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Research Paper

The Impact of Macroeconomic Variables on Stock Market Volatility in India. An in-depth study using Regression and GARCH Model.

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ABSTRACT: *Stock market returns are volatile and expose stock market investors to significant risks. A model to explain the volatility in the stock market can minimize investor risks. Understandably the area of volatility modeling has been of keen research interest over the past decades. TheGeneralized AutoRegressive Conditional Heteroskedasticity (GARCH) family of models, first proposed by Robert Engle and Tim Bollerslev, is the most preferred model for volatility modeling. These models mostly try to predict volatility from past volatility and return. The GARCH-G model looks extremely useful since it combines the traditional GARCH model with macroeconomic factors.This paper aims to find the key reasons behind the volatility in the Indian stock market using the GARCH-G model by Alshogeathri (2011). First, the correlation of key macroeconomic variables, including interest rates, oil prices, inflation rate, exchange rate, M3 money supply, oil prices, market PE Ratio and US stock market returns with India VIX was found using 10-year monthly data. Then GARCH(1,1) model and GARCH-G model were applied to find if these factors significantly impact volatility using monthly returns of Nifty 50.It was found that the macroeconomic variables have a weak correlation with the India VIX index. Also, these macroeconomic variables failed to improve the standard GARCH(1,1) model. Thus it was determined that these factors do not significantly affect the volatility of monthly returns of the Indian market. However, it might be worthwhile for future studies to apply the same approach to high-frequency data (daily return) and use different GARCH models, such as GARCH-MIDAS.*
KEYWORDS: *Macroeconomic, Nifty, Variables, High-frequency data*

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I. Introduction

Stock Market volatility means a continuous change in stock prices. Volatility is a measure of how fast and how much the price of an investment changes over time. Such volatility exposes investors to significant risk. The National Stock Exchange (NSE) and Bombay Stock Exchange (BSE) indices have been relatively volatile. One of the most popular and widely used methods for modeling and forecasting volatility is the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model. The GARCH model was developed by Bollerslev (1986) as an extension of the Autoregressive Conditional Heteroskedasticity (ARCH) model proposed by Engle (1982). The GARCH model captures the features of volatility clustering, persistence, and leverage effect commonly observed in financial time series.

1.1 Major Stock Market Indices in India

Stock market indices like BSE Sensex and Nifty 50 can measure volatility. BSE Sensex, the oldest stock index in India, was first launched in 1986. The BSE 30 is designed to reflect the growth and performance of the top 30 listed companies that are financially sound and well-established.

NSE 50 is currently the most popular stock market index. It consists of 50 top trade shares in the country and includes all 30 shares under BSE 30. The calculation of NSE 50 is done using a similar free float methodology used for BSE Sensex.

1.2 India VIX

Nifty VIX is an indicator that demonstrates the volatility of the Nifty for the next 30 days or so. The higher the value of the Nifty VIX, the higher the anticipated volatility in Nifty. The India VIX index is calculated by the

National Stock Exchange (NSE) from the order book of Nifty options (it is based on top bid-ask quotes for the upcoming and following month's Nifty options contracts).
The value of India VIX is derived by leveraging the Black and Scholes model. It is measured by using five variables of options contracts: strike price, the market price of the stock, volatility, expiry time, and the risk-free rate. The India VIX values indicate the percentage change anticipated in the Nifty index. For instance, if India VIX is at 20, the Nifty can rise or fall by 20% from its current state over the next 12 months.

II. Literature Review

Stock market volatility shows clustering, as demonstrated by Mandelbrot (1963). Volatility clustering refers to the phenomenon that a period of high volatility is likely to be followed by another period of volatility, and a period of small volatility is likely to be followed by small volatility. Engle (1982) formulated Auto Regressive Conditional Heteroskedasticity (ARCH) model based on this concept. Bollerslev (1986) extended this model to Generalized Auto Regressive Conditional Heteroskedasticity (GARCH) model. The GARCH family of models is currently the most popular tool to model stock market volatility. As per Dalhaus (2011), GARCH (1,1) model is a simple and widely used financial time series model.

Many branches of the GARCH model have evolved over the years. Multivariate GARCH models were introduced by Bollerslev, Engle, and Woolridge (1988). An exponential GARCH (EGARCH) model was proposed by Nelson (1991). Threshold GARCH (T-GARCH) model was proposed by Zakoian (1994). The DCC-GARCH model was introduced by Engle and Sheppard (2001). Many other variants of GARCH models have been proposed.

