Do Gold and Silver Hedge Inflation in India? Evidence from an ARDL Bounds Testing Approach

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Abstract:

This paper examines whether gold and silver prices in India hedge against inflation by analyzing their long-run and short-run relationships with consumer price inflation. Using annual data from 1985–2024, with inflation measured via the Consumer Price Index and metal prices sourced from Reserve Bank of India publications, the study applies the ARDL bounds testing approach to accommodate variables integrated at different orders. Unit root tests show inflation is stationary in levels, while gold and silver require first differencing. Bounds test results indicate a long-run relationship between gold and inflation, but not for silver. However, the long-run coefficient for gold is statistically insignificant, suggesting it is not a reliable inflation hedge. Short-run dynamics show no significant influence of inflation on either metal. Overall, while gold exhibits a stronger association with inflation than silver, neither effectively protects against inflation, highlighting limitations for investors and policymakers relying solely on precious metals.

1. Introduction:

Gold and silver have historically occupied a central position in monetary systems, functioning as mediums of exchange, stores of value, and units of account in the evolution of money and monetary policy (Goodman, 1956; Solt & Swanson, 1981). Inflation represents the general rise in prices of goods and services, which reduces consumers' purchasing power. To protect against this erosion, investors look for assets that can serve as effective inflation hedges. An inflation hedge is an investment that generates higher nominal returns when inflation rises, thereby maintaining the real value of the investment over time (Baral & Mei, 2023).

Recent financial market volatility and economic uncertainty have increased the importance of precious metals as investment assets for portfolio diversification and risk management. Traditionally, gold has been the preferred metal due to its stable value and historical role as a store of wealth, while other metals were mainly used in industrial applications. The development of Exchange-Traded Funds (ETFs) for silver, platinum, and palladium in the 2000s has expanded investment opportunities in these metals, enhancing their relevance for hedging and financial portfolio strategies (Bilgin et al., 2018). Gold has long been favored by investors and central banks as a hedge against inflation, whereas silver has received comparatively less attention. Evidence on silver's inflation-hedging ability is limited (Bampinas & Panagiotidis, 2015).

India represents a unique context for examining the inflation–precious metals nexus. Gold and silver are not only investment assets but also play important roles in savings, consumption, and social customs. In India, gold is closely embedded in cultural traditions and social practices, being widely used in jewellery, coinage, and electronic applications. It also holds considerable religious and ceremonial significance, particularly during festivals and weddings, where it represents wealth, prosperity, and tradition (Verma & Sharma, 2014).

At the same time, India has experienced varying inflationary regimes over the past few decades, alongside structural changes in financial markets, monetary policy frameworks, and global commodity price integration. Heightened geopolitical uncertainty, financial market volatility, inflationary concerns, currency depreciation, and instability in oil prices have consistently driven Gold and silver have played a foundational role in the evolution of monetary systems, historically serving as media of exchange, stores of value, and units of account within various economic frameworks (Goodman, 1956; Solt & Swanson, 1981). Inflation, defined as a sustained increase in the general price level of goods and services, erodes purchasing power and poses a significant challenge to wealth preservation. In response, investors seek assets capable of maintaining real value during inflationary periods. An inflation hedge refers to an investment whose nominal returns rise in tandem with inflation, thereby safeguarding real returns over time (Baral & Mei, 2023).

In recent years, heightened financial market volatility and growing macroeconomic uncertainty have renewed investor interest in precious metals as tools for diversification and risk management. Traditionally, gold has been viewed as the dominant precious metal investment due to its historical stability and monetary significance, while other metals were primarily associated with industrial use. However, the introduction of Exchange-Traded Funds (ETFs) for silver, platinum, and palladium during the early 2000s has broadened access to these assets, increasing their importance in contemporary portfolio construction and hedging strategies (Bilgin et al., 2018). Despite gold's longstanding recognition as a hedge against inflation, silver has attracted relatively limited scholarly attention, and empirical evidence regarding its inflation-hedging capability remains scarce (Bampinas & Panagiotidis, 2015).

The Indian economy provides a distinctive setting for analysing the relationship between inflation and precious metal prices. In India, gold and silver function not only as financial assets but also as important components of household savings, consumption patterns, and socio-cultural practices. Gold, in particular, occupies a prominent position in Indian society, with widespread use in jewellery, coinage, and electronic applications, as well as strong religious and ceremonial significance during festivals and weddings, where it symbolises wealth, prosperity, and tradition (Verma & Sharma, 2014).

Over the past several decades, India has experienced diverse inflationary episodes alongside structural transformations in financial markets, monetary policy regimes, and integration with global commodity markets. Periods of geopolitical tension, currency depreciation, inflationary pressures, oil price volatility, and financial market instability have repeatedly encouraged investors to view gold as a protective and safe-haven asset (O'Connell, 2007). At the same time, gold and silver exhibit distinct characteristics in terms of volatility, sources of demand, and investment behaviour. According to Morgan Stanley (2025), gold primarily functions as a monetary and investment asset, whereas silver is more strongly influenced by industrial demand and global commodity cycles. These structural differences suggest that the two metals may respond asymmetrically to inflationary dynamics, raising important questions about their effectiveness as inflation hedges in the contemporary Indian context.

Empirical research examining the relationship between gold prices and inflation has produced mixed and often inconclusive findings. While several studies document gold's effectiveness as an inflation hedge (Artigas, 2010; Bampinas & Panagiotidis, 2015), others report that this relationship is unstable over time and varies across countries and economic environments (Beckmann & Czudaj, 2013; Wang et al., 2011). Such divergent results indicate that the inflation-hedging properties of gold are highly context-dependent and sensitive to methodological choices and country-specific conditions.

