RESEARCH PAPER

A STUDY ON VOLATILITY OF SELECTED BASE METALS TRADED IN MULTI-COMMODITY EXCHANGE (MCX)

S. Rajesha[1], Dr. M. Sethuraman[2]

[1]Ph.D. Research Scholar (Part Time), PG and Research Department of Commerce, Annaivallankani Arts and Science College, Thanjavur-613003

Email: sri_reji2006@yahoo.co.in

Affiliated to Bharathidasan University, Tiruchirappalli-02, Tamil Nadu.

[2]Assistant Professor & Research Advisor, PG and Research Department of Commerce, Annaivallankani Arts and Science College, Thanjavur-613003

Email: sethuraman205@gmail.com

Affiliated to Bharathidasan University, Tiruchirappalli-02, Tamil Nadu.

ABSTRACT

The present study aims to conduct an analysis of the volatility structure in the base metal and the precious metal gold in Multi Commodity Exchange. The study mainly focus on the volatility of the base metal and gold which results more risk to the investor as compared to other commodities. This paper also examines whether the GARCH model is fit to test the volatility for both the metals. From the analysis through the descriptive statistics it is proven that there is a volatility between this metal, it showed that the first order autocorrelation for Aluminium, Copper, Lead and Nickel is in negative value and it was gradually increase to positive value after 20 lags for Aluminium and Nickel. It is clear from the results that all commodities were perfectly autocorrelated. So it is verified that all the sample base metals and gold are highly volatile during the study period. This study also examined the fitness of GARCH models to the data through the analysis part of likelihood ratio testing. The GARCH model selection was carried out using the Akaike's Information Criterion, Schwarz criterion and Log likelihood ratio is used. The Akaike Info Criterion (AIC) tool is the one having the lowest value in this analysis, the ARCH model value is one which is having the lowest AIC value compared to the other value which indicate that it is the best tool to analysis volatility.

Keywords: Commodity Market, Base metal, Volatility, AutoCorrelated, GARCH.

How to cite this article: Rajesha S, Sethuraman M. A Study on Volatility of Selected Base Metals Traded in Multi-Commodity Exchange (MCX). Int J Drug Deliv Technol. 2026;16(54s): 973-980. DOI: 10.25258/ijddt.16.54s.85

Source of support: Nil.

Conflict of interest: None.

INTRODUCTION

Commodity market is an important constituent of the financial markets of any country. It is the market where a wide range of products, viz., precious metals, base metals, crude oil, energy and soft commodities like palm oil, coffee etc. are traded. It is important to develop a vibrant, active and liquid commodity market.. In India MCX, NCDEX and NMCEIL are the three national level commodity exchanges and others 20 Regional Exchanges among that NCDEX is the biggest one. In National Commodity Derivatives Exchange (NCDEX) the precious metals which deal with gold, silver &platinum. Gold and silver markets evolved in classical civilizations. In MCX four commodities are traded which are bullion, base metal, Energy and Agriculture. Pricing in commodities futures has been less volatile compared with equity and bonds, thus providing an efficient portfolio diversification option. This would help investors hedge their commodity risk, take speculative positions in commodities and exploit arbitrage opportunities in the market

REVIEW OF LITERATURE

In this study 'Application of GARCH Models in forecasting the volatility of Agricultural Commodities' by Tony Guida, (2010) was tells about the different possible sources of forecasting improvement, using various statistical distributions and models. The implied goal of the study is to find out if the GARCH models are more fitted for stock indices than for precious commodities. This study reveals that base metals commodities time series could not be used with the same methodology than the financial series.

According to Guillermo Benavides, (2014) in his paper 'Price volatility forecasts for agricultural commodities: An Application of Historical volatility models, option implied and Composite Approaches for futures prices of Corn and Wheat' examined the volatility accuracy of volatility forecast models for the case of corn and wheat futures price returns. The models applied here are a univariate GARCH, a multivariate ARCH, an option implied and a composite forecast model. The study concluded that the option model was superior to the historical models in terms of accuracy and that the composite forecast model was the most accurate one having the lowest mean square errors.

OBJECTIVES OF THE STUDY

The present study is carried out with the following objectives,

1.To test the volatility structure of various base metal and Gold

2.To examine that the GARCH model are an effective tool to test the volatility in the various base metal.

3.To give suggestion to the commodity market investors and traders

HYPOTHESIS OF THE STUDY

The present study tested the following two hypotheses,

H_o: There is no constant volatility between the commodities .

