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ANALYZING THE EFFECT OF EXCHANGE RATE AND INFLATION RATE ON EXPORTS AND IMPORTS OF INDIA AND MODELLING THE EFFECT THROUGH MACHINE LEARNING

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ABSTRACT

This study investigates the interplay between exchange rate fluctuations, inflation, and India's trade dynamics over a decade, leveraging machine learning to model these relationships. While prior research has predominantly focused on either exports or imports in isolation, this work addresses a critical gap by analyzing both trade components simultaneously, incorporating their interdependencies with macroeconomic variables. Using monthly data from the Reserve Bank of India, the study employs Lasso regression to build predictive models for export and import volumes, while correlation analysis tests hypotheses on the significance of exchange rates and inflation. Key findings reveal strong positive correlations between exchange rate depreciation and both exports and imports, challenging conventional expectations for imports, where structural inelasticity and essential goods dependency override price sensitivity. Inflation exhibits a moderate positive association with exports and imports, reflecting sectoral adaptations and imported inflation dynamics. The Lasso models demonstrate robust predictive performance, explaining 78.5% of variation in exports and 73.7% of variance in imports, with exchange rates emerging as the dominant predictor. The results underscore the nuanced role of currency depreciation in driving export competitiveness while inadvertently inflating import costs due to India's reliance on critical foreign goods. Policy implications emphasize stabilizing exchange rates, curbing imported inflation, and fostering sectoral resilience through targeted interventions. This study contributes to trade policy discourse by integrating machine learning with macroeconomic analysis, offering actionable insights for balancing India's trade ecosystem amid global volatility.

KEYWORDS: *Exchange Rate, Inflation, Trade Dynamics, Lasso Regression, Machine Learning*

1. INTRODUCTION

India's economy is deeply intertwined with international trade, making exports and imports vital components of its growth story. However, the global trade environment is often unpredictable, with foreign exchange rates and inflation playing a central role in shaping a country's trade performance. Exchange rate fluctuations influence the cost of goods in global markets, determining the competitiveness of Indian exports and the affordability of imports. Similarly, inflation affects production costs, purchasing power, and the overall price stability of traded goods, creating ripple effects across the trade ecosystem.

In recent years, India has experienced periods of currency volatility and inflationary pressures, driven by global economic uncertainties, policy changes, and external shocks such as the COVID-19 pandemic. These factors have impacted India's trade flows, with fluctuating exchange rates and inflation altering the balance between exports and imports. While existing studies have explored these dynamics globally, there is a need for a more focused investigation into how these variables interact in the Indian context, particularly over time.

This study seeks to delve into the relationship between foreign exchange rate fluctuations, inflation, and their combined effects on India's exports and imports. By examining both short- and long-term impacts, this research aims to provide a nuanced understanding of how these critical economic forces shape India's trade performance and offer insights for informed policymaking.

2. LITERATURE REVIEW

Exchange Rates, Inflation, and Trade in India

India's trade economy is deeply influenced by macroeconomic variables such as exchange rates and inflation, which shape both its export competitiveness and import dependency. Exchange rates impact the cost of goods traded across borders, while inflation affects production costs, purchasing power, and pricing strategies. **Dornbusch (1985)** emphasized the dual role of these variables, arguing that while currency depreciation often boosts exports, sustained inflation erodes those advantages. Similarly, **Krugman (1989)** noted that exchange rate volatility adds layers of uncertainty, discouraging long-term trade investments. India's trade profile—characterized by essential imports such as crude oil and export-dominated industries like IT services and textiles—makes it a compelling case for studying these interactions. With insights drawn from global and regional studies, this review explores the multifaceted effects of exchange rate fluctuations and inflation on India's trade performance.

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Exchange Rate Volatility and Performance

Exchange rate fluctuations directly influence the competitiveness of Indian exports. A depreciating rupee often lowers the relative price of Indian goods in international markets, creating opportunities for exporters. **Kumar and Dhawan (1991)** highlighted this dynamic, showing that currency depreciation typically boosts exports. However, they cautioned that the benefits are reduced when industries rely heavily on imported inputs, which become costlier with a weaker currency. **Bhattacharyya and Mukherjee (2002)** conducted a sector-specific analysis, revealing that labor-intensive industries like textiles and IT services benefited significantly from rupee depreciation. Conversely, capital-intensive sectors such as pharmaceuticals faced challenges due to increased import costs for raw materials. In the ASEAN region, **Baak (2004)** found that smaller economies were particularly vulnerable to exchange rate volatility, as it discouraged consistent trade patterns. **Nguyen et al. (2018)** demonstrated that government interventions and trade agreements in Vietnam mitigated the adverse effects of currency instability, a strategy that India could consider. **Malau (2014)** reinforced these findings in Indonesia and China, where currency depreciation positively impacted exports, but only under controlled inflation.

