cereals (including rice, wheat and other cereals). For example, it increased by 6.2 percent in 2004, decreased by 7 percent in 2005 and again increased by 7.3 percent in 2006. It increased only marginally in 2007. During the global high price year of 2008, the net availability of cereals declined by 2.1 percent. This was despite 20.5 million tonnes jump in net domestic production, mainly due to increase in net exports and huge addition (17

million tonnes) to government stocks. However, in 2009 the net availability went up by 4.8 percent, despite decrease in production, due to reduction in net exports and lower addition to government stocks.

6.3 INTEGRATION OF DOMESTIC MARKETS

The integration among domestic markets was analyzed by selecting a sample of five major wholesale markets, five retail markets and eight primary wholesale markets for rice. In the case of wheat, the sample included five wholesale markets, five retail markets and four primary wholesale markets. Monthly prices for 16 years (1996 to 2011) were used for the analysis. The international prices were taken from the World Bank Pink Sheet. The Indian prices for each selected market were taken from the official publications. The monthly price series in nominal as well as real terms were logarithmically transformed for analysis. Both horizontal and vertical integration in the domestic markets were analyzed. The sequence of econometric analysis for assessment of market integration and price transmission has been checking for stationarity of price series; testing for cointegration; testing for causality; and testing for asymmetry. Apart from the econometric analysis, the transmission of international prices to the domestic markets and to the farmgate was also analyzed by looking at the movements in MSPs, prices actually received by sample farmers, wholesale price index during the peak marketing period, and prices in the primary assembling markets, and comparing these with the movement in international prices. The main results emerging from the study are summarized here.

RICE

(1) The wholesale, retail and primary market prices at first difference are integrated when linear trend is excluded from unit root test and there is, in general, a long-run equilibrium relationship in domestic rice markets.

(2) There is integration even among geographically dispersed rice wholesale markets. However, some market pairs show bi-directional causality and others unidirectional causality. Rice prices in different wholesale markets converge in the long-run. The speed of adjustment, however, varies across different market pairs. In the short-run also, rice wholesale markets are well-integrated and the price changes are transmitted contemporaneously, though not fully. The price transmission in most rice wholesale market pairs is asymmetric. In some pairs, however, it is symmetric.

(3) The rice retail markets exhibit almost the same pattern of integration as that in wholesale markets.

(4) The primary markets of rice show remarkable degree of integration, though these are geographically dispersed. However, the markets of eastern India show lack of integration with primary markets of south India.

(5) The vertical transmission of rice prices from wholesale to farmgate (primary markets) is quite smooth. There is a long-run equilibrium relationship between wholesale and farmgate prices and farmgate prices move in tandem with wholesale prices. However, the speed of adjustment is different, particularly between markets of north and south. The dynamics of price transmission is also different between the markets of north and south. In southern region, price transmission is asymmetric, while in the north, it is symmetric.

WHEAT

(1) In the case of wheat, the wholesale, retail and primary market prices at first difference are integrated when linear trend is excluded from the unit root test. There is, in general, a long-term equilibrium relationship in domestic wheat markets.

(2) Delhi wholesale market is integrated with Mumbai, Hyderabad and Bangalore wholesale markets, and the direction of price signal is from Delhi to others. Further, Bangalore and Hyderabad are integrated with Chennai, with price signals flowing from Bangalore and Hyderabad to Chennai. Nearly 11 to 15 % of divergence in prices is corrected within each month. The speed of adjustment is faster from Hyderabad to Chennai and from Delhi to Mumbai. In the short-run, price shocks are contemporaneously transmitted in these markets, but not fully. The price transmission in wheat wholesale markets is asymmetric.

(3) The integration of wheat retail markets is the same as that of wholesale markets.

(4) All the four primary wholesale wheat markets are, in general, integrated and behave in the same way as observed for wholesale markets.

(5) There is a long-run equilibrium relationship between prices in the wholesale markets and those at the farmgates. The price change in Delhi wholesale market causes almost an equal change in prices in the primary wheat markets. The speed of adjustment in primary market prices, in response to changes in wholesale market prices, is quite high and up to 57 percent of divergence is corrected each month. The nature of price transmission from Delhi wholesale to Karnal and Moga primary markets is symmetric and to Amritsar is asymmetric.

6.4 COINTEGRATION OF INTERNATIONAL AND DOMESTIC PRICES

(1) There is no cointegration between domestic and international rice prices.

(2) Delhi wholesale wheat prices appear to be cointegrated with international wheat prices. There is long-run equilibrium relationship between international and domestic wheat prices at different levels of markets. The long-run elasticity of price transmission from international to wheat wholesale and retail prices is higher than to farmgate prices.

(3) As regards the speed of adjustment, there is a difference between wheat wholesale and farmgate prices. In response to a change in the international prices, while correction in the wholesale prices is four percent, that in the farmgate prices is 48 percent.

(4) The transmission from international prices to farmgate prices is asymmetric, which shows that farmgate prices respond differently in rising and falling phases of international prices. The price transmission is symmetric in the case of wholesale prices of wheat.

(5) Interestingly, the short-run shocks in international prices do not have any significant influence on domestic prices at any level of wheat supply chain.

6.5 CONGRUENCE BETWEEN INTERNATIONAL AND DOMESTIC PRICES

(1) There is lack of congruence between international and domestic prices of rice and wheat. Domestic prices during the crisis period did increase but the increase was considerably lower than the increase in global prices.

(2) During 2007 to 2009, the movement in global prices and domestic prices of rice and wheat was almost in contrast to each other.

(3) During the five year period ending 2008-09 or 2009-10, the coefficient of variation in international prices was more than twice to three times than that in domestic prices of rice and wheat.

(4) The coefficients of correlation between monthly international and domestic prices of rice and wheat are, generally, quite low and insignificant, both during pre-crisis (1996-2007) and crisis (2007-11) periods.

(5) The main factors that impacted the transmission of abnormal increase in global prices to Indian markets were timely and effective government intervention in rice and wheat markets, and almost complete insulation of domestic fertilizer prices from increase in international crude oil and fertilizer prices.

6.6 PRICES AT THE FARMGATE

(1) The annual increases in the index of prices received by farmers during 2007, 2008 and 2009 were considerably higher than that during the preceding years. However, the change in the index of price paid was almost similar.

(2) The paddy and wheat growers in India received considerably higher prices during 2006-08 and continued during 2008-09, owing to the mix of domestic policies, including hike in MSPs.

(3) The farm harvest prices of wheat registered annual increase of 14 to 22 percent and that of rice increased by 7 to 20 percent continuously during 2006-07 to 2008-09, indicating that farmgate prices increased considerably during the world food crisis.

(4) Comparison of wheat and rice wholesale price index numbers of India and that of international prices during the peak marketing months (October for rice and April for wheat) shows that Indian farmers received higher prices during 2007 to 2009, when international prices fluctuated violently and even dipped later.

(5) The analysis of year-wise levels of MSPs for paddy and wheat fixed by the government shows that, as a part of food security policy package, there has been considerable hike in MSPs during 2007 and 2008. Obviously, Indian farmers received higher prices of rice and wheat during the global crisis of 2007 and 2008, owing to the policy response as a part of food security policy.

(6) The results of regression of MSPs of rice and wheat on international prices also corroborate the earlier observations that high global prices have impacted farmgate prices in India, not directly but through their influence on the decision of the government related to the levels of fixation of guaranteed support prices.

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Table 1
India: Selected Markets for Rice and Wheat

Commodity	Primary Wholesale Markets	Secondary Wholesale Markets	Retail Markets
Rice	Karnal (KAR) Amritsar (AMR) Nizamabad (NZM) Vijaywada (VIJ) Chidambaram (CRM) Kumbhakonam (KBM) Cooch Behar (CBE) Bankura (BNK)	Delhi (DEL) Mumbai (MUM) Hyderabad (HYD) Chennai (CHE) Kolkata (KOL)	Delhi Mumbai Hyderabad Chennai Kolkata
Wheat	Karnal Amritsar Moga (MOG) Kota (KOT)	Delhi Mumbai Hyderabad Chennai Bangalore (BAN)	Delhi Mumbai Hyderabad Chennai Bangalore

Parentheses show the abbreviation for the market, used throughout the paper.

Table 2
India: Compound Growth Rates of Area, Yield and Production of Rice and Wheat (% per annum)

Period	Rice			Wheat		
	A	Y	P	A	Y	P
1980-81 to 1989-90	0.14	3.19	3.62	0.46	3.10	3.57
1990-91 to 1999-00	0.68	1.34	2.02	1.72	1.83	3.57
2000-01 to 2010-11	(-) 0.10	1.61	1.51	1.28	0.87	2.16

A = Area, Y = Yield per ha, P = Production

Source: Government of India (2011), Agricultural Statistics at a Glance, 2011, p..200.

Table 3
India: Trend in Food Expenditure and Consumption of Rice and Wheat

Particulars	1993-94		2004-05		2009-10	
	Rural	Urban	Rural	Urban	Rural	Urban
% share of per capita total expenditure on Food						
Cereals	63.2	54.7	55.0	42.5	53.6	40.7
Monthly per capita Consumption (kg)	24.2	14.1	18.0	10.1	15.7	4.6
Rice (R)						
Wheat (W)	6.8	5.1	6.4	4.7	6.0	4.5
Total R+W	4.3	4.5	4.2	4.4	4.2	4.1
Total Cereals	11.1	9.6	10.6	9.1	10.2	8.6
	13.4	10.6	12.1	9.9	11.4	9.4

Source: Gupta, Shalini (2012), Food Expenditure and Intake in the 66th Round of NSSO (2009-10), Economic and Political Weekly, Vol. XLVII, No 2, January 14, 2012.

