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WTO AND PAKISTAN'S AGRICULTURE: A PRICE INTEGRATION AND WELFARE ANALYSIS FOR WHEAT

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This study evaluates the impacts of the Uruguay Round Agreement on Agriculture (URAoA) on wheat using a partial equilibrium model. We apply cointegration method for Pakistan in order to examine whether there exists a stable long run relationship between farm gate price and wholesale price and between wholesale price and world price of wheat. Further Granger causality test is applied to discover the direction of influence between the prices. Price integration analysis shows that there is a stable long run relationship between farm gate price and wholesale price and between wholesale price and world price of wheat. Direction of influence is from world price to wholesale price and from wholesale price to farm gate price. The welfare analysis has been conducted by estimating the domestic demand and supply functions and by using the concepts of consumer and producer surpluses. It is found that loss in consumer surplus exceeds gain in producer surplus and the nation will have to face net welfare loss in case of wheat under trade liberalization.

1. Introduction

Pakistan is a low-income, food-deficit country (LIFDC) with a gross national product per capita of US$950. Agriculture is a major economic activity in Pakistan. Although its share in the economy is declining and has come down to 20.9 percent of GDP, it is still the backbone of the economy. It is a dominant sector in terms of employment (43.4 percent), directly sustains 66 percent of population and claims a high share in the total trade (Pakistan, 2006).

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Pakistan joined World Trade Organization (WTO) in 1994. Being a signatory of WTO; Pakistan has accepted both the opportunity and the challenge of trade liberalization. In view of the importance of agriculture sector in its economy, Pakistan has actively supported agriculture sector liberalization in the Uruguay Round (UR) of trade negotiations with a view to increasing market access for its agriculture exports. While Pakistan has broadly fulfilled its obligations under the Agreement on Agriculture (AoA), the consequent changes in its policy have implications for various domestic stakeholders – consumers and producers.

Until the mid 1980, Pakistan pursued an economic policy that was strongly interventionist. One of the consequences has been price discrimination against agriculture in the sense that the government taxed the producers and subsidized consumers. During the late 1980s, Pakistan turned from inward-looking policies towards trade liberalization and export promotion strategies. From the late 1980s onwards, the governments changed frequently but all of them considerably liberalized the economy (Akhtar, 1999).

Crops are the most important sub-sector of Agriculture sector of Pakistan. Among the major food crops wheat is the main staple diet of the country's population. It contributes 74 percent of the overall production of food grains. Wheat area constitutes 36 percent of the total cropped area and its production accounts for 30 percent of the value added by major crops (APCOM, 2004). Pakistan is one of the major producers of wheat in the world. Yet the domestic wheat production remains insufficient for the needs of population, which is at present growing at about 1.9 percent per annum. Hence to ensure food security, the country has to supplement the local production with imports. It is estimated that imports cover from 10-20 percent of national consumption needs (Ashiq & Ahmed, 2001). By virtue of its high import dependence for essential items like wheat and edible oil that absorb 13 percent of total foreign exchange earnings, Pakistan is characterized as net food importing developing country (FAO, 1999).

Because of the strategic importance of wheat as a major staple food commodity, government used to intervene not only to guarantee affordable supplies to consumers, but also to provide market support to

producers. The present wheat policy is based on a system of official wheat procurement and releases of wheat at officially regulated procurement and release prices. It involves a significant cost to the public exchequer on account of marketing and storage of wheat by the public sector. In addition, the government of Pakistan has tried to keep the price of wheat below the international level in order to subsidize domestic consumers (Ghani, 1998).

The impact of the Uruguay Round Agreement on Agriculture (URAoA) on wheat has been predicted more than for most other grains due in part to the greater degree of subsidization of wheat in the past. Total subsidized wheat exports are scheduled to fall from 59 million tons in initial year to 40 million tons by 2004 (FAO, 1995). During the UR of Talks, the United States and Canada, promised to reduce government subsidies on wheat farmers. These two countries are major sources of wheat imports in Pakistan. Since they are major supplier of wheat in the world too, they are the price leaders. The elimination of subsidies on wheat by these countries would result in higher prices of Pakistan's wheat imports. Most global general exercises have predicted almost 7-11 percent increase in wheat price, following implementation of the UR Agreement on Agriculture.

The main objectives of this study are: first, to determine the impact of trade liberalization on domestic prices, production and consumption of wheat in Pakistan; second to examine the extent of benefits and losses to be gained by Pakistan as a result of trade liberalization with special reference to wheat.

2. Literature Review

In this section some of the past studies are reviewed keeping in view the objective of our study.

