

The Gold Price and Macroeconomic Fundamentals : A Nexus

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Abstract: As the gold price is hiking tremendously, it is legitimate to validate the association between the gold price and economic stability. The study explores the relationship between macroeconomic indicators and the gold prices using panel data regression from 2000 to 2021. It focuses on two independent variables, the stock exchange and exchange rate, and two control variables, FDI net flow, and total reserve. Data sources include Bloomberg, OECD Statistics, and the World Gold Council. The pooled OLS regression findings highlight gold as a protective measure against economic uncertainty, with investors seeking refuge in gold when facing stock market or currency instability. There is little evidence to suggest that foreign investment inflows have a significant impact on gold prices, indicating that FDI does not notably affect gold prices in the short term. The statistically significant and positive impact of total reserves on gold prices suggests that central banks regard gold as a safe haven asset. An increase in gold holdings by central banks can signal confidence in the global economy, thus boosting gold demand. However, it is crucial to note that this model only captures the correlation between gold prices and the selected variables and does not account for other factors, such as geopolitical events or mining supply fluctuations, that could affect gold prices.

Keywords: Gold Prices, Macroeconomics, Safe Haven Asset, Panel Data Regression, Global Economy

Introduction

Historically, gold has been utilized as a plan to mitigate the effects of inflation. Furthermore, existing research has shown that gold can be applied as a safeguard against financial uncertainties. Investors have the option to enhance portfolio diversification through gold allocation. Additionally, there is evidence that gold acts as a hedge against currency risk. When we emphasize characteristics of gold regarding

the finances, it is observed with clarity that the price of gold is highly dependent on global economic circumstances (Chiang, 2024). As an instance, investors often chose gold during periods of economic difficulty because they are concerned about risk. Similar to this, the inverse relationship observed between currency fluctuations and gold prices indicates a preference among investors to allocate towards

gold rather than holding depreciating currencies. The majority of investors are now gravitating towards the metal markets because at the periods of crisis marked by heightened risk aversion, such as increased instability in stock markets or prolonged volatility in oil prices, attention tends to shift towards metal markets, notably gold, which is perceived as a sanctuary or safe-haven asset. Several studies and inquiries have looked into how gold prices react to changes in global macroeconomic and institutional variables [e.g., Chaity, N. S., & Islam, K. M. (2021); Ghosh, I., & Chaudhuri, T. D. (2018); Shylaja, H. N., & Pachiyappan, S. (2022); Sudasinghe, S. L., & Herath, N. P. (2022)]. The global gold markets diverged from the stock market in China, considering the impacts of the worldwide financial turmoil during 2008 to 2009. In addition, it has been found that stocks can be kept secure in gold during economic downturns. In this scenario, Chinese stock investors ought to be motivated to keep more gold in their diversified portfolios than stocks. According to the existing findings, gold is too dissimilar to each other to be classified as a singular asset class. Particularly, monetary variables can be used to experimentally explain gold volatility. Gold demonstrates a substantial level of responsiveness to both inflationary pressures and fluctuations in exchange rates, implying its potential efficacy as a protective measure against these economic factors and that gold should make up the wider holdings of an ideal precious metals portfolio that minimizes risk (Pachiyappan & Chandrakala, 2022). Most notably, the effect of external factors on the price of gold should be considered. It is crucial for the analysis to encompass more than just the trends of the currency or the stock exchange when assessing the relationship between the price of gold, currency movements, and the stock market. The study reexamines the correlation between the price of gold and various fundamental financial indicators. Using annual data from 2000 to 2021, the analysis focuses on the gold prices of key currencies in countries around the world. We significantly test the impact of benchmark stock exchanges, such as the S&P 500, DAX (Deutscher Aktien Index), FTSE MIB