However, these models used only past returns and volatility to explain current volatility. Intuitively, macroeconomic variables like oil price, inflation, interest rate, GDP growth, etc., should affect stock market volatility. Lee (1994) extended the GARCH model into GARCH-X by adding additional explanatory variables as error correction terms. Engle (2002) modified this model using high-frequency data as the additional explanatory variable. In this model, the high-frequency data illustrate the intraday volatility of each trading day. Kapital (1998), Alshogeathri (2011), Hasan & Zaman (2017), and Wallen (2020) extended this model by using macroeconomic variables as explanatory variables in the GARCH-X model. Alshogeathri (2011) termed these models GARCH-S and GARCH-G models. Most of these papers found that different macroeconomic variables significantly impact stock market volatility.In the Indian context, Agarwal (2020) applied GARCH (1,1) model to the Indian stock market and concluded the presence of volatility clustering in BSE and NSE exchanges. Adhikary (2021) applied GARCH (1,1), TGARCH (1,1), and EGARCH (1,1) to Indian stock markets and concluded that the EGARCH model is best suited for Indian markets. Yadav et al. (2023) found a volatility spillover effect between the Indian and global stock markets using the DCC-GARCH model. As per available research, no attempt has been made to identify macroeconomic variables in the Indian stock market that may enhance the performance of the standard GARCH model.
The paper aims to apply GARCH (1,1) and GARCH-G (1,1) models to the Indian stock market to see if macroeconomic variables improve the performance of the GARCH model and, if so, which variables are most strongly correlated to volatility.

III. Research Methodology

The overall research methodology is to collect data on monthly stock market returns (Nifty 50) along with various macroeconomic variables such as M3 money supply, Consumer Price Index (CPI), FPI Investments, USDINR exchange rate, S&P 500 Index, and Oil Price for ten years (January 2010 – December 2019). The data during the Covid era (2020-2022) was left out because the high uncertainty during the Covid period may affect the ordinary relations with macroeconomic variables. This data is then applied to GARCH (1, 1) and GARCH-G models to see which model performs better and which macroeconomic indicators best explain the volatility in the stock market.

3.1 GARCH(1,1) Model

The GARCH model assumes that the conditional variance of a time series depends on its past values and the past values of the squared errors. The GARCH (1,1) model consists of two equations:

Conditional Mean Equation

The first step in the GARCH (1, 1) model is to estimate the mean equation. The function of the mean equation is to find the fitted squared errors (t), which will serve as the dependent variable in the conditional variance equation.

$$r(t) = \mu + \epsilon(t)$$
$$\epsilon(t) = \sigma(t) * z(t)$$

$z(t) \sim$ i.i.d(0,1)

where r(t) is the return of a stock at time t, μ is the conditional mean of r(t), ϵ(t) is the error term with zero mean and variance $\sigma(t)^2$, z(t) is a standard normal random variable

Conditional Variance Equation

Conditional variance equation gives the equation for instantaneous volatility. It is given by the following equation:

$$\sigma(t)^2 = \omega + \alpha*\epsilon(t-1)^2 + \beta*\sigma(t-1)^2$$

whereϵ(t) is the error term from the mean equation, σ(t−1) is the conditional volatility from the previous iteration of the mean equation, α and β are non-negative parameters that measure the impact of past shocks and past volatility on current volatility, respectively. The constraints on α and β are:

$\alpha > 0$

$\beta > 0$, and

$\alpha + \beta < 1$

Here the first term $\alpha*\epsilon(t-1)^2$ is called the GARCH term. It was introduced by Bollerslev to improve in original ARCH model by Engle. The second term $\beta*\sigma(t-1)^2$ is the ARCH term. With restriction of β>0, it implies volatility clustering. If the volatility in the previous period is higher, then the volatility in the current period will also be high because of this term.

