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An Empirical Exploration of Instability in Prices during Pre and Post-Recession in India

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Abstract

Instability in the prices of agricultural products has become a grave global concern in the present context and this calls for imminent and significant attention for seeking plausible solutions. Price instability is a general feature of competitive markets and it indicates important signs to producers and consumers. However, the efficacy of this system breaks down due to economic shocks. After any economic crisis there is often a steep and unpredictable increase in the prices of agricultural products. This anomaly needs the intervention of policy makers and strategists who must enlist measures to contain the price volatility. High volatility also has harmful and negative impact on poor people in a developing country, more so when they have to spend 70 percent of their income in procuring the food itself. According to FAO estimates, due to global financial crisis, around 80 million people have become malnourished. The financial crisis of 2007–2008, also known as the global financial crisis, is considered by many economists to have been the worst financial crisis since the great depression of the 1930s. Recession is an economic instability caused through the variation of aggregate demand and aggregate supply in economy. Due to the process of globalization it has both direct and indirect adverse impact on rest of the other countries in the world, be they the developed or the developing countries. In macroeconomics, the concept of instability refers to an uncertain movement of a random variable over a period of time. Volatility in agricultural commodity prices assumes a lot of importance because the uncertainty entailed is one of the major factors that affect the income security of producers and traders and it threatens the performance of agriculture as well as the welfare of the consumers. According to World Bank Report 2013, 1.2 million people are still living below 1.25 USD per capita per day. India's success in addressing food inflation, therefore, has important implications for global food security. Price rise adversely impacts the income and has substitution effect on food consumption by the poor, consequently, leading to serious implications on the household welfare. Price volatility can also 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. This study attempts to examine the extent and graph of fluctuation of food prices in pre and post-recession from 2002 to 2015. The study maps normal volatility or more volatility of prices in wheat or rice in a stipulated timeframe. The research has elementally focused on the prices of two food crops which are wheat and rice because these two crops are staple crops of the country and help in meeting a significant proportion of the daily calorie needs of the people. The data has been taken from the reliable and authentic data sources such as MOSPI data set. The monthly data has been taken for the time period from 2002 to 2015 in context of the Indian economy. Furthermore, this time period has been divided into two sub-categories, in pre and the post-recession period. The main purpose of this study is to examine the impact, if any, of external shocks such as global financial recession on the instability of food prices in Indian economy. To fulfill this aim, we have applied the ARCH/GARCH (GARCH.1.1) Model. To conclude, in the pre-recession period, the instability in price of wheat and rice has increased with high rate but the instability on prices of wheat is higher as compared to prices of rice. This is largely due to the influence by (own shock) or due to the past information about prices of agriculture commodities. Further, in the post-recession period, volatility on food prices of wheat and rice is largely influenced by the global financial crisis and past information about the prices of agriculture commodities. This study aims at a more conclusive approach by enunciating some suggestions and recommendations for policymakers which are: Concerted efforts are required by all stakeholders to ensure more investment in agricultural sector including agribusiness. Pivotal shift in policy by the governments in the wake of looming economic volatility or instability is essential with the key focus on food security and trade policy that effectively stems the adverse impact of price rise on the consumers and producers. It is imperative to ensure the timely availability and accessibility to good quality seeds, eco-friendly fertilizers, sensitisation on irrigation techniques for farmers, providing subsidies as and when required to the target groups. Public Distribution System (PDS) also needs a more efficacious and equitable approach.

Keywords: *Food Price Volatility, Financial Crisis 2008, Augmented Dickey Fuller Test, ARCH/GARCH Model.*

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Introduction

Instability or fluctuations in the prices of agricultural products have become a grave global concern in the present context and this call for imminent and significant attention for seeking plausible solutions. Price instability is a general feature of competitive markets and it indicates important signs to producers and consumers. However the efficacy of this system breaks down due to economic shocks. After any economic crisis there is often a steep and unpredictable increase in the prices of agricultural products. This anomaly needs the intervention of policy makers and strategists who must enlist measures to contain the price instability. High volatility or fluctuations also have harmful and negative impact on poor people in a developing country, more so when they have to spend 70 percent of their income in procuring the food itself. According to FAO estimates, due to global financial crisis, around 80 million people have become malnourished.

