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Research Article

Time Series Analysis And Forecasting With ARIMA Model-Gold Derivatives At MCX

Preeti Garg[1*], Dr. Rashmi Sharma[2]

[1*]Research Scholar, JECRC University, Jaipur, Rajasthan, India, preetigarg1106@gmail.com
[2]Associate Professor, Jaipur School of Business, JECRC University, Jaipur, Rajasthan, India, rashmi.sharma@jecrcu.edu.in

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ABSTRACT

Gold futures and options trading have emerged as a recent trend in the Indian financial market. The Securities and Exchange Board of India (SEBI) granted permission for commodity options trading in March 2017, and subsequently, the first gold options were introduced on October 17, 2017. In contrast, gold futures trading was initiated in 2003. Despite this development, there is a scarcity of research on commodity derivatives in India, with the existing studies primarily focusing on aspects such as the impact of derivatives on implied volatility, price discovery, hedging effectiveness, and concerns associated with derivatives trading.

This research paper aims to address this gap by analysing the trading volumes of gold options and gold futures from October 2017 to September 2022, utilizing data obtained from the Multi Commodity Exchange (MCX) website. Statistical techniques were employed to analyse the collected data, and the significance of the results was assessed through an ANOVA test. Also, in this paper ARIMA model is used for time series analysis and prediction of trading volumes. The analysis showed that the trading volumes data is seasonal so we used simple season model ARIMA (1,1,1) (1,1,1).

The findings of this analysis reveal that the trading volume of gold futures is considerably higher than that of gold options. This disparity can be attributed to the limited popularity of gold options among investors. It is apparent that investors possess inadequate knowledge regarding the specifications of options contracts and trading strategies involving options and futures.

Keywords—*ARIMA Model, Gold Futures, Trading Volumes, Gold Options, MCX.*

INTRODUCTION

The introduction of new economic policies in 1991 and the process of globalization have led to heightened price volatility in the gold market, consequently increasing the risk associated with purchasing gold. To mitigate this increased volatility, various derivative instruments have been introduced in India. Gold futures were initially launched in 2003, serving as a means of hedging against price fluctuations. However, it was only on March 26, 2017, that the Securities and Exchange Board of India (SEBI) authorized the trading of options. Notably, on the auspicious occasion of "Dhanteras" on October 17, 2017, the Finance Minister officially inaugurated option contracts specifically for gold.

The main purpose of introducing gold options & futures is to hedge the risk associated with gold price changes. In India, where demand for gold is high, derivative instruments like gold options & futures are needed to protect various stakeholders like mining companies, market intermediaries, merchandisers, jewellers and designers, importers, exporters, bullion traders, jewellery traders and customers from the price risks.

REVIEW OF LITERATURE

In a study conducted by Singhal Shelly in 2017[1], the role of commodity derivatives as a defensive instrument in hedging portfolio risk was analysed. The study also investigated whether commodity derivatives offered diversification benefits similar to those observed in developed commodity markets worldwide. Monthly returns

of various indices, including Sensex, Bond, MCX Comdex, MCX Energy, MCX Metal, and MCX AGRI, were collected for data analysis spanning the period from 2006 to 2013.The findings of the study indicated that bonds presented the lowest risk and return combination among the analysed assets. The risk associated with commodity indices was higher compared to the Sensex, India's stock market index. However, the returns from all commodity indices, except for MCX Metal, were lower than the Sensex. MCX Metal exhibited the highest risk and return among the analysed commodities. The study revealed that due to a low degree of positive correlation, commodity futures provided diversification benefits when combined with equity and bonds within a portfolio. Based on the results, the optimal combination ratio for the portfolio was determined to be 65% Sensex and 35% commodity for COMDEX and MCX Metal. For MCX Energy, the ratio was 3:1 for Sensex, while for MCX AGRI, the ratio was 7:3, respectively.

In 2018, Minakshi Bindal[2] carried out a comprehensive examination of the derivative market in India, focusing on the period from 2010 to 2018. The study employed empirical analysis and relied on secondary data to investigate the current state of financial derivatives in the country. The findings of the study led to the conclusion that the introduction of equity derivatives in the Indian market has been highly encouraging and successful. As a result of continuous innovation and effective risk management practices, financial derivatives have gained substantial prominence among various financial instruments.

In 2019, Surendren[3] conducted a study examining the determinants of commodity product prices in the MCX derivative market. The research revealed that commodity prices are influenced by a multitude of factors, including demand and supply dynamics, taxes, regulations, global commodity market trends, climate change, inflation, and currency exchange rates. Furthermore, the study demonstrated that engaging in trading within the commodity market offers the potential for significant profits while also carrying lower levels of risk.

