Inspira- Journal of Modern Management & Entrepreneurship (JMME)
ISSN : 2231–167X, General Impact Factor : 2.3982, Volume 07, No. 04, October, 2017, pp. 99-106

AN EMPIRICAL EVIDENCE OF HEDGING EFFECTIVENESS OF FUTURES CONTRACTS IN COMMODITIES MARKET

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ABSTRACT

The study uses well established methodologies to estimate the hedging efficiency of various futures contracts traded on India's largest commodity exchange-Multi Commodity Exchange of India Ltd (MCX). The focus of the research is to estimate the optimal hedge ratio and comparing the hedging effectiveness of the futures contracts i.e. hedging efficiency of the selected commodities. The study covered a period of 5 years from 2011 to 2016 and the daily spot and future prices of the commodities (gold, silver, copper and crude oil) were included.To investigate the hedge ratios and hedging effectiveness Vector Error Correction Model (VECM) is used. Such an investigation will also help in designing better hedging strategy and diversified portfolio.

KEYWORDS: *Futures Contracts, Hedging, Optimal Hedge Ratio, VECM, MCX, Future Prices.*

Introduction

India stands at a very unique place in terms of the investment environment today. It has become convenient for an Indian investor to choose from various investment and financial products. The country today hosts an organized, structured and regulated market platform in the equities, commodities and currencies space. India commodity market consists of both the retail and the wholesale market in the country. The commodity market in India facilitates multi commodity exchange within and outside the country based on requirements. The India Commodity market has undergone lots of changes due to the changing global economic scenario; thus throwing up many opportunities in the process. Demand for commodities both in the domestic and global market is estimated to grow by four times than the demand currently is by the next five years. Commodity trading is an interesting option for those who wish to diversify from the traditional options like shares, bonds and portfolios. The Government has made almost all commodities entitled for futures trading. Three multi commodity exchanges have were set up in the country to facilitate this for the retail investors. The three national exchanges in India are:

- Multi Commodity Exchange (MCX)
- National Commodity and Derivatives Exchange (NCDEX)
- National Multi-Commodity Exchange (NMCE)

The commodity futures market has advanced in terms of both network and volume. At present, there are 17 Commodity Exchanges (6 National and 11 Regional) regulating futures trading in commodities. (Ram & B.Ramesh, 2015) The history of the Indian commodity futures exchanges can be traced back to 2003, when the three national exchanges were launched. While just 10 years ago one would feel that commodities was a new market for India, the current scenario suggests, that Indian commodity exchanges have risen to global standards and have become one of the top exchanges in the world. The MCX stands as the third largest commodity futures exchange in the world in terms of the number of futures contracts traded. Earning this accolade has in turn made India stand neck-to-neck with

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global commodity players. Apart from this, the MCX has also bagged the tag of the world's No.1 exchange for gold and silver futures, No.2 rank for copper and natural gas futures and No.3 position in crude oil futures contracts. This shows the strength of Indian commodity exchanges and also showcases that the future in the commodities business looks bright. Since Indian commodity exchanges began their journey only about a decade ago, they are still in an evolving stage. The MCX began as an exchange focused on non-agricultural commodities, in today's time it too is looking forward to diversify and enhance business in the agricultural commodities In the Indian commodities market, the NCDEX has become a benchmark for futures trading in agricultural commodities and even though the exchange is targeting newer non-farm futures contracts, Recently, the exchange re-launched its Steel futures contract and additionally has taken a big leap forward by launching India's first Gold-Hedge contract. Apart from the MCX and the NCDEX, other exchanges that also have a foothold in the Indian commodity futures market are the NMCE and the ACE (Kotak Anchored Enterprise).While the NMCE stands strong in futures trading of plantation crops like coffee and rubber, the ACE on the other hand is a multi-commodity exchange.