The financial crisis of 2007–2008, also known as the global financial crisis, is considered by many economists to have been the worst financial crisis since the great depression of the 1930s (Temin, P., 2010). It began in 2007 with a crisis in the subprime mortgage market in the US and developed into a full-blown international banking crisis with the collapse of the Investment Bank Lehman Brothers on September 15, 2008 (Mark, W., 2012). Recession is an economic instability caused through the variation of aggregate demand and aggregate supply in economy. Due to the process of globalization it has both direct and indirect adverse impact on rest of the other countries in the world, be they the developed or the developing countries. Furthermore, according to Verma N M P, ed., 2013, recession is an economic instability that touches every person, the economy, and society in totality. It ultimately also affects other economies depending upon the volume of cross-country integration openness and trading. Also, in macroeconomics, the concept of volatility refers to an uncertain movement of a random variable over a period of time. Volatility in agricultural commodity prices assumes a lot of importance because the uncertainty entailed is one of the major factors that affect the income security of producers and traders and it threatens the performance of agriculture as well as the welfare of the consumers (World Bank, 1997 and OECD/FAO, 2011).

The macroeconomic objectives are growth rates, unemployment reduction, price stabilization, qualitative change in livelihood pattern, consumption and maintaining a nice sustainable balance. In other words, accomplishing good living standard, stability in the economy, a secured economic environment and long term sustainability are top most macroeconomic aims (NMP. Verma, 2017). Theoretically, the linkages between agriculture and macroeconomic policies and factors are analyzed through world market price, global conditions, exchange rate, trade (tariff and non-tariff barriers) and sectoral policies viz. support price, marketing and procurement (Schuh, 1974; In and Mount, 1994; Mamingi, 1996; Schiff and Valdes, 1998). With its origin in 1950s in the Latin American context, an enduring debate does exist between “structural” and “monetary” economists. Despite structuralists’ belief that rising prices are essential for economic growth, monetarists view it as detrimental to economic progress (Ramadas, S. et al., pp. 19, 2014).

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). Price volatility and inflation though are different phenomena yet are strongly interwoven and affect the welfare of both the producers and consumers (HLPE, 2011). The excessive changes in food prices create a situation of uncertainty that can have a drastic impact on the food supply chain investments and social development (OECD 2010). According to the latest estimates, the share of food in consumption expenditure in rural India is about 49% and about 69% of the Indian population lives in rural areas (*Census 2011*, Registrar General of India). Food price volatility vis-à-vis economic growth remains a controversial topic in both theoretical and empirical economics, (Wodon et al., 2008). Food grains account for about four-fifth of the calorie intake and a very high share of the total budget of the poorest households. High prices would undermine the purchasing power, resulting in inadequate access to food and calorie consumption and thereby push millions into poverty (Nasurudeen et al., 2006). India is a developing economy in which many people are dependent on agriculture for livelihood. In India, which has a population of 1.25 billion and which still has the largest number of poor and malnourished people in the world; ensuring food security for the masses is one of the prime concerns of the government policy (S. Saini and A. Gulati., 2016). It may be worth noting that an average Indian household still spends about 45% of its total expenditure on food (NSSO, 2013). According to World Bank Report 2013, 1.2 million people are still living below 1.25 USD per capita per day. India’s success in addressing food inflation, therefore, has important implications for global food security. Price rise adversely impacts the income and has substitution effect on food consumption by the poor, consequently, leading to serious implications on the household welfare. Price volatility can also have strong implications for food security

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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). Another significant fact to note is that nearly 22% of the population still lives below the poverty line, as estimated by the Planning Commission based on Tendulkar Poverty Line (Planning Commission, 2014).

Hence, in the framework of reasons posited above, it is imperative for every economist and policymaker to know of food prices volatility while deliberating on strategies. This Study attempts to examine the extent and graph of fluctuation of food prices in pre and post-recession from 2002 to 2015. The study maps normal volatility or more volatility of prices in wheat or rice in a stipulated timeframe. The research has elementally focused on the prices of two food crops which are wheat and rice because these two crops are staple crops of the country and help in meeting a significant proportion of the daily calorie needs of the people.

The remaining study is organised as follows: Section 2 enlists the review of literature. Section 3 focuses on the research methodology, objectives and hypothesis. Section 4 underlines the models and results which we have used: Augmented Dickey Fuller (ADF) test and ARCH/GARCH Model. Section 5 enunciates the conclusion and suggestions.

