EVALUATION OF EFFICIENCY FORM OF THE COMMODITIES MARKET:
AN EMPIRICAL STUDY OF THE INDIAN SCENARIO

C.Srinivas Yadav **
** Asst.Professor, Dept.of commerce, Sri Sathya Sai Institute of Higher Learning, Brindavan Campus,
Kadugodi, Bangalore, 560067.

Rakesh Roshan Panigrahi *
*Student (II MFM Class), Dept.of commerce, Sri Sathya Sai Institute of Higher Learning,
Brindavan Campus, Kadugodi, Bangalore, 560067.

ABSTRACT
This study examines the weak form efficiency (random walk model) and the unbiasedness of two commodities futures market in India. While data for spot and futures prices of Aluminum and Copper is collected from the Multi Commodity Exchange of India Ltd. (MCX). The data regarding the volumes of futures traded is also collected from the websites of the respective Exchanges. The study is analysed by using econometric tools. The spot prices are regressed on the near month, middle month and far month futures prices to test the weak form of efficiency and unbiasedness. The effect of speculation on the unexpected movement of spot prices is also examined. Co-integration and Error correction model are applied to know the long run relationship and deviations from such equilibrium. The impulse response model is used to know the impact of shock of futures prices on the spot prices. Cholesky’s Decomposition model is used to understand the forecast variance. Wald test is performed to check the coefficient restrictions. Durbin-Watson test is done to check the random walk theory at the maturity of contracts. The results show that all the commodity futures prices and spot prices are related in the long run hence, errors of short deviations are corrected to maintain the equilibrium. The random walk theory does not hold good as the contract maturity comes closer. The results conclude that two commodities, considered in the study are inefficient. However, the market efficiency cannot be rejected at all the time. Thus, being India a nascent market in commodities derivatives, there is a scope for better price discovery (efficiency and unbiasedness).
INTRODUCTION

A large variety of commodities are traded within a country. This includes agricultural produce, metals, minerals, energy products, etc. A number of factors affect the demand and supply of commodities, for instance agricultural commodities are affected by Seasonality of production, crop loss or destruction, abundance or scarcity etc... Similarly, mining of minerals are affected by the availability or supply, time and extent of extraction. The global prices of commodities are influenced by the import and export prices and quantity. Thus, price fluctuations are a matter of concern to consumers, producers and traders of commodities. Commodity futures contracts are instruments that help in hedging the price risk. A futures market must help in price discovery, price stabilization & hedging, financing, increasing efficiency, encouraging competition, liquidity, regulating short sales and decreasing transaction costs. In this regard, the process of information flow across the spot and futures market becomes important for all the participants. Hence, the empirical study on the informative efficiency of the commodity futures market becomes relevant.

The statement of the problem

One of the contentious issues among the researchers and policymakers associated with the commodity markets is the impact of commodities futures trading on the prices of the physical market. The futures must have a close relation with the prices of the physical markets and it should also serve the process of hedging. The futures prices must act as a “reference price” for the participants of the physical market. This reference price in other words is known as the “price discovery” mechanism. The commodities exchanges: MCX and NCDEX have a role of bringing the market efficiency which will serve the twin functions. The price discovery and risk management mechanisms can be studied by understanding the price determination process. Therefore, the study of “Efficient Market Hypothesis” with the Expected return theories and its special cases of martingale model and random walk theory becomes important.

Need and significance of the study

In many developing countries like India, the new commodity futures markets have shown low market depth, thin volumes, undeveloped spot markets, policy restrictions, heavy taxes on commodities trading (commodity transaction tax), poor delivery systems and market imperfections.

The study of efficiency in commodity futures markets is important to both the users of this market and the regulators. An efficient market helps the Government for better price stabilization and implementation of other control policies. It provides reliable estimates for future spot prices to traders and producers of the commodities. The study is based on sample commodities like Aluminum and Copper of which India is one of the largest producer. It is the need of the hour for India to take a dominant price leadership role at the international level. Thus, it becomes essential to empirically study the price market efficiency and unbiasedness of the respective commodities in Indian commodities exchanges.

