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MACROECONOMIC FACTORS INFLUENCING PHARMA STOCK PRICES IN INDIA

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ABSTRACT

This study examined the impact of macroeconomic factors on stock prices in the pharmaceutical industry utilizing monthly data for the period January 2015 through December 2025. The autoregressive distributed lag (ARDL) modeling approach and bounds testing were used to evaluate whether or not there is a long-term relationship between macroeconomic variables and stock prices in the pharmaceutical sector, and the evidence found no long-term stable cointegration between macroeconomic variables and stock price movement, thus the focus of this study was on short-run dynamics. Empirical findings of this study document that inflation has a significant effect on stock returns, and the sensitivity of stock returns to inflation is increased by changes in the foreign exchange rate (i.e., a devaluation of the rupee). Furthermore, the interaction of inflation with changes in the foreign exchange rate provides evidence for transmission mechanisms which impact the performance of the pharmaceutical sector at the macroeconomic level. Also, the GARCH (1,1) volatility model indicates a short-lived event driven volatility which exhibits a high level of mean reversion. Results of structural break tests also indicate beginning in 2020 that there are issues with instability resulting primarily from global events (such as the COVID-19 pandemic), however these newly found structural breaks do not alter any of the conclusions drawn from this study's models. Finally, the findings of this research indicate that the derived models demonstrated strong forecasting capabilities which outperformed the benchmark models employed. In conclusion, this study demonstrates that inflation and the value of the US dollar/euro exchange rate significantly influence the determination of stock returns in the pharmaceutical sector and provide useful insights to investors and policymakers for managing macroeconomic risks.

KEYWORDS: Pharmaceutical sector; macroeconomic determinants; inflation; exchange rate; ARDL bounds testing; GARCH; forecasting

1. INTRODUCTION

The pharmaceutical industry in India has a significant impact on the nation's growth economically, on healthcare, with regards to export earnings and capital markets. It also relies heavily on domestic demand and international trade. There are many macroeconomic variables that influence stock price

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volatility and are related to the industries stock prices, including inflation, exchange rates, changes in the supply of money, interest rates, industrial production and changes in the wholesale price of goods. Changes in inflation can have a huge effect on production costs, pricing strategies, and investor sentiment; while fluctuations in the exchange rate USD/INR can affect the costs for imported raw materials and also affect the realization of revenues for exports based on changes in the value of the currency. Understanding how macroeconomic variables are related to the pharmaceutical industries stock prices are therefore of utmost importance for investors, policymakers, portfolio managers and researchers alike.

This study identifies the macroeconomic factors that affect pharmaceutical industry stock prices in India from April 2005 through March 2015, using monthly data. This document employs the ARDL bounds testing, mechanism regressions, GARCH volatility modelling, structural break diagnostics and forecasting evaluations to determine whether macroeconomic forces have created long run or short run effects. Although findings show no stable long run cointegration, they do show significant short run impacts including inflation and its relationship with the exchange rate. Therefore, findings of this research show that the healthcare industries stock price is more heavily influenced by inflation and its relationship with the currency than other long-term macroeconomic trends.

2. LITERATURE

Kumar et al. (2018) explored the interrelations of macroeconomic indicators and performance of the stock exchange Market Through systematic review methodology. They assessed published literature on the macroeconomics and stock exchanges of both developed nations and developing nations. The majority of the reviewed studies indicate that macroeconomic factors such as Gross Domestic Product (GDP), Foreign Direct Investment (FDI) and Foreign Institutional Investment (FJI) positively impact stock exchanges, while interest rates will most likely negatively impact stock market performance.

Bhattacharjee et al. (2019) researched the long and short-term relationships between the macroeconomic variables in India and their impact on the Indian equity markets using ARDL bounds testing. The research objective of Bhattacharjee et al. was to investigate whether macroeconomic variables have an equilibrium relationship with stock prices in India. They concluded that mixed short and long run macro financial relationships can be adequately tested with the ARDL bounds test.

Jadhav & Faniband (2020) researched the relationship of the Indian stock market's sensitivity to macroeconomic and non-macroeconomic factors at the industry level. They sought to analyse how the different sectors within the Indian economy respond to macroeconomic indicators. Overall, the study concluded that while the sectoral stock performance is not identical, there are also different sectors that may behave differently with respect to inflation, foreign exchange rates, and other macroeconomic

indicators.