Ghani (1998) evaluates the impact on wheat production, consumption and trade of changing the input subsidy and output price subsidy policies. The results of the study indicate that there will be a greater decline in wheat production if the government eliminates the input subsidies at once than if there is a gradual phasing out of these. There will be a slight decline in the consumption of wheat due to an increase in

the consumer price of wheat. However, the low-income household with the higher number of family members will be affected more with the increase in the price of staple wheat. Imports of wheat are greater if the subsidies are eliminated at once, as compared to phase them out gradually. Akhtar (1999) estimates the impact of trade liberalization on wheat, rice (both Basmati and non-Basmati rice) and maize by using simple welfare analysis to conduct welfare analysis for these commodities. He finds net loss to Pakistan of Rs. 3711 million and Rs. 64.86 million for wheat and maize respectively during 1997-98. While in case of rice, net gain to Pakistan is calculated Rs. 3232.76 million during 1997-98. Ashfaq, et al (2001) identify the relevance and importance of various factors that have affected wheat market of Pakistan during the period of 1971-96. Their study is an improvement on earlier ones as it includes all-important activities of the wheat economy of Pakistan and as a larger time period is covered for the analysis. Various types of elasticities estimated in the study are found to be consistent with the results obtained by other researchers. The highly inelastic supply of wheat suggests that in future substantial increase in the supply of wheat will occur if price incentives are given along with other institutional supports like research and extension, timely availability of inputs and development of infrastructure like irrigation facilities which will bring additional land into cultivation. Conforti (2004) aims at providing evidence on price transmission in a number of agricultural markets, both per se and in support of analytical efforts in the area of agricultural trade policy analysis. His work is based on a price database collected from various sources in sixteen developing countries including Pakistan, primarily for basic food commodities. Data are analyzed with an econometric framework based on the estimation of Autoregressive Distributed lag Models and of the corresponding Error correction specification. Tests for Granger causality and for asymmetric transmission are also performed. Results of the test in case of Pakistan indicate the presence of long run equilibrium between the domestic and the world reference prices primarily for wheat, rice, maize and bovine meat. Khan *et al* (2004) probe into the interplay of the factors operating on supply side of the wheat economy of Pakistan. They carry out an analysis to determine the performance of the agricultural policy of the country in securing a sustainable measure of self-sufficiency in food production. The results show that supports price policy, adequate water availability and technology together helped enhance the wheat

production of the country. It is argued that achievement of the proclaimed objectives of the wheat support price policy in Pakistan has been constrained because of the incumbent governments' high political stakes, usually warranting protection of urban consumers and producers by keeping food prices low. They conclude that wheat production is not some peripheral issue and the target of increasing both wheat production and wheat growers' income must be central to the macro management policy in Pakistan.

3. Method of Analysis

The present study has used a partial equilibrium model in order to quantify the gains and losses to Pakistan after trade liberalization in case of wheat. We make use of Partial equilibrium trade models as they focus on international markets for a selected set of traded goods, such as agricultural goods. In most cases, they consider the agricultural system as a closed system without linkages to the rest of the economy. Effects of the rest of the domestic and world economy on the agricultural system could be included by altering parameters and exogenous variables. The models may be single or multi products. Partial equilibrium trade models have primarily been constructed to provide insight into the implications for domestic and international agricultural markets of existing and alternative agricultural policies. The models generate information on the effects of such policies on domestic supply, demand, prices, the volume of international trade and "world market" prices. This information is often used to compute partial equilibrium welfare measures such as producers' and consumers' surplus.

In order to assess the effects of trade liberalization on wheat, we first check whether there exists any co-integration between wholesale price and world price and between farm-gate price and wholesale price of wheat. If there is no stable relationship between the above prices, then the implementation of AoA of WTO has no important implications in case of wheat for Pakistan. The welfare analysis has been conducted by estimating the domestic demand and supply functions and by using the concepts of consumer and producer surplus. The demand, supply and price linkage equations are estimated using double log standard regression analysis. The multiplicative (or log-log) function has the advantage of facilitating use of results in terms of percentage change in

the variables, allowing estimated parameters to be interpreted as elasticities. To get more reliable estimates, all the equations are also corrected for autocorrelation.

3.1. Price Integration Model

For price integration, simple bivariate correlation coefficients measure price movements of a commodity in different markets. This is the simplest way to measure the spatial price relationships between two markets. However, this method clearly has some limitations, as it cannot measure the direction of price integration between two markets. The co-integration procedure measures the degree of price integration and takes into account the direction of price integration. This econometric technique provides more information than the correlation procedure, as it allows for the identification of both the integration process and its direction between two markets.

Domestic and World prices move over time because of various shocks. If in the long run they exhibit a constant linear relation, then they are co-integrated. In general, the presence of co-integration between two series is indicative of inter-dependence. In other words, co-integration indicates non-segmentation between the two series. Co-integration analysis is a useful tool to give an answer about the existence of a relation between two economic time-series.

We apply co- integration method developed by Engle and Granger (1987) in order to examine whether there exists a stable relationship between farm-gate price and wholesale price and between wholesale price and world price of wheat in case of Pakistan. Further Granger-Causality test is applied to find the direction of influences between the prices and to decide on the leading prices for rice. The objective of this exercise is to explore the possibility of trade liberalization in term of relationship between world prices and domestic prices of wheat.

