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Gold Prices and Macroeconomic Fundamentals in India: Exchange Rate Dominance, Inflation Hedging, and Long-Run Cointegration Evidence from ARDL Bounds Testing (2007–2022)

Snekha S
Student, Faculty of Management Studies,
CMS Business School, JAIN (Deemed-to-be University), Bengaluru, India.
Email: snekha_s24@cms.ac.in

Dr. Vedantam Seetha Ram
Associate Professor, Faculty of Management Studies,
CMS Business School, JAIN (Deemed-to-be University), Bengaluru, India
Email: Vedantam_seetharam@cms.ac.in

Abstract

This study empirically investigates the long-run and short-run determinants of domestic gold prices in India using monthly data spanning January 2007 to December 2022 (192 observations). Employing the Autoregressive Distributed Lag (ARDL) bounds testing framework of Pesaran, Shin, and Smith (2001), we establish a stable cointegrating relationship among gold prices and five macroeconomic fundamentals: consumer price inflation, the INR/USD exchange rate, the RBI repo rate, Brent crude oil prices, and the Nifty 50 equity index. The exchange rate emerges as the dominant driver with a super-unitary long-run elasticity of 1.23, reflecting India's structural import-dependence for gold. Inflation exhibits a near-unitary hedging elasticity of 0.87, confirming gold's role as a long-run inflation hedge. The repo rate exerts a significant negative effect (−0.34), validating opportunity cost theory, while crude oil (0.41) transmits positively through inflationary and current-account channels. The Nifty 50 yields a negative coefficient (−0.19), consistent with safe-haven substitution. The error correction term of −0.288 indicates that approximately 28.8% of short-run deviations from long-run equilibrium are corrected each month. Granger causality tests confirm unidirectional causality from all macroeconomic variables to gold prices, and Forecast Error Variance Decomposition attributes 61.2% of gold price forecast variance to macroeconomic fundamentals at the 24-month horizon. Comprehensive diagnostic tests confirm model adequacy. The findings carry significant implications for monetary policy transmission, portfolio diversification, and India's import management strategy.

Keywords: *Gold prices; ARDL bounds testing; Exchange rate passthrough; Inflation hedge; Safe-haven; Cointegration; India*

JEL Classification: C22; E31; F31; G11; Q02

INTRODUCTION

Gold occupies a singularly complex position in the Indian economy—simultaneously a cultural and ritual asset, a household savings vehicle, a monetary reserve, and an internationally traded commodity. India is consistently among the world's largest consumers and importers of gold, absorbing an estimated 700–900 tonnes annually, making the domestic price of gold highly sensitive to global dollar-denominated commodity cycles, currency market dynamics, and monetary policy conditions. Unlike many financial assets, gold does not generate a yield, which means its demand is fundamentally determined by macroeconomic conditions that alter its relative attractiveness as a store of value and portfolio hedge.

The macroeconomic determinants of gold prices in India operate through multiple simultaneous channels. Because India imports virtually all of its gold, the domestic rupee price is directly the product of the international dollar price multiplied by the prevailing INR/USD exchange rate, making currency depreciation a near-mechanical price passthrough mechanism. Inflation erodes the purchasing power of financial assets, increasing demand for inflation-resistant real assets such as gold. Rising interest rates increase the opportunity cost of holding non-yielding gold, reducing investment demand. Crude oil price shocks affect gold prices indirectly through their impact on general inflation and on India's current account deficit, which in turn generates rupee depreciation pressure. Finally, equity market booms reduce safe- haven demand for gold, while equity crashes trigger capital flight toward bullion.

Despite the theoretical richness of these transmission channels, existing empirical evidence on their relative magnitudes in the Indian context remains incomplete. Prior Indian studies, including Sharma (2014), Srinivasan (2014), and Jain and Biswal (2016), establish the broad significance of exchange rates and inflation but do not systematically quantify the elasticities of all five channels within a unified long- run and short-run framework. The more recent contributions of Khatri and Chhikara (2024) and Kumar and Goel (2024) provide updated estimates but do not fully address the speed-of-adjustment and structural stability dimensions essential for policy calibration.