In 2019, Dr. Sreesha and Ayisha K.[4] conducted a study exploring the expansion of financial derivatives within the National Stock Exchange of India. The research employed a descriptive research design, utilizing secondary data for analysis. The study encompassed the period from 2001 to 2018 for stock derivatives, 2008 to 2018 for currency futures, and 2010 to 2018 for currency options. The findings of the study indicated that derivative contracts within the NSE have shown significant growth over time. However, this growth was observed to be inconsistent rather than continuous.

In 2020, Prabhdeep Kaur and Jaspal Singh[5] conducted a study focusing on the comparative effectiveness of gold Exchange Traded Funds (ETFs) in relation to spot gold and gold futures within the Indian context. The research utilized a combination of conventional and threshold cointegration statistics to analyse the data. The findings of the study indicate that gold ETFs and spot gold, as well as gold ETFs and gold futures, exhibit convergence over the long term. Additionally, it was observed that movements in spot prices and futures prices precede changes in ETF prices. This finding suggests the potential for implementing profitable trading strategies involving ETFs. Furthermore, the study delves into exploring potential reasons behind the observed relative inefficiency in ETF prices.

In 2021, Soniya Garg[6] conducted an observation regarding the significance of gold as a prominent investment avenue among investors. The study highlighted that investor behaviour varies based on their individual needs, return expectations, and perceived benefits associated with different investment options. Each investment avenue comes with its own set of advantages and disadvantages. Gold, as an investment option, possesses distinct benefits that make it highly appealing. Traditionally, it has held significant value and served as a means of financial security. In the Indian context, gold is commonly purchased in the form of jewellery during festivals and weddings. However, contemporary investment options for gold have expanded beyond jewellery, now including alternatives such as gold bars, Gold Exchange-Traded Funds (ETFs), and Sovereign Gold Bonds (SGBs). This study aims to explore the various factors that influence investor behaviour towards gold investments through factor analysis.

OBJECTIVES OF STUDY

The objectives of doing this research are as follows:

(1)To calculate the total traded volumes of gold futures and gold options at MCX from October 2017 to September 2022.

(2)Time series analysis of total traded volumes of gold futures and gold options at MCX using ARIMA model.

(3)To predict the total traded volumes of gold futures and gold options at MCX from October 2022 to September 2023.

(4)To compare total traded volumes of gold futures and options at MCX using ANOVA test.

HYPOTHESIS FOR STUDY

H0: There is no significant difference in the Trading Volume of Gold Options & Gold Futures on MCX.
H1: There is a significant difference in the Trading Volume of Gold Options & Gold Futures on MCX.

RESEARCH METHODOLOGY

This research utilizes a combination of descriptive and analytical methods. The study adopts a time frame approach, focusing on the trading volumes of gold options and gold futures from October 2017 to September 2022. The data for this period is collected from the MCX website. Statistical techniques are employed to compare and analyse the trading volumes of gold options and futures. To assess the significance of the results, an ANOVA test is conducted. Time series Analysis Forecasting method ARIMA has been adopted for this study to project the future values of selected study variables.

GOLD FUTURES

When the nationalized commodity exchanges, like MCX and NCDEX came into existence in 2003, initially futures trading in Gold was allowed.[7] Over the years, there has been significant changes in the contract specifications. Currently, four variants of gold futures; namely, Gold 1 Kg (also called gold regular), Gold Mini (100 Gms), Gold Guinea (8 Gms) and Gold Petal (1 Gm) are available for trading at MCX.

As given in Table 1, quotation base for Gold 1Kg as well as GoldM 100 Gms is same 10 Gms. Expiry date is the 5th day of expiring month for Gold and GoldM whereas for Gold Guinea and Gold Petal, it is the last day of Calendar month.

Table 1: Specifications of different Gold Futures Contracts

Particular	Gold	Gold Mini	Gold Guinea	Gold Petal
Contract Size	1 Kg	100 grams	8 grams	1 gram
Quotation base	10 grams	10 grams	8 grams	1 gram
Expiry date	5th Day of Expiring Month	5th Day of Expiring Month	Last Day of Calendar Month	Last Day of Calendar Month
Tick Size (Minimum Price Movement)	Rs.1 / 10 grams	Rs.1 / 10 grams	Rs.1 / 8 grams	Rs.1 / 1 gram
Profit/loss per INR	100	10	1	1
Initial margin	Minimum 6 % or based on SPAN whichever is higher			
Extreme Loss Margin	Minimum 1 %			

GOLD OPTIONS

After taking over control of commodity market regulation from erstwhile *Forward Markets Commission* (FMC) on 28 September 2015, the *Securities and Exchange Board of India* strengthened the commodity market ecosystem by introducing series of measuresby including Options on commodity futures. In a first step, the Options on commodity futures in gold was allowed by the regulator and accordingly, the first Options contract on gold futures was launched on 17th October 2017. Table 3 gives glimpse of Options contract.

