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Price volatility trends and price transmission for major staples in India

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Abstract India is one of the largest producers as well as exporters of some major food commodities, and is often criticized for its protectionist measures to curb transmission of price shocks from international markets. This paper examines if such policies are necessary to protect domestic consumers from price fluctuations and what are their implications on international prices. To understand this, in this paper we have examined the patterns, trends and volatility in domestic and international prices of rice and wheat, and found that although both the international and domestic prices are volatile, the degree of volatility is higher in the international prices. The volatility in domestic prices is mainly due to internal production shocks and is not influenced much by the international prices. This disconnect is attributed to domestic policy measures, such as market support to farmers and public stockholding of food grains for public distribution and price stabilization.

Keywords Food price volatility, Food policies, Price transmission, India

JEL classification Q13, Q17, Q18

1 Introduction

Price volatility and inflation though are different phenomena yet are strongly interwoven, and affect welfare of both the producers and consumers (HLPE 2011). The excessive changes in food prices create a situation of uncertainty that can have huge cost on the food supply chain, investments and social development (OECD 2010). Several studies (Zimmerman & Carter 2003; Barrett & Bellemare 2011; Dawe et al. 2010; Headey 2014) have assessed the impact of food prices on poverty and find that persistent price volatility may lead to increase in income inequality resulting in poverty trap. In order to understand and manage the impact of food price volatility, it is important to understand the role of domestic markets as well as the influence of international on prices on domestic markets (Rapsomanikis 2011). The high price transmission from international to domestic markets

can be difficult to manage and would require different types of coping mechanisms than those designed to tackle volatility due to domestic factors.

Tracking food price volatility is important to plan for long-term food security and accordingly devise policies and strategies (OECD 2010). The global price hike in 2007-08 led to a sudden realisation to closely watch the price volatility and its impact on domestic prices (Minot 2014; OECD, 2010). This price shock adversely affected net consumers of cereals in the countries highly dependent on international markets for their food demands (Dawe 2009; Dorosh 2009; Timmer 1993). The 2007-08 price surge was the longest as well as the largest in the past several decades, and it was followed by another price surge in 2010-11 (Dawe et al. 2015, 2010). This happened due to continuous droughts in many parts of the world that led to a mis-match between food demand and supply. Low levels of food reserves, depleting stocks and trade restrictions further

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aggravated this mis-match in food-deficit countries. Besides, protectionist domestic policies of several countries aggravated the impact of the crisis. Pieters & Swinnen (2016) show that through domestic policies several countries could reduce the short-run impact of 2007-08 price spike.

In India, the food prices rose during the food crisis of 2007-08, but the evidence of price volatility is been mixed. India, though, is food self-sufficient, food security concern still loom large (Ahmad & Haseen 2012; Dasgupta et al. 2011; OECD 2010; Acharya et al. 2012). Price volatility can have strong implications for food security policies such as public distribution system and minimum support price or procurement price that serve as safety nets for producers as well as consumers (Mittal & Sethi 2011).

Thus, it is important to study the patterns in the prices received by the farmers for major staple food crops like wheat and rice. Comparing the trends of domestic prices with the international prices would enhance our understanding of the price transmission and its effects on food security. The main objectives of this paper are: (i) to examine the trends in food prices of wheat and rice in India and to decipher volatility there in; and (ii) to assess the relationship between domestic and international price volatility and measure the extent of price transmission from international market to domestic market.

2 Data and Method

2.1 Data

The study uses time series data on domestic and international prices of wheat and rice, that together account for nearly half of the total food budget in a majority of the developing countries (Dorosh 2009; Rapsomanikis 2011). The annual average of monthly domestic wholesale and retail prices, and international market prices are used to analyse the trends and

volatility in prices. Monthly wholesale prices in domestic market and international market prices are used to estimate elasticity of price transmission (PTE). In the paper, we consider annual wholesale prices as domestic prices.

The data on annual wholesale prices of wheat and rice from 1967 to 2010, retail prices from 1996 to 2013 and monthly wholesale prices from March 2001 to May 2015 have been collected from various issues of Agricultural Prices in India (GOI 2015) and online resources¹. The international prices from 1960 to 2014 and monthly international prices from March 2001 to May 2015 have been obtained from the Global Economic Monitor (GEM), popularly known as pink data sheet of the World Bank. The monthly data on the representative currency exchange rate between Indian Rupee (INR) and US dollar for the period were accessed from the online database of the International Monetary Fund (IMF).