Review of Literature

Broad results describe evidence in favour of significant interactions between macro economy and agriculture over a period of time. Nevertheless, the relative importance of various factors impacting agriculture differs across countries, sectors and commodities, which could be due to different time periods considered, specification of variables and choice of the model. And the conclusions indicate that the performance of agriculture, and also of the economy as a whole would not be the same in a situation of any change in exogenous factors, which in due course may also affect the overall economic system by the various channels. Such exogenous impulses, if happen, may positively influence growth as in the case of technological breakthroughs or may have adverse impact in a situation of global recession or hike in international oil price. Such shocks often cause unpredictable changes in the aggregate demand and short run aggregate supply, thereby inducing fluctuations in the short run growth rate (***Bhattacharya and Kar, 2007)***. Further, ***Walsh (2011***) found that food inflation is generally higher and more persistent than non-food inflation in many countries. This finding is of particular concern to developing countries such as India and has serious implications for food security, because food occupies a large share of the consumption basket in these countries. On the other hand, (***Khan and Senhadji, 2001***), estimated the threshold of inflation to be 1–3 percent for industrial countries and 11–12 percent for developing countries. There appears to be greater agreement about the negative effects of inflation on poor populations (***Easterly and Fischer, 2001***). ***Mishra and Roy (2011***) showed that food inflation in India is concentrated in a few commodity groups such as milk, fruits and vegetables, eggs, meat, and fish (EMF), and cereals. They mainly attributed this inflation to production shocks compounded by excessive government intervention in the country's food markets. ***Chand (2010***) argued that most of India's food inflation is due to production shocks. He recommended augmenting buffer stocks, improving storage facilities, and dovetailing trade policy with production scenarios in the country. ***Gopakumar and Pandit (2014***) built a structural simultaneous equation model for cereals that incorporated procurement. Using this model, they showed that demand-side management is more important than supply-side management. ***Nair and Eapen (2012)*** debated that production shortfalls and the cost of production played a major role in the inflation seen between January 2008 and July 2010 and that demand-side factors played little role.

Objective of This Study

- To examine the food price volatility of rice and wheat in pre and post-recession period in context of Indian economy.
- To examine if there is any impact of global financial crisis on food price through the examples of price volatility in wheat and rice.

Data Source and Methodology

We have used secondary time series dataset from (MOSPI) 2002-M1 to 2015-M12 for 14 years and we have taken two agriculture commodities which are rice and wheat. Research methodology is the whole process of research such as identifying a research problem, data collection and the analysis of data which is called the blueprint of research. According to ***Mugenda (2003),*** data analysis is the process which starts immediately after data collection and ends at the point of interpretation and processing. This study is based purely on the secondary data. The secondary data was used for the analysis because the verification process is more rapid and the reliability of information and conclusion is greatly enhanced. The secondary data also provided satisfactory evidence to test the hypotheses of this study. Finally, it was readily available and, hence, convenient to use (***Ghauri, et al., 2002***). Time series data is profiled on

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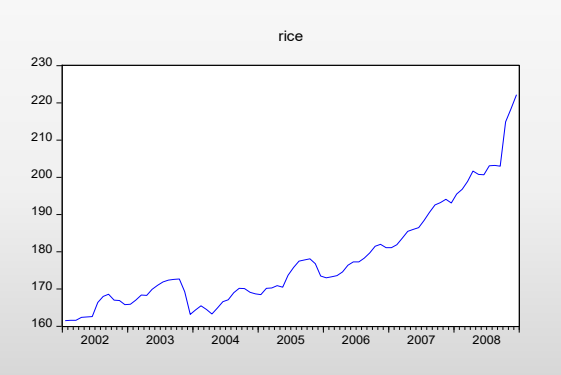
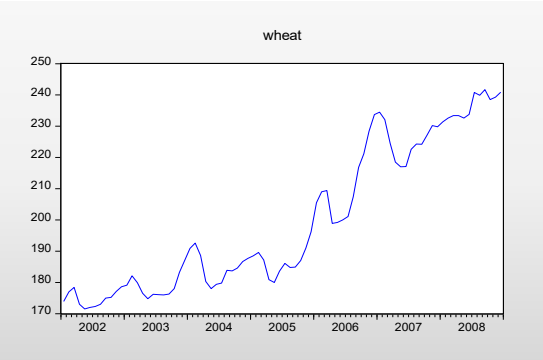
wheat and rice. The data has been taken from the reliable and authentic data sources such as MOSPI data set. The monthly data has been taken for the time period from 2002 to 2015 in context of the Indian economy. Furthermore, this time period has been divided into two sub-categories, in pre and the post-recession period. The main purpose of this study is to examine the impact, if any, of external shocks such as global financial recession on the volatility of food prices in Indian economy. To fulfill this aim, we have applied the ARCH/GARCH (GARCH.1.1) Model. To avoid the spurious or nonsense regression, the study applies the Augmented Dickey-Fuller test for the stationary of data. Dickey (1976) & Fuller (1976) describe that all the variables are non-stationary at a level, but they are made stationary after the first differentiation.