H_o: There is no significant effect on Using GARCH model in Commodity market.

METHODOLOGY

1. Sample Design

   In MCX there are six metals which are regularly traded. For the purpose of the study the base metal which are Aluminum, copper, Nickel, Lead and precious metal gold is chosen, this metals are regularly traded in MCX. This metals are selected because of regularly traded and which have a high volume of trading.

2. Period of the Study

   This study measured the volatility structure of base metals and gold for the period of three years. The spot data which is used from MCX for the period, from January 2020 to December 2023.

MCX SPOTDATA			
Basemetals	FROM		Location
Aluminium Copper Lead Nickel Gold	1JAN2020 1JAN,2020 1JAN,2020 1JAN,2020 1JAN,2020	31DEC2023 31DEC2023 31DEC2003 31DEC2023 31DEC2023 31DEC2023	MUMBAI&THANE& AHMEDABAD(GOLD)

TOOLS USED FOR ANALYSIS

1. **GARCH**

   GARCH stands for generalized autoregressive conditional heteroskedasticity GARCH models are conditionally heteroskedasticity but have a constant unconditional variance. The GARCH (1, 1) model can be generalized to a GARCH (p, q) model; that is, a model with additional lag terms. Such higher order models are often useful when a long span of data is used, like several decades of daily data or a year of hourly data.

$$\sigma_t^2 = k + \sum_{i=1}^{p} G_i \sigma_{t-i}^2 + \sum_{j=1}^{q} A_j \varepsilon_{t-j}^2$$

2. **Akaike's information criterion:**

   Akaike's information criterion, developed by Hirotsugu Akaike under the name of "an information criterion" (AIC) in 1971 and proposed in Akaike (1974).It is a measure of the goodness of fit of an estimated statistical model. The AIC is not a test on the model in the sense of hypothesis testing rather it is a tool for model selection .Given a data set; several competing models may be ranked according to their AIC, with the one having the lowest AIC being the best.

3. **Schwarz Criterion:**

   Schwarz Criterion is like Akaike's information criterion, Schwarz Criterion penalizes for the number of predictors in the model and the smallest Schwarz Criterion is best one for the data

4. **Augmented Dickey-Fuller test**

   Augmented Dickey-Fuller test (ADF) is a test for a unit root in a time series sample. It is an augmented version of the Dickey-Fuller test for a larger and more complicated set of time series models. The augmented Dickey-Fuller (ADF) statistic, used in the test, is a negative number. The more negative it is, the stronger the rejection of the hypothesis that there is a unit roots at some level of confidence. The testing procedure for the ADF test is the same as for the Dickey-Fuller test but it is applied to the model

Where,

α is a constant,

β the coefficient on a time trend and

p the lag order of the autoregressive process.

Imposing the constraints α = 0 and β = 0 corresponds to modeling a random walk and using the constraint β = 0 corresponds to modeling a random walk with a drift.

5. **Likelihood ratio Ratio :**

Likelihood ratio often denoted by Λ (the capital Greek letter lambda), is the ratio of the maximum probability of a result under two different hypotheses. A likelihood-ratio test is a statistical test for making a decision between two hypotheses based on the value of this ratio.A statistical model is often a parameterized family of probability density functions or probability mass functions fθ(x).The likelihood function is L(θ) = L(θ | x) = p(x | θ) = fθ(x) is a function of the parameter θ with x held fixed at the value that was actually observed, i.e., the data.Many common test statistics such as the Z-test, the F-test, Pearson's chi-square test and the G-test can be phrased as log-likelihood ratios.

Auto correlation

It is the same as calculating the correlation between two different time series, except that the same time series is used twice - once in its original form and once lagged one or more time periods.

$$R(k) = \frac{\sum[(X_t - \mu)(X_{t+k} - \mu)]}{\sigma^2}$$

Where k is the lag, it is common practice in many disciplines to drop the normalization by σ2. The autocorrelation can be quantified by providing qualitative checks for correlation using formal hypothesis lists, Such as the Ljung – Box –Piece Q-test Ljung – Box –Piece Q squared test and Engle's ARCH test.

