IPASJ International Journal of Management (IIJM)
A Publisher for Research Motivation........
Web Site: http://www.ipasj.org/IIJM/IIJM.htm
Email: editoriijm@ipasj.org
Volume 3, Issue 10, October 2015
ISSN 2321-645X

ESTIMATING OPTIMAL HEDGE RATIO AND TESTING HEDGING EFFICIENCY OF GOLD FUTURES

[1]Roopa Santh Lakshmi , [2]Dr. S. Kalaiselvi

[1]Ph.D Scholar in Commerce, Vellalar College for Women, Erode

[2.]Associate Professor and Head, Department of Commerce with Computer Applications
Vellalar College for Women, Erode.

ABSTRACT

The present study attempts to find whether gold futures are efficient in hedging. The study uses two static models.-OLS and VECM. It has been analyzed that gold futures were efficient in hedging gold spot. And the VECM model performed better than OLS.

Keywords : Hedge Ratio, Hedging efficiency, OLS, VECM

"Gold suffered a big jolt on Monday and plunged sharply to touch a two-year low as panic-stricken investors and speculators went on a selling spree sparked by global liquidation worries."

"The price of gold has definitively broken through what was seen as a key resistance level, setting the precious metal on a path to its first positive year-end finish in three years."

These are common headlines that create uproar among investors, jewelers and common public. The price of gold in January 2002 was Rs. 3097 per 10 grams but in December 2012 it was Rs. 31,150 per 10 grams. The gold prices during last decade have been increased by nearly 900%. The price of gold in October 2015 is Rs. 27, 18. Gold is not just a commodity but also an investment. In the above scenario it would be prudent for, jewellery shop owners, gold producers, importers, exporters and investors to use hedging to protect themselves from fluctuating gold prices.

Hedging is a risk management strategy of offsetting the probability of loss from fluctuations in the prices of commodities, currencies, or securities. Hedging employs various techniques but, basically, involves taking equal and opposite positions in two different markets (such as cash and futures markets). One of the hedging tools is futures. A futures contract is a contract between two parties where both parties agree to buy and sell a particular asset of specific quantity and at a predetermined price, at a specified date in future.

STATEMENT OF PROBLEM

There has been lots of literature in this area but empirical analyses on hedging efficiency of commodity futures have been conducted mainly for developed countries so far. Meanwhile, the relevant studies for emerging markets are significantly growing but limited. The literature in India has also concentrated more on agricultural products. So there is a need to explore other commodities like gold.

Given the soaring and volatile prices of precious metals and base metals one needs to look into efficiency of futures in managing the price risk in this area. These commodities are closely watched by countries, corporations and consumers alike. A proper hedging strategy would help the relevant parties to predict prices, manage stocks and control risk.

Past studies in India had generally been made for limited number of years. So these studies had not taken into account global economic events and cycles like recession. These structural changes have an impact on price of commodities. Though India was not very badly hit by these events, the prices of commodities were however influenced by this. The commodity prices especially the metals have strong linkage with international prices. So a proper representation of these elements needs to be included in the analysis. The literature so far has been deficient in this. So there arises a need to have a comprehensive analysis taking these structural breaks into account for a larger part of period in the area of metals. This would give a true overview of how Indian commodities futures markets have performed in the past in the area of metals.

This study is a revisit to the above debate and attempts to answer the following question.

1. Was the futures market efficient in the role of hedging price risk?

OBJECTIVES

1. To determine the optimal hedging ratio under static models.
2. To analyse the hedging efficiency of commodity futures under the above models.

REVIEW OF LITERATURE

There is no single opinion about what method yields the hedge ratio which optimally reduces the risk. According to Lien (2002) and Moosa (2003), OLS shows the best performance among the models with constant hedge ratio. On the other hand, according to Ghosh (1993), VECM (Vector Error Correction Model) is the most efficient among the models with constant hedge ratio. However, majority of papers, when it comes to hedge ratio and hedge efficiency, prefer to use bivariate GARCH (Baillie and Myers (1991), Kavussanos and Nomikos (2000), Floros and Vougas (2006)).

Brajesh Kumar, Priyanka Singh, and Ajay Pandey (2008) in their work examine hedging effectiveness of futures contracts on financial assets and commodities in the Indian markets. They show that in risk management understanding the optimal hedge ratio is crucial for devising an effective strategy. Suyash N. Bhatt (2010) investigates the hedging effectiveness of the futures market on financial assets and commodities in the Indian markets. Also, he estimates the constant hedge ratio using the Ordinary Least Squares (OLS) model, and the dynamic hedge ratio has been estimated using VAR-MGARCH model. He compares the in-sample performance of these models in reducing portfolio risk. The model providing the highest variance reduction is considered to be the most effective in hedging. Bhatt makes a conclusion that it is crucial to use the optimal amount of hedging instruments and determine the efficiency of hedging.