Table 4
India: State-wise Production and Marketed Surplus of Wheat
(2008-09 Crop Season and 2009-10 Marketing Season)

State	Production			Marketed Surplus (MS)		
	Million tonnes	Share (%)	Cumulative Share (%)	MS Ratio (%)	Million tonnes	Share (%)
Uttar Pradesh	28.6	35.4	35.4	66	18.9	33.0
Punjab	15.7	19.5	54.9	85	13.3	23.2
Haryana	10.8	13.4	68.3	81	8.7	15.2
Rajasthan	7.3	9.0	77.3	53	3.9	6.8
Madhya Pradesh	6.5	8.1	85.4	61	4.0	7.0
Bihar	4.4	5.5	90.9	66	2.9	5.1
Gujarat	2.6	3.2	94.1	84	2.2	3.8
Others	4.8	5.9	100.0	71	3.4	5.9
Total	80.7	100.0	100.0	71	57.3	100.0

Table 5
India: State-wise Production and Marketable Surplus of Rice
(2008-09 Crop Season and Marketing Season)

States	Production			Marketed Surplus		
	Million tonnes	Share (%)	Cumulative Share (%)	MS Ratio (%)	Million tonnes	Share (%)
West Bengal	15.0	15.2	15.2	58	8.7	11.6
Andhra Pradesh	14.2	14.4	29.6	82	11.6	15.5
Uttar Pradesh	13.1	13.2	42.8	79	10.3	13.8
Punjab	11.0	11.1	53.9	99	10.9	14.6
Orissa	6.8	6.9	60.8	62	4.2	5.6
Bihar	5.6	5.6	66.4	76	4.3	5.8
Tamil Nadu	5.2	5.2	71.6	85	4.4	5.9
Chhattisgarh	4.4	4.4	76.0	75	3.3	4.4
Assam	4.0	4.0	80.0	29	1.2	1.6
Haryana	3.3	3.3	83.3	99	3.3	4.4
Others	16.6	16.7	100.0	75	12.5	16.8
Total	99.2	100.0	100.0	75	74.7	100.0

Table 6

India: Trend in Price Support Procurement of Rice and Wheat

(million tonnes)

Marketing Year	Rice (Oct-Sept)	Wheat (Apr-March)
1996-97	12.97	8.16
1997-98	15.59	9.41
1998-99	12.60	13.19
1999-00	18.23	14.69
2000-01	21.18	16.71
2001-02	22.13	21.03
2002-03	16.42	19.58
2003-04	22.83	16.00
2004-05	24.68	17.16
2005-06	27.66	15.27
2006-07	25.11	9.23
2007-08	28.74	11.19
2008-09	33.68	26.04
2009-10	26.82	27.94
2010-11	32.35	22.08
2011-12	35.00*	28.30

*Likely (Procurement upto 1st March 2012 (26 mt) was 15% higher than that during the corresponding date of preceding year).

Source: Government of India (2011), Agricultural Statistics at a Glance, Ministry of Agriculture, New Delhi, p.227.

Table 7
India: State-wise Procurement of Rice and Wheat
(from the crop of 2008-09 season)

Crop/State	Procurement			
	(million tonnes)	% of Total	% of Production	% of Marketed Surplus
RICE				
West Bengal	1.7	5.0	11.3	19.5
Andhra Pradesh	9.1	26.9	64.1	78.4
Uttar Pradesh	3.7	11.0	28.2	35.9
Punjab	8.5	25.4	77.3	78.0
Orissa	2.8	8.3	41.2	66.7
Bihar	-	-	-	-
Tamil Nadu	1.2	3.6	23.1	27.3
Chhattisgarh	2.8	8.5	63.6	84.4
Assam	-	-	-	-
Haryana	1.4	4.2	42.4	42.4
Others	2.5	7.1	15.1	20.0
Total	33.7	100.0	34.0	44.7
WHEAT				
Uttar Pradesh	3.9	14.0	13.6	20.6
Punjab	10.7	38.4	68.2	80.5
Haryana	6.9	24.7	63.9	79.3
Madhya Pradesh	2.0	7.2	30.8	50.0
Rajasthan	1.2	4.3	16.4	30.8
Bihar	0.5	1.8	11.4	17.2
Gujarat	-	-	-	-
Others	2.7	9.6	56.2	79.4
Total	27.9	100.0	34.6	48.7

*Marketing season for the crop of 2008-09 is October 2008- September 2009 (2008-09) for rice and April 2009- March 2010 (2009-10) for wheat.
Source: For figures in col 1, Government of India (2011), Agricultural Statistics at a Glance, Ministry of Agriculture, New Delhi.

Table 8
India: Distribution (Off-take) of Subsidized Foodgrains
(Rice and Wheat) (million tonnes)

Year	TPDS				Welfare Schemes	OMS or for Exports	Total
	AAY	BPL	APL	Total			
2001-02	1.7	10.0	2.1	13.8	7.2	10.3	31.3
2002-03	3.5	13.7	3.1	20.3	11.4	18.1	49.8
2003-04	4.2	15.8	4.2	24.2	13.5	11.6	49.3
2004-05	5.5	17.5	6.7	29.7	10.6	1.2	41.5
2005-06	7.4	15.7	8.0	31.1	10.1	1.1	42.3
2006-07	8.7	14.7	8.5	31.4	5.4	-	36.8
2007-08	9.5	15.1	8.7	33.3	4.1	-	37.4
2008-09	9.5	15.6	9.5	34.6	3.7	1.2	39.5
2009-10	9.8	16.5	16.1	42.4	5.2	2.1	49.7
2010-11*	NA	NA	NA	53.9	4.8	3.7	62.4

Source: Government of India, Economic, Survey, 2006-07 to 2010-11.
* Likely, NA = Not Available, TPDS= Targeted Public Distribution System
AAY = Poorest of the poor, BPL = Below Poverty Line, APL = Above Poverty Line
OMS = Open Market Sale

Table 9
India: Rice and Wheat Distributed under Various Programmes (million tonnes)

Year	Rice	Wheat	Total
2003-04	25.0	24.3	49.3
2004-05	23.2	18.3	41.5
2005-06	25.1	17.2	42.3
2006-07	25.1	11.7	36.8
2007-08	25.2	12.2	37.4
2008-09	24.6	14.9	39.5
2009-10	27.4	22.3	49.7

Source: Same as for Table 9

Table 10
India: Economic Cost of Rice and Wheat (Rs per quintal)

Particulars	2007-08	2008-09	Average
RICE			
Procurement Price	1037.13	1216.09	1126.61 (68.6)
Procurement Incidentals	214.91	252.58	233.74 (14.3)
Distribution Cost	297.82	263.81	280.82 (17.1)
Total	1549.86	1732.48	1641.17 (100)
WHEAT			
Procurement Price	903.30	960.53	931.92 (69.1)
Procurement Incidentals	164.02	193.62	178.82 (13.3)
Distribution Cost	244.43	230.27	237.35 (17.6)
Total	1311.75	1384.42	1348.09 (100)

Source: For Column 2 and 3, Government of India, Economic Survey 2010-11, Ministry of Finance, p. 211.

Table 11
India: Central Issue Prices under PDS (unchanged since 2002) (Rs per kg)

Target Groups	Wheat	Rice	Families Covered
Poorest of the Poor (AAY)	2.00	3.00	20 million
Below Poverty Line (BPL)	4.15	5.65	65 million
Above Poverty Line (APL)	6.10	7.94	Variable

Table 12
India: Food Subsidy

Year	Food Subsidy (Rs in billion)	% change over preceding year
2000-01	120.01	-
2001-02	174.94	45.7
2002-03	241.76	38.2
2003-04	251.60	4.1
2004-05	257.46	2.3
2005-06	230.71	-10.4
2006-07	238.28	3.3
2007-08	312.60	31.2
2008-09	436.68	40.0
2009-10	582.42	33.4
2010-11	629.29	8.0

Source: Government of India, Economic Survey 2008-09 and 2010-11, Ministry of Finance, New Delhi (For latest year, updated from Official statements).

Table 13

India: Norms of Buffer Stocks and Actual Stocks

(million tonnes)

Year	Month	Rice		Wheat		Total	
		Norm	Actual	Norm	Actual	Norm	Actual
2002	Jan	8.40	25.62	8.40	32.42	16.80	58.03
	Apr	11.80	24.91	4.00	26.04	15.80	50.95
	Jul	10.00	21.94	14.30	41.07	24.30	63.01
	Oct	6.50	15.77	11.60	35.64	18.10	51.41
2003	Jan	8.40	19.37	8.40	28.83	16.80	48.20
	Apr	11.80	17.16	4.00	15.65	15.80	32.80
	Jul	10.00	10.97	14.30	24.19	24.30	35.17
	Oct	6.50	5.24	11.60	18.43	18.10	23.67
2004	Jan	8.40	11.73	8.40	12.69	16.80	24.41
	Apr	11.80	13.07	4.00	6.93	15.80	20.00
	Jul	10.00	10.76	14.30	19.15	24.30	29.92
	Oct	6.50	6.09	11.60	14.22	18.10	20.32
2005	Jan	8.40	12.76	8.40	8.93	16.80	21.69
	Apr	12.20	13.34	4.00	4.07	16.20	17.41
	Jul	9.80	10.07	17.10	14.45	26.90	24.53
	Oct	5.20	4.85	11.00	10.29	16.20	15.14
2006	Jan	11.80	12.64	8.20	6.19	20.00	18.83
	Apr	12.20	13.68	4.00	2.01	16.20	15.68
	Jul	9.80	11.14	17.10	8.21	26.90	19.35
	Oct	5.20	5.97	11.00	6.41	16.20	12.38
2007	Jan	11.80	11.98	8.20	5.43	20.00	17.41
	Apr	12.20	13.17	4.00	4.70	16.20	17.87
	Jul	9.80	10.98	17.10	12.93	26.90	23.90
	Oct	5.20	5.49	11.00	10.12	16.20	15.61
2008	Jan	11.80	11.48	8.20	7.71	20.00	19.19
	Apr	12.20	13.84	4.00	5.80	16.20	19.64
	Jul	9.80	11.25	20.10	24.91	29.90	36.16
	Oct	5.20	7.86	14.00	22.03	19.20	29.89
2009	Jan	13.80	17.58	11.20	18.21	25.00	35.79
	Apr	14.20	21.60	7.00	13.43	21.20	35.03
	Jul	11.80	19.62	20.10	32.92	31.90	52.54
	Oct	7.20	15.35	14.00	28.46	21.20	43.81
2010	Jan	13.80	24.35	11.20	23.09	25.00	47.45
	Apr	14.20	26.71	7.00	16.13	21.20	42.84
	Jul	11.80	24.27	20.10	33.58	31.90	57.85
	Oct	7.20	18.44	14.00	27.78	21.20	46.22
2011	Jan	13.80	25.58	11.20	21.54	25.00	47.12

Source: Government of India, Reports of the Commission for Agricultural Cost and Prices for Crops sown in 2010-11 Season, Ministry of Agriculture, p. 535, and updated from Ministry of Food, Government of India.

