*Ind. Jn. of Agri.Econ.*
*Vol.65, No.3, July-Sept. 2010*

# Impact of Global Meltdown on Agriculture – An Exploratory Study

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## I

## INTRODUCTION

The Indian economy has been affected by global recession mainly through the external sector. Agriculture is however not fully integrated with the external sector so far. But still it has made inroads into the external market especially in some selected commodities. International prices for agricultural commodities are known for their high volatility, a feature which has been, and continues to be a cause for concern among governments, traders, producers and consumers. At the same time, large fluctuations in prices can have a destabilising effect on real exchange rates, putting a severe strain on their economic environment and hampering efforts to reduce poverty. In a prolonged volatile environment, the problem of extracting the true price signal from the noise may arise, a situation that can lead to an inefficient allocation of resources. How far this recession has affected and at the same time has unfolded the opportunities for the global market is a matter to be explored. There is a view that in a period of recession when industry and services are languishing, it is agriculture that should take the responsibility of maintaining a tempo of growth of the economy. The global meltdown has affected the price level, especially of the export-oriented commodities which has resulted in high volatility. Many countries are still highly dependent on commodities, either in their export or import. While high price spikes can be a temporary boom to the export economy, they can also heighten the cost of importing foodstuffs and agricultural inputs. The volatility can attract significant speculative activity, which in turn can initiate a vicious cycle of destabilising cash prices. In this paper, an attempt has been made to examine the impact of global disturbances on mentha oil, which is mainly an export-oriented commodity. The main objective of the paper is to analyse the price volatility of mentha oil in cash and future markets.

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## II

## DATA AND METHODOLOGY

The secondary data used in the study pertains to futures trade in mentha oil at Multi Commodity Exchange (MCX), National Commodity and Derivatives Exchange (NCDEX) and Spot Market- Chandausi. The analysis was carried out for the period from January 2006 to December 2009. The global economic and financial disturbances are covered in the period of study.

### *Stationarity*

A stationary series is one whose parameters, namely, mean, variance and covariance are independent of time. If the original series is found to be non-stationary, the first difference of the series is tested for stationarity and so on it is differenced till it becomes stationary. The number of times the series is differenced to make it stationary is called the Order of Integration. The most widely used tests for unit roots are Dickey-Fuller (DF) test and the Augmented Dickey-Fuller (ADF) test. Both would test the null hypothesis that the series has unit root or non-stationary.

The DF test is stated as follows:

$$Y_t = \mu + \rho.Y_{t-1} + e_t \quad \ldots.(1)$$

Where $\mu$ and $\rho$ are parameters and $e_t$ is random term.

Here the null hypothesis is that $H_0 : \rho = 1$ indicating that the series is non-stationary.

$$\Delta Y_t = \mu + \gamma Y_{t-1} + e_t \quad \ldots.(2)$$

where $\gamma = \rho - 1$ and $\Delta Y_t = Y_t - Y_{t-1}$

The null hypothesis is $H_0 : \gamma = 0$.

The test can be carried out by performing a t-test on the estimated $\gamma$. The t-statistics under the null hypothesis of a unit root does not follow the conventional t-distribution. Dickey and Fuller (1979) showed that the distribution under null hypothesis is non-standard and simulated critical values for selected sample size. If the error term $e_t$ is auto-correlated, the equation (8) is modified as

$$\Delta Y_t = \mu + \gamma Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-1} + \in_t \quad \ldots.(3)$$

Where m = number of lagged difference terms required so that the error term $\in_t$ is serially independent.

The null hypothesis is the same as the DF test, i.e., $H_0 : \gamma = 0$, implying that $Y_t$ is non-stationary. When DF test is applied to models it is called Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1981).

*Price Volatility*

The origin of volatility differs for different groups of commodities. In agricultural commodities, volatility originates mainly from supply disturbances; whereas for industrial raw materials (both agricultural and metallic), it originates mainly from demand disturbances (Swaray, 2002). These disturbances coupled with short-run demand and supply elasticities give rise to acute price fluctuations. A price series can be highly volatile yet change over longer periods of time; or show little volatility but a considerably large change over time through discrete adjustments. The primary agricultural commodities generally fall in the former group while industrial products often conform to the latter. Persistence of volatility in the commodity series is measured by the sum of $\alpha$ and $\beta$.