Wholesale prices and international prices are available for several commodities in different markets. A brief review of literature is done to choose the right market that appropriately represents domestic situation. Several studies had considered different markets and approaches depending on the purpose and availability of data. Sharma & Kumar (2001) and Mittal & Virmani (2007) have discussed in detail markets for rice and wheat in India. Acharya et al. (2012) chose five secondary wholesale markets namely, Delhi, Mumbai, Hyderabad, Chennai and Kolkata for rice; and Delhi, Mumbai, Hyderabad, Chennai and Bengaluru for wheat. The semarkets were selected based on the availability of long time monthly price data and geographical spread. Ganguli & Gulati (2013) estimated domestic wholesale prices of wheat by averaging the monthly data across *mandis* (wholesale markets) in Punjab and Uttar Pradesh, and of rice by averaging the monthly data across government regulated market yards in all states. Based on this

¹ For calculating trends, price volatility and price transmission of wheat and rice, the domestic prices (both wholesale and retail prices) in Rupee per quintal are accessed from various issues of agricultural Prices in India and <http://eands.dacnet.nic.in/publications.htm>

For calculating trends, price volatility and price transmission of wheat and rice, the international prices in US dollars per metric tonnes are accessed from Global Economic Monitor (GEM) commodity data sheet, World Bank, <http://data.worldbank.org/data-catalog/global-economic-monitor>

The domestic prices in Indian rupee are converted to US Dollars using the representative exchange rates from IMF (http://www.imf.org/external/np/fin/data/param_rms_mth.aspx).

review, we selected Punjab and Uttar Pradesh markets for domestic wholesale prices of wheat, and national prices² for rice.

International price of rice and wheat are often represented by the price of Thai rice (5% broken) and US (HRW wheat), respectively (Acharya et al. 2012; Clarete et al. 2013). Bessler et al. (2003) analysed the relationship among wheat prices in five major wheat exporting countries (U.S., Canada, Australia, European Union and Argentina) and found that Canada and U.S. are the price leaders. Mohanty et al. (1996) found that there is no distinct price leader in wheat market, but prices are mainly influenced by Australia, Canada and U.S. The international wheat markets are integrated, with Australia being the dominant trading centre (Goodwin 1992; Shenoy 2008).

2.2 Method

2.2.1 Price volatility

To understand price trends, we compute average annual growth rates for different sub-periods. The price series is checked for stationarity. The Augmented Dickey Fuller (ADF) test is used for testing the stationarity of the price series of wheat and rice. Jordaan et al. (2007), Karali & Power (2013), May (2010), Moledina et al. (2004), Swaray (2007) and Yang et al. (2001) estimated price volatility employing generalised auto regressive heteroscedasticity (GARCH/ARCH) technique. It is argued that by distinguishing predictable and unpredictable components of prices, these techniques provide accurate estimates of volatility. Huchet-bourdon (2011) criticizes it stating that the parameters used to explain conditional volatility may not fully explain the actual situation. Few studies have attempted to establish linkages between price volatility of agricultural commodities and crude oil (Du et al. 2011; Nazlioglu et al. 2013) and exchange rates (Nazlioglu & Soytas 2012). Ott (2013), however, highlights difficulties in establishing such links due to lack of data. In our case, we have problems in accessing right data on the variables required to run a GARCH model. In this paper, we do not distinguish between predictable and unpredictable components of price series. The ‘standard deviation of logarithm of prices’ as used in

several studies (e.g., Kemény et al. 2012; Minot 2014 & Sekhar 2003) is used to compute instability of prices. For calculating inter-year variability, the annual average prices are calculated by averaging 12 monthly prices, and then growth rates of annual prices are calculated as $\log(P_t / P_{t-1})$. The average inter-year variability of annual prices for the decade is then calculated as the standard deviation of all the annual growth rates in the decade. However, the prices used in calculating this measure are the annual averages of monthly prices, thus short-run fluctuations in prices are not captured.

$$\text{Volatility} = \text{stdev}(r) = \left[\sum \frac{1}{N-1} (r_t - \bar{r})^2 \right]^{0.5}$$

where, $r_t = \ln P_t - \ln P_{t-1}$ and $\bar{r} = \sum \frac{1}{N} r_t$, $\text{stdev}(r)$ is the standard deviation of the logarithmic differences of prices (r_t), and P_t is the price in period ‘t’ and P_{t-1} is the price in period ‘t-1’.