From a methodological standpoint, a substantial portion of the literature relies on linear econometric techniques to assess the gold–inflation relationship, which may partly explain the inconsistency of empirical outcomes. Although some studies have adopted nonlinear or regime-switching approaches to capture complex dynamics, these methods are not always necessary when the primary objective is to identify stable long-run relationships within a single-country framework. In this regard, the Autoregressive Distributed Lag (ARDL) methodology offers a flexible and robust alternative, enabling the simultaneous estimation of short-run adjustments and long-run equilibrium relationships even when variables exhibit mixed orders of integration.

An additional limitation of earlier research is the widespread reliance on international benchmark gold prices or prices converted into domestic currencies, which may fail to reflect country-specific market conditions (Van Hoang et al., 2016). To address this concern, the present study employs gold and silver prices denominated in Indian currency, thereby capturing domestic price formation processes, inflationary conditions, and institutional characteristics unique to the Indian economy. Consumer Price Index (CPI) inflation is used instead of the Wholesale Price Index (WPI) because CPI better represents consumer-level inflation and is more relevant for analysing precious metal price behaviour and household investment decisions. By applying the ARDL bounds testing approach to Indian data, this study offers a focused and policy-relevant assessment of the inflation-hedging properties of gold and silver, contributing to both methodological refinement and contextual understanding in the existing literature.

2. Literature Review

The empirical literature provides substantial evidence supporting the role of gold as a hedge against inflation, particularly in the long run. Jaffe (1989) provides early evidence that gold offers protection against inflation and currency depreciation, highlighting its role as a long-term store of value. The study finds that gold maintains purchasing power during inflationary periods, supporting its use as an inflation hedge. Adrangi et al. (2003) find a positive long-run relationship between gold prices and inflation in the US, indicating that gold can hedge against inflation over extended horizons. However, short-run dynamics are found to be weak and unstable. Worthington and Pahlavani (2007) document a long-run cointegrating relationship between gold prices and inflation, supporting gold's role as an inflation hedge. Their findings emphasize that the hedging effectiveness of gold is more evident in the long run than in the short run. Ghosh, Levin, Macmillan, and Wright (2004) examine the relationship between gold prices and inflation across major economies. Their results indicate a stable long-run association, suggesting that gold effectively preserves purchasing power over time and serves as a reliable inflation hedge.

However, other studies report weaker, inconsistent, or context-dependent inflation-hedging properties of gold and silver. Ghazali et al. (2022) analyzed the gold–inflation relationship in Malaysia using TGARCH-based volatility and quantile techniques. The results show that gold provides only weak and inconsistent hedging and safe haven benefits, with protection against inflation occurring sporadically rather than persistently. The study concludes that gold does not reliably safeguard purchasing power during high inflationary periods. Bampinas and Panagiotidis (2015) examine the inflation-hedging properties of gold and silver using over two centuries of data for the UK and the US. Their results indicate that gold acts as an effective long-run hedge against various inflation measures, particularly in the US, while silver exhibits weaker and less consistent hedging ability. The findings highlight that inflation-hedging effectiveness varies across metals and countries. Beckmann and Czudaj (2013) examine gold's inflation-hedging role across major economies using a regime-switching VECM framework. The results suggest that gold provides partial long-run inflation hedging, with stronger effects in the USA and the UK, while its effectiveness varies across regimes and time horizons. The study highlights that gold's hedging ability is not constant and depends on prevailing economic conditions.

Employing a nonlinear ARDL (NARDL) approach, Van Hoang et al. (2016) provide evidence that gold does not function as a long-run hedge against inflation in most of the countries examined, as the long-run relationship between gold prices and consumer prices is weak or absent, including in the case of India. The lack of long-run equilibrium is attributed to country-specific factors such as regulatory controls, market structures, and the traditional role of gold, suggesting that the inflation-hedging ability of gold may be context-dependent rather than universal. Manuj (2021) examines whether gold acts as a hedge or safe haven against stock market risk in the U.S. (S&P 500) and India (BSE Sensex) using monthly data from 1980–2020. Applying linear regression and GARCH models, the study finds that gold does not exhibit hedging or safe-haven properties in either market, even during periods of extreme returns or volatility. The results suggest limited diversification benefits of gold for long-term equity investors in both developed and emerging markets. Aye, Chang, and Gupta (2016) examine gold's inflation-hedging ability in the U.S. using an interrupted Markov-switching cointegration framework. While conventional cointegration tests do not support gold as a stable inflation hedge, the nonlinear model reveals temporary hedging relationships during specific historical periods. The study concludes that gold's inflation-hedging role is episodic rather than persistent. Valadkhani, Nguyen, and Chiah (2022) analyze the asymmetric impact of inflation and interest rates on gold returns using threshold and piecewise regression models for U.S. monthly data. The findings indicate that gold acts as an effective inflation hedge only in high-inflation regimes, while remaining largely unresponsive during low or moderate inflation periods. The study argues that such regime-dependent behavior explains the mixed evidence on gold's hedging role in existing literature.

Overall, the literature indicates that gold has shown some long-run ability to hedge against inflation, whereas silver's hedging effectiveness is weaker and more inconsistent. Most prior studies have employed methods such as linear regressions, GARCH models, quantile regressions, threshold and piecewise regressions, and Markov-switching or nonlinear cointegration approaches to analyze the gold–inflation relationship. However, these studies often focus on specific countries or time periods and rarely consider both short-run and long-run dynamics simultaneously with variables integrated of mixed orders. This highlights a research gap in systematically examining the inflation-hedging role of gold and silver within a unified analytical framework. By applying the ARDL bounds testing approach, this study addresses that gap by capturing both short-run adjustments and long-run equilibrium relationships for gold and silver prices in India, thereby providing a methodological contribution and updated empirical evidence relevant to investors and policymakers.