Volatility clustering is a property of most heteroskedastic stochastic processes used in finance and economics. Heteroskedasticity is the property of time-varying (conditional or unconditional) variance in a stochastic process. Volatility clustering is the property that there are periods of high and low (conditional or unconditional) variance.

ARCH Model

An ordinary ARCH model (Bollerslev, 1986) is a special case of a GARCH specification in which there are no lagged forecast variances in the conditional variance equation, *i.e.,* a GARCH (0, 1). Often interpreted in a financial context, where an agent or trader predicts this period's variance by forming a weighted average of a long term average (the constant), the forecasted variance from last period (the GARCH term), and information about volatility observed in the previous period (the ARCH term).

If the asset return was unexpectedly large in either the upward or the downward direction, then the trader will increase the estimate of the variance for the next period. The steps involved in ARCH model are as follows.

1. Estimate the best fitting AR (q) model

$$y_t = a_0 + a_1 y_{t-1} + \ldots + a_q y_{t-q} + \varepsilon_t = a_0 + \sum_{i=1}^{q} a_1 y_{t-i} + \varepsilon_t \qquad \ldots(4)$$

2. Obtain the squares of the error $\hat{\varepsilon}^2$ and regress them on a constant and *q* lagged values:

$$\hat{\varepsilon}_1^2 = \hat{\alpha}_0 + \sum_{i=1}^{q} \hat{\alpha}_i \hat{\varepsilon}_{1-i}^2 \qquad \ldots.(5)$$

where *q* is the length of ARCH lags.

- The null hypothesis is that, in the absence of ARCH components, we have $\alpha_i = 0$ for all. i = 1,-----,q
- The alternative hypothesis is that, in the presence of ARCH components, at least one of the estimated $\alpha_i$ coefficients must be significant.
- In a sample of T residuals under the null hypothesis of no ARCH errors, the test statistic $TR^2$ follows $\chi^2$ distribution with *q* degrees of freedom.
- If $TR^2$ is greater than the Chi-square table value, we reject the null hypothesis and find that there is no ARCH effect in the ARMA model.
- If $TR^2$ is smaller than the Chi-square table value, we accept the null hypothesis.

In order to test the volatility of a series, it is necessary to conduct ARCH LM test, which is as follows:

The ARCH test is a Lagrange multiplier (LM) test for autoregressive conditional heteroskedasticity (ARCH) in the residuals (Engle, 1982). This particular heteroskedasticity specification was motivated by the observation that in many financial time series, the magnitude of residuals appeared to be related to the magnitude of recent residuals. ARCH in itself does not invalidate standard LS inference. However, ignoring ARCH effects may result in loss of efficiency. The ARCH LM test statistic is computed from an auxiliary test regression. To test the null hypothesis that there is no ARCH up to order q in the residuals, we run the regression:

$$e_t^2 = \beta_0 + \left[ \sum_{s=1}^{q} \beta_s e_{t-s}^2 \right] + \nu_t \qquad \ldots. (6)$$

where *e* is the residual. This is a regression of the squared residuals on constant and lagged squared residuals up to order q. The F-statistic is an omitted variable test for the joint significance of all lagged squared residuals. The observed R-squared statistic is Engle's LM test statistic, computed as the number of observations times the $R^2$ from the test regression. The exact finite sample distribution of the F-statistic under $H_0$ is not known, but the LM test statistic is asymptotically distributed as a $\chi^2_{(q)}$ under quite general conditions.

## III

## EMPIRICAL RESULTS

### *Mentha Oil*

The cultivation of Mentha in India is very successful as the scenario of net importing country upto 1966 has changed to large exporting one. This is *rabi* season crop and mostly grown in selected parts of Uttar Pradesh (90 per cent) followed by Punjab and parts of Rajasthan.