3.2. Domestic Demand Function

In accordance with standard demand theory, wheat demand in Pakistan is function of its own price, prices of substitutes and complementary

products and Per capita income. In the present study only two factors i.e. commodity's own price and Per capita income are being used.

$$Q_d = f(P_c, I) \quad (1)$$

Where
Q_d is Total quantity demanded of wheat;
P_c is Domestic market price of wheat;
I is Per capita income;
Elasticity of demand $(E_{pc}) = (\%\Delta Q_d) / (\%\Delta P_c)$.

3. 3. Domestic Supply Function

Agriculture production is affected by many and varying factors according to the nature of the crop. The supply response of wheat can be assumed to be a function of own output price, prices of all the other relevant crops and prices of inputs and technology (Ali, 1990). In this study, two variables namely commodity's own output price and technology have been used to measure price elasticity coefficients, while other factors are being kept constant.

$$Q_s = f(P_f, T) \quad (2)$$

Where
Q_{si} = total quantity supplied of wheat;
P_f = price of wheat at farm level;
T = trend variable used as a proxy for technology
Elasticity of supply (E_{pf}) = ($\%\Delta Q_s$) / ($\%\Delta P_f$).

Price transmission elasticity estimates (α_1 and β_1) will be computed using method of co-integration. Following Thompson and Bohl (1999), we define:

$$P_d = \alpha_0 + \alpha_1 Pw + u_1 \quad (3)$$

$$P_f = \beta_0 + \beta_1 P_c + v_1 \quad (4)$$

α_1 as the percentage change in the domestic price (P_d) in response to a one percent change in the world price (P_w) i.e. $\alpha_1 = (\% \Delta P_d) / (\%\Delta P_w)$ and β_1 as the percentage change in the farm level price (P_f) in response

to a one percent change in the wholesale price (P_d) ie. β_1= (% ΔP_f)/ (% ΔP_d). Normally α_1 and β_1 range from 0 to 1, where a high price transmission elasticity signifies a high degree of co movement of the prices of the above two sets of markets of a given commodity. For example, α_1= 1 means that a one percent change in the world price of a commodity is precisely reflected in a one percent change in the local price of that commodity, so a high value for α_1 can be taken as a measure of well integrated markets.

3.4. Welfare Analysis

The magnitude of the net welfare effect depends on the magnitude of the price change, the initial price and quantity, and the consumers' and producers' sensitivity to price changes. If consumers exhibit a high elasticity of demand, then they will greatly decrease their consumption when faced with a price increase. This flexibility allows them to escape the new high price, which softens the effect. On the other hand, if consumers have inelastic demand, changes in the price bring only a small response from consumers. In this case, price increases have a more harmful effect on consumers' welfare, as they do not escape the higher price by decreasing their consumption of the good. The welfare effect also depends on the producers' sensitivity to price changes. If producers have elastic supply, then they will greatly increase production at the higher price. However, in Pakistan and in other developing countries, there are many factors that can decrease the elasticity of supply. These include poor transportation infrastructure and limited ability to increase productivity due to a lack of access to credit.

One of the main objectives of our study is to determine the net welfare change for Pakistan as a result of trade liberalization in the light of Agreement on Agriculture (AoA) of WTO. To measure the net welfare change, we combine the change in producer surplus with the change in consumer surplus. Consumer surplus is the difference between the price of a unit of a good, and the maximum amount that the consumer would have been willing to spend on that unit. Producer surplus is difference between the cost of producing a unit of a good, and the price at which that unit is sold. Following equations have been estimated to measure the changes in consumer surplus and producer surplus for wheat.

$$Change\,in\ ConsumerSurplus = \left[(P_b - P_t)\{D' + (D - D')^* 0.5\}\right] \quad (5)$$

$$Change\,in\ \text{Pr}oducerSurplus = \left[(P_b - P_t)\{S + (S' - S)^* 0.5\}\right] \quad (6)$$

Net welfare effect = Change in Producer Surplus +Change in Consumer Surplus.

Where, P_{ti} is the price of wheat in the base year i.e 2003; P_w is the price of wheat after trade liberalization; *D* is the quantity demanded of wheat in the base year i.e 2003; *D'* is the quantity demanded of wheat after trade liberalization; *S* is the quantity supplied wheat in the base year i.e 2003; *S'* is the quantity supplied of wheat after trade liberalization.

4. Data Sources

The time series data for wheat have been used for quantitative analysis. The study covers the time period from 1980 to 2003. Ideally data should be from a single source to maintain consistency. However, there is no single source that can provide all relevant data. Therefore, different secondary sources of data have been used to take the above-required data. The data have been taken from Agricultural Statistics of Pakistan (various issues), Economic Survey of Pakistan (various issues), Agriculture Prices Commission, Islamabad, Pakistan, Federal Bureau of Statistics, Islamabad, Pakistan and Food & Agriculture Organization of United Nations, Rome, Italy.

