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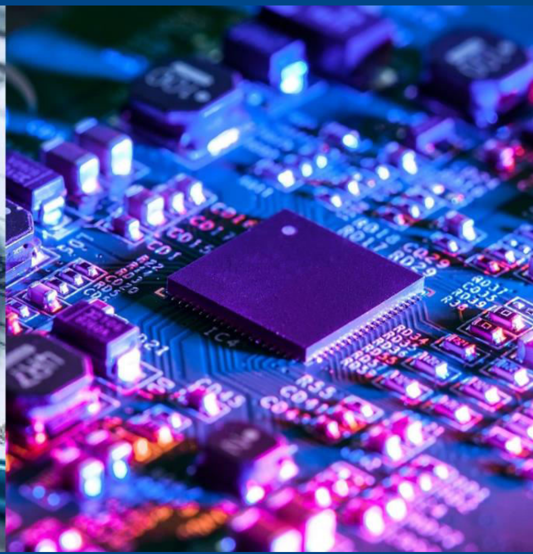

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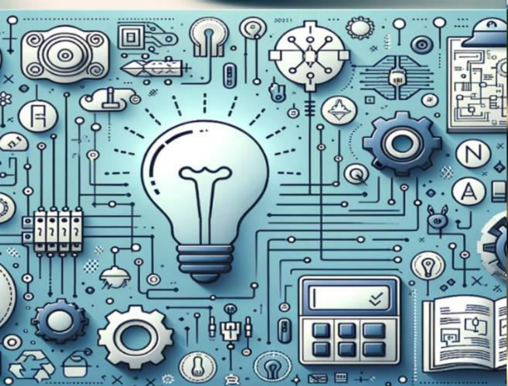

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Regime-Dependent Hedging and Safe Haven Properties of Gold: Evidence from the Indian Equity Market

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ABSTRACT: This study investigates whether gold can be considered a hedge or safe-haven asset in the Indian stock market using daily data from 2000 to 2025, based on NIFTY 50 and gold returns. The study is motivated by the traditional belief that gold provides protection against stock market risk, especially during periods of financial uncertainty. To examine this relationship, correlation analysis, regression analysis, and a two-state Markov switching model are employed to capture both static and dynamic interactions between gold and equity returns. The findings reveal a weak positive relationship between gold and stock market returns, indicating that gold does not move inversely with equities and therefore does not provide effective diversification benefits. Although the regression results are statistically significant, their practical relevance is limited due to low explanatory power. The ARCH test confirms the presence of volatility clustering, highlighting the time-varying nature of financial markets and justifying the use of advanced econometric techniques. The Markov switching results further indicate that while the relationship varies across different market regimes, it remains statistically insignificant in both low- and high-volatility periods. Overall, the study concludes that gold does not act as a reliable hedge or safe-haven asset in the Indian context, emphasizing the need for diversified investment strategies.

KEYWORDS: Gold; Hedge; Safe Haven; Markov Switching Model; NIFTY 50; Portfolio Diversification

I. INTRODUCTION

Financial markets are inherently volatile, and managing risk through portfolio diversification remains a central concern for investors and policymakers. Among various asset classes, gold has traditionally been viewed as a reliable hedge and safe-haven asset, particularly during periods of financial instability. However, empirical evidence regarding the role of gold remains inconclusive, especially in the context of emerging markets such as India. **[23,10,31].**

The Indian stock market, represented by the NIFTY 50 index, has experienced significant fluctuations over the past two decades due to global financial crises, economic reforms, and events such as the COVID-19 pandemic. These developments have renewed interest in examining whether gold can effectively protect investors against stock market volatility **[19,17,22]**. Although gold is a safe asset, the evidence of the hedging ability of gold is mixed **[9,25,33].**

Most existing studies rely on static models that assume a constant relationship between gold and equity markets. However, financial markets are dynamic, and asset relationships often change depending on market regimes. In this context, regime-switching models provide a more realistic framework for capturing time-varying interactions between financial assets. **[8,6,34].**

