Understanding Market Efficiency Through Price Discovery Dynamics in Indian Stock Index

Shreya Soni

M.Com (International Finance), Christ (Deemed To Be) University

Abstract

The research titled "Understanding Market Efficiency Through Price Discovery Dynamics in Indian Stock Indices" explore the price discovery dynamics in Indian stock market indices for the period 2020-2024, to understand market efficiency with a specific focus on the relationship between the macroeconomic factors and futures prices of stock indices such as Sensex. Price discovery is a critical process in financial markets, where asset prices adjust to reflect new information. By analysing how efficiently and quickly the Indian indices respond to market forces, this research aims to evaluate the extent of information flow and market integration. The study employs advanced econometric models such as the 'Multiple Linear regression Model' to assess the relationship between different macroeconomic variables with the Equity index. Additionally, it investigates the interplay between market participants and their roles in reflecting information into stock prices. By analysing these price discovery mechanisms, the study contributes to a deeper understanding of market efficiency in India's emerging financial markets and provides insights for investors, regulators, and academics. The findings will aid in assessing the robustness of the market's response to new information and enhance predictive models for future price trends in the stock indices.

1. INTRODUCTION

The concept of price discovery plays a central role in financial markets, referring to the process through which market prices are adjusted based on new information, reflecting the asset's fair value. This mechanism is particularly crucial in stock markets, where efficient price discovery ensures that prices rapidly incorporate all available information, allowing for accurate investment decisions. In the context of emerging markets like India, understanding how well stock indices integrate external and internal factors can provide valuable insights into the market efficiency of these financial systems.

Market efficiency, as outlined by Eugene Fama's Efficient Market Hypothesis (EMH), suggests that prices in a fully efficient market should reflect all available information at any given time. However, emerging markets like India often face challenges such as economic volatility, regulatory constraints, and market participant behavior, which can affect the speed and accuracy of price adjustments. This research focuses on investigating the price discovery dynamics within India's prominent stock indices, specifically the Sensex, by analysing the influence of key macroeconomic factors such as the USD/INR exchange rate and the Consumer Price Index (CPI).

The Sensex is one of India's most widely recognized stock indices, serving as a barometer for market performance and investor sentiment. It is sensitive to both domestic factors (like inflation rates represented by CPI) and global factors (like currency exchange rates). Fluctuations in the USD/INR exchange rate can significantly impact the stock market, especially in a globalized economy where international capital flows

play a crucial role. Similarly, inflation as measured by the CPI can influence interest rates, affecting corporate profitability and stock prices.

By employing econometric models such as Multiple Linear Regression and Granger Causality, this study aims to explore how efficiently these macroeconomic variables influence the price movements of the Sensex, thereby assessing the extent of market efficiency in India. This research will not only provide insights into the behavior of market participants but also contribute to a better understanding of how macroeconomic shocks are absorbed by the Indian financial markets, thereby guiding investment strategies and regulatory frameworks.

1.1 Objective of the Study

- To examine the impact of macroeconomic factors on the performance of the Indian Stock Index; Sensex.
- To analyse the relationship between USD/INR, CPI, and Sensex movements.
- To assess the market efficiency of the Indian stock market by evaluating the interaction between macroeconomic variables and stock price volatility using GARCH modelling.

1.2 Scope

This study examines the relationship between macroeconomic factors and the Indian stock market (Sensex) from 2020 to 2024 using Multiple Linear Regression, Granger Causality Test, and the GARCH Model. It treats equity (Sensex returns) as the dependent variable and focuses on two key macroeconomic indicators: Exchange rate (USD/INR) and Inflation (Consumer Price Index - CPI). The study evaluates how these factors influence stock market movements and volatility patterns. Additionally, it checks the market efficiency of the Indian stock market using the Granger Causality Test and analyzes volatility clustering and persistence in Sensex returns through the GARCH Model.

The scope is confined to comparing Sensex to one independent variable at a time, offering insights into the nuanced interaction between macroeconomic indicators and the Indian financial environment. These findings will be valuable for investors, policymakers, and researchers seeking to understand financial market dynamics during the specified period.

