EXTREME RISK, VALUE AT RISK AND EXPECTED SHORTFALL IN THE GOLD MARKET

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ABSTRACT

The present study made an attempt to investigate the gold price and extreme movement's theory of the gold market. The study applied extreme value theory to the gold indices, to quantify the risk over the study period from 1.4.2010 to 31.3.2015. The data of the study is based on daily gold returns of indices. The test for Stationary, Dickey Fuller Test indicated that the returns series were Stationary. GPD was found to be an appropriate model to describe the conditional excess distributions of a heteroskedastic gold log return series and provides adequate estimations for VaR and ES. Volatility of the gold market in selected indices was measured by using GRACH (1, 1) model and data Q-Q plots of the gold returns series confirmed non normality of data. The test of (EVT) Extreme Value Theory, one of the powerful statistics tools, which was used to capture the risk measure like VaR and ES, computed for gold returns. The overall results of the market efficiency and value at risk indentified the extreme loss or profit during the study period. The test of (EVT) Extreme Value Theory, one of the powerful statistics tools, which was used to capture the risk measure like VaR and ES, computed for gold returns. The study has implications for the investors, in evaluating the risk of investment.

INTRODUCTION

In earlier period, the development of the financial system in India; people who wanted to trade generally gathered on the streets which were popularly known as the dalal street where transaction took place. It was in year 1875 that the first stock exchange was formulated in the name of “the native share and stock brokers' association ‟”which is presently known as the **“Bombay stock exchange”**. It was in the year 1908 that the stock exchange in Calcutta was formulated under the ruler “the Calcutta stock exchange association”. In 1920 the madras stock exchange was started, with around 100 brokers. Gradually the commodities like Oil, Gold, Silver etc were traded in the stock market.

The Indian stock exchange is an organized market place, either corporation or mutual organization, where the members of the organization gather to trade the stocks or other securities. The member may act, either as agent for their customers or as principal for their own accounts. The trade on exchange is executed only by members and the stock brokers do not have role in the exchange.

Gold

Gold, as a financial indicator, is one of the most important commodities in the world and it is largely held by central banks. Central banks must maintain a proportion of their foreign exchange reserves in gold, as a store of value and as an assurance to redeem promises to pay depositors, note holders, or trading peers, or to secure a currency. Gold is also used by jewelers and investors as a hedging instrument. When currencies devaluate, investors move to the gold market and when currencies revaluate investors move away from the gold market. Gold has an influence on other precious metals. it states: "Among the major precious metal class, an increase in the gold price seem to lead to parallel movements in the prices of the other precious metals which are also considered investment assets as well as industrial commodities". The statement suggests that a model adequately explaining the gold prices could also contributes to models used in predicting the prices of other precious metals. Hence, many economists consider gold as a leading indicator in the precious metal pack.

RISK MEASURES

The amount of asset risk capital, reserved by financial institutes as per Basel accords, is directly associated to the portfolio risk level and two of the most common benchmark measure for evaluating such risk are VaR and ES. VaR is intended to assess the maximum possible loss of a portfolio over a given time period, and its calculations focus on the tails of a distribution, whereas ES evaluates the expected value of losses (or gains) that exceed a corresponding VaR level. Hence, the accuracies of VaR and ES estimation are dependent on how well a selected model portrays the extreme data observations.

VaR

Value at Risk (VaR) is a widely used metric for the measurement of market risk, measuring potential losses over a specified period at a specified confidence level. A key criticism of VaR is that it says nothing of the risks beyond the threshold measurement. In addition, VaR has been found to be a non-coherent measure, having undesirable mathematical characteristics such lack of sub additively.

REVIEW OF LITERATURE

Gençay and Selçuk (2004) in their paper entitled "Extreme value theory and Value-at-Risk: Relative performance in emerging markets" investigate the extreme value theory to generate VAR estimates and study the tail forecasts of daily returns for stress testing. Based on those applications of extreme value theory, it is the appropriate model that matches the purpose of this study best. This paper focuses on risk evaluation of gold price return and the tail distribution of extreme events in

gold price returns (in US dollars).