The strictly regulated environment has helped the Indian commodity markets achieve a controlled and structured platform, thus making it beneficial for the investor who is seeking to widen his/her portfolio and trade in commodities. Despite having a robust economy, India's share in the global commodity market is not as big as estimated. Except gold the share in other sectors of the commodity market is not very significant. India accounts for 3% of the global oil demands and 2% of global copper demands. In agriculture India's contribution to international trade volume is rather less compared to the huge production base available. Various infrastructure development projects that are being undertaken in India are being seen as a key growth driver in the coming days.

Hedge Ratio and Hedging Effectiveness

In portfolio theory, hedging with futures can be considered as a portfolio selection problem in which futures can be used as one of the assets in the portfolio to minimize the overall risk or to maximize utility function. Hedging with futures contracts involves purchase/sale of futures in combination with another commitment, usually with the expectation of favorable change in relative prices of spot and futures market (Castelino, 1992). The basic idea of hedging through futures market is to compensate loss/ profit in futures market by profit/loss in spot markets. The optimal hedge ratio is defined as the ratio of the size of position taken in the futures market to the size of the cash position which minimizes the total risk of portfolio. The return on an un-hedged and a hedged portfolio can be written as:

$$RU = St+1 - St$$

$$RH = (St+1 - St) – H (Ft+1 – Ft)$$

Variances of an un-hedged and a hedged portfolio are:

$$Var (U) = \sigma S2$$

$$Var (H) = \sigma S2 + H2\sigma 2F – 2H\sigma S, F$$

Where, St and Ft are natural logarithm of spot and futures prices,
H is the hedge ratio,
RH and RU are return from un-hedged and hedged portfolio,
σS and σF are standard deviation of the spot and futures return and
σS, F is the covariance.

Hedging effectiveness is defined as the ratio of the variance of the un-hedged position minus variance of hedge position over the variance of un-hedged position.

$$HE = \frac{Var(U) - Var(H}{Var(U)}$$

This paper Uses well established methodologies to estimate the hedging efficiency of various futures contracts traded on India's largest commodity exchange - Multi Commodity Exchange of India Ltd (MCX). The focus of the research is to estimate the optimal hedge ratio and comparing the hedging effectiveness of the futures contracts i.e. hedging efficiency of the selected commodities.

Literature Review

In studies of derivatives markets, interest has been paid to the hedging effectiveness of futures contracts as it is considered a significant determinant in explaining the success of futures contracts

(Johnston, Tashjian, & McConnell, (1989)).The measures all try to determine the extent to which hedgers were able to reduce cash price risk by using futures contracts. The degree to which futures contract offer a drop in overall risk is an important criterion for the management of the futures exchange to evaluate the hedging performance. ***(Pennings & Meulenberg, 1997).***

Measures, such as, better regulatory framework, wider participation of actual users in the commodity value chain and suitable contract specifications, are most essential for lucrative commodity markets. ***(Malhotra & Meenakshi, 2015)*** In this study, the risk reduction function of commodity futures was evaluated for commodities in the oil and oilseeds segment, namely, refined soya oil, mustard seed, mentha oil and crude palm oil. The minimum variance hedge ratio (MVHR) was calculated using the ordinary least square (OLS) method, OLS with additional variables and error correction model (ECM).Hedging effectiveness was calculated using MVHR.

The effect of the maturity on the hedging effectiveness of futures examined by ***(Ripple &moosa, 2007)***Daily and monthly data of crude oil futures and spot prices were used to work out hedge ratio and measure of hedging effectiveness for near month and distant month contracts. The optimal hedge ratio measured as the slope coefficient in a regression. The results revealed that futures hedging are more effective when the near-month contracts are used, rather than distant month contracts. The results also revealed that hedge ratios are lower for near month hedging, which is explained in terms of the ***Samuelson (1965)*** findings about the volatility of contracts with short and long maturities.

The simplest and most widely used tool as measure of hedging efficiency is through regression, using the Ordinary Least Square estimator. The change in spot prices is regressed as against the changes in future prices. The coefficient so obtained, is considered as the minimum variance hedge ratio. The R2 value of the regressed equation is considered as the hedging efficiency. However, The use of regression for the purpose of calculation of the hedge ratio and efficiency has been criticized on two grounds ***(Kumar, Singh, & Pandey, 2008)***, firstly, the hedge ratio projected using the OLS regression is grounded on an assumption of unconditional distribution of the spot and futures prices; However, the use of conditional distributions is more appropriate because hedging decision made by any hedger is based on all the information available at that time. Second, the estimates based on the OLS regression are time invariant whereas the joint distribution of the spot and futures maybe time variant.