2.2.2 Price transmission

Drawing from the existing literature on market integration and spatial price transmission, the lagged price transmission model is used to establish the relationship between international prices and domestic prices. The estimated parameter in this model can be directly interpreted as price transmission elasticity. The values of the parameters and their significance levels provide information about the extent to which markets share the same price shocks. The transmission parameter summarises the overall effects of the factors affecting price signals. A general specification of the international price transmission through a partial adjustment model as given in Bredahl et al. (1979) and Mittal & Reimer (2008) is,

$$\ln PD_t = \alpha + \lambda \ln PD_{t-1} + \beta \ln PW_{t-1} + \gamma T + \epsilon_t$$

Where, PD_t is domestic price at time ‘t’; PD_{t-1} is domestic price at time ‘t-1’, PW_{t-1} is the international price at time ‘t-1’, T is time trend; $\hat{\alpha}$ is the price transmission elasticity. It indicates the change in domestic price in the short term in response to a one percent increase in international price. The model is estimated with and without time trend.

² Average of all the whole sale market prices

3 Results and discussion

3.1 Behaviour of prices

The trends in domestic prices³ and minimum support prices (MSP) of rice and wheat vis-à-vis their corresponding international prices are shown in figure 1. Both the domestic and international prices show an upward trend, but a higher fluctuation is observed in international prices. Further, a common movement is observed in the prices of wheat as well rice, but differing in the magnitude.

For wheat, there was a sharp increase in domestic price in 1996 on abolition of the selective control on wheat exports in 1995-96. The government of India confronted price rise by reducing export quota and later banning export of wheat and wheat products (Sharma

& Kumar 2001). There was also an increase in international price of wheat because of low level of production in the preceding years and low stock (Pinstrup-Andersen & Garnett 1996), and speculation in future contracts (European Commission 2009). A sustained rise in the wholesale price of wheat is seen from 2005 onwards. Initially, it followed the global price trend but remained depressed because of the rapid increase in domestic food production in 2007-08 (Chand 2008). The minimum support prices, show a similar trend as do the wholesale prices.

Wholesale price of rice increased linearly until 2007. Thereafter it witnessed a drastic increase until 2009, but declined in 2010. Despite export restriction on basmati rice, the wholesale price of rice increased after 2006. A sudden rise in price in 2009 was attributed to

