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# COMPARATIVE ANALYSIS OF GOLD AND FOREIGN EXCHANGE RESERVES OF SELECTED COUNTRIES (2022-2024)

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**Abstract**

This study provides a comparative analysis of gold and foreign exchange (FX) reserves in selected countries United States, Germany, Italy, France, Russian Federation, China, Switzerland, Japan, and India from Q1 2022 to Q2 2024. The research examines the fluctuations in these reserves, the proportion of gold relative to total reserves, and the impact of significant global events, such as the COVID-19 pandemic and geopolitical tensions, on reserve management strategies. The results from the Augmented Dickey-Fuller (ADF) test and ARIMA model analysis reveal that the fluctuations in gold reserves across the selected countries are largely random, with no significant changes influenced by specific economic or policy factors. Similarly, the proportion of gold relative to total reserves has remained stable, indicating that the allocation towards gold as a reserve asset is unaffected by global economic conditions. However, the FX reserves of the United States and Japan exhibit signs of non-random changes, suggesting a possible impact of global events on their reserve management strategies. In contrast, Germany, Italy, and India show no significant influence from external factors on their FX reserves. The study concludes that while some countries adjusted their reserve strategies in response to global events, others maintained stable and unaffected reserve levels, reflecting diverse approaches to reserve management during the analyzed period.

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**Keywords:** Gold Reserves, Foreign Exchange Reserves, Reserve Management Strategies, Global Economic Stability, and Geopolitical Impact

## Introduction

This study explores the gold and foreign exchange (FX) reserves of nine major economies United States, Germany, Italy, France, Russian Federation, China, Switzerland, Japan, and India over the period from Q1 2022 to Q2 2024. By analyzing fluctuations in these reserves, the research aims to uncover the impact of global economic events and geopolitical tensions on reserve management strategies. The study also examines the stability of gold's proportion in total reserves, providing insights into how these countries navigate economic challenges and maintain financial stability amidst a volatile global environment.

## Research Objectives

- Analyze the Trends in Gold Reserves
- Examine the Fluctuations in Foreign Exchange Reserves
- Evaluate the Proportion of Gold in Total Reserves
- Identify the Impact of Economic and Geopolitical Events

## Methodology

The analysis is based on data extracted from quarterly reports of the selected countries from Q1 2022 to Q2 2024. The data includes gold reserves, FX reserves, and the percentage of total reserves held in gold. The study uses descriptive statistics to highlight the trends, and graphical representations to illustrate the changes over time. The countries selected represent a diverse set of economies, ranging from large, developed nations to emerging markets, providing a broad perspective on global reserve management.

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## REVIEW OF LITERATURE

**Mahida (2024)** explores the increasing scholarly interest in the study of foreign currency (FX) and gold reserves, particularly in the context of economic stability and policy-making. The research highlights the importance of understanding the fluctuations in FX and gold reserves among major economies, including China, Japan, Switzerland, the United States, and India from Q1 2020 to Q1 2024. Previous studies have focused on the impact of reserve management on economic stability, emphasizing the need for diversification and cautious strategies. Mahida's work contributes to this literature by providing a comparative analysis of reserve management techniques and cross-national correlations within a globally interconnected economy.

**Arslanalp, Eichengreen, and Simpson-Bell (2023)** examine the shifting dynamics of central bank gold holdings since the Global Financial Crisis, marking a reversal of a four-decade decline. Their research identifies "active diversifiers," primarily emerging markets, which have notably increased the share of gold in their reserves. This trend contrasts with the broader diversification of foreign currency reserves seen in both advanced and developing economies. The study underscores gold's attractiveness as a safe haven during periods of economic and geopolitical volatility and as a hedge against financial sanctions imposed by major reserve-issuing economies. This work contributes to the literature by emphasizing the geopolitical influences on central bank reserve management strategies.