Pre-Recession Period (2002-2008)

Movement of Agriculture Food Prices





Data Source: MOSPI, INDIA

Augmented Dickey Fuller Test for Stationary

Table 2: ADF Test for Differences First Order Data, (2002, M1 to 2008, M12)

Variables	ADF Value DF-T Statistics	Critical value of Mackinoon in levels of significance 1%	5%	Result of Test	Stationary or non Stationary
Rice	-6.606338	-3.5122	-2.8972	H0 is rejected	Stationary
Wheat	-5.486071	-3.5122	-2.8972	H0 is rejected	Stationary

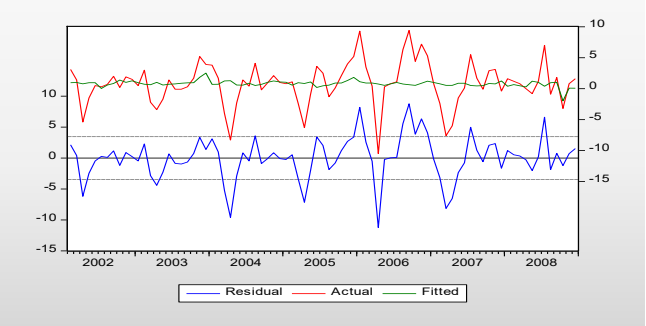
Table 2 describes the Augmented-Dickey Fuller test result and it tells us that data are non-stationary at the level, but we have converted them into first differentiate at order. Now all variables are stationary at level one. The prices of wheat and prices of rice are integrated at the same order. All variables are stationary at 1% level of significance.

ARCH Model

The Autoregressive Conditional Heteroscedasticity (ARCH) method offers an approach to model a change in variance in a time series that is time dependent, such as increasing or decreasing volatility. An extension of this approach named, Generalized Autoregressive Conditional Heteroscedasticity (GARCH), allows the method to support changes in the time dependent volatility, such as growing and declining volatility in the same series

For the application of ARCH/GARCH model, two conditions must be fulfilled such as clustering volatility and ARCH effect. Since the present study fulfills these conditions, we are applying ARCH/GARCH model.

Volatility of Wheat Price Figure 1



Volatility of Rice Price Figure 2

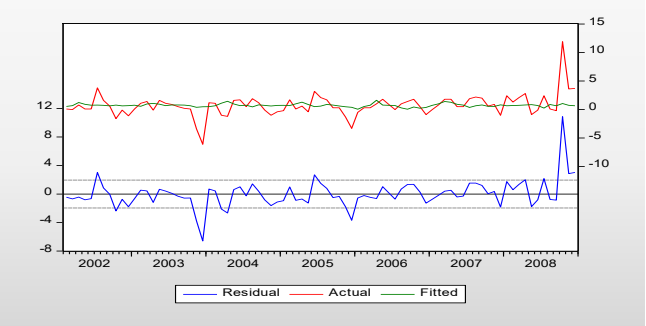


Table 3 ARCH LM Test Summary Statistics

Variables	Obs* R-Squared	t-statistics	Prob.
Ln Rice	58.59799	194.5101	0.0000
Ln wheat	57.52126	82.8671	0.0000

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Table 3 shows that the arch effect is there. According to Tsay (2005), the LM test was employed. The test statistic is defined as Obs.R2 and follows a chi-square distribution with q degrees of freedom. Apart from this, according to Engle, 1982, if the value of test statistic is greater than the critical value then the Chi-square distribution indicates the evidence of ARCH (q) effects.