The mentha is a cash crop and find its applications only in industrial use, hence the demand for the crop largely originated from the industrial sector. The study hypothesised that the prevalence of the global recession has affected the growth of industrial output and lowers the demand for raw material used in the sector. Mentha oil is primarily a raw material for industrial products and hence its demand has been affected in recent years and finally volatility has been generated in the price structure. The above graph showed that the production of Mentha oil is constantly on the rise and same is the case for surplus available for exports. This statement supports the presumption that a rise in the price volatility of Mentha oil in the recent years may be attributed to the economic and financial disturbances in the global economy. There may be some other factors, particularly in Mentha oil, which have also acted as a catalyst to generate volatility which can also be examined separately. In such a situation, this study may be treated as a case study to analyse the impact of economic and financial disturbances on the demand and volatility of agricultural products mainly used as raw material for the industrial sector.

### *Stationarity*

The ADF Test applied to the series data of future and spot prices to test the null hypothesis that the series has unit root or non-stationary. The results of the ADF test at level data are given in Table 1. The 't-statistic' obtained for two price series in all the years is significant and greater than at 1 per cent level, the null hypothesis of the series has unit root or non-stationary data series cannot be rejected. The alternative hypothesis of the stationary and no unit root is true. Thus the data series is subjected to first differencing to make the data stationary. The ADF results of differenced series data are given in Table 2. The 't-statistic' obtained for two price series in all the years is not significant and less than at 1 per cent level, the null hypothesis of which we are bound to reject the null hypothesis and the alternative hypothesis of stationary series and no unit root is true. The data series of future and spot price became stationary at one differencing and the data is ready for further econometric analysis.

TABLE 1. AUGMENTED DICKEY-FULLER TEST - LEVEL DATA

| | Augmented Dickey-Fuller test statistic | | | |
|---|---|---|---|---|
| | Future price | | Spot price | |
| Years (1) | t-statistic (2) | 1per cent level (3) | t-statistic (4) | 1per cent level (5) |
| 2006 | -2.476081 | -3.451993 | -1.64298 | -3.45199 |
| 2007 | -1.805146 | -3.451491 | -1.782244 | -3.45149 |
| 2008 | -2.016727 | -3.451703 | -1.780145 | -3.45178 |
| 2009 | -1.040295 | -3.451993 | -0.747206 | -3.45199 |

TABLE 2. AUGMENTED DICKEY-FULLER TEST - DIFFERENCED DATA

| | Augmented Dickey-Fuller test statistic | | | |
|---|---|---|---|---|
| | Future price | | Spot price | |
| Years (1) | t-statistic (2) | 1per cent level (3) | t-statistic (4) | 1per cent level (5) |
| 2006 | -14.7192 | -3.45207 | -15.7173 | -3.45207 |
| 2007 | -18.4946 | -3.45163 | -17.1905 | -3.45156 |
| 2008 | -24.8087 | -3.44026 | -21.6457 | -3.44026 |
| 2009 | -16.756 | -3.45207 | -15.7604 | -3.45207 |

*Price Volatility*

The volatility has been examined in the daily data of Mentha oil price at the future and spot markets during the years 2006-2009. It is presumed that the effect of economic and financial disturbances at the global level will be reflected in the form of higher volatility in the Mentha oil price during 2008 and 2009 as compared to 2006 and 2007. The results of the univariate GARCH (1,1) parameters for the mean and variance equations were obtained for the two price series of Mentha oil. Table 3 contains the results of volatility ($\alpha+\beta$) of future price. In the pre-disturbance period, i.e., in the year 2006 and 2007, persistence volatility in the future price series was 0.638924 and 0.534786 respectively. In the disturbance period, i.e., year 2008 and 2009, the persistence volatility in the future price series was 0.800083 and 1.003658. The volatility in the future price series was much higher even future price were perfectly volatile in the latest disturbed years. The results of volatility ($\alpha+\beta$) of spot price are given in Table 4. The volatility in spot price was the least (0.853967) in the year 2007 and maximum (0.99131) in the year 2008. However the spot price series showed a higher level of persistent volatility as compared to the future price series.