This study aims to examine the relationship between gold and the Indian stock market using daily data from 2000 to 2025. Specifically, the study investigates whether gold serves as a hedge or safe-haven asset by employing correlation analysis, linear regression, and a two-state Markov switching model. Unlike traditional approaches, the Markov switching framework allows the relationship between gold and stock returns to vary across different market regimes, capturing periods of stability and instability. **[7,35].**

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This study makes a contribution to the existing literature in three different ways. First, the study analyzes the gold-equity nexus in the light of the Indian market using recent data including major financial events **[30,14]**. Secondly, the study makes use of a Markov-switching model as opposed to static models **[8,29]**. Thirdly, the study offers new evidence on the conditional hedging ability of gold to investors in the context of emerging markets **[32,31].**

This study uses a long-time horizon covering multiple economic cycles, enhancing the robustness of regime-based analysis.

II. LITERATURE REVIEW

2.1 Gold as a Hedge Against Stock Markets

Some researches have confirmed that gold has hedging roles in stock markets.[1] concluded that gold can be used as a hedge tool during the COVID-19 pandemic, but its performance varies depending on the phases of the pandemic.[2] also concluded that gold can be used as a hedge tool to reduce stock market uncertainty, but its performance varies depending on the phases of uncertainty. [29] also confirmed that gold can be used as a hedge and diversification tool, but its performance varies depending on the type of economic shocks.

Other recent studies also confirm the hedging function of gold. [32] find that gold is one of the most reliable hedging instruments during times of crisis. [27] show that gold can be used to reduce portfolio risk in emerging markets, although its effectiveness is time-varying.

However, some studies have found that the hedging effectiveness of gold is not time-invariant. For example, Ming [33] suggests that the hedging effectiveness of gold is contingent on the macroeconomic environment, such as inflationary conditions, implying that the role of gold may be undervalued by time-invariant models.

The literature review indicates that gold is a weak to moderate hedge, but the hedging effectiveness of gold is time-varying.

2.2 Gold as a Safe Haven Asset

Some research papers have found that gold is a safe haven during times of crises. [1] found that gold was a safe haven during the early stages of the COVID-19 crisis, although this effect was less pronounced during the latter stages. Similarly, [27] found that gold shields investors during stock market crashes, especially in emerging markets.

Recent research further emphasizes the conditional nature of the safe-haven characteristics of gold. [33] reveals that gold has both strong and weak safe-haven qualities based on the crisis period and asset type. [29] further reveals that gold's safe-haven qualities differ based on the different stages of the COVID-19 crisis, suggesting that it is not always effective.

In addition, some research has discovered that gold does not always function as a strong safe haven asset. For example, [33] discovered that the function of gold as a safe haven is conditional upon economic conditions such as inflation states.

It is evident from the literature that gold is not a universal safe haven asset.

2.3 Time-Varying and Regime-Dependent Relationships

Some of the studies use the regime-switching models to analyze these dynamics. For instance, [6] used the Markov-switching model and found that the hedge and safe-haven properties of gold change depending on the market regime. Similarly, [29] used the Markov-switching model and found that gold changes depending on the high and low volatility regimes.

Recent evidence also supports the state dependence of financial linkages.[33] proposes that the role of safe-haven assets, such as gold, is not constant across different states of a crisis, whether it is a COVID-19 crisis or a geopolitical crisis. Ming [33] also finds that the dynamics of gold are not constant across different states of inflation, further emphasizing the importance of state-dependent analysis.

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The above evidence further supports that static models may not be effective in modeling financial linkages and, therefore, the importance of regime-switching models.

2.4 Evidence from Emerging and Indian Markets

The emerging markets also have their own characteristics such as higher volatility, lower liquidity, and different behavior of investors, which may affect the relationship between gold and stock markets. Certain research studies have also found that the hedging and safe-haven roles of gold may vary across regions due to structural differences [30,31]

Although some studies examine the significance of gold in emerging markets, comparatively fewer studies have focused on the Indian stock market with contemporary data, particularly in the context of regime-switching models. This highlights the relevance of further research in this domain.