GARCH 1.1

Simultaneous Estimation of the Mean and Variance Volatility Equations

Variables	Ln Rice			Ln Wheat		
Mean equation	Coefficient	Std. Error	P. value	Coefficient	Std. Error	P. value
AR (1) Q1	0.589676	0.016127	0.0000	1.398384	0.024470	0.0000*
Variance equation						
ARCH	1.295833	0.507417	0.0107	1.252563	0.019723	0.0433**
GARCH (1.1)	0.088977	0.074131	0.2300	0.092559	0.088808	0.2973

Result of mean equation shows that there is positive and significant relationship between prices of rice and wheat: Mean equation; $y = \alpha_0 + \beta_1 + \varepsilon_t$ ……(1.1)

Where: y is the dependent variable, α_0 constant coefficient, β_1 independent variable and et is the residual term.

Model 1 $LRICE = Constant._{Coef.} + \boldsymbol{\beta_{LWHEAT}} + \boldsymbol{\varepsilon_t}$

$$\boldsymbol{LRICE = Constant._{0.899676} + \beta_{0.0893440} + \varepsilon_t}$$

This means regression equation shows that positive relationship between price of wheat and price of rice indicates fluctuation in increasing way. If there is one percentage change in rice prices then there is 0.89 percent change in price of wheat.

Variance Equation: (1.2) : $\boldsymbol{h_t = constant_{coef.} + h_{t-i.} + e^2_{t-2} + \varepsilon_t}$

Where:- $\boldsymbol{h_t}$ = variance of the residual equation (1.2) derived from equation (1.1), it is also called as current day's variance or volatility of dependent variable. $\boldsymbol{h_{t-i.}}$ = previous day's residual variance or volatility of dependent variable. It is known as GARCH term. $\boldsymbol{e^2_{t-2}}$ = previous period squared residual derived from equation (1.1). It is also called previous day's price information about volatility. It is ARCH term and ε_t = error term.

Volatility in prices of rice = $\boldsymbol{constant}$ **1.30E-05+** $\boldsymbol{h_{t-i.}}$

$$\boldsymbol{0.08887+ e^2_{t-2}\ \ 1.295833 + \varepsilon_t}$$

Variance equation (1.2) indicates that volatility in prices of rice is largely influenced by own shock such as ARCH term but volatility from GARCH term did not contribute to the volatility of prices of rice.

Model 2

Mean equation (1. $\boldsymbol{LWHEAT = Constant._{Coef.} + \beta_{LRICE} + \varepsilon_t}$

$$\boldsymbol{LWHEAT = Constant._{-0.850755} + \beta_{1.398384} + \varepsilon_t}$$

This means regression equation shows the positive relationship between price of wheat and price of rice and this denotes fluctuation in increasing way. If we will make one percent change in the price of rice then there will be 1.39 percent change in the price of wheat.

$$\boldsymbol{h_t = constant_{coef.} + h_{t-i.} + e^2_{t-2} + \varepsilon_t}$$

Volatility in prices of wheat = $\boldsymbol{constant - 3.45E - 05 + h_{t-i.}\ 1.252563 + e^2_{t-2}\ \ 0.092559 + \varepsilon_t}$

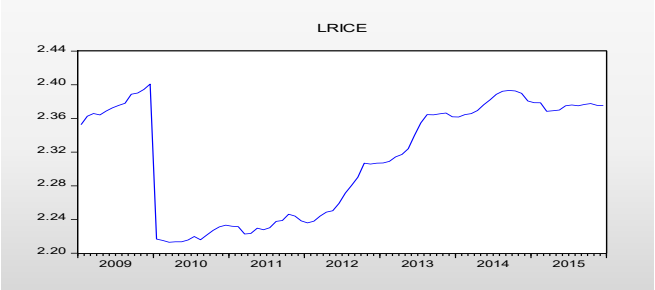
Variance equation (1.2) indicates that volatility in prices of wheat is largely influenced by own shock such as ARCH term but the volatility from GARCH term is not contributing in the volatility of prices of wheat.