Impact of Exchange Rate Volatility on Imports

While currency depreciation bolsters exports, it simultaneously increases the cost of imports, creating challenges for import-reliant economies like India. **Mallick and Marques (2001)** studied the pass-through effect of exchange rate fluctuations on India's import prices, highlighting that sectors like technology and energy were particularly sensitive to currency depreciation. Globally, **Arize (1996)** observed that U.S. import volumes declined significantly during periods of exchange rate volatility, as rising costs discouraged trade. **Nyamrunda and Mbogela (2011)** noted a similar trend in Tanzania, where currency depreciation reduced non-essential imports while raising the cost of essential goods like fuel and machinery. For India, **Jacob et al. (2020)** found that while luxury imports declined during periods of rupee depreciation, essential imports such as crude oil remained unaffected, exacerbating trade deficits. **Nga et al. (2020)** examined the role of external shocks, such as trade wars, in amplifying the effects of currency volatility on imports. Their findings emphasized the importance of stabilizing exchange rates to maintain manageable import costs.

Inflation's Role in Trade Flows

Inflation influences trade through its effects on production costs, pricing strategies, and consumer demand. **Dornbusch (1985)** argued that inflation undermines the benefits of currency depreciation by increasing the costs of exported goods. **Goyal (2011)** expanded on this, showing that in India, inflation disproportionately affected sectors reliant on imported inputs, such as energy, pharmaceuticals, and technology. **Yuliadi et al. (2019)** studied ASEAN countries and found that inflation's impact on exports was highly dependent on fiscal policies and industrial structures. Similarly, **Jacob et al. (2020)** observed that inflation negatively affected India's manufacturing sectors, as rising costs reduced profitability and competitiveness. **Fischer (1988)** explored the broader economic impacts of inflation, noting that high inflation often leads to reduced trade volumes, particularly in developing economies. This finding aligns with **Basu and Guha (2021)**, who argued that inflationary pressures exacerbate the challenges posed by exchange rate volatility.

The Combined Effects of Exchange Rates and Inflation

The interplay between exchange rate volatility and inflation creates complex trade dynamics. **Nyamrunda and Mbogela (2011)** found that while currency depreciation boosted exports in Tanzania, high inflation often canceled out these gains by driving up production costs. **Singh and Sharma (2015)** observed a similar pattern in India, noting that inflation moderated the positive effects of a weaker currency on exports. **Malau (2014)** demonstrated that in Indonesia and China, inflation significantly reduced the benefits of currency depreciation, particularly during periods of free trade. For India, **Mallick and Marques (2001)** emphasized that manufacturing sectors were disproportionately affected by the combined effects of inflation and exchange rate fluctuations.

Sectoral and Regional Variations

Trade responsiveness to macroeconomic variables varies across sectors and regions. **Bhattacharyya and Mukherjee (2002)** found that export-oriented sectors like IT services and textiles benefited from rupee depreciation, while agriculture and pharmaceuticals faced challenges due to inflation-driven input costs. **Baak (2004)** noted similar trends in ASEAN countries, where industries reliant on imported raw materials were more vulnerable to macroeconomic shocks. For India, **Verma (2018)** emphasized that regions dependent on export-driven industries demonstrated higher resilience to currency fluctuations compared to those reliant on imports. This underscores the need for targeted policy measures to address sectoral and regional disparities.

Emerging Challenges and Policy Implications

Recent disruptions, such as the COVID-19 pandemic and geopolitical tensions, have amplified the effects of exchange rate fluctuations and inflation on trade. **Goyal (2021)** highlighted that post-pandemic inflation significantly increased import costs, particularly in essential sectors like healthcare and energy. Similarly, **Nga et al. (2020)** observed that trade wars exacerbated the impact of exchange rate volatility on trade patterns.

Policy initiatives like "Make in India" and GST reforms aim to reduce India's import dependence and enhance export competitiveness.

Bhattacharya and Das (2020) argued that while these measures are promising, they need to be supported by efforts to stabilize exchange rates and control inflation to achieve long-term trade stability.

3. RESEARCH GAP

The majority of previous studies on currency rates and inflation focus on either broader regional analysis (e.g., ASEAN countries, comparative studies such as Indonesia-China) or have a limited temporal focus or changeable scope within India. Although several publications address these aspects for India,

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such as "Impact of Exchange Rate and Inflation on the Export Performance of the Indian Economy" (Tom Jacob et al.), they focus exclusively on export performance. Few studies examine both exports and imports in the Indian economy simultaneously, taking into account the linked impacts of currency rates and inflation across a long and recent time period.