2.5 Research Gap

Despite extensive research on gold as a hedge and safe-haven asset, several gaps remain in the literature. First, many studies rely on static models that fail to capture the dynamic nature of financial markets. Second, empirical evidence for emerging markets, particularly India, remains limited and inconclusive. Third, there is a lack of recent studies that incorporate regime-switching techniques to analyze the gold-equity relationship.

To address these gaps, the present study employs a two-state Markov switching model to examine the regime-dependent relationship between gold and the Indian stock market using recent data from 2000 to 2025. By doing so, the study provides new insights into the time-varying nature of gold's role as a hedge and safe haven asset.

III. DATA AND METHODOLOGY

3.1 Data Description

This research paper attempts to find the correlation between the prices of gold and the Indian stock market based on the data from January 2000 to 2025 [6,29,35]. The Indian stock market is represented by the NIFTY 50 index, which is a benchmark indicator for the performance of the Indian stock market [30].

The initial dataset consists of 6,750 daily observations covering the period from 2000 to 2025. After aligning the gold and NIFTY series and removing missing values arising from return calculations, the final sample used for empirical analysis consists of 1,330 observations [1,19,22]. The data is collected using a statistical programming language called "R" from publicly available financial databases and investing.com [16].

3.2 Return Calculation

To analyze the relationship between gold and equity markets, logarithmic returns are calculated from the price series [27,28]. Log returns are commonly used in financial studies because they stabilize variance and improve statistical properties of time-series data [6].

The returns are calculated as:

$$R_t = \ln (P_t/P_t\text{-}1)$$

Where:

- R_t represents the return at time t
- P_t represents the asset price at time t
- P_{t-1} represents the asset price at the previous time period

Using log returns also helps ensure stationarity in the time series, which is required for econometric modeling [8].

3.3 Stationarity Test

Before performing regression analysis, the stationarity of the return series is checked by using the Augmented Dickey-Fuller test [6]. The null hypothesis of the ADF test assumes that the series is non-stationary, meaning that it contains a unit root [8].

Financial return series are generally expected to be stationary [27]. Rejecting the null hypothesis confirms that the return series are suitable for further econometric analysis [29].

3.4 Regression Model

To examine whether gold acts as a hedge against stock market movements, a linear regression model is estimated [9,10]:

$$Nifty\_Return_t = \alpha + \beta \cdot Gold\_Return_t + \epsilon_t$$

Where:

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- $Nifty\_Return_t$ represents the return of the NIFTY index
- $Gold\_Return_t$ represents the return of gold prices
- A is the intercept
- β measures the sensitivity of stock returns to gold returns
- ϵ_t represents the error term

A negative and statistically significant coefficient of gold returns indicates that gold acts as a hedge against stock market movements [23,30].

3.5 ARCH Test for Volatility

Financial return series are also said to have the volatility clustering phenomenon, i.e., the volatility in the stock market tends to cluster [17,22]. In order to check whether the residuals of the regression equation have heteroscedasticity or not, the ARCH test is applied [26].

The ARCH test is applied in order to check whether there is any constant variance in the residuals of the regression equation. If there is constant variance in the residuals of the equation, it is a clear indication that the volatility clustering phenomenon is present in the stock market [31].

3.6 Markov Switching Model

To capture the time-varying relationship between gold and stock market returns, this study employs a two-regime Markov switching model [6,34]. Unlike traditional regression models, the Markov switching framework allows model parameters to change across different market regimes [8].

The model is specified as

$$Nifty\_Return_t = \alpha_{St} + \beta_{St} \cdot Gold\_Return_t + \epsilon_t$$

Where:

- S_t represents the unobserved regime at time t
- α_{St} and β_{St} are regime-dependent parameters

The model assumes two regimes:

Regime 1 – Low-volatility regime

Represents normal market conditions with relatively stable financial markets.

Regime 2 – High-volatility regime

Represents periods of financial turbulence or market stress [35].

The Markov switching model estimates the probability of the system being in each regime at every point in time and allows the relationship between gold and equity returns to vary across regimes [6,34]

IV. EMPIRICAL RESULTS

4.1 Descriptive Statistics

Table 1 presents the descriptive statistics for the return series of the NIFTY index and gold prices. The sample consists of daily observations covering the period from 2000 to 2025.