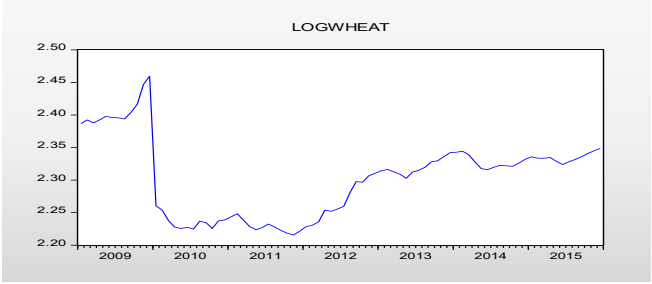
Table 4 Model Adequacy Checking in the Squared Residual

Variables	Model	Skewness	Kurtosis	Jarque-Bera Prob.
Ln rice	1.1.	0.049814	3.653482	0.465479
Ln wheat	1.1	-0.468650	3.452417	0.150225

Post-Recession Period (2009 To 2015)

Movement of Food Prices (2009 to 2015)





Data Source: MOSPI

In the post-recession period we have found structural breaks on both series, we also mentioned here break date: the same break date on both variables such as LOGWPI and LOG WHEAT (2010M1). Therefore, to capture the impact of structural breaks we have used the dummy variable. Define dummy variables such as **(0, 1).** 0 = No impact of structural breaks on agriculture food prices**.** 1 = there is impact of structural breaks on agriculture food prices

Table 2: ADF Test for Differences First Order Data, (2009, M1- 2015, M12)

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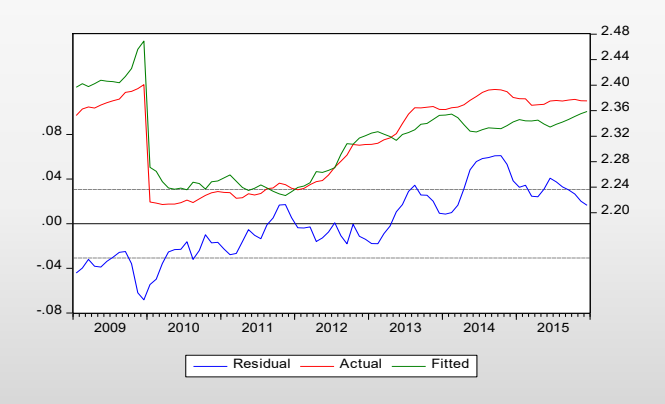
Variables	ADF Value DF-T Statistics	Critical value of Mackinoon in levels of significance 1%	5%	Result of Test	Stationary or not-Stationary
Rice	-8.889381	-3.512290	-2.897223	H0 is rejected	Stationary
Wheat	-6.818177	-3.513344	-2.897678	H0 is rejected	Stationary

Table 2 describes the Augmented-Dickey Fuller test result and it tells us that data are non-stationary at the level, but we have converted them into first differentiate at order. Now all variables are stationary at level one. The prices of wheat and prices of rice are also integrated at same order. All variables are stationary at 1% level of significance.

Volatility of Rice Price Figure 1



Volatility of Wheat Price Figure 2

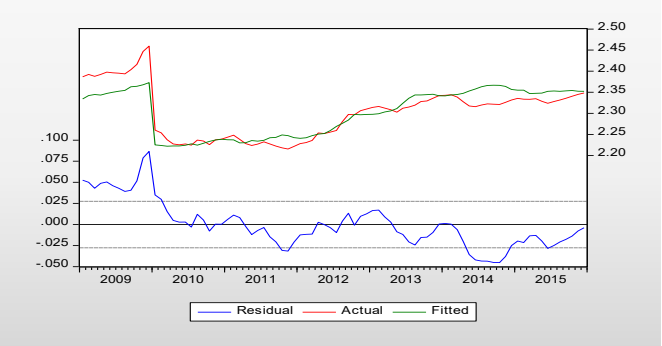


Table 3 ARCH LM Test Summary Statistics

Variables	Obs* R-Squared	t-statistics	Prob.
Ln Rice	52.17402	137.0953	0.0000
Ln wheat	56.78075	175.4147	0.0000

Table 3 shows that the ARCH effect is there because null hypo is accepted. In the alternative hypothesis there is no arch effect.