Knowledge Chinhamu et al. (2015**)**, in this paper entitled, "Extreme risk, value-at-risk and expected shortfall in the gold market". Proposed to use Generalized Pareto Distribution (GPD) model, to analyze the extreme returns in the gold market. This method provided the effective means of estimating tail risk measures, such as value at risk and expected shortfall. The study results found that GPD model was an appropriate model to describe the conditional excess distribution of heteroskedasticty gold log returns series and provide adequate estimation for VaR and ES.

The project entitled, "gold price returns using extreme value theory based decision on belief function theory**"** by Paponpat Taveapiradeechareo et al (2014). Studied the extreme value forecasting method, to predict the maximum returns of gold price. The data were used for predicting the time series data, during the study period from 2010-2015. The study based on the extreme value theory that is, EVT GEV based and EVT GPD, revealed that all the gold price under study received positive returns.

"Risk analysis for three pernicious metals: an application of extreme value theory", by qinlu chen and David E.gils (2014), analyzed the risk of investment in gold silver and platinum by employing extreme value theory to study historical daily data for changes in the price. The study estimated these measures by fitting the GPD, using the peak over threshold method and found the extreme daily price changes, according to the results of robustness, the sliver was the most risky metal among the three considered.

A study on, **"modeling conditional Heteroscedasticity in gold price returns using the generalized pareto distribution"**, by Caston Sigauke et al (2014), used model of heteroscedastic gold returns of all index. The results showed that the participants in the gold market can rely on EVT- based model such as GPD modeling. The study concluded and support that the combination of the GARCH model, with extreme value theory, was the best model to fit and estimated the upper extreme quartiles.

STATEMENT OF THE PROBLEM

The case of extreme large gold prices and declared a good fit with the generalized Pareto distribution (GPD). To determined the type of asymptotic distribution for modeling the extreme changes in US treasury yields. The best of our knowledge, there are limited discussions on the application of EVT to the gold market, which represents a crucial commodity to the world economy. Large losses are the main concern in the field of financial risk management. The study aims to see if the difference between extreme positive and negative relations of the returns distribution, could statistically demonstrate through the fat tails, that is, the extreme in the gold price. Hence the present study is an attempt to measure the risk of gold price, using the EVT.

NEED OF THE STUDY

This method provides effective means of estimating tail risk measures such as Value-at-Risk (VaR)

and Expected Shortfall (ES). This is confirmed by various back testing procedures. In particular, we utilize the Kupiec unconditional coverage test and the Christoffersen conditional coverage test for VaR back testing, while the Bootstrap test is used for ES back testing. The results indicate that GPD is superior to the traditional Gaussian and Students t models for VaR and ES estimations.

OBJECTIVES OF THE STUDY

The study is based on the following objectives. They are

1. To describe the Stationarity in the daily gold index movements of gold price during the period.
2. To analyze the normality between the daily gold index movements during the study period.
3. To identify the GRACH model of the daily gold index movements during the study period.
4. To estimate the value at risk in the daily gold index movements during the study period.

HYPOTHESIS OF THE STUDY

1. **H01**: There is no Stationarity in the daily gold price return movements of gold market

2. **H02**: There is no normality in the daily gold price return movements of gold market

3. **H03**: There is no descriptive statistics in the daily gold price return movements of gold market

4. **H04**: There is no value at risk in the daily gold price return movements of gold market

5. **H05**: There is no expected shortfall in the daily gold price return movements of market.

6. **H06**: There is no GRACH (1, 1) model in the daily gold price return movements of gold market

METHODOLOGY OF THE STUDY

Sample Selection

The study investigates the Extreme risk, value at risk and expected shortfall in the gold market with reference to daily gold price return value. A model adequately explaining the gold prices could also contributes to models used in predicting the prices.

Period of the Study

The daily gold price of sample for the study. It is proposed from 1-April-2010-31-March-2015 depends on the availability.

Source and Collection of the Data

The study mainly depends upon secondary data. The data related to the daily gold price will be collected from the www.rbi.org.in.