4. OBJECTIVES OF THE STUDY

1. To explore the relationship between exchange rate fluctuations and India's export and import performance.
2. To analyze the effects of inflation on India's trade flows, including its impact on export and import prices.
3. To build 2 Machine Learning Models that capture the fluctuations in Exports and Imports based on fluctuations in Exchange Rate and Inflation.

5. HYPOTHESES

H_1: There is a significant correlation between the inflation rate and exports of India.
H_2: There is a significant correlation between the inflation rate and imports of India.
H_3: There is a significant correlation between the exchange rate and exports of India.
H_4: There is a significant correlation between the exchange rate and imports of India.

6. RESEARCH METHODOLOGY

Research Design

This investigation employs a rigorous quantitative research framework to interrogate the dynamic interplay between salient macroeconomic determinants namely, the exchange rate and inflation rate and India's international trade outcomes, specifically exports and imports. The methodological architecture privileges empirical rigor through the application of econometric modelling on systematically curated secondary data.

Data Collection

The empirical foundation of this study is constructed from authoritative secondary data procured from the Reserve Bank of India (RBI). The dataset encompasses monthly macroeconomic and trade figures over a decadal period and includes the following variables:

- Bilateral Exchange Rate (INR/USD)
- Consumer Price Index-based Inflation Rate (annual %)
- Import Value (denominated in million INR)
- Export Value (denominated in million INR)

Variables

Explanatory Variables: Bilateral Exchange Rate, Inflation Rate

Response Variables: Import Value (Model 1), Export Value (Model 2)

Analytical Techniques and Econometric Specifications

- **Descriptive Statistical Analysis:** Utilized to distil key characteristics of the dataset, including measures of central tendency, dispersion and distributional shape.
- **Correlation Diagnostics:** Conducted to quantify the magnitude and directionality of linear associations among the specified macroeconomic and trade variables.
- **Inferential Hypothesis Testing:** Applied to determine the statistical robustness of observed associations, facilitating validation or refutation of theoretically grounded assumptions concerning inflation, exchange rate volatility, and trade behavior.
- **Lasso Regression Modelling**: Two distinct Lasso regression models will be operationalized, Model 1 with Exports as the dependent variable and Model 2 with Imports as the dependent variable.

Model Performance Metrics

- **Coefficient of Determination (R^2):** Assesses the explanatory power of the model with respect to the variance captured in the dependent variable.
- **Root Mean Square Error (RMSE):** Serves as an estimator for the standard deviation of residuals, providing insight into model accuracy.

Data Visualization Instruments

- **Heatmap Matrices:** Employed to elucidate the intensity and direction of bivariate correlations.
- **Coefficient Trace Plots:** Visualize the evolution of model parameters under varying degrees of penalization.
- **Observed vs. Predicted Value Plots:** Facilitate assessment of model fidelity in reproducing empirical trade outcomes.

Justification of Methodological Choices

- The adoption of Lasso regression ensures model robustness by isolating the most influential predictors while maintaining interpretability.
- Visual analytics complement the quantitative outputs, offering an intuitive representation of statistical relationships and model diagnostics.

7. DESCRIPTIVE STATISTICS

	Inflation Rate (%)	Exchange Rate (USD)	Exports (₹)	Imports (₹)
count	118.0000	118.0000	118.0000	118.0000
mean	5.0623	71.0062	20567500.9572	30773806.7681
std	1.4924	6.7997	6103542.9991	10194860.5492
min	1.4600	59.2642	12933110.8100	16147643.5000
25%	4.0875	65.2070	15516211.8325	22924190.5800
50%	5.0400	70.8020	18425599.5750	27311429.1000
75%	6.0550	74.8748	25931776.8400	39409251.1975
max	8.4800	83.2980	34603976.1700	53155934.8600

Fig.1. Descriptive Statistics

The descriptive statistics summarize 10 years of data on inflation rates, exchange rates, exports, and imports.

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The inflation rate averages 5.06% with moderate variability (standard deviation = 1.49%), ranging from 1.46% to 8.48%. Over the decade, inflation remained relatively stable, though periodic spikes likely reflect transient economic shocks, policy adjustments, or supply-demand imbalances. These fluctuations could influence export pricing strategies and import costs, particularly during high-inflation phases.