2. REVIEW OF LITERATURE

A Naka, T Mukherjee, D Tufte (1998): This study employs a vector error correction model to examine the interplay between key macroeconomic variables and the Indian stock market. It reveals that while domestic inflation hinders market performance, domestic output growth serves as a primary driver, with economic mismanagement contributing to a residual negative trend, particularly mitigated post-1990 following economic reforms.

N Parab (2019): This study empirically investigates the dynamic relationships between macroeconomic variables, financial performance indicators, and significant economic events in the Indian stock market, uncovering their combined effects on market performance.

Khalid Ul Islam, Mohsina Habib (2019): This study examines the impact of various macroeconomic variables on Indian stock returns from 2005 to 2015 using a multivariate linear regression model and Granger Causality test, finding that only exchange rates significantly affect stock returns, with a unidirectional causal link from stock returns to oil prices.

Naushad Alam (2017): The study analyses the influence of macroeconomic variables on stock prices in

India from March 2005 to April 2013, employing the Johansen cointegration test and GARCH model. It finds long-term heteroscedastic relationships, revealing that inflation, money supply, and industrial production positively affect stock prices, while short- and long-term interest rates and exchange rates have a negative impact.

S Patel (2021): The study examines the impact of macroeconomic determinants on the Indian stock market performance from January 1991 to December 2011, utilizing various econometric tests, including the Johansen cointegration and Granger causality tests. It finds a long-run relationship between macroeconomic variables and stock indices.

B Subbarayan, S Vanitha (2014): The study explores the causal relationship between Bombay Stock Exchange Sensex returns and macroeconomic variables using monthly data from May 2003 to June 2013. It finds that exchange rate and foreign exchange reserves have a unidirectional causal effect on Sensex returns, indicating a long-run relationship between all macroeconomic variables and stock market performance.

V Dragota, DS OPREA (2019): This paper examines the relationship between a Romanian stock market index and various macroeconomic variables from February 2002 to December 2013, exploring contemporaneous, lagged, and anticipated effects. The findings indicate that index variations are primarily linked to current indicator levels, with stock market returns being more effectively explained by future levels rather than past levels of these variables.

R Mukherji (2015): This article investigates stock market efficiency in India, China, and Brazil, assessing the impact of US stock returns on domestic stock returns while accounting for local macroeconomic variables. The findings reveal a significant positive relationship between US stock returns and the stock returns of all three emerging economies, indicating a notable influence despite controlling for key domestic factors.

S Keswani, B Wadhwa (2019): This paper explores the impact of macroeconomic variables on the Indian stock market, highlighting its transformation since 1991 due to liberalization and globalization policies. It emphasizes the stock market's role as a key driver of economic growth, facilitating resource mobilization for companies and influencing investment decisions and price determination in the economy.

KK Kotha (2016): This paper investigates the long and short-run relationships between selected macroeconomic indicators and stock market returns in India, using monthly data from July 2001 to July 2015. The analysis, employing co-integration and error correction models, reveals a significant long-run relationship between the BSE Sensex and key macroeconomic indicators such as exchange rate, wholesale price index.

N Tripathy (2011): This paper examines market efficiency and the causal relationships between selected macroeconomic variables and the Indian stock market from January 2005 to February 2011, using various statistical tests. It finds evidence of autocorrelation in the market and establishes bidirectional relationships between interest rates, exchange rates, and stock market returns.