Statistical Tools

1. Augmented Dickey Fuller Test
2. Descriptive Statistics
3. GARCH (1, 1) MODEL
4. GEV (generalized extreme value distribution)
5. VaR (Value at Risk)

RESULTS AND INTERPRETATION

Table-1: Results of descriptive statistics for daily gold return of the study period from 2010 to 2015

Particulars	Gold return value
Minimum	-4.7008
Maximum	2.4810
Mean	-.999828
Std. Deviation	1.2267143
Skewness	-.176
Kurtosis	1.332

Source: Data collected from www.rbi.org.in and computed using SPSS.

Table- 1 exhibits the results of descriptive statistics for daily gold returns during the study period which includes the minimum, maximum, mean, std. deviation, Skewness and kurtosis from 01.01.2010 to 31.12.2015. The minimum returns were - 4.7008 for gold return and maximum returns were at 2.4810 for gold return of BSE. The mean returns of daily gold return -999828. The std. deviation which measures the variance of the gold index return was found to be 1.2267143 witnessed more fluctuation than daily gold price return. With respect to the data distribution Negative Skewness was noticed in gold return where as gold return showed positive kurtosis which measures the Peak of data distribution was found to be Leptokurtic (kurtosis >3).

Table 2: Result of Augmented Dickey Fuller Test the Statistics for Daily Index Return Of gold During the Study Period From 01.01.2010 to 31.12.2015

Dependent	Variable:			
RETURN VALUE		Index	Level difference	
			ADF	
			t-Statistic	Prob.*
01.01.2010 to 31.12.15		Daily gold return	-15.91482	0.0000
Test critical values:		1% level	-3.434677	
		5% level	-2.863338	
		10% level	-2.567776	

Source: Data collected from www.rbi.org.in and Computed Used E views.

Table- 2 The results of Stationarity test using ADF daily gold price index return is tabulated in table 4. It is to be noted that the ADF (Augmented Dickey Fuller Test) - statistic value, ignoring the sign for gold return was 15.91482 and which is greater than the test critical values at 1% 5% 10%. Further the probability value was found to be less than 0.05 for both daily gold return values. This result clearly indicates the rejection of null hypothesis $NH0_1$ "there is no Stationarity in the daily gold returns on of sample expected gold risk and return" is rejected.

Table -3: Result of GRACH (1, 1) model the statistics for daily gold return from the period of 01.01.2010 to 31.12.2015

		Std.	z-	
Variable	Coefficient	Error	Statistic	Prob.
C	-1.10662	0.037841	-29.2437	0
	Variance Equation			
C	1.326659	0.088885	14.92563	0
RESID(-1)^2	0.328058	0.043942	7.465628	0
GARCH(-1)	-0.28157	0.047206	-5.96462	0
		Mean	dependent	
R-squared	-0.00749	VaR		-1.00051
Adjusted		S.D.	dependent	
R-squared	-0.00749	VaR		1.226855
S.E. of		Akaike	info	
regression	1.231439	criterion		3.06409
Sum				
squared				
Resid	2209.455	Schwarz criterion		3.078588
Log		Hannan-Quinn		
likelihood	-2229.72	criter.		3.069499
Durbin-				
Watson				
Stat	2.893531			

Source: Data collected from www.rbi.org.in and computed SPSS

Table- 3 the results of GRACH (1, 1) model, for measuring the volatility of gold market, during the study period 1april 2010 to 31st march 2015, are represented in table 4.1. The sum of coefficient values of RESID 0.328058 and GRACH 0.28157 was 0.609628, which was closer to value one. The probability value was also less than the significant level at one percent, 5 percent and ten percent level. This result indicates that high volatility was persistent in gold market daily returns, during the study period from 1april 2005 to 31st march 2015.

Hence the null hypothesis, „there is no significant volatility of daily index returns of gold market during the study period. Was rejected. The results suggest more volatility of gold market and the investor faced the risk factor.

Table-4: Result of normality test statistics for daily gold return for the period of 01.01.2010 to 31.12.2015 - Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Data	.179	1458	.000	.892	1458	.000

Source: Data collected from www.rbi.org.in and computed SPSS.