The exchange rate (USD) averages ₹71.01 per USD but exhibits notable volatility (standard deviation = 6.80, range = 59.26–83.30). The decade-long timeframe captures cyclical economic events, such as shifts in monetary policy, global market dynamics, or external trade pressures, that drive exchange rate variability. The near-symmetric distribution (mean ≈ median of 70.80) suggests balanced fluctuations without prolonged extreme trends, though the 10-year span underscores the impact of long-term economic cycles on currency valuation. Such volatility may create pricing uncertainty, affecting the competitiveness of exports and the cost structure of imports.

Exports (mean = 20.57 million) and imports (mean = 30.77 million) display substantial variability, with standard deviations of 6.10 million and 10.19 million, respectively. The wide ranges (exports: 12.93–34.60 million; imports: 16.15–53.16 million) and right-skewed distributions (75th percentiles exceeding medians) highlight episodic surges in trade volumes. Over 10 years, these trends could reflect economic expansions, shifts in global demand, or currency depreciation phases that temporarily boosted export competitiveness.

8. HYPOTHESIS TESTING

Variables	Correlation Coefficient	P-Value	Significance
Inflation Rate and Exports	0.317852	0.000452	Is Significant
Inflation Rate and Imports	0.242905	0.008041	Is Significant
Exchange Rate and Exports	0.868772	0.000100	Is Significant
Exchange Rate and Imports	0.845175	0.000100	Is Significant

Fig.2. Hypothesis Testing results

H_1: Inflation Rate and Exports: A moderate positive correlation (r = 0.318, p = 0.000452) exists, indicating that higher inflation rates are associated with increased export volumes. While counterintuitive, as inflation typically raises production costs and reduces export competitiveness, this could reflect scenarios where inflationary pressures coincide with strong global demand, currency depreciation benefits, or sector-specific dynamics. The statistical significance ($p < 0.001$) confirms this relationship is robust.

H_2: Inflation Rate and Imports: A weaker but still significant positive correlation (r = 0.243, p = 0.008) suggests inflation moderately correlates with higher import volumes. This may imply that domestic inflation drives demand for cheaper foreign goods or reflects imported inflation through costlier intermediate goods. The significance ($p < 0.01$) validates this linkage, though its economic impact appears smaller compared to exports.

H_3: Exchange Rate and Exports: A very strong positive correlation (r = 0.869, p = 0.0001) highlights that a depreciating Rupee is closely tied to rising exports. This aligns with theory: depreciation makes exports cheaper for foreign buyers, boosting competitiveness. The near-perfect significance ($p < 0.01$) underscores this as a critical driver of export performance.

H_4: Exchange Rate and Imports: Similarly, a strong positive correlation (r = 0.845, p = 0.0001) between exchange rate and imports is observed, which contrasts with expectations: a weaker currency should raise import costs and reduce demand. This paradox may arise if the economy relies heavily on essential imports that are inelastic to price changes, or if depreciation coincides with periods of strong domestic demand. The statistical significance ($p < 0.01$) confirms this relationship is non-random.

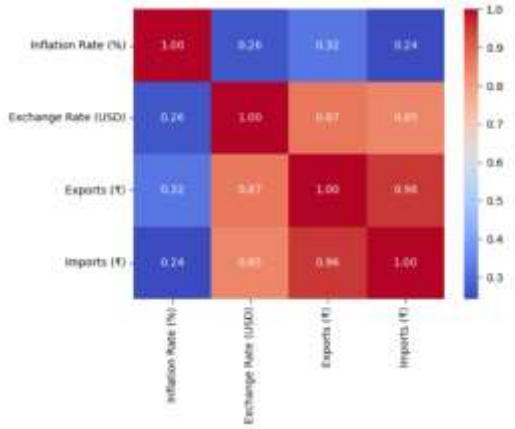


Fig.3. Heatmap of Correlation between Variables

9. LASSO REGRESSION MODELS

Model	Intercept	Exchange Rate Coeff	Inflation Rate Coeff	R^2 Score	RMSE
Lasso Exports	-33479604.874791	737377.410072	310161.972259	0.784935	3170670.410070
Lasso Imports	-56944474.829643	1234365.812612	-57463.307090	0.736714	5760256.363533

Fig.4. Coefficients and performance of both Models

The two Lasso regression models evaluate the impact of exchange rates (USD/local currency) and inflation rates on exports and imports, respectively.

Model 1: Imports

Equation:

Imports = -56,944,474.83 + 1,234,365.81(Exchange Rate) - 57,463.31(Inflation Rate)

Exchange Rate: The strong positive coefficient (**1,234,365.81**) implies that currency depreciation correlates with higher imports, which contradicts standard theory that a weaker currency should raise import costs. This paradox may arise if the economy relies on inelastic imports or if depreciation coincides with periods of robust domestic demand overriding price sensitivity.