3.2 GARCH-G Model

Alshogeathri (2011) defined GARCH-G model as an extended version of GARCH-X model. It is given by:

$$r(t) = \mu + \theta*r(t-1) + \epsilon(t)$$
$$\epsilon(t) = \sigma(t)*z(t)$$
$$\epsilon(t) \sim \text{i.i.d.}(0,1)$$
$$\sigma(t)^2 = \omega + \alpha*\epsilon(t-1)^2 + \beta*\sigma(t-1)^2 + \textstyle\sum_{n=1}^{8} \quad \lambda n * \Delta Xn\ (t-1) \sum_{n=1}^{8} \quad \lambda n * \Delta Xn\ (t-1)$$

Where,

r(t) is the return of a stock at time t defined by P(t) – P(t-1) (current price – previous period price), μ is the conditional mean of r(t), ϵ(t) is the error term with zero mean and conditional variance $\sigma(t)^2$, z(t) is a standard normal random variable, ω is a constant term, α and β are non-negative parameters that measure the impact of past shocks and past volatility on current volatility, respectively. $\lambda n \lambda n$is the coefficient of n^{th} macroeconomic variable and $\Delta Xn\ (t-1)\Delta Xn\ (t-1)$ is the first difference of n^{th} macroeconomic variable.

However, for the purpose of the paper, first term is modified as:

$$r(t) = \mu + \epsilon(t)$$

It is done to be consistent with the GARCH(1,1) model for a fair comparison.

$$r(t) = P(t) - P(t-1)$$

Where P(t) is the value of Nifty 50. Also:

$$\Delta Xn\ (t-1) = Xn\ (t-1) - Xn\ (t-2)$$

Alshogeathri, MAM (2011), Macroeconomic determinants of the stock market movements: empirical evidence from the Saudi stock market, Kansas State University, Dissertation

3.3 Macroeconomic Variables

Here is a description of critical macroeconomic variables used in the model and the reasons for using them:

Consumer Price Index (CPI): The Consumer Price Index (CPI) is a measure of the consumer prices based on a representative basket of goods and services. So change in CPI is a measure of inflation. An increase in inflation can affect consumer spending, which affects companies' profits. So a change in CPI can be correlated to volatility of stock prices. The data is taken from the investing.com website.

Foreign Portfolio Investments (FPI): FPI refers to the funds invested by foreign firms in the Indian equity and debt market. Extra funds from FPI should lead to higher stock prices, so FPI investments can lead to higher volatility. The data is taken from NSDL website.

M3 Money Supply (M3): M3 Money supply includes reserve currency base (M0) and all current deposits and time deposits with banks. It is a measure of liquidity in the system. Higher liquidity should ideally lead to higher investment in stock prices, and therefore sudden changes in money supply might affect the volatility. M3 Money supply data is taken from St. Louis Fed Website (https://fred.stlouisfed.org/).
Market PE Ratio (PER): Market PE ratio defines how expensive the market is. Expensive markets can lead to lower returns in the future, thus leading to higher volatility. The relationship between the PE ratio and market volatility has been studied by multiple researchers, including Kane (1996). We have used the PE ratio of Nifty 50 for our study. The data was taken from the website primeinvestor.com.
Oil Prices (OP): Oil is used as raw material in many industries and transportation of most goods. Thus an increase in oil prices affects inflation. It also increases the import bill of the country, thus affecting the exchange rate. Thus oil prices can be a macroeconomic variable affecting the volatility of the stock market. We have used Brent Crude Index as a measure of oil prices. The monthly oil price data is taken from St. Louis Fed website (https://fred.stlouisfed.org/)
Standard&Poor500 Index (SPX): SPX is the major stock market index of the US. Earlier studies have indicated the linkage of volatility of the domestic market to volatility in foreign markets. Hence, the S&P500 index has also been selected as a possible macroeconomic variable affecting the stock market's volatility. This data is taken from the investing.com website.
Ten-Year Sovereign Bond Yield (10Y): The ten-year sovereign bond yield determines the country's long-term interest rates, which determines how expensive it is to fund capital expenditure and other long-term expenses. This can be an important factor behind earning growth of companies and hence may also affect stock market volatility.
USDINR Exchange Rate (USDINR): The movement in the exchange rate is linked to investments in the country. If the rupee becomes more expensive compared to the dollar, it means money is flowing into the country from abroad. A higher inflow of funds in the country should affect the stock market prices. Thus USDINR exchange rate should also affect stock price volatility. The exchange rate data is taken from the investing.com website.

Table 1 shows the key statistical properties of these variables. The data used is monthly data from January 2010 to December 2019.

