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Volatility in Agriculture Commodity Prices in India: Impact and Macroeconomic and Sector-Specific Policy Responses

Seema Bathla[1]

1Jawaharlal Nehru University, Centre for the Study of Regional Development, New Delhi, India

seema.bathla@gmail.com

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Abstract

Globalization and trade liberalization have exposed agricultural sector of many developing countries to sudden disturbances, caused not just by demand-supply conditions within their economies but also by volatility in global commodity prices, exchange rate and surge in imports. This paper evaluates the magnitude of sensitivity of Indian agriculture to these factors, and explores policy options that may neutralize their adverse effects, maintain price incentives and stability. The analysis is undertaken for one important tradable commodity viz. wheat by applying a structural econometric model, separately under the exportable and importable scenarios from 1980-81 to 2009-10. Findings reveal wheat to be increasingly driven by an incentive structure based on its linkages with world price, exchange rate and other factors. Counterfactual simulation experiments indicate that due to trade and sector-specific policies, wheat price and output tend to be much more resilient to fluctuations in international price and other shocks compared to its exports and imports.

Keywords: Agricultural trade, Price transmission, Volatility, Macroeconomic policies

JEL classification: Q17, C22, E69, E60

1. INTRODUCTION

In many developing countries, agriculture markets had remained insulated for long from the effects of changes occurring in the international economy. Following the Structural Adjustment Programme and the subsequent Uruguay Round Agreement on Agriculture (UR AOA), agriculture was vigorously brought within the ambit of multilateral trade. Elimination of relative 'neglect of agriculture' and a need to 'get prices right' (i.e. raising real agricultural prices in accord with the world prices and turning terms of trade in favour of agriculture) for more production and hence exports became the central objectives. Accordingly, both macroeconomic and sector-specific policies were identified for implementation as they together are considered to have bearing on producers' incentives through change in relative prices.

Agricultural trade has grown rapidly following the UR AOA and developing countries' markets are now increasingly aligning with the world markets, indicating that globalization and trade liberalization have indeed influenced their agricultural sector. But at the same time, this

sector is exposed to drifts, which could be attributed to fluctuations in commodity prices and tariffs, imposition of non-tariff barriers, high domestic support against the WTO stipulations, demand and supply conditions within the country and other unexpected exogenous impulses. Concerns have, therefore, been raised on the likely impact of these factors on domestic prices, exports, imports, farm income, food security, employment and poverty (Chandrasekhar and Ghosh, 2002; Grimwade, 2004; Hoda and Gulati, 2007).

Among various aspects, price volatility has assumed utmost importance due to its adverse consequences on agricultural growth and income, especially of small and marginal farmers who constitute the bulk of the farming. As per the latest FAO estimates, wheat prices have surged by 60 to 80 percent from July to September 2010 in response to drought-fuelled crop losses in Russia and a subsequent export ban by the Russian Federation. International market prices of rice, maize and many other commodities may also increase, which may continue to keep food prices volatile for some more time. Soaring commodity prices are feared to raise the cost of basic food staples in many developing countries, thus making life difficult for the poorest people who spend between 60 and 80 percent of their meager income on food. The governments, are thus, bound to implement measures to first, cope with volatility in the international prices that often transcend to domestic markets, which may deprive people from essential commodities, second, maintain production and price incentives to encourage exports, and handle the situation if imports surge, and third, deal with situations arising due to drought and other unforeseen situations within the economy.

In this backdrop, this paper examines the impact of world market price, tariffs and exchange rate on the incentive structure, exports, imports, area and output and the role of macroeconomic and sector-specific policies and factors in making agriculture resilient to volatility in prices and other factors arising in a free trade regime. The study is undertaken in the Indian context with an aim to test two hypotheses. First, trade and macroeconomic policy changes have positively influenced agriculture prices, trade, acreage and production, and second, output and hence growth is resilient to unexpected divergences in the macro conditions and external and internal factors. In all, five alternate scenarios of change that influence agriculture are considered. These are variations in (a) world commodity price (b) exchange rate (c) tariffs (d) rainfall, and (e) support price. The analysis is undertaken for one important commodity viz. wheat due to (i) its large share (20 percent) in cultivated area, (ii) considerable interventions in internal trade through price and legislative policies on grounds of food security and self-sufficiency, (iii) increase in exports and imports that are again highly regulated, and (iv) it being a major factor in wholesale and consumer food price inflation indices (Annexure 1).