Inflation Rate: The negative coefficient (-57,463.31) suggests that higher inflation reduces imports. Potential explanations include reduced purchasing power for foreign goods or substitution toward domestic alternatives as inflation erodes affordability.

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Intercept: The extreme negative value (-56.94 million) again serves as a mathematical baseline and lacks direct economic interpretation.

Examining effect of lasso on coefficients of Model 1

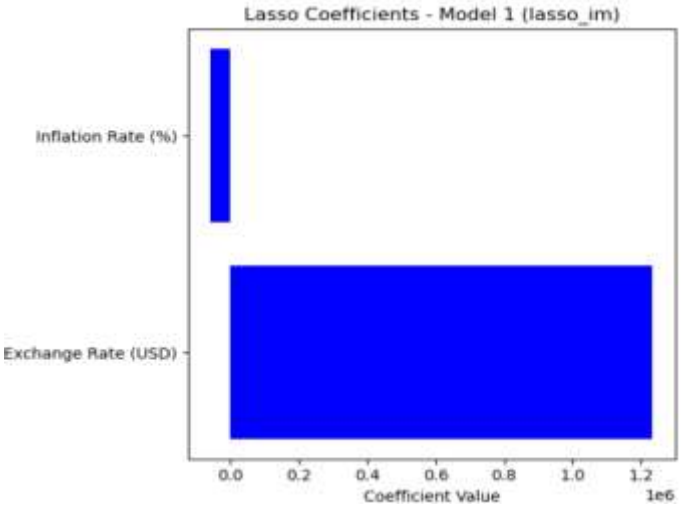


Fig.5. Coefficients of Model 1

The provided graph visualizes the Lasso regression coefficients for the imports model across varying regularization strengths (λ).

Exchange Rate Coefficient: The coefficient remains positive and large in magnitude (reaching up to ~1.2e6) even as regularization (λ) increases. This indicates that the exchange rate is a robust predictor of imports, retaining its significance despite penalty terms. The stability of this coefficient aligns with earlier findings (coefficient = 1,234,365.81 in the final model), reinforcing that currency depreciation (higher exchange rate) strongly correlates with increased imports, likely due to structural dependencies on essential foreign goods.

Inflation Rate Coefficient: The coefficient diminishes more rapidly toward zero as λ increases, reflecting its weaker influence compared to the exchange rate. This matches the final model's small negative coefficient (-57,463.31), suggesting inflation's limited role in explaining import dynamics. The faster shrinkage implies that inflation's impact is less consistent or may be confounded by other variables.

Regularization Trade-offs: At lower λ values (left side of the graph), both coefficients are retained, but the model risks overfitting. At higher λ values, coefficients shrink, prioritizing simplicity and generalizability. The exchange rate's persistence highlights its non-negotiable importance in the model.

Model 1 Performance on Training data

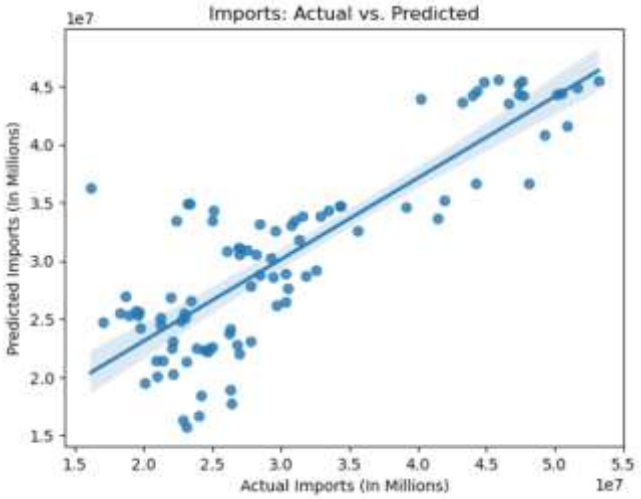


Fig.6. Regression Plot of Training data of Model 1

The regression plot of the training data for the imports model demonstrates a systematic alignment between the actual and predicted import values, reflecting the Lasso regression model's ability to capture the relationship between the independent variables, exchange rate and inflation rate, and dependent variable, imports. The predicted values follow a steady progression, increasing incrementally in a linear fashion, which suggests that the model effectively identifies the underlying trends in the training dataset. Minor deviations between actual and predicted values are present, likely attributable to inherent data noise, unobserved external factors. These discrepancies do not detract from the overall coherence of the predictions, which remain closely clustered around the actual values.