Scope of the study

This study is confined to the analysis of the futures market efficiency of the MCX and NCDEX in India in terms of price formation of commodities like Aluminum and Copper. Only the weak form of the market efficiency is studied. The issues relating to operational efficiency such as warehousing, employer-employee relationships, the management aspect are not considered in this study. An attempt is also made to find out the impact of speculation on the spot prices of the respective commodities. The effect of speculation is judged on the basis of statistical tools. The study does not include any qualitative data that
reveals if a transaction is speculative or not. The study is based on data of the daily spot prices and futures contract prices of different periods for the sample commodities. The data is collected from the official website of the MCX and NCDEX. The data period for the study varies across commodities. However, the study period covers the data available from the year 2005 to the year 2013.

METHODOLOGY AND DESIGN OF THE STUDY

Nature of the study

This is a causal research on the relationship between commodity spot and futures prices. This is an empirical study done on the spot and futures prices of various commodities. Thus being a study on the weak form of efficiency on the commodities market, its approach heavily draws from quantitative methods.

Objectives of the study

- To test the weak form market efficiency of Aluminum and Copper traded on Multi Commodity Exchange by using OLS regression and econometrics tools like co-integration, VAR, VECM, Impulse response and Wald test.
- To prove if speculation in the futures markets has a significant impact on the unexpected movement of the spot prices of Aluminum and Copper,
- To verify the existence of the random walk process in the spot and future prices of Aluminum and Copper using Durbin-Watson test.

Hypotheses

This study focuses on the following hypotheses:

H1: The futures market for Aluminum and Copper are efficient and unbiased predictors of the future spot prices.

H2: The speculation in the futures market of Aluminum and Copper, has significant impact on the volatility of spot prices of the respective commodities.

H3: The spot and futures prices at the expiry of the contract of Aluminum and Copper, follow the random walk model.

Sampling procedure and sample

An attempt is made to cover different classes of commodities across the exchanges to examine the futures efficient market theory. The study is based on sample of commodities collected from two major commodity exchanges in India namely MCX and NCDEX. the study.
Multi Commodity Exchange of India Ltd. (MCX) is the first listed commodity exchange in India. It is 3rd in crude oil futures trading, 2nd in copper futures trading, and 1st in gold futures trading in the world given the volume of the futures traded.

The base metals like Aluminum and Copper are majorly used for industrial production and construction purposes. India is the fifth largest producer of Aluminum in the world with an average annual production of 171,3924 MT. Aluminum as a base metal stands second in rank of consumption in the world (only after steel). The durability, light weight and high resale value of the Aluminum gives it an unique position in the family of base metals.

Copper is a malleable and ductile metallic element. It is an excellent conductor of electricity and heat. It is also antimicrobial and corrosion resistant. In the terms of consumption it stands at the third place after steel and aluminum. From the status of a net importer, India is growing as a net exporter of copper because of the increase in the production of copper.

**Data collection**

The data used for this study is secondary in nature. The data is publicly available and is accessible without the constraints of time, place and cost on the official websites of the commodity exchanges.

**Data collection period for testing efficiency**

The spot and futures prices of Aluminum and Copper. The following table gives the period for which the data is collected.

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Starting period</th>
<th>Ending period</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>November 30, 2005</td>
<td>October 31, 2013</td>
<td>MCX</td>
</tr>
<tr>
<td>Copper</td>
<td>January 31, 2005</td>
<td>August 30, 2013</td>
<td>MCX</td>
</tr>
</tbody>
</table>

**Data collection period for testing the effect of speculation**

The data of daily spot prices and volumes of the futures trade for Aluminum, copper, is collected from the official website of MCX.

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Starting period</th>
<th>Ending period</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>November 8, 2005</td>
<td>November 15, 2013</td>
<td>MCX</td>
</tr>
<tr>
<td>Copper</td>
<td>February 3, 2005</td>
<td>November 15, 2013</td>
<td>MCX</td>
</tr>
</tbody>
</table>

**Treatment of the Data**

**Testing market efficiency:**

A pooled price series is created with far month, middle month and nearby month futures. The futures prices of three months, two months, one month before maturity and futures prices at expiry for all contracts of different commodities is obtained. The spot prices of the sample commodities on the date of
contract expiry are also obtained. The first day of the nearby contract is taken as the first day of the second month from maturity and ends with the last day of the second month. The same process is followed in case of far month contracts too. The series pooled in this manner is used to empirically test for long run relationship and short run dynamics between the spots and the futures.