Table-4 the results of the normality test, by using Kolmogorov – Smirnov (k-s) and Shapiro–Wilks test for gold price daily returns, during the study period 01 April 2010 to 31 march 2015, are presented in the table 7. The results of significant value of both Kolmogorov –Smirnov and Shapiro-Wilks tests were .000.

This significant value was less than the critical value at 5 percent level. The results of k-s test indicated that the gold market daily returns were Stationarity and distributed during the study period. Hence the null hypothesis, „the gold market daily returns are not normally distributed during the study period, was rejected.

Figure -1.1 Results of Q-Q plots of graphical technique

Q-Q plots are a graphical technique which is used to find out if data set comes from the population, with similar distribution. Figure 1.1 exhibits the Q-Q plot, for gold market daily returns, during the study period. It reveals straight line to a normal distribution.

Some plots departed from the reference line but majority of plots are on the reference line. This signifies that the data distribution corresponded to normal distribution.

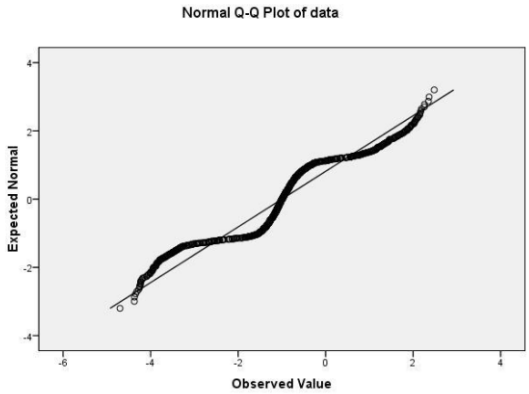

Figure-1.2 Q-Q Results of Graphical Technique

Q-Q plots, for gold market daily return, during the study period 1st April 2010 to 31st April 2015, are depicted in figure 1.2. it is to be noted that the straight line of the returns is the reference line to a normal distribution. It can be inferred that the empirical line departed from the reference line only to both the ends and his indicated a distribution of data to be parallel to the normal distribution. Hence, it can be stated that the gold market return were normally distributed during the study period.

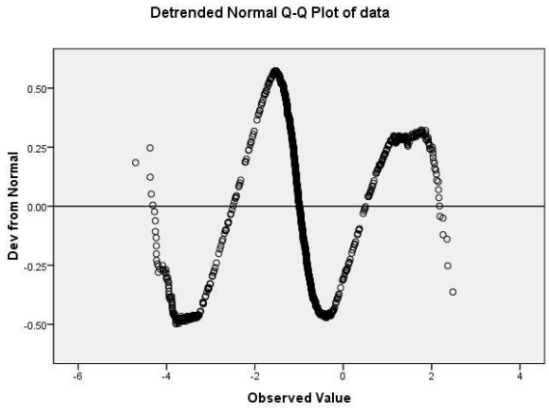

Table- 5: Result of value at risk the statistics for daily gold return from the period of 01.01.2010 to 31.12.2015

Period	Var. Ratio	Std. Error	z-Statistic	Probability
11	0.221742	0.188279	-4.133530	0.0000
Test Details (Mean = 0.0925925925926)				
Period	Variance	Var. Ratio	Obs.	
1	0.08560	--	54	
11	0.01898	0.22174	50	

Source: Data collected from www.rbi.org.in and computed E views.

Table-5 the values of VaR for gold market, at various confidence levels are presented in the table 1.5. It is to be noted that right tail indicates maximum profit earned by the investor and similarly, left tail depicts maximum possible losses during the study period. These results indicate that for the investor, the maximum possible profit from the gold price return. These results clearly indicate that through the VaR and expected shortfall, negative value was high. The investor could earn maximum profit on their investment.

Table- 6: Result of correlation statistics for daily gold return for the period of 01.01.2010 to 31.12.2015

Correlations	Variable 1	Variable 2
Gold price	1	-.366**
Return value	-.366**	1

Source: Data collected from www.rbi.org.in and computed E views.