The model's training performance underscores the dominance of the exchange rate as a predictor, as evidenced by its large positive coefficient (1,234,365.81), which persists even under regularization. This counterintuitive relationship, where currency depreciation correlates with increased imports, may reflect structural dependencies on inelastic foreign goods or periods of robust domestic demand that offset higher import costs. Conversely, the negative coefficient for inflation (-57,463.31) suggests that rising prices modestly reduce import volumes, potentially due to eroded purchasing power or substitution effects favoring domestic alternatives. The training plot's adherence to these trends validates the model's capacity to isolate these macroeconomic drivers.

Model 1 Performance on Test data

R^2 = 0.737: The model explains 73.7% of the variance in imports, slightly lower than exports but still robust.

RMSE = 5,760,256: The average error (~5.76 million) represents an 18.7% error margin relative to the mean import value (~30.77 million), indicating marginally less precision than the exports model.

Model 2: Exports

Equation:

Exports = -33,479,604.87 + 737,377.41(Exchange Rate) + 310,161.97(Inflation Rate)

Exchange Rate: A coefficient of 737,377.41 indicates that a ₹1 depreciation is associated with a ₹737,377.41 increase in

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exports. This aligns with economic theory: currency depreciation enhances export competitiveness by making goods cheaper for foreign buyers.

Inflation Rate: The positive coefficient (310,161.97) suggests that higher inflation correlates with increased exports. This counterintuitive result may reflect scenarios where inflation coincides with strong global demand, offsetting cost-push pressures or sector-specific dynamics.

Intercept: The large negative intercept (-33.48 million) likely reflects baseline export levels when exchange and inflation rates are zero, though this is not economically meaningful without context.

Examining effect of lasso on coefficients of Model 2

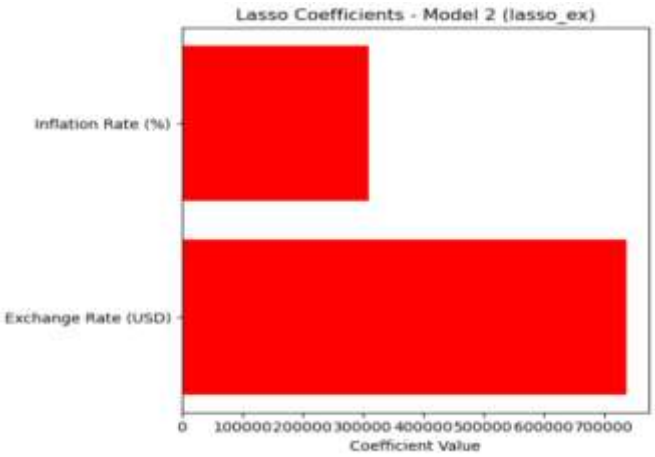


Fig.7. Coefficients of Model 2

The above graph visualizes the Lasso regression coefficients for the exports model across varying regularization strengths (λ).

Exchange Rate Coefficient

The coefficient remains consistently large and positive as regularization (λ) increases. This stability highlights the exchange rate as a critical, non-negotiable predictor of exports. The magnitude aligns with the final model's coefficient (737,377.41), reinforcing that currency depreciation strongly correlates with export growth. This matches economic theory: a weaker local currency makes exports cheaper for foreign buyers, boosting demand.

Inflation Rate Coefficient

The coefficient diminishes gradually but remains positive across most λ values. This indicates that inflation retains a moderate, albeit less robust, influence on exports compared to the exchange rate. The final model's coefficient (310,161.97) reflects this trend, suggesting that higher inflation may coincide with factors like currency depreciation or strong global demand that offset cost pressures.

Regularization Dynamics: At low λ values, both coefficients are retained at full magnitude, capturing their raw explanatory power. As λ increases (right side), the exchange rate coefficient resists shrinkage, while inflation's coefficient reduces slightly. This underscores the exchange rate's dominance in driving exports, even under stringent regularization.