Table 14

Import and Export of Cereals During 1980s and 1990s

(000 tonnes per year)

Five Year Block	Export	Import	Net Export
1980-81 to 1984-85	537	1419	(-) 882
1985-86 to 1989-90	482	696	(-) 214
1990-91 to 1994-95	918	386	(+) 532
1995-96 to 1999-00	3718	1105	(+) 2613
2000-01 to 2004-05	6439	12	(+) 6427

Source: Govt. of India, DGCI&S, Kolkata, Min. of Commerce & Industry, quoted in CACP Report for 2006-07, p. 261-63.

Table 15
Exports and Imports of Rice and Wheat ('000 tonnes)

Year	Exports		Imports	Net Exports		
	Rice	Wheat	Wheat	Rice	Wheat	Total
2001-02	2208	2649	1	2208	2648	4856
2002-03	4968	3671	-	4968	3671	8639
2003-04	3412	4093	*	3412	4093	7505
2004-05	4778	2009	-	4778	2009	6787
2005-06	4089	746	-	4089	746	4835
2006-07	4748	47	6080	4748	(-) 6033	(-) 1285
2007-08	6469	*	1793	6469	(-) 1793	4676
2008-09	2488	1	*	2488	1	2489
2009-10	2157	*	164	2157	(-) 164	1993
2010-11	2282	*	184	2282	(-) 184	2098

Source: Government of India, Ag. Stat. at a Glance, 2011, p. 246-50

* less than 500 tonnes.

Table 16
% Share of Basmati & Non-Basmati Rice in Exports

Year	Basmati Rice	Non-Basmati Rice	Total
2001-02	30.2 (667)	69.8	100
2002-03	14.3 (709)	85.7	100
2003-04	22.6 (771)	77.4	100
2004-05	24.3 (1163)	75.7	100
2005-06	28.5 (1167)	71.5	100
2006-07	22.0 (1046)	78.0	100
2007-08	18.3 (1183)	81.7	100
2008-09	62.5 (1556)	37.5	100
2009-10	93.5 (2017)	6.5	100
2010-11 (p)	95.8 (2186)	4.2	100

Source: Government of India, Ag. Stat. at a glance, 2011, p. 246-50.

Figures in the parentheses are quantities in thousand tonnes.

P = Provisional

Table 17
India: Net Availability of Cereals (million tonnes)

Year	Net production	Net Exports	Change in Government Stocks	Net Availability	% Change
2003	143.2	7.1	(-) 23.2	159.3	-
2004	173.5	7.7	(-) 3.3	169.1	6.2
2005	162.1	7.2	(-) 2.4	157.3	(-) 7.0
2006	170.8	3.8	(-) 1.8	168.8	7.3
2007	177.7	7.0	(+) 1.7	169.4	0.4
2008	197.2	14.4	(+) 17.0	165.8	(-) 2.1
2009	192.4	7.2	(+) 11.5	173.7	4.8

Source: Government of India (2011), Economic Survey 2010-11, Ministry of Finance, p. A22.

Table 18

India: Per Capita Net Availability of Cereals (kgs per year)

Year	Rice	Wheat	Other Cereals	Total Cereals	% Change
2003	66.2	65.8	17.1	149.1	-
2004	71.3	59.2	25.3	155.8	4.5
2005	64.7	56.3	21.7	142.7	(-) 8.4
2006	72.3	56.3	22.1	150.7	5.6
2007	70.8	57.6	20.3	148.7	(-) 1.3
2008	64.0	53.0	19.7	143.9	(-) 3.2
2009	68.8	56.5	23.3	148.6	3.3
2010^{p}	67.4	61.3	19.8	148.5	*

Source: Government of India, Ag. Stat. at a glance, 2011, Ministry of Agriculture, p. 237.

P= Provisional, * = negligible

Table 19: Unit Root Tests with Intercept for Rice Market

Markets	LEVEL SERIES		FIRST DIFFERENCE	
	Probabilities		Probabilities	
	ADF	PP	ADF	PP
Wholesale				
Delhi	0.822	0.883	0.000	0.000
Chennai	0.774	0.919	0.000	0.000
Kolkatta	0.810	0.792	0.000	0.000
Hyderabad	0.773	0.700	0.000	0.000
Mumbai	0.819	0.619	0.000	0.000
Retail				
Delhi	0.797	0.787	0.000	0.000
Chennai	0.673	0.813	0.000	0.000
Kolkatta	0.685	0.719	0.000	0.000
Hyderabad	0.948	0.967	0.000	0.000
Mumbai	0.786	0.772	0.000	0.000
Farmgate				
Karnal	0.596	0.803	0.000	0.000
Kumbhakonam	0.683	0.782	0.000	0.000
Nizamabad	0.290	0.309	0.000	0.000
Vijaywada	0.729	0.787	0.000	0.000
Amritsar	0.539	0.498	0.000	0.000
Bankura	0.727	0.716	0.000	0.000
Chidambaram	0.703	0.843	0.000	0.000
Cooch Behar	0.372	0.525	0.000	0.000
International				
THAI 5% Broken	0.827	0.837	0.000	0.000

All values in last two columns are less than 0.0005.

Table 20: Pairwise Cointegration of Wholesale Markets of Rice

Market	Delhi	Mumbai	Kolkata	Hyderabad	Chennai
Delhi	1	No	No	No	Yes
Mumbai	No	1	Yes	No	No
Kolkata	No	Yes	1	No	No
Hyderabad	No	No	No	1	Yes
Chennai	Yes	No	No	Yes	1

Table 21: Cointegrating Equations for Wholesale Rice Markets

CHE_W(-1)	C	HYD_W(-1)
Coeff.	-0.153	-0.996
S.E		0.041
t-stat		[-24.41]
CHE_W(-1)	C	DEL_W(-1)
Coeff.	0.178	-1.027
S.E		0.070
t-stat		[-14.6101]
KOL_W(-1)	C	MUM_W(-1)
Coeff.	-1.686	-0.735
S.E		0.106
t-stat		[-6.93]

C is intercept, W is wholesale price.

Table 22: Results of Error Correction Model for Rice Wholesale Markets

D(CHE_W)	Coeff.	D(CHE_W)	Coeff.	D(KOL_W)	Coeff.
Speed of Adjustment	-0.120	Speed of Adjustment	-0.215	Speed of Adjustment	-0.073
	[-3.54]		[-4.69]		[-3.60]
C	0.004	C	0.004	C	0.006
	[1.21]		[1.10]		[1.71]
D(CHE_W(-1))	0.196	D(CHE_W(-1))	0.247	D(KOL_W(-1))	0.094
	[2.66]		[3.34]		[1.34]
D(CHE_W(-2))	0.136	D(CHE_W(-2))	0.193	D(KOL_W(-2))	-0.169
	[1.81]		[2.52]		[-2.38]
D(DEL_W(-1))	-0.062	D(HYD_W(-1))	-0.098	D(MUM_W(-1))	-0.068
	[-0.88]		[-1.17]		[-1.45]
D(DEL_W(-2))	-0.102	D(HYD_W(-2))	-0.051	D(MUM_W(-2))	-0.018
	[-1.46]		[-0.62]		[-0.38]
Goodness of Fit of Model					
Adj. R-squared	0.065		0.107		0.080
F-statistic	3.623		5.505		4.267
Akaike AIC	-3.305		-3.351		-3.386
Schwarz SC	-3.202		-3.248		-3.283

Note: D denotes first difference, C denotes intercept, W stands for wholesale price, and (-1) is the first order lag.
Figures in parenthesis are t-values.

Table 23: Results of Asymmetric Error Correction Model for Rice Wholesale Markets

CHE_W	Coeff.	CHE_W	Coeff.	KOL_W	Coeff.
C	0.157	C	0.106	C	1.353
	[2.39]		[1.81]		[11.94]
DEL-CHE (-)	0.441	CHE-HYD(-)	0.594	KOL-MUM (-)	0.490
	[6.91]		[8.50]		[10.29]
DEL-CHE(+)	0.536	CHE_HYD (+)	0.581	KOL_MUM (+)	0.504
	[9.24]		[8.96]		[10.99]
CHE_W(-1)	0.619	CHE_W(-1)	0.492	KOL_W(-1)	0.469
	[8.79]		[7.22]		[7.27]
CHE_W(-2)	-0.105	CHE_W(-2)	-0.072	KOL_W(-2)	-0.008
	[-1.84]		[-1.31]		[-0.15]
DEL_W(-1)	0.500	HYD_W(-1)	0.524	MUM_W(-1)	0.228
	[7.45]		[7.61]		[6.44]
DEL_W(-2)	-0.035	HYD_W(-2)	0.052	MUM_W(-2)	0.106
	[-0.64]		[0.86]		[3.29]
Goodness of Fit of Model					
Adj. R-squared	0.986		0.988		0.989
F-statistic	2167.238		2579.299		2742.693
Akaike AIC	-3.818		-3.990		-4.056
Schwarz SC	-3.699		-3.870		-3.936
Asymmetry Test					
t-stat	-15.174		1.885		-2.900
Co-variance	0.061		0.067		0.047

Note: C denotes intercept W stands for wholesale price and (-1) is the first order lag
Figures in parenthesis are t-values.

