AN EMPIRICAL EVIDENCE OF HEDGING PERFORMANCE IN INDIAN COMMODITY DERIVATIVES MARKET

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ABSTRACT

Risk management and price discovery are the two main functions of futures market. The prime objective behind establishment of Futures markets was to enable companies and individuals to insure against the possible adverse effects of changes in interest and exchange rates. Futures were established to enable portfolio managers and other investors to insure against the possible adverse effects of changes in stock prices. Thus the main role of financial futures markets is the reduction of risk or 'hedging'. 'Hedging' has the significant role in stabilizing the market, realizing market efficiency and enabling minimization of risk and thus maximizing utility. This paper tries to evaluate the long term and short term co-integration in spot and future prices & estimate the hedge ratio and hedging effectiveness for select actively traded Indian commodity futures using selected models.

Keywords: Futures Market, Commodity Futures, Hedge Ratio, Hedging Effectiveness.

INTRODUCTION

The volatile financial market today has taken financial risk as centre point in every sphere of economic activity. Therefore, hedging of risk has become a very important concern worldwide. However, hedging is still an underutilized tool. International practices for hedging against commodity price risk involve both static and dynamic hedging techniques. In a static hedge, the physical commodity price is locked in by hedging in Futures market. This is irrespective of whether the commodity price increases or decreases, the underlying objective being protection against market risk.

In a dynamic hedge, judgmental positions are taken in Futures markets, taking into account particular assumptions on conceivable value developments in the physical business sector. This may rely on upon crucial variables of interest and supply that effect commodity costs. Dynamic hedge includes more serious danger as contrasted and a static support.

Supporting utilizing Futures Contracts includes distinguishing proof and evaluation of the hedge proportion (the proportion of the quantity of Futures gets, each on one unit of the underlying asset to be supported, as contrasted and one unit of the money asset that should be supported). The degree of unpredictability in Futures contract costs as contrasted and the instability in real money business sector costs should be learned alongside the connection between's the money cost and Futures cost. The count of the support proportion is all the more imperative in light of the danger of being under-supported or over-supported. A critical info in the supporting of danger is the ideal hedge proportion.

Numerous studies point out that the expected relationship between economic or financial variables may be better captured by a time varying parameter model rather than a fixed coefficient model. So the optimal hedge ratio can be a time varying rather than constant.

Thus, the role of hedging while using multiple risky assets, using Futures market for minimizing the risk of Spot market fluctuation has attracted considerable attention. The focus of current empirical financial research is on effective use of Futures contract in making hedging decisions and there is considerable amount of research being carried out to find optimal hedge ratio and improve the hedging effectiveness.

LITERATURE REVIEW

The relationship between the Futures and Spot costs is of awesome centrality to the individuals who wish to fence the value danger utilizing Futures contracts (Kumar and Shollapur, 2015). There is long haul equilibrium relationship between the Futures and Spot costs of all Commodities. The long-run causality flows from Futures market to the Spot market and not in the opposite direction in all Commodities. The Futures markets are able to meet their intended objectives of price discovery and hence aid in price risk hedging. As the price discovery process becomes more efficient, the hedgers in agricultural Commodities would start deriving greater benefits while managing the price risk.

The Optimal hedge ratio and hedging effectiveness provided by Futures contract has been researched extensively. Various estimation techniques have been developed for estimation of constant as well as dynamic hedge ratio, which is based on conditional distribution of covariance of Spot and Futures returns and conditional variances. Traditionally, the hedge ratio was considered to be ‘-1’, i.e., taking a position in Futures market which is equal in magnitude and opposite in sign to Spot market. If the movement of changes in Spot prices and Futures prices is same, then such a strategy eliminates the price risk. Such a perfect correlation between Spot and Futures prices is rarely observed in markets and hence there was a need felt for a better approach. Johnson (1960) came up with an approach called 'minimum variance hedge ratio (MVHR)'. The primary target of minimizing the danger was kept in place yet the idea of utility expansion (mean) was likewise brought. Danger was characterized as the change of profit for a two-asset supported position. Hedging effectiveness of Futures markets is one of the critical determinants of achievement of Futures contracts (Silber, 1985; Pennings and Meulenberg, 1997).