Index, CAC 40, London Stock Exchange (LSE), Toronto Stock Exchange (TSX), SMI (Swiss Market Index), and TOPIX (Total Return Index), as well as various exchange rates on the price of gold. Additionally, we examine the impact of FDI net flow and total reserves, employing alternative explanations for the connection between the price of gold and macroeconomic fundamentals. Subsequent sections of this study are organized as follows. The Literature Review section provides a comprehensive overview of existing research related to the topic, identifying key themes and gaps in the current knowledge. Following this, the Theoretical Underpinning section outlines the theoretical framework guiding this study. The section Hypotheses of the Study highlights the hypotheses derived from theories, detailing their basis and expected outcomes. The Research Method section outlines the methods and procedures employed to collect and analyze data, ensuring the study's robustness and validity. The analysis of data and the results are presented in the section Analysis & Results. Subsequently, the Summary of Findings section presents the main results and interprets their significance in relation to the research questions. The Conclusion and Implications section concludes the study and discusses the practical applications of the findings for practitioners and decision-makers. Finally, the Scope for Further Research section identifies potential areas for future investigation, building on the insights gained from this study.

Literature Review

According to Shaique et al. (2016), there is no persistent connection between gold prices and the KSE 100 index. Meanwhile, Raza et al. (2016) investigates the impact of gold prices, oil prices, and their volatilities on stock markets in emerging economies. Both gold and oil volatilities had negative effects in the short and long term, with oil prices negatively influencing all emerging markets. Conversely, Gokmenoglu and Fazlollahi (2015) analyzed the relationship between stock indices and gold and oil prices, along with gold price volatility (GVZ) and oil price volatility

(OVX), revealing a sustained equilibrium among these variables. They further observed that the S&P 500 stock market index tends towards equilibrium over the long term. Choudhry et al. (2015) explored dynamic interactions showing non-linear correlations between UK stock market volatility, gold returns, and stock market returns, suggesting a bidirectional relationship where gold may not always act as a reliable safe-haven asset during financial crises. Regarding global gold prices and China's stock market, Aroui et al. (2015) argue that including gold with China's stocks in a portfolio enhances returns adjusted for risk and reduces exposure to stock market risks. Jain and Biswal (2016) explores the interplay among global gold prices, crude oil, the USD-INR exchange rate, and the Indian stock market. He observes a diminishing relationship between the value of the rupee and the benchmark Sensex index, as well as between gold and crude oil prices. Meanwhile, Bhunia and Pakira's (2014) investigation using the Granger causality test examines the impact of gold prices and exchange rates on India's Sensex, revealing either bidirectional causality or no causality between them. Among major currencies, floating exchange rates have significantly influenced the global gold market. Fluctuations in the US dollar value exert considerable influence on gold prices when evaluated in other currencies, contrasting with findings from an earlier study (Sjaastad, 2008). Haque et al. (2015) noted a robust positive correlation, suggesting that a one percent increase in the nominal price of gold leads to an upward shift in the AUD/USD nominal exchange rate, based on the US-quoted gold price and the AUD/USD exchange rate. According to Giannellis and Koukouritakis (2019), investors tend to favour gold as the misalignment of the real effective exchange rate increases. They also exhibit greater reluctance to sell gold in favour of higher-return assets during periods of significant interest rate hikes. In their study in Malaysia, Bin Sukri et al. (2015) investigated the relationships among gold and crude oil prices, fluctuations in the Malaysian ringgit exchange rate, real Malaysian GDP, and inflation. They discovered a strong positive

correlation between crude oil prices and gold prices, while noting a significant negative correlation with the Malaysian ringgit exchange rate. Meanwhile, Fang et al. (2018) found no clear correlation between inflation rates and gold prices, but identified a statistically significant negative relationship between real Malaysian GDP and gold prices. Qian et al. (2019) analyzed six factors—S&P 500, federal funds rate, CPI, exchange rates, oil prices, and the dollar index—and found that except for CPI, each showed a non-positive association with gold prices. Shakil et al. (2018) examined the Saudi Arabian gold price in relation to variables such as consumer price index (CPI), exchange rates, interest rates, oil prices, and stock market indices, concluding that gold serves as a hedge against inflation and portfolio risk. Apergis et al. (2019) argues that this is evidenced by gold's lack of responsiveness to CPI changes and its role as a hedge against fluctuations in real interest rates.