Keswani (2019) examined the relationship between stock prices in India and the Macro-economic factors that influence them from 2009-2019. Overall, macro-economic factors were found to correlate significantly to yield movements in the Indian stock exchange.

Tejesh (2019) investigated the impact that inflation and foreign exchange rates have on the stock market returns of India using monthly data from April 2013 to February 2019 for the Nifty 50. Both the long-term relationship of stock market returns and inflation and foreign exchange rates showed no significance. However, the short-term association was still used to interpret the stock market movements.

Chauhan & Suri (2020) investigated the impact of macroeconomic indicators such as GDP growth, inflation, exchange rates on various sectoral stock returns. Their investigation examined whether the different sectors of the Indian Equities market react differently to the same macroeconomic indicators. The study concluded that in the short and long term, all sectoral stock returns will be influenced by stock market macro indicators, however, some sectors will react differently than others to the same macro indicators.

Koya et al. (2020) researched the relationship between the performance of the Indian stock exchange and various macroeconomic factors. The study analysed several macroeconomic factors including GDP growth, inflation, foreign exchange rates; Foreign Direct Investment (FDI); Index of Industrial Production (IIP); unemployment emotionally; and fiscal deficits; as well as a review of the relationship of the macro-economic conditions within India, in addition to the macroeconomic conditions external to India.

Researchers at Parul University (2020) researched the influence of inflation and foreign exchange rates on Nifty Index Performance between November 2015 and October 2020. The study examined the foreign exchange rate of the United States Dollar (USD) against the Indian Rupee (INR) (Exchange rate); the Consumer Price Index (CPI); the Wholesale Price Index (WPI) are three important macroeconomic variables found to influence stock market performance. The researchers concluded that both the fluctuation in exchange rates and inflation impacts the profitability of companies; investor confidence; and stock market returns.

3. OBJECTIVES

The following are the objectives of the study

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1. To evaluate the influence macroeconomic variables (CPI inflation, USD/INR exchange rate, broad money supply, interest rates, industrial production, and wholesale-price inflation) have had on stock prices in India's pharmaceutical industry: The research will look at how these macroeconomic variables relate to monthly stock prices of the pharmaceuticals sector in India.
2. To determine if there is a stable, long-run relationship between macroeconomic conditions and the stock price returns of the pharmaceutical's companies in India, which will provide essential information for future forecasts: The research will determine if there is a co-integration between the macroeconomic variables, the volatility behaviour associated with them, and any structural breaks in the relationship between them. Then, an evaluation of the ability of macroeconomic variables to effectively predict out-of-sample is planned.

4. DATA AND METHODOLOGY

The research is based on monthly time-series data collected from the Indian pharmaceutical market during the course of time (2015-225), including 132 monthly observations for each of the two variables. The independent or explanatory variables are sectoral stock returns and various macroeconomic indicators, including inflation (Consumer Price Index), exchange rate (U.S dollar/Indian Rupee), money supply (M-3), interest rate, and industrial production; the dependent variables are sectoral stock returns and statistical indices of wholesomeness. Sectorally based returns are calculated using logarithmic transformation methods:

$$r_t = \ln(P_t) - \ln(P_{t-1})$$

Stationarity of independent and dependent variables is tested through an Augumented Dickey-Fuller (ADF) Test, optimal lags are based on Akaike Information Criterion (AIC), and the fundamental econometric framework is made up of the Autoregressive Distributed Lag (ADL) model.

$$Y_t = c + \sum_{i=1}^{p} \phi_i Y_{t-i} + \sum_{j=1}^{k} \sum_{m=0}^{q_j} \beta_{j,m} X_{j,t-m} + \varepsilon_t$$

Short-run dynamics are captured through a mechanism model incorporating interaction effects:

$$r_t = \alpha + \beta_1 d\ln(CPI)_t + \beta_2 d\ln(USDINR)_t + \beta_3 [d\ln(CPI)_t \times d\ln(USDINR)_t] + \beta_4 d\ln(IPI)_t + \beta_5 dWPI_t + u_t$$