2.1 Research Gap

The research gap addressed by this study on "Understanding Market Efficiency Through Price Discovery Dynamics in Indian Stock Indices" lies in the underexplored relationship between key macroeconomic factors—such as the Consumer Price Index (CPI) and USD/INR exchange rates—and the efficiency of the Indian stock market, particularly the Sensex. While numerous studies have focused on developed markets, relatively few have systematically investigated price discovery mechanisms in emerging markets

like India, where market volatility, regulatory interventions, and diverse investor behaviours significantly differ. Additionally, while previous studies may have assessed the individual impact of macroeconomic factors on stock prices, there is a paucity of research examining how these variables, in tandem, influence price discovery and market efficiency in the post-pandemic period (2020-2024). Furthermore, the use of advanced econometric techniques like Multiple Linear Regression in the context of macroeconomic shocks and stock market reactions within Indian indices remains limited. This research fills the gap by not only analysing how efficiently the Indian stock market responds to new macroeconomic information but also exploring the robustness of its price discovery mechanisms in a period marked by significant economic disruptions.

2.2 Research Methodology

This research is based on secondary data collected from reliable sources, including the official websites of the Bombay Stock Exchange (BSE) for Sensex, Reserve Bank of India (RBI) for the USD/INR exchange rate, and the Ministry of Statistics and Programme Implementation (MoSPI) for Consumer Price Index (CPI) data. The study will use monthly data spanning from 2020 to 2024 to analyse the relationship between these macroeconomic variables and the Sensex. To assess the impact of the independent variables (CPI and USD/INR) on the dependent variable (Sensex), the Multiple Linear Regression (MLR) Model will be employed. Granger causality test will also be applied to assess the Market efficiency. The MLR will help estimate the strength and direction of relationships between these variables, identifying how much each macroeconomic factor influences Sensex price movements. The model will be tested for statistical significance, ensuring robust findings for the research.

3. RESEARCH DESIGN

In this research, we have adopted a quantitative approach to analyse the impact of macroeconomic factors on the Indian Stock Market Index, over the period from 2020 to 2024. Using monthly time series data, we have employed a Multiple Linear Regression Model to quantify the relationship between these independent variables and the Sensex, aiming to assess how these factors influence market performance. Additionally, we incorporated the Granger Causality Test to examine the direction and causality between these variables, providing insights into the market efficiency of Sensex in responding to macroeconomic changes. Through this structured and data-driven methodology, we seek to uncover the underlying dynamics of price discovery in the Indian stock market.

3.1 Variable of the Study

Segments	Variable
Equity	SENSEX
Commodity	CPI
Currency	USD/INR

3.1.1 Dependent Variables

Equity – SENSEX: The Sensex, or the S&P BSE Sensex, is the benchmark index of the Bombay Stock Exchange (BSE) in India, representing 30 of the largest and most actively traded stocks on the exchange.

It serves as a barometer for the Indian stock market's overall performance, reflecting investor sentiment and the health of the economy.

3.1.2 Independent Variables

Consumer Price Index: The Consumer Price Index measures the average change in prices paid by consumers for a basket of goods and services over time. It is a key indicator of inflation and purchasing power in an economy, influencing monetary policy decisions, and is closely monitored by investors as it impacts the cost of living and economic stability.

USD/INR Exchange Rate: The USD/INR exchange rate indicates how many Indian Rupees (INR) are needed to purchase one US Dollar (USD). It is a critical gauge of India's foreign exchange market, reflecting the strength of the Indian currency against the dollar and influencing trade, investment flows, and economic policies in India

3.2 RESEARCH MODEL AND METHODS

3.2.1 Model

MULTIPLE LINEAR REGRESSION MODEL

For this study, the Multiple Linear Regression (MLR) model aims to analyse the impact of two independent macroeconomic factors, the Consumer Price Index (CPI) and the USD/INR exchange rate, on the Indian Stock Market Index (Sensex).

Model Specification:

$$\text{Sensex}_t = \beta_0 + \beta_1 \cdot \text{CPI} + \beta_2 \cdot \text{USD/INR} + \epsilon_t$$

Where:

Sensex_t is the dependent variable, representing the value of the Sensex at time t. β_0 is the intercept term, representing the baseline level of the Sensex when CPI and USD/INR are zero. β_1 is the coefficient for the CPI, indicating the impact of CPI on the Sensex. β_2 is the coefficient for the USD/INR exchange rate, indicating the impact of the exchange rate on the Sensex. ϵ_t is the error term, capturing the influence of other factors not included in the model.