This paper addresses these gaps by applying the ARDL bounds testing approach of Pesaran, Shin, and Smith (2001) to 192 monthly observations from January 2007 to December 2022. This period is particularly analytically rich, encompassing the Global Financial Crisis (2008–2009), the commodity super-cycle and gold price peak (2011–2013), the US Federal Reserve's taper tantrum (2013–2015), India's adoption of flexible inflation targeting (2016), and the COVID-19 pandemic safe-haven demand episode (2020–2022). The ARDL framework is chosen because it accommodates variables of mixed integration orders, delivers reliable estimates in moderate sample sizes, and enables simultaneous estimation of long-run elasticities and the Error Correction Model within a single equation.

Our principal contributions are fourfold. First, we provide the most comprehensive elasticity decomposition of gold price determinants in India across all five macroeconomic channels to date, covering the full 2007–2022 macroeconomic cycle. Second, we document a super-unitary exchange rate passthrough elasticity of 1.23, which exceeds the theoretical benchmark of unity and has significant implications for current account deficit management. Third, we demonstrate that macroeconomic fundamentals collectively explain over 61% of gold price forecast variance at the 24-month horizon, establishing the primacy of macroeconomic over idiosyncratic factors. Fourth, we provide policymakers and investors with a precisely calibrated adjustment speed estimate of 28.8% per month, implying a convergence half-life of approximately 2.1 months from any macroeconomic shock.

The remainder of this paper is organized as follows: Section 2 reviews the theoretical and empirical literature. Section 3 describes the data and econometric methodology. Section 4 presents and interprets the empirical results. Section 5 discusses implications and policy recommendations. Section 6 concludes.

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

Theoretical Foundations

The macroeconomic determination of gold prices is grounded in four theoretical pillars. The Inflation Hedge Theory (Jastram, 1977; Beckmann et al., 2015) posits that gold maintains purchasing power over long horizons because its supply grows slowly relative to fiat money creation. A unitary long-run inflation elasticity implies perfect hedging; sub-unitary elasticity indicates partial hedging. The Opportunity Cost Theory (Frankel, 2006; Wang and Chueh, 2013) argues that the gold price is inversely related to real interest rates because holding gold forfeits the yield available from interest-bearing assets. The Exchange Rate Passthrough Theory holds that for import-dependent economies, domestic commodity prices are mechanically transmitted through exchange rate changes, with the degree of passthrough determined by market microstructure, trade costs, and monetary policy credibility. The Safe Haven and Portfolio Diversification Theory (Baur and McDermott, 2010; Reboredo, 2013) predicts a negative relationship between equity market performance and gold prices, arising from flight-to-safety behavior during financial stress.

Empirical Literature

The empirical literature on gold price determinants spans advanced and emerging economies. Beckmann et al. (2015) and Bredin et al. (2015) document the conditional inflation-hedging and safe-haven properties of gold in developed markets using smooth transition regression and wavelet methods respectively. Madani and Ftiti (2019) employ wavelet-based extreme value theory to establish gold's hedge properties against oil and currency movements. In the Indian context, Sharma (2014) first confirmed macroeconomic determinants of gold prices but relied on Ordinary Least Squares without cointegration analysis. Srinivasan (2014) applied VAR methods to establish the gold-exchange rate-stock market nexus. Jain and Biswal (2016) demonstrated dynamic linkages among gold, oil, exchange rates, and equities using time- varying copulas, finding that gold-exchange rate linkages strengthened during crisis periods. More recently, Khatri and Chhikara (2024) applied quarterly ARDL analysis over 2010–2023 to confirm inflation and exchange rate dominance. The present study advances this literature by using higher- frequency monthly data spanning a longer and more structurally diverse period, incorporating all five macroeconomic channels simultaneously, and providing impulse response and variance decomposition evidence alongside elasticity estimates.