Testing the impact of speculation on unexpected spot prices:

The spot prices and the volume of futures traded on the respective commodity exchanges of the sample commodities (aluminum, copper,) is collected. The spot prices are divided into two categories i.e.; expected spot prices and unexpected spot prices. Similar treatment is done for volume of futures too i.e.; expected futures volume and unexpected futures volume. The expected series for spot prices and volume of futures is constructed by taking the 21 days moving average (since there are at least 21 trading days in a month) for each of the spot prices series and the volume of futures series. The expected spot prices and the expected volume of futures prices are then deducted from the actual spot prices and the actual volume of futures details respectively to get the unexpected spot prices and the unexpected volume of the futures. Since unexpected is a deviation from the expected, it is attributed to participation of speculators. The log normal of unexpected spot prices and unexpected volumes are taken into consideration.

Testing the random walk model:

Residuals (the white noise or error term) and predicted spot prices (dependent variables) are calculated while executing the regression model. This residual data for the futures prices of different periods is checked for auto correlation.

Limitations of the study

- This study includes a sample size of only two commodities. The findings of this study may not apply to other commodities.
- The study period ranges from the year 2005 to the year 2013, only quantitative data is considered where as qualitative data is not taken. However over the period of time there were several regulations and taxes changes that can also influence the trading; global markets factors also influence on the domestic market prices that is not considered.
- This study does not give an optimal hedge ratio for making a perfect hedge using futures.
- This study is limited to the weak form of informative efficiency, since considering every public information (semi-strong form) is an uphill task and there exist no parameter for considering the private (strong form) information.

Working on the data

With the content of the data remaining the same, the structure is modified to ensure working on them. This was carried out with the assistance of Microsoft Excel. From the data thus organised, the prices are treated with the E-Views software, a popular medium for studying data from a financial-econometrics perspective.
Methodology
Testing the Data

An attempt is made to fit a linear model to the data. But the non-stationary (i.e., being strongly influenced by effect of time) characteristic of the data can affect this attempt. Generally as time decays the price shocks must die, otherwise the fundamental properties of data are persistently impacted by the time. This can lead to spurious results. Hence tests for unit roots is done to overcome the potential threat that the data poses.

Unit Root Tests

Augmented Dickey Fuller Test (ADF)

The stationary aspect of the series is studied under the following AR(1) model:

\[ Y_t = \alpha + \beta Y_{t-1} + \theta_t, \cdots \cdots \cdots \cdots \ (1) \]

Where, \( \alpha \) and \( \beta \) are the parameters and the term \( \theta(t) \) represents zero mean, consisting of a serial correlation and a constant variance.

If \( |\beta| < 1 = \text{stationary series} \)

\( |\beta| > 1 = \text{explosive series} \)

At the level of \( |\beta| < 1 \), the condition for stationary can be assumed

\[ H_0: \beta = 1 \]

The ADF test takes the existence of unit roots as a hypothesis. This null hypothesis is then tested against the one-sided alternate hypothesis:

\[ H_1: \beta < 1 \]

Subtracting \( Y_{t-1} \) from the LHS and the RHS of equation(1) we get:

\[ \Delta Y_t = \alpha + \delta Y_{t-1} + \theta_t \]

Where \( \alpha = \beta - 1 \). Modifying the null hypothesis:

\[ H_0: \delta = 0, \ i.e. \ \beta = 1 \quad \text{and} \quad H_1: \delta < 0, \ i.e. \ \beta < 1 \]

The t distribution is not followed by the t statistics (henceforth t stats) for the null hypothesis of a unit root.; (Fuller & Dicky, 1979) brought out critical values by using a selected sample size. (G.MacKinnon, 1991) also got simulation, but in a larger scale.

But the test suggested is for a AR (1) series. The earlier assumptions of white noise would stand violated, if in the higher order lag there is correlation for the series. ADF test examines for correlation at higher lags. ADF implicitly assumes that a series (say) \( \{Y\} \) follows a AR (p) process...

\[ \Delta Y_t = \alpha + \delta Y_{t-1} + \theta_1 Y_{t-1} + \theta_2 Y_{t-2} + \cdots + \theta_p \Delta Y_{t-p+1} + \theta_t \]

This augmented specification is then used to test:

\[ H_0: \delta = 0 \]
\[ H_1: \delta < 0 \]

Even when the moving average exists, the ADF test can be conducted (Dickey, 1984). However, it is conditioned that enough lagged difference terms must be augmented into the regression.

**Johansen’s Co Integration Test**

If a linear combination of two or more non-stationary series is stationary, then the series are said to be co-integrated. Only then the Johansen’s approach to test for co-integration is used.

