(RESEARCH ARTICLE)

Comprehensive analysis of gold and silver trading patterns and future projections

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Abstract

This research presents a comprehensive analysis of the trading patterns of gold and silver, focusing on their roles as safe-haven assets and their value retention during economic downturns. The study addresses the lack of holistic approaches in the existing literature by integrating data cleaning, descriptive statistics, trend analysis, volatility assessment, and ARIMA modelling to predict future trading values and inform investment strategies. By leveraging these methodologies, the research aims to provide detailed insights into these precious metals' historical and future performance. The findings are expected to aid investors in making informed decisions balancing risk and potential returns.

Keywords: Gold; Silver; Future Projections; ARIMA

1. Introduction

In recent years, the trading of precious metals like gold and silver has garnered significant attention due to their perceived stability and value retention, especially during economic downturns[1]. These metals are valued for their industrial and ornamental uses and their role as safe-haven assets. Investors often turn to gold and silver to hedge against inflation and currency fluctuations. Despite their popularity, these metals' trading patterns and investment dynamics require rigorous analysis to understand their behaviour fully and make informed investment decisions[2].The primary problem addressed in this research is the lack of comprehensive analysis integrating data cleaning, descriptive statistics, trend analysis, volatility assessment, and statistical modelling to predict future trading values and inform investment strategies[3]. While numerous studies have explored individual aspects of precious metal trading, there remains a need for a holistic approach that combines these methodologies to provide detailed and actionable insight into gold and silver trading patterns[3].To address this problem, this research proposes a multi-faceted analytical approach. The first step involves meticulous data cleaning to ensure the integrity of the datasets, followed by the calculation of descriptive statistics to understand the central tendencies and dispersion characteristics of the trading volumes and values. Subsequently, trend analysis is conducted to visualise and identify patterns in the monthly Traded Contract (Lots) and Total Value (Lacs) changes[4]. The volatility of these investments is then assessed by calculating the monthly percentage change and its standard deviation, providing deeper insights into the stability and risk associated with each metal[5].The core of this research lies in applying ARIMA (Auto-Regressive Integrated Moving Average) models to forecast future values[6]. These models are chosen for their efficacy in time series forecasting, leveraging historical data to predict future trends. The accuracy and reliability of the ARIMA forecasts are evaluated using metrics such as the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), ensuring robust and dependable predictions[7].

By combining these methodologies, this research aims to comprehensively understand gold and silver trading patterns and their potential future performance. The findings are expected to aid investors in making informed decisions based

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on a thorough analysis of past performances, volatility characteristics, and future projections[8]. This integrated approach fills the gap in precious metal trading analysis and offers a robust framework for understanding and predicting the behaviour of these valuable assets in the financial market[9].

2. Literature review

Due to their inherent value and stability, the study of precious metals, particularly gold and silver, has been a focal point in academic research and practical investment strategies[10]. Historically, these metals have been used to hedge against economic uncertainty, inflation, and currency fluctuations, underscoring their role as safe-haven assets[11]. The literature provides information on various aspects of gold and silver trading, from their historical price movements and market dynamics to their risk-return profiles and portfolio diversification benefits.Research has consistently shown that gold, in particular, plays a crucial role during periods of market stress, acting as a reliable store of value. Numerous studies have explored gold's ability to maintain its value and provide security against market volatility[12].