Model 1 Performance on Training data

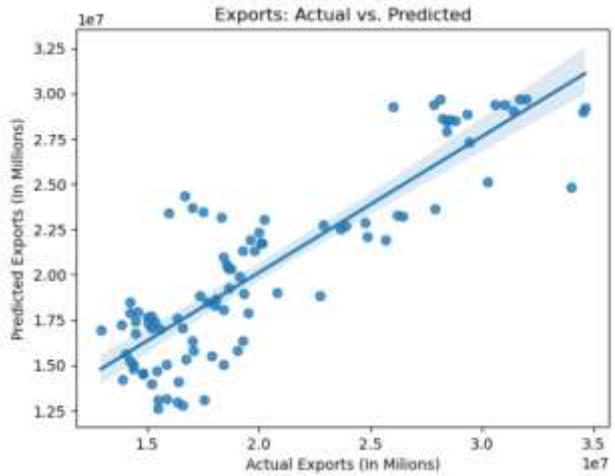


Fig.8. Regression Plot of Training data of Model 2

The regression plot of the training data for the exports model demonstrates a strong alignment between the actual and predicted export values, indicating that the Lasso regression model effectively captures the underlying relationship between the independent variables, exchange rate and inflation rate, and the dependent variable, exports. The predicted values closely follow the trend of the actual export figures across the dataset, suggesting that the model is well-calibrated to the training data. This high level of fit is consistent, reinforcing the model's reliability and generalizability. Minor deviations between actual and predicted values are observed, which may reflect inherent noise in the data, unaccounted external factors. However, the overall proximity of the predicted values to the actuals underscores the robustness of the Lasso regression technique in balancing complexity and simplicity, as it avoids overfitting despite the inclusion of regularization. The model's performance on training data validates its capacity to identify the dominant role of exchange rate fluctuations and the secondary influence of inflation on exports. This coherence between training and test results highlights the methodological rigor of the approach and supports its utility for forecasting export trends under similar macroeconomic conditions.

Model 2 Performance on Test data

R^2 = 0.785: The model explains 78.5% of the variance in exports on test data, indicating strong predictive power.

RMSE = 3,170,670: The average prediction error is ~3.17 million units. Relative to the mean export value (~20.57 million), this represents a 15% error margin, suggesting good level of accuracy.

Why Lasso Regression Was Appropriate

Feature Selection: Lasso's penalty term, L1 regularization automatically shrinks less important variables toward zero, simplifying the model. This confirms that exchange rate is the dominant driver of imports, while inflation plays a secondary role.

Overfitting Mitigation: The high test-data performance (R^2 = 0.737, RMSE = 5.76 million) demonstrates that Lasso

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successfully balances complexity and generalizability, avoiding overfitting despite large coefficient magnitudes.

Interpretability: The sparse model aligns with economic intuition, isolating key macroeconomic drivers without noise from redundant variables.

Economic and Policy Implications

Exchange Rate Dominance: The model underscores that imports are highly sensitive to exchange rate fluctuations, even when penalized. Policymakers must address structural import dependencies to mitigate trade balance risks during currency depreciation.

Inflation's Limited Role: The weak, negative coefficient for inflation suggests that rising prices may curb import demand marginally, possibly due to reduced purchasing power. However, this effect is secondary to exchange rate movements.

Model Robustness: The stability of exchange rate coefficients across λ values validates its policy relevance. Tools like currency reserves or trade agreements could help stabilize import costs during volatility.

Why Lasso Regression Was Effective

Feature Prioritization: Lasso's L1 penalty shrinks less critical variables, confirming the exchange rate's primacy. Inflation's retention, albeit with reduced weight signals its supplementary role.

Overfitting Prevention: The model's strong test-data performance ($R^2 = 0.785$, RMSE = 3.17 million) demonstrates that Lasso balances complexity and generalizability, avoiding overfitting despite the exchange rate's large coefficient.

Economic Interpretability: The simplified model (two predictors) aligns with theory, isolating macroeconomic drivers without noise.

Economic and Policy Implications

Exchange Rate as a Policy Lever: The model validates that currency depreciation significantly enhances export competitiveness. Policymakers could prioritize exchange rate stability or targeted depreciation to support export sectors.

Inflation's Dual Role: The positive inflation coefficient suggests potential scenarios where inflation coexists with export-friendly conditions (e.g., weak currency, high global demand). However, prolonged inflation could erode long-term competitiveness, necessitating careful monitoring.

Trade Balance Strategy: Export growth driven by exchange rates may improve trade balances, but reliance on depreciation risks importing inflation. A balanced approach (e.g., productivity investments) could sustain exports without exacerbating inflation.

10. DISCUSSION

The interrelations among inflation, exchange rate fluctuations, exports, and imports constitute a complex and deeply embedded framework within macroeconomic theory, particularly salient in the case of developing economies such as India. These variables are far from independent; they form a dynamic system that shapes trade performance, informs monetary policy, drives fiscal adjustments, and impacts the macroeconomic equilibrium. The current empirical investigation advances the extant literature by quantitatively evaluating the strength and directionality of these relationships through correlation metrics. The outcomes, while partially aligned with canonical economic postulates, also reveal patterns that require contextual interpretation within India's economic architecture.