Table 24: Pairwise Cointegration of Retail Markets of Rice

Market	Delhi	Mumbai	Kolkata	Hyderabad	Chennai
Delhi	1	No	No	No	Yes
Mumbai	No	1	Yes	No	No
Kolkata	No	Yes	1	No	No
Hyderabad	No	No	No	1	Yes
Chennai	Yes	No	No	Yes	1

Table 25: Pair-wise Cointegration of Primary Wholesale Markets of Rice

Market	KAR	AMR	BNK	CBE	NZM	VIJ	KBM	CRM
Karnal	1	Yes	No	No	Yes	No	No	Yes
Amritsar	Yes	1	Yes	No	No	Yes	Yes	Yes
Bankura	No	Yes	1	No	No	No	No	No
Cooch Behar	No	No	No	1	No	No	No	No
Nizamabad	Yes	No	No	No	1	Yes	Yes	Yes
Vijaywada	No	Yes	No	No	Yes	1	No	No
Kumbhakonam	No	Yes	No	No	Yes	No	1	Yes
Chidambaram	Yes	Yes	No	No	Yes	No	Yes	1

Table 26: Cointegrating Equations for Vertical Transmission of Rice Prices

	NIZ_PW(-1)	**C**	**HYD_W(-1)**
Coeff.	1	-1.931	-0.731
SE			0.087
t-stat			[-8.38]
	CRM_PW(-1)	**C**	**CHE_W(-1)**
Coeff.	1	0.005	-1.000
SE			0.027
t-stat			[-36.47]
	KUM_PW(-1)	**C**	**CHE_W(-1)**
Coeff.	1	-0.003	-0.999
SE			0.047
t-stat			[-21.18]
	AMR_PW(-1)	**C**	**DELHI_W(-1)**
Coeff.	1	-0.391	-0.958
SE			0.120
t-stat			[-7.98]
	KAR_PW(-1)	**C**	**DELHI_W(-1)**
Coeff.	1	-0.741	-0.884
SE			0.047
t-stat			[-18.63]

Note: C denotes intercept. W stands for Wholesale price, PW denotes Primary Wholesale and (-1) is the first order lag. Figures in parenthesis are t-values.

Table 27: Results of Error Correction Model for Rice Markets for Vertical Transmission

D(NIZ_PW)	Coeff.	D(CRM_PW)	Coeff.	D(KUM_PW)	Coeff.	D(AMR_PW)	Coeff.	D(KAR_PW)	Coeff.
Speed of adjustment	-0.157	Speed of adjustment	-0.158	Speed of adjustment	-0.203	Speed of adjustment	-0.119	Speed of adjustment	-0.266
	[-3.90]		[-2.24]		[-2.84]		[-3.45]		[-4.60]
D(NIZ_PW(-1))	-0.002	D(CRM_PW(-1))	0.072	D(KUM_PW(-1))	-0.123	D(AMR_PW(-1))	0.147	D(KAR_PW(-1))	0.067
	[-0.03]		[0.83]		[-1.49]		[2.01]		[0.85]
D(NIZ_PW(-2))	0.107	D(CRM_PW(-2))	-0.035	D(KUM_PW(-2))	-0.182	D(AMR_PW(-2))	0.011	D(KAR_PW(-2))	0.127
	[1.47]		[-0.43]		[-2.39]		[0.15]		[1.69]
D(HYD_W(-1))	0.083	D(CHE_W(-1))	-0.019	D(CHE_W(-1))	0.092	D(DEL_W(-1))	0.166	D(DEL_W(-1))	0.027
	[0.77]		[-0.21]		[0.79]		[1.78]		[0.28]
D(HYD_W(-2))	0.062	D(CHE_W(-2))	0.072	D(CHE_W(-2))	0.150	D(DEL_W(-2))	-0.129	D(DEL_W(-2))	-0.100
	[0.58]		[0.83]		[1.30]		[-1.37]		[-1.07]
C	0.004	C	0.005	C	0.005	C	0.004	C	0.004
	[0.81]		[1.19]		[1.03]		[0.79]		[0.92]
Goodness of fit									
Adj. R-squared	0.069		0.024		0.135		0.078		0.096
F-statistic	3.803		1.922		6.875		4.176		4.997
Akaike AIC	-2.782		-3.052		-2.438		-2.709		-2.730
Schwarz SC	-2.679		-2.949		-2.335		-2.606		-2.627

Note: C denotes intercept. W stands for Wholesale price, PW denotes Primary Wholesale and (-1) is the first order lag. Figures in parenthesis are t-values.

Table 28: Results of Asymmetric Error Correction Model for Rice Markets for Vertical Transmission

NIZ_PW	Coeff.	CHI_PW	Coeff.	KUM_PW	Coeff.	AMR_PW	Coeff.	KAR_PW	Coeff.
C	1.240	C	0.098	C	0.222	C	0.520	C	0.693
	[17.55]		[1.20]		[3.03]		[6.72]		[8.82]
NIZ-HYD (-)	0.737	CRM-CHE (-)	0.324	KUM-CHE (-)	0.696	AMR-DEL (-)	0.675	KAR-DEL (-)	0.707
	[14.31]		[3.48]		[9.97]		[11.54]		[9.79]
NIZ-HYD (+)	0.816	CRM-CHE (+)	0.436	KUM-CHE (+)	0.860	AMR-DEL (+)	0.672	KAR-DEL (+)	0.728
	[21.41]		[5.12]		[14.71]		[14.66]		[13.16]
NIZ_PW(-1)	0.161	CHI_PW(-1)	0.773	KUM_PW(-1)	0.276	AMR_PW(-1)	0.318	KAR_PW(-1)	0.324
	[3.64]		[11.66]		[5.77]		[5.19]		[6.21]
NIZ_PW(-2)	0.048	CHI_PW(-2)	0.081	KUM_PW(-2)	-0.005	AMR_PW(-2)	0.005	KAR_PW(-2)	-0.020
	[1.37]		[1.24]		[-0.12]		[0.12]		[-0.44]
HYD_W(-1)	0.582	DEL_W(-1)	0.062	CHE_W(-1)	0.855	DEL_W(-1)	0.740	DEL_W(-1)	0.682
	[10.78]		[0.91]		[11.82]		[11.61]		[11.07]
HYD_W(-2)	0.037	DEL_W(-2)	0.070	CHE_W(-2)	-0.159	DEL_W(-2)	-0.127	DEL_W(-2)	-0.093
	[0.71]		[1.02]		[-2.44]		[-2.18]		[-1.65]
Goodness of fit									
Adj. R-squared	0.987		0.977		0.982		0.983		0.980
F-statistic	2380.196		1336.781		1685.650		1794.334		1546.480
Akaike AIC	-4.258		-3.344		-3.547		-3.647		-3.735
Schwarz SC	-4.138		-3.225		-3.427		-3.527		-3.615
Assymetry test									
t-stat	-3.116		-3.136		-5.405		-0.131		-0.700
Co-variance	0.247		0.348		0.295		0.266		0.294

Note: C denotes intercept. W stands for Wholesale price, PW denotes Primary Wholesale and (-1) is the first order lag. Figures in parenthesis are t-values.

Table 29: Unit Root Tests with Intercept for Wheat

MARKETS	LEVEL SERIES (Probability)		FIRST DIFFERENCE (Probability)	
Wholesale	ADF	PP	ADF	PP
Delhi	0.461	0.585	0.000	0.000
Chennai	0.778	0.763	0.000	0.000
Bangalore	0.582	0.532	0.000	0.000
Hyderabad	0.787	0.787	0.000	0.000
Mumbai	0.565	0.528	0.000	0.000
Retail				
Delhi	0.764	0.760	0.000	0.000
Chennai	0.888	0.833	0.000	0.000
Bangalore	0.510	0.544	0.000	0.000
Hyderabad	0.735	0.759	0.000	0.000
Mumbai	0.762	0.740	0.000	0.000
Farmgate				
Karnal	0.384	0.484	0.000	0.000
Moga	0.313	0.430	0.000	0.000
Amritsar	0.315	0.409	0.000	0.000
Kota	0.447	0.572	0.000	0.000
International				
US HRW	0.869	0.824	0.000	0.000

Figures in last two columns are less than 0.0005.

Table 30: Pairwise Cointegration in Wheat Wholesale Markets

Market	Delhi	Mumbai	Bangalore	Hyderabad	Chennai
Delhi	1	Yes	Yes	Yes	No
Mumbai	Yes	1	No	No	No
Bangalore	Yes	No	1	No	Yes
Hyderabad	Yes	No	No	1	Yes
Chennai	No	No	Yes	Yes	1

Table 31: Cointegrating Equations for Wholesale Wheat Markets

Cointegrating Equation:		
MUM_W(-1)	Constant	DEL_W(-1)
Coeff.	1.809	-1.332
SE		0.109
t-stat		[-12.24]
HYD_W(-1)	C	DEL_W(-1)
Coeff.	0.799	-1.157
SE		0.084
t-stat		[-13.7538]
CHE_W(-1)	C	HYD_W(-1)
Coeff.	-1.208	-0.844
SE		0.062
t-stat		[-13.53]
BANGALORE_W(-1)	C	DEL_W(-1)
Coeff.	1.012	-1.219
SE		0.086
t-stat		[-14.12]
CHE_W(-1)	C	BAN_W(-1)
Coeff.	-1.437	-0.788
SE		0.087
t-stat		[-9.02]

Note: C denotes intercept, W Wholesale price and (-1) is the first order lag. Figures in parenthesis are t-values.