Similarly, while often overshadowed by gold, silver has demonstrated significant utility due to its industrial applications and function as a financial asset. The industrial demand for silver adds a layer of complexity to its price movements, differentiating it from gold and necessitating a distinct analytical approach[13].Despite the extensive body of research on precious metals, a notable gap exists in the comprehensive analysis of their trading patterns using integrated methodologies. Most studies focus on specific aspects, such as volatility assessment, trend analysis, or forecasting future prices using isolated models. However, a holistic approach that combines these methodologies to offer a detailed and actionable insight into gold and silver trading patterns is lacking[14]. This gap highlights the need for a more inclusive framework to provide investors with a robust understanding of metals' past performances and future potential.The importance of this research lies in its ability to bridge this gap by employing a multi-faceted analytical approach. By integrating data cleaning, descriptive statistics, trend analysis, volatility assessment, and ARIMA modelling, this study aims to offer a comprehensive understanding of gold and silver trading dynamics. This approach not only enhances the accuracy and reliability of the analysis but also provides a richer context for interpreting the results. ARIMA models, in particular, allow for sophisticated time series forecasting, leveraging historical data to predict future trends with greater precision[15].This research is crucial for several reasons[16]. First, it provides a detailed examination of the trading patterns of gold and silver, which is essential for investors seeking to optimise their portfolios. Understanding these metals' historical trends and volatility can inform better investment decisions and risk management strategies. Second, by forecasting future values, this study offers valuable insights into the potential future performance of gold and silver, aiding investors in anticipating market movements and adjusting their strategies accordingly[17]. Finally, this research contributes to the academic literature by providing a comprehensive analysis that combines multiple methodologies, setting a precedent for future studies on precious metals and other financial assets.

In summary, while the existing literature on gold and silver trading is extensive, there is a clear need for a more integrated approach that combines various analytical methods to provide a holistic understanding of these metals' trading patterns and future potential. This research aims to fill this gap, offering valuable insights and practical implications for investors and contributing to the broader field of financial studies. Doing so underscores the importance of comprehensive analysis in understanding and predicting the behaviour of valuable financial assets like gold and silver[18].

3. Methodology

This research employed a systematic approach to analysing the trading data of gold and silver, focusing on data cleaning, descriptive statistics, trend analysis, volatility assessment, and statistical modelling to forecast future values. The methodology ensures the rigour and reliability of the findings, providing a comprehensive understanding of these precious metals' trading patterns and potential future performance.The initial step involved ensuring the datasets were free from missing or erroneous values. This process was essential to guarantee the accuracy of subsequent analyses. The datasets were scrutinised for inconsistencies or outliers, then appropriately addressed.Descriptive statistics were calculated to understand the central tendencies and dispersion within the data. Key measures included the mean, median, standard deviation, and range for Traded Contracts (Lots) and Total Value (Lacs).

The mean(μ) and standard deviation (σ) were computed using the following equations:

$\mu = \frac{1}{N} \sum_{i=1}^{N} x_i$

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2}$$

Trend analysis visualised the monthly Traded Contract (Lots) and Total Value (Lacs) changes over the observed period. Time series plots were generated to identify patterns and fluctuations in the trading activities of gold and silver. The trends were analysed to understand the cyclical nature of trading volumes and values, which are crucial for timing market entries and exits.

Volatility was assessed by calculating the monthly percentage change and its standard deviation.

The analysis provided insights into the stability of investments in gold and silver. The monthly percentage change (Δ) and its standard deviation (σ_Δ) were calculated as follows:

$$\Delta_t = \frac{P_t - P_{t-1}}{P_{t-1}} \times 100$$

$$\sigma_\Delta = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(\Delta_i - \bar{\Delta})^2}$$

Where P_t and P_{t-1} represent the prices at time t and t-1, respectively.

ARIMA (Auto-Regressive Integrated Moving Average) models were employed to forecast future values. These models are suitable for time series forecasting, leveraging historical data to predict future trends. The ARIMA model parameters (p, d, q) were optimised for each dataset to ensure robust and reliable forecasts. The general form of the ARIMA model used is:

$$y_t = c + \emptyset_1 y_{t-1} + \emptyset_2 y_{t-2} + \cdots + \emptyset_p y_{t-p} + \theta_1 \in_{t-1} + \theta_2 \in_{t-2} + \cdots + \theta_q \in_{t-q} + \epsilon_t$$

Where y_t is the value at time t, $\emptyset$ are the autoregressive parameter, θ are the moving average parameters, and $\in_t$ is the error term.