Table 1 Descriptive Statistics of Returns

Variable	Mean	Std Dev	Min	Max	Skewness	Kurtosis
Nifty_Return	0.000	0.01	-0.0613	0.05	-0.46	3.69
Gold_Return	0.000	0.01	-0.06	0.05	-0.57	2.96

The descriptive statistics indicate that both NIFTY and gold return series exhibit characteristics typical of financial time series. The mean returns are approximately zero, which is expected for daily data. The standard deviation for both series is around 0.01, indicating moderate volatility.

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The minimum and maximum values suggest the presence of extreme movements in both markets. Notably, the negative skewness values (-0.46 for NIFTY and -0.57 for gold) indicate that both return distributions are skewed to the left, implying a higher probability of extreme negative returns.

Furthermore, the kurtosis values exceed the normal benchmark of 3 for NIFTY (3.69), indicating leptokurtic behavior and the presence of fat tails. This suggests that extreme market events occur more frequently than predicted by a normal distribution. Overall, these findings confirm that both return series exhibit non-normal distribution, which is a well-documented feature of financial data.

4.2 Correlation Analysis

The correlation matrix between gold returns and NIFTY return is presented in Table2.

The correlation analysis reveals a coefficient of 0.0625 between gold returns and NIFTY returns, indicating a weak positive relationship. This suggests that both assets tend to move slightly in the same direction rather than in opposite directions.

The low magnitude of the correlation implies that gold provides limited diversification benefits. However, the positive sign contradicts the traditional view of gold as a hedge, as a hedging asset is expected to exhibit a negative or near-zero correlation with equity markets. Therefore, the results indicate that gold does not serve as an effective hedge in the Indian stock market.

Table 2 Correlation Matrix

Variable	Nifty_Return	Gold_Return
Nifty_Return	1.000	0.0625
Gold_Return	0.0625	1.000

4.3 Stationarity Test

Before estimating the regression model, the stationarity of the return series was tested using the Augmented Dickey-Fuller (ADF) test.

The results strongly reject the null hypothesis of a unit root for both return series. The ADF statistic for NIFTY returns is -11.97, while the ADF statistic for gold returns is -11.45, both with p-values less than 0.01.

These results confirm that both return series are stationary and suitable for further econometric analysis.

Table 3 Augmented Dickey-Fuller Test

Variable	ADF Statistic	p-value	Result
Nifty_Return	-11.97	<0.01	Stationary
Gold_Return	-11.45	<0.01	Stationary

4.4 Regression Analysis

To examine whether gold acts as a hedge against stock market movements, the following regression model was estimated

$$Nifty\_Return_t = \alpha + \beta \cdot Gold\_Return_t + \epsilon_t$$

The regression results are presented in Table 4.

The coefficient of gold returns is 0.0538, which is positive and statistically significant at the 5% level ($p = 0.022$). This indicates that increases in gold returns are associated with increases in NIFTY returns.

The positive relationship suggests that gold does not act as a hedge against stock market movements in the Indian context. Instead, gold appears to move in the same direction as equity markets, indicating co-movement rather than risk protection.

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The R-squared value of 0.0039 is relatively low, indicating that gold returns explain only a small portion of the variation in stock returns. This is expected for high-frequency financial data, where asset prices are influenced by multiple factors. Overall, the results suggest that gold provides limited diversification benefits and does not serve as a reliable hedging instrument.

Table 4 Regression Results

Variable	Coefficient	Std Error	t-Statistic	p-value
Intercept	0.0006857	0.0002484	2.760	0.0059
Gold_Return	0.0538026	0.0235782	2.282	0.0226

Notes
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

4.5 ARCH Test

To examine the presence of volatility clustering in the regression residuals, an ARCH test was conducted.
The results show a Chi-square statistic of 105.72 with a p-value less than 2.2×10^{-16}, indicating strong evidence of ARCH effects.
This finding suggests the presence of conditional heteroskedasticity in the return series, which is a common feature of financial time series and supports the use of dynamic modeling approaches.