Variable	Mean	Max	Min	Std. Dev.	Skew	Kurtosis	JB Stat	Prob>z	Obs
Nifty	7,801.4	12,168	4,624.3	2,248.6	.35	1.80	9.64	.01	120
VIX	17.61	31.94	10.86	4.39	.98	3.57	20.86	.00	120
CPI	7.4%	16.2%	1.1%	3.1%	0.29	2.83	1.91	0.39	120
FPI	5,104.7	33,782	-27,623	11,408	.08	2.87	0.2	0.9	120
M3	103,945	161,646	53,688	30,909	0.11	1.85	6.79	.03	120
PER	22.16	29.25	16.12	3.43	0.21	2.00	5.87	.05	120
OP	79.57	125.5	30.7	26.15	.09	1.61	1.85	2.87	120
SPX	1,969.4	3,230.8	1,030.0	594.6	0.21	1.93	6.60	.04	120
10Y	7.76%	9.04%	6.24%	0.68%	-0.35	2.43	4.17	0.12	120
USDINR	61.37	75.59	44.21	9.21	-0.57	2.03	11.25	.004	120

Table 1: Statistical Properties of the Key Variables

The normality of the variables is tested using the Jarques-Bera test. According to the test, the p value (Pro>z) should be greater than 0.05 for null hypothesis of normality to be rejected. As we can see from the table, only CPI inflation, FPI, Oil Price and 10 year bond yield are normally distributed. The rest of the variables are not normally distributed. This suggests the use of a GARCH model to model its volatility (Alshogeathri, 2011)

IV. Research Results

The study first finds the correlation between macroeconomic variables and volatility measured by India VIX to see if a relationship exists between volatility and these macroeconomic variables. Table 2 shows the correlation of these economic variables with India's VIX, which is a good measure of volatility in the stock market. The data for India VIX was taken from the website investing.com. The data used is from January 2010 to December 2019.

Macroeconomic Variable	Correlation with India VIX
Consumer Price Index (CPI)	.50
Foreign Portfolio Investments (FPI)	-.03
M3 Money Supply (M3)	-0.55
Market PE Ratio (PER)	-0.43

Macroeconomic Variable	Correlation with India VIX
Oil Prices (OP)	0.40
S&P 500 Index (SPX)	-0.57
Ten Year Sovereign Bond Yield (10Y)	0.47
USDINR Exchange Rate (USDINR)	-0.49

Table 2: Correlation of India VIX with various Macroeconomic Variables

According to the table, all variables except FPI have a strong correlation with volatility as measured by the India VIX index. Consequently, we can drop FPI from further analysis.
As a second step, the stationarity of the variables is tested using the ADF test.

Variable	ADF Stat – (Level)	Prob> z (Level)	ADF Stat – (First Diff)	Prob> z (First Diff)
Nifty	-0.11	0.95	-10.00	0.00
VIX	-5.10	0.00	-14.69	0.00
CPI	-2.66	.084	-8.95	0.00
M3	1.00	0.99	-12.25	0.00
PER	-0.81	0.81	-10.46	0.00
OP	-1.49	0.53	-8.09	0.00
SPX	0.56	0.99	-13.25	0.00
10Y	-1.27	.64	-11.04	0.00
USDINR	-1.14	.70	-11.04	0.00

Table 3: ADF Test Stats for Level & First Difference

As the stat shows, only India VIX is stationary at level. However, all variables are stationary at first difference. Thus all further tests will be done using the first differences of these variables, measured as per Table 4.

Variable	Symbol	Monthly Change
Nifty 50 Index	$\Delta\Delta_{Nifty}$	$Nifty_t – Nifty_{t-1}$
India VIX Index	$\Delta\Delta_{VIX}$	$VIX_t – VIX_{t-1}$
CPI Inflation	$\Delta\Delta_{CPI}$	$CPI_t – CPI_{t-1}$
M3 Money Supply	$\Delta\Delta_{M3}$	$M3_t - M3_{t-1}$
Nifty PE Ratio	$\Delta\Delta_{PER}$	$PER_t – PER_{t-1}$
Oil Price	$\Delta\Delta_{OP}$	$OP_t – OP_{t-1}$
S&P 500 Index	$\Delta\Delta_{SPX}$	$SPX_t – SPX_{t-1}$
10 Year Bond Yield	$\Delta\Delta_{10Y}$	$10Y_t - 10Y_{t-1}$
USDINR Exchange Rate	$\Delta\Delta_{USDINR}$	$USDINR_t – USDINR_{t-1}$