Mandal & Anandadeep, 2008, studied hedging effectiveness in Indian stock index futures market. The study focused on the procedure to estimate time-varying and static optimal hedge ratios. Traditional OLS regressions, modified OLS viz. LTS , error correction model (ECM), vector error correction model (VECM) and multivariate generalized autoregressive heteroscedastic (M-GARCH) models were used to estimate hedge ratios, not only for mirror index underlying the futures contract but also for mutual funds. The findings revealed mutual funds tend to be a good proxy for market portfolios. Simple OLS as well as complex models like VECM were used to find out the hedging effectiveness in terms of risk reduction for the Indian futures market.

Bhaduri & Durai, 2005, as compared to the OLS estimator, DVEC-GARCH model is preferred as this time varying model gives a higher mean returns compared to its other counterparts. In most of the markets, the spot and future prices are co-integrated in the long run, estimation of constant Hedge ratio through Vector Error Correction Model (VECM) is hence considered appropriate and widely used. The co-integration in the short run calls for estimating the hedge ratio through Vector Auto-Regressive Model (VAR) ***(Ram & B. Ramesh, 2015).***

Objectives of the Study

- To identify the existence of long term or short term co-integration in the spot and future prices of the selected commodities.
- To estimate the optimal hedge ratio for the selected commodities.
- To find out the hedging efficiency of select commodities in the Indian derivatives segment.

Research Methodology

Research methodology is a methodology for collecting all sorts of information and data pertaining to the subject in question through primary and secondary data collection.

- **Sources of Data**: The present study is based on the secondary data. This paper investigates optimal hedge ratio and hedging effectiveness of four non-agricultural future contracts traded on MCX. i.e. gold, silver, copper and crude oil. The spot price and future prices of these commodities have been collected using Bloomberg database. The commodities are selected as per the 2015

FIA Annual VolumeSurvey, which indicated the futures contracts on Gold, Silver, Copper, Crude Oil offered byMCX ranked among the top 20 global futures contracts in their respective segments.The contract specifications information has been obtained from www.mcx.com.

- **Period of Study:** The study covered a period of 5 years from 2011 to 2016 of the daily spot and future prices of the commodities.
- **Methodology of the Study:** Daily returns are calculated for all the commodities for both Spot and Future prices using the following equations:

$$R_{S_1t} = \ln\left[\frac{S_t}{S_{t-1}}\right] \qquad R_{F_1t} = \ln\left[\frac{F_t}{F_{t-1}}\right]$$

Where;

R_s – Daily spot returns

R_f – Daily future returns

S_t – Closing price of commodities for spot

F_t – Closing price of commodities for futures

t – Corresponding day

Generally, financial time series contain a unit root. Therefore, prior to modelling any relationship, non-stationary must be tested. Stationary means that the mean and variance of the series are constant through time and the auto covariance of the series is not time varying. If the series are non-stationary, we test the order of integration of the spot and futures price series for each commodity. Integration means that past shocks remaining undiluted, affects the realization of the series forever and a series has theoretically infinite variance and a time-dependent mean. If all of the series are non-stationary in levels, it should be stationary in first difference with the same level of lags. Stationary of the prices and their first difference are tested using ADF test statistics and co integration between spot and futures prices are tested using Johansen co integration tests. To investigate the hedge ratios and hedging effectiveness Vector Error Correction Model (VECM) is used.