5. Results and Discussion

The core of this study is to determine the impact of trade liberalization on domestic prices, production and consumption of wheat in Pakistan and to conduct the welfare analysis. For this purpose, the equations specified in the research methodology have been estimated, using data on the relevant variables for the period 1980-2003. The number of observations used for each price series (about 24) prevents us from obtaining fully conclusive evidence from tests on dynamic properties of the price series and therefore, also from the co-integration tests. So, for getting more concrete evidence on price transmission, a future analysis

will have to concentrate on using a more significant number of observations for each price series.

Using the FAO's study on "Impact of Uruguay Round on Agriculture ", 1995, it is assumed that the international price of wheat would increase by 7 percent at world level. Different price elasticity coefficients have been then used to estimate this projected increase in price on wheat at national level.

5.1. Price Integration of Wheat

To start with, we investigate the stochastic properties of the three price series of wheat that is determine their order of integration, arranged into two pairs where pair one contains LWPW[1] and LIPW while pair two includes LFPW and LWPW. If price series are stationary or integrated of order zero, it is denoted as I(0).If series must be differenced once to become stationary , it is denoted as I(1).If series must be differenced d times to become stationary , it is denoted as I(d).The difference between I(d) and I(0) is the I(0) has finite mean and variance when for the former they do not exist. In order to be integrated, price need to be integrated of the same order. Usually prices are found to be I(1) their first differencing would give I(0).If prices are integrated of different order, no co integration exist, because at least one of the series contains explosive components. To check for the order of integration we apply Augmented Dickey-Fuller test on two pairs of price series of wheat. The results of ADF tests support the presence of unit root in each case. Test results are presented in detail in Appendix. According to the methodology; prices are checked for the order of integration. Prices in both the pairs are integrated of order (1) that is each is non-stationary in levels but stationary in first difference and there exists a linear combination between them, which is stationary.

[1] LWPW=Natural log of Wholesale Price of Wheat at Lahore
LIPW= Natural log of International Price of Wheat
LFPW=Natural log of Farm gate Price of Wheat

Table 5.1 Checking prices of Pair One for the order of integration

Variable		Decision	Test Statistics	t-stat., Critical value at 5 % S.L
LWPW	Level	Accepted	-1.41402	-1.9566
	First Difference	Rejected	-2.363858	-1.9574
LIPW	Level	Accepted	-1.444808	-1.9602
	First Difference	Rejected	-4.931795	-1.6257

*Decision is based on 5% level of significance. H_0 : non-stationary series

Table 5.2. Checking prices of Pair Two for the order of integration

Variable		Decision	Test Statistics	t-stat., Critical value at 5 % S.L
LWPW	Level	Accepted	-1.41402	-1.9566
	First Difference	Rejected	-2.363858	-1.9574
LFPW	Level	Accepted	-1.140138	-1.9566
	First Difference	Rejected	-2.917878	-1.9574

*Decision is based on 5% level of significance. H_0: non-stationary series.

The estimated long-run relationship between the world price and wholesale price of wheat and between the farm gate and wholesale price of wheat is given in Appendix. These equations are estimated in order to determine whether the prices are co integrated. The coefficients give the relationship between the above prices in the form of two price linkage equations.

(a) LWPW = -1.912 + 1.213*LIPW

(-2.25) (11.85)***

R^2 =0.88 D.W = 1.73

*** t-values given in parenthesis with, ***, **, *, indicate significance at 1 pertcent,5 percent and 10 percent probability level respectively.

(b) LFPW = 0.030 + 0.980*LWPW
(0.19) (52.35)***
R^2 =0.99 D.W =1.91

Each of the price series is non-stationary and transformation into the first difference is required to obtain a stationary series. The linear combination of the two price series in both the pairs gives the residuals which are stationary I(0) and this gives the basis for condition that two price series are indeed co integrated in each pair. The corresponding co integration test is presented in tables 5.3, 5.4 and in Appendix.

Table 5.3. Checking Residuals for the presence of a unit root

Variable		Decision	Test - Statistics	t- stat
Residuals from (a)	Level	Rejected	-3.767933	-1.9602

*Decision is based on 5% level of significance

Table 5.4. Checking Residuals for the presence of a unit root

Variable		Decision	Test - Statistics	t- stat
Residuals from (b)	Level	Rejected	-4.495793	-1.9566

*Decision is based on 5% level of significance

However, to a certain degree, the world and domestic prices should influence each other, so this study does the causality test to investigate the direction of the influences. In order to analyze the causality pattern in detail, this study applies the Granger-causality method to do test with 1~ 3 lagged periods respectively. The results are listed in table 5.5 and 5.6 respectively.