Table 2: Specification of Gold Options Contracts

Parameters	Description
UNDERLYING	MCX Gold Futures (1 Kg) Contract
Expiry Day (Last Trading Day)	8 business days prior to expiry of underlying
Underlying Quotation / Base Value	Rs. / 10 grams
Strike Price Intervals	Rs. 100
Tick Size (Minimum Price Movement)	Rs. 0.50
Daily Price Limit	The upper & lower price band shall be determined based on statistical method using *Black and Sholes Options pricing model* and relaxed considering the movement in the underlying futures contract.
Settlement	On expiry of an Options contract, the open position shall devolve into underlying futures position as follows: -
	• Long call position shall devolve into long position in the underlying futures contract
	• Long put position shall devolve into short position in the underlying futures contract
	• Short call position shall devolve into short position in the underlying futures contract
	• Short put position shall devolve into long position in the underlying futures contract

Gold options are options contracts that utilize either physical gold or gold futuresas their underlying instrument. **Call options** on gold give the contract holder the *rightto buy* the metal at a pre-set price before it expires, and **put options** the *right to sell*.

Gold options in India are European style options where the buyer can exercise the right solely on the specific date that is the date on which the option contract expires.

TIME SERIES ANALYSIS AND PREDICTIONS USING ARIMA

Trend and prediction of time series can be computed by using ARIMA model. ARIMA (p, d, q) model is a complex linear model. There are three parts: AR (Autoregressive) – linear combination of the influence of previous values; I (Integrative) – random walk; MA (Moving average) – linear combination of previous errors. These models are very flexible, quite hard for computing and for the understanding of the results. They demand quality and a large number of dealing dates (60 observations used in this study).

In ARIMA models, we assume dependence between the quantities y_{t-2}, y_{t-1}, y_t, y_{t+1}, y_{t+2}, ... If this process contains the seasonal fluctuation, as it is in this model, we can expect also the dependence seasons: y_{t-2s}, y_{t-s}, y_{ts}, y_{t+s}, y_{t+2s}..., where s is the length of the period (in this case 12).

This process is called SARIMA (p, d, q) (P, D, Q) s, where

p is order of process AR,
q is the order of process MA,
d is the order of difference,
P is order of seasonal process AR,
Q is the order of seasonal process MA,
D is order of seasonal difference,
s is the length of seasonal period.

Table 3: Observed and Predicted Trading Volumes of Gold futures and Gold options

Month	Observed Trading volume (in lacs) FUTCOM	Observed Trading volume (in lacs) OPTFUT	Predicted Trading volume (in lacs) FUTCOM	Predicted Trading volume (in lacs) OPTFUT
Oct-17	4696781	329759.4	-	-
Nov-17	5655808	286577.1	-	-
Dec-17	4166956	127547.5	-	-
Jan-18	5542897	170458.5	-	-
Feb-18	5950792	50657.14	-	-
Mar-18	6670034	70392.82	-	-
Apr-18	6620953	264042.4	-	-
May-18	7391188	1485921	-	-
Jun-18	5381739	1091762	-	-
Jul-18	5556186	1540513	-	-
Aug-18	5459885	672312.9	-	-
Sep-18	7670406	4260022	-	-
Oct-18	7715335	1055559	-	-
Nov-18	6589625	416428.5	9526279.5	1024295.6
Dec-18	7154408	458609.6	5393200.1	539011.85
Jan-19	9267884	444406.3	9062975.6	590454.52
Feb-19	8108647	404147.9	9740986	440461.04
Mar-19	10293460	757961.8	9581519.8	472820.81
Apr-19	7384888	266014.8	10164233	760278.35
May-19	9903169	856618.6	9131140.7	1847350.6
Jun-19	11494994	688462.1	7261945.2	1272561.5
Jul-19	17862663	1335036	10261514	1693838
Aug-19	17332386	1091285	14012301	820016.61
Sep-19	17691564	1541171	21097600	4483801.9
Oct-19	13519445	745193.3	17783193	357606.72
Nov-19	13087478	928090.2	14582004	340275.64
Dec-19	11258922	498288.2	12152912	453265.56
Jan-20	17332542	1777074	15203247	445403.59
Feb-20	16136024	1339977	16134426	681845.12
Mar-20	24630219	3355078	18779086	921175.47
Apr-20	9183002	468082.3	18794260	1207128.3
May-20	16943614	1226934	13535175	1742699.6
Jun-20	18660640	818122.7	15148534	1426672.1
Jul-20	23365614	1413130	21624364	1934798.5
Aug-20	25792958	1719448	21453894	1378853.1
Sep-20	20254345	2110641	28337663	3454351.6
Oct-20	15705520	535403.3	19063802	1290217.6
Nov-20	18468995	1988182	16553439	1086602.1
Dec-20	15238186	1061728	15782280	1127488.9
Jan-21	15589282	2079430	20666077	1751064.7
Feb-21	15026799	828479.7	15945606	1563102.7
Mar-21	13728228	1254732	19830111	2717392.4