Table 32: Results of Error Correction Model for Wheat Wholesale Markets

D(CHE_W)	**Coeff.**	**D(BAN_W)**	**Coeff.**	**D(CHE_W)**	**Coeff.**	**D(HYD_W)**	**Coeff.**	**D(MUM_W)**	**Coeff.**
Speed of Adjustment	-0.113	Speed of Adjustment	-0.132	Speed of Adjustment	-0.152	Speed of Adjustment	-0.107	Speed of Adjustment	-0.141
	[-3.44]		[-2.57]		[-4.10]		[-3.09]		[-3.14]
C	0.005	C	0.005	C	0.006	C	0.005	C	0.007
	[1.33]		[0.96]		[1.64]		[1.42]		[1.13]
D(CHE_W(-1))	0.135	D(BAN_W(-1))	-0.246	D(CHE_W(-1))	0.172	D(HYD_W(-1))	-0.11	D(MUM_W(-1))	-0.225
	[1.70]		[-3.15]		[2.41]		[-1.50]		[-3.03]
D(CHE_W(-2))	-0.187	D(BAN_W(-2))	-0.095	D(CHE_W(-2))	-0.096	D(HYD_W(-2))	-0.04	D(MUM_W(-2))	-0.155
	[-2.58]		[-1.31]		[-1.34]		[-0.55]		[-2.18]
D(BAN_W(-1))	-0.036	D(DEL_W(-1))	0.147	D(HYD_W(-1))	-0.086	D(DEL_W(-1))	-0.041	D(DEL_W(-1))	0.099
	[-0.69]		[1.43]		[-1.21]		[-0.56]		[0.90]
D(BAN_W(-2))	0.02	D(DEL_W(-2))	0.151	D(HYD_W(-2))	-0.259	D(DEL_W(-2))	0.064	D(DEL_W(-2))	0.117
	[0.39]		[1.48]		[-3.70]		[0.89]		[1.08]
Goodness of Fit of Model									
Adj. R-squared	0.093		0.133		0.141		0.061		0.14
F-statistic	4.875		6.761		7.16		3.435		7.101
Log likelihood	302.897		229.117		307.965		294.871		216.585
Akaike AIC	-3.142		-2.361		-3.195		-3.057		-2.228
Schwarz SC	-3.039		-2.258		-3.092		-2.954		-2.126

Note: D denotes first difference, C denotes intercept. W stands for Wholesale price and (-1) is the first order lag. Figures in parenthesis are t-values.

Table 33: Results of Asymmetric Error Correction Model for Wheat Wholesale Markets

BAN_W	Coeff.	BANGALORE_W	Coeff.	HYD_W	Coeff.	MUM_W	Coeff.	HYDERABAD_W	Coeff.
C	-0.428	C	-0.004	C	-0.632	C	-0.523	C	0.142
	[-4.21]		[-0.04]		[-5.42]		[-5.23]		[2.02]
BAN-CHE (-)	0.598	BAN-DEL (+)	0.797	HYD-CHE (-)	-0.465	MUM-DEL (-)	0.512	HYD-DEL (-)	0.52
	[10.57]		[12.08]		[-5.67]		[7.94]		[8.40]
BAN-CHE (+)	0.674	BAN-DEL (-)	0.037	HYD-CHE (+)	-0.49	MUM-DEL (+)	0.647	HYD-DEL (+)	0.37
	[13.30]		[2.14]		[-6.61]		[11.09]		[5.37]
CHE_W(-1)	0.845	DEL_W(-1)	0.588	HYD_W(-1)	0.562	DEL_W(-1)	0.733	HYD_W(-1)	0.494
	[10.67]		[7.52]		[7.63]		[9.13]		[7.41]
CHE_W(-2)	-0.191	DEL_W(-2)	-0.041	HYD_W(-2)	0.079	DEL_W(-2)	0.003	HYD_W(-2)	0.012
	[-2.73]		[-0.54]		[1.20]		[0.04]		[0.20]
BAN_W(-1)	0.27	BAN_W(-1)	0.317	CHE_W(-1)	0.466	MUM_W(-1)	0.296	DEL_W(-1)	0.44
	[5.01]		[5.17]		[5.20]		[5.19]		[6.62]
BAN_W(-2)	0.143	BAN_W(-2)	0.167	CHE_W(-2)	-0.023	MUM_W(-2)	0.084	DEL_W(-2)	0.053
	[2.97]		[3.10]		[-0.34]		[1.69]		[0.94]
Goodness of Fit of Model									
Adj. R-squared	0.981		0.975		0.98		0.98		0.983
F-statistic	1610.098		1246.122		1528.277		1509.037		1866.944
Log likelihood	309.222		285.392		321.111		285.861		339.789
Akaike AIC	-3.181		-2.93		-3.306		-2.935		-3.503
Schwarz SC	-3.062		-2.811		-3.187		-2.816		-3.383
Asymmetry Test									
t-stat	-13.84		153.66		3.16		-21.38		22.28
Co-variance	0.05		0.05		0.08		0.06		0.07

Note: C denotes intercept. W stands for Wholesale price, PW denotes Primary Wholesale and (-1) is the first order lag. Figures in parenthesis are t-values.

Table 34: Pairwise Cointegration of Primary Wholesale Markets of Wheat

	Karnal	Amritsar	Moga	Kota
Karnal	1	Yes	Yes	No
Amritsar	Yes	1	Yes	Yes
Moga	Yes	Yes	1	Yes
Kota	No	Yes	Yes	1

Table 35: Cointegrating Equations for Vertical Transmission in Wheat

AMR_PW(-1)	C	DEL_W(-1)
Coeff.	-0.616	-0.904
SE		0.039
t-stat		[-22.92]
MOG_PW(-1)	C	DEL_W(-1)
Coeff.	-0.148	-0.963
SE		0.030
t-stat		[-31.64]
KAR_PW(-1)	C	DEL_W(-1)
Coeff.	-0.231	-0.961
SE		0.017
t-stat		[-55.82]

Note: C denotes intercept. W stands for Wholesale price, PW denotes Primary Wholesale and (-1) is the first order lag. Figures in parenthesis are t-values.

Table 36: Results of Error Correction Model for Wheat Markets for Vertical Transmission

D(AMR_PW)	Coeff.	D(MOG_PW)	Coeff.	D(KAR_PW)	Coeff.
Speed of adjustment	-0.333	Speed of adjustment	-0.430	Speed of adjustment	-0.571
	[-5.50]		[-5.10]		[-5.38]
D(AMR_PW(-1))	0.002	D(MOG_PW(-1))	0.067	D(KAR_PW(-1))	0.192
	[0.02]		[0.75]		[1.89]
D(AMR_PW(-2))	0.039	D(MOG_PW(-2))	0.092	D(KAR_PW(-2))	0.043
	[0.51]		[1.14]		[0.46]
D(DEL_W(-1))	0.151	D(DEL_W(-1))	-0.075	D(DEL_W(-1))	-0.213
	[1.53]		[-0.71]		[-1.98]
D(DEL_W(-2))	0.011	D(DEL_W(-2))	-0.156	D(DEL_W(-2))	-0.159
	[0.12]		[-1.66]		[-1.63]
C	0.004	C	0.006	C	0.006
	[1.07]		[1.18]		[1.59]
Goodness of fit					
Adj. R-squared	0.246		0.143		0.142
F-statistic	13.265		7.293		7.200
Akaike AIC	-3.042		-2.604		-3.062
Schwarz SC	-2.939		-2.501		-2.959

Note: D denotes first difference, C denotes intercept. R stands for Retail price, PW denotes Primary Wholesale and (-1) is the first order lag. Figures in parenthesis are t-values.

Table 37: Results of Asymmetric Error Correction Model for Wheat Markets for Vertical Transmission

AMRITSAR_PW	Coeff.	KARNAL_PW	Coeff.	MOGA_PW	Coeff.
C	0.531	C	0.289	C	0.306
	[6.19]		[3.41]		[3.81]
AMR-DEL (-)	0.652	KAR-DEL (-)	0.437	MOS-DEL (-)	0.657
	[7.13]		[3.77]		[8.24]
AMR-DEL (+)	0.460	KAR-DEL (+)	0.457	MOS-DEL (-)	0.724
	[5.18]		[2.86]		[7.58]
AMR_PW(-1)	0.159	KAR_PW(-1)	0.385	MOG_PW(-1)	0.378
	[1.69]		[3.76]		[6.38]
AMR_PW(-2)	0.053	KAR_PW(-2)	-0.071	MOG_PW(-2)	-0.095
	[0.82]		[-0.82]		[-1.66]
DEL_W(-1)	0.710	DEL_W(-1)	0.544	DEL_W(-1)	0.618
	[9.75]		[5.78]		[8.78]
DEL_W(-2)	-0.003	DEL_W(-2)	0.098	DEL_W(-2)	0.043
	[-0.04]		[1.08]		[0.64]
Goodness of fit					
Adj. R-squared	0.975		0.971		0.974
F-statistic	1238.377		1056.232		1163.584
Akaike AIC	-3.389		-3.191		-3.268
Schwarz SC	-3.269		-3.072		-3.148
Assymetry test					
t-stat	5.365		-0.453		-1.889
Co-variance	0.350		0.432		0.345

Note: C denotes intercept. W stands for Wholesale price, PW denotes Primary Wholesale and (-1) is the first order lag. Figures in parenthesis are t-values.