Table 5.5: Price Causality between LWPW and LIPW

Lagged years	Null Hypothesis	Decision
1	No causality from LWPW to LIPW	Accepted
	No causality from LIPW to LWPW	Rejected
2	No causality from LWPW to LIPW	Accepted
	No causality from LIPW to LWPW	Rejected
3	No causality from LWPW to LIPW	Accepted
	No causality from LIPW to LWPW	Rejected

Table 5.6.Price Causality between LFPW and LWPW

Lagged years	Null Hypothesis	Decision
1	No causality from LFPW to LWPW	Accepted
	No causality from LWPW to LFPW	Rejected
2	No causality from LFPW to LWPW	Accepted
	No causality from LWPW to LFPW	Rejected
3	No causality from LFPW to LWPW	Accepted
	No causality from LWPW to LFPW	Rejected

The causality test results in table 5.5 show that world price of wheat cause wholesale price of wheat in Pakistan and causality of prices is only in one direction. These results are in accordance with the expectations as Pakistan is a small net importer of Wheat, so its wholesale price of Wheat cannot influence the world price of wheat but being net importer of wheat its wholesale price of wheat is certainly affected by the world price of wheat. While the causality test results in table 5.6 show that wholesale price of wheat cause farm gate price of wheat in Pakistan and causality of prices is only in one direction.

5.2. Impact of Trade Liberalization on Wheat at National Level

The required estimated equations for wheat are exhibited in Appendix. The equations fit the data reasonably well with summary statistics such as R^2 and D.W etc. Price transmission, domestic supply and demand elasticities computed from estimated equations are given in Table 5.7.The estimated parameters are consistent across equations and with prior expectations concerning sign and statistical significance.

TABLE 5.7. Price Transmission, Demand and Supply Elasticities for Wheat

Wholesale price transmission elasticity	1.21
Farm gate price transmission elasticity	0.98
Domestic Demand elasticity	-0.131
Domestic supply elasticity	0.313

5.2.1. Impact on Domestic Prices of Wheat

The elasticity of price transmission of wholesale price of wheat at the Lahore market with respect to the international price of wheat (c.i.f. Karachi) is 1.21. This means that a 1 percent increase in the international price of wheat would increase the Lahore wholesale price of wheat by 1.21 percent. Therefore, the increase in world price of wheat by 7 percent would cause an increase in wholesale price of wheat by 8.50 percent in Pakistan due to trade liberalization. Thus Rs. 9326/ton wholesale price of wheat in 2003, which has been taken as a base year, would become Rs. 10119/ton after the trade liberalization at current market price.

The price elasticity of transmission of wheat price received by farmers with respect to the wholesale price of wheat is 0.95. It means that a 1 percent change in wholesale price will result in a 0.98 percent change to farm level prices. Since wholesale price is expected to increase by 8.50 percent under total trade liberalization, farm gate price to be received by farmers is expected to increase by 8.33 percent i.e. from Rs 8687/ton to 9411/ton.

5.2.2. Impact on Domestic Demand for Wheat

The demand elasticity with respect to Lahore wholesale price is –0.131 as presented in table 5.7. This means that a 1 percent increase in the Lahore wholesale price of wheat is estimated to decrease the domestic demand by 0.131 percent. Therefore the impact of increase in the world price of wheat by 7 percent would cause the demand for wheat to decline by 1.11 percent i.e. from 18233 thousand tons to 18031 thousand tons during 2003-04.The increase in wholesale price of wheat in Pakistan and resulting decrease in quantity demanded would cause a change in consumer surplus of -Rs. 14379 millions.

5.2.3. Impact on Domestic Supply of Wheat

The elasticity supply of wheat with respect to the farm level price of wheat is 0.313 as presented in table 5.7. This value indicates that if price of wheat is increased by 1 percent, production of wheat goes up by 0.313 percent. The impact of the 7 percent increase in the world price of

wheat on the price of wheat received by the Pakistani farmers is estimated at 8.33 percent. Therefore, this would cause an increase in domestic production of wheat by 2.6 percent i.e. from 19500 thousand tons to 20007 thousand tons. This increase in the production of wheat would generate a change in producer surplus of Rs. 14302 millions (using the equation for producer surplus in the analytical framework).
It is concluded from the above analysis that the seven percent increase in the international price of wheat due to the UR agreement will have a positive impact on the production of wheat in Pakistan. On the other hand, it will have a negative impact on the consumers. However, the overall impact to Pakistan is negative (Rs 77 million).

The inelastic supply elasticity of wheat suggests that price incentives alone cannot boost the production to a substantial level. Institutional support like research and extension is prerequisite to take the full advantage of UR induced higher prices of wheat.

6. Conclusions and Policy Implications

Agriculture is a key sector in Pakistan because of its major share (around one-fourth in GDP) in the economy in terms of its contribution to national income and employment. Crops are the most important sub-sector of Agriculture sector of Pakistan. Among the major food crops, wheat is the main staple food of the country's population and it occupies more land under agriculture than all other crops. Considering the importance of wheat, we have analyzed the impact of trade liberalization on wheat both at national and farm levels in Pakistan. Although Pakistan is a greater producer of wheat in the world yet it has to import substantial amount of wheat in order to ensure food security. The challenges for agriculture sector of Pakistan and particularly for wheat are quite different from those met in the previous decades, as it will soon engage in free international trade of agricultural products.