**Oktay, Öztunç, and Serin (2016)** delve into the determinants of gold reserves in central banks, focusing particularly on the G-7 countries. Their empirical analysis, spanning 24 years, uncovers that the factors influencing gold reserves are distinct from those affecting total and non-gold international reserves. The study finds that GDP growth and exports have a positive impact on gold reserves, whereas population, net FDI liabilities, and current account balance negatively affect them. This research significantly contributes to the broader understanding of reserve management by highlighting the unique economic drivers behind gold reserves in major economies.

**Kuncoro and Pardede (2024)** provide a nuanced analysis of the central bank's behavior in accumulating foreign reserves, specifically in the case of Indonesia. Unlike previous studies, their research disaggregates foreign reserves into components such as foreign currency, securities, gold, and special drawing rights. Using the Almost Ideal Demand System combined with the Error Correction Model, they reveal that the own-price coefficients are negative and significant, aligning with standard demand theory. The study further identifies substitution and complementarity relationships among reserve components, offering insights into optimal reserve rebalancing strategies for maintaining macroeconomic stability.

**Sultanova et al. (2024)** investigate the volatility structures of energy companies listed on the Kazakhstan Stock Exchange (KASE) in comparison to international market indices, including gold and oil prices, for the period from January 2021 to June 2023. Their study applies various models to analyze volatility and explores the causal relationships between KASE returns and international indices. The findings indicate that, except for KASE, other indices exhibit similar variance structures. Additionally, the study reveals that international indices significantly impact the Kazakhstan market, suggesting structural compatibility and integration with global financial markets.

## ANALYSIS AND DISCUSSION

**$H0_1$:** There is no significant change in the quarterly gold reserves of the selected countries (United States, Germany, Italy, France, Russian Federation, China, Switzerland, Japan, and India) from Q1 2022 to Q2 2024. The observed fluctuations in gold reserves are random and not influenced by specific economic or policy factors.

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**Quarterly Gold Reserves (US$ millions) of Selected Countries: Q1 2022 - Q2 2024**

| Country | United States | Germany | Italy | France | Russian Federation | China, P.R.: Mainland | Switzerland | Japan | India |
|---|---|---|---|---|---|---|---|---|---|
| **Q1 2022** | 507870.9 | 209711.4 | 153097.7 | 152140.3 | 143913.3 | 121656.3 | 64939.7 | 52824.3 | 47482 |
| **Q2 2022** | 475144.3 | 196001.6 | 143232.3 | 142343.8 | 135729.9 | 113816.9 | 60755 | 49420.4 | 44858.8 |
| **Q3 2022** | 437160.8 | 180333.3 | 131782.4 | 130966.6 | 125218.5 | 104718.4 | 55898.3 | 45469.7 | 42211.2 |
| **Q4 2022** | 474293.7 | 195651 | 142976.1 | 142096.4 | 136031.3 | 117240.8 | 60646.4 | 49332 | 45914.2 |
| **Q1 2023** | 517689.4 | 213536.4 | 156057.8 | 155101.6 | 148081.6 | 131650.1 | 66195.2 | 53845.6 | 50577.7 |
| **Q2 2023** | 500051.3 | 206123.3 | 150740.8 | 149821 | 143227.5 | 129937.4 | 63939.9 | 52011.1 | 49026.9 |
| **Q3 2023** | 489133.7 | 201623.1 | 147449.6 | 146551.8 | 140287.5 | 131795.4 | 62543.9 | 50875.5 | 48157.7 |
| **Q4 2023** | 543499.4 | 224032.8 | 163838.2 | 162844.7 | 155880 | 149374.6 | 69495.5 | 56530.2 | 53697.3 |
| **Q1 2024** | 579050.1 | 238662.6 | 174555 | 173492.1 | 166076.3 | 161071.8 | 74041.2 | 60227.8 | 58527.6 |
| **Q2 2024** | 609527.8 | 251166.1 | 183742.5 | 182628.3 | 175050.6 | 169689.5 | - | 63397.9 | 63007.2 |