This study is structured into five sections. Section one introduces the research. Section two reviews the relevant literature, while section three explains the data and ARDL methodology. Section four presents the empirical results on gold and silver as inflation hedges. Section five concludes with key findings and implications for investors and policymakers.

3. Research Objectives

The primary objective of this study is to examine whether gold and silver act as effective hedges against inflation in India. Specifically, the study seeks to:

1. Examine the stationarity properties of inflation, gold prices, and silver prices using unit root tests.
2. Examine the short-run relationship between inflation and precious metal prices (gold and silver) in India.
3. Test for the existence of long-run cointegrating relationships between inflation and precious metal prices (gold and silver) in India using the ARDL bounds testing approach.
4. Examine the magnitude and statistical significance of the long-run impact of inflation on gold prices in India
5. Compare the inflation-hedging effectiveness of gold and silver in the Indian context.
6. Assess the stability and robustness of the estimated ARDL models through diagnostic and stability tests.

4. Data and Methodology

4.1 Data and Sample Description

The analysis is conducted using annual time-series data for India over the period 1985–2024, subject to data availability. Inflation is represented by the annual Consumer Price Index (CPI) inflation rate, obtained from the World Bank's World Development Indicators (World Bank, 2024), which compile official national statistics. Data on gold and silver prices are sourced from the Handbook of Statistics on the Indian Economy published by the Reserve Bank of India (Reserve Bank of India, 2025).

Gold prices are expressed in Indian rupees per 10 grams, while silver prices are measured in Indian rupees per kilogram. To ensure comparability and to mitigate potential scale effects, gold and silver prices are transformed into natural logarithmic form, whereas inflation is retained in level form. This specification allows the estimated coefficients to be interpreted meaningfully within a log–level framework.

The variables employed in the analysis are defined as follows:

- **INF**: Annual CPI inflation rate (%)
- **LGOLD**: Natural logarithm of gold price (₹ per 10 grams)
- **LSILVER**: Natural logarithm of silver price (₹ per kilogram)

4.2 Econometric Methodology

To examine the relationship between inflation and precious metal prices in India, this study employs the Autoregressive Distributed Lag (ARDL) bounds testing approach developed by Pesaran, Shin, and Smith (2001). The ARDL framework is particularly suitable for this analysis because it allows for the simultaneous estimation of short-run dynamics and long-run equilibrium relationships when the variables are integrated of mixed orders, I(0) and I(1), provided that none of the series is integrated of order I(2). In addition, the ARDL approach performs well in small samples and helps mitigate potential endogeneity through the inclusion of lagged dependent and independent variables.

Prior to estimating the ARDL models, the stationarity properties of the variables are examined using the Augmented Dickey–Fuller (ADF) unit root test (Dickey & Fuller, 1979). The unit root test results indicate that inflation is stationary at level, while gold and silver prices become stationary after first differencing. The presence of a mixed order of integration among the variables supports the application of the ARDL bounds testing methodology.

Two separate ARDL models are specified to examine the inflation relationship with gold and silver independently.

Gold–Inflation Model

$$\Delta \ln(GOLD_t) = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i} \Delta \ln(GOLD_{t-i}) + \sum_{j=0}^{q} \alpha_{2j} \Delta INF_{t-j} + \beta_1 \ln(GOLD_{t-1}) + \beta_2 INF_{t-1} + \varepsilon_t$$

Silver–Inflation Model

$$\Delta \ln(SILVER_t) = \gamma_0 + \sum_{i=1}^{p} \gamma_{1i} \Delta \ln(SILVER_{t-i}) + \sum_{j=0}^{q} \gamma_{2j} \Delta INF_{t-j} + \delta_1 \ln(SILVER_{t-1}) + \delta_2 INF_{t-1} + u_t$$

In these equations, Δ denotes the first-difference operator, ln(GOLDt) and ln(SILVERt) represent the natural logarithms of gold and silver prices, and INFt denotes the CPI inflation rate. The parameters p and q denote the optimal lag lengths selected using the Akaike Information Criterion (AIC), while εt and ut are white-noise error terms.

The existence of a long-run equilibrium relationship between inflation and precious metal prices is examined using the ARDL bounds testing procedure. The null hypothesis of no cointegration is tested against the alternative of a long-run relationship by evaluating the joint significance of the lagged level variables. The bounds test is conducted under the restricted constant and no-trend specification, following Pesaran et al. (2001).

Where cointegration is confirmed, long-run coefficients are estimated along with an error correction model (ECM) to capture short-run adjustments toward long-run equilibrium. The ECM specification for the gold model is expressed as:

$$\Delta \ln(GOLD_t) = \varphi_0 + \sum_{i=1}^{p} \varphi_{1i} \Delta \ln(GOLD_{t-i}) + \sum_{j=0}^{q} \varphi_{2j} \Delta\, INF_{t-j} + \lambda\, ECM_{t-1} + \eta_t$$

where ECMt−1 represents the lagged error correction term derived from the long-run relationship, and λ measures the speed of adjustment toward long-run equilibrium. A negative and statistically significant value of λ confirms the presence of a stable long-run relationship.