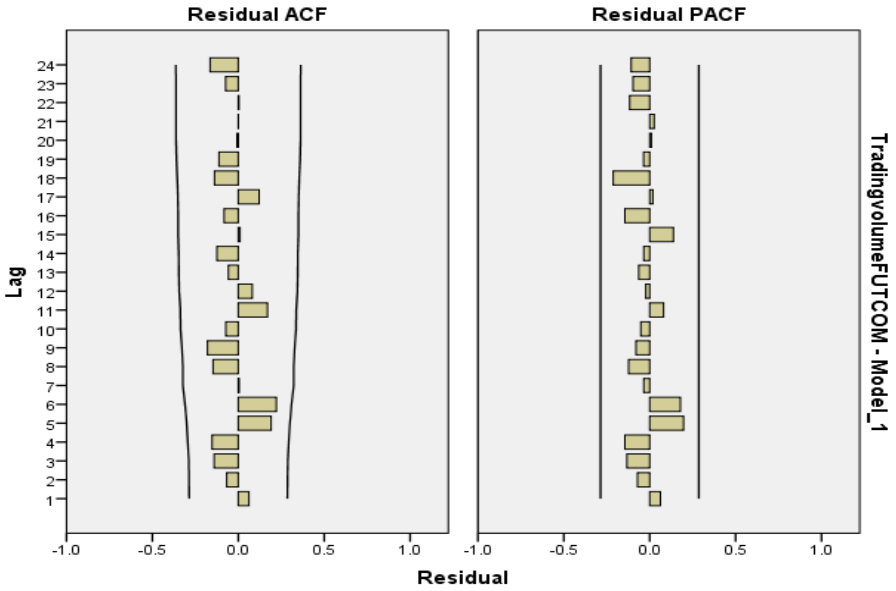
Apr-21	10257462	741685.8	9964352	732690.59
May-21	12103667	1616689	14399632	1548102.6
Jun-21	10415771	818628.6	12290637	1302127.2
Jul-21	10965459	1790035	13821648	1870222.2
Aug-21	9208527	1059079	11963431	2011289.2
Sep-21	10321306	2434266	10542502	2156662.3
Oct-21	9384724	1316427	8838470.7	1204302.3
Nov-21	10653909	2668542	9317861.1	2145377
Dec-21	7464731	962507.2	8547358.4	1497936.7
Jan-22	7783331	1710487	9570702	2585202
Feb-22	9034000	1430582	7748190	1619232.4
Mar-22	14396768	5561488	10154176	2920589.2
Apr-22	8089339	1431989	8159759.8	1640945.6
May-22	9945502	3629402	10159669	2210475.3
Jun-22	9301832	1178099	9067420.6	1780722.6
Jul-22	9893524	3215768	10759370	2373730.8
Aug-22	8245161	1478438	9509250.9	2309244
Sep-22	11332403	3934817	8857946.6	3081661.2
Oct-22	-	-	8776690.3	1911748.4
Nov-22	-	-	8626458.2	3308553
Dec-22	-	-	6797135.2	1940381.3
Jan-23	-	-	7952310.6	2805986.9
Feb-23	-	-	7467364	2067579.5
Mar-23	-	-	8857296.3	4459796.7
Apr-23	-	-	5423460	2104888.1
May-23	-	-	6805588.1	3727700.3
Jun-23	-	-	6098943.5	2020334.4
Jul-23	-	-	6822724.8	3613217.1
Aug-23	-	-	6103810.1	2292705.3
Sep-23	-	-	6417106.8	4325324.4