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**Table 1: Results of Augmented Dickey-Fuller Test and ARIMA Model Analysis for Quarterly Gold Reserves of Selected Countries (Q1 2022 - Q2 2024)**

| Country | ADF Statistic | p-value | ARIMA Model Coefficient (AR1) | ARIMA Model Coefficient (MA1) | Sigma^2 (Error Variance) | Interpretation |
|---|---|---|---|---|---|---|
| United States | 4.67 | 1 | -1 | 1 | 1.10E+09 | Non-stationary, Random Changes |
| Germany | 4.47 | 1 | -0.977 | 0.9999 | 2.08E+08 | Non-stationary, Random Changes |
| Italy | 4.67 | 1 | 0.2424 | -0.3082 | 3.27E+07 | Non-stationary, Random Changes |
| Japan | 4.67 | 1 | -1 | 1 | 1.32E+07 | Non-stationary, Random Changes |
| India | 1.92 | 0.998 | -0.9746 | 0.9951 | 1.37E+07 | Non-stationary, Random Changes |

**Interpretation**

Based on the results from the Augmented Dickey-Fuller (ADF) test and ARIMA model analysis, the null hypothesis (H01) that there is no significant change in the quarterly gold reserves of the selected countries (United States, Germany, Italy, Japan, and India) from Q1 2022 to Q2 2024 is **accepted**. The ADF test results show high p-values, and the ARIMA model coefficients indicate that the gold reserves are non-stationary, with random changes. This suggests that the fluctuations observed in the gold reserves are not influenced by specific economic or policy factors but are instead random. Therefore, the data does not provide sufficient evidence to reject the null hypothesis, supporting the conclusion that the quarterly

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changes in gold reserves for these countries during the specified period were likely due to random variations rather than systematic influences.

**$H0_2$:** The quarterly fluctuations in foreign exchange reserves of the selected countries are not significantly affected by economic and geopolitical factors from Q1 2022 to Q2 2024. The reserve levels remain consistent, regardless of external influences.

**Quarterly FX Reserves (US$ millions) of Selected Countries: Q1 2022 - Q2 2024**

| Quarter | United States | Germany | Italy | France | Russian Federation | China | Switzerland | Japan | India |
|---|---|---|---|---|---|---|---|---|---|
| Q1 2022 | 237182.5 | 99904.4 | 82518.7 | 99981.9 | 464318.8 | 3251625.8 | 999929.8 | 1303245.9 | 564868.3 |
| Q2 2022 | 227534.2 | 97231.8 | 80084 | 98428.8 | 448189.3 | 3133187.7 | 901685.1 | 1261832.3 | 548774 |
| Q3 2022 | 219111.7 | 94825.6 | 77895.7 | 96413.4 | 416863.4 | 3089365.6 | 836245.8 | 1192584 | 495189.2 |
| Q4 2022 | 232716.6 | 98413.7 | 81714.8 | 100428.9 | 445783.7 | 3189689.1 | 863028 | 1178279.4 | 521419.4 |
| Q1 2023 | 235948.8 | 99735.4 | 82676.8 | 76505.5 | 446712.8 | 3247256.6 | 827698.7 | 1203213.3 | 533279.8 |
| Q2 2023 | 232967.3 | 99753.7 | 83427.2 | 76062.1 | 439325.2 | 3254813.1 | 822737.8 | 1195165.3 | 551201.1 |
| Q3 2023 | 229949.2 | 97780.3 | 81467 | 75184.7 | 428333.2 | 3176997.4 | 755903.8 | 1186370.2 | 544405.4 |
| Q4 2023 | 234110.8 | 100391.9 | 84819.5 | 79200.9 | 442537.1 | 3301319.7 | 794931.4 | 1238541.1 | 574508.8 |
| Q1 2024 | 232761.2 | 99591.6 | 83849.2 | 79374.8 | 424146.1 | 3308705.4 | 807496.9 | 1230377.1 | 593744 |
| Q2 2024 | 232299.1 | 100307.5 | 85158.6 | 78323.8 | 418955.9 | 3285272 | - | 1168515.8 | 595469 |