Theoretical Underpinning

To discern the connection among the gold prices and stock indices, exchange rate, as well as macroeconomic indicators, the present study meticulously conceptualizes the need for theoretical background (See Table 1).

Theory Background for gold price and stock indices

According to safe haven theory, when investors are unsure of the economy or financial markets, they tend to reallocate their investments from high-risk assets, like stocks, to safer alternatives, such as gold. As a result, the need for gold rises, which drives up its price. At the same time, the demand for stocks decreases, which drives down their prices. According to the inflation hedge theory, gold is frequently utilized as a safeguard against the erosive effects of inflation. because its price rises when inflation is high. Inflation erodes the value of currency and decreases the purchasing power of stocks, which makes them less attractive to investors. Investors may hold both gold and stocks in their portfolios as a way to diversify their risk, according to portfolio

diversification theory. Gold is often seen as a hedge against systemic risk, while stocks provide potential long-term growth.

Theory Background for gold price and exchange rates

When a country's money loses value or depreciates, its value compared to other currencies decreases, according to currency devaluation theory. As a result, the price of gold in that country's currency may increase, as gold is denominated in US dollars, and a weaker currency may mean more of that currency is needed to buying a fixed amount of gold. According to the theory of parity between interest rates, the difference in interest rates between two countries should match the difference in exchange rates in a perfect market. If there is a difference between the two, then there is an arbitrage opportunity, where investors can earn risk-free profits by borrowing in one currency and lending in another. If a country is experiencing economic or political instability, its currency may weaken, and investors may choose

to shift their assets to gold according to the flight to quality theory, which may cause the price of gold in that currency to increase.

Theory Background for gold price and macro-indicators

The portfolio diversification theory suggests that investors may allocate a portion of their portfolios to gold as a way to diversify their risk and protect against market volatility. This can affect investment flows into and out of different asset classes, including stocks, bonds, and commodities. The reserve asset theory implies that central banks may hold gold as a reserve asset in order to vary their foreign exchange reserves and mitigate risk. Variations in gold prices can impact these reserves value and the monetary policies of central banks.

Hypotheses of the Study

The dependent variable and exogenous variables are hypothesized based on the above theoretical understanding in the present study.

Table 1: Hypotheses based on Theories

S. No	Gold Price & Stock index	Expected Relationship
1.	Safe Haven Theory	Negative relationship
2.	Inflation Hedge Theory	Positive relationship
3.	Portfolio Diversification Theory	Positive relationship
S.No	Gold Price & Exchange rate	Expected Relationship
1.	Currency Devaluation Theory	Positive relationship
2.	Interest Rate Parity Theory	Negative relationship
3.	Flight to Quality Theory	Positive relationship
S. No	Macro-variable	Expected Relationship
1.	Investment flows	Positive relationship
2.	Reserves	Positive relationship

Source: Based on the theoretical understanding

Research Method

To assess the influence of the exogenous variables on price of gold in selected countries, the present study utilized panel data regression analysis using the data collected from World Gold Council, OECD statistics and World Development Indicators. The data were collected for the period of 2000 to 2021. The panel data estimators were

estimated using STATA, the data analysis was done by employing econometric methods such as pooled OLS regression model, fixed effect regression model, and random effect regression model. The outcomes of BPLM test and Hausman test for choosing a model were considered to determine the most suitable estimator for the empirical analysis.

Analysis & Results

To assess the influence of macro-indicators on gold price the study forms an equation to analyze using panel data regression.

The econometric form of the equation taken in log form;

$$\text{Lg_GPR}_{it} = \alpha_{it} + \beta_1 \text{Lg_STI}_{it} + \beta_2 \text{Lg_EXR}_{it} + \beta_3 \text{Lg_FDI}_{it} + \beta_4 \text{Lg_TotR}_{it} + u_{it}$$

Where,

GPR is the gold prices of selected nations in their own currency as a dependent variable

STI is the benchmark stock exchange of selected countries as an independent variable

EXR is the exchange rate of selected countries as an independent variable

FDI is the net flow of foreign investment in to the countries selected as a control variable

TotR is the total reserve of selected countries as a control variable

Pooled OLS

Here, pooled OLS regression analysis is employed to investigate the connection between the cost of gold and a set of exogenous variables, including stock index, exchange rate, FDI net flow and total reserve.