TABLE 3. AUTO REGRESSIVE CONDITIONAL HETEROSCEDASTICITY (ARCH) WITH FUTURE PRICE (LOG) AS DEPENDENT

| Dependent Variable: Future Price-2006<br>Method: ML - ARCH (Marquardt) - Normal distribution | | | | |
|---|---|---|---|---|
| GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*GARCH(-1) | | | | |
| Variable<br>(1) | Coefficient<br>(2) | Std. error<br>(3) | z-statistic<br>(4) | Prob.<br>(5) |
| C | 0.178425 | 0.783204 | 0.227814 | 0.8198 |
| | | Variance equation | | |
| C | 74.28677 | 14.12796 | 5.258138 | 0 |
| RESID(-1)^2 | 0.385779 | 0.112225 | 3.437542 | 0.0006 |
| GARCH(-1) | 0.253145 | 0.108189 | 2.33984 | 0.0193 |
| | | Dependent Variable: Future Price-2007 | | |
| C | -0.585048 | 0.733124 | -0.798021 | 0.4249 |
| | | Variance equation | | |
| C | 46.76467 | 30.05875 | 1.555776 | 0.1198 |
| RESID(-1)^2 | -0.016455 | 0.015685 | -1.049098 | 0.2941 |
| GARCH(-1) | 0.551241 | 0.290604 | 1.896879 | 0.0578 |
| | | Dependent Variable: Future Price-2008 | | |
| C | 0.13171 | 0.404202 | 0.325853 | 0.7445 |
| | | Variance equation | | |
| C | 22.39846 | 2.534513 | 8.837382 | 0 |
| RESID(-1)^2 | 0.252231 | 0.053308 | 4.731625 | 0 |
| GARCH(-1) | 0.547852 | 0.05306 | 10.32513 | 0 |
| | | Dependent Variable: Future Price-2009 | | |
| C | -0.076156 | 0.442386 | -0.172148 | 0.8633 |
| | | Variance equation | | |
| C | 0.736109 | 0.365663 | 2.013082 | 0.0441 |
| RESID(-1)^2 | 0.087135 | 0.016986 | 5.129652 | 0 |
| GARCH(-1) | 0.916523 | 0.010077 | 90.95384 | 0 |

*Volatility Clustering*

It is a property of most heteroskedastic stochastic processes used in economics. Heteroskedasticity, recall, is the property of time-varying (conditional or unconditional) variance in a stochastic process. Volatility clustering is the property that there are periods of high and low (conditional or unconditional) variance. The quantitative manifestation of this fact is that, while returns themselves are uncorrelated, absolute returns |rt| or their squares display a positive, significant and slowly decaying autocorrelation function: corr(|rt|, |rt+τ |) > 0 for τ ranging from a few minutes to a several weeks. The cluster graph for future and spot price series as given in the following pages revealed that the two series are volatile as they have periods of elevated volatility interspersed among more tranquil periods. The frequency of high and low variance is more prominent in the year 2008 in case of

TABLE 4. AUTO REGRESSIVE CONDITIONAL HETROSCEDASTICITY (ARCH) WITH SPOT PRICE (LOG) AS DEPENDENT

| Dependent Variable: Spot Price-2006<br>Method: ML - ARCH (Marquardt) - Normal distribution<br>GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*GARCH(-1) | | | | |
|---|---|---|---|---|
| Variable<br>(1) | Coefficient<br>(2) | Std. error<br>(3) | z-statistic<br>(4) | Prob.<br>(5) |
| C | 0.050266 | 0.770857 | 0.065208 | 0.948 |
| | | Variance equation | | |
| C | 13.43429 | 3.86671 | 3.474347 | 0.0005 |
| RESID(-1)^2 | 0.161398 | 0.032491 | 4.967519 | 0 |
| GARCH(-1) | 0.772226 | 0.045016 | 17.15432 | 0 |
| | | Dependent Variable: Spot Price-2007 | | |
| C | 0.37284 | 0.365744 | 1.019403 | 0.308 |
| | | Variance equation | | |
| C | 5.776142 | 2.581289 | 2.237697 | 0.0252 |
| RESID(-1)^2 | 0.17165 | 0.065701 | 2.612596 | 0.009 |
| GARCH(-1) | 0.682317 | 0.110726 | 6.162199 | 0 |
| | | Dependent Variable: Spot Price-2008 | | |
| C | -0.112802 | 0.198192 | -0.56915 | 0.5693 |
| | | Variance Equation | | |
| C | 2.091434 | 0.407931 | 5.126933 | 0 |
| RESID(-1)^2 | 0.21643 | 0.031594 | 6.850328 | 0 |
| GARCH(-1) | 0.77488 | 0.026689 | 29.03351 | 0 |
| | | Dependent Variable: Spot Price-2009 | | |
| C | -0.261745 | 0.277152 | -0.94441 | 0.345 |
| | | Variance equation | | |
| C | 4.090688 | 1.506665 | 2.715062 | 0.0066 |
| RESID(-1)^2 | 0.329344 | 0.046911 | 7.020606 | 0 |
| GARCH(-1) | 0.567376 | 0.088916 | 6.381026 | 0 |