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**Table 2: Results of Augmented Dickey-Fuller Test and ARIMA Model Analysis for Quarterly Foreign Exchange Reserves of Selected Countries (Q1 2022 - Q2 2024)**

| Country | ADF Statistic | p-value | ARIMA Model Coefficient (AR1) | ARIMA Model Coefficient (MA1) | Sigma^2 (Error Variance) | Interpretation |
|---|---|---|---|---|---|---|
| United States | -3.72 | 0.0038 | 0.1977 | -0.2518 | 5.37E+06 | Stationary, Possible Non-Random Changes |
| Germany | -2.13 | 0.2335 | -0.9755 | 0.998 | 3.54E+06 | Non-stationary, Random Changes |
| Italy | -1.07 | 0.7264 | 0.1667 | -0.2139 | 2.69E+06 | Non-stationary, Random Changes |
| Japan | -4.13 | 0.0009 | -0.9633 | 0.963 | 9.10E+08 | Stationary, Possible Non-Random Changes |
| India | -0.82 | 0.8146 | -0.8668 | 0.9035 | 2.95E+08 | Non-stationary, Random Changes |

**Interpretation**

Based on the results from the Augmented Dickey-Fuller (ADF) test and ARIMA model analysis, the null hypothesis (H02) that the quarterly fluctuations in foreign exchange reserves of the selected countries are not significantly affected by economic and geopolitical factors from Q1 2022 to Q2 2024 is partially rejected. The ADF test results show that the foreign exchange reserves of the United States and Japan are stationary, with p-values below 0.05, indicating possible non-random changes. This suggests that the fluctuations in these countries'

reserves may have been influenced by economic and geopolitical factors. Conversely, the reserves for Germany, Italy, and India are non-stationary, with high p-values, implying that their fluctuations are random and not significantly influenced by external factors. Therefore, while some countries exhibit evidence of influence from global events, others maintain random, unaffected reserve levels, leading to a partial rejection of the null hypothesis.

**$H0_3$:** The proportion of gold relative to total reserves in the selected countries has not significantly changed from Q1 2022 to Q2 2024. The allocation towards gold as a reserve asset is stable and unaffected by changes in global economic conditions.

**Quarterly Gold % of Total Reserves of Selected Countries: Q1 2022 - Q2 2024**

| Quarter | United States | Germany | Italy | France | Russian Federation | China | Switzerland | Japan | India |
|---|---|---|---|---|---|---|---|---|---|
| Q1 2022 | 0.682 | 0.677 | 0.65 | 0.603 | 0.237 | 0.036 | 0.061 | 0.039 | 0.078 |
| Q2 2022 | 0.676 | 0.668 | 0.641 | 0.591 | 0.232 | 0.035 | 0.063 | 0.038 | 0.076 |
| Q3 2022 | 0.666 | 0.655 | 0.628 | 0.576 | 0.231 | 0.033 | 0.063 | 0.037 | 0.079 |
| Q4 2022 | 0.671 | 0.665 | 0.636 | 0.586 | 0.234 | 0.035 | 0.066 | 0.04 | 0.081 |
| Q1 2023 | 0.687 | 0.682 | 0.654 | 0.67 | 0.249 | 0.039 | 0.074 | 0.043 | 0.087 |
| Q2 2023 | 0.682 | 0.674 | 0.644 | 0.663 | 0.246 | 0.038 | 0.072 | 0.042 | 0.082 |
| Q3 2023 | 0.68 | 0.673 | 0.644 | 0.661 | 0.247 | 0.04 | 0.076 | 0.041 | 0.081 |
| Q4 2023 | 0.699 | 0.691 | 0.659 | 0.673 | 0.26 | 0.043 | 0.08 | 0.044 | 0.085 |
| Q1 2024 | 0.713 | 0.706 | 0.676 | 0.686 | 0.281 | 0.046 | 0.084 | 0.047 | 0.09 |
| Q2 2024 | 0.724 | 0.715 | 0.683 | 0.7 | 0.295 | 0.049 | - | 0.051 | 0.096 |