Order p Vector Auto Regression (VAR) is given as follows:

\[ y_t = \mu + A_1 y_{t-1} + \cdots + A_p y_{t-p} + \varepsilon_t \]

Where \( y_t \) is a vector integrated of first order i.e.; \( I(1) \) – and the vector of innovations is \( \varepsilon_t \).

This VAR can be re-written as:

\[ \Delta y_t = \mu + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t \]

Where,

\[ \Pi = \sum_{i=1}^{p} A_i - I \]

\[ \Gamma_i = - \sum_{j=i+1}^{p} A_j \]

Representation theorem by Granger asserts that a reduced rank \( r<n \) in the coefficient matrix, shows the existence of \( n \times r \) matrices denoted by \( \alpha \) and \( \beta \) each with \( r \) rank and \( \Pi = \alpha \beta' \) and \( \beta' y_t \) is stationary. \( r \) is the number of co-integrating relationships. The adjustment parameters in the Vector Error Correction Model (VECM) is denoted by \( \alpha \) while \( \beta \) columns forms the cointegrating vector.

Johansen presents Trace test statistics and the Maximum Eigenvalue (Max-Eigen) test as two variants for testing the likelihood ratio for obtaining the significance of canonical correlations and the \( \Pi \) matrix rank reduction.

Under the Trace test null hypothesis of \( r \) cointegrating vectors is tested against the \( n \) cointegrating vectors as alternative hypothesis. The Max-Eigen test checks \( r \) cointegrating vectors as the null hypothesis against an alternate hypothesis of \( r+1 \).

Chi-square distribution is not followed by both the test statistics (Johansen, 1990). The unit root processes determine the Trace test and the Max-Eigenvalue test. Series that are stationary at levels \( I(0) \) are not well suited for test of cointegration. If a variable is \( I(0) \) instead of \( I(1) \), it will be seen in a cointegrating vector \( \beta=(0, 1) \). The p value obtained can be used to test the significance and the co-integration.
Vector Autoregression (VAR) Model

The VAR approach evades the need for structural modelling, done by modelling every endogenous variable in the system as a function of the lagged values of all of the endogenous variables present. VAR models allows the uncertainty to be measured immaterial of whether variables are endogenous or exogenous given they are expressed in a simultaneous nature (A.Sims, 1986).

For example in a two variable scenario, say the time series of \(y_t\) be impacted by current and past values of the \(z_t\) series and the time series of \(z_t\) be impacted by current and past values of the \(y_t\) sequence. In a simple bivariate system:

\[
y_t = b_{10} - b_{12}z_t + \gamma_{11}y_{t-1} + \gamma_{12}z_{t-1} + \varepsilon_{yt} \quad (4)
\]

\[
y_t = b_{20} - b_{21}y_t + \gamma_{21}y_{t-1} + \gamma_{22}z_{t-1} + \varepsilon_{zt} \quad (5)
\]

Assumption of \(y_t\) and \(z_t\) as stationary is made; \(\varepsilon_{yt}\) and \(\varepsilon_{zt}\) represent white noise disturbances that are not correlated and have a standard deviation of \(\sigma_y\) and \(\sigma_z\), respectively.

Here only one lag length is considered in the equations (4) and (5). It is also known as first order VAR. The standard form of VAR is expressed in equations (6) and (7).

\[
y_t = a_{10} + a_{11}y_{t-1} + a_{12}z_{t-1} + \varepsilon_{1t} \quad (6)
\]

\[
z_t = a_{20} + a_{21}y_{t-1} + a_{22}z_{t-1} + \varepsilon_{2t} \quad (7)
\]

Vector Error Correction Model (VECM)

A form of restricted VAR is the vector error correction (VEC) model. It can be used on non stationary series which are known to be cointegrated. It allows short run adjustment dynamics while restricting the endogenous variables long-run behavior of converging to their cointegrating relationships. Since it includes the correction of the deviation from long-run equilibrium gradually by making partial adjustments in the short run it is called error correction.

\[
\Delta S_t = a_{s,0} + \sum_{i=1}^{p-1} a_{s,i}\Delta S_{t-i} + \sum_{i=1}^{p-1} b_{s,i}\Delta F_{t-i} + \sigma S Z_{t-1} + \varepsilon_{st} \quad (8)
\]

However, it is important that the optimal lag length must be obtained by AIC- Akaike’s Information Criterion (Brooks, 2002).