Table 38
Long Term Trend in International Prices of Rice and Wheat

Year/Particulars	Nominal Price of Wheat - HRW	Nominal Price of Rice Thai 5% broken
1950-71 Range	57–72	132-206
Mean	65	151
1975-2005 Range	107-207	173-434
Mean	146	280
2005	152	288
2006	192	304
2007	255	332
January 2008	370	393
February 2008	425	481
March 2008	440	580
April 2008	362	907

Source: IMF Financial Statistics, various issues, quoted in Chand (2008).

Table 39: Percent Change in Prices of Rice and Wheat between 2005 and 2008.

	International	India
Food Index		
Nominal	85.23	**27.32**
Real	**63.20**	**5.36**
Rice		
Nominal	127.12	29.83
Real	100.1	7.43
Wheat		
Nominal	100.06	43.27
Real	76.26	18.55
Fertilizer		
Nominal	246.47	4.67
Real	205.49	-13.39

Table 40
Trend in International Prices of Wheat and Rice (Rs per tonne)

Month/Year	Nominal Prices of Wheat	Nominal Prices of Rice
June 2008	14925	32415
June 2009	12260	27445
June 2010	7342	20490
June 2011	14620	23021

Source: National Centre for Agricultural Economics and Policy Research (NCAP), Data Base (Communication in January 2012).

Table 41
Inflation in World and Domestic Prices of Rice and Wheat (Year-on Inflation in %)

Month & Year	Rice		Wheat	
	WCPI	IWPI	WCPI	IWPI
April 08	206.4	8.7	82.7	6.9
May 08	204.9	8.0	68.0	7.2
June 08	151.9	7.6	56.3	7.7
July 08	138.5	7.7	37.7	8.2
Aug 08	126.3	6.6	26.8	6.9
Sept 08	123.3	5.4	-9.5	7.8
Oct 08	94.4	11.2	-29.2	5.0
Nov 08	68.4	12.6	-29.5	4.0
Dec 08	53.1	15.1	-40.3	4.8
Jan 09	59.2	15.2	-35.5	5.2
Feb 09	27.1	17.1	-47.1	6.1
Mar 09	4.7	16.7	-47.5	4.6

Source: Government of India, Economic Survey 2008-09, Ministry of Finance, 2009, p. 75
WCPI taken from World Bank Pink Sheet and IWPI is the Indian Wholesale Price Index released by Government of India Department of Industrial Promotion and Policy, New Delhi.

Table 42
Annual Price Levels and Year-on-Year Rates of Inflation in Cereal Prices at Global and Domestic Level

Year	Global (FAO Price Index)		India (Wholesale Price Index)			
	Cereals Index	% Change over previous year	Rice		Wheat	
			WPI	% Change	WPI	% Change
2005-06	103.5	-	105.2	-	105.0	-
2006-07	121.7	17.6	110.0	4.6	125.1	19.1
2007-08	166.9	37.1	122.5	11.4	134.3	7.4
2008-09	237.8	42.5	140.6	14.8	147.6	9.9
2009-10	173.7	(-) 27.0	157.9	12.3	166.5	12.8
2010-11	182.6	5.1	167.2	5.8	171.4	2.9

The base for FAO Price Index is 2002-2004=100 and for India's WPI is 2004-05=100
Source: For Global index –FAOSTAT Website and for India's WPI,
Agricultural Statistics at a Glance, 2011, Government of India, Ministry of Agriculture, p. 255.

Table 43
Comparison of Variation in International and Domestic Farm Level Prices of Rice and Wheat

Particulars	Rice		Wheat	
	Average Price	CV %	Average Price	CV %
International Price	277.95*	30.85	144.49**	56.73
Farm Harvest Price in India (Rs. per quintal)	808.66***	10.35	882.00a	18.27
Implicit Price Received by Indian Farmers	645.93***	15.24	901.38a	20.86

* = Rice Thailand 35% Average of five year period ending 2009-10
** = Average of five year ending 2009-10
*** = Average of Paddy prices for the Five year ending 2008-09
A = Average for FY period ending 2007-08
Source: Government of India, Ministry of Agriculture (2011), Reports of the Commission for Agriculture Cost and Prices for the Crops Sown During 2010-11 Season, p. 288-89 and p. 442-43.

Table 44: Correlation Coefficients between International and Domestic Prices

Rice: 1996 to 2008					
	Chennai	**Delhi**	**Kolkatta**	**Mumbai**	**Hyderabad**
THAI 5%	-0.05	0.12	-0.22	-0.11	-0.11
t-Statistic	-0.61	1.33	-2.58**	-1.31	-1.26
Rice: 2008 to 2011					
THAI 5%	-0.18	-0.24	-0.44	0.18	-0.08
t-Statistic	-1.23	-1.70	-3.29**	1.27	-0.57
Wheat: 1996 to 2007 June					
	Bangalore	**Chennai**	**Delhi**	**Hyderabad**	**Mumbai**
US HRW	0.66	0.44	0.46	0.57	0.51
t-Statistic	10.18**	5.67**	5.99**	8.15	6.85**
Wheat: 2007 June to 2011					
US HRW	0.09	0.10	0.09	-0.15	0.09
t-Statistic	0.64	0.77	0.63	-1.10	0.64

** denotes significance at 1 per cent level.

Table 45: Pairwise Johansen Cointegration Test Results for International and Domestic Markets

International price: Rice				
No. of Co-integrating equations	Eigenvalue	Trace Statistic	Critical Value 0.05	Prob.**
Delhi				
None	0.051	9.733	15.495	0.302
At most 1	0.000	0.012	3.841	0.912
Chennai				
None	0.038	7.333	15.495	0.539
At most 1	0.000	0.080	3.841	0.777
Kolkata				
None	0.038	7.307	15.495	0.542
At most 1	0.000	0.005	3.841	0.943
Mumbai				
None	0.051	10.65	15.495	0.234
At most 1	0.005	0.930	3.841	0.335
Hyderabad				
None	0.036	9.718	15.495	0.303
At most 1	0.015	2.772	3.841	0.096
Trace test indicates no cointegration at the 0.05 level.				
International price : Wheat				
Delhi				
None *	0.088	17.211	15.495	0.027
At most 1	0.000	0.021	3.841	0.886
Mumbai				
None	0.07	13.929	15.495	0.085
At most 1	0.002	0.404	3.841	0.525
Bangalore				
None	0.068	13.388	15.495	0.101
At most 1	0.002	0.285	3.841	0.593
Chennai				
None *	0.098	19.338	15.495	0.013
At most 1	0.000	0.064	3.841	0.800
Hyderabad				
None	0.078	15.479	15.495	0.050
At most 1	0.001	0.229	3.841	0.633
* denotes cointegration with international prices (hypothesis of no cointegration is rejected at the 0.05 level)				
**MacKinnon-Haug-Michelis (1999) p-values				

Table 46: Cointegrating Equations for Vertical Transmission

	DEL_W(-1)	C	INT_WHEAT(-1)	
Coeff.	1	-0.78	-0.738	
SE			0.129	
t-stat			[-5.73]	
	MOG_PW(-1)	**C**	**DEL_W(-1)**	**INT_WHEAT(-1)**
Coeff.	1	-0.813	0	-0.692
SE				0.124
t-stat				[-5.59]
Coeff.	0	-0.788	1	-0.736
SE				0.13
t-stat				[-5.66]
	DEL_R(-1)	**C**	**DELHI_W(-1)**	**INT_WHEAT(-1)**
Coeff.	1	-0.822	0	-0.776
SE				0.134
t-stat				[-5.79]
Coeff.	0	-0.759	1	-0.746
SE				0.123
t-stat				[-6.06]

Note: C denotes intercept. W stands for Wholesale price,R stands for retail, PW denotes Primary Wholesale and (-1) is the first order lag. Figures in parenthesis are t-values.

Table 47: Results of Error Correction Model for Wheat Markets for Vertical Transmission

D(DEL_W)	Coeff.	D(MOG_PW)	Coeff.	D(DEL_R)	Coeff.
Speed of adjustment	-0.044	Speed of adjustment	-0.475	Speed of adjustment	-0.296
	[-1.73]		[-5.46]		[-7.29]
D(DEL_W(-1))	-0.010	CointEq2	0.418	CointEq2	0.326
	[-0.14]		[4.84]		[7.52]
D(DEL_W(-2))	-0.028	D(MOG_PW(-1))	0.115	D(DEL_R(-1))	0.102
	[-0.37]		[1.28]		[1.77]
D(INT_WHEAT(-1))	0.001	D(MOG_PW(-2))	0.116	D(DEL_R(-2))	0.026
	[0.01]		[1.42]		[0.45]
D(INT_WHEAT(-2))	-0.021	D(DEL_W(-1))	-0.073	D(DEL_W(-1))	-0.170
	[-0.34]		[-0.67]		[-2.84]
C	0.003	D(DEL_W(-2))	-0.156	D(DEL_W(-2))	0.108
	[0.82]		[-1.61]		[1.89]
		D(INT_WHEAT(-1))	0.046	D(INT_WHEAT(-1))	0.042
			[0.64]		[1.09]
		D(INT_WHEAT(-2))	-0.050	D(INT_WHEAT(-2))	-0.033
			[-0.70]		[-0.86]
		C	0.003	C	0.003
			[0.64]		[1.08]
Goodness of fit					
Adj. R-squared	-0.008		0.148		0.411
F-statistic	0.710		5.098		17.422
Akaike AIC	-2.910		-2.580		-3.850
Schwarz SC	-2.807		-2.426		-3.696

D denotes first difference, C denotes intercept. W stands for Wholesale price,,R stands for retail, PW denotes Primary Wholesale and (-1) is the first order lag. Figures in parenthesis are t-values.