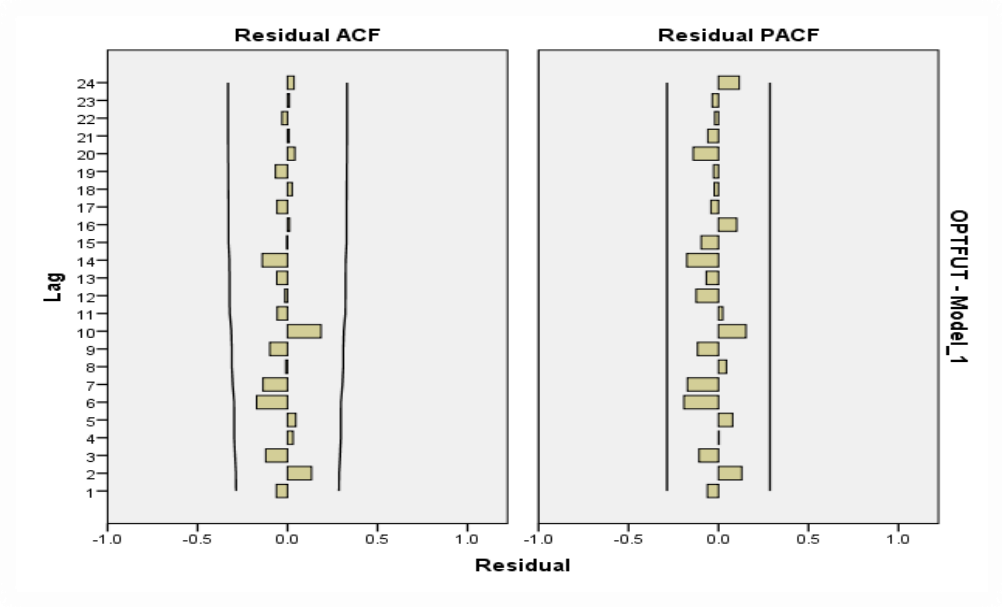
Source: Computed

The above table shows the trading volumes of gold futures and gold options from October 2017 to September 2023. We used ARIMA model in SPSS software to forecast and analyze the study variables. The test statistics of ARIMA Model (1,1,1) (1,1,1) as generated with SPSS software are as follows:

Model Statistics

Model	Number of Predictors	Model Fit statistics		Ljung-Box Q (18)			Number of Outliers
		Stationary R-squared	R-squared	Statistics	DF	Sig.	
FUTCOM-Model_1	0	0.3	0.502	17.77	14	0.217	0
OPTFUT-Model_1	0	0.48	0.2	9.676	14	0.785	0





The test result shows the R^2 value for the Futures trading volume 0.502 and for Options trading volume 0.200. It shows that stronger correlation is present among trading volumes of gold futures contracts in comparison to gold options contracts. The model statistics shows the Ljung-Box Q value of 0.217 & 0.785, these are >0.05 so we can conclude that the model is a good fit for this data. The number of outlires is zero for both the variables. The Auto-correlation and Partial Auto-correlation charts shows the seasonal effect on the trading volumes. The following figures shows the predicted and observed trading volumes of Gold Futures and Gold Options contracts from Oct 2017 to Sep 2023.