Benninga (1984) defines Minimum Variance Hedge Ratio as the slope coefficient in the OLS regression of changes in spot prices on changes in futures price. In other words, MVHR is the regression coefficient which gives maximum hedging effectiveness. A lot of studies focus on measuring hedging efficiency. They try to find to what extent investors are able to reduce price risk by using futures contracts. Markowitz (1959) measured hedge effectiveness as the reduction in standard deviation of portfolio returns associated with a hedge. But later Johnson (1960), Stein (1961), Working (1962) and Ederington (1979) measured hedging effectiveness as the percent reduction in variability.

METHODOLOGY

The methodology adopted in the present study was as follows

Data and Period of the Study

This study covered a period of nine years from 1st January 2006 to 31st December 2014. The present study was based on the secondary data. The required data was obtained from the website of Multi Commodity Exchange. The data was collected on weekly basis and converted into natural logs. The study is divided into two sample periods. Around 90% of the data is used for in sample period and the last 10% is used to test for out sample. The first in sample period is from 1st January 2006 to 31st June 2014. And the corresponding out of sample period is from 1st July 2014 to 31st December 2014. The second in sample period starts from 1st January 2006 to 31st June 2013 and the subsequent out of sample period is from 1st July 2013 to 31st June 2014. This is done to avoid overlapping.

The data is the near month data and next to near month data and a continuous time series is formed. A structural break is taken into consideration which is determined endogenously.

Framework of Analysis

Minimum Variance Hedge Ratio

The minimum variance hedge ratio is the most widely employed strategy to optimize hedge ratio. It is called MV hedge ratio as well, which based on minimizing the variance of the hedge portfolio. (Johnson, 1960; Ederington, 1979)

The estimation of hedge effectiveness is defined in the MV hedge ratio as following:

$$K = \frac{Var(U) - Var(H)}{Var(U)} \qquad (1)$$

Where Var(U) is the variance of unhedged portfolio and Var(H) is the variance of the hedged portfolio.

Constant Hedge Ratio Model

Suppose there is a two-period (t_1,t_2) investment decision that an investor faces and the futures contracts are the only way to hedge against risks. An investor buys a unit of the spot and short sells β units of the futures at time t_1. The payoff X at time t_2 of the hedge portfolio as following:

$$X = s - \beta f \qquad (2)$$

Where ‘s’ and ‘f’ are the prices changes between t_1 and t_2 in spot and futures markets respectively. The variance of the hedge portfolio is as following:

$$Var\ (X) = Var(s - \beta f) = Var(s) + \beta^2 Var(f) - 2\beta Cov(s, f) \qquad (3)$$

According to the first order condition, we could minimize Var(X) to obtain the optimal hedge ratio.

$$\beta = \frac{\sigma_{sf}}{\sigma_f^2} \qquad (4)$$

OLS Model

The MV hedge ratio is a slope coefficient of the OLS regression. It is the ratio of covariance of spot prices or futures prices and variance of futures prices. The R-square shows the hedging effectiveness of the model. The equation of OLS is the following:

$$R_{st} = \alpha + HR_{ft} + DU_t + DT_t + D_t + \epsilon_t \qquad (5)$$

Where, R_{st} is the return on spot and R_{ft} is the return on futures. H is the optimal hedge ratio. ϵ_t is the error term in the OLS equation. DU_t, DT_t and D_t are dummy variables for change in level, change in slope and a crash dummy respectively.

VECM Model

The Error Correction Model (VECM) considers the long-term cointegration between spot and futures prices. If the spot and futures prices are cointegrated of order one, the VECM is presented as

$$R_{st} = \alpha_s + \beta_s s_{t-1} + \gamma_f f_{t-1} + \sum_{i=2}^{k} \beta_{si} R_{st-i} + \sum_{j=2}^{l} \gamma_{fj} R_{ft-j} + DU_t + DT_t + D_t + \epsilon_{st} \qquad (6)$$

Unit Root test with a break point

Modified Augmented Dickey-Fuller Break point unit root test is applied to find stationarity and order of integration. It also endogenously finds the break date.

A unit root test tests whether a time series variable is non-stationary using an autoregressive model. A well-known **test** that is valid in large samples is the augmented Dickey–Fuller **test**. However, as Perron (1989) points out, structural change and unit roots are closely related, and so conventional unit root tests are biased toward a false unit root null when the data are trend stationary with a structural break. This research uses a modified augmented Dickey-Fuller test which allow for levels and trends that differ across a single break date.