Table 2: Results of Pooled OLS

Lg_GPR	Coefficients	Std. Error	P> T
Lg_STI	.0453189	.0183895	0.015
Lg_EXR	.775966	.0320055	0.000
Lg_FDI	-.0122339	.0156567	0.436
Lg_Tot R	.4690788	.0514869	0.000
cons	-5.504791	1.314642	0.000
Prob> F	0.0000		
R-squared	0.9115		
AdjR-squared	0.9094		

Source: Computed in STATA

Table 2 shows the results of pooled OLS regression where the stock index and exchange rate exhibits a notable positive influence on the gold cost: The p values for both independent variables are less than 0.05, which means that their coefficients are significantly different from zero at the 95% confidence level. The positive coefficients (0.0453189 and 0.775966, respectively) indicate that an increase in stock index or exchange rate is associated with a corresponding increase in gold price. The Foreign Direct Investment (FDI) net flow shows a non-significant negative influence on the price of gold: The negative coefficient of FDI net flow indicates the rise in FDI net flow is correlated with a declining in the price of gold. However, the p-value is not significant, which means that these variable lacks statistical significance in explaining the fluctuation in the price of gold. Total reserve has a substantial beneficial impact on gold price. The total reserve coefficient is positive and large

which means a rise in total reserves is connected to a rise in the price of gold.

The overall model is fit and explains the r-square with 91%: The high R- squared value (91%) indicates that the model is well for the data and that the price of gold can be explained by independent variables in a substantial way.

Test for Heteroscedasticity

A heteroscedasticity test is employed to determine if the error's variance in a regression model remains consistent or varies.

B-P/Cook-Weisberg test for heteroskedasticity

Ho: Constant variance

Variables: fitted values of lg_GPR

chi2(1)=0.01

Prob>chi2=0.9258

Since this probability value is not statistically significant (i.e., not less than 0.05 or any pre-determined significance level), the test fails to reject the null hypothesis, indicating insufficient evidence to support the existence of heteroscedasticity.

Random Effect Model

A random effect model is a type of linear regression model that accounts for both within-

group and between-group variation by assuming that the intercept term of the regression equation varies randomly across different groups or clusters in the data. In this case, the random effect model indicates that the groups or countries included in the dataset have distinct unobserved factors influencing the association between the cost of gold and the external variables.

Table 3: Results of Random Effect Model

Lg_GPP	Coefficients	Std. Error	P> T
Lg_STI	.0453953	.0166224	0.006
Lg_EXR	.7108139	.0357143	0.000
Lg_FDI	-.0015029	.0138934	0.914
Lg_Tot R	.6177431	.0499298	0.000
_cons	-9.585153	1.279782	0.000
Prob> F	0.0000		
R-Sq: Within	0.7038		
Between	0.9416		
Overall	0.9068		

Source: Computed in STATA

The fact that the results from the random effects model in Table 3 are similar to those from the pooled OLS model suggests that the variation in the intercept term across different groups is relatively small and doesn't significantly affect the exogenous variables estimated coefficients.

BPLM Test

The BPLM test is used to examine how well a pooled OLS model and a random effects model perform. The alternative hypothesis for the test proposes that the random effects model fits the data better than the pooled OLS model. According to the null hypothesis, there is no discernible difference in the performance of the two models.