DATA AND ECONOMETRIC METHODOLOGY

Data Sources and Variable Construction

The study uses monthly data from January 2007 to December 2022 (T = 192 observations), providing sufficient degrees of freedom for robust ARDL estimation. All variables are transformed into natural logarithms, so estimated coefficients represent elasticities directly. Table 1 defines each variable and its data source. The dependent variable is the domestic gold price in INR per 10 grams, sourced from the Multi Commodity Exchange of India (MCX) and the Indian Bullion and Jewellers Association (IBJA). Explanatory variables are: the Consumer Price Index (CPI, base 2012=100) from MoSPI and the RBI Handbook of Statistics; the bilateral INR/USD nominal exchange rate from the RBI Database on Indian Economy; the RBI repo rate (annual percentage); Brent crude oil prices in USD per barrel from the World Bank Pink Sheet; and the Nifty 50 index from the National Stock Exchange of India.

Econometric Framework

The study follows a five-stage sequential analytical framework. Stage 1 examines descriptive statistics. Stage 2 tests for unit roots using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests in both levels and first differences. Stage 3 applies the ARDL bounds test for cointegration. Stage 4 estimates long-run coefficients and the short-run Error Correction Model (ECM). Stage 5 conducts Granger causality analysis and Forecast Error Variance Decomposition (FEVD) within a VAR framework.

The ARDL(p, q_1, q_2, q_3, q_4, q_5) model for gold prices takes the form:

$$\Delta lnGOLDt = \alpha_0 + \Sigma_{i=1}{}^{p}\ \beta_{1i}\Delta lnGOLDt-i + \Sigma_{j=0}{}^{\wedge}q_1\ \beta_{2j}\Delta lnCPIt-j + \Sigma_{j=0}{}^{\wedge}q_2\ \beta_{3j}\Delta lnEXRATEt-j + \Sigma_{j=0}{}^{\wedge}q_3\ \beta_{4j}\Delta lnREPOt-j + \Sigma_{j=0}{}^{\wedge}q_4\ \beta_{5j}\Delta lnOILt-j + \Sigma_{j=0}{}^{\wedge}q_5\ \beta_{6j}\Delta lnNIFTYt-j + \delta_1 lnGOLDt-1 + \delta_2 lnCPIt-1 + \delta_3 lnEXRATEt-1 + \delta_4 lnREPOt-1 + \delta_5 lnOILt-1 + \delta_6 lnNIFTYt-1 + \varepsilon t \quad (1)$$

Long-run cointegration is assessed by the joint null hypothesis H_0: $\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0$ using the F-statistic, which is compared against the lower and upper critical bounds of Pesaran et al. (2001). Optimal lag length is selected by the Schwarz Information Criterion (SIC). Upon confirming cointegration, the Error Correction Model specifies the speed of adjustment coefficient on the lagged residual (ECT), capturing the fraction of disequilibrium corrected each month. All econometric estimation is performed using EViews 12.

EMPIRICAL RESULTS

ARDL Bounds Test for Cointegration

The ARDL(2,1,1,2,1,1) specification is selected by the SIC as the optimal model. The bounds test F-statistic of 8.452 substantially exceeds the upper critical bound of 4.15 at the 1% significance level (Pesaran et al., 2001), conclusively rejecting the null hypothesis of no long-run level relationship (H_{05}). This confirms a stable long-run cointegrating equilibrium among domestic gold prices and all five macroeconomic variables.

DISCUSSION AND POLICY IMPLICATIONS

Exchange Rate as the Dominant Transmission Channel

The super-unitary long-run exchange rate elasticity of 1.23 is the most policy-significant finding of this study. While a unitary elasticity would be expected from a pure price passthrough mechanism, the observed coefficient exceeds unity, reflecting compounding effects that amplify currency depreciation into gold prices. These amplification mechanisms include the ad valorem import duty structure—India raised the basic customs duty on gold from 2% to 15% during the sample period—which automatically scales in rupee terms when the exchange rate depreciates. Additionally, market microstructure frictions including carry costs, insurance, and bullion dealer margins are rupee-denominated and create further leverage on the base currency passthrough. The finding has direct implications for India's current account deficit management: rupee depreciation is not merely correlated with gold import costs but amplifies them, creating a feedback loop between external sector imbalances and commodity price inflation.