A structural econometric model is used, separately under the exportable and importable scenarios from 1980-81 to 2009-10. The structural econometric model is preferred over other models as it (i) can easily incorporate Nerlovian framework, (ii) enables to study inter-linkages between sector specific variables with other sectors, and (iii) is suitable for forecasts/simulations

under alternate scenarios[1]. The model represents a simultaneous equation system of four behavioural equations and a few identities. The impact of key external factors viz. world price, exchange rate and tariffs along with other exogenous variables viz. production, support price, procurement, rainfall, irrigation, technology etc. is quantified on four endogenous variables viz. price, export-import, area and yield. The equations are estimated individually and simultaneously in double log form using OLS and three stage least squares (3SLS) methods. The estimates obtained are used to calibrate a simulation over the observed time period. Simulations are done by conceiving 'what would happen if' best and worst scenarios wherein one time change or multiple changes are introduced in the exogenous variables at a time and their impact on endogenous variables is examined. The hypothetical divergences are described under the optimistic (best) and pessimistic (shock) scenarios based on the maximum and minimum annual percentage change in the selected exogenous variables in the past. In each case, the model is first validated. A change is then introduced and the predicted values of endogenous variables are estimated for five years from 2005-06 to 2009-10 using the Gauss-Seidel method. The base run values of endogenous variables are compared with their respective simulated values to analyze the degree of resilience of wheat to unexpected changes.

In what follows, section II explains the econometric model in terms of behavioral equations and identities followed by estimated results on the impact of various factors on wheat prices, trade area and production. Section III presents simulation model and results of the validation exercise. Section IV describes various optimistic and pessimistic scenarios that may impinge upon the performance of wheat in an open economy and analyses results obtained from simulation exercises. Section V summarizes the key findings and their implications.

2. ANALYZING LINKAGES BETWEEN AGRICULTURE AND MACROECONOMY

Theoretically, the linkages between agriculture and macroeconomic policies and factors are analysed 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). Though macroeconomic and sector specific policies are inter-linked, the effect of the former on producers' incentives is stated to be indirect and that of the latter direct. A quantification of the impact of macro conditions, policies and of several unforeseen situations on agriculture has been based on both economy wide macro modeling and time series econometric models. Sector specific and commodity specific models have also been developed in assessing the growth performance of

[1] Since time series models usually suffers from the problem of multicollinearity, auto correlated error term, omitted variables and spurious regression due to non-stationarity of data, care has been taken to minimize such effects by appropriately specifying variables and improving estimation procedures.

agriculture in totality and separately for foodgrains and non-foodgrains[2]. Some of the possible scenarios that have been considered from the supply as well as demand sides include deceleration in the volume of world trade, sudden capital outflow, hike in oil price, fiscal profligacy of the government, increase in prices of fertilizer and food, exchange rate depreciation, tariffs and monetary shocks.

Broad results provide evidence in favour of significant interactions between macro economy and agriculture over a period of time. However, 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. The findings 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 through various channels. Such exogenous impulses, if happen may positively influence growth as has happened 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).

The theoretical and empirical linkages given in the literature have provided a framework for analysis. The model represents a simultaneous equation system of four behavioural equations and a few identities as follows.

<u>Under Exportable Scenario:</u>

Pe = Pw * Exchange Rate …… ……(1)

Pd = f(Pe, MSP, Production, Procurement, Export) ……..…(2)

Export = f(Pe/Pd, Stock, Production, Procurement, World Per Capita Income, Openness) …..(3)

Area = f(Lagged Pd/Ip, Pc, Rainfall, Area Irrigated, Technology, Risk, Road Density, Lagged Crop Area) …….(4)

Yield = f(Rainfall, Fertilizer Consumption/GCA, Irrigation, Technology) ……(5)

Production = Crop Area * Yield ……..…..(6)

<u>Under Importable Scenario:</u>

Pi = Pw * Exchange Rate …… …….(1)

Pit =Pi * (1+Tariff) ……(1a)

Pd = f(Pit, MSP, Production, Procurement, Import) ……..(2)

Import = f(Pit/Pd, Stock, Procurement, Personal Disposal Income, Openness, NTBs/Dummy) ……..(3)

Area = f(Lagged Pd/Ip, Pc, Rainfall, Area Irrigated, Technology, Risk, Road Density, Lagged Crop Area) ……(4)

[2] See among others, Storm (1993), Lassaad and Womack (1998), McKay, Morrissey and Vaillant (1998), Gulati and Kelly (1999), Ardeni and Freebairn (2002), Kalirajan and Bhide (2003), Bhattacharya and Kar (2007) and Bhanumurthy and Kumawat (2009).