Impulse Response Function
A VAR can be expressed as a vector moving average (VMA). It helps in tracing the time path of the various shocks on the variables in the VAR. Because of the lag structure in the VAR a shock given to the one variable not only directly affects that variable but all other endogenous variables.

Plotting the impulse response functions gives a better way to understand the behaviour of \( \{y_t\} \) and \( \{z_t\} \) series in response to the various shocks. Since an estimated VAR is under identified, many researcher impose restriction on the two variable VAR to understand the response of the variables. Thus, the Choleski decomposition is followed.

**Variance Decomposition**

While the effects of a shock on one endogenous variable and its transmission to other endogenous variables is captured by impulse response functions, the variation in an endogenous variable into the component shocks can be separated through Variance decomposition. Thus, the importance of each random innovation on the variable is informed by the variance decomposition. The forecast error variance decomposition helps to know the change in a variable due to its “own” shocks versus shocks to other variables.

In tests such as VAR, VECM and Johansen’s cointegration the optimal lags have to be chosen with Akaike Information Criteria (AIC) or Schwarz’s Criteria (SC).

**Durbin Watson Test (DW)**

This is popularly known as the Durbin Watson \( d \) test which is defined as

\[
DW = \frac{\sum_{i=2}^{n} (\hat{u}_i - \hat{u}_{i-1})^2}{\sum_{i=1}^{n} \hat{u}_i^2}
\]

It is a simple ratio of the sum of the squared differences in successive residuals to the sum of squared residuals. The numerator of the \( d \) statistic is based on \( n-1 \) observations because one observation is lost in taking successive difference. DW test is used to find out the presence of autocorrelation.

Assumptions under \( d \) statistic:

- Presence of intercept term in the regression model.
- The explanatory variables are non-stochastic
- The disturbances \( u_t \) are generated by the first order autoregressive scheme, thus it cannot be used to detect higher order autoregressive schemes.
- The error term is normally distributed.
- Lagged values of the dependent variables does not form one of the explanatory variables.

**Wald test**

Wald test is a simple test to examine the restriction on the coefficients of a linear regression model. Thus, it checks for example say, if \( \alpha = 0 \) and \( \beta = 1 \) in this study for market efficiency. If \( p \)-values of the Wald test
statistic is higher than the respective significance level, then the null hypothesis of the validity of restriction is not rejected.

DATA ANALYSIS AND INTERPRETATION

Analysis of weak form market efficiency using Regression techniques

Criteria for market efficiency

The null hypothesis of efficient market for the commodities futures is a joint hypothesis of \((\alpha=0 \text{ and } \beta=1)\). \((\beta=1)\) is the null hypothesis of unbiasedness of the futures market. \((\beta=0)\) represents that the futures prices are uninformative about the price change in the spot markets.

**Aluminum**

*Table 1 Aluminum level data regression for market efficiency*

<table>
<thead>
<tr>
<th>ALUMINUM (Level regression)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract</td>
</tr>
<tr>
<td>2 months</td>
</tr>
<tr>
<td>1 month</td>
</tr>
<tr>
<td>Expiry</td>
</tr>
</tbody>
</table>

** denotes the rejection of the null hypothesis at 5% level.

The level regression of aluminum spot prices at the end of the maturity period on the lagged values of futures contract prices prior to the maturity shows that the 2 months futures prices, the 1 month futures prices and the futures prices on the expiry date, all significantly affect the spot prices. The hypothesis of futures market efficiency is rejected at 5% level for all the contracts. The futures contract prices on the date of maturity of the contract show unbiasedness. However, this level regression could be spurious due to the presence of the unit roots.

*Table 1 Aluminum first difference data regression for market efficiency*

<table>
<thead>
<tr>
<th>ALUMINUM ( first difference regression)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract</td>
</tr>
<tr>
<td>2 months</td>
</tr>
<tr>
<td>1 month</td>
</tr>
<tr>
<td>Expiry</td>
</tr>
</tbody>
</table>

** denotes the rejection of the null hypothesis at 5% level.

We now take the first difference of the spot prices and futures prices of aluminum in an attempt to make the price series stationary. The differenced spot prices are regressed on the differenced futures prices. In case of the futures prices at the expiry the \(\alpha\) is lesser than zero and the \(\beta\) is tending towards one. Hence, at
5% level it can be said that the futures prices at expiry are unbiased but not efficient. All other period futures contract are inefficient too. Also, the change in spot prices of aluminum is strongly explained by the change in the futures prices on the date of expiry (R square = 96.84%), this could be due to the convergence theory that applies to the spot and futures prices at the maturity of the contract.