4.1.5 Breusch and Pagan Lagrangian multiplier test for random effects

$$Lg_GPR [Country\ 1,t] = Xb + u[Country1] + e[Country1,t]$$

Estimated results: Var sd = sqrt (Var)

Lg_GPR	2.862435	1.691873
e	.1026119	.3203309
u	.0050472	.0710439

Test: Var(u) = 0

$$\text{Chibar2}(01) = 253.48$$

$$\text{Prob} > \text{chibar2} = 0.0000$$

In this case, the p-value of the BPLM test is 0.000, which is less than the conventional significance level of 0.05. This outcome indicates strong proof against the null hypothesis. Thus, as compared to the pooled OLS model, the random effects model provides a significantly better fit for the data.

Fixed Effect Model

The fixed effect model represents a variant of panel data regression models that accounts for time- in variant heterogeneity across different units or entities in the data by including a set of dummy variables for each entity. In this case, according to the fixed effect model, the connection between the gold price and the exogenous variables is influenced by a few time-invariant unobserved factors that differ depending on which of the entities in dataset you include.

Table 4: Results of Fixed Effect Model

Lg GPR	Coefficients	Std. Error	P> T
Lg STI	.0401443	.0131766	0.003
Lg EXR	.6809317	.2047416	0.001
Lg FDI	.0145765	.0104264	0.164
Lg Tot R	.8571721	.0460479	0.000
cons	-16.10919	1.264875	0.000
Prob> F	0.0000		
R-Sq: Within	0.7156		
Between	0.9143		
Overall	0.8896		

Source: Computed in STATA

The fact that the results from the fixed effect model in Table 4 are different from those obtained from the pooled OLS and random effects models suggests that the time-invariant unobserved factors have a significant impact on the association between the external variables and the price of gold. Specifically, the fixed effect model estimates the effects of the exogenous variables on gold price while controlling for the heterogeneity that remains constant over time across different entities in the data.

The positive significant effects of a stock index, exchange rate, and total reserve on gold price suggest that these variables have a strong impact on the price of gold, while the insignificant positive effect of FDI net suggests that FDI net flow may

not be a significant predictor of gold price in the existence of time-invariant unobserved factors.

Hausman Test

The Hausman test is used to evaluate how well fixed effects and random effects models perform. The reason fixed effects are important to the model is that they help account for factors that are not observed but are consistent across time and might have relationships with the independent variables, that impact how the independent and dependent variables are related to one another. By including fixed effects in the model, the estimates of the regression coefficients for the dependent variables are less likely to be biased due to omitted variable bias or unobserved heterogeneity.

Table 5: Results of Hausman Test

	(b)re	(B) fe	(b-B) Difference	sqrt(diag(V_b-V_B))S.E.
Lg_STI	.0453953	.0401443	.005251	.0101331
Lg_EXR	.7108139	.6809317	.0298822	.
Lg_FDINET	-.0015029	.0145765	-.0160794	.0091824
lg_TotR	.6177431	.8571721	-.239429	.0193023

Source: Computed in STATA

Test: Ho: difference in coefficient not systematic

$$\text{Chi2}(4) = (b-B)' [V_b - V_B]^{-1} (b-B) = 81.83$$

Prob>chi2 = 0.0000

The rejection of the null hypothesis of Hausman test in Table 5 is in favour of the fixed effect model. It suggests that the time-invariant unobserved factors have a significant influence on the connectivity between gold price and the exogenous

variables and cannot be captured by the model incorporating random effects.

Overall, the fixed effect model is significant for the regression analysis because it accounts for time-invariant unobserved factors that affect the association between gold price and the exogenous variables. The positive significant effects of stock index, exchange rate, and total reserve suggest that these variables are significant indicators of the price of gold, while the insignificant positive effect of FDI net suggests that its impact on gold price may be limited in the presence of time-invariant unobserved factors.

