



Does the Rupee or Inflation Drive Gold? An ARIMAX Analysis of Gold Price Determinants in India

Babitha L

Higher Secondary School Teacher (Economics), Government Higher Secondary School, Mangalam, Alappuzha, Kerala, 690515, Email: babitha.research@gmail.com, Orcid ID: 0009-0002-7346-9902

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ABSTRACT

This study asks a deceptively simple question about the world's second-largest gold market: is the domestic price of gold in India driven more by movements in the rupee or by domestic inflation, and does accounting for these macroeconomic forces improve the ability to forecast gold prices? Using 144 monthly observations from January 2014 to December 2025, the analysis first models the price with a univariate Box-Jenkins framework and then augments it with an autoregressive integrated moving average model with exogenous regressors (ARIMAX), in which the USD/INR exchange rate and the Consumer Price Index enter as transfer functions alongside deterministic controls for the COVID-19 disruption and the July 2024 reduction in gold import duty. Augmented Dickey-Fuller tests confirm that all series are integrated of order one, and the models are therefore estimated in log-first differences. The exchange rate is found to exert a positive and statistically significant influence on gold prices, with an estimated elasticity of approximately 0.42: a depreciating rupee raises the domestic price of gold within the same month. Inflation, by contrast, carries the expected positive sign but is statistically insignificant, a result consistent with the view that gold's inflation-hedging property operates through a long-run equilibrium

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relationship rather than through month-to-month co-movement. The ARIMAX improves in-sample fit and marginally lowers out-of-sample forecast error relative to the univariate benchmark, although a Diebold-Mariano test indicates the improvement is directional rather than statistically decisive. The central conclusion is that currency depreciation, and not short-run inflation, is the dominant macroeconomic determinant of Indian gold prices, a finding with direct relevance for investors, importers and monetary authorities.

1. Introduction

Gold occupies a position in the Indian economy that few other assets can rival. It functions at once as an ornament, an intergenerational store of value, a vehicle for household savings beyond the formal financial system, and a refuge in times of macroeconomic stress. Because this demand is culturally rooted and comparatively insensitive to price, India's substantial gold imports weigh directly on its external accounts, and the domestic price of gold becomes a consequence for importers, investors and policymakers alike. Understanding what moves that price is therefore not merely an academic pursuit; it bears on the management of foreign-exchange reserves and the balance of payments.

Economic theory identifies two macroeconomic channels with clear claims on the domestic gold price. The first is the exchange rate. As bullion is quoted internationally in US dollars, the rupee price of gold is, mechanically, close to the world dollar price multiplied by the USD/INR rate together with applicable duties; a depreciation of the rupee thus raises the cost of gold even when the world price is unchanged. The second is inflation. If gold preserves its real value while paper currency loses purchasing power, savers substitute towards it as prices rise, and the additional demand lifts its price. These two mechanisms motivate the hypotheses examined here.

A large body of work has modelled gold prices, yet two gaps persist. Purely univariate time-series models capture the price's own momentum. Still, they are, by construction, blind to macroeconomic fundamentals. At the same time, fully multivariate systems often impose a degree of feedback that is implausible for the Indian retail market, where domestic demand does not move the global exchange rate. The ARIMAX specification occupies a defensible middle ground, retaining an interpretable autoregressive structure while admitting the exchange rate and inflation as one-way exogenous inputs. Furthermore, much of the existing evidence predates the two major structural shocks that dominate the recent Indian experience, namely the

COVID-19 shock and the July 2024 reduction in the gold import duty, which any credible contemporary model must accommodate. This study addresses these gaps by estimating a parsimonious, structurally adjusted ARIMAX over the period 2014-2025 and asking, directly, whether the rupee or inflation is the more powerful driver of gold prices, and whether either materially improves forecasting performance.

2. Objectives

The study pursues three objectives:

- To characterise the stochastic properties and short-run dynamics of monthly Indian gold prices within a Box-Jenkins framework;
- To quantify the effect of the USD/INR exchange rate and of domestic inflation on gold prices by estimating an ARIMAX model in which these variables enter as exogenous transfer functions; and
- To evaluate whether incorporating these macroeconomic drivers improves out-of-sample forecasting accuracy relative to a univariate benchmark.