Yield = f(Rainfall, Fertilizer consumption/GCA, Irrigation, Technology) ……(5)
Production = Crop Area * Yield ……....(6)
Where,
Er is nominal exchange rate in Rs./Dollar;
Pw is the world reference price in US dollars;
Pi and Pe are world reference price in Rs./tonne and represents export (fob) price and import (cif) price of commodities;
Pd is wholesale commodity price in domestic markets in Rs./tonne;
Pc is price of competing crop in Rs./tonne;
Ip is input price represented by fertilizer (NPK) in Rs./tonne weighted by consumption of NPK;
Irrigation is represented by irrigation ratio (gross irrigated area (GIA) per gross cropped area (GCA);
Technology is represented by relative yield i.e. ratio of own crop yield to competing crop yield (yieldc);
MSP is minimum support price as fixed by the government in Rs./tonne;
Risk (price or yield) is estimated by squared deviation of difference between actual and expected price or crop yield. The latter is taken to be three years moving average.
Dummy represents NTBs and other factors not captured by specified variables;
Openness is captured indirectly through India's share of value of agricultural trade in world agricultural trade or share of value of export and imports in GDP agriculture.

To begin with, domestic price of wheat (Pd) under exportable/importable scenario is postulated to be determined by export/import price (Pe/Pi), which, in turn is taken to be exogenously influenced by the world reference price, exchange rate and tariff in case of importables. Other factors that affect domestic price of wheat are minimum support price (MSP), procurement for running public distribution system for people below poverty line, production and absolute volume of trade. Lags are used in some equations to incorporate the dynamic behaviour. In some studies, lagged dependent variable is taken to gauge asymmetric process of price transmission between the world and domestic wheat markets (Dasgupta, Dubey, and Sathish, 2011). Exports are determined by export price/domestic price indicating competitiveness, procurement, public stocks, world per capita income and openness of Indian agriculture to world trade. Theoretically, all these variables are expected to have a positive sign. In the case of import function, the expected sign of relative price, stocks and procurement is expected to be negative and that of personal disposable income to be positive. Dummy is specified to capture the effect of NTBs and other factors, if any[3]. Since most of the restrictions got removed only from 1999 when India was asked by the WTO to replace quantitative restrictions (QRs) with tariffs, the value of dummy is taken as 1 from 1980-81 to 1998-99 and 0 from 1999-2000 to 2009-10. Its expected sign is negative, which implies that external trade will

[3] NTBs could be obtaining permits or license, quota and quantitative ceilings etc. Though most of the barriers got removed from 1999-2000, a few continue on food security and health grounds.

get a boost with decrease in QRs. As NTBs are to be replaced by tariffs, the tariff equivalents of NTBs were also tried as an explanatory variable in place of dummy. The results, however, remained unchanged.

Acreage under a crop is influenced by price incentives, which is explained either by own price or profitability, defined as ratio of output price to input price. Own price of wheat is employed both as an endogenous as well as an exogenous variable in the model. It is taken as an exogenous variable in acreage response function equation to examine the price effect/incentives on land allocation. Both current year and one-year lagged price or relative output and input price are used to see the response of wheat area in forming expectations. Assuming that farmers are profit maximizers and also that trade liberalization has created a positive environment through increase in price, this variable is expected to be positive. An increase in the price of competing crop (rapeseed) is likely to yield a negative influence on acreage. Other factors, termed as non-price are expected to exert a positive influence on area. The variable, risk (price or yield) may bear a negative sign. Lagged dependent variable represents partial adjustment i.e. farmers respond slowly to changes in the relative prices and other variables in the short run. However, in the long run certain desired levels of acreage and output may be achieved.

Data on the selected variables are collected from Agriculture Statistics at a Glance, Ministry of Agriculture, Handbook of Statistics on the Indian Economy, Reserve Bank of India (RBI), Fertilizer Statistics, Fertilizer Association of India, FAO Trade and Production Statistics (**www.fao.org**) and National Accounts Statistics, Government of India. Exchange rate (Rs./US $) is extracted from Report on Currency and Finance, RBI. World income/gross domestic product (GDP) is taken from World Development Indicators, World Bank. World wheat price (No.1, US Hard Red Winter, FOB Gulf of Mexico) is taken from International Financial Statistics, IMF. Price variables are specified in Rs. per tonne and are converted into real prices using wholesale price index of all commodities at base 1993-94. Price series given in US $ are converted into Rupees using appropriate exchange rate and is deflated.

2.1. Empirical Results on the Impact of Macro and Sectoral Policies and Factors on Output

Table 1 presents empirical results obtained from OLS and simultaneous equation methods, separately under the exportable and importable scenarios. Due to the presence of multicollinearity alternate equations have been tried. It is evident from the estimates that wholesale price of wheat in India is explained more by its respective administered price (elasticity 0.49) than by the world reference price. Low price transmission elasticity between the world and domestic markets (0.12) could be explained by lack of competitiveness of wheat in the global markets, adhocism in trade policy, restrictions and controls on private trade. Further, domestic wheat price is influenced by procurement with an expected negative sign. The insignificance of exports and imports in determining domestic price of wheat is explained by lagged relationship between production and export. A high production in year t is followed by