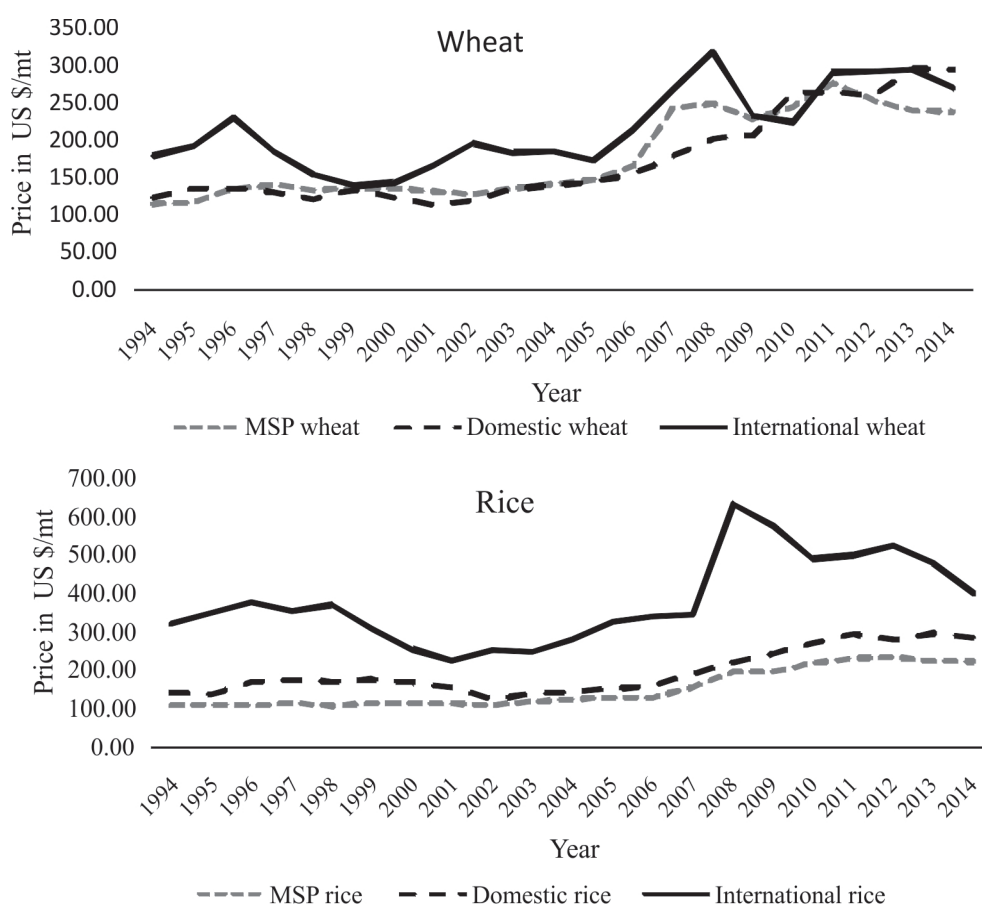


Figure 1. Price trends of domestic (wholesale price), MSP and international prices for wheat and rice

Note: MSP rice is for common variety. Prices are in real terms at 2011 prices.

Source: Computed from author from various sources: Global Economic Monitor (GEM) commodity data sheet, World Bank and Agricultural Prices in India.

³ Domestic prices here mean the average annual wholesale prices.

Table 1. Rate of growth in domestic and international prices of wheat and rice

Time period	Wheat (International)	Wheat (Domestic)	Rice (International)	Rice (Domestic)
1960-69	0.3	-	5.7	-
1970-79	10.3	5.8	11.8	4.7
1980-89	-2.0	5.2	-7.3	6.5
1990-99	-0.8	11.1	1.8	8.5
2000-09	10.1	4.7	14.2	6.4
2010-14/15	-2.6	9.6	-4.2	12.0
1970-14/2015	2.5	6.6	1.7	7.3

Note: Data for international prices are available until 2015 and for domestic prices until 2014. Data for domestic series are available from 1970 onwards.

Source: Global Economic Monitor (GEM), and Agricultural Prices in India.

severe drought in 2008-09 (Ganguli & Gulati 2013), and relaxation of export ban on rice (Acharya et al. 2012). Bumper harvest in 2009-10 led to a decline in rice price.

The decadal growth rates in domestic and International prices are shown in the table 1. Both had a linear upward trend throughout 1970-71 to 2014-15. The growth in international prices is less than that in the domestic prices, although the instability in the international prices is evident from the negative decadal growth rates in between. It clearly shows higher instability in international prices than in domestic prices.

2.2 Price volatility

The price trends as discussed above do demonstrate instability in prices. Usually, the domestic markets are less volatile than the international markets (OECD 2010; Rapsomanikis 2011). Also, India's agricultural markets are less volatile than the world markets (Chand 2002; Nayyar & Sen 1994). Price volatility is computed to re-confirm the pattern and magnitude of instability as observed.

The volatility coefficients for domestic and international prices are presented in table 2. To test their robustness, we compute volatility in different type of domestic prices – retail prices, average annual wholesale prices and wholesale prices. Similarly, volatility coefficients are computed for average annual international prices. The value of coefficient closer to zero implies less volatility or vice versa.

In the domestic market, wheat prices are the least volatile. However, the wholesale price in Uttar Pradesh are more volatile (0.15) than in Punjab (0.086). This might be possible because Uttar Pradesh is a large state and there are additional transportation, transaction and marketing costs involved. For rice, the volatility is higher in retail prices (0.144) than in the wholesale prices (0.093). The comparable results for price differential in the wholesale and retail prices of rice have been reported by Singhi (2015). Similarly, Acharya et al. (2012) found that the wholesale rice prices in different markets tend to converge at a faster rate in the long run, but in the case of retail prices, there exists price asymmetry among markets. This is because of high transaction cost, lack of infrastructure and information asymmetry. The transaction cost in northern states is higher compared to other states due to more intermediaries between wholesalers and retailers (Sharma & Kumar 2001).