To ensure the reliability and robustness of the estimated ARDL models, several post-estimation diagnostic tests are conducted. These include the Breusch–Godfrey LM test for serial correlation (Godfrey, 1978), the ARCH test for heteroskedasticity (Engle, 1982), the Jarque–Bera test for normality of residuals (Jarque & Bera, 1987), and the Ramsey RESET test for functional form specification (Ramsey, 1969). In addition, the stability of the estimated parameters is examined using the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests proposed by Brown et al. (1975).

5. Empirical Results

This section presents the empirical findings of the study. It begins with unit root test results, followed by ARDL dynamic estimates, bounds test results, long-run coefficients, and a comparative assessment of gold and silver as inflation hedges in India.

5.1 Unit Root Test Results

Objective 1: Examine the stationarity properties of inflation, gold prices, and silver prices using unit root tests.

This subsection presents the results of the Augmented Dickey–Fuller (ADF) unit root tests conducted to determine the order of integration of the variables used in the study.

Table 1: Results of Augmented Dickey–Fuller (ADF) Unit Root Tests

Variable	ADF Statistic (Level)	p-value	ADF Statistic (First Difference)	p-alue	Order of Integration
Inflation Rate	−3.0733	0.0370	—	—	I(0)
ln(Gold Price)	0.1669	0.9667	−4.5533	0.0008	I(1)
ln(Silver Price)	−0.4858	0.8830	−4.2655	0.0018	I(1)

Source: Authors' compilation using EViews.

Interpretation of Unit Root Test Results

Table 1 reports the Augmented Dickey–Fuller (ADF) unit root test results for inflation, gold prices, and silver prices. The null hypothesis of the ADF test is the presence of a unit root. Lag lengths were selected using the Schwarz Information Criterion (SIC). Gold and silver prices are expressed in natural logarithmic form, while inflation is retained in level form.

Conclusion for objective 1: The results indicate that the inflation rate is stationary at level, as the null hypothesis of a unit root is rejected at the 5 percent significance level. In contrast, the logarithms of gold and silver prices are non-stationary at level but become stationary after first differencing. Accordingly, inflation is integrated of order zero, I(0), while gold and silver prices are integrated of order one, I(1). The presence of this mixed order of integration justifies the application of the ARDL bounds testing approach to examine both the short-run and long-run relationships between inflation and precious metal prices in India.

5.2 ARDL Dynamic Specification (Levels Form)

Objective 2: Examine the short-run relationship between inflation and precious metal prices (gold and silver) in India.

This subsection analyses the short-run dynamics between inflation and gold and silver prices based on the estimated ARDL models. Although the ARDL dynamic specification in levels provides preliminary insights into the contemporaneous association between inflation and precious metal prices, the short-run relationship is formally examined through the error correction representation of the ARDL model, where coefficients on differenced variables capture short-run effects.

ARDL Model Specification and Estimation

Following Pesaran et al. (2001), the ARDL framework is employed to examine the short-run relationship between inflation and gold prices and inflation and silver prices in India. Two separate ARDL models are estimated, with the natural logarithm of gold prices and natural logarithm of silver prices specified as dependent variables, while inflation is used as the explanatory variable. The ARDL methodology is appropriate as the variables are integrated of mixed order, I(0) and I(1), with none integrated of order I(2).

The estimated ARDL dynamic specifications expressed in levels form are as follows:

$$ln(GOLD\_t) = \alpha 0 + \alpha 1 \, ln(GOLD\_(t-1)) + \beta 0 \, INF\_t + \varepsilon\_t$$

$$ln(SILVER\_t) = \gamma 0 + \gamma 1 \, ln(SILVER\_\{t-1\}) + \gamma 2 \, ln(SILVER\_\{t-2\}) + \delta \, INF\_t + \mu\_t$$

These equations represent the dynamic ARDL models estimated in levels, where the lagged dependent variables capture price persistence, while the inflation coefficient reflects contemporaneous effects rather than formal short-run dynamics. The optimal lag structures were selected using the Akaike Information Criterion (AIC). Formal short-run dynamics are examined through the error-correction representation reported in Section 5.4, where coefficients on differenced variables capture short-run effects and the error correction term reflects adjustment toward long-run equilibrium.

Table 2: ARDL Dynamic Estimates (Levels Form)

Variable	**Gold (ARDL 1,0) Coefficient (p-value)**	**Silver (ARDL 2,0) Coefficient (p-value)**
ln_{t-1}	1.0159*** (0.0000)	1.3155*** (0.0000)
ln_{t-2}	—	−0.3275* (0.0601)
Inflation (INF)	0.0088 (0.1717)	0.0010 (0.9090)
Constant	−0.1205 (0.5188)	0.1598 (0.5892)
R^2	0.9897	0.9759
Adjusted R^2	0.9891	0.9739
F-statistic	1724.30***	460.51***
Durbin–Watson	1.6075	1.8991

Note: ****, **, * denote significance at 1%, 5%, and 10% levels, respectively.*

Source: Authors' compilation using EViews.

Table 2 reports the short-run ARDL estimation results for gold and silver prices in India.

For the gold price model (ARDL 1,0), the coefficient of the lagged gold price is 1.0159 and is highly statistically significant (p = 0.0000), indicating strong persistence in gold price movements. This implies that a 1% increase in gold prices in the previous period leads to approximately a 1.02% increase in current gold prices, holding inflation constant. The inflation coefficient is 0.0088 and statistically insignificant ($p = 0.1717$), suggesting that inflation does not exert a significant short-run influence on gold prices in India.