Following Perron (1989), Perron and Vogelsang (1992a, 1992b), and Vogelsang and Perron (1998), there are four distinct specifications for the Dickey-Fuller regression which correspond to different assumptions for the trend and break behavior. This study chooses a break in intercept and trend with an innovational outliner. The model can be given as:

$$Y t = \mu + \beta t + \theta DU_t(T_b) + \gamma DT_t(T_b) + \omega D_t(T_b) + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + \mu_t \qquad (7)$$

Where the intercept dummy DU_t represents a change in the level DU_t =1 if (t >Tb) and zero otherwise; the slope dummy DT_t represents a change in the slope of the trend function; DT_t = t- Tb (or DT_t = t if t > Tb) and zero otherwise; the crash dummy (D_t) = 1 if t =Tb +1, and zero otherwise; and Tb is the break date.

Johenson Co-integration test

A linear combination of two or more non-stationary series may be stationary. If such a stationary linear combination exists, the non-stationary time series are said to be cointegrated. The stationary linear combination is called the cointegrating equation and may be interpreted as a long-run equilibrium relationship among the variables. Johenson Cointegration test is a test that uses VAR model to test long run cointegration.

For the Johenson Cointegration test with structural breaks, the study uses the methods introduced by Johansen *et al*. (2000). The practical rule would be to include in the test regression the intercept, a lagged dummy intercept, a first difference dummy intercept, the trend, and the lagged dummy times the trend.

So the following exogenous variables are used in the VAR model:

- (Linear) trend
- $DU_{t,t-k}$ (where *k*, the maximum lag length)
- Trend* $DU_{t,t-k}$
- $D_{t,t}$; $D_{t,t-1}$; ......; $D_{t,(t-(k-1)}$;

We then construct the usual Johansen trace test statistics. Johansen *et al*. (2000) calls this the $H_l(r)$ test. The asymptotic distribution of the test is different from what it would usually be for the trace test. The asymptotic critical values depend on the proportion of the way through the sample that the break occurs.

Results and Discussion

Break point Unit root test

The modified ADF test has been used which determines the break date endogenously. The break date estimated was July, 2011. From September 2010 to September 2011, gold prices jumped 50.6 percent, mainly the result of speculation surrounding an uneven recovery and volatility in the U.S. financial markets, with gold reaching an all-time high of $1,917.90 per ounce in August 2011.

The unit root test indicated that the gold spot and futures ware non-stationary in their Levels series but stationary in their First Difference. So both are integrated to the order of I(1).

Table 1: Break point Unit root test

Log Spot Level	Log Spot I Difference	Order of Integration	Log Future Level	Log Future I Difference	Order of Integration
-4.094007	-10.69934	I(1)	-4.372504	10.24767	I(1)
Non-Stationary	Stationary		Non-Stationary	Stationary	

The critical at 5% significance is (-5.155006). The ADF test uses existence of unit root as Null Hypothesis. To test the long run co-integration for Vecm model Johensons Cointegration test is applied. Since structural breaks are included we test the Cointegration using the procedure given by Johenson et al.

Table 2: Johenson Cointegration Test

No. of cointegrating equations	$H_l(r)$	10% Critical Value	5% Critical Value	Outcome
Zero	37.52332	16.61239	18.77590387	**Reject**
At Most 1	9.242299	16.61239	18.77590387	**Do Not Reject**

The $H_l(r)$ test indicates that the null hypothesis of no cointegration as the Table value is geater than the critical value. The Hypothesis of 1 cointegration relationship is accepted as the table value is less than critical value. Thus the gold spot and future are cointegrated in the long run.

Estimating Hedge Ratios and Hedging Efficiency

OLS

OLS method is employed to test the constant hedge ratio and hedging effectiveness. The hedge ratio could be obtained from the slope of the regression equation and the hedging effectiveness is given by R-square. The estimation for In Sample OLS is given in Table 5.

VECM

Long run cointegration is taken into consideration in VECM model. Errors are calculated first and then hedge ratio and hedging effectiveness is estimated. The estimation for In Sample VECM is given in Table 6.

Table 3: Comparison of Hedge ratios

Coefficients	OLS	VECM
In Sample1	0.868460	0.8914823
In Sample2	0.906779	0.9039973

From the study, it can be inferred that hedge ratio is slightly high when using VECM model. But when the sample size is decreased the hedge ratios for OLS and VECM are almost equal which is 0.90.