The volatility in international prices of wheat is higher than that in the domestic prices; the volatility coefficient being in the range of 0.165 to 0.185 for international prices, and in the range of 0.086 to 0.150 for domestic prices. These are in synchronisation with the simple price trends as discussed earlier. For rice, the international prices are much more volatile than the domestic prices. Gulati & Dutta (2010) attribute it to the export bans on rice by major rice exporting countries like China, Thailand, India and Vietnam. There are evidences that Indian domestic markets are closely integrated, except that of rice (Sekhar 2012).

Table 2. Price volatility in domestic and international prices of wheat and rice

Variables [#]	Number of observation (years)	Mean*	Price volatility ⁺
Wheat (Retail price)	18	0.070	0.086
Rice (Retail price)	18	0.069	0.144
Wheat (Domestic)	48	0.059	0.099
Rice (Domestic)	48	0.067	0.093
Wheat (Punjab)	47	0.062	0.086
Wheat (Uttar Pradesh)	47	0.057	0.150
Wheat US (HRW)	56	0.023	0.185
Wheat US (SRW)	37	0.008	0.165
Wheat (International)	56	0.023	0.180
Rice (5% Thailand)	56	0.023	0.237
Rice (25% Thailand)	26	0.028	0.185
Rice (A1 Thailand)	30	0.045	0.223
Rice (International)	56	0.023	0.248

Note: [#] The domestic price series is in Indian Rupees per quintal and international prices in US dollars per metric tonnes. Wheat (Domestic) and Rice (Domestic) is the average of wheat prices across different wholesale markets respectively. Wheat Punjab and Wheat Uttar Pradesh are the wholesale prices in Punjab and Uttar Pradesh respectively. US HRW is the hard-red winter wheat in United States and US SRW is the soft red winter wheat. Thai A1 rice is the white rice long grain variety exported from Thailand.

*mean value of the first difference of logarithm of prices.

+ The standard deviation for each price depicts the price volatility.

The Augmented Dickey Fuller (ADF) test is used for testing the stationarity of the price series of wheat and rice (table A1). The results show that price series are non-stationary but stationery at first difference.

3.3 Price transmission

Price signals transmit across markets but often lack perfect co-integration due to higher transaction and transport cost, lack of communication, varying contract enforcement and varying intervention by the state governments (Kankaraj et al. 2009; Shenoy 2008). Ghosh (2003) provide evidence in favour of spatial integration of the regional wheat markets in India. The prices across geographically dispersed markets show long-run spatial linkage, suggesting price integration (Mittal & Virmani 2007). Though the markets are geographically separated the price signals are

transmitted across markets. However, the law of one price may not prevail (Ghosh 2003; Mittal & Virmani 2007).

For an open economy, Yavapolkul et al. (2006) have shown existence of equilibrium relationship in prices among developed and developing countries. They also show that Indian markets respond strongly to the price change in other countries. Dasgupta et al. (2011) have found that the wholesale domestic wheat market in India is significantly affected by the domestic factors and moderately by the international price movements.

In this paper, we compute price transmission elasticity (PTE) to understand the magnitude of effect of international prices on domestic prices, and the results are presented in table 3.

The price transmission results show that the lagged domestic prices have a positive and large effect on

Table 3. Regression between domestic and international price of wheat and rice

	Independent variables	With trend	Without trend
Rice	PD _{t-1}	0.852***	0.858***
	PW _{t-1}	0.040	-0.0003
	Trend	-0.004	-
	Constant	0.861***	0.808***
	F-test	185.97	277.31
	Prob>F	<0.0001	<0.0001
	R-Square	0.7707	0.7686
	Adjusted R-Square	0.7665	0.7658
	DW-Stat	2.40	2.40
Wheat	PD _{t-1}	0.829***	0.865***
	PW _{t-1}	0.044*	0.059**
	Trend	0.003*	-
	Constant	0.512***	0.423**
	F-test	757.02	1122.08
	Prob>F	<0.0001	<0.0001
	R-Square	0.9319	0.9307
	Adjusted R-Square	0.9307	0.9299
	DW-Stat	2.08	2.13

Note: ***indicates at 1 per cent level, **indicates at 5 per cent and *indicates at 10 per cent level. is the Domestic Price of respective crops at time 't'. PD_{t-1}= Domestic Price (one lag), PW_{t-1}= International Price. Dependent Variable (PD.) Number of observations = 170 for each of the crop

domestic prices as compared to the international prices. The international prices represented by PW_{t-1} have positive but non-significant effect on the domestic price of rice, but a significant effect on wheat price. Even if the price transmission elasticity for rice is significant, its coefficient is very small as compared to the coefficient of domestic lagged price. This shows poor transmission of international prices in domestic markets.