Table 1: Empirical Results under Exportable and Importable Scenarios: 1980-81–2009-10

Exportable Scenario: Price	World Price	Support Price	Export	Procurement	Production	Trend	Constant	R^2	D-W
OLS I	0.014 (0.22)#	0.49* (3.51)	-0.002 (-0.76)#	-0.08*** (-1.81)	-	0.002 (1.47)	4.81	0.68	2.12
OLS II	0.12*** (1.67)	--	-0.007** (-2.18)#	-0.08 (-1.45)	-0.06 (-0.30)	0.008*** (1.66)	8.55	0.52	2.00
3SLS	0.01 (0.26)	0.49* (3.74)	-0.003 (-1.05)	-0.09** (-2.07)	-	0.003*** (1.68)	4.93	0.68	2.14
Export	Pe/Pd	Stock	World Income	Openness	Lagged Export	-	Constant	R^2	D-W
OLS	1.93 (0.42)	3.11*# (2.76)	2.77*** (1.68)	-7.68* (-2.34)	0.29*** (1.70)	-	-41.86	0.40	2.18
3SLS	0.72 (0.17)	2.72* (2.71)	2.27 (1.54)	-6.35* (-2.15)	0.43* (2.57)	-	-35.83	0.38	2.3
Area	Lagged Pd	Rain Index	% Area Irrigated	Competing crop Price-Pc	Risk	Lagged Area	Constant	R^2	D-W
OLS I	0.19** (2.05)	0.16* (2.65)	0.36* (2.63)	-0.08 (-1.21)	0.0004 (0.22)	0.35** (1.98)	3.58	0.86	1.67
OLS II	0.10* (2.20)@	0.18* (2.82)	-	-0.09 (-1.23)	-0.0003 (-0.09)	0.46* (2.50)	5.45	0.82	2.00
3SLS	0.19* (2.49)	0.17* (3.37)	0.40* (3.48)	-0.094 (-1.56)	0.002 (0.85)	0.29** (2.01)	3.96	0.86	1.64
Yield	Irrigation	Technology	Fert.con/GCA	-	-	-	Constant	R^2	D-W
OLS	0.51** (1.86)	0.17** (2.13)	0.23** (2.23)#	-	-	-	4.76	0.92	1.61
3SLS	1.17* (4.20)	0.13** (1.86)	-0.0004 (-0.25)	-	-	-	3.42	0.92	1.83$
Importable Scenario: Price	World Price	Support Price	Import	Procurement	Trend	-	Constant	R^2	D-W
OLS	-0.03 (-0.58)	0.58* (4.82)	-0.001 (-0.51)#	-0.07*** (-1.64)	0.003 (1.17)	-	4.41	0.68	2.15
3SLS	-0.008 (-0.19)	0.59* (5.97)	-0.002 (-0.67)#	-0.05 (-1.53)	0.00 (0.76)	-	4.08	0.67	2.13
Import	Pit/Pd	Stock	Procurement	Openness	Dummy (NTB)	-	Constant	R^2	D-W
OLS	-6.06** (-2.03)#	-0.69 (-0.60)#	-6.98* (-2.38)	7.59* (2.33)	-2.15 (-0.83)	-	62.19	0.36	2.30
3SLS	-3.53 (-1.29)	-0.63 (-0.47)#	-5.77** (-2.05)	5.53** (1.99)	-1.22 (-0.56)	-	53.6	0.28	2.27

Notes: Figures in parentheses are t-values. *,** &*** denote 1,5 & 10% level of significance. # denotes one year lag. @wheat price/input price (fertilizer). $ specified using AR(1). The estimates are respective elasticities based on double log functional form. Estimates obtained from area and yield equations remain same under the two scenarios.

an increase in exports in the subsequent period (year), which also happens to coincide with lower prices. In many instances, domestic prices have influenced decision to go in for export

and import rather than export/import being a lead factor in affecting the domestic prices. If this kind of situation occurs, then the relationship between domestic price and exports turns out to be negative, which otherwise is expected to be positive. All these factors explain 68 percent of variations in the wholesale price. These results, among other factors suggests that though price policy, backed by procurement provides protection from unexpected plunge in the world price, it may dissuade full price transmission from world to domestic markets and could also bring imbalances in the latter such as rise in grain stocks.

Turning to export function, it is found that variations in wheat exports are not influenced by relative world and domestic prices primarily due to higher domestic price than the world price in most of the years. Wheat stocks with the government significantly influences decision to undertake export. Under import function, relative price has the expected negative sign and is statistically significant too. Among other factors, level of income or economic growth and openness determine imports. From early 2000, India has raised tariffs to control imports.