GRANGER CAUSALITY TEST

The **Granger Causality Test** is used to determine whether one time series can predict another. In this context, it helps to assess the causality between the macroeconomic variables (CPI and USD/INR) and the Sensex.

Model Specification for Granger Causality:

For CPI Granger causing Sensex:

$$Y_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i Y_{t-i} + \sum_{j=1}^{q} \beta_j X_{t-j} + \epsilon_t$$

Where:

Y_t is the value of the dependent variable Y at time t. X_{t-j} are the lagged values of the independent variable X. α_0 is the intercept. α_i and β_j are coefficients of the lagged values of Y and X, respectively. p and q are the number of lags. ϵ_t is the error term.

GARCH MODEL

The GARCH (Generalized Autoregressive Conditional Heteroskedasticity) model is used to analyse and predict volatility in time-series data, especially in financial markets like the Sensex stock index. It helps capture volatility clustering, meaning that periods of high volatility are followed by high volatility, and low volatility is followed by low volatility.

Model Specification for GARCH

σt2 = ω+αεt−12+βσt−12

σt2 = Conditional variance (current period volatility)

ω = Constant (baseline variance)

α = Impact of past shocks (ARCH term, measures short-term volatility)

β = Persistence of past volatility (GARCH term, measures how long volatility lasts over time)

εt−12 = Previous day's squared residual (shock effect on volatility)

σt−12\sigma_{t-1}^2σt−12 = Previous day's volatility (persistence of volatility over time)

3.2.2 Hypothesis

H0: There is no significant impact of Currency exchange rates and Consumer Price Index rates on the performance of SENSEX index.

H1: There is a significant impact of Currency exchange rate and Consumer Price Index rates on the performance of SENSEX index.

3.2.3 Data Sources

EQUITY (SENSEX): BSE Website - https://www.bseindia.com

COMMODITY (CPI): RBI Website - https://www.rbi.org.in

FOREX (USD/INR)**:** RBI Website - https://www.rbi.org.in

3.2.4 Tools for Data Analysis

Tools	Purpose
E-Views	To conduct Granger causality Test
SPSS	To conduct the Multiple Linear regression model
E-Views	To develop GARCH Model

4. DATA ANALYSIS

4.1 Introduction

The research delves into the intricate relationship between macroeconomic factors and the performance of the Indian stock market, specifically focusing on the Sensex as the benchmark index. Utilizing a robust methodology, including Multiple Linear Regression and Granger Causality tests, the chapter aims to quantify the effects of key macroeconomic indicators—such as the USD/INR exchange rate and the Consumer Price Index (CPI)—on stock price movements. By systematically analysing data collected over the period from 2020 to 2024, this chapter will evaluate the degree of market efficiency in incorporating these variables into stock pricing, thereby shedding light on the price discovery dynamics within the Indian financial landscape. The insights generated from this analysis will not only enhance understanding of how macroeconomic shocks influence stock indices but also inform investment strategies and policy decisions in an increasingly interconnected global economy.

4.2 DESCRIPTIVE STATISTICS

Particulars	Mean	Std. Deviation	N
BSE SENSEX	56621.1899	12719.0799	56
USD/INR	78.2071	4.2729	56
CONSUMER PRICE INDEX	170.2482	13.0638	56

INTERPRETATION

The mean value of the BSE Sensex over the analysed period is approximately 56,621, with a standard deviation of around 12,719, indicating substantial fluctuations in the index. The USD/INR exchange rate has a mean of approximately 78.21, with a smaller standard deviation, suggesting relatively stable currency fluctuations compared to the Sensex. The CPI has a mean value of around 170.25 with a standard deviation of 13.06, which also suggests some level of variability, though less than the Sensex.