VOLATILITY TEST ON BASE METALS BASED ON AUTOCORRELATION AND DESCRIPTIVE STATISTICS

Volatility is a statistical measure of the dispersion of returns for a given security or market index. In all most all cases, the higher the volatility, the riskier the security. Volatility is often measured from either the standard deviation or variance between returns from that same security or market index. It represents how large an asset's prices swing around the mean price,it is a statistical measure of its dispersion of returns. There are several ways to measure volatility, including beta coefficients, option pricing models, and standard deviations of returns. The most common terms are Absolute Volatility and Relative Volatility. Absolute Volatility can be calculated using different time scales. The time scale can be intraday, inter day, range etc. In intraday volatility, the degree of fluctuation between the days's low and high is calculated, and

in inter-day volatility, difference between the closing prices of consecutive days is calculated. Relative volatility measures the volatility on relative basis. Co-efficient of variation is the common measure of relative volatility. Volatile assets are often considered riskier than less volatile assets because the price is expected to be less predictable. Implied volatility measures how volatile the market will be while historical volatility measures price changes over predetermined periods of time

I. GENERAL DESCRIPTIVE STATISTICS

The descriptive statistics analysis gives a summary of security returns when performing empirical and analytical analysis, it also provides a historical account of return behavior. Although past information is useful in any analysis, one should always consider the expectations of future events. Following tables displays some descriptive statistics about the different commodities.

Summary Statistics

Table 1.1 shows the statistics summary of base metals in that skewness and kurtosis are clearly observed in the futures contract for four base metals in MCX for the period of JAN 2020-DEC 2023during this day which is confirmation that fast related to extreme values with high frequencies data. All the kurtosis less than 3, which is the normal value; it implies a flatter distribution also called platykurtic and the negative skewness indicating a relatively long left tail compared to the right implies a left-skewed distribution. But the Nickel futures market had a positive skewness (0.6131) mean that the right tails is particularly extreme. The Nickel futures market seemed to be the most volatile on the considered period regarding standard deviation (5734.25), maximum and minimum values. On the other hand, the Aluminum seemed to be the less volatile (11.817) compared to the other commodities. From the below summary statistics of base metal it is clear that compared to other commodities Aluminum is a less volatile metal.

Table 1.1 Descriptive Statistics for base metal in Multi Commodity Exchange

Commodities	Aluminium	Copper	Nickel	Lead
Mean	104.943	250.730	1077.60	139.836
Maximum	152.4	396.4	2180.4	204.92
Minimum	86.3	118.35	495	90.6

Standard Deviation	11.817	78.463	573.25	25.639
Skewness	-0.009	-0.235	0.6131	-0.182
Kurtosis	-0.101	-1.265	-0.5776	-0.071

Source:-www.mcxindia.com

Descriptive Statistics for Gold Spot Data

The descriptive statistics of the gold return spot data is shown in Table1. 2, by the help of these statistics, The mean returns are almost identical for these series, and it is close to zero (0.000682).It can be seen that the kurtosis exceeds 3 (5.638977) which is the normal value it provides a evidence for peaked distribution, in which it takes into account excess kurtosis (fat tail behavior) and volatility clustering and in the Skewness (-0.660140) the distribution is left skewed; the left tail is longer then the mass of the distribution and it is concentrated on the right of the figure, which means the return data is not normal. In the case of standard deviation, the high value is 0.011253 while the minimum value 0.066586 and the maximum values are 0. 034939.These reflect that the higher standard deviation, maximum and minimum values are used to measure the volatility of the market.

Table 1.2 Descriptive Statistics for Gold in Multi Commodity Exchange

Observations	1020
Mean	0.000682
Median	0.001054
Maximum	0.034939
Minimum	-0.066586
Std.Dev.	0.011253
Skewness	-0.660140
Kurtosis	5.638977
Jarque-Bera	370.0618
Probability	0.000000

II. AUTOCORRELATION FOR MCX BASE METAL

Tables: 1.3 showed the result of autocorrelation for commodity futures prices of all base metal sample commodities in the MCX. In this the current error term may not only contain information from its own period but may be affected with information from previous time periods. In this case, the error term are said to be correlated in some way i.e. autocorrelation. It should always be tested when working with time-series data. It also explains the autocorrelation of sample commodities in MCX. It showed that the first order autocorrelation is respectively 0.062, -0.121, -0.052 and 0.093 for Aluminum, Copper, Nickel, and Lead. It was gradually increase to 0.011 and 0.008 after 20 lags for Copper and Nickel. They gradually decline to -0.063 and 0.086 after 20 lags for Aluminum and Lead. It is clear from the table that all commodities were perfectly autocorrelated.

It means that all commodities obtained heteroskedasticity. It is understood that all the sample base metals observed the high volatility during the study period.

