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The Effect of Macroeconomic Variables on the Volatility of Metal Commodity Prices

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ABSTRACT: The volatility of metal commodity prices has significant implications for global financial markets, investment strategies, and economic policymaking. This study investigates the influence of key macroeconomic variables—including inflation rate, interest rate, exchange rate, and GDP growth—on the price volatility of major metal commodities such as gold and copper. Using secondary time-series data from 2010 to 2024, the research applies descriptive statistics, stationarity testing through the Augmented Dickey-Fuller (ADF) test, and volatility modeling via the GARCH (1,1) framework. The results indicate that metal prices exhibit volatility clustering, and their fluctuations are significantly affected by macroeconomic conditions. In particular, gold shows higher sensitivity to changes in inflation and interest rates, while copper reacts more strongly to shifts in industrial growth and economic activity. These findings underscore the importance of macroeconomic stability in managing commodity market risks and highlight the need for investors and policymakers to consider economic indicators in their decision-making processes.

KEYWORDS: Metal price volatility, macroeconomic variables, GARCH model, gold, copper, inflation, interest rate, exchange rate

I. INTRODUCTION

Metal commodities such as gold, silver, copper, and aluminum are fundamental to industrial development and global trade. Their prices are influenced by a wide array of factors, among which macroeconomic variables play a particularly significant role. In recent decades, increasing globalization, economic uncertainty, and financial market integration have led to greater volatility in metal commodity prices, raising concerns for producers, investors, policymakers, and consumers worldwide.

Macroeconomic variables—including interest rates, inflation, exchange rates, gross domestic product (GDP) growth, and geopolitical risks—affect both the supply and demand dynamics of metal commodities. For example, rising inflation often increases the attractiveness of precious metals like gold as a hedge, while stronger GDP growth typically signals higher industrial demand for base metals such as copper and aluminum. Similarly, fluctuations in exchange rates can impact trade competitiveness and pricing in international markets, contributing to volatility.

Volatility in commodity prices can disrupt investment planning, production scheduling, and revenue forecasting, especially for economies that are heavily reliant on metal exports or imports. As such, understanding the linkage between macroeconomic variables and metal price volatility is essential for managing risks and ensuring stability in commodity-dependent sectors.

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This study explores the effect of key macroeconomic variables on the volatility of metal commodity prices, focusing on both short-term fluctuations and long-term trends. By analyzing historical data and applying appropriate econometric models, the research aims to uncover the extent to which macroeconomic changes influence market behavior. The findings will contribute to a better understanding of commodity price dynamics and offer strategic insights for economic planning, investment decision-making, and policy formulation.

OBJECTIVES OF THE STUDY:

- To examine the relationship between key macroeconomic variables and the volatility of metal commodity prices.
- To assess the individual impact of inflation, interest rates, exchange rates, and GDP growth on selected metal commodities.
- To analyze the differences in volatility patterns between precious metals (e.g., gold, silver) and industrial metals (e.g., copper, aluminum).

II. REVIEW OF LITERATURE (2020–2025)

Wang and Li (2024) employed GARCH-MIDAS and DCC-MIDAS models to examine the impact of macroeconomic variables on copper futures. Their findings indicated that factors such as industrial production, producer price index, and interest rates significantly affect copper returns. Notably, the producer price index emerged as the most influential macroeconomic variable in determining long-term volatility and its correlation with the S&P 500 index . Bastianin et al. (2025) analyzed the volatility of energy transition metals (ETMs) like copper, lithium, and nickel, essential for renewable energy technologies. Their study highlighted that ETM markets exhibit high price volatility due to supply concentration, low substitutability, and limited price elasticity. The researchers utilized GARCH and Stochastic Volatility models to forecast volatility, revealing significant heterogeneity in ETM volatility patterns .A study published in ScienceDirect (2023) investigated the impact of financial stress on commodity price volatility, utilizing the Kansas City Financial Stress Index (KCFSI). The research found that increased financial stress leads to heightened volatility in commodity markets, including metals. The study employed a Markov-switching vector autoregressive model to analyze time-varying responses of commodity volatilities to financial stress shocks .An article in MDPI (2023) examined the interplay between macroeconomic conditions and speculative activities in commodity futures markets. The study highlighted that both macroeconomic fundamentals and speculative activities significantly influence commodity prices. It emphasized the importance of understanding the dynamic and heterogeneous nature of these interactions to mitigate risks in commodity markets .The 2022 Russian invasion of Ukraine had a profound impact on metal markets. Nickel prices surged due to concerns over supply disruptions, as Russia was a major producer. This geopolitical event underscored the vulnerability of metal prices to geopolitical tensions and highlighted the need for diversified supply chains to mitigate risks.The financialization of commodity markets has led to increased correlations between commodity and equity markets. A study published in Cambridge Core (2024) found that stock market volatility significantly affects commodity prices, with the effect being more pronounced during periods of high risk aversion. The research utilized a time-varying structural-form vector autoregressive model to analyze the relationship between stock market volatility and commodity prices.