3. Hypotheses

Two directional hypotheses are tested:

- H1: The exchange rate has a positive effect on gold prices
- H2: Inflation has a positive effect on gold prices

4. Related Works

4.1 Gold and the exchange rate

The inverse relationship between gold and the US dollar is among the most durable regularities in asset pricing. Capie et al. (2005), using three decades of weekly data, documented a negative and typically inelastic relationship between the dollar gold price and the sterling-dollar and yen-dollar exchange rates, concluding that gold serves as a hedge against fluctuations in the external value of the dollar, albeit to a degree that shifts over time. Reboredo (2013) formalised the relationship using copulas and found significant positive dependence between gold and dollar depreciation, together with symmetric tail dependence that renders gold an effective haven against extreme currency movements. For the Indian market specifically, Gangopadhyay et al. (2015) estimated a vector error-correction model on official data and reported that the domestic gold price rises when the rupee weakens, describing gold as a good hedge

against the dollar from the standpoint of domestic investors. Jain and Biswal (2016) likewise identified significant dynamic linkages among the global gold price, the USD/INR exchange rate and the Indian stock market. Collectively, this literature provides strong prior support for a positive association between rupee depreciation and domestic gold prices.

4.2 Gold and inflation

The evidence on gold as an inflation hedge is older and more qualified. Ghosh et al. (2004) advanced a theoretical model in which the price of gold rises with the general price level over the long run, while emphasising that short-run movements are disturbed by other factors, including the real interest rate and the dollar exchange rate, that generate substantial short-run volatility. This distinction between a long-run equilibrium and short-run deviations is central to the interpretation of the present study's results. Conlon et al. (2017) refined the picture using a wavelet decomposition, showing that gold's inflation-hedging capacity is time-scale dependent and varies across horizons and economies. Salisu (2019) found gold to be an effective inflation hedge across OECD countries, while noting that its strength is contingent and, in several markets, sensitive to sample and horizon. The common thread is that gold's inflation hedge is chiefly a long-horizon, equilibrium phenomenon rather than a month-to-month relationship.

4.3 Forecasting gold: from ARIMA to ARIMAX

The Box-Jenkins methodology (Box & Jenkins, 1976) remains the standard approach to univariate commodity forecasting, and applied work consistently finds low-order specifications adequate for gold. The recognised limitation of the pure model is its exclusion of fundamentals, which the ARIMAX addresses by embedding exogenous regressors as transfer functions within the same error structure. The unit-root apparatus underpinning the modelling decisions derives from Dickey and Fuller (1979), and the formal comparison of competing forecasts rests on Diebold and Mariano (1995). Together, these strands justify the design adopted here: model the price's own dynamics, introduce the two fundamentals identified by theory, control for known structural breaks, and let an out-of-sample contest determine whether the additions improve forecasting.

5. Materials and Methods

5.1 Data and variables

The analysis employs monthly secondary data spanning January 2014 to December 2025, yielding 144 observations. The dependent variable is the Indian retail gold price, expressed in rupees per ten grams. The

exogenous variables are the USD/INR nominal exchange rate (rupees per US dollar) and the All-India Consumer Price Index (Combined; base 2012 = 100). The gold price and the exchange rate are official series reported by the Reserve Bank of India, and the price index is compiled by the Ministry of Statistics and Programme Implementation. The three series were aligned on a common monthly index and screened for gaps, missing values and duplicate records; none were present, giving a continuous and complete series over the sample window.

5.2 Data transformation and justification

Three standard transformations prepare the data for estimation. First, each series is expressed in natural logarithms. Because the variables grow approximately multiplicatively and their variance widens with their level, the logarithmic transformation stabilises the variance and, importantly for the hypotheses, renders the estimated coefficients as elasticities. Second, the logged series are first-differenced. The level series are non-stationary, and regressing one non-stationary series on another risks a spurious relationship; differencing the logarithm removes the stochastic trend and yields a stationary series that approximates the monthly growth rate (Box & Jenkins, 1976). Third, two deterministic dummy variables isolate episodes that do not belong to the ordinary macroeconomic relationship: a pulse control for the acute phase of the COVID-19 disruption in 2020, and a control for the July 2024 reduction of gold import duty to six per cent. Absorbing these episodes allows the transfer-function coefficients to reflect normal transmission rather than one-off shocks.