Table 1.3 Autocorrelation Statistic in Base Metals Multi Commodity Exchange

Lag	Aluminium	Copper	Nickel	Lead
1	.062	-.121	-.052	.093
2	.053	.014	-.053	-.068
3	-.101	-.014	.016	.025
4	.039	-.040	.065	.091
5	.001	.033	.005	-.080
6	-.100	.006	.008	-.063
7	-.086	.038	-.047	-.020
8	-.031	-.006	.022	.004
9	.064	.005	.060	-.056
10	.049	.007	-.039	.060
11	.044	.112	-.051	-.003
12	-.042	-.009	-.001	.017
13	.043	.011	-.010	-.025
14	-.004	-.008	.065	-.012
15	.072	.000	-.037	-.008
16	.020	.012	-.020	-.055
17	.051	.021	.015	-.007
18	-.030	.000	-.042	.028
19	.018	.052	-.039	-.016
20	-.063	.011	.008	.086

Source:-www.mcxindia.com

CHART 1.1 - ALUMINIUM

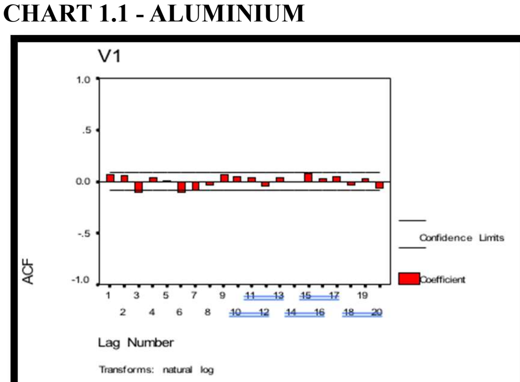
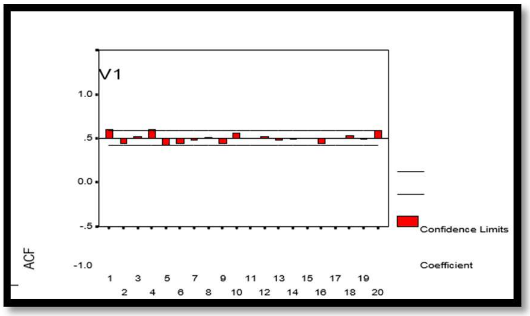


CHART 1.2 – Lead



From the above charts of base metal Aluminium and Lead shows that there is less volatile in the market during the study period Jan 2020-Dec 2023.s

HYPOTHESES

From the above test (Descriptive Statistics, and Autocorrelation) it is found that there is heteroskedasticity in the sample commodities. Thus, the null hypothesis 1, namely, “There is no heteroskedasticity in the sample commodities” is rejected.

VOLATILITY TESTED BY USING GARCH MODEL UNIT ROOT TEST:

Empirical tests assume the variable i.e. return series in this data are stationery. So, this study conduct test for the stationery of the log future series. For this analysis the return series are expected to be stationery. To test futures for a unit root test, the augmented Dickey fuller test is made.

A. ADF Test for Aluminium

Table 2.1 gives that the empirical results from Augmented Dickey-Fuller test (ADF) for Aluminium. It presents if the data is stationary where a value smaller than the critical value. The statistic value for ADF test is 5.770743. The test suggests significant result at 1% level (-2.368962) when time series was included. The ADF test proves that the series are stationary. The critical values include three levels respectively level 1%, 5% (-1.941371) and 10% (-1.516332). The stationary confirmed in the level 1% itself therefore no further progress is necessary.

Table 2.1 ADF Test for Aluminium

		t-statistic	**Probability**
AugmentedDickey-Fullerteststatistic		-5.770743	0.0000
Testcriticalvalues:	**1% level**	-2.368962	
	5% level	-1.941371	
	10% level	-1.516332	

Source:-www.mcxindia.com

B) ADF Test for Copper

Table 2.2 From these analytical results from Augmented Dickey-Fuller test (ADF) for copper. The statistic value for ADF test is -6.355896. The test produced significant result at 1% level (-2.667531) when time series was included. It is proved from the below table the T-value was far exceed than the statistical value thus it proves that the sample data lies on a stationary. The test critical values include three levels respectively level 1%, 5% (-1.941175) and 10% (1.516463). When the time series get no autocorrelation, it indicates that there is stationery in time series.