- **Tools and Techniques:** The constant hedge ratio can be estimated by OLS (Ordinary Least Square model) in regression of the cash price against the futures price. However, the OLS method ignores the existence of a long-run co-integrating relationship between spot and futures prices. VAR (Vector Autoregressive model) and VECM (Vector Error Correction model) are also two models which are used to calculate the constant hedge ratios apart from OLS regression. The use of the two models depends upon the long term and short term co-integration of the variables. These three models are based on the assumption that the joint distribution of spot and futures prices is time invariant and does not take into account the conditional covariance structure of spot and futures price:
  - **Test of Unit Root and Co-Integration**: A unit root test helps in determining whether a time series data variable is stationary. The Augmented Dickey Fuller test is a well – known test that is used to check if the data points are stationary and as such has been used on the Spot and Future prices of commodities. The co-integration test is conducted using the Johansen's Co–integration method. Co-integration signifies when time series data points exhibit a similar or common stochastic drift. The study has tried to analyze the long term co integration in movement of Spot prices and Future prices of selected commodities.
  - **Vector Error Correction Model:** When futures and spot prices are co-integrated, return dynamics of the both prices can be modeled through vector error correction model. VECM is used to estimate hedge ratios. In particular, the unconditional Variances of the spot prices (σS), futures prices (σF) and the covariance (σSF) of the two series are obtained from the residual covariance matrix of the VECM**.**

Limitations

The study is based on secondary data of selected commodities and the results are obtained thereof. This study can be enhanced by using Multivariate GARCH model. Also, more commodities (agricultural) can be used to obtain effective results. The study estimates the hedge ratios and the hedging effectiveness using one model only.

Data Analysis and Interpretation

- **Descriptive Statistics:** The descriptive statistics is used for the study so as to obtain the mean, standard deviation, skewness and kurtosis.

Descriptive Statistics of Spot and Future Prices

	Copper		Crude Oil		Gold		Silver	
	Future	**Spot**	**Future**	**Spot**	**Future**	**Spot**	**Future**	**Spot**
Mean	-0.0202	-0.0205	-0.0406	-0.0402	0.0223	0.0232	-0.0206	-0.0214
Std. Dev.	1.2097	1.3608	1.8081	2.0972	1.0527	0.8915	1.6706	1.6509
Skewness	-0.0093	0.14362	0.30847	0.23737	-0.935	-0.32052	-0.88532	-0.86003
Kurtosis	6.2031	5.63271	6.62855	7.56244	14.1322	8.49236	13.2162	14.4925
Jarque-Bera	620.329	424.0462	819.0361	1272.096	7704.471	1848.621	6499.898	8163.437
Probability	0	0	0	0	0	0	0	0
Observations	1451	1451	1451	1451	1451	1451	1451	1451

The Summary statistics of spot and future prices of the four commodities are provided in table above. The rate of return as given by the mean is greater for the futures market than compared with spot market. The volatility as given by standard deviation is higher for crude oil and lower for gold. That means, from amongst the above four commodities, gold prices are least volatile. The measure of skewness indicates that all of the data points are symmetric wherein the data points lie within +/- 1 and are moderately skewed. The kurtosis data points for all data series lies above three which indicates leptokurtic behavior of the data series featuring sharper peaks longer and fatter tails on both the ends. The Jarque-Bera test is used to test the normality of the data series. The null hypothesis for the test is given as H0= all the data series are normally distributed. As can be observed from the above tables we reject the null hypothesis. Hence, indicating that the data series aren't normally distributed.

- **Unit Root Test**

A unit root test helps in determining whether a time series data variable is stationary. The Augmented Dickey Fuller test is a well – known test that is used to check if the data points are stationary and as such has been used on the closing prices of all the indexes. The test is given as H0: Series has a unit root (Non stationary). It is found that for all the commodities, the p-value is less than 0.05, Hence we reject the null hypothesis and accept the alternate one . Therefore; spot prices as well as future prices of the commodities do not have a unit root problem, and are stationary. That means the data points were found to be stationary at first difference.

- **Johansen Test for Co-integration**

This test tries to establish the presence of co integrating relationship between spot and future prices. This test tries to find the number of co integrating equations and determine the long term association and causal relationship between the spot and future markets.