Both the international and domestic prices show rising trend but international prices are more volatile. This is because rice and wheat prices are controlled through government-administered minimum support price. This policy helps in maintaining price stability. During the period of food price crisis, there was high rate of increase in MSP of wheat and rice to incentivise the farmers to produce sufficient quantities of these cereals to meet the public distribution commitments of the government (Acharya et al. 2012). Had international prices been transmitted to domestic market during the food crisis in 2007-08, this would have adversely affected the poor consumers (Dasgupta et al. 2011).

Several countries, for example China and Japan also use price stabilisation policies (Rapsomanikis 2011; OECD 2010). These policies are put in place to safeguard domestic food security from highly volatile international markets, and from several other factors beyond the control of domestic policy (OECD 2010).

4 Conclusions and policy implications

Volatile international prices could result in higher instability in the domestic prices and increase the incidences of food insecurity (Feder et al. 1977; Sekhar 2003). When a sudden spike in international prices happens, countries resort to trade barriers to insulate the domestic markets (Anderson & Nelgen 2012).

The study shows that both international and domestic prices are volatile, and the degree of volatility is higher in international prices. There is no clear pattern on how the price volatility trends have changed over time, but it is evident that wheat prices have become more unstable as compared to historic data (OECD 2010). The volatility in domestic prices is due to domestic factors rather than influenced by the international prices. This is evident from the result that lagged domestic price coefficient is significant for both the crops. Domestic price instability is also an effect of

domestic demand-supply mismatch and market irregularities (Acharya et al. 2012). This disconnect is mainly due to domestic policy measures, such as trade controls through restrictions and tariffs, market support to farmers and public stockholding of food grains for public distribution and price stabilization.

The 2007-08 food crisis witnessed increased level of government interventions, in terms of import ban and release of stock to stabilise domestic prices (Ganguly & Gulati 2013). Indian price stabilising and price intervention policies remained in place even after the food crisis, but short-term ban on export of essential food commodities was later lifted in 2009 (Dorosh 2009; OECD 2010). It also had implication on the futures trading and commodity exchange listing of essential food commodities. As a long-term policy, the government has also revisited the food security policies by increasing the emphasis on improved productivity and sustainable agriculture. The National Food Security Act was passed in 2014 which has comprehensive set of interventions to ensure the food security of an individual in the country (Acharya 2009; Narayanan 2015). The policies that are being used to manage international price volatility using trade distortion need to be discouraged while other social security measures for producers and consumers need to be ensured (Anderson 2013). For example, income diversification along with crop diversification had been promoted to mitigate the impact of price fluctuations.

The government is criticised for its policy to maintain price stability by promoting high prices to the food producers and subsidizing the food to consumer. It often calls for a food policy dilemma as it causes loss in efficiency. There is a demand to increase private sector participation in the market because it is believed that free trade might be a better substitute than a government subsidized buffer stock (Landes 2008; Minot 2014; Rashid et al. 2008; Sekhar, 2003; Timmer et al. 1983). These are the most recommended policy options to safeguard the interest of the population in times of international food crisis and high price volatility (Dasgupta et al. 2011; Dorosh 2009; Nayyar & Sen 1994; Sekhar 2003, 2004).

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Annex table 1. Results of Augmented Dickey-Fuller used to test the stationarity of price series

Price series	Number of observations	Test statistic at	
		P_t	ΔP_t
Rice (Domestic)	169	-3.348	-17.279
Rice(International)	169	-1.633	-7.728
Wheat (Domestic)	169	-2.287	-14.952
Wheat (International)	169	-1.801	-10.043
Critical values	At 1%	At 5%	At 10%
	-3.487	-2.885	-2.575

Note: P_t is the price at time 't' and ΔP_t is the difference of the prices at time 't' and 't-1'.