Table 5 ARCH Test

Statistic	df	p-value
105.72	12	<0.001

4.6 Markov Switching Regression Results

The regime-dependent coefficients estimated from the Markov switching model are presented in Table 6

Table 6 Markov Switching Results

Variable	Regime 1 (Low Volatility)	Regime 2 (High Volatility)
Intercept	0.0012	-0.0004
Gold_Return	0.0344	0.0818
Std Error	0.0235	0.0605
t-statistic	1.4638	1.3521
p-value	0.1432	0.1763

Notes:
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Transition Probability Matrix

From/To	Regime 1	Regime 2
Regime 1	0.9647	0.0686
Regime 2	0.0353	0.9314

The Markov switching model identifies two distinct regimes representing different market conditions. In Regime 1 (low-volatility regime), the coefficient of gold returns is positive (0.0344) but statistically insignificant, indicating weak co-movement between gold and stock returns.

In Regime 2 (high-volatility regime), the coefficient of gold returns increases to 0.0818 but remains statistically insignificant. This suggests that gold does not provide significant hedging or safe-haven benefits even during periods of market stress.

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The transition probability matrix indicates strong persistence in both regimes. The probability of remaining in Regime 1 is 0.9647, while the probability of remaining in Regime 2 is 0.9314. This implies that once the market enters a particular regime, it tends to remain in that state for a prolonged period.

Overall, the results suggest that gold does not act as a reliable hedge or safe-haven asset in the Indian stock market, as its relationship with equity returns remains weak and statistically insignificant across both regimes.

Regime Persistence

The transition probability matrix shows strong persistence within each regime. The probability of remaining in Regime 1 is 0.964, while the probability of remaining in Regime 2 is 0.9314. This indicates that once the market enters a particular regime, it is likely to remain in that state for a considerable period.

Such persistence is typical in financial markets and supports the use of regime-switching models to capture structural changes in asset relationships.

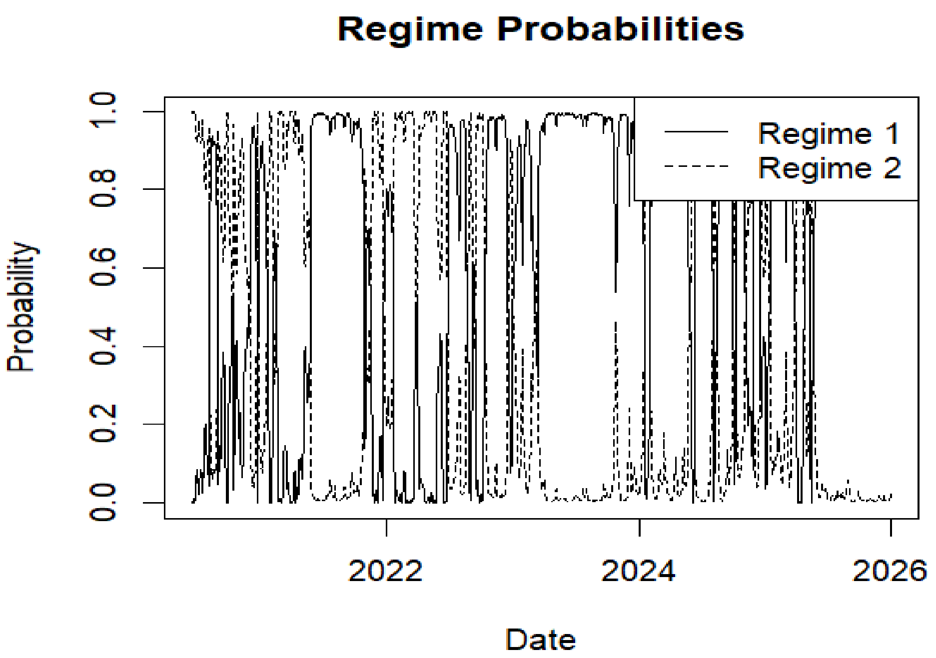

Figure 1. Smoothed probabilities of the two regimes estimated using the Markov-switching model.