The estimates obtained from acreage response equation show that price incentives, attributable to liberal measures have positively and significantly explained changes in absolute area under wheat. Area price elasticity estimate, which was always on the lower side, varying within 0.06 to 0.13 from early seventies to late nineties, has risen to 0.19 now[4]. Results further indicate supply side factors such as irrigation to influence acreage the most, which is visible from estimated coefficient of rainfall at 0.16 and that of percentage of irrigated wheat area at 0.36 respectively. The final equation explains yield, which is taken to be influenced by rainfall, irrigation and technology. Since most of the explanatory variables in area and yield equations overlap, the analysis was tried without specification of yield equation i.e. assuming yield to be determined exogenously. The results, however, did not vary much and suggest these factors to positively and significantly influence crop productivity.

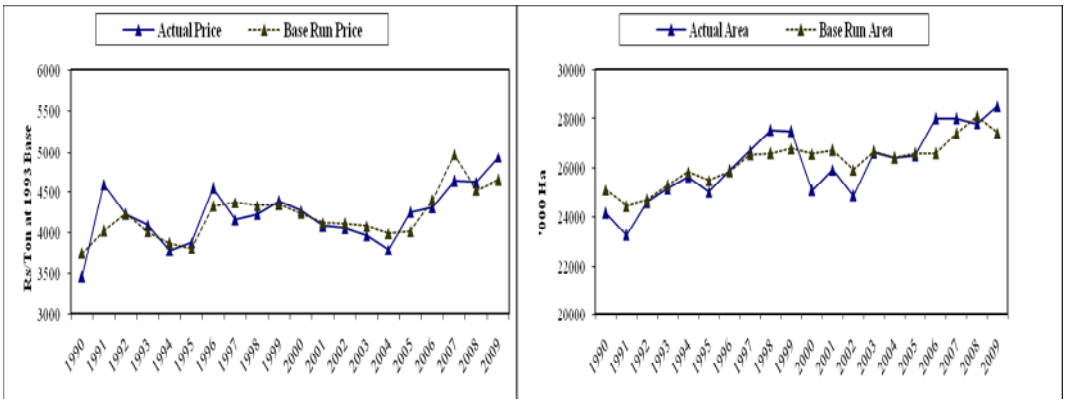
3. SIMULATION MODEL AND VALIDATION OF ENDOGENOUS VARIABLES

The behavioural equations determined on the basis of two methods show estimates to be by and large consistent. Simulations are performed on OLS as the estimated parameters also show robustness based on t-test and other tests. The actual estimates are used to calibrate a simulation over the period by introducing a hypothetical change in some of the exogenous variables. Before this, the effectiveness of the model in generating simulations is determined. Validation is done by comparing the actual past and base run simulated values of endogenous variables without introducing any change in the exogenous variables. The base run simulated values are representative of equilibrium values that are generated on the basis of actual time paths of exogenous variables and given time paths of factors relating to trade, exchange rate and

[4]A rather low supply response may be attributable to adhocism in exports-imports, regulations on trade and inadequate advancements in technology, irrigation and infrastructure (Gulati & Kelly, 1999; Bathla, 2011).

world prices. Fig. 1 reveals difference between the actual and base run simulated values of price and acreage. A negligible difference between the two is found, indicating that the error is low and unbiased. Deviations between the actual and base run values of area and exports are identified during early 2000. Occurrence of such errors can be explained by both statistical and economic reasons[5]. It is important to mention that such distortionary changes, identified in some years cannot be quantified. However, broad economic variables in the model correctly elicit directional changes. After validation, a maximum or a minimum change is introduced in the exogenous variable at a given time to explain the magnitude of its impact on endogenous variables in 2005/06, 2006/07, 2007/08, 2008/09 and 2009/10.

Fig.1: Actual and Base Run Estimates of Price and Area of Wheat:1990/91 to 2009/10



4. OPTIMISTIC AND PESSIMISTIC SCENARIOS OF CHANGE AND KEY RESULTS

This section presents plausible scenarios that are generated for carrying out counterfactual simulations along with the estimated results. Table 2 shows five years (2005/06 to 2009/10) annual average percentage change in the base run and simulated values of price, exports, imports and acreage/production of wheat under each scenario.