Table-6 presents the results of correlation function, for daily returns of gold price during the study period 1st April 2010 to 31st march 2015. The table records positive values and negative values. The first lag started with positive returns but immediately the next lag changed into negative returns. The negative returns at 0.001 level significance. From the analysis, it is clear that the gold return did not attain continuous similar sign returns. The overall analysis of daily index returns of gold price was dependent on the each other and the gold price had its impact on the return value. The results of correlation identified short memory and value at risk during future years. The results suggested the presence of correlation modeling of GARH model. Hence the null hypothesis, "there is no correlation in selected indices daily gold returns during the study period" was rejected.

Table- 7: Result of regression statistics for daily gold return for the period of 01.01.2010 to 31-12-2015

Model Summary

			Adjusted R	Std. Error of the
Model	R	R Square	Square	Estimate
1	.366[a]	.	.	
		.134	.134	1.477465

Source: Data collected from www.rbi.org.in and computed SPSS.

Table-7 Shows the results of the model summary. According to the table „R " indicates the correlation and 36.6 percent of relationship was noticed between gold price and return value. The results of R square value additionally indicated that 13.4 percent of variation in daily gold price. The standard estimate value at 1.47745, closer that two and it indicated the absence of correlation. It is proved that the specified model was fit.

Table -8: Result of regression statistics for daily gold return for the period of 01.01.2010 to 31.12.2015

ANOVA

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	4.926E12	1	4.926E12	225.664	.000[a]
Residual	3.178E13	1456	2.183E10		
Total	3.671E13	1457			

Source: Data collected from www.rbi.org.in and computed SPSS.

Table- 8 shows the results of ANOVA. It was found that the „P " value was less than 0.05, which indicated that the results were statistically significant. Hence the NH2a, there is no impact of daily gold price and return value of the study during period, from 01.01.2010-31.12.2015, was rejected

Table- 9: Result of regression statistics for daily gold return for the period of 01.01.2010 to 31.12.2015

		Unstandardized Coefficients		Coefficients Beta	t	Sig.
		B	Std. Error			
1	Constant	118992.231	4993.565		23.829	.000
	VAR00002	-47394.040	3154.948	-.366	-15.022	.000

Source: Data collected from www.rbi.org.in and computed SPSS.

The co-efficient results of **Table-9** indicated that daily gold price and return value were statistically significant and these variables could explain more about the gold price. The other variables, namely, growth and opportunity, did not contribute that much towards of daily price. The positive value indicated in the maximum return and negative value indicated in the minimum risk of the gold price.

CONCLUSION

From the above analysis we can conclude that the sample indices gold witnessed high mean returns at -.999828, during the study period. The standard deviation, which is considered a measure of volatility, was high for daily gold return, at 1.2267143, during the study period. The skewness and kurtosis test indicated that the sample indices of gold were normally distributed during the study period. Q-Q plot graphical techniques, used for identifying data distribution, correspond to normal distribution of the standardized residuals and they showed that the series was not normal. The augmented Dicky Fuller test indicate that all the selected sample indices of gold attained Stationarity, at the level difference, as the value of t statistics of both the tests, were less than the test critical value, during the study period. The result of Stationarity, for all sample indices, evidence the existence of short term memory, over previous day gold price, on the next day price movements. There were no stable movements, in the gold price of sample indices and majority of

lags witnessed a mix of positive and negative values. The variance equation of GRACH (1, 1) model revealed that the selected sample indices of gold were highly volatile as the sum of GRACH values closer to one during the study period. The results clearly indicated that the time series of the selected sample indices was none linearly dependent, which was one of the indications of gold price. All the secondary analysis revealed that the selected data were fitted to apply the (EVT) Extreme value theory. The investor of gold price, earned a maximum profit at 2.4810 and minimum loss at -4.7008, which was the extreme movement for gold price, during the study period. The extreme movements for gold price were 0.221742 for positive and -4.133530 for negative returns during the study period. From the whole sample, the gold realized maximum profit and minimum loss, with minimum risk, during the study period.

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