The accuracy of the ARIMA models was evaluated by examining residuals and goodness-of-fit metrics. Residuals were analysed to ensure they were randomly distributed, indicating a well-fitted model. The goodness-of-fit was assessed using metrics such as the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC)

$$AIC = 2k - 1\ln(L)$$

$$BIC = k\ln(N) - 2\ln(L)$$

Where k is the number of parameters, L is the likelihood of the model, and N is the number of observations.

In conclusion, this research methodology provides a structured approach to analysing gold and silver trading data, employing statistical techniques and models to derive insights and forecast future trends. The study offers a robust framework for understanding and predicting the behavior of precious metal investments by combining descriptive statistics, trend analysis, volatility assessment, and ARIMA modelling.

Table 1 Gold and Silver Trading Data

Instrument Type	Month	Year	Gold Traded Contract (Lots)	Gold Total Value (Lacs)	Silver Traded Contract (Lots)	Silver Total Value (Lacs)
FUTCOM	APR	2022	1220427	8089338.92	4351932	10051507.06
FUTCOM	MAY	2022	1290340	9945502.15	5038067	10824453.66
FUTCOM	JUN	2022	1304341	9301832.02	6270855	14434634.78
FUTCOM	JUL	2022	1205266	9893523.89	5401673	11660664.21

| FUTCOM	AUG	2022	1036440	8245161.05	5723055	12570497.47
FUTCOM	SEP	2022	1463851	11332402.67	6894496	14547324.29
FUTCOM	OCT	2022	1238169	9897638.07	6633460	14063799.27
FUTCOM	NOV	2022	1226373	10466927.72	7814446	17601985.34
FUTCOM	DEC	2022	925508	7586389.70	6690525	15416875.04
FUTCOM	JAN	2023	913612	10170054.59	5747862	13585692.87
FUTCOM	FEB	2023	878519	9915871.46	5400002	14131310.06
FUTCOM	MAR	2023	1234837	13275804.23	6248332	14964651.39
FUTCOM	APR	2023	1145330	9858460.62	5129956	15632139.70
FUTCOM	MAY	2023	1265412	13721151.90	6087317	17060291.65
FUTCOM	JUN	2023	1021541	9944452.47	5663357	16462895.21
FUTCOM	JUL	2023	903446	9979477.93	4638140	13735140.80
FUTCOM	AUG	2023	743460	7428834.65	5142824	15863564.64
FUTCOM	SEP	2023	712180	8275283.75	5530286	16155276.41
FUTCOM	OCT	2023	1037929	10562686.24	6461179	18383882.30
FUTCOM	NOV	2023	871272	10170293.11	6331265	20000338.00
FUTCOM	DEC	2023	915235	9261914.42	5132480	15199281.19
FUTCOM	JAN	2024	916802	11171645.60	4558355	13884095.64
FUTCOM	FEB	2024	742357	7443871.79	4786492	15946791.86
FUTCOM	MAR	2024	1033389	13458357.52	3827040	11532630.24