The Minimum-Variance Hedge Ratio (Benninga et al, 1983) has been suggested as slope coefficient of the OLS regression, for changes in Spot prices on changes in Futures prices. Many authors defined hedging effectiveness as the reduction in variances and considered utility function as risk minimization problem (Johnson, 1960, Ederington, 1979). However, Rolfo (1980) and Anderson and Danthine (1981) calculated optimal hedge ratio by maximizing traders' expected utility, which is determined by both expected return and variance of portfolio.

The use of regression for calculating the hedge ratio and hedging effectiveness has been criticized on mainly two grounds (Kumar et al, 2008). First, it is based on unconditional second moments, whereas the covariance and variance should be conditional because hedging decision made by any trader is based on all the information available at that time. Second, the estimates based on OLS regression is time invariant but the joint distribution of Spot and Futures prices may be time variant. In most of the markets, Spot and Futures prices are co-integrated in long-run (which is a necessary condition of market efficiency) application of vector autoregressive model (VAR) is also not appropriate. Estimation of constant hedge ratio through Vector Error Correction (VECM) Model, which considers the long run co-integration between Spot and Futures, is therefore widely used.

OBJECTIVES

- To identify long term and short term Co-integration in Spot and Future prices of selected Commodities.
- To estimate the hedge ratio and hedging effectiveness for select actively traded Indian commodity Futures using selected models.

RESEARCH METHODOLOGY

This paper investigates optimal hedge ratio and hedging effectiveness of 4 Non-agricultural (Crude Oil, Natural Gas, Gold, Nickel) Futures Contracts traded on Multi Commodity Exchange (MCX) in India using VECM Model. The data period considered in the analysis is from January 2010 to December 2014.

Data Sources

The study is based on secondary data i.e. Spot and Future prices of Crude oil, Natural gas, Copper, Nickel, Gold and Silver and has been collected from **www.mcx.com** and using Bloomberg database and for a period of 5 years from January 2010 to December 2014. The Commodities are selected based on most actively traded Commodities in terms of Volume. One month, two month and three months contract where trading volume is high are analysed.

Tools for Analysis

Model for Estimating Hedging Effectiveness and Hedge Ratio

Several models are used to estimate constant hedge ratio. The OLS, VAR and VECM models estimate constant hedge ratio. In this study, only VECM is used to estimate hedge ratio as many critics contradict the efficiency of OLS and VAR.

Test of Unit Root and Co Integration

Augmented Dickey Fuller model is used to test the presence of unit root. 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 data points were found to be stationary at first difference. In order to test the co-integration between Spot and Future prices, we used the Johansen's co-integration test. Johansen Co–integration is a statistical tool used to analyse time – series variables. Co-integration signifies when time series data points exhibit a similar or common stochastic drift. The study has tried to analyse the long term co integration in movement of Spot prices and Future prices of selected Commodities.

Vector Error Correction Model (VECM)

When Futures and Spot prices are co-integrated, return dynamics of the both prices can be modeled through vector error correction model. Vector error correction model specifications allow a long-run equilibrium error correction in prices in the conditional mean equations (Engle and Granger, 1987). Similar approach has been used to model short run relationship of co-integrated variables (Harris et al, 1995; Cheung and Fung, 1997; Ghosh, Saidi and Johnson, 1999).

RESULTS AND INTERPRETATION

Descriptive Statistics

Summary statistics of contract wise Spot and Future prices of four Commodities are provided in table numbers' 1 to 3. The rate of return as given by the mean is greater for the Spot markets than compared with Futures market under each category of contract except in the case of gold for three month Future contract.