For quantifying the impacts of trade liberalization on wheat in Pakistan, a partial equilibrium model has been used where we tested price integration to check the relationship between wholesale price and world price and between farm gate price and wholesale price of wheat. Price integration analysis shows that there is a stable long run relationship between the wholesale price and world price and between farm gate

price and the wholesale price for wheat. Direction of influence is from world price to wholesale price and from wholesale price to farm gate price under Granger causality test.

The impact of increase in world price of wheat as a result of trade liberalization on wholesale and farm gate level prices of wheat in Pakistan has been estimated using elasticity coefficients from estimated demand, supply and price linkage equations. The demand elasticity is found less elastic, which shows that along with increase in its price, there will be very small decrease in the demand of wheat. Moreover, it is evident that with the increase in wheat price, there will be increase in the import bill of wheat on one hand and on the other hand further burden on the poor people who purchase food grains from the market. The supply elasticity is also found to be low by any reasonable standard. Thus, increase in wheat production may not be sufficient to meet the country's demand as a result of rise in its price after trade liberalization. Under welfare analysis, it is found that loss in consumer surplus exceeds gain in producer surplus and the nation will have to face net welfare loss in case of wheat under trade liberalization.

- The present study shows that domestic price of wheat will rise in future and as a result will harm the poor consumers. In order to protect the consumers from high or sudden rise in price and to ensure food security, following essential conditions are recommended:

(a) Food security objectives should not be compromised in any case and major reliance will have to be placed on government stocks for price stability and availability of staple food to entire population.

(b) Along with public sector, efforts should be made to encourage the investment by the private sector in marketing and procurement of wheat. But the issue of food security cannot be left entirely at the mercy of private sector and the government should always be there to play a supervisory and dominant role.

(c) Targeted consumer subsidies should be provided to the low-income groups and people below the poverty line who are expected to be adversely affected by increase in food prices.

- The responsiveness of wheat production to change in price has been found to be very low. Therefore, price policy of agriculture should not be pressed to increase production but its main function should be to act as a signal for proper allocation of resources.

- In order to increase the productivity of wheat, non-price factors should be well appreciated. Non- price support can be provided to producers through the Special and Differential Treatment (SDT) provisions and the Green Box exemptions. Following measures can be applied to take the full advantage of these exemptions:

(a) Technology meant to increase water efficiency and other inputs can be made available for hiring at union council level.

(b) Proper and timely supply of inputs like seeds, fertilizers and permitted pesticides etc. should be ensured.

(d) Agriculture policy needs to aim at improved infrastructure so that Pakistan may able to take full advantage of the price increase in the world market.

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APPENDIX

- **Order of Integration of Price Series LWPW and LIPW (Pair 1) of Wheat**

Augmented Dickey –Fuller Unit Root Test on LWPW

ADF Test Statistic	-1.414102	1% Critical Value*	-2.6700
		5% Critical Value	-1.9566
		10% Critical Value	-1.6235

Augmented Dickey –Fuller Unit Root Test on D(LWPW)

ADF Test Statistic	-2.363858	1% Critical Value*	-2.6756
		5% Critical Value	-1.9574
		10% Critical Value	-1.6238

Augmented Dickey –Fuller Unit Root Test on LIPW

ADF Test Statistic	-1.444808	1% Critical Value*	-2.6968
		5% Critical Value	-1.9602
		10% Critical Value	-1.6251

Augmented Dickey –Fuller Unit Root Test on D(LIPW)

ADF Test Statistic	-4.931795	1% Critical Value*	-2.7057
		5% Critical Value	-1.9614
		10% Critical Value	-1.6257

Augmented Dickey –Fuller Unit Root Test on e_1(Residual Series)

ADF Test Statistic	-3.658803	1% Critical Value*	-3.8304
		5% Critical Value	-3.0294
		10% Critical Value	-2.6552

Causality between LWPW and LIPW

Pairwise Granger Causality Tests

Date: 02/08/01 Time: 00:39

Sample: 1980 2003

Lags: 1

Null Hypothesis:	Obs	F-Statistic	Probability
LIPW does not Granger Cause LWPW	19	10.0562	0.00593
LWPW does not Granger Cause LIPW		2.08753	0.16781

Pairwise Granger Causality Tests

Date: 02/08/01 Time: 00:40

Sample: 1980 2003

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
LIPW does not Granger Cause LWPW	18	9.76046	0.01145
LWPW does not Granger Cause LIPW		1.41015	0.27908

Pairwise Granger Causality Tests

Date: 02/08/01 Time: 00:40

Sample: 1980 2003

Lags: 3

Null Hypothesis:	Obs	F-Statistic	Probability
LIPW does not Granger Cause LWPW	17	13.66418	0.00149
LWPW does not Granger Cause LIPW		2.32480	0.13663