5.3 Econometric procedure

The empirical strategy proceeds in sequence. The order of integration of each series is established using the Augmented Dickey-Fuller (ADF) test, with a constant and trend at the level and a constant at the first difference; lag lengths are selected automatically by the Schwarz information criterion. The autoregressive and moving-average orders of the differenced gold series are identified from the sample autocorrelation and partial autocorrelation functions. A univariate ARIMA is then estimated as a benchmark, followed by the ARIMAX, which adds the exchange rate and inflation growth rates and the two dummies as exogenous regressors. Both models are estimated by maximum likelihood. The adequacy of the preferred model is assessed through the Ljung-Box Q-statistic for residual autocorrelation, an ARCH test for conditional heteroskedasticity, and the Jarque-Bera statistic for normality. Finally, forecasting performance is evaluated out of sample using the root mean squared error (RMSE), mean absolute error (MAE), mean absolute percentage error (MAPE) and Theil's inequality coefficient, with a Diebold-Mariano (1995) test assessing the statistical significance of any difference in accuracy.

6. Analysis of Data

6.1 Descriptive statistics

Table 1 summarises the three series over the sample. The gold price is strongly right-skewed and leptokurtic, and its Jarque-Bera statistic decisively rejects normality, reflecting the pronounced acceleration of the price in the final two years of the window. The exchange rate and the price index are closer to symmetric but still depart from normality at conventional levels. Figure 1 plots the three series in levels; the shared upward trend and the visible disturbances around 2020 and mid-2024 are evident.

Table 1. Descriptive statistics of the variables (levels, n = 144)

Statistic	GOLD (₹/10g)	USDINR	CPI (2012=100)
Mean	46,263.37	73.0162	153.3896
Median	39,099.00	72.0080	148.8500
Maximum	131,172.0	90.0350	198.0000
Minimum	25,207.00	59.2843	113.6000
Std. deviation	22,124.16	8.2665	25.8920
Skewness	1.5639	0.2661	0.2784
Kurtosis	5.4536	1.8640	1.7512
Jarque-Bera	94.8182	9.4421	11.2171
Probability	0.0000	0.0089	0.0037

Source: Author's computation using EViews.

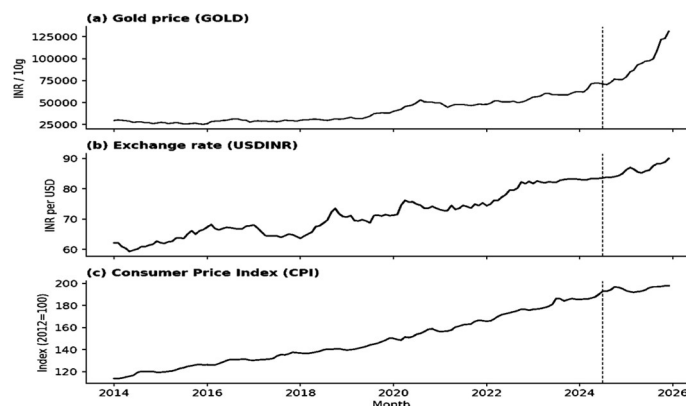


Figure 1. Monthly Gold Price, USD/INR exchange rate and CPI in levels, 2014-2025

Source: Author's computation.

6.2 Correlation

Table 2 reports the correlation among the stationary (log-differenced) series that enter the models. The simultaneous association between gold and the exchange rate is positive and modest, while that between gold and inflation is close to zero, foreshadowing the regression results. The exchange rate and inflation are essentially uncorrelated, which mitigates concerns about collinearity between the two exogenous regressors.

Table 2. Correlation matrix of the log-differenced variables

	$\Delta \ln \text{GOLD}$	$\Delta \ln \text{USDINR}$	$\Delta \ln \text{CPI}$
$\Delta \ln \text{GOLD}$	1.0000	0.1805	-0.0295
$\Delta \ln \text{USDINR}$	0.1805	1.0000	-0.0012
$\Delta \ln \text{CPI}$	-0.0295	-0.0012	1.0000

Source: Author's computation using EViews.

6.3 Stationarity

Table 3 presents the ADF results. At the level, none of the three series rejects the unit-root null at the five per cent level, whereas at the first difference each rejects it decisively. All three variables are therefore integrated of order one, confirming that estimation in log-first differences is appropriate and that modelling the levels directly would risk a spurious regression.

Table 3. Augmented Dickey-Fuller unit-root test results

Series	ADF (level)	Prob.	ADF (1st diff.)	Prob.	Order
$\ln \text{GOLD}$	-0.7344	0.9680	-8.6669	0.0000	I(1)
$\ln \text{USDINR}$	-2.7028	0.2372	-10.4177	0.0000	I(1)
$\ln \text{CPI}$	-3.3852	0.0575	-8.4175	0.0000	I(1)

Source: Author's computation using EViews.