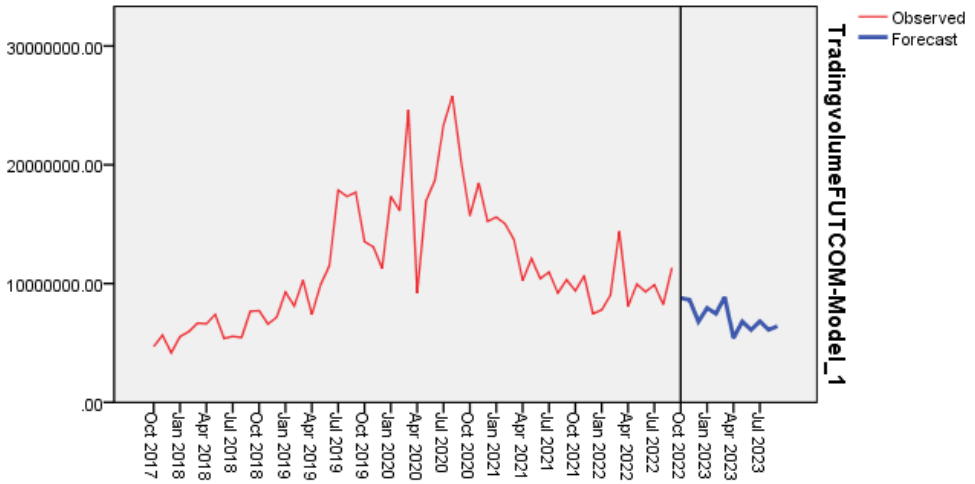


Figure 1: Observed and Predicted trading Volume of Gold Futures at MCX

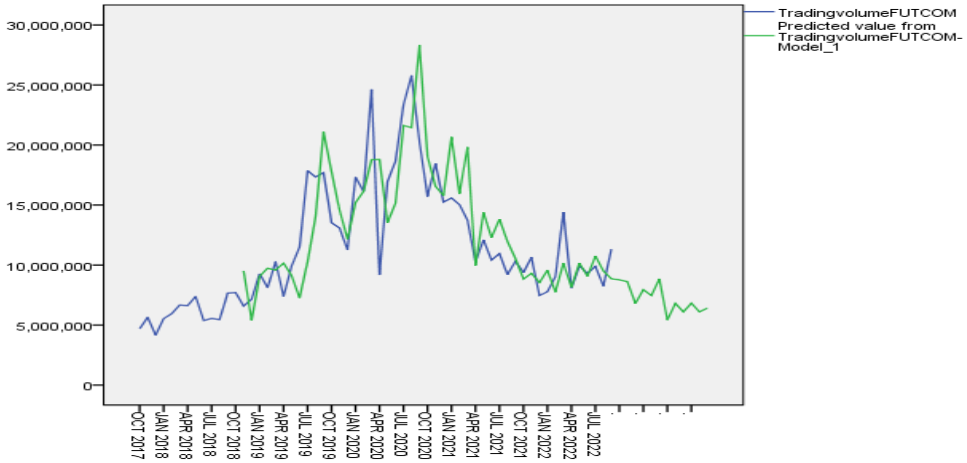


Figure 2: Observed and Predicted trading Volume of Gold Futures at MCX

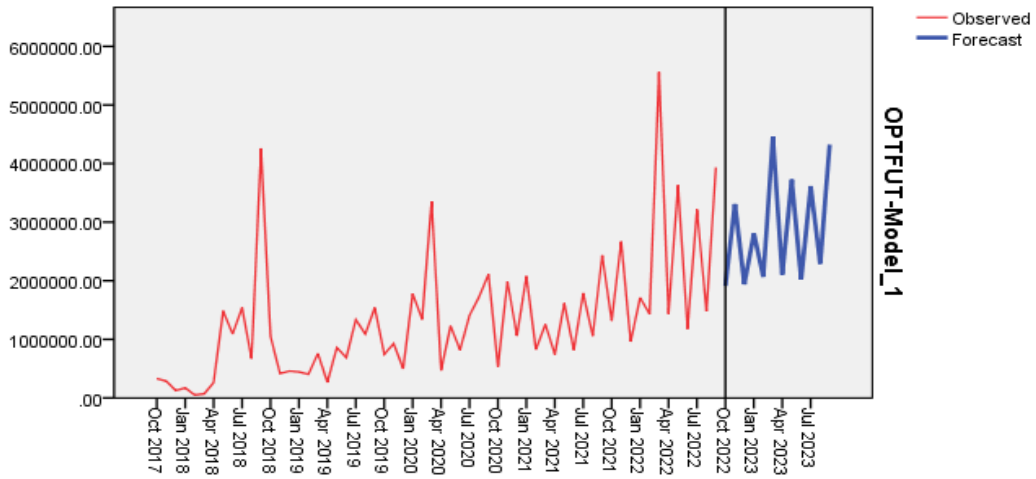


Figure 3: Observed and Predicted trading Volume of Gold Options at MCX

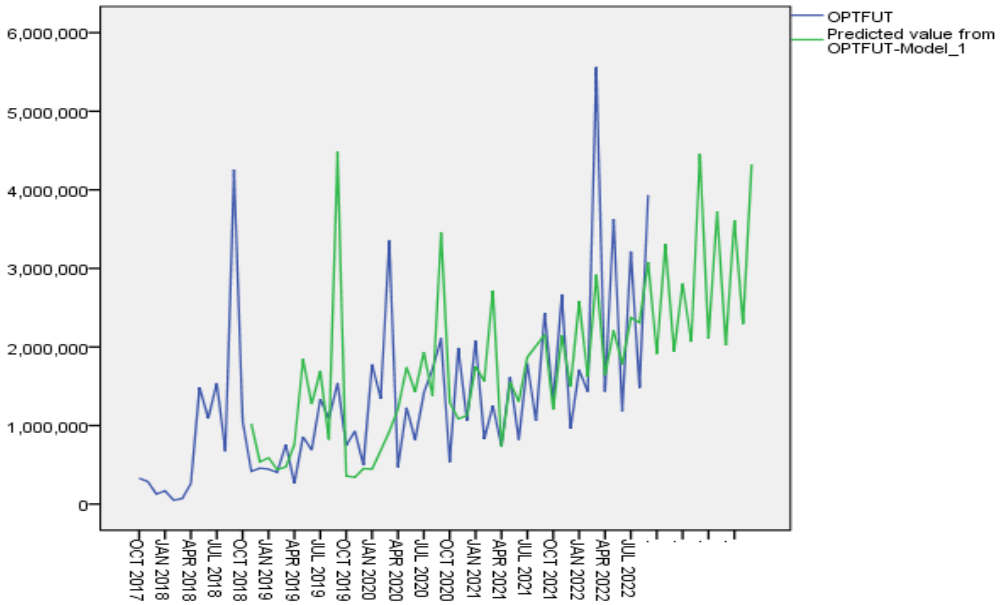


Figure 4: Observed and Predicted trading Volume of Gold Options at MCX

COMPARISON OF GOLD FUTURES AND OPTIONS

Trading volume of all four Gold Futures categories has been compared with trading volume of all Gold Options categoriesat MCX for the period of 5 years from October 2017 to September 2022.

Fig. 5: All Contracts' trading volume of Gold Futures at MCX

Fig. 5 showing trend of overall trading volume of Gold Futures (inlots) at MCX during the period under study. Initially in October 2017, trading volume was **4,09,263 lots (lowest)** which showed small variations and fluctuations until December 2019 when volume was slightly higher at 7,72,386 lots. Then, it increased gradually with fluctuations and reached up to **42,32,995 lots (highest)** in August 