Error Correction Model for Pair 1

Dependent Variable: D(LWPW)
Method: Least Squares
Date: 01/29/01 Time: 06:01
Sample(adjusted): 1981 2000
Included observations: 20 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.087844	0.012828	6.847827	0.0000
E_1(-1)	-0.119480	0.071956	-1.660463	0.1141

R-squared	0.132828	Mean dependent var	0.087844
Adjusted R-squared	0.084652	S.D. dependent var	0.059962
S.E. of regression	0.057368	Akaike info criterion	-2.784007
Sum squared resid	0.059240	Schwarz criterion	-2.684434
Log likelihood	29.84007	F-statistic	2.757137
Durbin-Watson stat	1.646551	Prob(F-statistic)	0.114141

Dependent Variable: D(LIPW)
Method: Least Squares
Date: 01/29/01 Time: 06:05
Sample(adjusted): 1981 1999
Included observations: 19 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.069367	0.035905	1.931966	0.0702
E_1(-1)	0.631770	0.197632	3.196703	0.0053

R-squared	0.375434	Mean dependent var	0.066296
Adjusted R-squared	0.338695	S.D. dependent var	0.192386
S.E. of regression	0.156450	Akaike info criterion	-0.772865
Sum squared resid	0.416100	Schwarz criterion	-0.673450
Log likelihood	9.342215	F-statistic	10.21891
Durbin-Watson stat	1.932346	Prob(F-statistic)	0.005285

Dependent Variable: LWPW
Method: Least Squares
Date: 01/29/01 Time: 06:06
Sample(adjusted): 1980 1999
Included observations: 20 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.912143	0.848668	-2.253111	0.0370
LIPW	1.213710	0.102432	11.84896	0.0000

R-squared	0.886362	Mean dependent var	8.131355
Adjusted R-squared	0.880049	S.D. dependent var	0.542586
S.E. of regression	0.187919	Akaike info criterion	-0.410971
Sum squared resid	0.635644	Schwarz criterion	-0.311398
Log likelihood	6.109713	F-statistic	140.3978
Durbin-Watson stat	1.737124	Prob(F-statistic)	0.000000

Stability Condition under ECM

-0.119480 - 1.213710 (0.631770) = -0.8865 < 0

Therefore, cointegration between LWPW and LIPW is stable. Where,
LWPW= Natural log of wholesale price of Wheat at Lahore in Rs./ton
LIPW= Natural log of International price of Wheat (c.i.f Karachi) in Rs./ton

- **Order of Integration of Price Series LFPW and LWPW (Pair 2) of Wheat**

Augmented Dickey –Fuller Unit Root Test on LFPW

ADF Test Statistic	-1.140138	1% Critical Value*	-2.6700
		5% Critical Value	-1.9566
		10% Critical Value	-1.6235

Augmented Dickey –Fuller Unit Root Test on D(LFPW)

ADF Test Statistic	-2.917878	1% Critical Value*	-2.6756
		5% Critical Value	-1.9574
		10% Critical Value	-1.6238

Augmented Dickey –Fuller Unit Root Test on LWPW

ADF Test Statistic	-1.414102	1% Critical Value*	-2.6700
		5% Critical Value	-1.9566
		10% Critical Value	-1.6235

Augmented Dickey –Fuller Unit Root Test on D(LWPW)

ADF Test Statistic	-2.363858	1% Critical Value*	-2.6756
		5% Critical Value	-1.9574
		10% Critical Value	-1.6238

Augmented Dickey –Fuller Unit Root Test on e_2(Residual Series)

ADF Test Statistic	-4.495793	1% Critical Value*	-2.6700
		5% Critical Value	-1.9566
		10% Critical Value	-1.6235

Causality Between LFPW and LWPW

Pairwise Granger Causality Tests
Date: 02/08/01 Time: 00:43
Sample: 1980 2003
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Probability
LWPW does not Granger Cause LFPW	23	23.0893	0.00011
LFPW does not Granger Cause LWPW		0.00370	0.95208

Pairwise Granger Causality Tests
Date: 02/08/01 Time: 00:44
Sample: 1980 2003
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
LWPW does not Granger Cause LFPW	22	14.0763	0.00025
LFPW does not Granger Cause LWPW		0.06273	0.93941

Pairwise Granger Causality Tests
Date: 02/08/01 Time: 00:46
Sample: 1980 2003
Lags: 3

Null Hypothesis:	Obs	F-Statistic	Probability
LWPW does not Granger Cause LFPW	21	8.42231	0.00191
LFPW does not Granger Cause LWPW		0.35790	0.78427

Error Correction Model for Pair 2

Dependent Variable: D(LFPW)
Method: Least Squares
Date: 01/29/01 Time: 06:16
Sample(adjusted): 1981 2003
Included observations: 23 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.080202	0.010634	7.542347	0.0000
E_2 (-1)	-0.990407	0.208544	-4.749156	0.0001