Figure 1 represents the smoothed probabilities of the two regimes obtained from the Markov-switching model. Regime 1 corresponds to periods of relatively stable market conditions, while Regime 2 represents period of higher market instability. The figure illustrates how the probability of each regime evolves over time, indicating shifts in market dynamics.

V. DISCUSSIONS

The empirical findings of this study provide important insights into the relationship between gold and the Indian stock market. Contrary to the traditional view of gold as a hedge or safe-haven asset, the results indicate a weak positive relationship between gold returns and NIFTY returns. This suggests that gold does not move inversely to equity markets and therefore does not provide effective protection against stock market risk in the Indian context.

The correlation and regression results consistently indicate a positive and statistically significant relationship between gold and stock returns. Although the magnitude of the relationship is relatively small, the positive sign implies that gold

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tends to move in the same direction as the equity market. This finding challenges the conventional perception of gold as a hedging instrument and suggests that its diversification benefits are limited.

The presence of volatility clustering, as confirmed by the ARCH test, indicates that financial market behavior is characterized by time-varying risk. This justifies the use of more advanced econometric models, such as the Markov switching framework, to better capture dynamic relationships between assets.

The Markov switching results further reveal that the gold-equity relationship is regime-dependent but remains statistically insignificant across both regimes. In the low-volatility regime, gold exhibits weak co-movement with stock returns, while in the high-volatility regime, the relationship becomes stronger in magnitude but remains statistically insignificant. Importantly, gold does not demonstrate any significant negative relationship with equity returns in either regime, indicating the absence of hedging or safe-haven properties.

These findings are consistent with recent literature that emphasizes the time-varying and conditional nature of asset relationships. In emerging markets such as India, factors such as global market integration, investor behavior, and macroeconomic conditions may influence both gold and equity prices in a similar direction, thereby reducing the effectiveness of gold as a hedge.

Furthermore, the high persistence of regimes, as indicated by the transition probabilities, suggests that market conditions tend to remain stable over extended periods. This reinforces the importance of considering regime-dependent dynamics when analyzing financial relationships.

Overall, the results suggest that gold should not be viewed as a reliable hedging or safe-haven asset in the Indian stock market. Instead, it may serve as a supplementary asset with limited diversification benefits, whose effectiveness varies depending on prevailing market conditions.

VI. CONCLUSION AND IMPLICATIONS

This study examines the relationship between gold prices and the Indian stock market using daily data from 2000 to 2025. By employing correlation analysis, linear regression, and a two-state Markov switching model, the study evaluates whether gold serves as a hedge or safe-haven asset in the Indian context.

The empirical findings reveal that gold returns exhibit a weak positive relationship with NIFTY returns. The regression results further confirm a positive and statistically significant association between gold and equity returns, indicating that gold does not act as a hedge against stock market movements. Instead, gold tends to move in the same direction as the equity market, suggesting limited diversification benefits.

The Markov switching model highlights that the gold-equity relationship is time-varying but remains statistically insignificant across both low- and high-volatility regimes. This implies that gold does not consistently provide protection during periods of market stress and therefore cannot be considered a reliable safe-haven asset in the Indian stock market.

From an investment perspective, the findings suggest that gold should not be relied upon as a primary hedging instrument for equity portfolios. While it may offer some diversification benefits, these benefits are limited and conditional on market conditions. Investors should therefore consider a broader set of assets when constructing diversified portfolios.

From a theoretical standpoint, the results emphasize the importance of using dynamic models, such as the Markov switching framework, to capture regime-dependent relationships in financial markets. The findings also contribute to the growing body of literature that questions the universal role of gold as a hedge and safe-haven asset, particularly in emerging markets.

Future research can extend this study by incorporating additional asset classes, such as bonds or cryptocurrencies, and by applying alternative econometric techniques, including GARCH-type models, to better capture volatility dynamics.

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Additionally, examining the role of macroeconomic variables may provide further insights into the factors influencing the gold-equity relationship.

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