The differenced log gold series and its correlogram are shown in Figure 2. Both the autocorrelation and partial autocorrelation functions exhibit a single significant spike at the first lag before decaying within the confidence band, a signature consistent with a low-order process and guiding the specification of the mean equation.

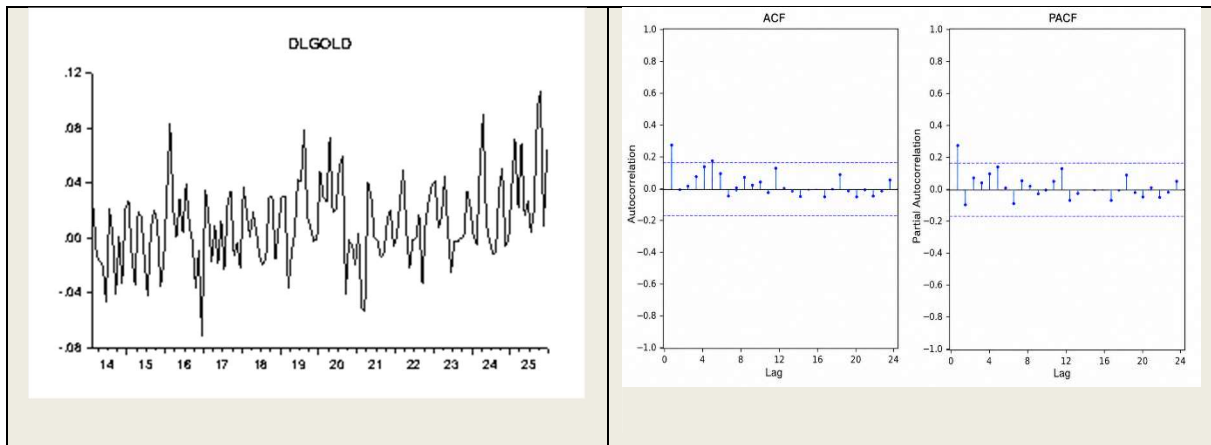


Figure 2. The first log-difference of gold with its ACF and PACF

Source: Author's computation.

6.4 Model estimation

Table 4 reports the univariate benchmark. The intercept is positive and significant, corresponding to an average monthly drift in the log price of about one per cent, while the autoregressive and moving-average terms are individually insignificant, indicating that a parsimonious low-order structure adequately captures the price's own dynamics.

Table 4. Baseline ARIMA estimation of $\Delta \ln \text{GOLD}$

Variable	Coefficient	Std. error	t-statistic	Prob.
Constant	0.0106	0.0032	3.3077	0.0012
AR (1)	-0.0150	0.2577	-0.0582	0.9536
MA (1)	0.3365	0.2441	1.3781	0.1704
σ^2	0.0008	0.0001	8.4557	0.0000

Source: Author's computation using EViews.

Table 5 reports the ARIMAX. The coefficient on the exchange-rate growth rate is positive and significant at the five per cent level, with a magnitude of 0.42, while the coefficient on inflation is positively signed but statistically insignificant. Both structural-break controls are significant. The model's explanatory power is materially higher than that of the benchmark: the adjusted coefficient of determination rises from 0.072 to 0.169, the log-likelihood increases from 302.76 to 312.74, and the Akaike information criterion falls from -4.178 to -4.262, indicating that the exogenous variables and controls make a genuine contribution to fit.

Table 5. ARIMAX estimation of $\Delta \ln$ GOLD with exogenous regressors and structural-break controls

Variable	Coefficient	Std. error	t-statistic	Prob.
Constant	0.0040	0.0035	1.1655	0.2459
$\Delta \ln$ USDINR	0.4155	0.2000	2.0774	0.0397
$\Delta \ln$ CPI	0.1356	0.4086	0.3318	0.7406
DUMMY_COVID	0.0342	0.0134	2.5534	0.0118
DUMMY_JUL24	0.0273	0.0083	3.2958	0.0013
AR(1)	-0.1977	0.2596	-0.7616	0.4477
MA(1)	0.4531	0.2323	1.9503	0.0532
σ^2	0.0007	0.0001	8.4557	0.0000

Source: Author's computation using EViews.

Diagnostic tests confirm the adequacy of the ARIMAX (Table 6). The Ljung-Box statistic indicates no residual autocorrelation, the ARCH test finds no conditional heteroskedasticity, and the Jarque-Bera statistic does not reject normality of the residuals. The estimated relationships may therefore be interpreted with confidence.