In the silver price model (ARDL 2,0), the first lag of silver prices has a positive and highly significant coefficient of 1.3155 ($p = 0.0000$), reflecting strong inertia in silver price dynamics. The second lag is negative with a coefficient of −0.3275 and is marginally significant at the 10% level ($p = 0.0601$), indicating partial mean-reverting behavior in silver prices. The inflation coefficient is 0.0010 and statistically insignificant ($p = 0.9090$), further confirming the absence of a meaningful short-run relationship between inflation and silver prices.

The overall explanatory power of both models is high, with R^2 values of 0.9897 for gold and 0.9759 for silver, indicating that nearly 99% and 98% of the variation in gold and silver prices, respectively, is explained by the models. The F-statistics for both models (1724.30 for gold and 460.51 for silver, $p < 0.01$) confirm the joint significance of the estimated regressors. Additionally, the Durbin–Watson statistics of 1.6075 (gold) and 1.8991 (silver) suggest no evidence of serious serial correlation.

Conclusion for Objective 2

Overall, the results indicate that while gold and silver prices exhibit strong short-run persistence driven by their own past values, inflation does not significantly affect either asset in the short run, implying that gold and silver do not function as effective short-run inflation hedges in the Indian context.

Thus, Objective 2 is achieved, demonstrating that inflation does not exert a statistically significant short-run effect on gold and silver prices in India.

5.3 ARDL Bounds Test for Cointegration (Long-Run Relationship)

Objective 3: Test for the existence of long-run cointegrating relationships between inflation and precious metal prices (gold and silver) in India.

This subsection reports the results of the ARDL bounds testing procedure used to examine the existence of long-run equilibrium relationships between inflation and gold and silver prices.

The existence of long-run relationships between inflation and gold prices, and inflation and silver prices, was examined using the Autoregressive Distributed Lag (ARDL) bounds testing approach to cointegration proposed by Pesaran, Shin, and Smith (2001). The bounds test was conducted under Case 2: Restricted Constant and No Trend, which is appropriate when the model includes an intercept but no deterministic trend.

Table 3: ARDL Bounds Test Results for Cointegration (Gold and Silver)

(Case 2: Restricted Constant and No Trend)

Variable (Model)	F-statistic	k	10% I(0)	10% I(1)	5% I(0)	5% I(1)	1% I(0)	1% I(1)	Cointegration
Gold Model	**9.4297**	1	3.02	3.51	3.62	4.16	4.94	5.58	**Yes**
Silver Model	**1.3277**	1	3.02	3.51	3.62	4.16	4.94	5.58	**No**

Source: Authors' compilation using EViews.

Notes:

- The bounds test is conducted under **Case 2 (restricted constant and no trend)**.
- k denotes the number of regressors in the ARDL model.
- Critical values are taken from Pesaran et al. (2001).

Interpretation

Table 3 reports the results of the ARDL bounds test for cointegration between inflation and precious metal prices in India. For the gold model, the computed F-statistic of **9.4297** exceeds the upper bound critical value at the **1% significance level (I(1) = 5.58)**. Accordingly, the null hypothesis of no long-run relationship is rejected, confirming the existence of a stable long-run cointegrating relationship between inflation and gold prices.

In contrast, for the silver model, the calculated F-statistic of **1.3277** is below the lower bound critical value even at the 10% significance level (I(0) = 3.02). Therefore, the null hypothesis of no level relationship cannot be rejected, indicating the absence of a long-run cointegrating relationship between inflation and silver prices.

Consequently, long-run coefficients are estimated only for the gold model, whereas no long-run estimation is performed for the silver model due to the lack of cointegration.

Conclusion for Objective 3

Overall, the ARDL bounds test results achieves Objective 3 by confirming the presence of a long-run cointegrating relationship between inflation and gold prices, while revealing no evidence of cointegration between inflation and silver prices in India.

5.4 Long-Run Impact of Inflation on Gold Prices

This subsection discusses the estimated long-run coefficients obtained from the ARDL model, focusing on the direction, magnitude, and statistical significance of inflation's impact on gold prices.

Objective 4: Examine the magnitude and statistical significance of the long-run impact of inflation on gold prices in India Following the confirmation of a long-run cointegrating relationship between inflation and gold prices under Objective 3, this objective estimates and interprets the long-run coefficients obtained from the ARDL model. Since no cointegration was detected between inflation and silver prices, the long-run analysis is restricted to the gold model only.

Table 4: Long-Run Coefficients (Levels Equation – Gold Model)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INF	−0.5505	0.6259	−0.8796	0.3849
Constant	7.5718	3.9326	1.9254	0.0621

Source: Authors' estimation using EViews.

Long-Run Equation

Based on the estimated levels equation from the ARDL model, the long-run relationship between gold prices and inflation is expressed as:

$$\boldsymbol{ln(GOLD\_t) = 7.5718 - 0.5505\, INF\_t}$$

Interpretation

Table 4 presents the long-run coefficients derived from the ARDL levels equation, representing the long-run equilibrium relationship between gold prices and inflation in India. The model is specified in a log–level form, with gold prices expressed in natural logarithms and inflation measured in levels.

The estimated coefficient of inflation is −0.5505, implying that a one percentage point increase in inflation is associated with an approximate 0.55 percent decrease in gold prices in the long run. However, this coefficient is statistically insignificant, as indicated by the p-value of 0.3849. Consequently, the null hypothesis that inflation has no long-run effect on gold prices cannot be rejected.

The constant term is positive and marginally significant at the 10 percent level, capturing the long-run average level of gold prices when inflation is zero.

Overall, the results indicate that although gold prices and inflation are cointegrated, inflation does not exert a statistically significant influence on gold prices in the long run. This finding suggests that gold does not function as a strong long-run hedge against inflation in the Indian context during the sample period.