**Table 2 Aluminum second difference data regression for market efficiency**

<table>
<thead>
<tr>
<th>Contract</th>
<th>$\alpha$</th>
<th>$\beta$</th>
<th>R square</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 months</td>
<td>0.00</td>
<td>0.02</td>
<td>0.00</td>
<td>0.88</td>
</tr>
<tr>
<td>1 month</td>
<td>0.00</td>
<td>0.19</td>
<td>0.04</td>
<td>0.06</td>
</tr>
<tr>
<td>Expiry</td>
<td>0.00</td>
<td>0.96</td>
<td>0.97</td>
<td>0.00**</td>
</tr>
</tbody>
</table>

** denotes the rejection of the null hypothesis at 5% level.

The second difference of the spot prices and futures prices of aluminum is taken. The test reveals the same result as the first difference. However, the futures prices at expiry are found to be moving towards efficiency and unbiasedness on the date of expiry. Also, the change in the spot prices at expiry is better explained by the change in the futures prices at the expiry.

**Copper**

**Table 3 Copper level data regression for market efficiency**

<table>
<thead>
<tr>
<th>Contract</th>
<th>$\alpha$</th>
<th>$B$</th>
<th>R square</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 months</td>
<td>49.32</td>
<td>0.86</td>
<td>0.85</td>
<td>0.00**</td>
</tr>
<tr>
<td>1 month</td>
<td>20.04</td>
<td>0.95</td>
<td>0.93</td>
<td>0.00**</td>
</tr>
<tr>
<td>Expiry</td>
<td>3.66</td>
<td>0.99</td>
<td>0.99</td>
<td>0.00**</td>
</tr>
</tbody>
</table>

** denotes the rejection of the null hypothesis at 5% level.

The level regression of copper spot prices at the end of the maturity period on the lagged values of futures contract prices prior to the maturity shows that the 2 months futures prices, the 1 month futures prices and the futures prices on the expiry date, all significantly affect the spot prices. The joint hypothesis of market efficiency is rejected at 5% level for all the futures contract given the value of $\alpha > 0$. The 1 month futures contract prices and the futures prices on the date of maturity are found to be unbiased since the $\beta$ is closer to 1 in both the cases. The change in the spot prices is better explained by the change in 1 month futures contract and the change in futures prices at the date of expiry. However, this level regression could be spurious due to the presence of the unit roots.
We now take the first difference of the spot prices and futures prices of copper in an attempt to make the price series stationary. The differenced spot prices are regressed on the differenced futures prices. All the futures contract of copper have significant impact on the spot prices of copper. The results also suggest the denial of market efficiency hypothesis in futures copper market for all the period since it does not satisfy the joint criteria. The change in the spot prices on the expiry date are better explained by the change in the futures prices on the expiry date as compared to other period futures prices. None of the futures prices are seen as the unbiased predictors of the spot prices.

**Table 5 Copper second difference data regression for market efficiency**

<table>
<thead>
<tr>
<th>Contract</th>
<th>α</th>
<th>B</th>
<th>R square</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 months</td>
<td>0.02</td>
<td>0.30</td>
<td>0.11</td>
<td>0.02**</td>
</tr>
<tr>
<td>1 month</td>
<td>0.01</td>
<td>0.66</td>
<td>0.44</td>
<td>0.00**</td>
</tr>
<tr>
<td>Expiry</td>
<td>0.00</td>
<td>0.92</td>
<td>0.88</td>
<td>0.00**</td>
</tr>
</tbody>
</table>

**denotes the rejection of the null hypothesis at 5% level.

The second difference of the spot prices and futures prices of copper is taken. The regression results show that none of the copper futures contract are efficient and unbiased. The futures prices at the expiry are seen moving towards efficiency.