World Price Volatility: The first experiment relates to volatility in the world reference price. Commodity prices are subject to fluctuations due to changing demand and supply conditions. An increase in the world market price may act as an incentive due to competitiveness of commodities and hence an increase in demand for export. On the contrary, a fall in it can have negative implications. In any situation, producers need to accommodate in their land and

[5] Some of these include (a) regression techniques that determine the behavioural equations have an inherent stochastic component that represents random nature of variables, (b) techniques used in constructing and solving the model, (c) dynamic method used to do simulations/forecasts because the present values of impact variables are generated on the basis of forecasted past values rather than actual values of the past. Errors tend to be more in dynamic model compared to static model, (d) behavioural equations developed are based on theories with well developed market structures and hence may not explain conditions in the Indian context satisfactorily, (e) mix of sample period pertaining to pre- and post-reforms having year-to-year changes in NTBs, (f) imposition of internal trade barriers may distort prices (Bhattacharya and Kar, 2007).

production decisions such price fluctuations that often arise in the world markets. During 1980-81 to 2009-10, while international price of wheat varied from a minimum 112 US$ to a maximum 325 US$ per tonne (Rs.2527 to 6400 per tonne), real domestic price was within the range of Rs. 3458 to 4929 per tonne. For carrying out simulations, world price is hypothetically increased to 35 percent and decreased to 25 percent based on the maximum and minimum change in price from 1990-91 to 2009-10.

Results furnished in Table 2 show that volatility on the higher side increases average annual domestic price of wheat by 1.17 percent. Acceleration in exports is clearly visible by 287 percent. As expected, an increase in world price relative to domestic price brings the level of imports downward by 85 percent and raises average annual acreage/production by 0.05 percent. A fall in the world price affects imports without bringing much change in the domestic price and exports. These results, though not strictly comparable with the estimates given in the literature due to different methodology and time period considered, are yet similar in demonstrating directional changes in price, output and exports. Gulati and Kelly (1999) found the impact of an increase in domestic price in tune with international price on percentage change in price and supply to be 6.38 and 4.95 percent for wheat from base level during 1993-94. Wheat exports may increase to 5.1 million tons. In contrast, a pessimistic scenario, if it occurs, would negatively affect exports. The impact is also extensive in terms of import surge, which may badly affect area/production. A hike in the tariff rate can be followed to counter this shock. Notably, the impact of world price shock on area may not be severe as it is influenced more by MSP than by price movements in the international markets.

Exchange Rate Fluctuations: India undertook devaluation of currency once during 1991 and then twice in 1992-93. Since then, exchange rate is market driven and has an in-built mechanism that stabilizes its movements. From early nineties, nominal exchange rate has shown a maximum yearly increase of 30 percent and a minimum of 2 percent. For simulation, a hypothetical maximum and minimum change is introduced at a time from the existing level. Keeping in view the fact that exchange rate appreciated from 2003-04 with the result that nominal rate came down from Rs. 48.8 per dollar to Rs. 40.24 per dollar in 2007-08 and subsequently rose to Rs. 47.42, another experiment is done by allowing the rate to appreciate annually by 5 percent from its existing level. Currency depreciation by 30 percent raises nominal exchange rate from Rs. 44.27, Rs.45.28, 40.24, 45.91 and Rs.47.42 per dollar to Rs.57.55, Rs.58.86, 52.31, 59.68 and Rs.61.65 respectively during 2005/06 to 2009/10. Similarly a minimum change of 2 percent increases it slightly. In contrast, an appreciation of currency by 5 percent reduces nominal exchange rate to Rs.42.06, 43.02, 38.23, 43.61 and 45.05 per dollar from the existing level. Keeping other variables unchanged, maximum variations in exchange rate would increase exports and decrease imports through change in price structure.

The impact of exchange rate variations is directly visible on the volume of trade. It indicates that had India been more open to world trade during the eighties, average wheat export would have been higher by 256 percent. The impact of depreciation on area shows an average annual percentage increase by 0.04 only. Estimates on area response (equation 4) have also

indicated that technology and irrigation play significant role in inducing area along with price incentives. Under a scenario of a minimum depreciation of currency, average price rises by 0.97 percent, which is less than what is observed under an optimistic scenario. The situation also affects area to be put under cultivation. Exports tend to fall under a scenario of moderate currency appreciation and imports would be negative. In case of a severe shock through appreciation of currency, average rate of exports tend to fall and imports increase, suggesting lack of resilience of wheat to this change. However, the impact may not be severe as world price has a moderate influence on price. Since exchange rate is now market determined, agriculture can be resilient to its adverse impact. Import surge caused by appreciation and also by world price shocks can be handled by keeping a check on imports and imposing higher tariffs. Price stability in the domestic markets has always been maintained by storing and managing public stocks and resorting to open-market sales of acquired stocks. A variable tariff policy must synchronize with price policy in terms of fixation of MSP and release of stocks in accordance with conditions prevailing in domestic and world markets. Basu (2011) has discussed various options to strengthen open-market operations and public distribution system in the country.