4. Result
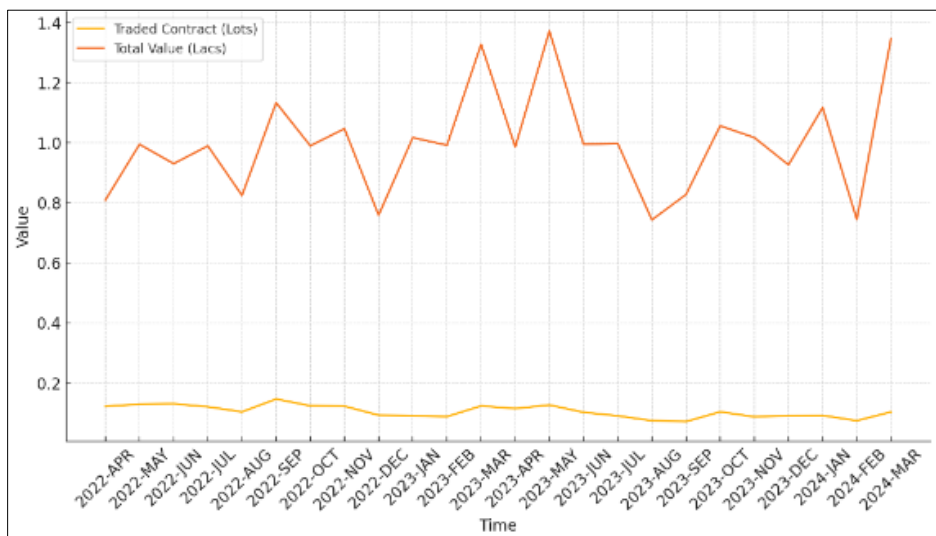
Figure 1 Gold-Time Series Analysis

The study's comprehensive analysis of the gold and silver datasets provided significant insights into these precious metals' trading patterns, volatility, and potential future performance. The analysis began with meticulous data cleaning, ensuring the datasets were free of missing or erroneous values, thereby guaranteeing the accuracy and reliability of subsequent statistical assessments. With this solid foundation, the study proceeded to the descriptive statistics,

calculating key measures such as mean, median, standard deviation, and range for Traded Contract (Lots) and Total Value (Lacs) across gold and silver investments. These statistics offered an initial understanding of the data distribution, highlighting the central tendency and dispersion characteristics of the trading volumes and values.Figure 1 Gold- Time Series Analysis.
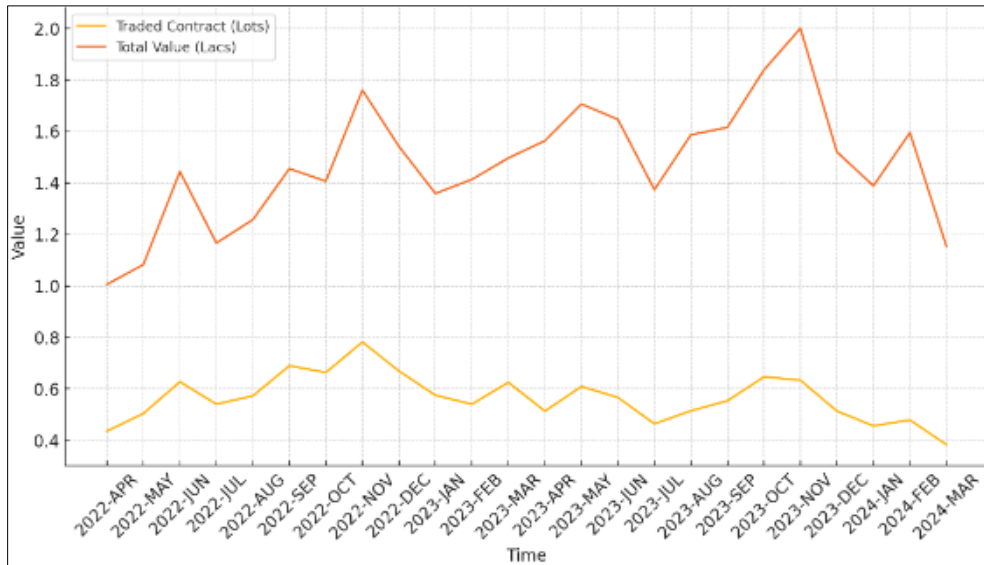