Garch 1.1: Simultaneous Estimation of the Mean and Variance Volatility Equations

Variables	Ln Rice				Ln Wheat			
Mean equation	Coef.	Std. Error	P. value	Coef.	Std. Error	P. value		
AR(1) Q1	1.408129	0.035969	0.0000*	0.674343	0.015960	0.0000*		
Dummy rice	0.084451	0.005429	0.0000*	Dum Wheat	0.062923	0.002199	0.0000*	
ARCH	1.130951	0.555353	0.0417**	1.307833	0.577280	0.0235**		
GARCH (1.1)	-0.113015	0.092411	0.2213	0.101077	0.086566	0.2430		
Dummy wheat	5.70E-05	6.87E-05	0.4070	Dummy rice	1.75E-05	3.21E-05	0.5849	

Mean Regression Equation (1.1)

$$L\,rice = Constant._{Coef.} + \beta 1_{Lwheat} + \beta 2_{dummyrice} + \varepsilon_t$$

$$Lrice = Constant._{-1.001170} + \beta_{1..48129} + \beta 2_{0.844451} + \varepsilon_t$$

This mean regression equation shows the positive relationship between price of wheat and price of rice and this means that there is fluctuation in increasing way. If we will make one percent change in the price of rice then there will be 0.67 percent change in the price of wheat. Apart from this, there is significant impact of dummy variable on prices of rice which showed fluctuations in increasing way.

Variance Equation: (1.2) Derived from Equation (1.1)

$$\text{Volatility in prices of rice} = constant_{4.47E-05.} + h_{t-i.} - 0.113015 + e^2_{t-2} 1.130951 + dum\,wheat_{5.70E-05.} + \varepsilon_t$$

Variance equation (1.2) indicates that volatility in prices of rice is largely influenced by own shock such as ARCH term but the volatility from GARCH term is not contributing in the volatility of prices of rice. Exogenous variable of dummy variable has not contributed significantly.

Model 2

Mean Regression Equation (1.1)

$$L\,wheat = Constant._{Coef.} + \beta 1_{Lrice} + \beta 2_{dummyrice} + \varepsilon_t$$

$$L\,wheat = Constant._{0.796264.} + \beta 1_{0.674343} + \beta 2_{-0.062923} + \varepsilon_t$$

This mean regression equation shows the positive relationship between the price of wheat and price of rice which means that it is fluctuating in increasing way. If we will make one percent of change in wheat prices than 0.67 percent change will be there in the price of rice.

Variance Equation (1.2) Derived from Mean Equation (1.1)

$$h_t = constant_{coef.} + h_{t-i.} + e^2_{t-2} + dum\,wheat + \varepsilon_t$$

$$\text{Volatility in prices of wheat} = constant_{2.05E-05.} + h_{t-i.} - 0.101077 + e^2_{t-2} 1,307833 + dum\,rice_{1.75E-05.} + \varepsilon_t$$

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Variance equation (1.2) indicates that volatility in prices of wheat is largely influenced by own shock such as ARCH term but the volatility from GARCH term is not contributing in the volatility of prices of wheat and there is no significant impact of dummy variable of rice on the fluctuations of wheat prices.

Table 4 Model Adequacy Checking in the Squared Residual

Variable	model	Skewness	Kurtosis	Jarque-Bera Prob.
Ln rice	(1.1)	-0.549737	4.192622	0.010006
Ln wheat	(1.1)	0.268219	4.076552	0.079517

Conclusion and Suggestions

To sum up this present study it is evident that in the pre-recession period, the volatility in price of wheat and rice has increased with high rate but the volatility on prices of wheat is higher as compared to prices of rice. This is largely due to the influence by (own shock) or due to the past information about prices of agriculture commodities. Further, in the post-recession period, volatility on food prices of wheat and rice is largely influenced by the global financial crisis and past information about the prices of agriculture commodities. This study aims at a more conclusive approach by enunciating some suggestions and recommendations for policymakers which are:

- Concerted efforts are required by all stakeholders to ensure more investment in agricultural sector including agribusiness.
- Pivotal shift in policy by the governments in the wake of looming economic volatility is essential with the key focus on food security and trade policy that effectively stems the adverse impact of price rise on the consumers and producers.
- It is imperative to ensure the timely availability and accessibility to good quality seeds, eco-friendly fertilizers, sensitisation on irrigation techniques for farmers, providing subsidies as and when required to the target groups.
- Public Distribution System (PDS) also needs a more efficacious and equitable approach.

As emphasized in the study earlier, instability in the food prices can have a most debilitating effect on the world's population leaving a significant share of our people malnourished. Hence, it is hoped that the strategists will work towards weaving effective safety nets to counter price instability.

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