2020, after that decreased sharply and came down to 20,03,691 lots within two months in October 2020, then it increased steadily and reached to 27,77,175 lots in February 2021 but after that, declined gradually and finally, came down to 14,63,851 lots in September 2022.

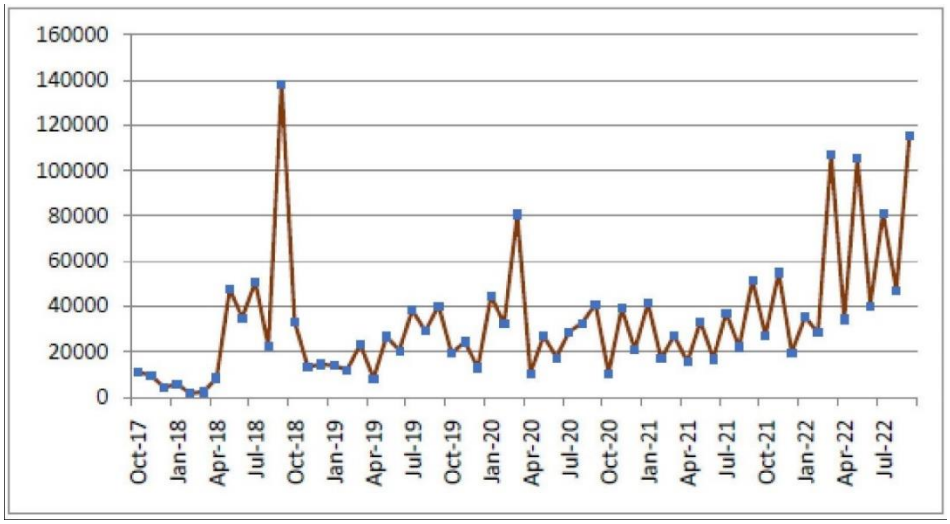


Fig. 6: All Contracts' trading volume of Gold Options at MCX

Fig. 6 showing trend of overall trading volume of Gold Options (in lots) at MCX during the period under study. Initially in October 2017, total trading volume was 11,052 lots which showed decreasing trend and came down to **1,673 lots (lowest)** in Feb 2018. Then, it increased and reached up to 47,362 lots in May 2018, declined to 34,878 lots in June 2018, increased again to 50,763 lots in July 2018 butcame down sharply to 22,366 lots in August 2018. In September 2018, it climbed upto **1,38,222 lots (highest)** which fall down to 33,156 in October 2018 only. Afterwards, it remained fluctuating in zig-zag manner and reached finally to 1,15,344 lots in September 2022. In this way, overall trend of total Options trading volume is slightly upward during the period under study.