Table 5: Error Correction Representation of ARDL Model (Gold)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CointEq(−1)	−0.0159	0.0029	−5.4645	0.0000

Interpretation

Table 5 reveals that, the coefficient of the error correction term, CointEq(−1), is negative and statistically significant at the 1 percent level, confirming the existence of a stable long-run equilibrium relationship between gold prices and inflation. The estimated coefficient of −0.0159 indicates that approximately 1.6 percent of the short-run disequilibrium in gold prices is corrected each year towards the long-run equilibrium. This suggests a slow but stable adjustment process following short-term shocks, implying that deviations from the long-run equilibrium persist for an extended period before being fully corrected.

Conclusion for Objective 4

In summary, although a stable long-run equilibrium relationship exists between gold prices and inflation in India, the estimated long-run coefficient of inflation is statistically insignificant. This indicates that inflation does not exert a meaningful long-run influence on gold prices over the study period. Consequently, gold cannot be regarded as an effective long-run hedge against inflation in the Indian context, despite the presence of cointegration between the two variables.

5.5 Comparative Analysis of Gold and Silver as Inflation Hedges

This subsection compares the empirical findings for gold and silver to assess their relative effectiveness as inflation hedges in the Indian context.

Objective 5: Compare the inflation-hedging effectiveness of gold and silver in the Indian context

Table 6: Comparative Analysis of Gold and Silver as Inflation Hedges in India

Aspect	Gold	Silver
Order of integration	I(1)	I(1)
Inflation order	I(0)	I(0)
Selected ARDL model	ARDL(1,0)	ARDL(2,0)
Bounds test F-statistic	9.43	1.33
Cointegration	Yes	No

Long-run inflation effect	Negative, statistically insignificant	Not estimated
Short-run inflation effect	Statistically insignificant	Statistically insignificant
Error correction term	Negative and statistically significant	Error correction term not interpreted due to absence of cointegration
Diagnostic tests	Passed	Passed
Stability (CUSUM/CUSUMSQ)	Stable	Stable

Source: Authors' estimation using EViews.

Interpretation of Comparative Results

The comparative ARDL analysis in Table 6 above, provides important insights into the relative inflation-hedging effectiveness of gold and silver in India. Although both gold and silver prices are integrated of order one [I(1)], and inflation is stationary at level [I(0)], the ARDL bounds test results reveal a fundamental divergence in their long-run relationships with inflation.

For gold, the bounds test F-statistic of 9.43 exceeds the upper critical bound, confirming the existence of a long-run cointegrating relationship between gold prices and inflation. In contrast, the corresponding F-statistic for silver (1.33) falls below the lower bound, indicating the absence of cointegration. This suggests that gold prices and inflation share a stable long-run equilibrium relationship, whereas silver prices do not exhibit systematic long-run adjustment to inflationary movements.

Despite the presence of cointegration in the gold model, the estimated long-run coefficient of inflation is statistically insignificant, implying that inflation does not exert a meaningful long-term influence on gold prices. Consequently, gold cannot be characterized as a strong long-run hedge against inflation in India, even though it maintains a stable long-run association with inflation. In the case of silver, the absence of cointegration implies that long-run inflation-hedging effectiveness cannot be established, and the long-run impact of inflation is therefore not estimated.

In the short run, inflation exerts a statistically insignificant effect on both gold and silver prices, indicating that neither metal provides effective short-term protection against inflationary shocks. Although the error correction term in the gold model is negative and statistically significant, confirming gradual adjustment toward long-run equilibrium, the corresponding term in the silver model cannot be interpreted meaningfully due to the failure of the bounds test to establish cointegration.

The diagnostic and stability tests for both ARDL models are satisfactory, and the CUSUM and CUSUM of Squares tests confirm parameter stability over the sample period. Hence, the observed differences in inflation-hedging performance between gold and silver are not attributable to econometric deficiencies but reflect genuine structural differences in their price–inflation dynamics.

Conclusion for Objective 5

Overall, the comparative analysis indicates that **gold exhibits relatively stronger inflation-hedging characteristics than silver in India**, as evidenced by the presence of a long-run cointegrating relationship with inflation. However, the lack of a statistically significant long-run inflation coefficient suggests that gold's hedging effectiveness is limited in magnitude. Silver, on the other hand, does not demonstrate either short-run or long-run inflation-hedging capability. Therefore, among the two precious metals, gold performs comparatively better as an inflation hedge in the Indian context, albeit with weak long-run effectiveness.

6. Diagnostic and Stability Test Results

Objective 6: Assess the stability and robustness of the estimated ARDL models through diagnostic and stability tests

To ensure the reliability and robustness of the estimated ARDL models for gold and silver prices, a series of diagnostic and stability tests were conducted. These include tests for serial correlation, heteroskedasticity, normality of residuals, functional form specification, and parameter stability.

6.1 Serial Correlation LM Test

The Breusch–Godfrey Lagrange Multiplier (LM) test is employed to examine whether the residuals of the ARDL model are free from serial correlation (Godfrey, 1978).

H_0: There is no serial correlation in the residuals of the ARDL model.

Table 7: Serial Correlation LM Test

Model	Statistic	Value	Probability
Gold	F-statistic	0.8378	0.4414
Gold	Obs*R-squared	1.8317	0.4002
Silver	F-statistic	0.5594	0.5770
Silver	Obs*R-squared	1.2838	0.5263

Source: Authors' estimation using EViews.