both futures as well as spot price series. This statement confirms the fact that the large number of spikes did occur during the year 2008 mainly due to global disturbances. Volatile periods are hectic periods with large price fluctuations. Intuitively, such periods reflect investor uncertainty and one may suspect that such uncertainty is caused by uncertainty about the fundamentals in the economy. This has proven true to a certain extent. Uncertainty about fundamentals, however, is known to explain only a moderate portion of the observed financial market volatility.

## IV

## CONCLUSION

The study concludes that the two price series, i.e, future and spot, of Mentha oil becomes stationary at first difference. The persistent volatility was much severe in the financially disturbed years, i.e, 2008 and 2009 as compared to the previous years. The spot price series showed a higher level of persistent volatility as compared to future price series. A special mention can be made regarding futures trading, which provides an opportunity to lower down the extent of volatility. The volatility clusters of high and low variance were more prominent in the year 2008 in case of both future as well

as spot price series. This gives an indication that the ill effect of economic turmoil was reflected through higher volatility in the years 2008 and 2009.

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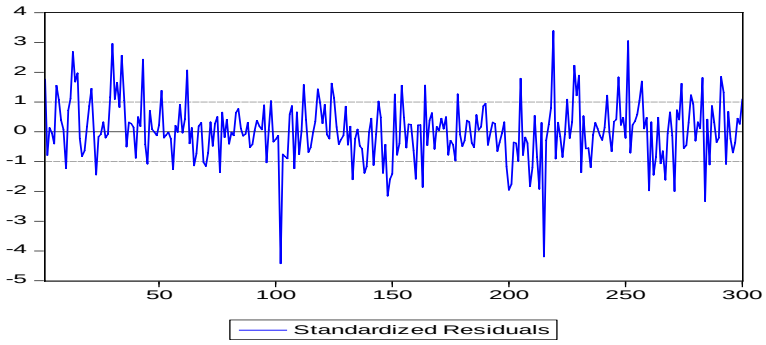
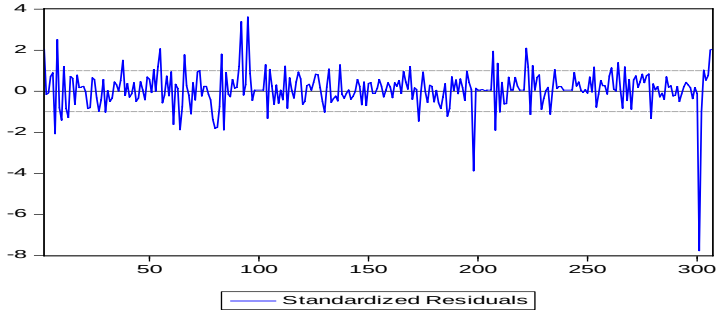
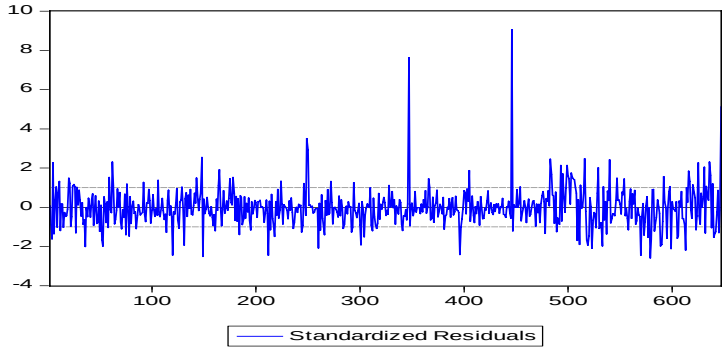
Cluster Graph-Future Price-2006