Table 48: Results of Asymmetric Error Correction Model for Vertical Transmission

DEL_W	Coeff.	MOG_PW	Coeff.	DEL_R	Coeff.
C	0.776	C	0.147	C	0.100
	[15.60]		[3.98]		[3.86]
DEL-INT (-)	0.656	MOG-DEL-INT (-)	0.770	R-W-INT(-)	0.281
	[13.54]		[9.47]		[4.96]
DEL-INT (+)	0.700	MOG-DEL-INT (+)	0.675	R-W-INT (+)	0.368
	[15.96]		[7.10]		[7.96]
DEL_W(-1)	0.381	MOG_PW(-1)	0.358	DEL_R(-1)	0.537
	[6.80]		[6.14]		[8.51]
DEL_W(-2)	-0.038	MOG_PW(-2)	-0.121	DEL_R(-2)	-0.076
	[-0.82]		[-2.18]		[-1.57]
INT_WHEAT(-1)	0.493	DEL_W(-1)	0.637	DEL_W(-1)	0.374
	[10.63]		[9.05]		[7.99]
INT_WHEAT(-2)	-0.102	DEL_W(-2)	0.016	DEL_W(-2)	0.130
	[-2.74]		[0.24]		[2.72]
		INT_WHEAT(-1)	0.064	INT_WHEAT(-1)	0.074
			[1.29]		[2.30]
		INT_WHEAT(-2)	-0.029	INT_WHEAT(-2)	-0.044
			[-0.59]		[-1.40]
Goodness of fit					
Adj. R-squared	0.984		0.969		0.989
F-statistic	1920.009		748.468		2118.197
Akaike AIC	-3.877		-3.305		-4.167
Schwarz SC	-3.758		-3.151		-4.013
Assymetry test					
t-stat	-1.731		2.684		-3.214
Co-variance	0.250		0.346		0.264

D denotes first difference, C denotes intercept. W stands for Wholesale price, R stands for retail, PW denotes Primary Wholesale and (-1) is the first order lag. Figures in parenthesis are t-values.

Table 49
India: Index of Prices Received, Prices Paid and Terms of Trade for Farmers (Base = TE 1990-91 =100)

Year	Index of Prices Received	Index of Prices Paid	Index of Terms of Trade for Farmers
2000-01	225.0	223.0	100.9
2001-02	235.3	229.0	102.8
2002-03	247.9	239.3	103.6
2003-04	251.2	248.7	101.0
2004-05	258.5 (2.9)	257.5 (3.5)	100.3
2005-06	275.8 (6.7)	270.6 (5.1)	101.9
2006-07	291.2 (5.6)	285.8 (5.6)	101.9
2007-08	324.3 (11.4)	320.1 (12.0)	101.3
2008-09	350.9 (8.3)	348.3 (8.8)	100.7
2009-10	411.6 (17.3)	401.1 (15.2)	102.6

Figures in the parenthesis are percentage change over the preceding year.

Table 50
India: Average Prices Received by the Farmers for Paddy and Wheat (Rs per quintal)

Crop/State	2005-06	2006-07	2007-08	2008-09
WHEAT				
Uttar Pradesh	724	868	1000	NA
Punjab	700	850	1001	1096
Haryana	695	856	1000	1080
Rajasthan	817	931	1035	1101
Average	734	876	1009	1092
PADDY				
Andhra Pradesh	594	627	762	NA
Punjab	608	662	824	NA
Uttar Pradesh	564	630	746	NA
West Bengal	539	588	681	NA
Orissa	481	527	674	NA
Average	557	607	737	-

Source: Government of India, Ministry of Agriculture, Reports of the commission of Agricultural Cost and Prices for the crops sown in various years 2006-07 to 2010-11.

Table 51
India: Farm Harvest Prices of Paddy and Rice (Rs per quintal)

State	2005-06	2006-07	2007-08	2008-09
WHEAT				
Punjab	635	692	NA	NA
Haryana	730	880	1050	NA
Chandiharh	822	871	918	NA
Madhya Pradesh	850	909	1125	NA
Chhattisgarh	885	1144	1289	1334
Average	784	899(14.7)	1096(21.9)	1334(21.7)
PADDY				
Andhra Pradesh	617	650	774	977
Punjab	913	966	NA	NA
West Bengal	543	620	710	738
Orissa	482	473	673	779
Tamil Nadu	494	503	698	NA
Assam	522	NA	618	NA
Average	595	642(7.9)	695(8.3)	831(19.6)

Source: Data Bank of National Centre for Agricultural Economics and Policy Research (NCAP), New Delhi.
Figures in the parenthesis are percent change over the preceding year.

Table 52
Prices of Wheat and Rice During Peak Marketing Months

Year	Wheat (April)				Rice (October)			
	International		India		International		India	
	Index	Change over the year	index	Change over the year	index	Change over the year	index	Change over the year
2001	100.0	-	100.0	-	100.0	-	100.0	-
2002	99.8	-0.2	99.5	-0.5	110.0	10.0	98.9	-1.1
2003	108.3	9.5	101.5	2.0	108.5	-1.5	102.2	3.3
2004	120.6	12.3	103.7	2.2	136.4	-27.9	100.7	-1.5
2005	101.6	-19.0	104.0	0.3	156.7	20.3	105.4	4.7
2006	133.6	32.0	114.4	10.4	162.2	5.5	107.5	2.1
2007	137.8	4.2	125.6	11.2	158.8	-3.4	114.4	6.9
2008	239.0	+101.2	134.2	8.6	361.9	203.1	127.2	12.8
2009	195.1	-43.9	141.9	7.7	281.2	-80.7	145.4	18.2
2010	143.3	-51.8	155.2	13.3	263.1	-18.1	NA	NA

NA = Not Available

Source: International Monetary Fund (NCAP Data Base) for international prices and Government of India, Economic Survey, Various Issues for domestic WPI. Index with base 2001 computed by us.

Table 53
India: Minimum Support Prices of Paddy and Wheat (Rs per quintal)

Marketing Year	Rice (Common Grade)		Rice (Grade A)		Wheat	
2001-02	530		560		610	
2002-03	550		580		620	
2003-04	550		580		630	
2004-05	560		590		630	
2005-06	570		600		640	
2006-07	620	(8.8)	650	(8.3)	700	(9.4)
2007-08	745	(20.2)	775	(19.2)	850	(21.4)
2008-09	900	(20.8)	930	(20.0)	1000	(17.6)
2009-10	1000	(11.1)	1030	(10.8)	1080	(8.0)
2010-11	1000		1030		1100	
2011-12	1080		1100		1120	
2012-13	NA		NA		1285	(14.7)

- NA = Not Yet announced
- Marketing Year for Paddy is Oct-September and for Wheat April-June
- The prices include the bonus, if any, announced by the central government
- The figures in the parenthesis are % change from the preceding year.

Source: Government of India, Ministry of Agriculture, Agricultural Statistics at a Glance, 2011.

Table 54
Results of Regression of MSP on International Prices (1996-2010)

Explanatory Variables	Rice		Wheat	
	Coefficient	t-Value	Coefficient	t-Value
Constant	64.45	6.32**	34.02	2.02
Trend	6.96	6.82**	4.92	3.36**
International price, t	0.1	2.26*	0.31	2.29*
International price, t-1	0.14	3.42**	0.18	1.43
Adjusted R-square	0.94		0.85	

*and ** denote significance at 5 and 1 percent, respectively.

Figure 1: Monthly Off-take of Foodgrains from PDS: 2006-11 (million tonnes)

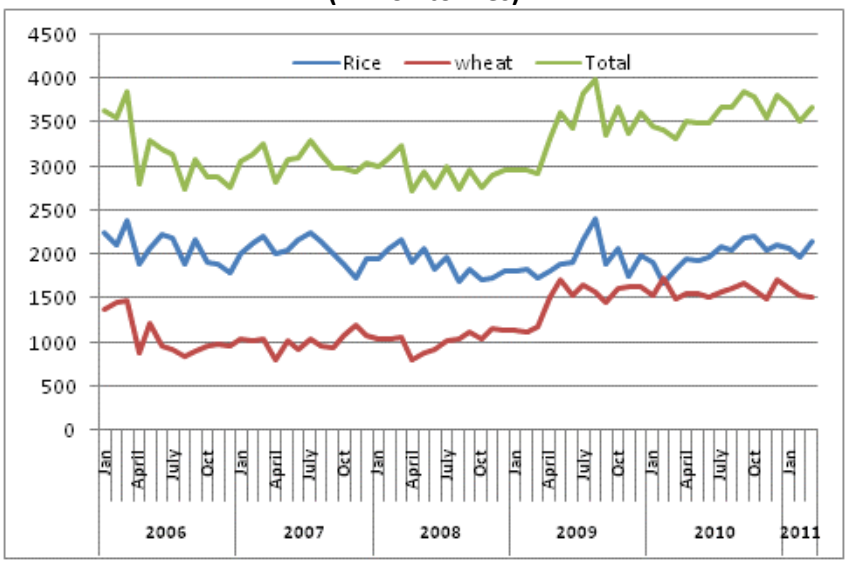


Figure 2: Difference between Stock and Buffer Norms for Rice and Wheat (million tonnes)