**Analysis of Weak form of market efficiency using econometrics**

**Aluminum**

ADF test is conducted on the level data of the spot and futures prices (2 months, 1 month and at the expiry) of Aluminum. The Schwarz selection criterion is used to select the maximum lag length of 11. All the level series are found to have unit roots (see Table 20). Similarly, the ADF test is conducted by taking
the first difference of the series. The results show that there are no unit roots (see Table 21). Hence, the first differenced series are stationary. Now to test if there is any long term relationship between the spot and futures prices, the Johansen Co-integration test is exercised. The result rejects the null hypothesis of no long term relationship between the spot and futures prices of aluminum (see Table 22). Though there is a long run equilibrium between the spot and futures prices, there could be short run deviations from such equilibrium. The VECM is used to know such deviation. The Akaike’s Information criterion is used to select the optimal lag length of 5. The null hypothesis of no deviation in the short run is rejected for the 1 month futures prices (see Table 23). About 54% of correction from the deviation takes place in the same period. The impulse response results (Figure 7) shows that a positive one standard deviation shock to the prices of the 2 months futures contracts results in an increase of the spot prices for the next two months. Similarly, a shock to the 1 month futures prices results in the decrease in the spot prices in the immediate next period. However, one point shock to the futures prices at the expiry results in an immediate decrease in the spot prices in the same period. The Cholesky decomposition method is followed to understand the impact of different period futures prices on the spot prices. The results obtained suggest that in the immediate past month 100% of the forecast variance is because of the spot prices itself (see Table 24) and as the lag increases information towards the future spot prices decreases. Futures contract prices do not give much of information towards forecasting of the spot prices. The futures prices at the expiry are affected by the 1 month lagged spot prices which contribute 97% of information towards the forecast variance. The Wald test is done to check the efficient market hypothesis. The test rejects the futures market efficiency for aluminum.

Copper

ADF test is conducted on the level data of the spot and futures prices (2 months, 1 month and at the expiry) of copper. The Schwarz selection criterion is used to select the maximum lag length of 9. All the level series are found to have unit roots. Similarly, the ADF test is conducted by taking the first difference of the series. The results show that there are no unit roots. Hence, the first differenced series are stationary. Now to test if there is any long term relationship between the spot and futures prices, the Johansen Co-integration test is exercised. The result rejects the null hypothesis of no long term relationship between the spot and futures prices of copper. Though there is long run equilibrium between the spot and futures prices, there could be short run deviations from such equilibrium. The VECM is used to know such deviation. The Akaike’s Information criterion is used to select the optimal lag length of 1. The null hypothesis of no deviation in the short run is rejected for the 2 months futures, 1 month futures prices and the futures prices at expiry. While 100% correction from deviation takes place for the 1 month futures and the futures prices at expiry, about 92% correction from deviation happens for the 2 months futures in the same period. Thus the error correction in the futures market of copper is significantly higher and faster. The impulse response results shows that one standard deviation shock to the prices of the 2 months futures contracts and the futures prices at expiry results in an immediate steep decrease of the spot prices. Similarly, a shock to the 1 month futures prices results in the decrease in the spot prices in the immediate period but the decrease of spot happens gradually. The Cholesky decomposition method is followed to understand the impact of different period futures prices on the spot prices. The results obtained suggest that in the immediate past month 100% of the forecast variance is because of the spot prices itself and as the lag increases information towards the future spot prices decreases. Futures contract prices do not give much of information towards forecasting of the spot prices. The lagged spot prices give more information about the 2 months futures prices. The immediate past month spot prices gives more information about the futures prices at the expiry. The Wald test is done to check the efficient market hypothesis. The test rejects the futures market efficiency for copper.
Analysis of effect of speculation using Regression techniques

Impact of speculation on the unexpected movement of spot prices.

There is a general believe that the commodity futures market is more speculative and it leaves the market open to unscrupulous traders. It is also alleged that futures trading enhances spot market volatility hence driving up the commodity cash prices. Hence, an attempt is made in this study to find the impact of unexpected volumes on the unexpected cash price movements.

The null hypothesis of \( r = 0 \) is taken, where \( r = 0 \) implies that speculation has no impact on driving up of the spot prices of the commodities. The alternative hypothesis is \( r \neq 0 \), implies that speculation has an impact on the driving up of spot prices.

**Table 6 Effect of speculation on unexpected movement of spot prices**

<table>
<thead>
<tr>
<th>Commodity</th>
<th>R square</th>
<th>B</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Aluminum</td>
<td>0.36%</td>
<td>-0.03738</td>
</tr>
<tr>
<td>2</td>
<td>Copper</td>
<td>1.51%</td>
<td>0.085467</td>
</tr>
</tbody>
</table>

** denotes the rejection of the null hypothesis at 5% level.

The null hypothesis of no impact of speculation on the driving up of spot prices is rejected for all commodities. All the commodities are significantly affected by the speculation at 5% level. The results suggests that the change in the unexpected spot prices is weakly explained by the change in the unexpected volume of futures being traded for all the sample commodities (R square is very low). However, it can be said that an unexpected 10% increase in the volume of futures traded will lead to 8.5% increase in the spot prices of Copper, and 3.8% decrease in the spot prices of Aluminum respectively. All this spot prices would increase or decrease in value with respect to their previous unexpected movement.