Table 1: Descriptive Statistics for Spot and one month Future Contracts

	Crude Oil		Natural Gas		Gold		Nickel	
	Spot	Future	Spot	Future	Spot	Future	Spot	Future
Mean	0.003	0.003	0.002	0.002	0.005	0.00	0.02	0.02
Median	0.00	0.00	0.00	4.46E	0.04	0.00	0.01	0.01
Maximum	0.26	0.25	0.38	0.39	0.03	0.03	23.01	22.16
Minimum	-0.09	-0.09	-0.33	-0.28	-0.03	-0.04	-16.36	-14.93
Std. Dev.	0.035	0.03	0.058	0.05	0.09	0.01	3.25	3.05
Skewness	4.30	4.32	1.01	2.34	-0.13	-0.84	1.60	2.10
Kurtosis	35.37	37.13	30.86	34.82	6.06	11.09	35.23	36.63
Jarque-Bera	6502.37	7164.48	5298.74	6405.70	85.82	1000.67	6675.66	7129.46
Probability	0	0	0	0	0.04	0.16	0	0

Source: Author Compilation.

Table 2: Descriptive Statistics for Spot and two month Future Contracts

	Crude Oil		Natural Gas		Gold		Nickel	
	Spot	Future	Spot	Future	Spot	Future	Spot	Future
Mean	0.17	0.15	0.00	0.00	0.00	0.00	0.04	0.04
Median	0.02	0.021	0.00	-0.00	0.00	0.00	0.02	0.04
Maximum	26.05	26.13	0.33	0.34	0.04	0.03	12.17	13.28
Minimum	-7.58	-7.47	-0.29	-0.22	-0.05	-0.05	-8.37	-6.38
Std. Dev.	2.64	2.57	0.04	0.03	0.01	0.01	2.33	2.24
Skewness	4.92	5.80	1.02	2.96	-0.74	-0.67	0.86	1.72
Kurtosis	50.59	61.76	38.82	48.74	12.61	9.61	15.34	18.20
Jarque-Bera	29628.07	41780	19053.09	29483.75	2393.32	935.88	1226.76	1769.57
Probability	0	0	0	0.00	0.00	0	0.00	0.00

Source: Author Compilation.

Table 3: Descriptive Statistics for Spot and three month Future Contracts

	Crude Oil		Natural Gas		Gold		Nickel	
	Spot	Future	Spot	Future	Spot	Future	Spot	Future
Mean	0.11	0.10	0.05	0.02	0.12	0.12	0.01	0.02
Median	0.02	0.02	0.00	-0.03	0.08	0.04	0.03	0.00
Maximum	27.31	29.37	29.52	34.14	12.29	12.36	22.01	22.56
Minimum	-7.60	-6.34	-29.51	-20.58	-7.68	-6.79	-12.70	-10.02
Std. Dev.	2.36	2.35	3.56	3.13	1.34	1.32	2.22	2.09
Skewness	5.15	7.27	0.17	3.37	2.32	2.48	2.45	3.62
Kurtosis	59.89	90.17	49.99	60.43	41.97	42.79	44.77	52.70
Jarque-Bera	57552.8	13625.2	49088.18	63270.79	36809.23	41746.96	34159.47	45618.06
Probability	0	0	0	0	0.16	0.07	0	0

Source: Author Compilation.

The volatility as given by the standard deviation is higher for far away contracts as compared to near month contracts. Natural gas and Crude oil have a highly volatile Future and Spot market as compared to other commodity. The measure of Skewness indicates that none of the data points are symmetric with the exception of Natural Gas one month and two month Spot where in 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 H_0 all the data series are normally distributed. As it can be observed from the above tables and it 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. It is found that for all the Commodities, Spot prices, one month Future prices, two month Future prices and three month Future price series have unit root and return series are stationary. That means the data points were found to be stationary at first difference.

Johansen test for co-integration

The Johansen test for co-integration tries to establish the presence of co integrating relationship between contract wise Spot and Future prices. The contract wise results of the test are summarized in table 4, 5 and 6. This tries to find the number of co integrating equations. Here the test is try to determine the long term association and causal relationship between the Spot and Future markets.