Johansen test for co-integration (Spot and futures)

Commodity	Hypothesized no. of CEs.	Eigen value	Trace statistic	Critical value	Probability**
Copper	None*	0.354801	855.3564	15.49471	0.0001
	At most 1*	0.142159	221.725	3.841466	0
Crude oil	None*	0.37768	916.5711	15.49471	0.0001
	At most 1*	0.147486	230.7318	3.841466	0
Gold	None*	0.272686	679.6946	15.49471	0.0001
	At most 1*	0.140715	219.2925	3.841466	0
Silver	None*	0.334555	811.0533	15.49471	0.0001
	At most 1*	0.142381	222.0984	3.841466	0

Note: *denotes rejection of null hypothesis at 5 percent significance

The above table highlights, that the prices of spot and future for all the commodities are co integrated and hence exhibit a long term equilibrium relationship. It is a very important characteristic that when prices are trending either upward or downward they exhibit a co related movement in their prices otherwise the efficiency of futures market in providing a hedging platform decreases. A strong association and causal relationship between spot and future market also facilitates better and efficient hedging opportunities.

- **Vector Error Correction Model**

The Johansen test helps us in understanding the association and long term trends in movement among both the markets. The Vector error correction model helps in analyzing the short run causality between both the markets. It explains the direction and significance of long run and short run causality that each market can have on one another. The error correction mechanism between both the markets helps in maintaining the prices of both the markets at equilibrium.

Vector Error Correction Estimates

Commodity	Copper	Crude Oil	Gold	Silver
Cs	0.000424	-0.00499	0.003114	-0.00138
S_{t-1}	-0.45745	-0.57131	-0.74384	-0.44372
S_{t-2}	-0.21295	-0.2833	-0.38908	-0.2597
F_{t-1}	-0.78502	-0.92217	-0.49575	-0.80985
F_{t-2}	-0.26324	-0.30124	-0.11998	-0.23312
constant	-0.0003	0.003316	-0.00035	-0.00172

The above table explains the co-efficient of VECM model with the future market as dependent variable and the spot market as explanatory variable. Hedging always takes place in the futures market with perspective from the spot market hence we are trying to understand the causality between both the markets. It can be observed that the error co-efficient Cs is negatively significant for crude oil and silver commodities. This shows that there is long term error correction flowing from the spot market to the futures market. The error coefficients for gold and copper are positively significant and hence it can be said that there is no long term error correction flowing from the spot market to the futures market for these two commodities. Here the long term causal relationship is flowing from the spot markets to the futures market. The following error correction variables are explained as:

St-1 : Spot one day lag
St-2 : Spot two day lag
Ft-1 : Future one day lag
Ft-2 : Future two day lag

The table shows that St-1 and St-2 is not significant for any of the commodities which signifies that there exist no short run causal relationship between the spot and future prices. It implies that future prices in the short run move independently of spot prices. In such cases the hedging of risks and volatilities from spot market to future market is very difficult as it is not possible to establish any short run causal relationship between both the markets and hence the hedging won't be effective or provide for optimal risk coverage. It can be observed that Ft-1 is significant across all the commodities which explain that future one lag returns influence the present day future prices. Similarly it can also be observed that Ft-2 is significant for all the commodities. In can be summarized that exist a strong unidirectional causality flowing from the spot markets to the future markets in the long run except in gold commodity where the relationship is observed as bi-directional.. However there exist no causality between spot and futures in the short run. It can also be inferred that spot markets factor in new information and pass on the same to the futures market in the long, however futures market in the short run are affected by its own previous movements.

- **Hedge Ratio and Hedging Effectiveness**

Hedge ratio and hedging effectiveness of four commodities are calculated based upon the vector error correction model parameters. Hedging effectiveness is defined as the ratio of the variance of the un-hedged position minus variance of hedged position over the variance of un-hedged position.