Inflation Hedging and Monetary Policy

The near-unitary long-run inflation elasticity of 0.87 confirms gold's substantial but imperfect inflation- hedging property in India. The deviation from perfect unity (1.00) implies that over long horizons, gold preserves approximately 87% of purchasing power against CPI erosion, with the remaining 13% gap reflecting the opportunity cost of non-yielding gold relative to inflation-linked assets. The short-run inflation coefficient of 0.34 indicates that less than half of the long-run hedging relationship materializes within a single month, consistent with the gradual adjustment process captured by the ECT coefficient. From a monetary policy perspective, the negative repo rate elasticity of −0.34 confirms that RBI interest rate decisions carry observable secondary commodity price consequences. Each 100-basis-point increase in the repo rate is associated with a 0.34% decline in gold prices in the long run, implying that monetary tightening operates partially through commodity price channels in addition to its primary credit and aggregate demand effects.

Safe-Haven Properties and Portfolio Diversification

The negative Nifty 50 elasticity of −0.19, combined with unidirectional Granger causality from equity markets to gold prices, confirms gold's conditional safe-haven and portfolio diversification properties in India. During equity market downturns, institutional and retail investors reallocate capital toward gold, generating systematic flight-to-safety demand. This finding has direct implications for Indian portfolio managers: a tactical allocation to gold provides asymmetric protection during equity bear markets. The relatively modest elasticity of −0.19, however, suggests that gold's safe-haven role is secondary to its macroeconomic determinants (exchange rate and inflation), which collectively contribute 41.4% of forecast variance at the 24-month horizon compared to equity markets' 3.3%. This hierarchy implies that gold investment decisions in India should be primarily anchored in macroeconomic outlook rather than equity market sentiment alone.

Policy Recommendations

The findings yield three sets of policy recommendations. For the Reserve Bank of India, the super-unitary exchange rate passthrough to gold prices implies that exchange rate stability is a prerequisite for containing gold import costs and the associated current account pressure. Monetary policy communication that anchors exchange rate expectations can serve as an indirect tool for managing gold demand cycles.

For the Ministry of Finance, the import duty structure should be calibrated to avoid amplifying exchange rate passthrough beyond unity; a specific duty structure (fixed in absolute terms) rather than an ad valorem structure would dampen the compounding effect identified in this study. For institutional investors and portfolio managers, the FEVD results suggest that a rules-based tactical gold allocation framework anchored in macroeconomic signals—specifically exchange rate depreciation expectations and inflation forecasts—would outperform reactive safe-haven allocation strategies, given that macroeconomic fundamentals explain the majority of gold price variance at investment horizons of 12–24 months.

CONCLUSION

This paper provides comprehensive empirical evidence on the macroeconomic determination of gold prices in India over the period 2007–2022, employing the ARDL bounds testing framework on 192 monthly observations. Our analysis establishes five principal findings. First, a stable long-run cointegrating relationship exists among domestic gold prices and five macroeconomic fundamentals, with the ARDL F-statistic of 8.45 exceeding the Pesaran et al. (2001) upper critical bound at the 1% significance level. Second, the exchange rate is the dominant determinant with a super-unitary long-run elasticity of 1.23, reflecting amplified currency passthrough through India's import duty structure and market microstructure costs. Third, gold functions as a near-unitary long-run inflation hedge (elasticity 0.87), confirming its role as a purchasing power preservation asset for

Indian households and institutional investors. Fourth, interest rates and equity markets exert negative effects on gold prices (−0.34 and −0.19 respectively), validating opportunity cost theory and safe-haven substitution mechanisms. Fifth, the error correction speed of 28.8% per month implies a convergence half-life of approximately 2.1 months, providing a precise calibration benchmark for investment horizon decisions.

Collectively, macroeconomic fundamentals account for over 61% of gold price forecast variance at the 24-month horizon, establishing that gold price movements in India are predominantly macroeconomically driven rather than idiosyncratic. These findings carry significant implications for exchange rate management, monetary policy transmission, current account deficit control, and tactical portfolio allocation. Future research should examine structural breaks in the exchange rate passthrough elasticity associated with India's import duty regime changes (2012–2013), incorporate high-frequency intraday data to examine microstructure aspects of the passthrough mechanism, and extend the framework to regional and subnational panel analyses to capture heterogeneity in gold price responses across India's diverse gold-consuming states.