Changes in Tariffs and Elimination of NTBs: Tariffs on wheat imports were imposed only from 2000-01. Tariff rate has been lower than the WTO prescribed bound rate of 100 percent, which indicates that there is further room for increasing import duties. The optimistic scenario represents a maximum increase in tariff equal to the bound rate and the pessimistic scenario focuses on minimum or complete removal of tariff[6]. Wheat tariff was 0 till 1999-2000 and got imposed at 108 and 50 percent during 2001 to 2003 followed by 100 percent till 2006-07 and then fell to 42 and 37 percent. Two simulations are, therefore carried out, one with maximum tariff equal to bound rate and second with minimum or zero tariff. The optimistic scenario reveals a slight decrease in domestic price and import. As expected, the impact of hike in tariff may not be high enough to accelerate or decelerate acreage. In a situation of no tariff i.e. shock, results reveal that had we not raised tariffs in wheat from 2000, the impact would have been extensive in terms of import surge. Finally, acreage is somewhat resilient to tariff shock as average percentage change in it is estimated to be only -0.04. A flexible tariff rate policy is, therefore, desirable.

Variations in Rainfall: Despite advancements in major and minor irrigation in India, agriculture continues to be dependent on weather. A less than normal rainfall (index=100) affects production and hence overall growth due to inter-sectoral demand and supply linkages. Bhattacharya and Kar (2007) found that due to rainfall shock, agricultural growth rate in India fell substantially from 3.3 percent to -1.7 percent in the short run and from 2.6 to 2.0 percent in the long run. The extent to which rainfall shock affecting area is studied under an optimistic scenario, which depicts above normal rainfall, taken to be 15 percent during the last more than

[6] The first scenario also takes care of the impact of removal of NTBs. The estimated tariff equivalents of NTBs fall within the range of 1 to 48 percent for wheat. Since current rates are well below the bound rates, imposition of maximum tariff equal to bound rate will account for the effects of NTBs on imports.

10 years. The pessimistic one depicts below average normal rainfall i.e. drought, which is observed to be 20 percent in 1987, 2002 and 2009. Rainfall index is assumed to be the maximum at 113.9, 108.99, 113.59, 103.3 and 93.57 and minimum at 79.24, 75.82, 79.02, 71.88 and 65.09 compared to actual values of 99.05, 94.77, 98.78, 89.85 and 81.37 respectively from 2005-06 to 2009-10. An above normal rainfall is expected to increase production whereas a below normal rainfall represents drought conditions, which negatively affects output. Simulated results estimate an average fall in area by 3.21 percent per year. In both situations, domestic prices are not much affected. A small impact of rainfall on price could be due to fixation of support price. There is not much variation in the volume of trade as a result of change in rainfall. The shocks arising due to drought can be countered on its own as rainfall has tendency to follow a cyclical pattern.

Changes in Minimum Support Price (MSP): Government fixes support price of essential commodities and undertakes procurement of a few in order to provide incentives to farmers and bring price stability through open market sales. The issue is highly debatable because the policy is argued to suffer from regional and crop bias as it acts as a floor price mainly for wheat and paddy/rice that too in states where procurement operations are undertaken. Besides, many think that it is inflationary in nature, distort the process of market mechanism and bring demand-supply imbalances (Chand, 2009). Further, due to opening up of markets, opportunities to export cereals have been growing. The degree of sensitivity of price, export-import and output as a result of changes in the support price is estimated. The maximum and minimum (negative) variations observed in support price from 1990-91 to 2009-10 are: +20 and -8 percent. Under an optimistic scenario, MSP rose from Rs. 4153 in 2005-06 to Rs. 5665 per tonne in 2009-10 and the same under a pessimistic scenario increased from Rs. 3057 to Rs. 4169 per tonne respectively during these years. Based on these, the existing price in each year is changed.

Table 2: Impact of Variations in Various Factors on Wheat (Annual Average % Change 2005/06 to 2009/10)

Commodity	Price	Export	Import	Area/Production	Price	Export	Import	Area/ Production
World Price:	Max.: +35%				Min.:-25%			
	1.17	287.29	-84.79	0.05	0.75	9.73	489.79	-0.03
Exchange Rate:	Max.: +30%				Min.:+2%			
	1.14	256.72	-80.76	0.04	0.97	111.22	-13.02	0.01
					Min.:-5%			
					0.92	81.37	35.38	0.003
Tariffs:	Max.: +100%				Min.:0%			
	-0.39	-	-4.18	-0.34	1.06	-	7066.56	-0.04
Rainfall:	Max: +15%				Min. -20%			
	0.81	111.25	-1.57	3.21	0.96	102.40	-1.57	-4.72
Support Price:	Max.: +25%				Min.:-8%			
	10.66	88.27	113.44	1.63	-2.40	108.88	-26.16	-0.59

Results reveal that with a hike and fall in MSP, average price increases and decreases by 10.66 and 2.40 percent per year. Clearly, under an optimistic scenario, production gets a boost but exports may get dissuaded. Average imports may rise annually by 113 percent respectively. In contrast, a decrease in support price may bring down price and raise average exports by 108 per year and turn down imports. The effect of this shock may lead to an average yearly decrease in area by 0.59 percent, which is not large as variations in support price do not indicate much change in yield. Overall results indicate some resilience of acreage to a given change in MSP.