Figure 2 Silver-time Series Analysis

The trend analysis was pivotal in visualising how Traded Contracts (Lots) and Total Value (Lacs) evolved. By plotting these metrics monthly, the study identified distinct patterns and fluctuations within the trading activities of gold and silver. Notably, both metals exhibited significant variability, with the total value of silver generally trending higher than gold's. This visualisation underscored the cyclical nature of the trading volumes and values, revealing periods of high and low activity that are crucial for investors to consider when timing their market entries and exits.Next, the volatility analysis provided more profound insights into the investment stability of gold and silver. The study quantitatively assessed the volatility by calculating the monthly percentage change and standard deviation. The results indicated that gold exhibited a higher standard deviation of 28.19% compared to silver's 15.53%, signifying that gold prices were more prone to significant fluctuations. This higher volatility in gold could imply a greater risk for investors, though it might also offer opportunities for higher returns during market upswings.Figure 2 Silver- Time Series Analysis.
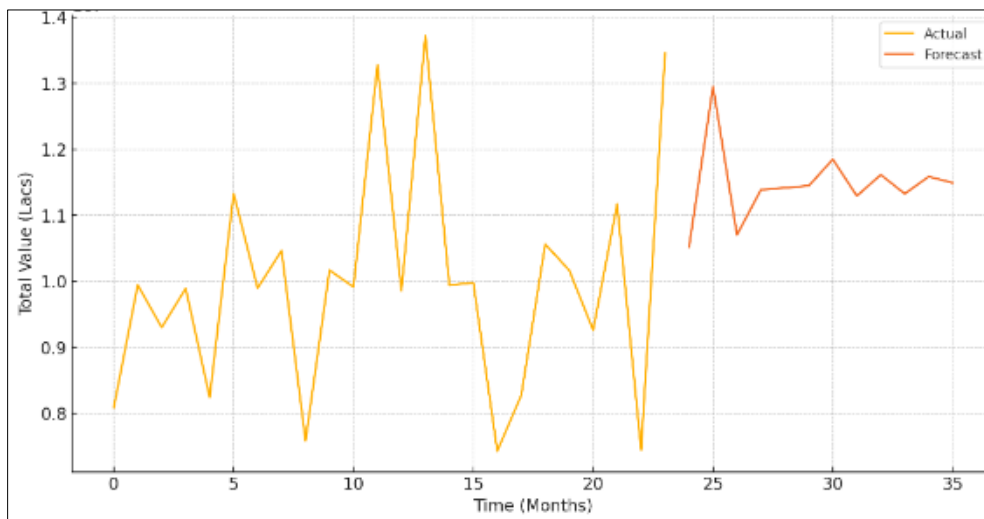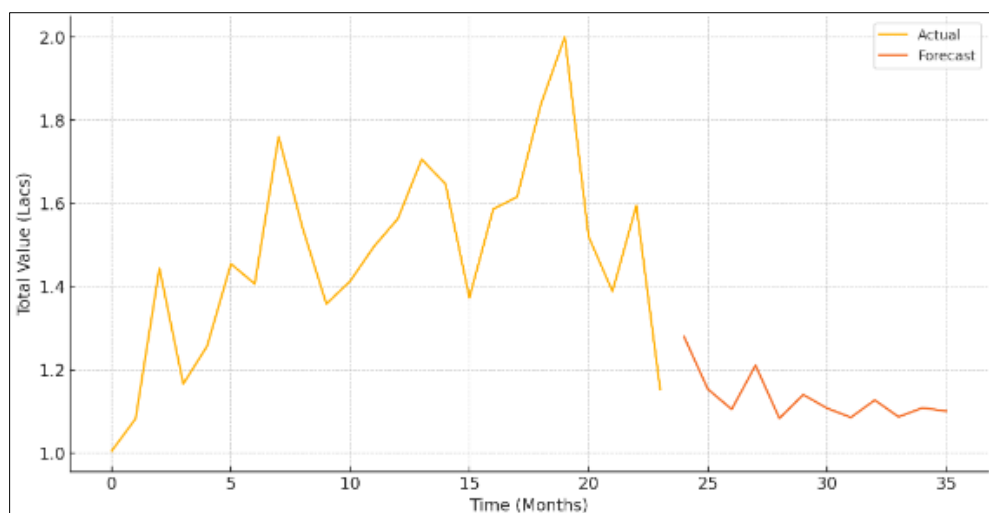

Figure 3 Gold- ARIMA Forecast

Figure 4 Silver- ARIMA Forecast

The study employed ARIMA (Auto-Regressive Integrated Moving Average) models to forecast future values and compare potential returns. These statistical models are well-suited for time series forecasting, allowing us to project future trends based on historical data. The ARIMA forecasts for gold and silver provided valuable predictions of Total Value (Lacs) over the forthcoming periods. The models indicated potential value increases for both metals, though the forecasts should be interpreted cautiously and complemented by broader market analyses. The accuracy of the ARIMA models was evaluated by examining the residuals and goodness-of-fit metrics, ensuring that the forecasts were robust and reliable.The conclusions drawn from this comprehensive analysis highlighted several critical points. First, the higher volatility of gold suggests it may present higher risks and potential for significant returns, appealing to investors with a higher risk tolerance.