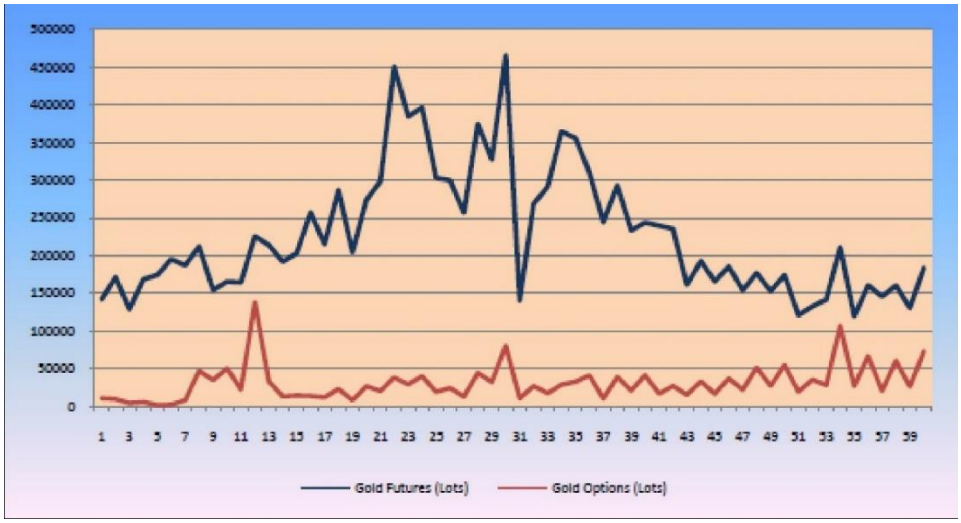


Fig. 7: All Contracts' trading volume of Gold Futures & Options at MCX

Fig. 7 is the combination of Figs. 2 and 3 showing both Gold Futures & Options total trading volume during 60 months or 5 years from Oct 2017 to Sept 2022. It isclear from this line diagram that Gold Futures traded volume (shown by blue line) remained quite high and never meet to Gold Options traded volume (shown by red line).

ANOVA Test

To test the hypothesis, ANOVA test has been conducted and results are given infollowing Table 4.
For Group-I: Gold Futures:
N = 60 months

Mean = 1364085.5333
Standard Deviation = 810498.7053
For Group-II: Gold Options:
N = 60 months
Mean = 33482.9667
Standard Deviation = 27963.036

Table 4: ANOVA Table

Source ofVariation	Sum of Squares	d.f.	Variance	F	P
BetweenGroups	53115095707275.22	1	53115095707275.22	161.5201	0.0000
WithinGroups	38803714877843.50	118	328845041337.66		
Total	91918810585118.72	119			

The calculated F-value is 161.5201 and critical F-value at 95% level of significanceis 3.9201. As Fcal value 161.5201 > 3.9201 (Fcritical), and p-value = 0.0000 < 0.05, **null hypothesis is rejected** and there is a significant difference between two groups of Futuresand Options data.

CONCLUSION

Based on the analysis conducted, it is evident that the trading volume of Gold Futures surpasses that of Gold Options significantly. The primary reason behind this discrepancy is the comparatively lower popularity of Gold Options among investors. It is worth noting that Gold Options in India currently operate in only two categories: options on 1Kg gold futures, which were launched in October 2017, and options on 100Gm gold futures, which commenced in April 2022. In contrast, Gold Futures offer four categories for trading and have been available for a longer duration.
To gain a deeper understanding of gold options trading in India, further comprehensive research is required. This research should specifically focus on identifying the underlying reasons contributing to the substantially lower trade volume of gold options compared to gold futures.

RECOMMENDATIONS

There are several measures that could potentially improve gold options trading at the Multi Commodity Exchange of India (MCX). Here are some suggestions:

1. Increase awareness: The MCX could run awareness campaigns to educate traders about the benefits and risks of trading in gold options. This could include seminars, workshops, and online training sessions.
2. Provide better liquidity: To encourage more participation in gold options trading, the MCX could take steps to increase liquidity in the market. This could include incentivizing market makers to provide quotes, reducing transaction costs, and providing better trading infrastructure.
3. Introduce new products: The MCX could consider introducing new gold options products that cater to different segments of the market.
4. Offer incentives: The MCX could consider offering incentives to traders who participate in gold options trading, such as reduced transaction costs, waived exchange fees, or rebates for providing liquidity to the market.

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