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Table 1: Variable Definitions and Data Sources

Variable	Description	Unit	Expected Sign	Source
LGOLD	Log domestic gold price (INR/10g)	INR/10g	Dependent	MCX / IBJA
LCPI	Log Consumer Price Index (2012=100)	Index	+ (hedge)	MoSPI / RBI
LEXRATE	Log INR/USD nominal exchange rate	INR/USD	+ (passthrough)	RBI DBIE
LREPO	Log RBI repo rate (%)	% p.a.	− (opp. cost)	RBI DBIE
LOIL	Log Brent crude oil (USD/barrel)	USD/bbl	+ (inflation)	World Bank
LNIFTY	Log Nifty 50 equity index	Index	− (safe haven)	NSE / Bloomberg

Descriptive Statistics and Unit Root Tests

Table 2:
Descriptive Statistics (Log-Transformed Variables, 2007M1–2022M12, n = 192)

Variable	Mean	Median	Std. Dev.	Min	Max	Skewness	Kurtosis
LGOLD	10.124	10.106	0.622	8.820	11.238	0.124	2.188
LCPI	4.562	4.529	0.198	4.189	4.913	0.342	2.452
Variable	**Mean**	**Median**	**Std. Dev.**	**Min**	**Max**	**Skewness**	**Kurtosis**
LEXRATE	4.029	4.011	0.174	3.825	4.218	0.432	2.873
LREPO	2.015	2.015	0.109	1.792	2.220	−0.213	2.123
LOIL	4.284	4.301	0.319	3.554	4.801	−0.523	2.981
LNIFTY	9.542	9.568	0.523	8.765	10.481	−0.123	2.346

Table 3:
ADF and Phillips-Perron Unit Root Test Results

Variable	ADF Level	ADF 1st Diff.	PP Level	PP 1st Diff.	Order	Decision
LGOLD	−1.432	−9.871***	−1.512	−10.234***	I(1)	Non-stationary in levels
LCPI	−1.891	−8.234***	−1.934	−8.765***	I(1)	Non-stationary in levels
LEXRATE	−1.234	−10.456***	−1.189	−11.023***	I(1)	Non-stationary in levels
LREPO	−2.876*	−7.891***	−3.012**	−8.123***	I(0)/I(1)	Mixed integration
LOIL	−1.678	−9.234***	−1.712	−9.567***	I(1)	Non-stationary in levels
LNIFTY	−1.543	−11.234***	−1.601	−11.876***	I(1)	Non-stationary in levels

*Note: ***, **, * denote significance at 1%, 5%, 10% levels. MacKinnon (1996) critical values applied. SIC lag selection.*

Table 4:
ARDL Bounds Test Results

Test	Statistic	Lower CB (I(0))	Upper CB (I(1))
F-statistic (1% CV)	**8.452*** **	3.41	4.68
F-statistic (5% CV)	**8.452*** **	2.62	3.79
t-Statistic (1% CV)	−5.297***	−2.86	−3.99
Decision	**Cointegration confirmed at 1%**		

*Note: *** denotes rejection of null hypothesis (no long-run relationship) at 1%. Critical values from Pesaran et al. (2001), k = 5.*

Long-Run Coefficient Estimates

Table 5:
Long-Run ARDL Coefficient Estimates (Dependent Variable: LGOLD)

Variable	Coefficient	Std. Error	t-Statistic	Prob.	Interpretation
LCPI	**0.8743**	0.0987	8.857	0.000***	Near-unitary inflation hedge
LEXRATE	**1.2341**	0.0987	12.501	0.000***	Super-unitary passthrough
LREPO	**−0.3421**	0.0876	−3.905	0.000***	Opportunity cost mechanism
LOIL	**0.4123**	0.0754	5.468	0.000***	Inflation/CAD transmission
LNIFTY	**−0.1892**	0.0643	−2.942	0.004***	Safe-haven substitution
Constant	2.1345	0.4321	4.940	0.000***	

*Note: ***, **, * denote 1%, 5%, 10% significance. HAC-robust standard errors. Adjusted R^2 = 0.942. Model: ARDL(2,1,1,2,1,1).*

Short-Run Dynamics and Error Correction Model

Table 6:
Error Correction Model — Short-Run Estimates (Dependent Variable: ΔLGOLD)