Table 4: Johansen test for Co integration (Spot and Futures), One month contract

Commodity	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value	Probability*
Crude Oil	None	0.33	78.04	15.49	0
	At most 1	0.19	26.99	3.08	0
Natural Gas	None	0.35	76.48	15.49	0
	At most 1	0.17	23.46	3.84	0
Nickel	None	0.31	67.76	15.49	0
	At most 1	0.16	21.77	3.84	0
Gold	None	0.31	51.92	15.49	0
	At most 1	0.13	14.92	3.84	0.01

Source: Author Compilation, Note: * denotes rejection of hypothesis at 5 percent significance

The presence of co integrating equations also supports the fact that there exists a causal relationship between both the markets throughout different contract durations. A strong association and causal relationship between Spot and Future market also facilitates better and efficient hedging opportunities.

Table 5: Johansen test for Co integration (Spot and Futures), Two month contract

Commodity	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value	Prob.*
Crude Oil	None	0.32	141.32	15.49	0.00
	At most 1	0.16	44.83	3.84	0
Natural Gas	None	0.27	119.81	15.49	0.00
	At most 1	0.14	39.20	3.84	0
Nickel	None	0.38	64.71	15.49	0
	At most 1	0.17	18.58	3.84	0.00
Gold	None	0.29	107.40	15.49	0.00
	At most 1	0.12	29.29	3.84	0.00

Source: Author Compilation, Note: * denotes rejection of hypothesis at 5 percent significance

Table 6: Johansen test for co integration (Spot and Futures), Three month contract

Commodity	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value	Prob.*
Crude Oil	None	0.32	212.46	15.49	0.00
	At most 1	0.16	66.84	3.84	0
Natural Gas	None	0.29	183.16	15.49	0.00
	At most 1	0.16	62.18	3.84	0
Nickel	None	0.32	210.46	15.49	0.00
	At most 1	0.16	65.41	3.84	0
Gold	None	0.34	148.07	15.49	6.25E
	At most 1	0.15	44.32	3.84	0.00

Source: Author Compilation, Note: * denotes rejection of hypothesis at 5 percent significance

The above tables' highlight that the prices of Spot and Future for one month contract, two month contract and three month contract for all the four Commodities are co-integrated and hence exhibit a long term equilibrium and causal 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. It can also be noted that irrespective of the duration of the contract the prices move in a co integrated and manner. If such a relationship isn't observed among both the data series, the efficiency of Futures market in providing a hedging platform decreases.

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. The results are shown below in Tables 7, 8, and 9.

Table 7: Estimates of Vector Correction Model- One month contract

Commodity	Crude Oil	Natural Gas	Gold	Nickel
Cs	-0.77072*	-1.49003*	-1.70665*	-1.10137*
$s_{,t-1}$	-0.04265	0.032577	0.228172	-0.2154
$S_{,t-2}$	-0.04796	-0.08225	-0.03294	-0.18839
$f_{,t-1}$	0.170745*	-0.76845*	-0.70411*	-0.47897*
$f_{,t-2}$	-0.00526*	-0.26785*	-0.22496*	-0.12961*
constant	-2.3218	-0.00046	-0.000005	0.008362

Source: Author Compilation, Note: * indicates rejection of null hypothesis at 5 percent.

Table 8: Estimates of Vector Correction Model - Two Month Contract

Commodity	Crude Oil	Natural Gas	Gold	Nickel
Cs	-0.98052*	-1.14382*	-1.73951*	-1.75144*
$s_{,t-1}$	-0.07245	-0.15046	0.221629	0.240022
$S_{,t-2}$	-0.04154	-0.16519	-0.03149	0.003672
$f_{,t-1}$	0.1778*	-0.50856*	-0.74357*	-0.81562*
$f_{,t-2}$	-0.0153*	-0.17103*	-0.23314*	-0.25992
constant	-2.711	0.0176	-0.00034	0.028782

Source: Author Compilation, Note: * indicates rejection of null hypothesis at 5 percent.

Table 9: Estimates of Vector Correction Model - Three Month Contract

Commodity	Crude Oil	Natural Gas	Gold	Nickel
Cs	-0.77072*	-0.164898*	-1.71334*	-1.51355*
$S_{,t-1}$	-0.04265	0.120651	0.222702	0.078529
$S_{,t-2}$	-0.04796	0.063554	-0.08265	-0.09386
$f_{,t-1}$	0.170745*	0.143312*	-0.78534*	-0.73547*
$f_{,t-2}$	-0.00526*	0.084349*	-0.23269*	-0.20762
constant	-2.3218	0.180127	0.003224	0.005095

Source: Author Compilation, Note: * indicates rejection of null hypothesis at 5 percent.