Hedging Effectiveness

Table 4: Comparison of Hedging effectiveness

Coefficients	OLS	VECM
In Sample1	0.743849	0.9184013
Out of Sample1	0.7124155	0.8153104
In Sample2	0.7124155	0.8551534
Out of Sample2	0.5341733	0.4823567

The hedging efficiency is high in VECM model compared to OLS as the former takes errors into consideration. When hedging efficiency is compared for two samples, the hedging efficiency decreases for the out of sample compared to the in sample under both the models. The decrease in hedging efficiency is more under VECM model. For a six month out of sample the decrease in Ols model is around 3% whereas under VECM the decrease is around 10%. For a 1 year out of sample the hedging efficiency in OLS decreases by 18% and around 37%. The estimation for out of sample OLS is given in Table 7 and for VECM in Table 8.

Table 5: Estimation for In Sample OLS

Coefficients	ample 1	Sample2
β	868460	0.906779
R^2	743849	0.763602

VECM

Table 6: Estimation of Hedging Ratio and Hedging Effectiveness for In Sample

	Sample 1	Sample2
var of s or var of U	0.0006825	0.0006497
var of f(res)	0.0007114	0.0006799
cov sf	0.0006342	0.0006146
heding ratio, h (cov sf/ var f)	0.8914823	0.9039973
var of H (var s + h^2 var f - 2h cov)	0.0000557	0.0000941
hedging efficiency (var U- var H)/ var U	0.9184013	0.8551534

Estimations for Out of Sample
OLS

Table 7: Estimation of Hedging Rtaio and Hedging Effectiveness for Out of Sample

	ample 1	Sample2
var of s or var of U	0.0003162	0.0005966
var of f(res)	0.0003610	0.0009165
cov sf	0.0002864	0.0005913

heding ratio, h (cov sf/ var f)	0.86846	0.9067790
var of H (var s + h^2 var f - 2h cov)	0.0000909	0.0002779
hedging efficiency (var U- var H)/ var U	0.7124155	0.5341733

VECM

Table 8: Estimation of Hedging Rtaio and Hedging Effectiveness for Out of Sample

	Sample 1	**Sample2**
var of s or var of U	0.0005138	0.0006123
var of f(res)	0.0005659	0.0006145
cov sf	0.0004872	0.0004411
heding ratio, h (cov sf/ var f)	0.8914823	0.9039973
var of H (var s + h^2 var f - 2h cov)	0.0000949	0.0003169
hedging efficiency (var U- var H)/ var U	0.8153104	0.4823567

Conclusion

This study is an attempt to find out whether the futures market is efficient in hedging gold prices. The study also considers structural breaks into consideration. The study has used two static models. It has been found that the futures were efficient in hedging gold. The VECM model is more efficient compared to an OLS model in Hedging. The hedging efficiency for out of sample decreases compared to the in sample and the decrease is high when the out of sample size increases.

The study could be further analysed by including transaction costs and also could be researched on the relationship between Indian and other International Markets.

References

[1]. Bertus, M. and Stanhouse, B. (2001). Rational speculative bubbles in the gold futures market: An application of dynamic factor analysis. Journal of Futures Markets, 21(1), pp. 79-108.

[2]. Bhatt, Dr. Suyash N. (2010). Hedging Effectiveness of Constant and Time-Varying Hedge Ratio in Indian Stock & Commodities Future Market. K.J. Somaiya Institute of Management Studies and Research.

[3]. Bose, S. (2007). Understanding the Volatility Characteristics and Transmission Effects in the Indian Stock Index and Index Futures Market. Money and Finance, ICRA Bulletin, 139-162.

[4]. Brajesh Kumar, Priyanka Singh, Ajay Pandey. (2008). Hedging Effectiveness of Constant and Time-Varying Hedge Ratio in Indian Stock and Commodity Futures Markets. IIM Ahmedabad.

[5]. Casillo, A. (2004). Model specification for the estimation of the optimal hedge ratio with stock index futures: an application to the Italian derivatives market. In: Pro. "Derivatives and Financial Stability" October 25, Rome, Italy.

[6]. Chen, S. S., Lee, C. F., Shrestha, K. (2001). On a mean-generalized semi variance approach to determining the hedge ratio. Journal of Futures Markets, 21, 581–598.

[7]. Choudhry, T. (2004). The hedging effectiveness of constant and time-varying hedge ratios using three Pacific Basin stock futures. International Review of Economics and Finance, 13, 371–385.

[8]. Giles(2011). Cointegration at the Hips. Available at http://davegiles.blogspot.in/2011/05/cointegrated-at-hips.html

[9]. Joyeux, R. (2007). How to deal with structural breaks in practical cointegration analysis? In B. B. Rao (ed.), Cointegration for the Applied Economist, ***Second Edition***, Palgrave Macmillan, New York, 195-221.

[10]. Pavlov and Yang(2011). Hedging with gold futures: Evidence from China and India. Lund University.

[11]. Perron, P. and T. J. Vogelsang (1993). The great crash, the oil price shock and the unit root hypothesis: erratum. *Econometrica* 61, 248-249.