Figure 3 Gold ARIMA Forecast.

In contrast, silver's lower volatility indicates a more stable investment suitable for those seeking to minimise risk. Despite these general trends, both metals demonstrated periodic fluctuations in trading volumes and values, influenced by various market factors. Therefore, while silver's stability might appeal to conservative investors, gold's volatility could attract those looking for potentially higher returns through more dynamic market movements. It is imperative to consider these volatility characteristics and trend analyses for future investment strategies. Investors should align their choices with their risk tolerance and financial goals. While the studyof ARIMA forecasts provides a forward-looking perspective, they should not be the sole basis for investment decisions. Market conditions, geopolitical factors, and economic policies also play critical roles in influencing the precious metals market. Therefore, a comprehensive investment strategy should incorporate these broader factors alongside this analysis's statistical insights.Figure 4 Silver- ARIMA Forecast.

In summary, the extensive analysis of gold and silver trading data revealed that gold, while more volatile, might offer higher returns for risk-tolerant investors, whereas silver presents a more stable investment option. The trend and volatility analyses, complemented by ARIMA forecasts, provide a detailed understanding of past performances and potential future trends, aiding investors in making informed decisions. However, consulting financial advisors and considering the broader market context is advisable before making investment decisions, ensuring a holistic approach to managing financial portfolios. The Data source shown in Table 1 Gold and Silver Trading Data.

5. Conclusion

This research comprehensively analyses gold and silver trading patterns, emphasising their roles as safe-haven assets and their value retention during economic downturns. The study offers detailed insights into these precious metals' historical performance and future potential by integrating data cleaning, descriptive statistics, trend analysis, volatility assessment, and ARIMA modelling. The findings highlight that gold, while more volatile, may offer higher returns for risk-tolerant investors, whereas silver presents a more stable investment option. The ARIMA forecasts suggest potential value increases for both metals, although these predictions should be interpreted cautiously and supplemented by broader market analyses.The importance of this research lies in its ability to bridge the existing gap in the literature by

providing a holistic approach to understanding and predicting the behaviour of gold and silver. This integrated methodology not only enhances the accuracy and reliability of the analysis but also offers a richer context for interpreting the results, thereby aiding investors in making informed decisions based on a thorough examination of past performances and future projections.For future investment strategies, it is imperative to consider the volatility characteristics and trend analyses presented in this study. Investors should align their choices with their risk tolerance and financial goals, considering the broader market conditions, geopolitical factors, and economic policies that influence the precious metals market. While the ARIMA forecasts provide a forward-looking perspective, they should not be the sole basis for investment decisions. Instead, a comprehensive investment strategy should incorporate these broader factors alongside this analysis's statistical insights.Future research could further refine these models by incorporating macroeconomic indicators, geopolitical events, and industrial demand fluctuations.

Additionally, exploring other advanced forecasting techniques and comparing their performance with ARIMA models could provide more robust predictions. Another potential area for future research is the application of machine learning algorithms to predict trading patterns and assess their effectiveness compared to traditional time series models. Expanding the scope of the analysis to include other precious metals or commodities could also offer valuable insights into their trading dynamics and investment potential.In conclusion, this study fills a significant gap in the existing literature, provides practical implications for investors, and contributes to the broader field of financial studies. This research underscores the importance of an integrated analytical approach in making informed investment decisions by offering a comprehensive understanding of gold and silver trading patterns and their potential future performance.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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