Table 4: Method of Measuring First Difference of All Variables

The third step was to form a regression equation of the first difference of volatility and the first difference of seven macroeconomic variables to confirm the relationship between volatility and these seven macroeconomic variables. The regressions equation formed is:

$$\Delta\Delta VIX = m1*\Delta\Delta CPI + m2*\Delta\Delta M3 + m3*\Delta\Delta PER+m4*\Delta\Delta OP+m5*\Delta\Delta SPX+ m6*\Delta\Delta 10Y+ m7*\Delta\Delta USDINR+ c$$

Where $\Delta\Delta$VIX, $\Delta\Delta$M3, $\Delta\Delta$PER, $\Delta\Delta$OP, $\Delta\Delta$SPX, $\Delta\Delta$10Y, $\Delta\Delta$USDINR are the first differences of India VIX and 7 macroeconomic variables; m1 … m7 are coefficients and c is the intercept.
The Adjusted R-square of this equation was found to be 0.141, which is not significant. Thus as per regressions analysis, the macroeconomic variables do not seem to have a significant impact on the volatility. The key statistics of all variables in this regression equation are:

Variable	**Coefficient**	**Std. Error**	**T Stat**	**Prob.**
Intercept	-0.38	.43	-0.88	0.38
$\Delta\Delta_{CPI}$	46.78	34.59	1.35	0.18
$\Delta\Delta_{M3}$	.000178	.0003	.59	0.56
$\Delta\Delta_{PER}$	-.187	.431	-0.433	0.67
$\Delta\Delta_{OP}$	-.0041	.062	-.066	0.95
$\Delta\Delta_{SPX}$	-.0036	.0052	-0.69	0.49
$\Delta\Delta_{10Y}$	-1.10	1.58	-0.70	0.49
$\Delta\Delta_{USDINR}$	0.97	0.26	3.77	0.0003

Table 5: Regression Statistics of the 7 Variables

As per the statistics, we can reject the null hypothesis only for USDINR exchange rate. Hence the only variable with which India VIX may have some dependent relationship is USDINR.

In the third step, the key statistics of the first differences were found for all variables except FPI (FPI flow was dropped earlier as a variable under consideration) to find their suitability for the GARCH models.

Variable	**Mean**	**Max**	**Min**	**Std. Dev.**	**Skew**	**Kurtosis**	**JB Stat**	**Prob**	**Obs**
$\Delta\Delta_{Nifty}$	58.07	831.4	-750.05	324.0	-0.11	2.73	0.60	0.74	120
$\Delta\Delta_{CPI}$	0%	2.2%	-2.9%	0.9%	-0.50	3.72	7.5	0.02	120
$\Delta\Delta_{M3}$	909.94	5,361.07	-3,318.2	1,026	0.689	8.89	182.7	0	120
$\Delta\Delta_{PER}$	0.05	1.56	-2.41	0.86	-0.772	3.12	12.0	0.002	120
$\Delta\Delta_{OP}$	-0.06	10.92	-17.1	5.47	-0.71	3.73	12.8	0.002	120
$\Delta\Delta_{SPX}$	17.63	197.25	-253.32	70.12	-0.77	5.24	37.1	0	120
$\Delta\Delta_{10Y}$	-0.01%	0.73%	-0.64%	0.21%	0.259	3.92	5.59	0.06	120
$\Delta\Delta_{USDINR}$	0.21	4.86	-4.31	1.39	0.089	4.51	11.6	0.003	120

Table 6: Statistical Properties of the First Difference Key Variables

As per the table above, only the first difference of Nifty is normally distributed, and the rest of the variables are not. Hence, the GARCH models can be estimated to model its volatility (Alshogeathri, 2011).