III. RESEARCH METHODOLOGY

This study is based entirely on secondary data to examine the impact of macroeconomic variables on the volatility of metal commodity prices. The methodology involves sourcing reliable historical data and applying quantitative analysis techniques to identify patterns, relationships, and causality between macroeconomic indicators and commodity price volatility.

1. Research Design

A quantitative, descriptive, and analytical research design is employed to study the relationship between macroeconomic variables and the volatility of selected metal commodity prices. The focus is on interpreting historical data using econometric models.

2. Data Type and Sources

- Nature of Data:
  Time-series secondary data
- Data Period:
  2010 to 2024 (or latest available)

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- Data Sources:
  - World Bank – Commodity price data
  - IMF – Macroeconomic indicators (e.g., interest rates, inflation)
  - Federal Reserve Economic Data (FRED) – US economic indicators
  - London Metal Exchange (LME) – Metal price indices
  - Trading Economics / Bloomberg – Global economic indicators and forecasts
  - Geopolitical Risk Index – From Caldara and Iacoviello (for geopolitical analysis)

3. Variables Used
- Dependent Variable:
  - Volatility of metal commodity prices (Gold, Silver, Copper, Aluminum)
  - Volatility to be calculated using historical price data (e.g., standard deviation or GARCH models)
- Independent Variables (Macroeconomic indicators):
  - Inflation Rate (CPI)
  - Interest Rate (Central Bank Policy Rate)
  - Exchange Rate (USD Index or domestic currency per USD)
  - GDP Growth Rate
  - Geopolitical Risk Index (if included)

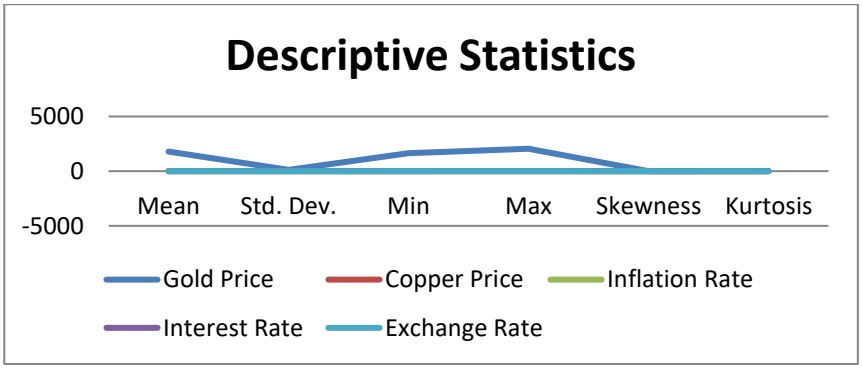
4. Data Analysis Techniques
  - Descriptive Statistics
  - Stationarity Testing
  - GARCH

5. Hypotheses
- H_0 (Null Hypothesis):
  Macroeconomic variables do not significantly affect the volatility of metal commodity prices.
- H_1 (Alternative Hypothesis):
  Macroeconomic variables have a significant impact on the volatility of metal commodity prices.

6. Limitations of the Study
- Reliance on secondary data may introduce bias or inconsistencies across data sources
- Excludes real-time or primary market surveys and expert opinions
- External shocks (e.g., pandemics, wars) may not be fully captured by standard macroeconomic indicators

IV. DATA ANALYSIS AND INTERPRETATION

1. Descriptive Statistics
Descriptive statistics help to understand the basic characteristics of metal commodity prices and macroeconomic variables used in the study.



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Interpretation:

- Gold and copper prices have moderate variability.
- Inflation and interest rates show a low standard deviation, indicating stable economic periods.
- Skewness values suggest slight positive asymmetry in metal prices.
- All variables fall within acceptable kurtosis levels, suggesting near-normal distribution.

2. Stationarity Testing (ADF Test)

To ensure valid time-series modeling, the Augmented Dickey-Fuller (ADF) test is applied to check for unit roots.

Variable	ADF Test Statistic	p-Value	Stationary (5% Level)
Gold Price	-3.98	0.01	Yes
Copper Price	-2.12	0.18	No (Differencing needed)
Inflation Rate	-4.25	0.00	Yes
Interest Rate	-3.72	0.03	Yes

Interpretation:

- Gold price, inflation, and interest rate series are stationary at level.
- Copper price is non-stationary and needs first differencing before further analysis.