Table2.2 ADF Test for Copper

		t-statistic	**Probability**
AugmentedDickey-Fullerteststatistic		-6.355896	0.0000
Testcriticalvalues:	**1% level**	-2.667531	
	5% level	-1.941175	
	10% level	-1.516463	

Source:-www.mcxindia.com

C) Augmented-Dickey Filler Test for Nickel

Table 2.3suggests that the empirical results from Augmented Dickey-Fuller test (ADF) for Nickel. The statistic value for ADF test is -20.81064. from the analysis of significant result at 1% level (-2.567666) it is clear the time trend was included. From the and their significant level ADF test provides evidence that the series are stationary. The test critical values include three levels respectively level 1%, 5% (-1.941193) and 10% (-1.616450). The stationary is confirmed in the level 1% itself therefore no further progress is necessary

Table2.3 ADF TestforNickel

		t-statistic	**Probability**
AugmentedDickey-Fullerteststatistic		-20.81064	0.0000
Testcriticalvalues:	**1% level**	-2.567666	
	5% level	-1.941193	
	10% level	-1.616450	

Source:-www.mcxindia.com

D). ADF Test for Lead

Table 2.4 examines that the empirical results from Augmented Dickey-Fuller test (ADF) for Lead. The statistic T- value of ADF test is -10.45049. The test produced significant result at 1% level (- 2.569308) when time trend was included. It is cleared that statistics T-value if far exceed than the critical value .It is proved that the sample data has a stationary. The test critical values include three levels respectively level 1%, 5% (-1.941418) and 10% (-1.616300). The stationary is confirmed in the level 1% and hence it is confirmed in this stage itself.

Table 2.4 ADF Test for Lead

		t-statistic	Probability
AugmentedDickey-Fullerteststatistic		-10.45049	0.0000
Testcriticalvalues:	**1% level**	-2.569308	
	5% level	-1.941418	
	10% level	-1.616300	

Source:-www.mcxindia.com

I. (ii) TESTING PRICE VOLATILITY IN ALL BASE METALS USING GARCH MODEL – MCX

This section examines the price volatility by using two models such as ARCH and GARCH used in this study. Forecasts performance could be evaluated using the coefficient given by the forecasts output.

TESTING PRICE VOLATILITY IN BASE METALS USING GARCH

Table 3.1. Price Volatility in Base Metals Using GARCH – MCX

	Aluminium	Copper	Nickel	Lead
C	0.501260	0.492558	0.482864	0.499198
ARCH	-0.008715	-0.016768	-0.016909	-0.010704
GARCH	0.513422	0.533338	0.523179	0.523660

Source:-www.mcxindia.com

Table 3.2 TESTING PRICE VOLATILTY IN GOLD USING GARCH MODEL GARCH (1, 1) model

Variable	Co-efficient	Standarderror
C	0.489031	1.275410
RESID(-1)^2	-0.008505	0.029838
GARCH(-1)	0.519943	1.271485

R-squared	0.490599	**Akaikeinfo criterion**	2.842121
AdjustedR-squared	0.483923	**Schwarzcriterion**	2.861445
DurbinWatson stat	2.000445	**Z-Statistic**	1.786735
S.Ddependent variable	0.011938	**Probability**	0.0740

From the above table the overall analysis of gold data fitness of Garch is tested. The basic GARCH (1, 1) results are given in Table – 3.2. The three coefficients in the variance equation are listed as C, the intercept; ARCH (1), the first lag of the squared return; and GARCH (1), the first lag of the conditional variance. The R-squared denotes the regression coefficient of dependent variable with independent variable .The adjusted R-squared (0.533106) and the R-squared (0.523105) value show that there is a linear relation between the two and the value is close to 1.This value clearly indicates that the yesterday's price has influenced the today's price.

TESTING OF HYPOTHESIS:

From the above analysis of both base metal and precious metal Gold GARCH volatility test is conducted. Hence it is proved that ARCH model is fit to test the volatility of the precious and base metal during the study period of 2020 to 2023. From this analysis it is clear from the table value, the critical value is comparatively low in Aluminum and other base metal. Hence it is proved thus the null hypothesis is rejected.

Findings of the study:

- From the study of descriptive statistics of all base metal it is clear during the study period, the Nickel is having more volatile. It shows a positive skewness and high standard deviation. On the other hand, the Aluminum seemed to be the less volatile (11.817) compared to the other commodities. it is clear that compared to all another commodities Aluminum and lead is less volatile.
- From this study, It is clear that in the gold Spot market, the value of Akaike Info criterion value is Rs.2.842054 which is less than the Schwarz criterion value (Rs2.861377) this indicate that the yesterday's price has influenced the today's share price. The R-squared value (0.533106) and the adjusted R-squared value (0.523105) has a positive correlation

towards the gold price. The standard error value (1.271485) which is also less than the statistical value (1.815932) it indicates that there is volatility in the gold spot market.