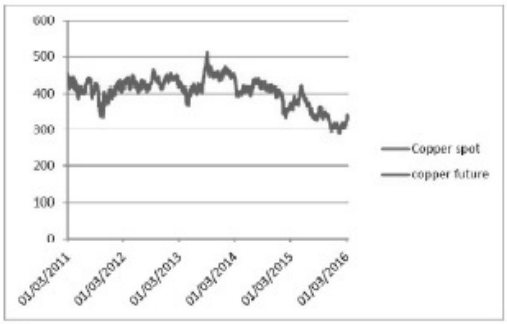
Hedge ratio and hedging effectiveness

	Variance (spot)	Variance (future)	Covariance (Spot; future)	Hedge ratio	Variance (Unhedged)	Variance (Hedged)	Hedging Efficiency
Copper	0.196062	0.031337	0.045406	0.29249	0.196062	0.172187	0.12177
Crude Oil	0.202996	0.082133	-0.080268	0.61009	0.202996	0.331509	-0.633086
Gold	0.035985	0.136271	-0.029331	0.923103	0.035985	0.206255	-4.731657
Silver	0.198492	0.019155	-0.021163	0.961871	0.1984912	0.256926	-0.294391

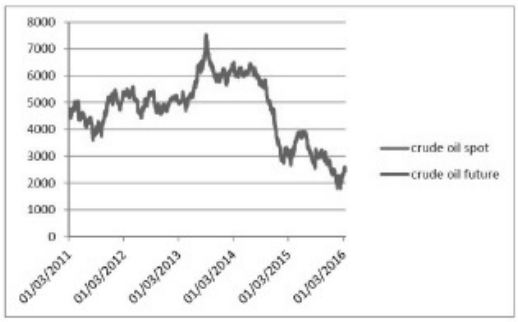
The optimal hedge ratio and hedge effectiveness for all commodities are presented in the above table. The hedge contracts have optimal hedge ratios in the range of 0.29 to 0.96, the lowest being of Copper and the highest being of Silver. It can be observed that gold doesn't provide an optimal hedging opportunity in the short run given the volatility in global gold prices. Copper however provides a hedging effectiveness of 12 percent.

Graphical representation of Commodity wise Spot and Future prices

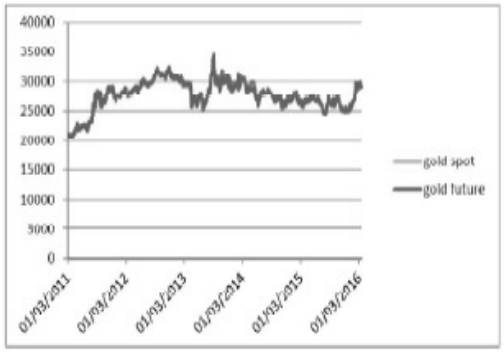
- Copper



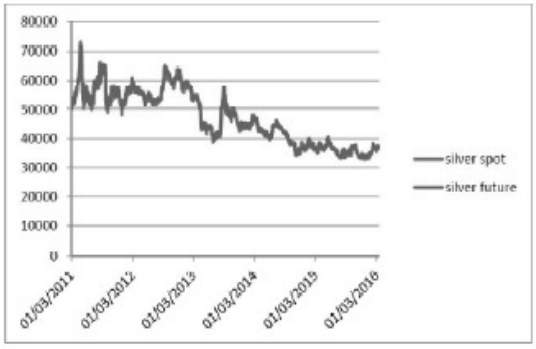
- Crude oil



- Gold



- Silver



Findings and Conclusion

This paper has tried to study the linkages and co-integrated movement in commodity prices and its implications on the hedge ratio and hedging efficiency comprising of four commodities. The findings indicate a strong co-integration in the movement of spot and future prices indicating a long run synchronized movement in prices. The paper also identifies a long term equilibrium relationship between future and spot prices. In the short run there exists unidirectional causality among different commodities.

It is also found that Indian commodity derivatives market serves the purpose of risk transfer by aiding in efficient hedging opportunities. The efficient hedge ratio is found to be in the range of 0.29 to 0.96. It was also found that copper could provide an efficient hedging ratio which can be attributed to the volatility in global crude oil prices. Indian Commodity market has gained much of its importance in recent years but still Commodity trading in India is at its early days and thus requires an aggressive growth plan with innovative ideas. Liberal policies in commodity trading will definitely boost the commodity trading and it surely has the potential to drive the future of the economy to greater heights.

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