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**Table 3: Results of Augmented Dickey-Fuller Test and ARIMA Model Analysis for Proportion of Gold Relative to Total Reserves in Selected Countries (Q1 2022 - Q2 2024)**

| Country | ADF Statistic | p-value | ARIMA Model Coefficient (AR1) | ARIMA Model Coefficient (MA1) | Sigma^2 (Error Variance) | Interpretation |
|---|---|---|---|---|---|---|
| United States | 4.67 | 1 | -0.0632 | 0.9461 | 6.52E-05 | Non-stationary, Random Changes |
| Germany | 4.39 | 1 | -0.0049 | 0.9197 | 7.53E-05 | Non-stationary, Random Changes |
| Italy | 7.03 | 1 | -0.2082 | 0.7636 | 1.00E-04 | Non-stationary, Random Changes |
| Japan | 1.07 | 0.995 | 0.0999 | 0.912 | 3.44E-06 | Non-stationary, Random Changes |
| India | 0.19 | 0.972 | 0.359 | -0.0527 | 1.63E-05 | Non-stationary, Random Changes |

**Interpretation**

Based on the results from the Augmented Dickey-Fuller (ADF) test and ARIMA model analysis, the null hypothesis (H03) that the proportion of gold relative to total reserves in the selected countries has not significantly changed from Q1 2022 to Q2 2024 is accepted. The high p-values across all countries, coupled with the non-stationary nature of the time series, suggest that any fluctuations in the proportion of gold relative to total reserves are random and not influenced by specific economic conditions. This indicates stability in the allocation towards gold as a reserve asset, with no significant shifts attributable to global economic factors

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during the analyzed period. Therefore, the observed changes in the gold proportion are likely incidental and do not reflect any deliberate adjustments in reserve management strategies. The null hypothesis is upheld, confirming that the allocation to gold remains stable.

**$H0_4$:** Significant global events, such as the COVID-19 pandemic and geopolitical tensions, have had no measurable impact on the reserve management strategies of the selected countries. The levels of gold and FX reserves have not been significantly altered by these events during the period from Q1 2022 to Q2 2024.

**Table 4: Results of Augmented Dickey-Fuller Test and ARIMA Model Analysis for Gold and FX Reserves of Selected Countries (Q1 2022 - Q2 2024)**

| Country | Reserve Type | ADF Statistic | p-value | ARIMA Model Coefficient (AR1) | ARIMA Model Coefficient (MA1) | Sigma^2 (Error Variance) | Interpretation |
|---|---|---|---|---|---|---|---|
| **United States** | Gold | 4.67 | 1 | -1 | 1 | 1.10E+09 | Non-stationary, Random Changes |
| **United States** | FX | -3.72 | 0.0038 | 0.1977 | -0.2518 | 5.37E+06 | Stationary, Possible Non-Random Changes |
| **Germany** | Gold | 4.47 | 1 | -0.977 | 0.9999 | 2.08E+08 | Non-stationary, Random Changes |
| **Germany** | FX | -2.13 | 0.2335 | -0.9755 | 0.998 | 3.54E+06 | Non-stationary, Random Changes |
| **Italy** | Gold | 4.67 | 1 | 0.2424 | -0.3082 | 3.27E+07 | Non-stationary, Random Changes |
| **Italy** | FX | 4.67 | 1 | 0.1667 | -0.2139 | 2.69E+06 | Non-stationary, Random Changes |
| **Japan** | Gold | 4.67 | 1 | -1 | 1 | 1.32E+07 | Non-stationary, Random Changes |

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|---|---|---|---|---|---|---|---|
| **Japan** | FX | -4.13 | 0.0009 | -0.9633 | 0.963 | 9.10E+08 | Stationary, Possible Non-Random Changes |
| **India** | Gold | 1.92 | 0.999 | -0.9746 | 0.9951 | 1.37E+07 | Non-stationary, Random Changes |
| **India** | FX | -0.82 | 0.815 | -0.8668 | 0.9035 | 2.95E+08 | Non-stationary, Random Changes |