Table 6. Residual diagnostic tests for the ARIMAX model

Test	Statistic	Prob.	Inference
Ljung-Box Q(12)	9.34	0.500	No autocorrelation
ARCH LM (12)	12.79	0.384	Homoskedastic
Jarque-Bera	0.42	0.809	Normal residuals

Source: Author's computation using EViews.

6.5 Out-of-sample forecasting

To assess forecasting performance, both models were re-estimated on data through December 2024 and used to generate dynamic forecasts of the twelve months of 2025. Table 7 reports the accuracy measures together with the Diebold-Mariano test. The ARIMAX attains a lower error on every metric, though the margin is small; the Diebold-Mariano statistic, while positive, does not reject equal predictive accuracy. Figure 3 clarifies the pattern: both models project a gentle continuation of the historical drift and substantially under-predict the exceptional 2025 rally, in which the price advanced from roughly ₹79,000 to

₹131,000 per ten grams under the influence of global forces outside the scope of a domestic two-variable model.

Table 7. Out-of-sample forecast accuracy (holdout: 2025) and Diebold-Mariano test

Measure	ARIMA	ARIMAX	Difference
RMSE (₹/10g)	25,575.72	25,173.49	ARIMAX lower
MAE (₹/10g)	21,536.56	21,317.83	ARIMAX lower
MAPE (%)	19.68	19.51	ARIMAX lower
Theil's U	0.1399	0.1375	ARIMAX lower
Diebold-Mariano	stat = 1.19	p = 0.258	Not significant

Source: Author's computation using EViews.

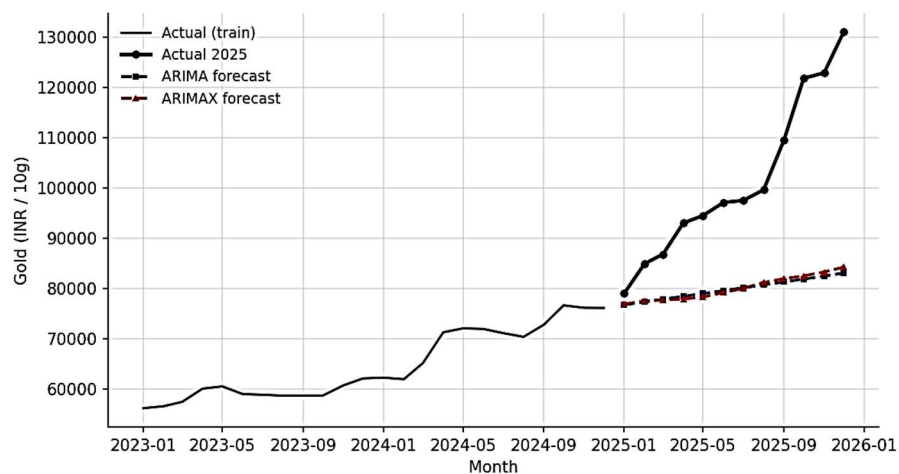


Figure 3. Actual gold price and dynamic out-of-sample forecasts, 2025

Source: Author's computation.

7. Results and Discussion

The estimated ARIMAX provides a direct test of the two hypotheses set out in Section 3. The outcome is summarised in Table 8 and discussed in turn below.

Table 8. Summary of hypothesis testing

Hypothesis	Result	Statistical basis
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H1: The exchange rate has a positive effect on gold prices	Supported	$\Delta \ln \text{USDINR} = 0.42$ ($p = 0.040$)
H2: Inflation has a positive effect on gold prices	Not supported	$\Delta \ln \text{CPI} = 0.14$ ($p = 0.741$); correct sign, insignificant

Source: Author's computation using EViews.

Hypothesis 1 is supported. Between the two macroeconomic candidates, it is the rupee, not inflation, that drives the domestic price of gold. The exchange-rate elasticity of approximately 0.42, significant at the five per cent level, implies that a one per cent depreciation of the rupee raises the domestic gold price by about four-tenths of a per cent within the same month, holding inflation and the structural episodes constant. This is precisely the currency-transmission mechanism the hypothesis anticipates, and it accords closely with the Indian evidence of Gangopadhyay et al. (2015) and Jain and Biswal (2016), as well as with the international findings of Capie et al. (2005) and Reboredo (2013). Since India meets the greater part of its gold demand through imports priced in dollars, a weaker rupee raises the landed cost directly, and the estimated elasticity quantifies the strength of that pass-through.