Interpretation:

Table 7 shows that the Breusch–Godfrey LM test yields probability values exceeding the 5 percent significance level for both the gold and silver models. Accordingly, the null hypothesis of no serial correlation cannot be rejected, indicating that the residuals of both ARDL models are free from autocorrelation

6.2 Heteroskedasticity Test (ARCH Test)

The ARCH Lagrange Multiplier test was applied to the model residuals to detect the presence of conditional heteroskedasticity (Engle, 1982). The heteroskedasticity test is used to assess whether the variance of the model residuals remains constant over time.

H_0: The residuals of the ARDL model are **homoskedastic** (constant variance).

Table 8: Heteroskedasticity Test (ARCH Test)

Model	Statistic	Value	Probability
Gold	F-statistic	0.8640	0.3588
Gold	Obs*R-squared	0.8906	0.3453
Silver	F-statistic	0.4118	0.5252
Silver	Obs*R-squared	0.4303	0.5119

Source: Authors' estimation using EViews.

Interpretation:

Table 8 presents the results of the ARCH test, which indicate that the probability values for both models exceed the 5 percent significance level. Consequently, the null hypothesis of homoskedasticity cannot be rejected, implying that the residuals exhibit constant variance over time. Thus, there is no evidence of heteroskedasticity in either ARDL model.

6.3 Normality Test (Jarque–Bera Test)

The Jarque–Bera test was employed to assess whether the residuals of the estimated model follow a normal distribution (Jarque & Bera, 1987).

H_0: The residuals of the ARDL model are normally distributed.

Table 9: Normality Test (Jarque–Bera Test)

Model	Jarque–Bera	Probability	Observations
Gold	0.1851	0.9116	38
Silver	4.0620	0.1312	38

Source: Authors' estimation using EViews.

Interpretation:

As shown in Table 9 above, for both gold and silver models, the Jarque–Bera probability values exceed the 5% significance level. Therefore, the null hypothesis of normally distributed residuals cannot be rejected. This confirms that the residuals of both models are approximately normally distributed, supporting the validity of statistical inference.

6.4 Ramsey RESET Test

After model estimation, the Ramsey Regression Equation Specification Error Test (RESET) was employed to examine whether the functional form of the model is correctly specified (Ramsey, 1969). The Ramsey RESET test is conducted to examine whether the ARDL model is correctly specified and free from functional form misspecification.

H_0: The ARDL model is correctly specified and has no functional form misspecification.

Table 10: Ramsey RESET Test

Model	Statistic	Value	Probability
Gold	F-statistic	0.1124	0.7394
Silver	F-statistic	1.8475	0.1833

Source: Authors' estimation using EViews.

Interpretation:

The Ramsey RESET test results as presented in table 10 above, for both models show probability values greater than 0.05. Accordingly, the null hypothesis of correct model specification cannot be rejected. This indicates that the ARDL models are correctly specified and do not suffer from functional form misspecification or omitted variable bias.

6.5 Stability Tests (CUSUM and CUSUMSQ)

The stability of the estimated coefficients was examined using the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests (Brown et al., 1975).

CUSUM Test:

The CUSUM test is used to assess the stability of the estimated coefficients over the sample period (Brown et al., 1975).

H_0: The coefficients of the ARDL model are stable over the sample period.

CUSUM of Squares Test:

The CUSUM of Squares test is employed to examine the stability of the variance of the residuals and detect any structural instability in the model (Brown et al., 1975).

H_0: The variance of the residuals is stable over time, indicating no structural instability.

Figures 1 and 2 depict the results of the CUSUM and CUSUM of Squares tests used to examine the structural stability of the gold and silver ARDL models.

Figure 1: CUSUM and CUSUM of Squares Tests for Gold Price ARDL Model

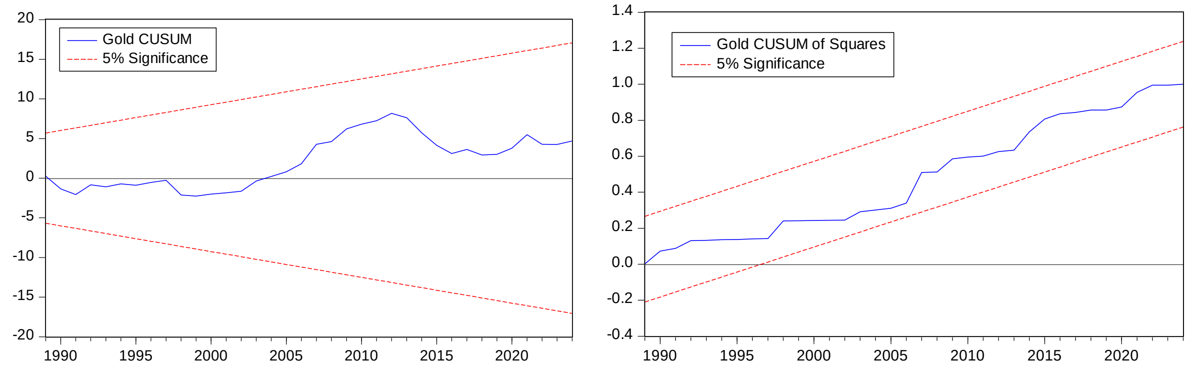
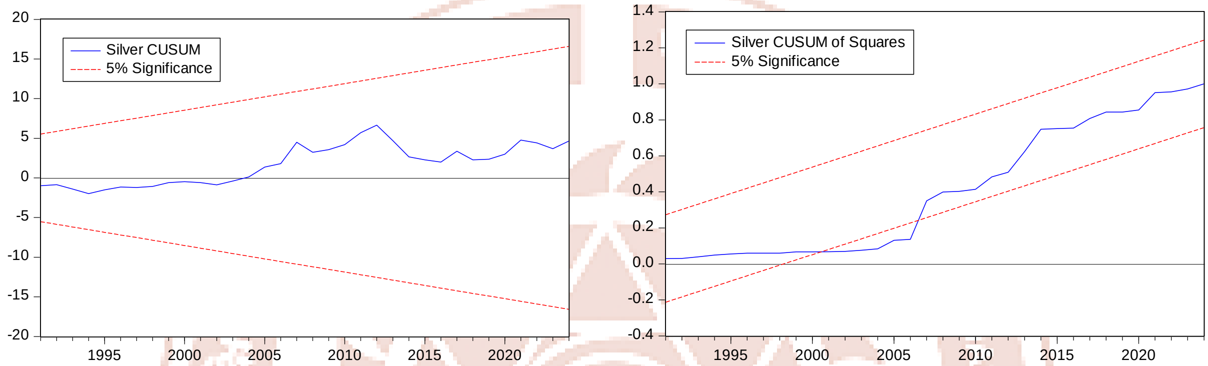