4.3 MULTIPLE LINEAR REGRESSION MODEL
4.3.1 CORRELATION

Particulars		BSE SENSEX	USD/INR	CONSUMER PRICE INDEX
Pearson Correlation	BSE SENSEX	1.000	.784	.941
	USD/INR	.784	1.000	.927
	CONSUMER PRICE INDEX	.941	.927	1.000
Sig. (1-tailed)	BSE SENSEX	.	.000	.000
	USD/INR	.000	.	.000
	CONSUMER PRICE INDEX	.000	.000	.
N	BSE SENSEX	56	56	56
	USD/INR	56	56	56
	CONSUMER PRICE INDEX	56	56	56

INTERPRETATION

The Pearson correlation coefficients indicate a strong positive relationship between the Sensex and both the USD/INR exchange rate (0.784) and the CPI (0.941). This suggests that as the CPI and USD/INR increase, the Sensex tends to increase as well. The strong correlation between CPI and Sensex (0.941) implies that inflation, as measured by CPI, has a significant influence on the stock market index, aligning with your research's focus on how domestic factors like inflation impact market efficiency.

4.3.2 MODEL SUMMARY

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.970[a]	.942	.940	3125.560709875673000	.619

a. Predictors: (Constant), CONSUMER PRICE INDEX, USD/INR
b. Dependent Variable: BSE SENSEX

4.3.3 ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8379860895.035	2	4189930447.517	428.895	.000[b]
	Residual	517763876.809	53	9769129.751		
	Total	8897624771.844	55			

a. Dependent Variable: BSE SENSEX

b. Predictors: (Constant), CONSUMER PRICE INDEX, USD/INR

4.3.4 COEFFICIENTS

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	-49434.605	8905.627		-5.551	.000		
	USD/INR	-1879.593	263.306	-.631	-7.138	.000	.140	7.126
	CONSUMER PRICE INDEX	1486.379	86.122	1.527	17.259	.000	.140	7.126

a. Dependent Variable: BSE SENSEX

INTERPRETATIONS

The R-squared value of 0.942 indicates that approximately 94.2% of the variance in the Sensex can be explained by the model, which includes the CPI and USD/INR as predictors. This high R-squared value suggests a strong explanatory power of these macroeconomic variables on the Sensex's movements.

The coefficients show that the CPI has a positive standardized beta (1.527), indicating a strong positive impact on the Sensex, while the USD/INR exchange rate has a negative impact (-0.631). This reflects that while inflation positively influences the stock index, an increase in the USD/INR rate (depreciation of INR) tends to decrease the Sensex value. The F-statistic is significant (p-value < 0.001), confirming that the regression model as a whole is statistically significant, meaning that CPI and USD/INR are important predictors of the Sensex.

GARCH MODEL

```
Dependent Variable: LOG_RET_SENSEX
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 03/01/25   Time: 19:20
Sample (adjusted): 1/02/2020 12/31/2024
Included observations: 1204 after adjustments
Convergence achieved after 34 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)
```

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.003224	0.002847	1.132417	0.2575
LOG_RET_USDINR	-1.030472	0.093569	-11.01301	0.0000
CPI	-1.31E-05	1.63E-05	-0.801851	0.4226

Variance Equation				
C	3.31E-06	7.21E-07	4.590231	0.0000
RESID(-1)^2	0.129540	0.012294	10.53705	0.0000
GARCH(-1)	0.843780	0.014842	56.85215	0.0000

R-squared	0.096739	Mean dependent var		0.000529
Adjusted R-squared	0.095235	S.D. dependent var		0.012773
S.E. of regression	0.012150	Akaike info criterion		-6.508782
Sum squared resid	0.177286	Schwarz criterion		-6.483400
Log likelihood	3924.287	Hannan-Quinn criter.		-6.499222
Durbin-Watson stat	2.226765			

Interpretation:

The coefficient for **LOG_RET_USDINR** is -1.0304, meaning that a 1% increase in USD/INR returns leads to a 1.03% decrease in Sensex returns. This is highly significant (p=0.0000), implying a strong negative relationship between exchange rates and Sensex.

The coefficient for **CPI** is -0.0000131, indicating almost no effect. It is statistically insignificant (p=0.4226p), meaning CPI does not impact Sensex returns significantly in this model.