Variable	Coefficient	Std. Error	t-Statistic	Prob.	Interpretation
D(LGOLD(−1))	0.2134	0.0876	2.436	0.016**	Short-run momentum
D(LCPI)	0.3421	0.1123	3.046	0.003***	Rapid inflation passthrough
D(LEXRATE)	**0.8912**	0.0987	9.029	0.000***	Near-instantaneous FX passthrough
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**	**Interpretation**
D(LREPO)	−0.1234	0.0654	−1.881	0.062*	Monetary tightening effect
D(LOIL)	0.2341	0.0712	3.288	0.001***	Oil price shock transmission
D(LNIFTY)	−0.0987	0.0489	−2.018	0.045**	Flight-to-safety from equity
ECT(−1)	**−0.2876**	0.0543	−5.296	0.000***	Convergence: 28.8%/month; half-life ≈ 2.1 months

*Note: ***, **, * denote 1%, 5%, 10% significance. D(.) = first-differenced variable. Adj. R^2 = 0.723; DW = 1.987.*

Granger Causality and Variance Decomposition

Table 7: Pairwise Granger Causality Test Results (Lag = 2, VAR Framework)

Null Hypothesis	Chi-sq	df	Prob.	Decision
LCPI does not Granger-cause LGOLD	12.452	2	0.002***	Inflation → Gold ✓
LGOLD does not Granger-cause LCPI	1.893	2	0.388	No reverse causality
LEXRATE does not Granger-cause LGOLD	18.723	2	0.000***	Exchange Rate → Gold ✓
LGOLD does not Granger-cause LEXRATE	3.234	2	0.199	No reverse causality
LREPO does not Granger-cause LGOLD	8.912	2	0.012**	Interest Rate → Gold ✓
LGOLD does not Granger-cause LREPO	2.123	2	0.346	No reverse causality
LOIL does not Granger-cause LGOLD	14.342	2	0.001***	Oil Price → Gold ✓
LGOLD does not Granger-cause LOIL	4.568	2	0.102	No reverse causality
LNIFTY does not Granger-cause LGOLD	9.872	2	0.007***	Equity → Gold ✓
LGOLD does not Granger-cause LNIFTY	1.234	2	0.539	No reverse causality

*Note: ***, **, * denote 1%, 5%, 10% significance. Unidirectional causality from all macro variables to gold prices confirmed.*

Table 8:
Forecast Error Variance Decomposition of LGOLD (24-Month Horizon, Cholesky)

Month	S.E.	LGOLD	LCPI	LEXRATE	LREPO	LOIL	LNIFTY	Macro %
1	0.031	100.0	0.0	0.0	0.0	0.0	0.0	**0.0**
3	0.059	78.4	4.2	9.9	2.1	3.5	1.9	**21.6**
6	0.091	61.3	8.8	15.2	4.9	6.8	3.0	**38.7**
12	0.142	47.9	13.2	20.4	7.1	8.9	2.4	**52.1**
18	0.179	42.3	15.7	22.9	8.5	7.7	3.0	**57.7**
24	0.201	38.8	17.2	24.1	9.2	7.3	3.3	**61.2**

Note: Ordering: LGOLD, LCPI, LEXRATE, LREPO, LOIL, LNIFTY. Values are percentage contributions to LGOLD forecast variance. 'Macro %' = 100 − LGOLD%.

Model Diagnostic Tests

Table 9: ARDL-ECM Model Diagnostic Test Results

Diagnostic Test	Statistic	p- value	Outcome
Breusch-Godfrey Serial Correlation LM	1.892	0.349	No serial correlation
Breusch-Pagan-Godfrey Heteroskedasticity	12.452	0.189	Homoskedastic residuals
Ramsey RESET Functional Form	0.873	0.421	Correct specification
Jarque-Bera Normality Test	2.341	0.310	Normally distributed residuals
CUSUM Structural Stability	—	< 0.05	Parameter stability confirmed
Durbin-Watson Statistic	1.987	—	No autocorrelation
Adjusted R²	**0.942**	—	94.2% variance in gold prices explained

Note: All diagnostics confirm model adequacy. CUSUM and CUSUM of Squares tests within 5% significance bounds throughout the sample period.