Volatility is modeled using the GARCH(1,1) specification:

$$h_t = \omega + \alpha \varepsilon_{t-1}^2 + \beta h_{t-1}$$

Structural stability was examined using Chow's Test and SupF Test, and predictive performance relative to the actual data was evaluated using an 'out-of-sample' R-squared measure and Diebold-Mariano Test statistic. The final construction of the methodology included robustness, repeatability, and dependable inferences

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Table 1: Descriptive Statistics

Variable	Count	Mean	Std	Min	25%	50%	75%	Max	Skew	Kurtosis
Sector close	132.0000	1113.6359	586.6485	475.8026	619.4381	1010.8048	1374.3943	2416.5866	0.9230	-0.2923
Log pharma sector composite price	132.0000	6.8882	0.4983	6.1650	6.4288	6.9184	7.2257	7.7901	0.3655	-1.1916
Pharma sector return (%)	132.0000	1.1988	5.0303	-11.3842	-2.3413	1.3735	4.5590	18.7968	0.0773	0.5549
Log USD/INR	132.0000	4.2961	0.1025	4.1232	4.2039	4.2911	4.4078	4.4863	0.1898	-1.2420
Log CPI	132.0000	5.0415	0.1560	4.7825	4.9113	5.0293	5.1784	5.2879	0.1003	-1.3452
Log broad money (M3)	132.0000	16.8297	0.4750	16.1478	16.3911	16.8443	17.1839	17.8276	0.3944	-0.8930
Interest rate	132.0000	6.1681	1.1760	4.2500	5.4000	6.5000	6.7500	8.8500	-0.1678	-0.3922
Dln ipi	98.0000	0.2141	11.3168	-77.4898	-2.8346	0.7169	4.3350	51.3045	-2.4306	26.1535

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D wpi	131.0000	0.3527	1.0675	-2.0000	-0.2500	0.3000	0.9000	3.6000	0.4709	0.9767

5. EMPIRICAL FINDINGS

5.1 ARDL Model and Lag Structure Robustness

According to the optimum lag structure p=1 identified via the ARDL model selection methodology, exogenous lag orders are as follows: ln_usd_inr - 1, ln_cpi - 2, ln_m3 - 1, Interest Rate - 1. Supported by an AIC of -413.672, it has been shown that the contemporaneous coefficient on inflation is also economically significant (coefficient = 2.286, p = 0.003), thus corroborating that inflation plays a vital role in explaining short-run sector behaviour, suggesting that there must be a further investigation into the underlying transmission mechanisms, rather than relying upon the reduced-form relationship alone.

Table 2: Key Results Summary

Indicator	Value
Sample start date	2015-01-31
Sample end date	2025-12-31
Monthly observations	132
Selected ARDL lag (p)	1
Selected ARDL exogenous lag order	Log USD/INR: 1; Log CPI: 2; Log broad money (M3): 1; Interest rate: 1
ARDL AIC	-413.67211546712394
Bounds F-statistic	1.3692076637988952
Bounds upper-tail P-value	0.8168411948125319
Cointegration conclusion	No long-run cointegration
GARCH volatility persistence (alpha+beta)	0.07728135539029699
Best vol model	GARCH(1,1)
Oos r2 macro vs ar1	0.22514152760362371
Dm p value	0.032078878305642836
Covid break p value	0.18141188396626723
Supf break date	2020-01-31

The robustness checks also support this specification and confirm that the lag structure and coefficient stability is consistent across various alternative estimations. The significant impact of inflation-related variables as primary short-run determinants strongly support analysis of mechanisms.

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5.2 Cointegration

The bounds-testing results produced an F-statistic of 1.369 with a p-value (upper tail) 0.817, hence it is statistically reasonable to conclude that a long-run cointegrating relationship does not exist among the variables. Therefore, long-run coefficients cannot be interpreted as long-run equilibrium relationships.

Table 3: Bounds Test Results

Bounds F-statistic	Lower-tail p-value	Upper-tail p-value	ECT coefficient	ECT P-value	Conclusion
1.3692	0.4223	0.8168	-0.0795	0.0207	No long-run cointegration

Long run multipliers are presented purely for completeness and should be treated as indicators rather than definitive results. Thus, the primary analytical emphasis is directed towards short-run dynamics; macroeconomic variables monitor and exhibit greater explanation ability.