R-squared	0.517845	Mean dependent var	0.083599
Adjusted R-squared	0.494885	S.D. dependent var	0.071591
S.E. of regression	0.050881	Akaike info criterion	-3.035712
Sum squared resid	0.054366	Schwarz criterion	-2.936973
Log likelihood	36.91069	F-statistic	22.55448
Durbin-Watson stat	1.378506	Prob(F-statistic)	0.000109

Dependent Variable: D(LWPW)
Method: Least Squares
Date: 01/29/01 Time: 06:17
Sample(adjusted): 1981 2003
Included observations: 23 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.081777	0.012461	6.562373	0.0000
E_2(-1)	0.017008	0.244394	0.069591	0.9452

R-squared	0.000231	Mean dependent var	0.081719
Adjusted R-squared	-0.047378	S.D. dependent var	0.058264
S.E. of regression	0.059628	Akaike info criterion	-2.718451
Sum squared resid	0.074665	Schwarz criterion	-2.619712
Log likelihood	33.26218	F-statistic	0.004843
Durbin-Watson stat	1.667933	Prob(F-statistic)	0.945178

Dependent Variable: LFPW
Method: Least Squares
Date: 01/29/01 Time: 06:13
Sample: 1980 2003
Included observations: 24

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.030523	0.155590	0.196175	0.8463
LWPW	0.980265	0.018723	52.35496	0.0000

R-squared	0.992038	Mean dependent var	8.155340
Adjusted R-squared	0.991676	S.D. dependent var	0.600440
S.E. of regression	0.054782	Akaike info criterion	-2.891245
Sum squared resid	0.066024	Schwarz criterion	-2.793074
Log likelihood	36.69494	F-statistic	2741.041
Durbin-Watson stat	1.918585	Prob(F-statistic)	0.000000

Stability Condition under ECM

-0.99-(0.98)(0.17) = -1.01

As –1.01 < 0, therefore, there exists a strong long run relationship between LFPW and LWPW.

Where,
LFPW= Natural log of Farm gate price of Wheat in Rs./ton

Wheat Estimated Model

Estimated Domestic Demand Equation For Wheat in Pakistan (PCCW):

LPCCW = 10.223 - 0.131*LWPW + 0.007*LPCI♦

(17.82)*** (-10.45)*** (0.101)

R^2 =0.99 E_{dw} = -0.131 D.W = 1.38

Where,
LPCCW =Natural log of Per capita consumption of Wheat in kg

WCONS = Total consumption of Wheat (PCCW * POP) in thousands tonnes

POP = Population

LWPB = Natural log of wholesale price of Rice at Lahore in Rs./ton

E_{db} =Elasticity of demand of Wheat w.r.t. Wholesale price of Wheat

LPCI = Natural log of Per capita income

♦ For all estimated equations, t-values given in parenthesis, with ***, **, * indicate significance at 1 percent, 5 percent and 10 percent probability level respectively.

Estimated Supply Equation For Wheat in Pakistan (QSW):

$$LQSW = 7.12 + 0.313*LFPW(-1)^{\spadesuit} - 0.0009*TR$$
$$(7.81)^{**} \quad (20.36)^{***} \quad (-0.07)$$

$R^2 = 0.90$ $E_{sw} = 0.313$ D.W = 2.1

Where,

LQSW = Natural log of total production of Wheat ('000 tons)

LFPW = Natural log of farm level prices received by Wheat growers (Rs./ton)

E_{sw} = elasticity of supply w.r.t. Farm level price of Wheat

TR= Trend=Year as proxy for technology (1980=1, 1981=2…2003=24)

Price Linkage Equations: There are two sets of price linkage equations, which represent the relationship between the price of wheat at farm level and price of Wheat at various market channels**.**

(a) Wholesale price of Wheat at Lahore versus International price of Wheat:

$$LWPW = -1.912 + 1.213*LIPW$$
$$(-2.25) \quad (11.85)^{***}$$

$R^2 = 0.88$ $E_{ww} = 1.213$ D.W = 1.73

Where,

E_{ww}=Elasticity of Wholesale price of Wheat at Lahore w.r.t. International price of Wheat or Elasticity of price transmission.

$^{\spadesuit}$ One year lag value of farm gate price has been used in the supply function because the supply of many agricultural commodities reacts to price with a lag of one time period and thus supply decisions take time to implement (Gujrati,2003)

(b) Price of Wheat received by farmers versus wholesale price of Wheat at Lahore:

$$LFPW = 0.030 + 0.980*LWPW$$
$$(0.19) \quad (52.35)^{***}$$

$R^2 = 0.99$ $E_{fw} = 0.98$ D.W = 1.91

Where,

E_{fw}=Elasticity of. farm gate price of Wheat w.r.t Wholesale price of Wheat at Lahore or Elasticity of price transmission.