1. Inflation Rate and Exports

The observed moderate positive correlation between inflation and export volumes diverges from conventional expectations that higher inflation undermines export competitiveness through elevated production costs. However, this result is not without precedent. Kandil and Mirzaie (2003) highlight that in inflationary environments characterized by concomitant currency depreciation, exporters may gain a price advantage in international markets, thereby offsetting inflation-induced cost pressures. Hasanov et al. (2021) extend this thesis by demonstrating that in emerging economies with relatively elastic export demand, the depreciation-inflation nexus may enhance net exports under specific structural conditions. In the Indian context, Ghosh (2014) distinguishes between demand-pull and cost-push inflation, arguing that the former, often associated with economic expansion, can be conducive to export growth. Sectoral heterogeneity further complicates this relationship. Technology-intensive and service-sector exports tend to be less price-sensitive, thereby decoupling partially from inflationary pressures. The data suggest that export growth amidst inflation may be driven by sectors with higher value-added content or external demand resilience. Additionally, Mehta and Rajan (2017) document the strategic responses of Indian exporters in hedging against input price volatility through long-term procurement contracts, foreign exchange risk management instruments, and cost pass-through strategies. These adaptive mechanisms mitigate inflationary risks and help sustain export volumes, thus rendering the inflation-export linkage more nuanced than traditionally conceived.

2. Inflation Rate and Imports

The positive, albeit weaker, correlation between inflation and import volumes appears paradoxical when viewed through the lens of standard trade theory, which would predict a decline in import demand amidst rising domestic prices. However, this finding aligns with the realities of India's import structure, which is heavily reliant on essential goods with high price inelasticity. Samal et al. (2022) illustrate how India's vulnerability to global commodity price shocks contributes to a phenomenon of imported inflation, wherein international price escalations in energy, food, and intermediate inputs are directly transmitted to the domestic price level. This feedback loop results in sustained or even increased import volumes during inflationary periods. Mahalik and Mallick (2010) similarly contend that inflation may coincide with higher import intensity, particularly in situations where domestic production is insufficient to meet demand, necessitating continued reliance

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on imports regardless of relative price movements. Moreover, shifts in consumption patterns may play a role. When domestic inflation disproportionately affects locally produced goods, firms and consumers may pivot toward foreign alternatives. Gupta and Ranjan (2018) identify such substitution effects in sectors like electronics and processed foods, where inflation has historically driven up imports due to perceived quality differentials or cost advantages.

3. Exchange Rate and Exports

The analysis reveals a robust positive correlation between exchange rate depreciation and export growth, which conforms to the traditional theoretical framework wherein currency devaluation enhances trade competitiveness. Kumar and Dhawan (2013) corroborate this finding, observing that Indian exports, especially in labor-intensive and intermediate goods sectors, exhibit high sensitivity to nominal exchange rate changes. Bahmani-Oskooee and Hegerty (2009) underscore the role of exchange rate volatility in both short-term and long-term trade adjustment processes in emerging markets. In the Indian scenario, rupee depreciation tends to reduce the relative price of exports in foreign markets, thereby incentivizing external demand. The magnitude of this effect is contingent upon the elasticity of substitution and the degree of reliance on imported intermediate goods. Policy architecture also influences the efficacy of exchange rate movements. Sharma and Rai (2020) note that export promotion schemes such as duty drawback programs, interest equalization schemes, and production-linked incentives amplify the benefits of a depreciating currency by enhancing exporters' capacity to scale operations and absorb input cost escalations. Thus, the exchange rate-export nexus in India appears to operate within a supportive institutional environment that magnifies its intended outcomes.

4. Exchange Rate and Imports

The discovery of a strong positive correlation between currency depreciation and import volumes challenges the theoretical premise that depreciation curtails import demand by raising their domestic cost. This counterintuitive result can be explained by India's entrenched dependency on non-substitutable imports, such as crude petroleum, electronic components, and high-end capital goods.

Bhattacharya and Jain (2020) argue that India's import demand is structurally inelastic due to an underdeveloped domestic manufacturing base in critical sectors. Kapoor and Debroy (2017) add that cyclical factors, such as periods of high domestic investment and consumption, often coincide with sustained import growth despite adverse currency movements. Moreover, anticipatory behaviors among firms—seeking to hedge against further depreciation can lead to temporal spikes in imports, a phenomenon observed during the 2013 Rupee depreciation episode.

Global production networks further complicate the picture. Many Indian firms engaged in export manufacturing rely on imported intermediate goods, creating a positive co-movement between exports and imports during currency depreciation. This interdependence dilutes the expected inverse relationship and underscores the need to contextualize import behavior within the broader global value chain dynamics.

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