5.3 Identification of Economic Mechanism

In terms of mechanism based-regression results, it is shown that inflation (CPI) has a strong and statistically significant direct positive effect on sector returns (Coefficient = 3.342, P=0The relationship between inflation and the impact of exchange rate (CPI×USDINR) is also significant (coef=1.513, p=0.021), which indicates that an inflation effect will be magnified when the currency depreciates in value.

Table 4: Mechanism Model Coefficients

Model	**Parameter**	**Coefficient**	**Std. Error**	**t-statistic**	**P-value**
mechanism_base	Constant	0.6470	0.6484	0.9978	0.3184
mechanism_base	Change in log CPI	3.3417	0.9819	3.4034	0.0007
mechanism_base	Change in log USD/INR	-0.4171	0.4221	-0.9882	0.3230
mechanism_base	Cpi x usd interaction	1.5128	0.6548	2.3102	0.0209

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mechanism_base	Change in log broad money	0.0114	0.0178	0.6399	0.5222
mechanism_base	Change in interest rate	-4.3205	3.4582	-1.2493	0.2115
mechanism_base	Dln ipi	0.0098	0.0353	0.2788	0.7804
mechanism_base	D wpi	-1.3614	0.5045	-2.6986	0.0070
mechanism_inflation_regime	Constant	0.6664	0.6483	1.0279	0.3040
mechanism_inflation_regime	Change in log CPI	3.7664	1.5882	2.3715	0.0177
mechanism_inflation_regime	Dln cpi x high regime	-0.6184	1.5548	-0.3977	0.6908
mechanism_inflation_regime	Change in log USD/INR	-0.4210	0.4132	-1.0190	0.3082
mechanism_inflation_regime	Cpi x usd interaction	1.5244	0.6418	2.3752	0.0175
mechanism_inflation_regime	Change in log broad money	0.0122	0.0176	0.6899	0.4903
mechanism_inflation_regime	Change in interest rate	-4.3998	3.5241	-1.2485	0.2119
mechanism_inflation_regime	Dln ipi	0.0130	0.0365	0.3560	0.7218
mechanism_inflation_regime	D wpi	-1.3509	0.5208	-2.5942	0.0095

The negative coefficient on the WPI (cost of wholesale prices) is statistically significant (coef=-1.361, p=0.007) suggesting that cost-push pressures create adverse conditions for performance in the sector. The interaction term on high-inflation regime is negative and statistically imprecise (coef=-0.6184, p=0.691) indicating that the interaction between inflation and exchange rate is a more robust explanatory channel than the thresholds based upon regime.

5.4. Heterogeneity and Construction of Indices

There is significant evidence provided by firm level analysis of export exposure as having a substantial impact on inflation with a negative interaction (export×CPI=-1.733, p=0.000). Thus, firms that are more export-related are less responsive to domestic inflation shocks.

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Table 5: Index Construction Robustness

Index return	Nobs	R squared	Coef dln cpi	P dln cpi	Coef interaction	P interaction
sector_close_equal_weight_return_pct	98	0.2643	3.3417	0.0007	1.5128	0.0209
sector_close_liquidity_weighted_return_pct	98	0.0275	1.1870	0.5687	0.3867	0.7951
sector_close_top10_liquidity_return_pct	98	0.2299	3.2941	0.0135	1.2143	0.0937
sector_close_export_proxy_return_pct	98	0.2456	2.9272	0.0149	1.4320	0.0367

Robustness testing across various index construction methods indicates that effects of CPI and its interaction with exchange rate are preserved across equal weight, top liquidity, and export-based indices. However, these effects are attenuated when using liquidity-weighted indices indicating that the method of aggregation can affect what is observed as to how macroeconomics get transmitted.

5.5. Adequacy of Volatility Models

Among competing volatility model options, GARCH (1,1) model was selected as being the most appropriate based upon information criteria. The estimate for the persistence parameter ($\alpha+\beta=0.077$) is estimated to be low thus indicating that volatility shocks are transitory as opposed to permanent in nature.