The above tables explain the co-efficient of VECM model with the Future market as dependant 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 from the table 7, 8 and 9 that the error co-efficient is negatively significant for all the Commodities across all contracts. This shows that is long term error correction flowing from the Spot market to the Futures market. This finding further substantiates our findings from the co-integration test that there must be at least one long term causal relationship in one direction. Here the long term causal relationship is flowing from the Spot markets to the Futures market.

The tables shows that S_{t-1} and S_{t-2} is not significant for any of the Commodities across all the contracts, 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 F_{t-1} is significant across all the Commodities for all the contracts which explain that Future one lag returns influence the present day Future prices. Similarly it can also be observed that F_{t-2} is significant for all the Commodities except for nickel in two month and three month contract.

The following error correction variables are explained as:

$S_{,t-1}$	: Spot one day lag
$S_{,t-2}$	: Spot two day lag
$f_{,t-1}$	: Future one day lag
$f_{,t-2}$	: Future two day lag

Table 10: Hedge ratio and hedging effectiveness – Two month contract

	Covar (Spot, Future)	Variance (Spot)	Variance (Future)	Hedge Ratio	Variance (Hedged)	Variance (Unhedged)	Hedging Effectiveness
Crude oil	0.33	2.77	1.76	0.17	2.65	2.77	0.03
Natural Gas	0.30	7.54	4.12	0.14	7.78	7.54	-0.00
Gold	0.37	0.98	1.05	0.31	0.88	0.98	0.09
Nickel	1.20	2.61	2.12	0.78	2.46	2.61	0.15

Source: Author Compilation.

In can be summarized that exist a strong unidirectional causality flowing from the Spot markets to the Future markets in the long run. However there exists 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. It can also be observed that the long run causality as captured by Crude oil contracts gets stronger in the near month and then weakens in the far away month.

The optimal hedge ratio and hedge effectiveness for all Commodities for next to near month contract are presented in table 10. Two month contracts have optimal hedge ratios in the range of 0.14 to 0.78, the lowest being of Natural gas and the highest being of Nickel. It can be observed that Natural Gas doesn't provide an optimal hedging opportunity in the short run given the volatility in global crude oil prices. Nickel however provides a hedging effectiveness of 15 percent followed by gold at 9 percent.

The optimal hedge ratio and hedge effectiveness for all Commodities for far away contract are presented in table 10 and 11. Three month contracts have an optimal hedge ratio in the range of 0.14 to 0.78, the lowest being of Natural gas and the highest being of Nickel. It can be observed that Natural Gas doesn't provide an optimal hedging opportunity in the short run given the volatility in global crude oil prices. Nickel however provides a hedging effectiveness of 14 percent followed by gold at 10 percent.

Table 10: Hedge ratio and hedging effectiveness – Three month contract

	Covariance (Spot, Future)	Variance (Spot)	Variance (Future)	Hedge Ratio	Variance (Hedged)	Variance (Unhedged)	Hedging Effectiveness
Crude oil	0.23	2.72	1.72	0.17	2.63	2.72	0.03
Natural Gas	0.30	6.75	4.02	0.14	6.85	6.75	-0.00
Gold	0.38	1.04	1.07	0.33	0.93	1.04	0.10
Nickel	1.22	2.69	2.21	0.78	2.46	2.69	0.14

Source: Author Compilation.

CONCLUSIONS

The inherent purpose of structured products aims in mitigating risk, transferring risk, efficient price discovery among others. 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 0.14 to 0.78. It was also found that crude oil could provide an efficient hedging ratio which can be attributed to the volatility in global crude oil prices. Nickel provided a hedging efficiency of 14 percent across different contracts.India has witnessed a tremendous growth path in organized Commodities market; however still a lot more needs to be done.

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