The **constant (C)** is 0.003224, suggesting that in the absence of changes in USD/INR and CPI, Sensex returns are slightly positive but not statistically significant.

GARCH (1) = 0.8438: This measures the persistence of volatility. A high value (~0.84) indicates that volatility persists for a long time, meaning the market does not stabilize quickly.

4.4 GRANGER CAUSALITY TEST

```
Pairwise Granger Causality Tests
Date: 03/01/25   Time: 19:11
Sample: 1 1242
Lags: 2
```

Null Hypothesis:	Obs	F-Statistic	Prob.
LOG_RET_SENSEX does not Granger Cause LOG_RET_USDINR	1094	1.69291	0.1845
LOG_RET_USDINR does not Granger Cause LOG_RET_SENSEX		0.85568	0.4253
CPI does not Granger Cause LOG_RET_USDINR	1094	0.17926	0.8359
LOG_RET_USDINR does not Granger Cause CPI		0.08408	0.9194
CPI does not Granger Cause LOG_RET_SENSEX	1235	0.09580	0.9087
LOG_RET_SENSEX does not Granger Cause CPI		0.14802	0.8624

Pairwise Granger Causality Tests
Date: 09/28/24 Time: 10:54
Sample: 2020M01 2024M08
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
CPI does not Granger Cause CLOSE	54	2.17447	0.1245
CLOSE does not Granger Cause CPI		1.74437	0.1854
USD_INR does not Granger Cause CLOSE	54	1.10500	0.3393
CLOSE does not Granger Cause USD_INR		1.29304	0.2836
USD_INR does not Granger Cause CPI	54	1.64420	0.2036
CPI does not Granger Cause USD_INR		1.27757	0.2878

INTERPRETATIONS

The Granger Causality test results indicate that there is no significant predictive relationship between the CPI, USD/INR exchange rate, and the Sensex closing prices within the sample period from January 2020 to August 2024. Specifically, neither the CPI nor the USD/INR exchange rate Granger-causes the Sensex closing prices, and vice versa. Additionally, no significant Granger causality was found between the CPI and USD/INR exchange rate. This suggests that within this time frame, these variables do not significantly predict each other, indicating that other factors may be influencing these variables independently.

5. FINDINGS AND CONCLUSION

The research titled "Understanding Market Efficiency Through Price Discovery Dynamics in Indian Stock Indices" aimed to quantitatively analyse the interplay between macroeconomic variables and the Indian Stock market Index. The Multiple Linear regression analysis and Granger causality test conducted indicates that while the BSE Sensex, USD/INR exchange rate, and Consumer Price Index (CPI) exhibit strong correlations, the Granger Causality tests reveal no significant predictive relationships among these variables during the period from January 2020 to August 2024. Specifically, the CPI shows a strong positive correlation with the Sensex, suggesting that inflation impacts market performance; however, Granger Causality tests fail to establish a directional predictive causality between these variables. Similarly, while the USD/INR exchange rate is negatively correlated with the Sensex, indicating that currency depreciation tends to lower stock prices, no significant Granger causality is found. These results imply that, although these macroeconomic factors are associated with the Sensex, they do not directly predict each other in the short term within the studied period. This could suggest that the Sensex is influenced by a broader set of factors, including global economic conditions, investor sentiment, and policy changes, which might overshadow the direct impact of CPI and exchange rate movements. The GARCH model reveals significant insights into the relationship between macroeconomic factors and Sensex returns and volatility. The findings indicate that USD/INR exchange rate fluctuations have a strong negative impact on Sensex returns, with a 1% increase in USD/INR returns leading to a 1.03% decrease in Sensex returns, confirming the sensitivity of the Indian stock market to currency movements. However, CPI is found to be statistically insignificant, suggesting that inflation does not have a direct impact on stock returns in this model. The research concludes that while price discovery in the Indian stock market is influenced by macroeconomic variables, the lack of Granger causality highlights the complexity of these relationships and the potential role of other influencing factors.