**Interpretation**

Based on the results from the Augmented Dickey-Fuller (ADF) test and ARIMA model analysis, the null hypothesis (H04) that significant global events, such as the COVID-19 pandemic and geopolitical tensions, have had no measurable impact on the reserve management strategies of the selected countries is partially rejected. The FX reserves for the United States and Japan show stationarity, with p-values below 0.05, indicating potential non-random changes that may reflect the impact of global events. This suggests that these countries adjusted their reserve strategies in response to external influences. In contrast, the gold reserves and the FX reserves of Germany, Italy, and India exhibit non-stationary behavior, with high p-values, suggesting that any changes in these reserves are random and not significantly influenced by global events. Therefore, while the reserve management strategies in some countries appear to have been affected by global events, others remained unaffected, leading to a partial rejection of the null hypothesis.

**Key Findings and Discussion**

1. **Stability in Gold Reserves**: The analysis revealed that the fluctuations in the gold reserves of the selected countries from Q1 2022 to Q2 2024 were largely random. The ADF test and ARIMA model indicated no significant economic or policy-driven changes in gold reserves across the countries, suggesting that gold remains a stable reserve asset, unaffected by short-term global events.

2. **Divergence in FX Reserve Management**: While the FX reserves of the United States and Japan showed evidence of non-random changes, potentially influenced by global economic conditions and geopolitical tensions, other countries like Germany, Italy, and India exhibited random fluctuations. This divergence indicates varying reserve management strategies, with some nations responding more dynamically to external pressures.
3. **Proportion of Gold to Total Reserves**: The proportion of gold relative to total reserves remained stable across the selected countries during the study period. This stability suggests that countries maintained consistent strategies regarding gold allocation, despite the global economic environment, reinforcing gold's role as a long-term store of value.
4. **Impact of Global Events on Reserve Strategies**: The study found that significant global events had a measurable impact on the reserve strategies of certain countries, particularly the United States and Japan. However, for other nations, such as Germany, Italy, and India, these events did not significantly alter their reserve levels, highlighting the resilience or differing priorities of their reserve management policies.
5. **Diverse Reserve Management Approaches**: The findings underscore the diversity in reserve management approaches among the selected countries. While some focused on maintaining stability in gold reserves, others showed more active management of FX reserves in response to global economic fluctuations. This diversity reflects differing economic conditions, policy frameworks, and strategic priorities across these nations.

**Suggestions and Recommendations**

1. **Enhance Flexibility in Reserve Management**: Countries should consider adopting more flexible reserve management strategies that can quickly adapt to changing global economic conditions. This flexibility would help mitigate the impacts of economic shocks and geopolitical tensions on national reserves.
2. **Diversification of Reserve Assets**: To enhance economic stability, countries should diversify their reserve portfolios by balancing gold, FX reserves, and other financial instruments. Diversification can reduce the risk associated with over-reliance on a single type of reserve asset and provide greater financial security.

3. **Continuous Monitoring of Global Events**: Governments should implement robust monitoring systems to track global economic and geopolitical developments continuously. By doing so, they can proactively adjust their reserve management strategies to respond to potential risks and opportunities more effectively.
4. **Strengthen International Cooperation**: Countries should collaborate more closely on reserve management practices, sharing insights and strategies to navigate global economic challenges. International cooperation can help stabilize global financial systems and reduce the impact of regional or global crises on individual economies.
5. **Invest in Gold as a Hedge Against Uncertainty**: Given gold's stability during the study period, countries should consider increasing their gold reserves as a hedge against economic uncertainty. As a time-tested store of value, gold can provide a reliable foundation for national reserves, especially during periods of economic volatility.

**Conclusion**

The analysis highlights the diverse approaches to reserve management among the selected countries during the study period. While gold reserves remained largely stable, reflecting their role as a reliable asset, the FX reserves in countries like the United States and Japan were influenced by global events, indicating more dynamic management strategies. In contrast, other nations exhibited random fluctuations in their reserves, suggesting different priorities or resilience to external factors. Overall, the findings emphasize the importance of tailored reserve strategies that balance stability and adaptability to effectively navigate global economic uncertainties.

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