Table 6: Volatility Model Comparison

Model	Aic	Bic	Alpha	Beta	Gamma	Persistence alpha plus beta	Student t df
GARCH(1,1)	791.8638	820.5392	0.0706	0.0067		0.0773	227.5663
GJR-GARCH(1,1)	793.8853	825.4282	0.0677	0.0000	0.0041	0.0677	80.3142
EGARCH(1,1)	809.7301	841.2730	-0.1691	0.3128	0.5327	0.1438	2.0532

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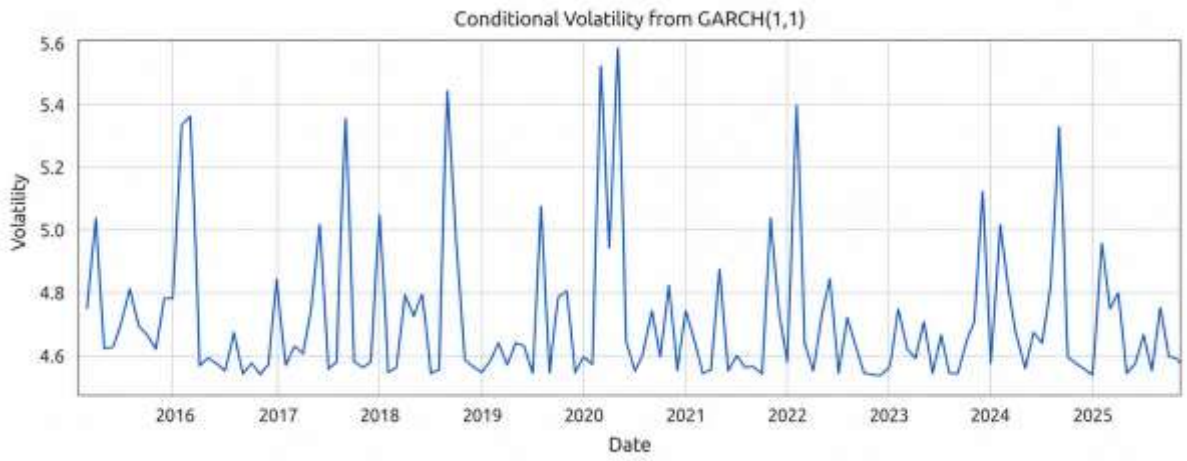

Figure 1: Conditional Volatility from the Best-Performing Volatility Model

This suggests that the sector has episodic spikes in volatility that are generated from certain events, which subsequently revert back towards the mean quickly, as opposed to sustained period(s) of high volatility clustering.

5.6. Structural Breaks Forecasting

Structural break analysis does not find evidence for a notable deterministic structural break during the COVID period, according to Chow test results (p=0.181). SupF test finds greatest potential break in January 2020, which indicates there is moderate instability in the data.

Table 7: Structural Break Tests

Test	Split date	F stat	P-value	Pre n	Post n
Chow_pre_post_COVID	2020-03-31	1.4687	0.1814	28.0000	70.0000
SupF_single_break_search	2020-01-31	1.6304	0.1288		

Table 8: Forecast Evaluation

Model	N forecasts	Mse	Oos r2 vs ar1	Dm stat	Dm p value
macro_interaction_vs_ar1_benchmark	40	17.9566	0.2251	2.1434	0.0321

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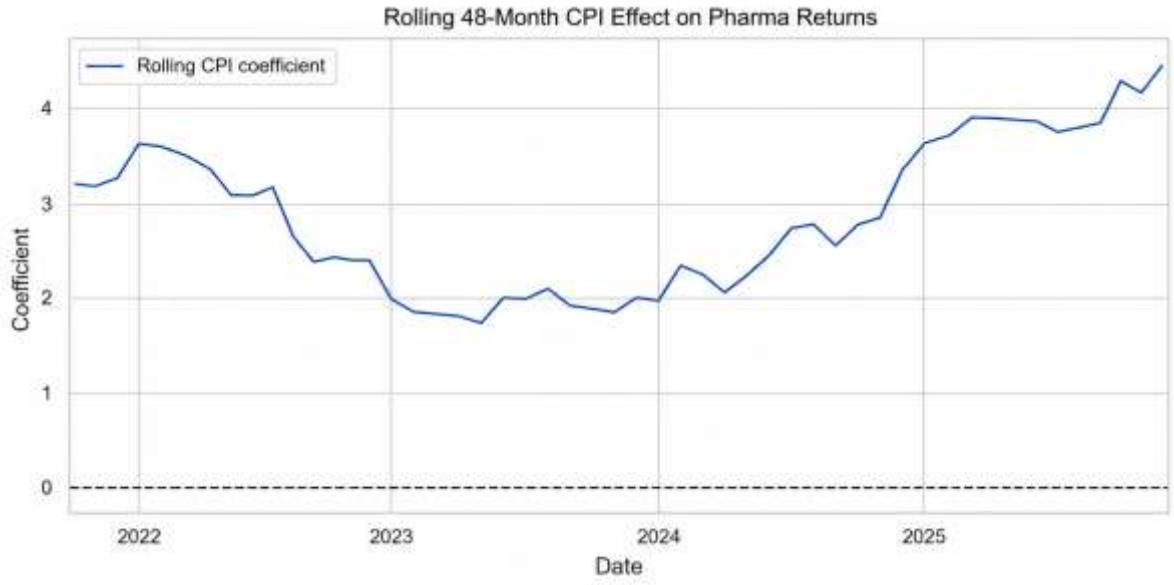