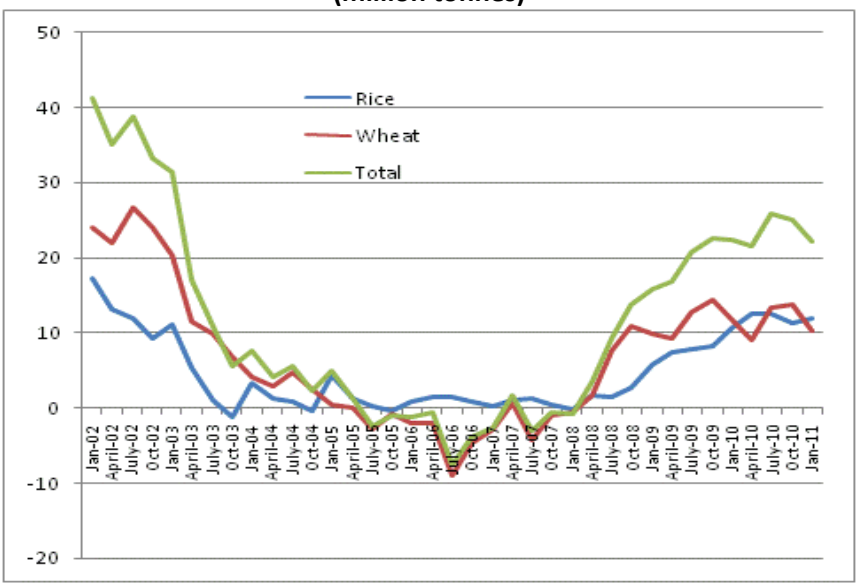
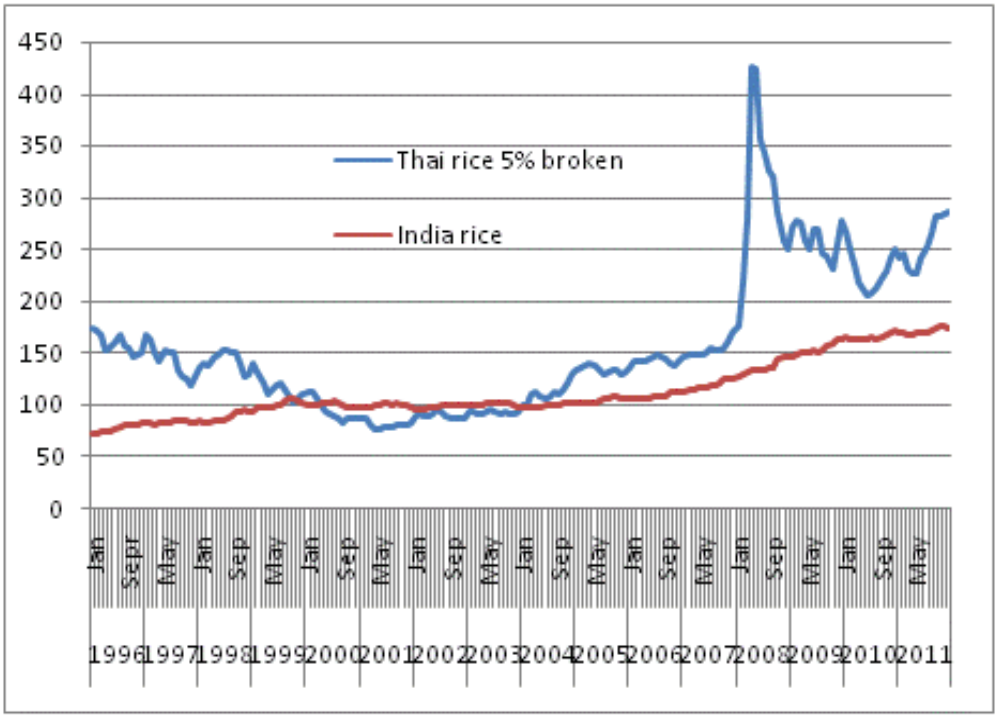


Figure 3: Index for Rice and Wheat prices (at 2004-05 prices)



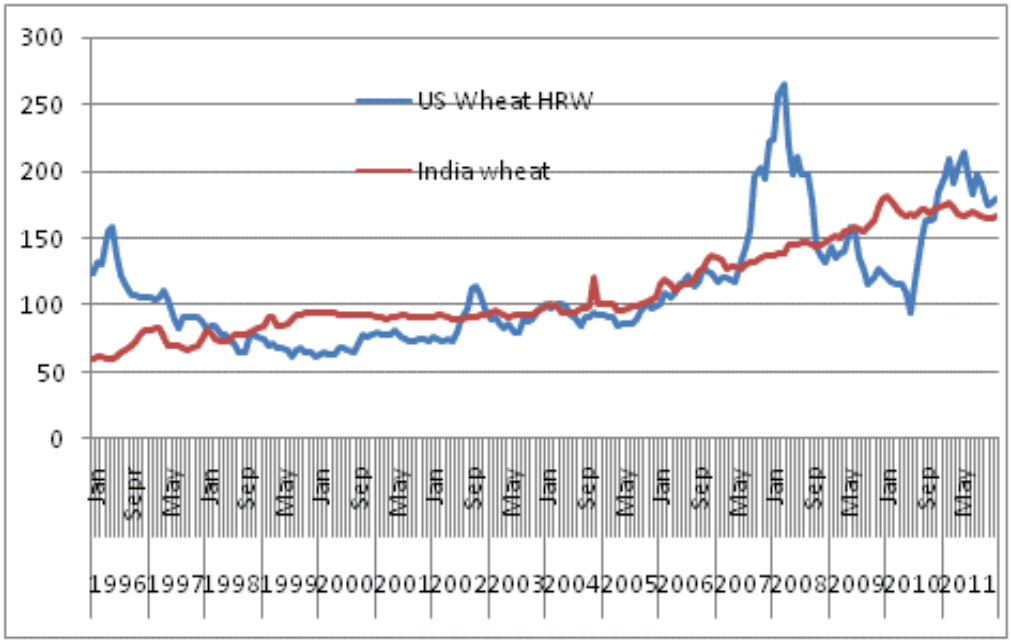


Figure 4: Domestic and International Prices of Rice (US $/MT)

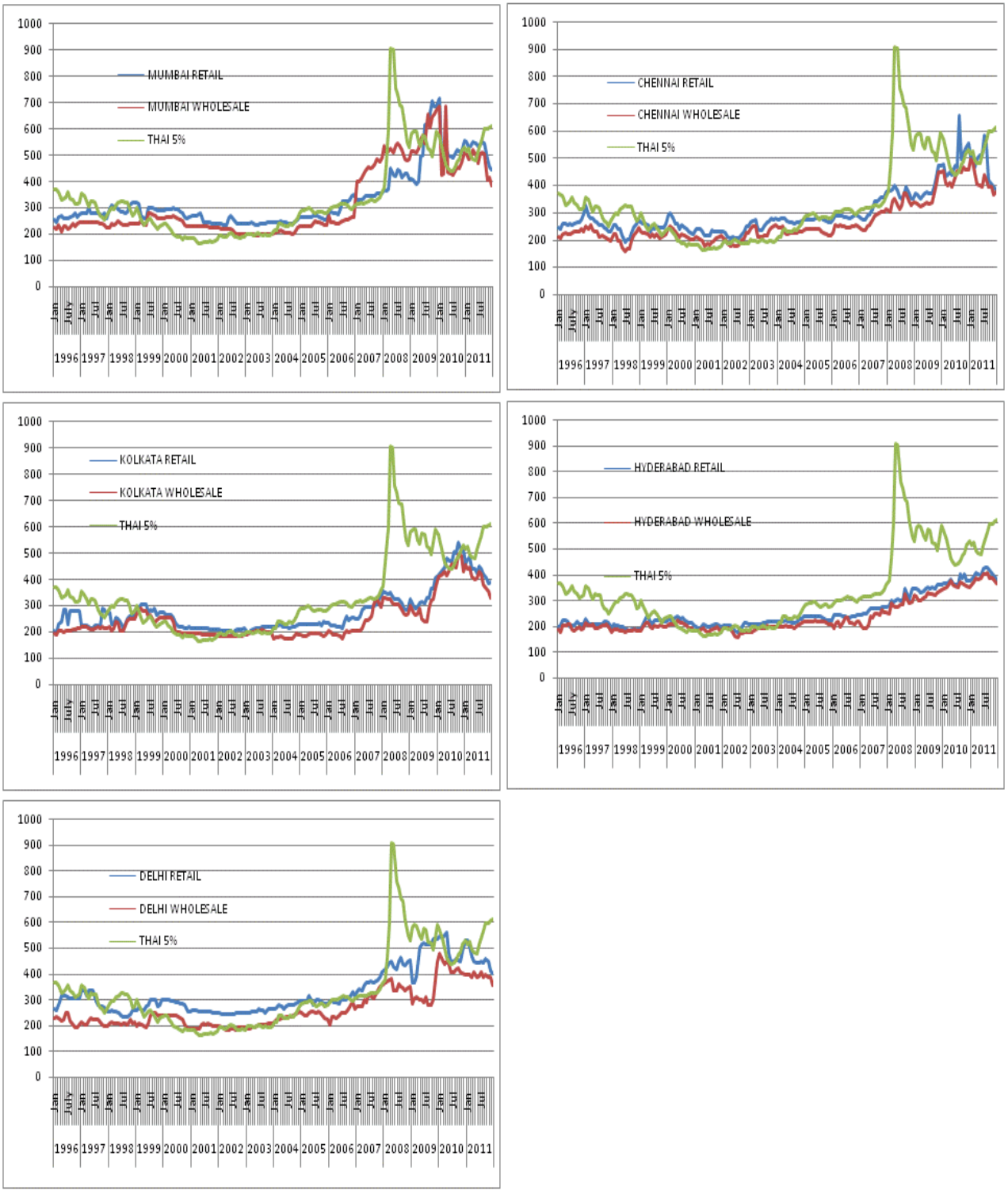


Figure 5: Domestic and International Prices of Wheat (US $/MT)