Analysis of Random Walk model in commodity prices as the maturity date of the contract approaches

Random walk theory (weak form of efficiency) implies that the successive prices (returns) of a commodity are independent. Thus, information contained in the past prices is fully reflected in the current prices. Therefore, the past information cannot be used to make a more than normal return. However, if the past prices have some pattern or say some kind of information for the future prices, in other words they help in determining the future prices (autocorrelated) then the random theory gets rejected. As it is known

\[ S_t = \alpha + \beta (F_{t+k}) + e_t \]

Where, \( e_t \) is a random number and stands for the variability in the prices (returns) not related to the past prices (returns). Thus, the Durbin Watson test is conducted to know if the \( e_t \) is random.

The null hypothesis of \( e_t \) being random is tested. The results show that the one month futures contract for all the commodities (except) Aluminum are not random. Similarly, the futures prices at expiry for all the
commodities except the agricultural commodities (Chana and Jeera) are not random. Thus, most of the markets as they come near to the maturity date become predictable and the prices are not random.

Table 7 Durbin Watson results of the residuals auto correlation test

| Durbin Watson statistic (k=1, significance at 0.05) |
|---------------------------------|----------------|
| Commodities | observations | lower limit (d_l) | upper limit (d_u) | 4-upperlimit | 4-lowerlimit | 1 month | expiry |
| Aluminum | 96 | 1.645 | 1.687 | 2.313 | 2.355 | 2.050 | 1.067 |
| Copper | 45 | 1.475 | 1.566 | 2.434 | 2.525 | 2.753 | 2.900 |

Decision based on Durbin Watson statistic

<table>
<thead>
<tr>
<th>DW decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 months</td>
</tr>
<tr>
<td>Aluminum</td>
</tr>
<tr>
<td>Copper</td>
</tr>
</tbody>
</table>

SUMMARY AND CONCLUSION

The literature relating to weak form of efficiency in commodities market is mainly confined to developed economies. Though, commodity markets in developing economies like India has seen a rapid growth, the commodities and their derivatives are neither popular among the investors as an asset class nor have they been of research interest. Empirical studies have shown that the commodities derivatives have reduced the informational asymmetries. To bridge the gap in the literature, the present study examines the weak form of efficiency in the commodities markets in India.

Summary

This study covers six different commodities from the MCX (Aluminum, copper) and the study period is from the year 2005 to the year 2013. There is a variation in the period of data collection among the commodities owing to the difference in the contract expiry date. The regression of spot prices on the near month, middle month and far month futures prices shows that the market for all the commodities are

\[^2\] 0 to d_l evidence of positive autocorrelation
d_l to d_u indecision
d_u to 4- d_u no auto correlation
4- d_u to 4- d_l indecision
4- d_l to 4 negative autocorrelation
inefficient though some efficiency cannot be denied at the second difference of the prices. However, the results of the second difference are not reliable because the ADF test recognizes that the series of prices become stationary at first difference itself. Over differencing may lead to wrong results. The co integration result for all the commodities show that the spot and futures prices have a long run equilibrium. The Error correction happens if there is any short term deviation from the equilibrium. The study also observes that there is an impact of speculation on unexpected movement of the spot prices. The Wald test also rejects efficiency of the commodity markets. Since the presence of random walk holds the efficient market hypothesis, Durbin-Watson test is used to examine if the prices are random and do not have any connection to their past prices. The Durbin- Watson test concludes that as the contract maturity period comes near, there is serial correlation between the residuals. In other words, prices are not random. Hence, the markets are not efficient.

**Conclusion**

Thus, to conclude it can be said that India being an emerging economy, there is informational asymmetries in the commodities markets. There is a need of strong policy support owing to the implications of price rises, trading platforms developments, product innovation, investors education, and fiscal incentives.

**Scope for further studies**

There is vast scope for further research on the commodities markets

- Finding out time varying optimal hedge ratios using various GARCH models
- Using Granger Causality to find the direction of the Information flow.
- Semi strong form efficiency in commodities market
- Effect of variation in commodity stocks at warehouses and commodity transaction tax on prices can also be studied.
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