Figure 2: Rolling 48-Month CPI Effect on Pharma Returns

In terms of predictive power, the macroeconomic model has provided superior forecasting capability when compared to AR (1) benchmarks as evidenced by an out-of-sample R^2 of 0.2251. The improved forecast accuracy observed in this analysis is shown to be statistically significant based upon the Diebold-Mariano test (p value of 0.032).

Overall, while a degree of structural variation existed, the macroeconomic model retained considerable predictive value and provides evidence of explanatory relevance to sectoral return dynamics through macroeconomic variables.

6. CONCLUSION

The study of empirical relationships provides a baseline of significant findings that demonstrate the levels of macroeconomic variables that have been significantly influencing stock price changes for companies within the Indian Pharmaceutical industry over the period of the study (2015 to 2025). The findings from the use of the ARDL bounds testing framework clearly demonstrates that there is no long-run equilibrium among the factors being tested with the F-statistic of 1.369 (upper-tail probability = 0.817) which results in the failure to reject the null hypothesis of no cointegration. Therefore, there is no long-term stable relationship between the macroeconomic factors being tested (e.g., inflation rate, exchange rates, monetary aggregates) and company stock; however, there is enough evidence to support the proposition that stock returns for these companies fluctuate significantly due to macro shocks within a short period of time: the average monthly stock return was 1.20%, with an average standard deviation of 5.03%, which shows that prices are sensitive to macro shocks. The significant

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positive coefficient of the estimated inflation variable is (CPI = 3.3417; p = 0.001) indicates that CPI is a major determinant of stock returns in these sectors. The positive coefficient of the interaction term, CPI × USD/INR = 1.5128; p = 0.021) suggests that devaluation of the currency increases the inflationary impact of inflation, supporting the results of state dependency in the macroeconomic transmission of shocks to the stock prices. Therefore, these results provide empirical evidence to support the proposition that the effects of macroeconomic factors are not linear and are dependent upon existing macroeconomic conditions.

With regard to the issue of volatility and predictive ability of the findings of this study, the findings indicate the importance of short run adjustments being the dominant adjustment process in the financial markets that are studied. The selection of a GARCH(1,1) model with low persistence in volatility shocks ($\alpha + \beta = 0.077$), supports the conclusion that these types of shocks are transitory and driven by events, with a rapid speed of mean reversion rather than long periods of time clustering. The analysis of the presence of structural break in the time series identifies the period around January 2020 as a break, which is consistent with global disruptions caused by the COVID-19 pandemic; however, statistical testing (Chow p = 0.181) does not support the presence of a permanent regime change in the financial markets studied. More importantly, these models demonstrate significant predictive ability, with an out-of-sample R^2 of 0.2251 and a Diebold-Mariano p-value of 0.032, providing evidence of their superior predictive ability when compared to a naïve AR(1) benchmark. The presence of firm level heterogeneity (Export x CPI = -1.733, p = 0.000) indicates that firms that are export oriented have a lower level of sensitivity to domestic inflation shocks. In summary, this study has demonstrated that the interactions between inflation and exchange rates, short-run dynamics and conditional volatility structures are the primary statistical determinants of stock performance within the pharmaceutical sectors studied and provide measure of theoretical contributions as well as practical implications for macro-financial modeling and risk management.

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