Summary of Findings

The results of pooled OLS suggest that investors tend to buy gold when they are uncertain about the stock market or the strength of their currency. FDI net flow has a negative insignificant means that the growth in FDI net flow is related with a decrease in gold price. However, the p-value is not significant, which means, this variable does not show statistical significance in explaining the variation in gold price. This outcome implies that FDI net flow is not a major driver of gold prices, at least not in the short run. The significant strong effect of total reserve on gold price suggests that central banks tend to hold gold as a reserve asset, and an increase in their gold holdings can signal confidence in the world economy and raise the need for gold. It is important to note that the model only captures the relationship between gold prices and the chosen exogenous variables, without considering other factors that could influence gold prices, such as geopolitical events or fluctuations in mining supply. The outcome from the random effects model suggests that assuming homogeneity of regression coefficients across different groups is justified, and that a pooled OLS regression model can offer dependable estimates of the relationship between gold price and the chosen exogenous variables. However, the null hypothesis of the BPLM test is rejected, indicating that the random effects model provides a significantly superior fit. According to the fixed effect model, the positive significant effects of stock index, exchange rate, and total reserve on gold price suggest that these

variables have a positive impact on the price of gold, while the insignificant positive effect of FDI net suggests that FDI net flow may not be a significant predictor of gold price in the presence of time-invariant unobserved factors. The Hausman test rejects the null hypothesis in support of the fixed effects model, which implies that time-invariant unobserved factors influence the association between the cost of gold and the exogenous variables, which cannot be accounted for by the random effects model. Hence, the fixed effect model is an appropriate choice for the analysis as it accounts for the unobserved heterogeneity across different entities in dataset. The results imply that the stock exchange price, exchange rate, and total reserve are important predictors of gold price, while the influence of FDI net on gold price may be limited in the presence of unobserved heterogeneity. It is important to note that the fixed-effect model is only applicable to data, where the same entities are observed over multiple time periods.

Conclusion and Implications

The analysis confirms that gold is considered a sanctuary asset, with investors purchasing it during times of market or currency uncertainty. While FDI net flow shows a negative but insignificant impact on gold prices, total reserves have a strong positive effect, indicating central banks' preference for holding gold as a reserve asset. The random effects model, supported by the BPLM test, fits better than the P-OLS model. However, the fixed effects model, validated by the Hausman test, is deemed more appropriate due to its ability to account for time-invariant unobserved factors. The study concludes that stock exchange price, exchange rate, and total reserves are significant predictors of gold prices, whereas FDI net flow is not. The findings of this study carry significant implications for managers and policymakers. Firstly, the confirmation of gold as a sanctuary asset underscores its value in investment portfolios, especially during times of market uncertainty. Investment managers should consider increasing gold allocations when forecasting economic instability or currency weakness. Additionally, central banks' strong influence on gold prices through their reserves suggests that policymakers should monitor and

potentially adjust their gold holdings to signal economic confidence and stabilize markets. For multinational corporations, the study indicates that fluctuations in the stock market, exchange rates, and total reserves significantly impact gold prices. Therefore, financial strategists should incorporate these variables into their risk management frameworks. Companies involved in gold trading or those with substantial gold reserves should pay close attention to changes in these economic indicators to optimize buying and selling decisions. The finding that FDI net flow has an insignificant effect on gold prices suggests that managers should focus more on other economic indicators rather than FDI when predicting gold price movements. This insight can streamline the decision-making process and direct attention to more influential factors.

Scope for Future Research

While this study provides valuable insights, there are several areas for further research to enhance understanding of gold price dynamics. Future studies could explore the impact of geopolitical events and changes in mining supply on gold prices, as these factors were not accounted for in the current model. Additionally, examining the role of technological advancements in gold extraction and their influence on supply and price could provide a more comprehensive view. Another avenue for research is the investigation of gold price movements in relation to other alternative investment assets, such as cryptocurrencies or real estate. Comparing the behavior of gold prices with these assets during economic fluctuations could offer deeper insights for investors seeking diversification. Further research could also focus on a broader set of countries to determine if the findings of this study hold globally or if there are regional variations. Longitudinal studies examining the long-term trends and cyclicalities of gold prices in relation to macroeconomic variables would also be beneficial. Lastly, incorporating machine learning techniques to predict gold prices using a wide range of economic, political, and social variables could lead to the development of more sophisticated and accurate predictive models. These models could significantly aid investors and policymakers in making more informed decisions.

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