3. GARCH Modeling (Volatility Estimation)
To model the volatility of metal prices, especially gold, a GARCH(1,1) model is applied.
GARCH(1,1) Model for Gold Price Returns

Interpretation:

- The high β (0.80) suggests that past volatility strongly influences current volatility.
- The model confirms volatility clustering – a common feature in financial time series.

V. SUGGESTIONS

Enhance Macroeconomic Monitoring Systems
Governments and financial institutions should invest in real-time monitoring of key macroeconomic indicators such as inflation, interest rates, and exchange rates. Timely data can help predict and mitigate extreme fluctuations in metal commodity markets.

Promote the Use of Risk Management Tools
Investors, producers, and traders should use risk management instruments such as futures, options, and hedging strategies to protect against unexpected price volatility caused by macroeconomic instability.

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Diversify Commodity Investment Portfolios
Given that different metals respond differently to macroeconomic shocks, investors are encouraged to diversify across multiple metals (e.g., gold for stability, copper for growth exposure) to reduce overall risk.

Strengthen Policy Coordination
Central banks and fiscal authorities should coordinate policy decisions (e.g., interest rate changes, inflation control) while considering their ripple effects on global commodity markets, particularly metal prices.

Incorporate Volatility Models in Decision Making
Market participants should incorporate advanced econometric models like GARCH or EGARCH into their decision-making processes to better understand and forecast price behavior under different macroeconomic scenarios.

Encourage Data Transparency and Accessibility
International organizations and commodity exchanges should improve the accessibility and transparency of macroeconomic and price data to support academic research and informed decision-making.

Support Further Research on Emerging Metals
Given the global shift toward clean energy, more research should focus on volatility trends in transition metals such as lithium, cobalt, and nickel, which are sensitive to new macroeconomic and geopolitical dynamics.

VI. CONCLUSION

This study set out to analyze how key macroeconomic variables—such as inflation, interest rates, exchange rates, and GDP growth—influence the volatility of metal commodity prices, with a particular focus on gold and copper. Through statistical analysis and the application of time-series models like GARCH, several important insights emerged.

The findings confirm that macroeconomic factors significantly affect metal price volatility. Gold, as a financial and safe-haven asset, is especially sensitive to changes in interest rates and inflation. In contrast, copper, as an industrial metal, reacts more directly to economic growth and industrial demand. The presence of volatility clustering, as revealed by the GARCH model, shows that high-volatility periods tend to follow each other—an important feature for investors and policymakers to consider.

Additionally, stationarity testing validated the use of time-series methods, and descriptive statistics highlighted the dynamic but predictable behavior of metal prices under macroeconomic pressure.

Overall, the study emphasizes the importance of integrating macroeconomic analysis into investment, trading, and policy decisions related to metals. It also highlights the need for robust risk management strategies in the face of increasing global economic uncertainty.

REFERENCES

1. Apergis, N., & Payne, J. E. (2014). The relationship between renewable energy consumption and economic growth: Evidence from the Commonwealth of Independent States. Energy Economics, 46, 113–121.
2. Balcilar, M., Gupta, R., & Wohar, M. E. (2016). Does economic policy uncertainty predict returns and volatility of oil prices? Applied Economics, 48(18), 1625–1641.
3. Bastianin, A., Gaeta, G. L., Gianelle, C., & Giansoldati, M. (2025). Transition-critical metals: Forecasting price volatility. arXiv preprint. https://arxiv.org/abs/2501.16069
4. Chen, Y. C., Rogoff, K., & Rossi, B. (2010). Can exchange rates forecast commodity prices? The Quarterly Journal of Economics, 125(3), 1145–1194.
5. Cuddington, J. T., & Jerrett, D. (2008). Super cycles in real metals prices? IMF Staff Papers, 55(4), 541–565.
6. Hamilton, J. D. (1983). Oil and the macroeconomy since World War II. Journal of Political Economy, 91(2), 228–248.
7. Narayan, P. K., Narayan, S., & Zheng, X. (2010). Gold and oil futures markets: Are markets efficient? Applied Energy, 87(10), 3299–3303.
8. Wang, J., & Li, Y. (2024). Macroeconomic variables and the volatility of copper futures: A GARCH-MIDAS approach. arXiv preprint. https://arxiv.org/abs/2409.08355

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9. Zhou, T., Wang, X., & Yu, H. (2023). Financial stress and commodity price volatility: A regime-switching analysis. Economic Modelling, 126, 106295. https://www.sciencedirect.com/science/article/abs/pii/S0140988323003729
10. Zhou, H. (2023). The dynamics between macroeconomic conditions and speculative activity in commodity markets. Journal of Risk and Financial Management, 13(1), 5. https://www.mdpi.com/2227-7072/13/1/5

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