Table 3 shows relative as well as total impact on wheat of selected policy, price and natural factors based on sum total of each of the percentage changes corresponding to various factors under optimistic and pessimistic scenarios. It is clear that fluctuations in world price, exchange rate and tariffs have relatively stronger effects (positive/negative) compared to those in support price and rainfall. The movements in the world market price and tariffs have relatively stronger effects on both price and trade. A change in the support price has a considerable impact on domestic price and area than on exports. Rainfall shock has a significant impact on impeding growth in area. An overall impact of shock may not bring much change in the average annual price (+1.29%) but could induce significant changes in exports (+302%), imports (+7563%) and production (-5.37%) respectively.

Table 3: Relative Impact of Changes in Various Factors on Wheat (Average Annual % Change from 2005-06 to 2009-10)

	Exchange Rate	Tariff Rate	World Price	Support Price	Rainfall	Total
Optimistic Scenario:						
Price	1.14	-0.39	1.17	10.66	0.81	13.40
Exports	256.72	--	287.29	88.27	111.25	743.54
Imports	-80.76	-4.18	-84.79	113.44	-1.57	-57.87
Area/Production	0.04	-0.34	0.05	1.63	3.21	4.60
Pessimistic Scenario:						
Price	0.92	1.06	0.75	-2.40	0.96	1.29
Exports	81.37	--	9.73	108.88	102.40	302.37
Imports	35.38	7077.56	489.79	-26.16	-1.57	7563.99
Area/Production	0.003	-0.04	-0.03	-0.59	-4.72	-5.37

5. KEY FINDINGS AND IMPLICATIONS

An attempt is made to examine the impact of macroeconomic and sector specific policies and factors on wheat output in India and the extent to which it is resilient to shocks caused by price, policies and other factors. A structural econometric model is applied, separately under the exportable and importable scenarios from 1980-81 to 2009-10. Five counterfactual simulations experiments are carried out to quantify the magnitude of sensitivity of price, exports, imports, area and production of wheat to exogenous impulses and explore options that may neutralize their adverse effects.

Broad results reveal wheat price to be increasingly driven by an incentive structure arising out of liberal exchange rate, trade and other policies and a greater openness of domestic markets to international markets. However, domestic price is not much vulnerable to shocks as it shows a moderate response to price movements in the international market. Also, wheat crop is backed by administered price and procurement, which provide cushion against shocks caused by an unexpected plunge in its global market price. Nevertheless, empirical results indicate that sudden disturbances caused by a fall in the world price, tariffs and currency appreciation are relatively more pervasive than support price and rainfall in changing the incentive structure, exports and imports. Shocks arising due to various policy variables tend to bring down wheat price but may not lead to much change in its area. Only exceptional case is that of a rainfall shock that affects acreage. Further, there are considerable tradeoffs involved, viz. a hike in support price may increase domestic price and acreage but may dissuade higher exports. Overall results indicate that wheat could be sensitive to exogenous impulses caused by external conditions. Nonetheless, due to macroeconomic, trade and price policy measures, its price and output tend to be much more resilient to various shocks compared to its exports and imports. Appropriate and timely adjustments in tariffs together with changes in support price and operation of open-market sales of public stocks may help to counter the adverse effects of likely divergences, maintain incentive structure and price stability in a market driven economy.

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Annexure I: Broad Statistics on Wheat in India: Decadal Averages from 1980-81 to 2009-10

	1980/81-1989/90	1990/91-1999-00	2000/01-2009/10
Area (Million Hectare)	23.30	25.54	26.77
Share of Area in Net Cultivated Area (%)	16	18	19
Area Irrigated (%)	75.44	84.98	89.4
Production (Million Tonne)	44.76	63.95	74.46
Yield (Kg./Hectare)	1918	2498	2783
Wheat Procured by the State (%)	18	17	23
Exports (Million Tonne)	0.087	0.27	1.42
Share of Exports in Production (%)	0.20	0.43	2
Imports (Million Tonne)	0.896	0.694	0.914
Share of Imports in Production (%)	2.98	1.04	1.19
Share of Value of Wheat Trade in Agriculture Trade (%)	5.13	2.37	2.77
Share of Agriculture Trade in GDP Agriculture (%)	5.96	7.59	12.26
India's Value of Agriculture Trade in World Agriculture Trade (%)	0.80	0.76	1.15
Support Price (Rs. Per Tonne at 1993-94 base)	3263.07	3526.67	3894.12
Domestic Wholesale Price	3836.46	4134.33	4290.81
World Reference Price (No.1, US Hard Red Winter)	3471.00	4288.07	4220.49