- The results of the statistical verification of the GARCH models indicate that the ARCH components of the variance are statistically significant. The ARCH model value which is significant to the gold spot data in garch model.

Suggestions of the Study:

The following are the important suggestions of the study:

- It is recommended that the investors who want to take moderate risk they may invest in the less volatile commodity.
- The Speculative type of investors should invest in the gold spot market. They can earn high return when the market is more volatile.
- It is suggested that the investors who want to measure the accurate volatility of the gold market, the ARCH model which is the best one to measure the gold spot market data.

CONCLUSION:

This study investigated the empirical relation between base metal and gold in MCX. The GARCH results suggest that there is a variation across the gold spot market. The result which shows that the spot market is having a more volatility than the other base metal. Regarding the Base metal according to the descriptive analysis though there is a volatility in all the base metal. The aluminum and Nickel is having less volatile compared to other base metal. This study also examined the goodness of fit of GARCH models to the data. The GARCH model selection was carried out using the adjusted R square, Durbin Watson, it is concluded that the best model for gold spot ARCH model which is having the lowest Akaike's information criterion and Schwarz criterion value. Like that to test the base metal volatility ARCH model is fit to test the data during the study period.

References

1. Edel tully and Brain M Lucey (January 2020).”Seasonality, Risk and Return in Daily COMEX Gold” and IIIS Discussion Paper No. 57
2. W.kramer and G.trenkler (2003)”Modellierung von kapitalmarketrendienmittelsasymmetrischer GARCH-model” and journal of financial Economics 31, 281-318.
3. Ali M. Kutan* and Tansu Aksoy(2020) “Public Information Arrival and Gold Market Returns in Emerging Markets Evidence from the Istanbul Gold Exchange” and Scientific Journal of Administrative Development” volume 2 I.A.D 2004
4. Hany A Shawky,Acila Marathe and Christopher L Barrett “A First look at the Empirical relationship between spot and future electricity prices in the United States” The Journal of Futures Markets, Vol. 23, No. 10, 931–955 (2003)
5. Dr. Coskun Kucukozmen (February 2019)” comparison of conditional variance models for gold returns: an application to us dollar, Japanese yen and South African rand" The Financial Review, 2.6, 367-386
6. Chirstos Floros and V.Vogas “Trading Volume and Return Relationship in Greek Stock Index Future Market: GARCH vs. GMM” International Research Journal of finance and Economics-Issue 12 (2007)
7. Huu N. Duong and Petko S. Kalev “An Intraday Analysis of the Samuelson Hypothesis for Commodity Futures Contracts” International Economic Review 39(4), 885-905.
8. Jeff Fleming, Chris Kirby and Barbara Ostdiek “The Economic Value of Volatility Timing Using “Realized” Volatility” Accounting and Finance Research 12,2001
9. Rainer Frey(2005) “Exchange Rate Volatility and International Trade – Some GARCH Estimations Stress the Importance of Trade Diversification” International Economic Journal, Vol. 12, No. 3, autumn 1998, p. 31 – 40
10. Ruey S. Tsay “Multivariate volatility models” Institute of Mathematical Statistics, 2006 Vol. 52 (2006) 210–222
11. Kon s.Lai and yin Wong chenug”Lag order and Critical values of the Augmented Dickey Fuller Test” Journal of business and economics statistics, July 1995, volume 13.no.3
12. Pierre Giot1 and Sebastian Laurent (November 2002)” Market Risk in Commodity Markets: a Var Approach” Journal of Econometrics, 31, 307–327.
13. Nash, Y Chen a, Ray Y Chou b,, Nathan Liu c and Gang Shyy (December 31,2006) “Estimating Time-Varying Hedge Ratios with A Range-Based Multivariate Volatility Model” Institute of Finance, volume 31,234- 312
14. Tony Guida and Olivier Matringe (September 2004)”Application of GARCH models in forecasting the volatility of Agricultural Commodities “Journal of applied econometrics

WEB SITES:

- www.kitco.com
- www.fxstreet.com
- www.dailyfx.com

- www.bulliondesk.com
- www.litwick.com
- www.yahoofinance.com
- www.gold.org
- www.ncdex.com
- www.commodity.com
- www.kerford.org