Hypothesis 2 is not supported at the monthly frequency examined here. The coefficient on the price index is positive, consistent with the hedging hypothesis, but it is not statistically significant. This outcome is neither anomalous nor at odds with the literature. As Ghosh et al. (2004) demonstrate, the inflation-hedging property of gold is fundamentally a long-run equilibrium relationship, with short-run movements governed by other factors, including the exchange rate; a model estimated in first differences is, by design, oriented to short-run co-movement rather than to the long-run equilibrium. The near-zero simultaneous correlation between gold and inflation reported in Table 2 reinforces this reading, as does the observation that Indian consumer prices evolve smoothly from month to month and thus carry little short-run signal for a volatile asset. Conlon et al. (2017) and Salisu (2019) similarly find the inflation hedge to be horizon-dependent and contingent. The appropriate conclusion is therefore that gold's inflation-hedging role in India operates over longer horizons than a monthly ARIMAX is designed to detect, rather than that it is absent.

The structural-break controls behave sensibly. The COVID-19 coefficient is positive and significant, capturing the elevated gold returns of the flight-to-safety episode in 2020. The July 2024 control is also positive and significant; in a differenced specification, this coefficient reflects the change in the average monthly return following the policy change, a period during which gold appreciated strongly under global influences, so that the control absorbs the momentum of the post-2024 rally rather than the level effect of



the duty reduction in isolation. Its inclusion is nonetheless important, as it prevents that episode from contaminating the estimated transfer functions.

On the question of forecasting, the results are measured. The ARIMAX improves in-sample fit substantially and lowers out-of-sample error on every accuracy measure, yet the Diebold-Mariano test cannot certify the improvement as statistically significant over the holdout. The explanation lies in the character of the test period: the 2025 rally was of exceptional magnitude and was propelled by international factors, so that both models, anchored to domestic information and to the price's own recent history, under-predicted it and the gap between them narrowed. The high bias component of Theil's coefficient confirms that the forecast error is dominated by systematic under-prediction rather than random dispersion. The practical implication is that the exogenous variables genuinely add explanatory content, particularly the exchange rate, but that a two-variable domestic model cannot, on its own, anticipate globally-driven surges in the gold price.

8. Suggestions

Several practical and research implications follow. For investors and importers, the exchange rate emerges as the single most important domestic macroeconomic variable to monitor when forming a view on gold; hedging rupee exposure is, in effect, partial hedging of domestic gold-price risk. For monetary authorities, the strength of the exchange-rate pass-through underscores the link between currency stability, gold imports and the external accounts, and supports attention to orderly exchange-rate management. For researchers, the finding that inflation is insignificant in first differences should be read as an invitation rather than a closure: a natural next step is to test directly for a long-run cointegrating relationship among the levels of gold, the exchange rate and prices, using the Johansen or bounds-testing frameworks, which examine the equilibrium at the horizon where the inflation hedge is expected to operate. Extending the information set to include the global dollar gold price, real interest rates and measures of global uncertainty would help to explain the globally-driven episodes that the present model cannot, and modelling the conditional variance through the GARCH family would illuminate the volatility dynamics that accompany such episodes.

9. Conclusion

This study set out to determine whether the rupee or inflation is the more powerful driver of gold prices in India, and whether accounting for these forces improves the ability to forecast the price. Drawing on 144 monthly observations from 2014 to 2025 and an ARIMAX specification that controls explicitly for the COVID-19 disruption and the July 2024 duty reduction, the analysis reaches a clear and differentiated conclusion. All three series are integrated of order one, and gold's own dynamics are those of a



parsimonious low-order process. Of the two macroeconomic candidates, the exchange rate is a genuine, statistically significant and positively-signed determinant of gold prices, with an estimated elasticity of approximately 0.42, whereas inflation, though correctly signed, exerts no significant short-run effect, a pattern consistent with an inflation hedge that operates over longer horizons than monthly differencing can capture. Incorporating the two fundamentals improves the model's fit and lowers its forecast error, but the forecasting gain over a univariate benchmark is directional rather than decisive, because the extraordinary rally of 2025 was driven by global forces beyond a domestic two-variable model. The overarching message is unambiguous: currency depreciation, and not short-run inflation, is the dominant macroeconomic determinant of Indian gold prices. This finding carries direct significance for portfolio managers seeking to hedge gold-price risk, for importers exposed to currency movements, and for policymakers concerned with the interplay of the exchange rate, gold imports and external stability, and it points naturally towards a long-run cointegration analysis as the next stage of enquiry.

Conflict of Interest

The research was carried out independently, and no external funding agency, commercial entity, or sponsoring organisation had any involvement in the study

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request

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