Figure 2: CUSUM and CUSUM of Squares Tests for Silver Price ARDL Model



Source: Authors' estimation using EViews.

Note: The blue line represents the cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares (CUSUMSQ), while the red dashed lines denote the 5 percent significance boundaries. Since the plots remain within the critical bounds, the ARDL models are structurally stable.

Table 11: Stability Tests (CUSUM and CUSUMSQ)

Model	CUSUM	CUSUM of Squares
Gold	Stable	Stable
Silver	Stable	Stable

Source: Authors' estimation using EViews.

Interpretation:

The CUSUM and CUSUM of Squares tests in figure 1 and 2 above, indicate that the cumulative sums of recursive residuals remain within the 5% significance bounds throughout the sample period for both models. This confirms the structural stability of the ARDL models and the constancy of the estimated parameters over time.

Conclusion for Objective 6

Overall, the diagnostic and stability test results confirm that the estimated ARDL models for both gold and silver prices satisfy the key econometric assumptions. The residuals are free from serial correlation, homoskedastic, and approximately normally distributed. In addition, the models are correctly specified and exhibit parameter stability over the sample period. These findings demonstrate that the ARDL estimations are statistically sound, robust, and reliable for inference.

7. Discussion of Findings

The findings indicate that gold exhibits a relatively stronger long-run association with inflation in India compared to silver, although the magnitude of this relationship is weak and statistically insignificant. This outcome can be attributed to gold's long-standing role as a store of value and its widespread acceptance as a monetary and investment asset within the Indian economy. In contrast, silver prices appear to be driven predominantly by industrial demand, technological applications, and global commodity market dynamics, which reduce their sensitivity to domestic inflationary pressures. These results suggest that cultural preference and traditional investment appeal alone are insufficient to ensure effective inflation hedging.

More broadly, the absence of a statistically significant inflation-hedging role for both precious metals challenge the conventional assumption that gold and silver automatically provide protection against inflation. In the Indian context, factors such as financial market integration, policy interventions, availability of alternative investment instruments, and evolving investor behavior may weaken the direct transmission of inflationary pressures to precious metal prices.

This study addresses all stated research objectives. The unit root analysis confirms a mixed order of integration among the variables, thereby validating the use of the ARDL bounds testing methodology. Short-run results indicate that inflation does not exert a statistically significant influence on either gold or silver prices. The ARDL bounds test confirms the existence of a long-run cointegrating relationship between gold prices and inflation, while no such relationship is found for silver. However, the long-run inflation coefficient for gold is statistically insignificant, indicating that gold does not function as a robust inflation hedge. Comparative analysis further demonstrates that although gold exhibits a relatively stronger long-run linkage with inflation than silver, neither metal provides effective inflation protection. Finally, comprehensive diagnostic and stability tests confirm that the estimated ARDL models are statistically sound, well-specified, and stable over the sample period.

Policy and Investment Implications

From an investment perspective, the findings suggest that gold may offer limited long-term diversification benefits during inflationary periods, but it does not provide a statistically reliable hedge against inflation in India. Silver, on the other hand, shows no meaningful inflation-hedging capability and should not be relied upon for inflation protection. Investors should therefore adopt diversified portfolio strategies that incorporate alternative inflation-sensitive assets rather than relying solely on precious metals.

From a policy standpoint, the results highlight the need to strengthen and promote diversified inflation-protection instruments beyond traditional precious metals. Policymakers may consider encouraging greater participation in inflation-indexed bonds, financial derivatives, and market-based hedging mechanisms to enhance investors' ability to manage inflation risk more effectively.

8. Conclusion

This study examined the relationship between inflation and precious metal prices in India using the ARDL bounds testing approach. The present study adopts a linear ARDL framework and therefore assumes symmetric adjustment of gold prices to inflationary changes. Exploring potential asymmetric and nonlinear effects using nonlinear extensions such as NARDL is left for future research. The results confirm the presence of a long-run equilibrium relationship between gold prices and inflation, although the long-run impact of inflation on gold prices is statistically insignificant. In contrast, no cointegration is observed between silver prices and inflation. Overall, the findings indicate that neither gold nor silver serves as a strong or reliable hedge against inflation in India, despite gold exhibiting a relatively stronger long-run linkage with inflation than silver. These results contribute to the existing literature by providing empirical evidence that challenges the traditional view of precious metals as effective inflation hedges in emerging market economies such as India.

Conflict of interest: The author declares that there is no conflict of interest regarding the publication of this paper.

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