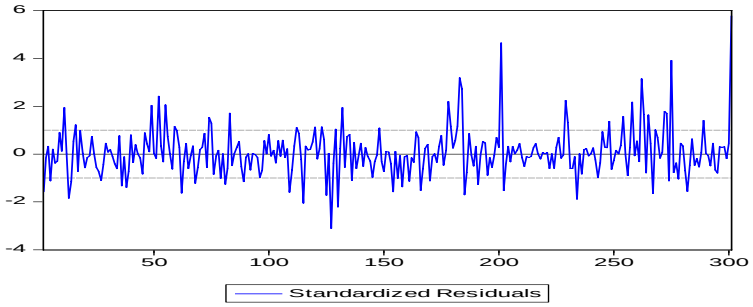

Cluster Graph-Future Price-2007



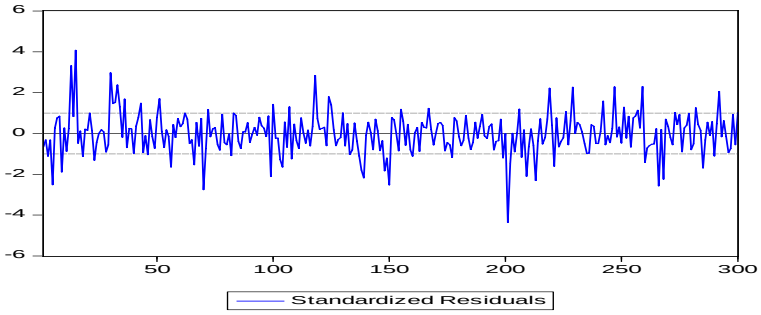
Cluster Graph-Future Price-2008



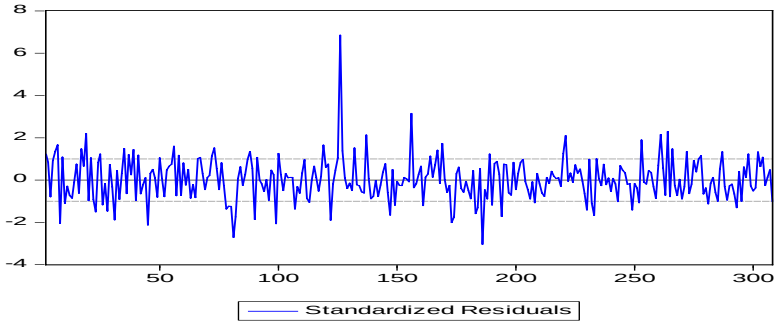

Cluster Graph-Future Price-2009



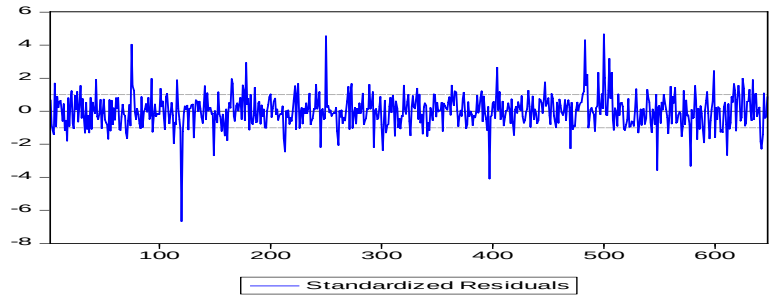

Cluster Graph-Spot Price-2006



Cluster Graph-Spot Price-2007




Cluster Graph-Spot Price-2008




Cluster Graph-Spot Price-2009