The fourth step is the run the GARCH (1,1) model on the above variables. The result of the GARCH(1,1) model is as follows:

Coefficient	**Mean**
μ	60.23 (.079)
ω	260.67 (0.977)
α	0 (0.99)
β	0.999 (0.00)

Table 7: Coefficients of GARCH(1,1,) Model

Note: Values in bracket show p-value

So the estimated GARCH(1,1) model is

$r(t) \quad = \quad 60.23 + \epsilon(t)$

$\sigma(t)^2 \quad = \quad 260.67 + 0.999*\sigma(t-1)^2$

In the fifth step, we run the GARCH-G(1,1) model using the 7 macroeconomic variables. The resultant equation is given below:

Coefficient	Mean
μ	122.71
ω	159,831.3
α	-.081
β	-0.512
$\lambda\lambda_1$ ($\Delta\Delta_{CPI}$)	8.43E-07
$\lambda\lambda_2$ ($\Delta\Delta_{M3}$)	21.70
$\lambda\lambda_3$ ($\Delta\Delta_{PER}$)	-1968.35
$\lambda\lambda_4$ ($\Delta\Delta_{OP}$)	-302.26
$\lambda\lambda_5$ ($\Delta\Delta_{SPX}$)	-170.0
$\lambda\lambda_6$ ($\Delta\Delta_{10Y}$)	-3.0
$\lambda\lambda_7$ ($\Delta\Delta_{USDINR}$)	-1068.5

Table 8: Coefficients of GARCH-G(1,1,) Model

In this case, both α & β are less than zero, which is unacceptable for the GARCH model. Also, comparing the statistical values of the two models, we get the following:

Criteria	GARCH (1,1)	GARCH-G (1,1)
Log Likelihood	-863.13	-857.52
Akaikes	14.452	14.48
Hannan Quinn	14.49	14.58

Table 9: Comparison of GARCH(1,1) and GARCH-G(1,1)

Here Log-likelihood is lesser for GARCH (1,1), and Akaikes and Hannan Quinn Information criteria are more for GARCH (1,1). All these criteria indicate that GARCH (1,1) model is the better model for modeling volatility in the Indian stock market. In other words, macroeconomic parameters do not have a statistically significant impact on the volatility of the Indian stock market.

V. Findings

We have determined that macroeconomic factors do not impact the volatility of the monthly returns of Nifty50. Not only have we found that the six factors (CPI, M3 Money Supply, Price Earning Ratio of Nifty 50, Oil Price, S&P 500 Index, and 10-year bond yield) have a very weak correlation with the India VIX (volatility index) and only USDINR exchange rate has a statistically significant correlation with the volatility. We also found that these seven factors do not improve the GARCH (1,1) model.

In the regression analysis of India VIX (dependent variable) and seven macroeconomic factors (CPI, M3 Money Supply, Price Earning Ratio of Nifty 50, Oil Price, S&P 500 Index, 10-year bond yield, USDINR exchange rate), it was found that the adjusted R2 is 0.141 which indicates that:

i. The independent variable did not explain the variation in the dependent variables.
ii. T-test was applied to determine which individual coefficient was significant, keeping all the others constant.
iii. After applying the T-Test critical values, along with R(square) and adjusted R, it was found that only USD/INR exchange had a significant value.

The stock market indicates a leaning toward Foreign Institutional Investment (FII) and Foreign Portfolio Investment (FPI), which is why the exchange factor becomes an important factor. Many pension funds from the developed economies invest in India, as they earn a better return, indicating the importance of the USD/INR exchange return.

However, the study doesn't encompass the qualitative macroeconomic variables. These include political stability, investors' confidence, ease of doing business, the bull phase of the market, herd mentality, etc.

The stock market may not truly reflect the important indicators of the economy, like unemployment, inflation, and increasing inequalities of income. There could also be big manipulators in the market whose funds could have a significant influence on the volatility of the market.

VI. Short-Comings of the Study

i. The study only covers ten years of monthly data. A total of 120 observations may be insufficient to make a conclusive case.
ii. There is no comparison set available. A comparative study for different decades may better determine the prominence of variables and GARCH.

iii. The study does not encompass high-frequency data. Daily data might be better suited to study volatility instead of monthly data.

iv. Many macroeconomic variables underwent changes in definitions during the study period. For example, there was a change in the base year in CPI and Wholesale Price Index, which is the basis on which inflation is measured. If the definition is going to change, the comparison will change. For an accurate comparison, definitions need to be the same.

VII. Conclusion

The volatility of the monthly value of Nifty 50 is not influenced by macroeconomic variables and only USDINR exchange rate had statistically significant impact on monthly returns of Nifty 50. However, it may still be worthwhile to repeat the study using daily returns and also using different GARCH models such as GARCH-MIDAS.

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